

# Atlas of Dentistry in Cats and Dogs

Markus Eickhoff











# **Atlas of Dentistry in Cats and Dogs**

Markus Eickhoff

Translated by Karen Leube

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Dr. med. vet. Markus **Eickhoff**  
Tierärztliche Praxis für Zahn-,  
Mund- und Kieferheilkunde  
Iptinger Str. 48  
71287 Weissach  
Germany

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## Preface

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After over 20 years of veterinary medical practice, I feel that the only way to share helpful insights about diagnosing and treating conditions in the oral cavity is with images. Owners are not usually the proper audience for sharing images that can contain graphic details; on the other hand, veterinarians can learn the proper procedure for treating individual conditions through these images and image series.

Dentistry requires the use of diverse medical devices and instruments, and dentists must be prepared to offer a wide range of options to meet the specific requirements comprising highly variable parameters and conditions with suitable equipment. They also need the proper expertise in dental procedures, which extends far beyond the normal range required for a general practitioner. Thus, dentistry in human medicine has become a medical discipline in its own right. In veterinary medi-

cine, however, such a development is unlikely, so appropriate dental treatment for cats and dogs will remain in the domain of veterinarians, who have to become specialized. This book does not aim to enable all veterinarians to treat all dental conditions, but rather to acquaint them with the problems and possible treatments. This in turn can permit veterinarians to offer the proper treatment or refer the client to a specialist; this approach can prevent years of suffering and pain and initiate a healing process.

Although dealing with fractures, bleeding and pain can be stressful for the veterinary dentist, it brightens the future for many animals.

Weissach, Spring 2017

**Markus Eickhoff**

*Most importantly, this book is dedicated to  
my wife Sandra and my children Dana and Jared,  
who were so patient with me while I wrote this book.  
I am grateful to you.*

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## Author's Introduction

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Dr. Markus Eickhoff is a fully qualified dentist and veterinarian. He has practiced veterinary dentistry in his own practice since 2002. Dr. Eickhoff served as president of the German Veterinary Dentistry Society from 2007 to 2010 and has written a number of books on veterinary dentistry.



## Part 1 Fundamentals

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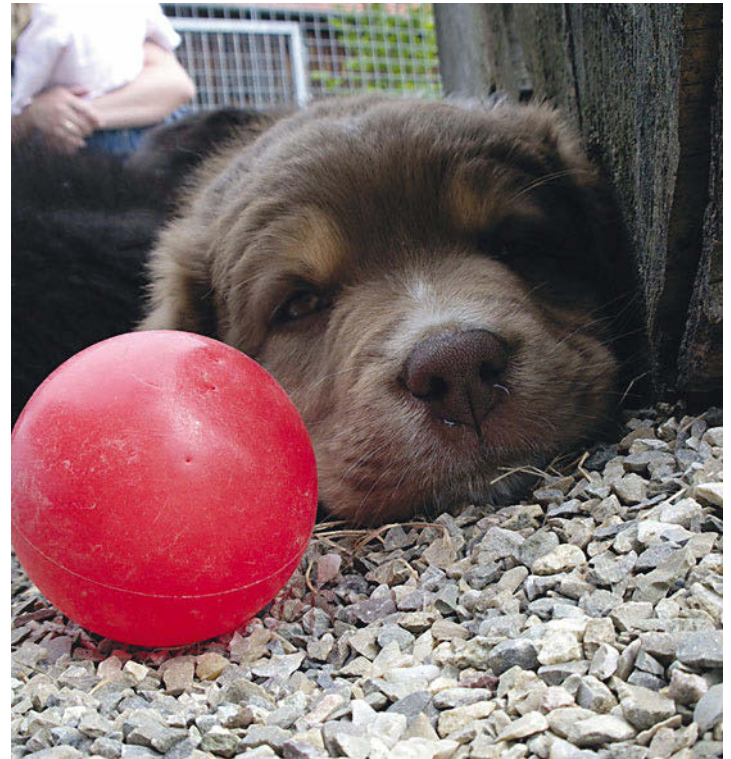
# 1 Patient History

When examining the oral cavity of an uncooperative animal, the veterinarian generally has to work quickly. Before the actual examination, the veterinarian must pay careful attention while taking the history in order to pinpoint the region of focus. Dental issues in adult dogs can originate when they are young (► Fig. 1.1). When puppies bite each other while tussling, for example, their very sharp deciduous canine teeth can cause problems in later dental development that are not apparent until their permanent teeth erupt.



► **Fig. 1.1 Puppies tussling.** Puppies' tussling is sometimes so aggressive that it leads to injuries of the deciduous teeth or the dental follicles of the permanent teeth.

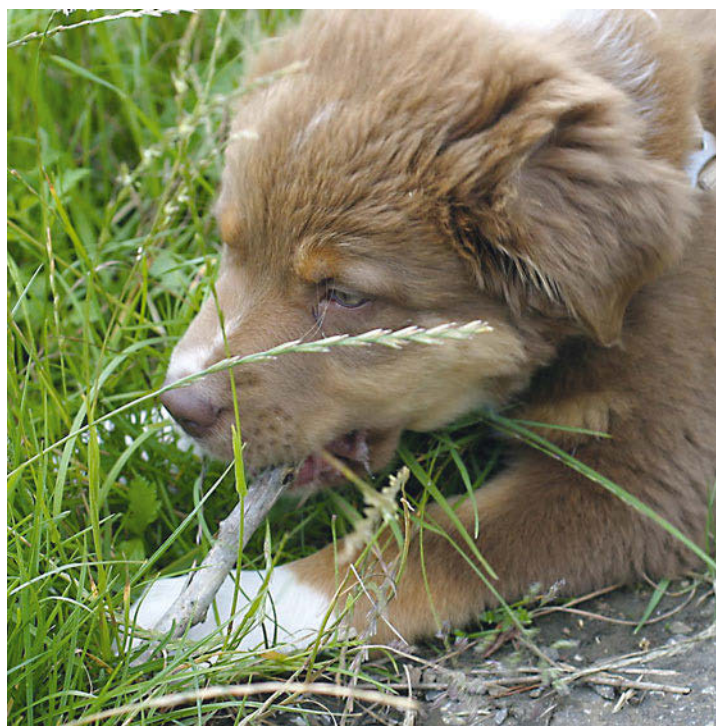
Abrasive toys, such as a tennis ball, can lead to exposure of the pulp of the deciduous teeth. The open channel then enables opportunistic oral bacteria to reach the deeper-lying jawbone (► Fig. 1.2).



► **Fig. 1.2 Smooth rubber toy.** For puppies, smooth rubber toys are preferred, since rough materials such as the felt covering of a tennis ball can abrade the teeth. In the worst-case scenario, such abrasion can impact the dental pulp of a deciduous tooth.



In contrast to blunt or abrasive toys, the main problem of dogs playing with sticks (► Fig. 1.3) is the potential for acute injury where the stick penetrates the soft tissue, causing injuries that are often hidden below the tongue or behind the molars. The injury is not always immediately detectable. For example, the first signs may be a restricted jaw opening that can be observed when the dog yawns, plays, or eats (► Fig. 1.4).



► **Fig. 1.3 Dog with stick.** Playing with sticks can lead to penetration injuries of the oral cavity. While the foreign body does not always remain in the wound, the stick fragments or the initial inflammatory response can cause problems.



► **Fig. 1.4 Relaxed yawning with maximum jaw opening.** Relaxed, contented yawning is usually a sign that jaw opening is unhindered. If jaw opening is restricted by an inflammatory process resulting from a stick injury, for example, further examination and treatment are warranted.

Abnormal behaviors may result from the way an animal is kept. For example, an animal may bite on the metal bars of an enclosure, which can damage the teeth. Signs include metallic deposits on the surface of the teeth, as well as dental abrasion or even fractures (► Fig. 1.5). The type of food also influences dental health. In animals fed dry food, the food tends to remove some of the dental calculus but it may cause teeth to fracture; in animals fed only wet food, this cleaning effect is absent.



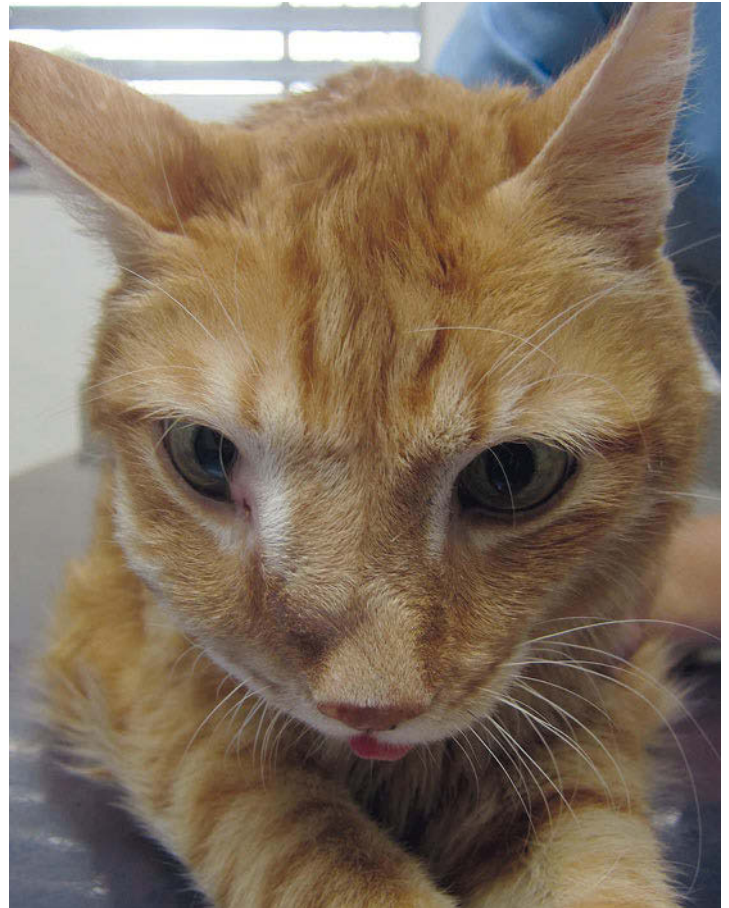
► **Fig. 1.5 Metallic abrasion in a dog kept in a kennel.** Dark, flat, firmly adhered metallic deposits on teeth suggest the dog's unfulfilled need to play or lack of activity. This piques the dog's interest in the grid of its enclosure or the bars of its car crate, which may lead to biting that damages the teeth. A "cage biter" typically exhibits abrasion of the distal surfaces of the canine teeth.

In many cases, specific breeds have particular characteristics that predispose them to certain dental issues. Depending on the breed and the skull type, the animal may be prone to certain disorders. For example, Boxers are strong candidates for retained first premolars and “epulis” (► Fig. 1.6), while Shetland Sheepdogs tend to develop mesioverted canine teeth (lance canine teeth) and young Maine Coon cats are predisposed to hyperplastic gingivitis.



► **Fig. 1.6 Skull shape.** Boxers, with their characteristic skull shape, have breed-typical dental disorders. In many cases, they have unerupted, retained first premolars, often with follicular cysts, as well as teeth that are completely covered by gum tissue.

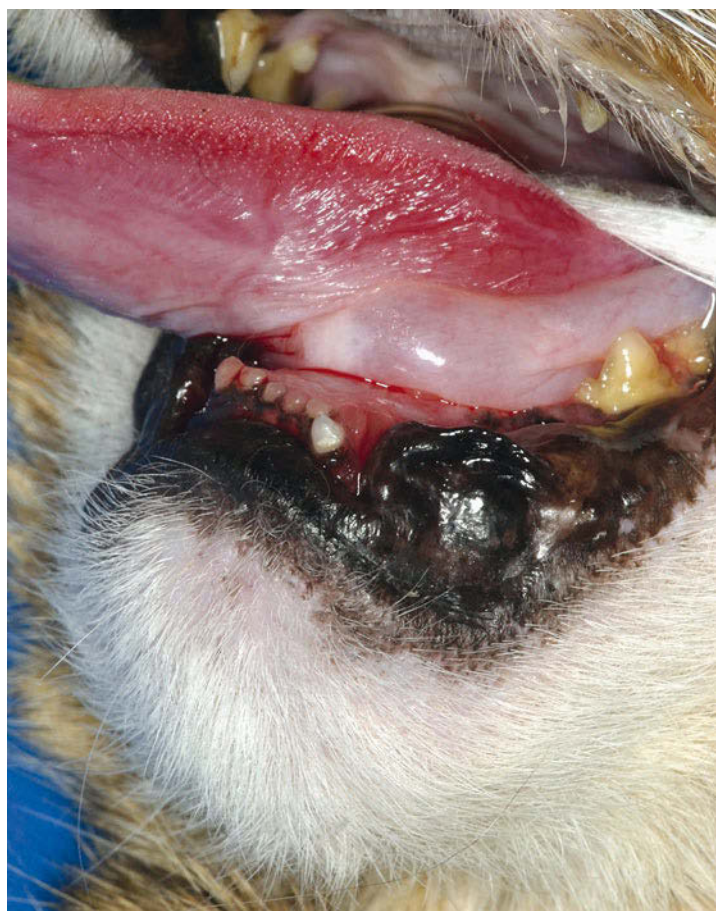
While an asymmetrical jaw generally results from a dental disorder, the cause in older animals may be neoplastic (► Fig. 1.7).



► **Fig. 1.7 Swelling on the upper jaw of a cat.** With the massive changes to the front of the skull, as in this cat, a pathological growth is suspected. A biopsy is needed for diagnostic purposes.



Squamous cell carcinoma in the oral cavity of cats commonly occurs on the floor of the mouth or at the base of the tongue (► Fig. 1.8). If it causes the entire mandible to swell, the area of concern is obvious. Unfortunately, however, these tumors commonly hide in the submandibular space. A typical clinical sign is hardening of the entire floor of the mouth, which can cause problems with eating.



► **Fig. 1.8 Sublingual enlargement.** During the clinical examination for suspected squamous cell carcinoma at the base of the tongue, the veterinarian should be able to lift the tongue by palpating the submandibular space. Any significant hardening generally warrants biopsy.

When a cat is involved in a car accident or falls from a greater height (high-rise syndrome), the jaw is often involved. These situations generally include tooth and/or bone fractures that prevent normal closure of the jaw and normal eating. In addition to obvious fractures, such as in the rostral jaw (► Fig. 1.9), the other sections of the jaw and area of the temporomandibular joint should also be radiographed.



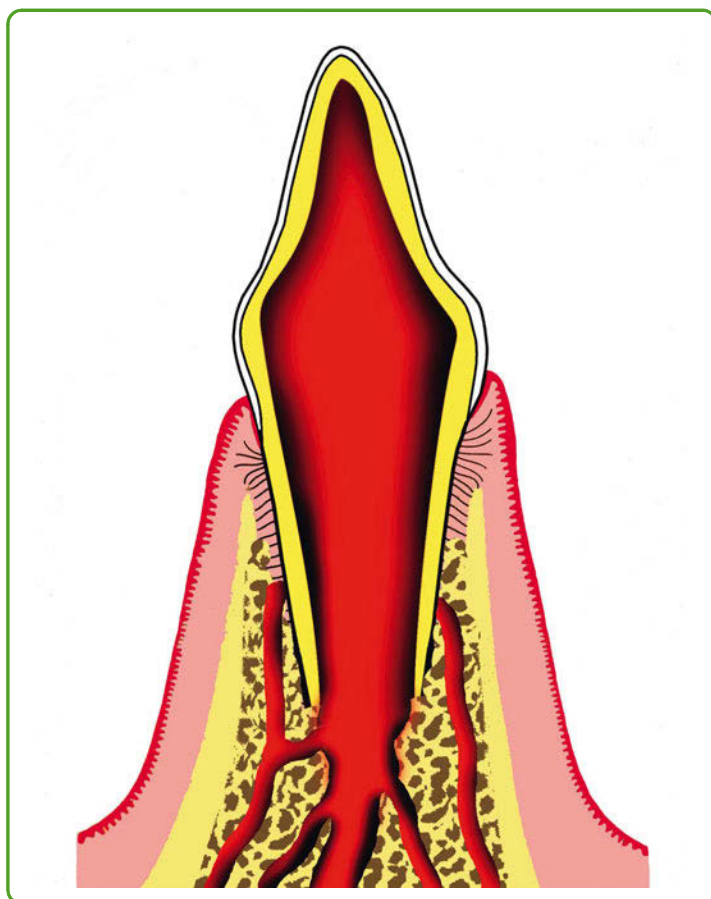
► **Fig. 1.9 Cat involved in accident.** This cat was involved in an accident with a rostral mandibular fracture involving the teeth and jawbone.

## 2 Examining the Head and Oral Cavity

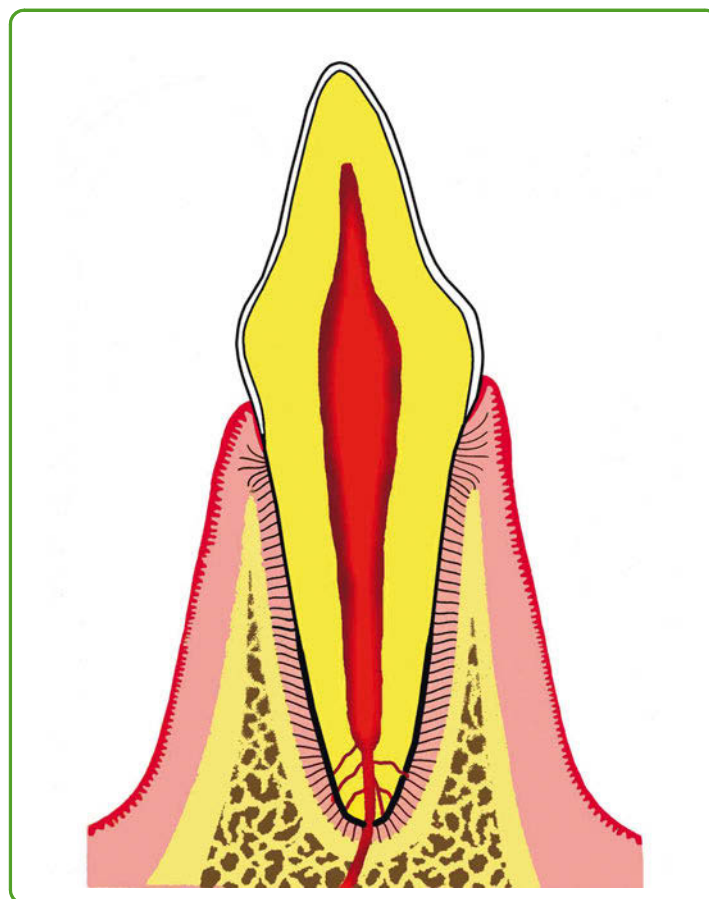
### 2.1

#### Anatomy and Morphology of the Oral Cavity

Even after the crown of a tooth has erupted, the development of the tooth is far from complete. A mature root takes several months to develop. Initially, development is dominated by a large pulp cavity and an open apical foramen (► Fig. 2.1). During this period, dental injuries with subsequent pulpitis usually cannot be treated, which is why stress on the teeth should be minimized in the animal's first year of life. The development of an individual tooth is not complete until the root apex has formed and the tooth has reached its full height (► Fig. 2.2). The development periods vary due to the differences in eruption patterns.



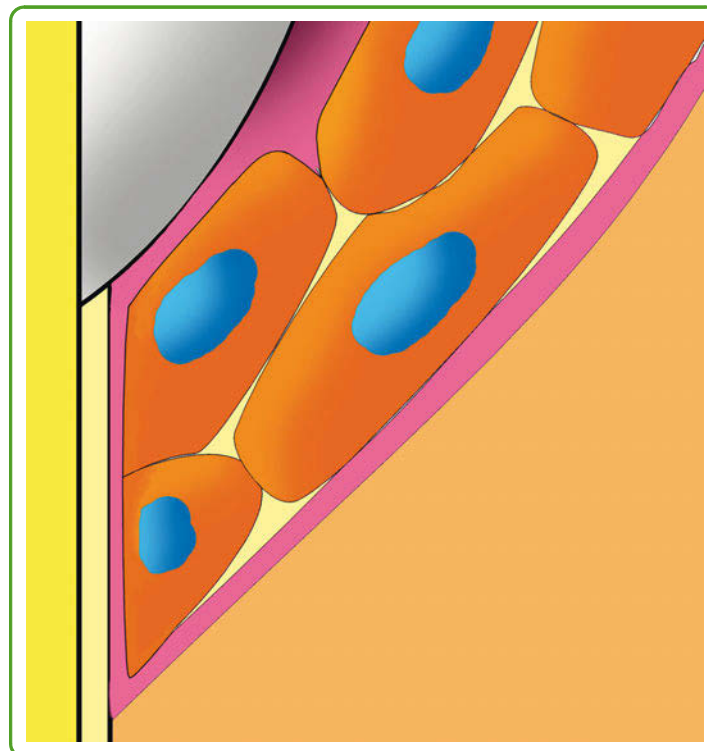
► **Fig. 2.1 Diagram of a young tooth.** The pulp of the crown and root occupies a great deal of space, while the tooth walls are still very thin. The Hertwig epithelial root sheath is soft and the apical foramen provides a wide point of entry to the dental pulp.



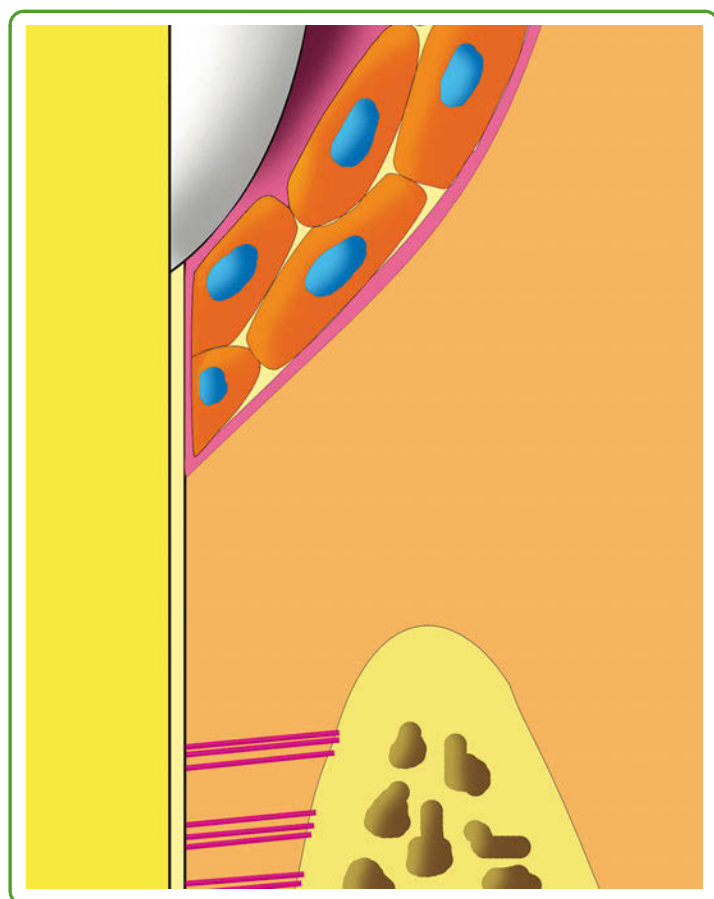
► **Fig. 2.2 Diagram of a mature tooth.** The "adult" tooth has a closed pulp chamber that narrows and shrinks inward as the animal ages, forming normal dentin.



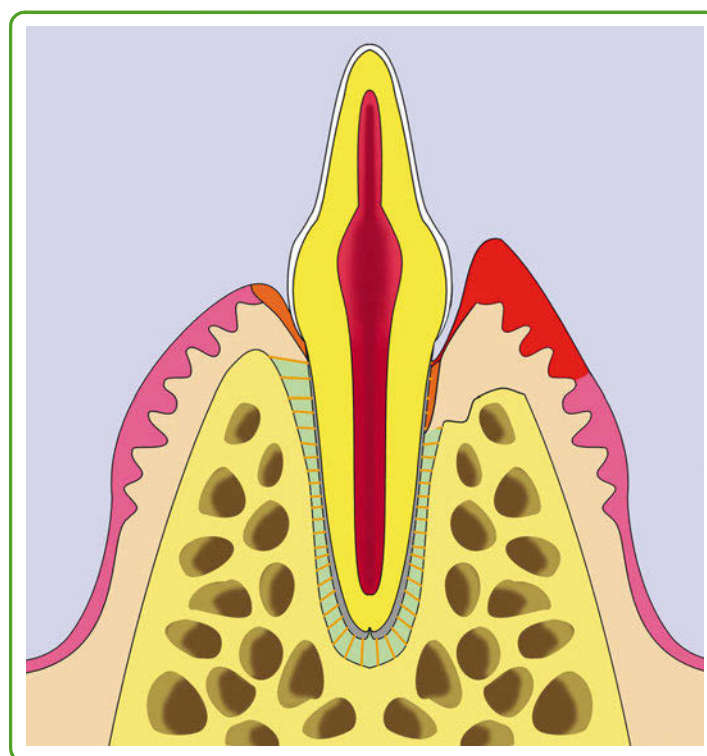
The junctional gingival epithelium (► Fig. 2.3, ► Fig. 2.4) creates the epithelial attachment, the first barrier in the gingival sulcus. Attached via hemidesmosomes, this barrier prevents bacteria and their toxins from entering the fibrous, desmodontal attachment. However, the epithelial attachment is susceptible to trauma, which is why dental health requires good dental care to preserve this structure. The bacteria in the soft plaque and the development of a biofilm impair the epithelial attachment and destroy the desmodontal attachment. The next step is the deterioration of the periodontal ligament and resorption of the alveolar bone (► Fig. 2.5).



► **Fig. 2.4 Cells of the junctional gingival epithelium.** The cells of the junctional gingival epithelium employ hemidesmosomes for attachment to the tooth surface. The epithelial cells are connected via desmosomes. Because they are non-keratinized, these cell layers are permeable and permit the host's immune factors and cells to penetrate the gingiva at the sulcus.

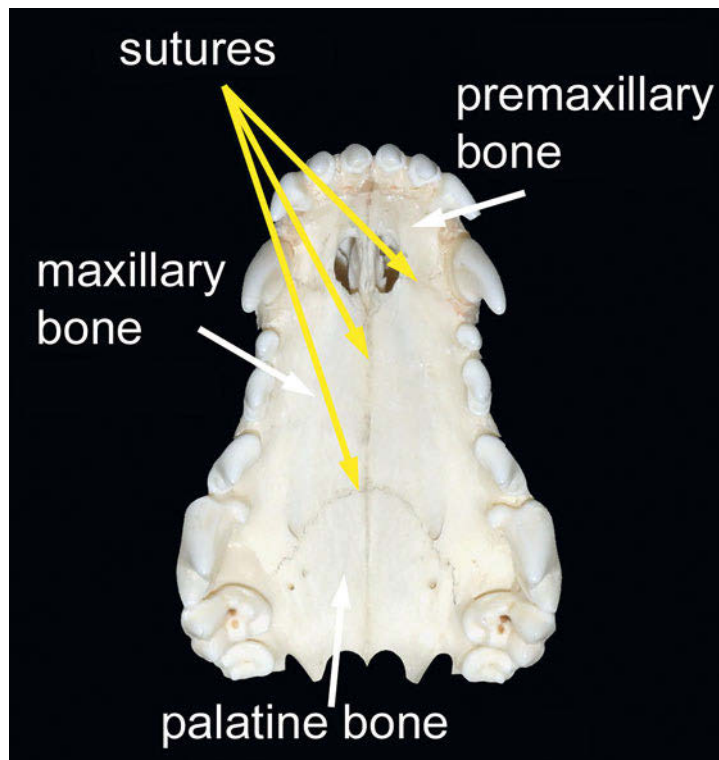


► **Fig. 2.3 Junctional gingival epithelium.** In a medium-sized dog, the normal gingival sulcus is approximately 2 mm deep and in cats, it is approximately 1 mm deep. Near the sulcus floor, special non-keratinized cells attach the gingiva to the tooth at the cemento-enamel junction.



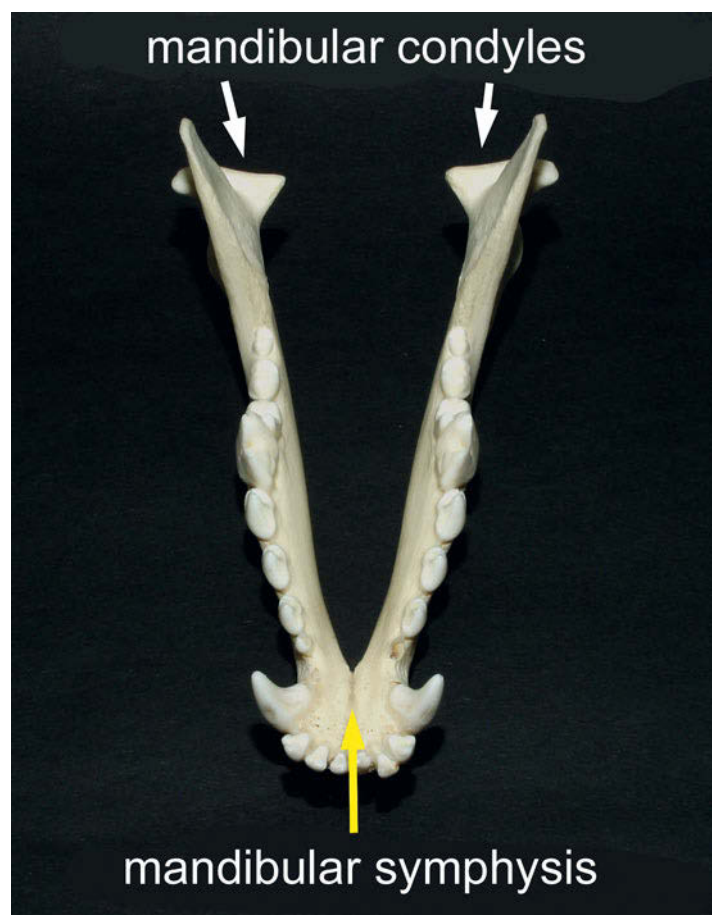
► **Fig. 2.5 Comparison of healthy and diseased periodontium.** The periodontium on the left is healthy. The inner lining of the gingival sulcus, along with the junctional gingival epithelium, seals off the periodontium on the oral cavity side, forming a gingival cuff. The periodontium on the right is diseased. The junctional gingival epithelium (orange) has migrated apically. Normal gingival mucosal cells have shifted into the sulcus, but are unable to provide a barrier. The gingival sulcus has deepened due to the damaged epithelium and desmodontal attachment and the loss of the fibrous and bony support of the alveolar bone.

The maxilla (► Fig. 2.6) consists of the maxillary, premaxillary and palatine bones, all of them paired, which are connected by sutures.



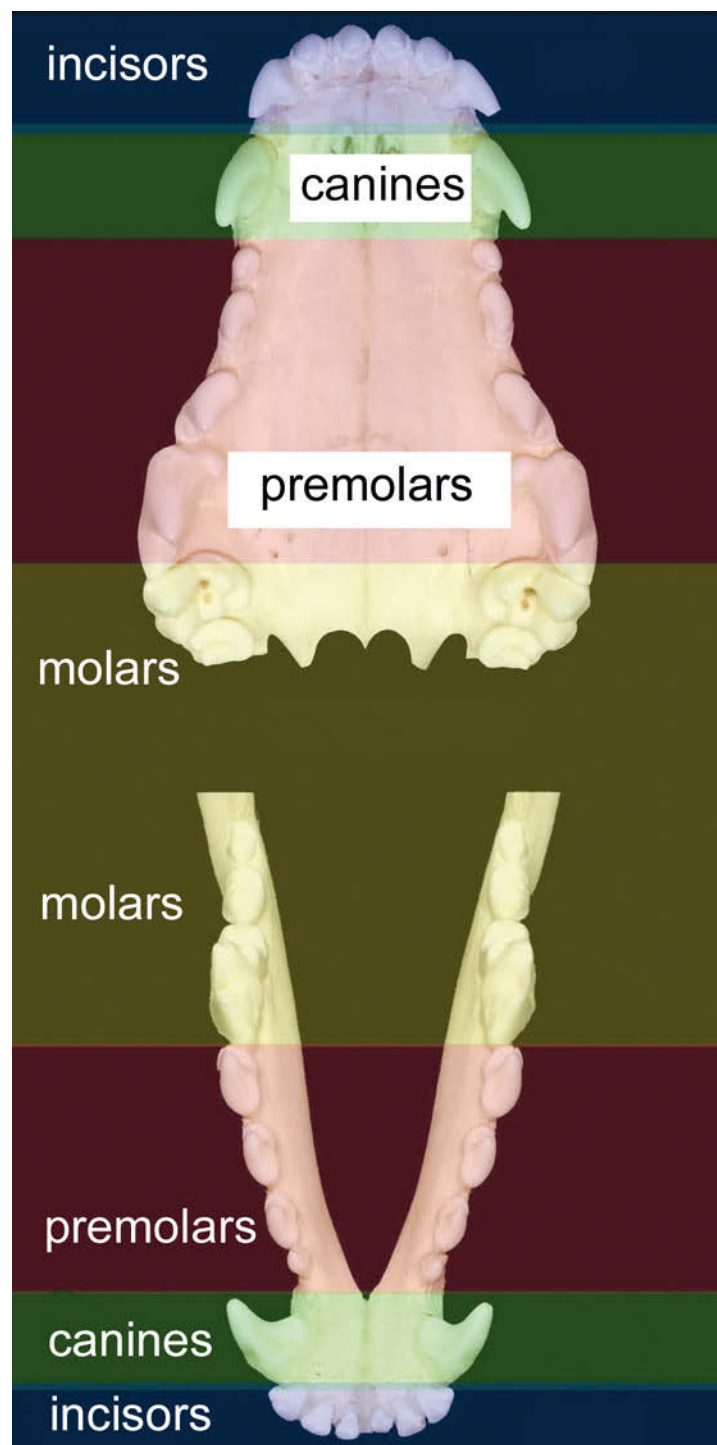
► **Fig. 2.6 Maxilla.** The incisors are located in the premaxillary bone, and the canine teeth and cheek teeth are embedded in the maxillary bone. The palatine bone does not contain any teeth. The two large rostral openings between the maxillary and premaxillary bones are the palatine fissures, through which the vomeronasal organ communicates with the oral cavity.

The mandible (► Fig. 2.7) consists of the paired mandibular bones, which are connected rostrally in the band-like symphysis. Unlike in humans, no solid bony structure is formed at the symphysis.



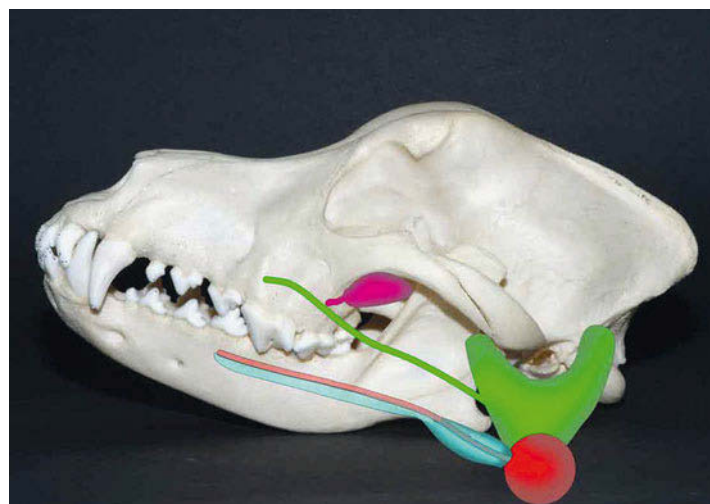
► **Fig. 2.7 Mandible.** The mandible consists of the horizontal body of the mandible and the vertical ramus of mandible. While the maxilla increases in size apportionally and along the sutures, the mandible widens caudally. Each mandibular condyle articulates with the base of the skull at the mandibular fossa of the temporal bone.

The teeth can be classified by function (► Fig. 2.8). The mandibular teeth are all embedded in the alveolar part of the mandible while the maxillary incisors are embedded in the alveolar part of the premaxillary bone, and the canine teeth and cheek teeth are embedded in the alveolar part of the maxillary bone.

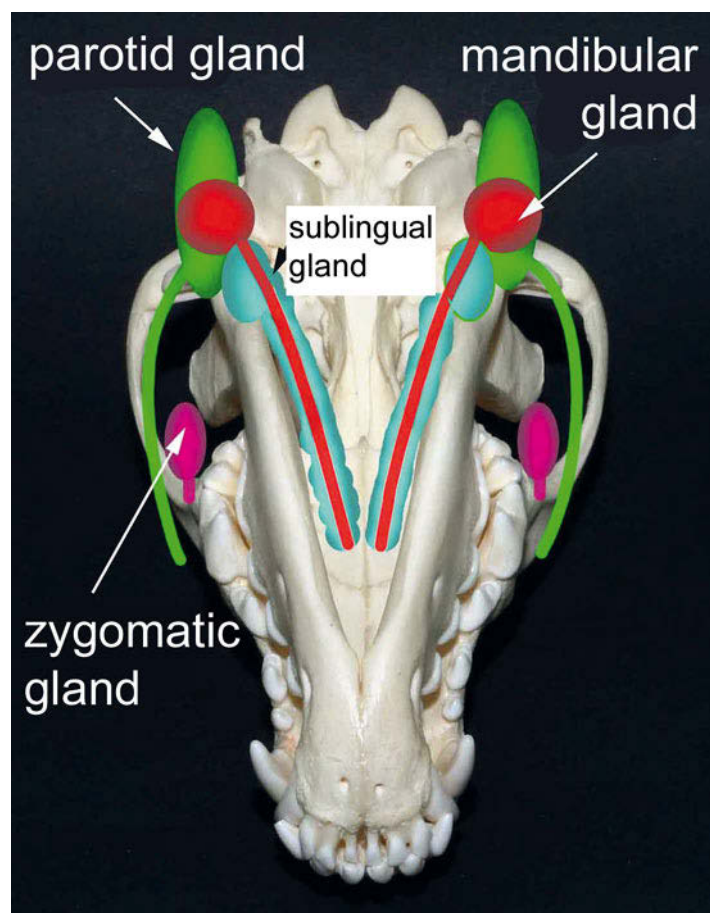


► Fig. 2.8 **Tooth classification.** The different groups of teeth are color-coded as follows: incisors: blue; canine teeth: green; premolars: orange; molars: yellow.

In dogs and cats, the salivary glands are grouped caudally to the angle of the mandible. Only the zygomatic gland is located separately behind the zygomatic arch (► Fig. 2.9, ► Fig. 2.10).



► Fig. 2.9 **Lateral view of the salivary glands.** The parotid gland (green) is situated directly below the base of the ear with one rostral and one caudal part. Directly below the parotid glands, in the area of Viborg's triangle, is the mandibular gland (red), which is covered by a capsule that includes the caudal part of the sublingual gland (blue). The zygomatic gland (magenta), is located separately, behind the zygomatic arch.



► Fig. 2.10 **Ventral view of the salivary glands.** The ducts of the mandibular and sublingual glands open at the frenulum of the tongue. The duct of the parotid gland opens on the buccal mucosa at the level of the buccal surface of the maxillary carnassial teeth. The short duct of the zygomatic gland opens just caudally to this.





**Eickhoff**

► **Fig. 2.12 Feline dental chart, dentition.** Cats have 30 teeth, all of which have only a cutting function.

treatment performed

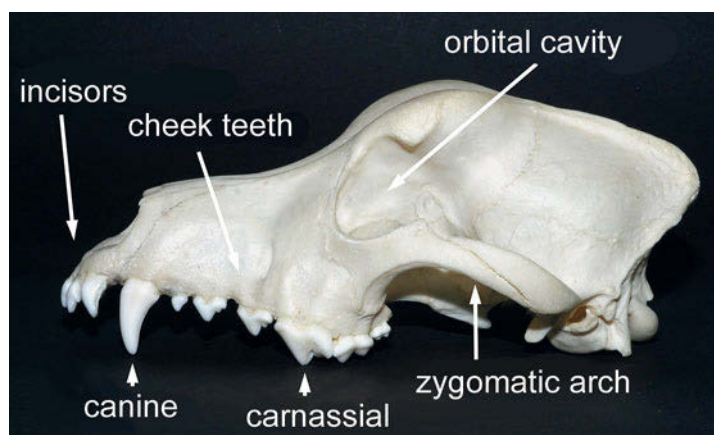
► **Fig. 2.13 Canine dental chart, detail.** The boxes containing an “x” are used to record the individual pocket depths of each area. The veterinarian can also record planned and past treatments here.



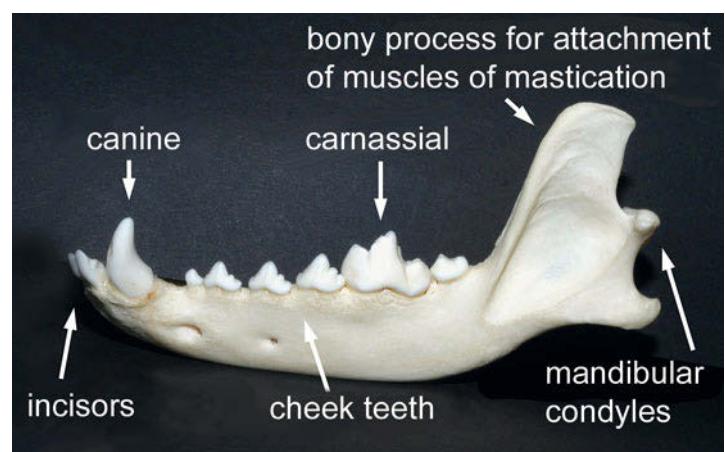
In dogs and cats, normal occlusion involves close interdigitation of the upper and lower teeth, so even small anomalies in an individual tooth or minimal changes in position can alter the jaw's closure. The powerful coronoid process of the caudal ramus of the mandible, which attaches to the powerful mouth-closing muscles, controls movement. The close anatomical proximity of the dental roots to the adjacent structures of the head is illustrated in ► Fig. 2.14, ► Fig. 2.15 and ► Fig. 2.16.



► **Fig. 2.14 Canine skull, frontal view.** The frontal view of the canine skull shows the close anatomical proximity of the maxillary canine roots to the nasal cavity. The mesial surface of the maxillary canine root is separated from the nasal cavity by only a paper-thin bony cover.

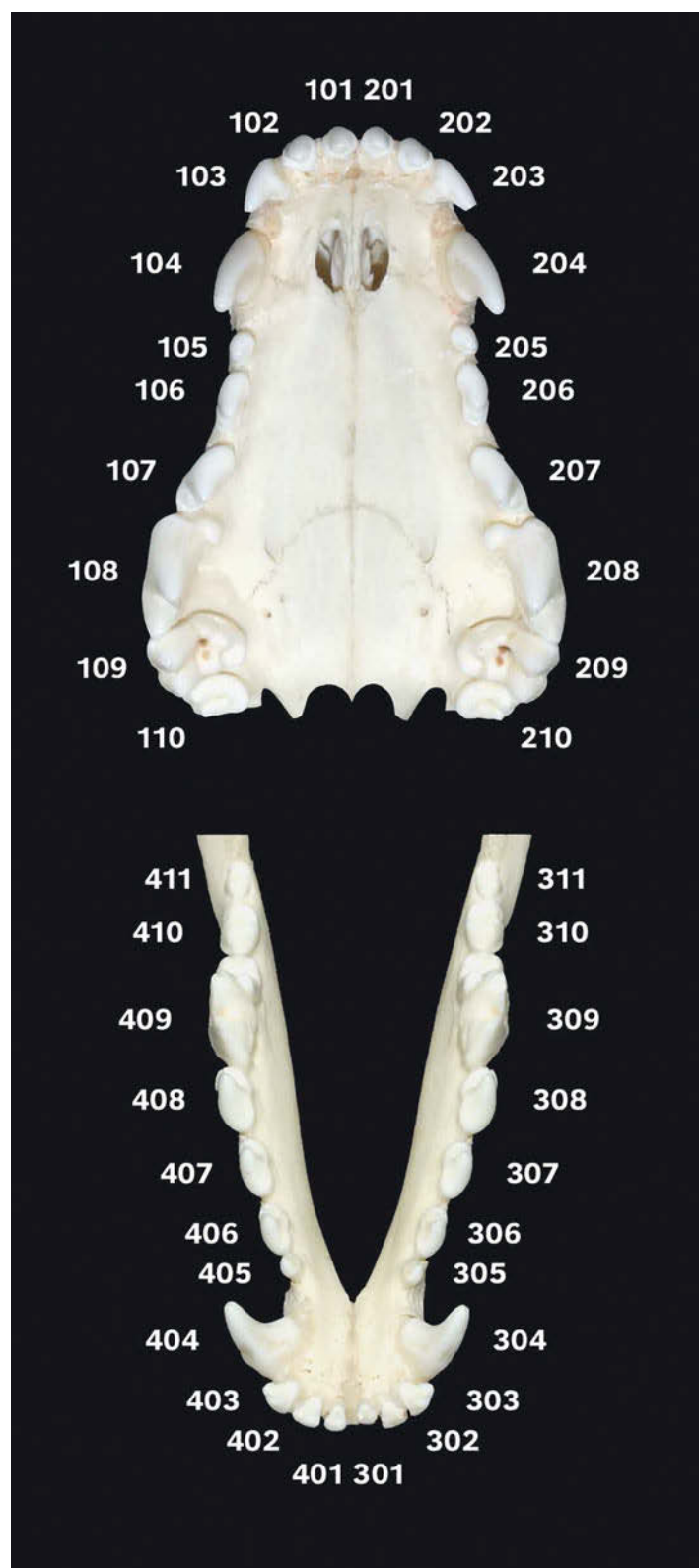


► **Fig. 2.15 Canine maxilla, lateral view.** The lateral view shows the proximity of the caudal maxillary cheek teeth and the orbital cavity. The orbital floor is not protected by a bony structure, but consists of soft tissue. Firmness of the orbital floor thus may indicate inflammatory changes in the caudal maxilla or in the space caudal to the molars.



► **Fig. 2.16 Canine mandible, lateral view.** The most powerful mandibular cheek tooth is the first molar, which is called the carnassial tooth. In the maxilla, the opposing carnassial tooth is the fourth premolar.

The modified Triadan system of dental charting allows veterinarians to unequivocally designate canine and feline teeth. Feline evolution has caused the appearance of gaps between teeth in the system, because only the existing teeth are assigned the relevant three-digit number. The first digit identifies the quadrant, where the numbering starts from the examiner's perspective in the patient's right maxilla and continues in a clockwise fashion. The second digit starts at the median between the central incisors, counting caudally. Because dogs can have more than nine teeth per quadrant, a third digit is required, and digits two and three are read as a single number (► Fig. 2.17).



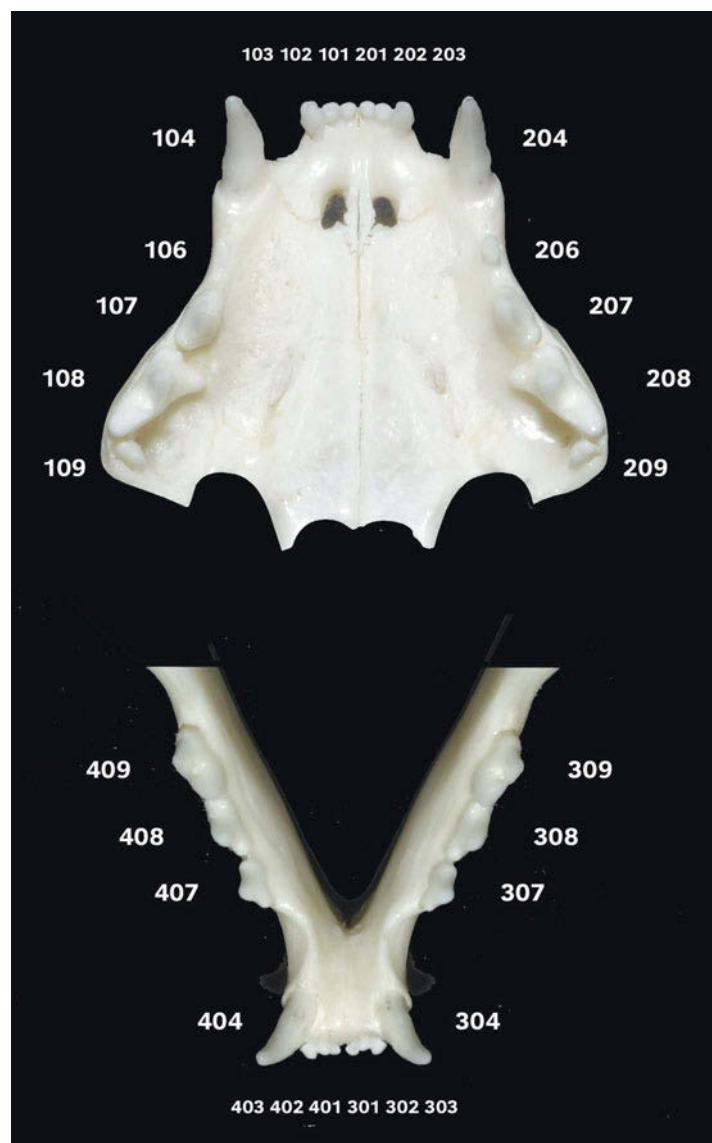
► **Fig. 2.17 Tooth number in dogs.** The teeth are numbered in sequence, beginning in the patient's right upper quadrant from the examiner's perspective, going in a clockwise fashion, and from the medians between the central incisors, going in a caudal direction.

In cats too, the anatomical proximity between the oronasal cavity and the orbital cavity is readily apparent (► Fig. 2.18). In cats, the upper and lower teeth occlude very closely together and the jaw joints are restricted, permitting only a pure hinge-like movement and precluding any lateral movements for grinding food.



► **Fig. 2.18 Feline skull, frontal view.** In cats, the skull shape is significantly more uniform than in dogs because there is less variation among the different cat breeds.

As in dogs, Triadan tooth numbering in cats also uses a three-digit system (► Fig. 2.19), although a two-digit system would actually suffice for the total number of cat teeth per jaw quadrant.



► **Fig. 2.19 Tooth numbering in cats.** Tooth numbering in cats is similar to that in dogs. However, unlike in dogs, gaps in the numeric sequence (e.g., 304 followed by 307, with no 305 or 306) represent the teeth that are no longer present.



## 2.2

**Canine Oral Cavity**

Canine deciduous teeth may undergo changes that require treatment and influence the development of the permanent teeth. Dogs have a total of 28 deciduous teeth, with 7 teeth per quadrant (► Fig. 2.20). If teeth are absent or malpositioned, the cause and possible impact on the permanent teeth should be investigated.

If the jaw is wide enough, the teeth can stand in a row (► Fig. 2.21). In dogs with a short jaw, however, rotated premolars are common, as is crowding in the mandibular incisors, signs of which may already appear in the deciduous teeth and become more obvious as the number of permanent teeth increases.



► **Fig. 2.20 Maxillary deciduous teeth.** Deciduous teeth in dogs comprise three incisors, one canine tooth and three molars per quadrant. The deciduous teeth are significantly smaller than the permanent teeth, and the interdental gaps of the deciduous teeth widen as the jaw grows.



► **Fig. 2.21 Mandibular deciduous teeth.** Wear and tear from use of the deciduous teeth presents in forms such as the abrasion of the canine tooth cusps depicted here. Treatment is not needed as long as the pulp is not involved.

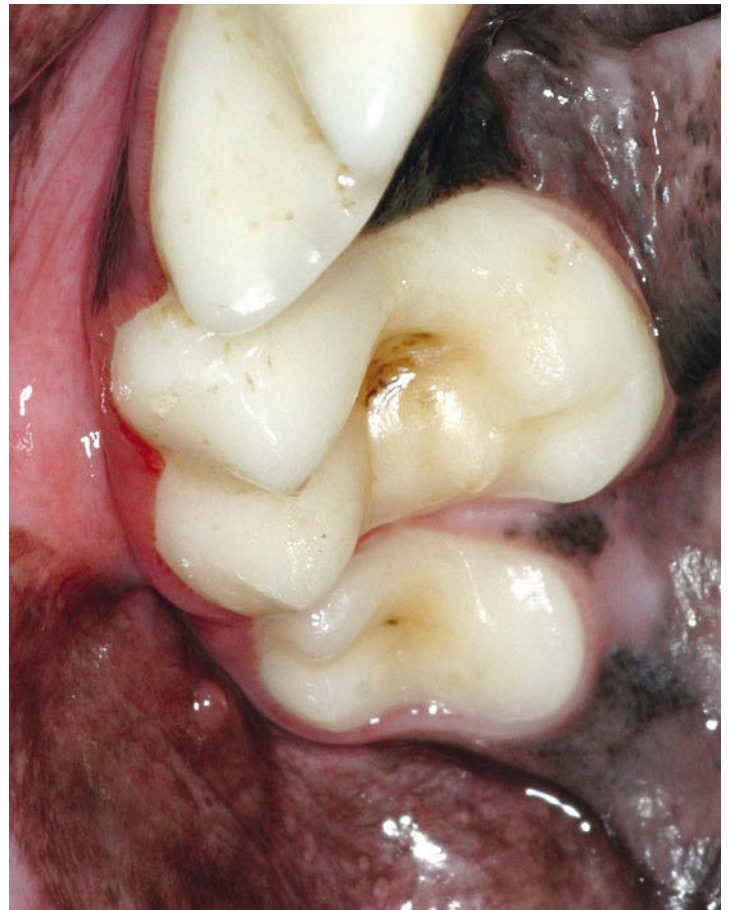


Exfoliation does not always occur in the sequence of “deciduous tooth falls out and permanent tooth appears.” In the transitional period, deciduous teeth or deciduous teeth remnants may remain in place parallel to the eruption of the permanent teeth (► Fig. 2.22). If malalignment may result from the deciduous teeth remaining in place, they must be removed immediately.



► **Fig. 2.22 Crown of a deciduous molar.** While during mixed dentition, the roots of the deciduous teeth are physiologically resorbed, the crowns may remain until the permanent tooth causes them to fall out. These crowns can generally be easily removed or fall out on their own.

A dog has 42 permanent teeth. Each maxillary quadrant has 10 teeth, while each mandibular quadrant has 11 teeth. They are classified as brachydont teeth with short crowns and long roots. Dogs are considered to be heterodont, because they have different tooth morphology for performing different functions. The upper teeth, with their incisal edges or buccal cusps (► Fig. 2.23) are located labial to the mandibular teeth, with the mandibular arch somewhat narrower.



► **Fig. 2.23 Maxillary molars.** The maxillary molars are designed to perform the grinding function in carnivore dentition. Cusps and fossae of the maxillary molars create a surface for grinding.

The carnassial teeth are the most important teeth for processing food (► Fig. 2.24). This stress on the carnassial teeth unfortunately also makes them prone to fracture.



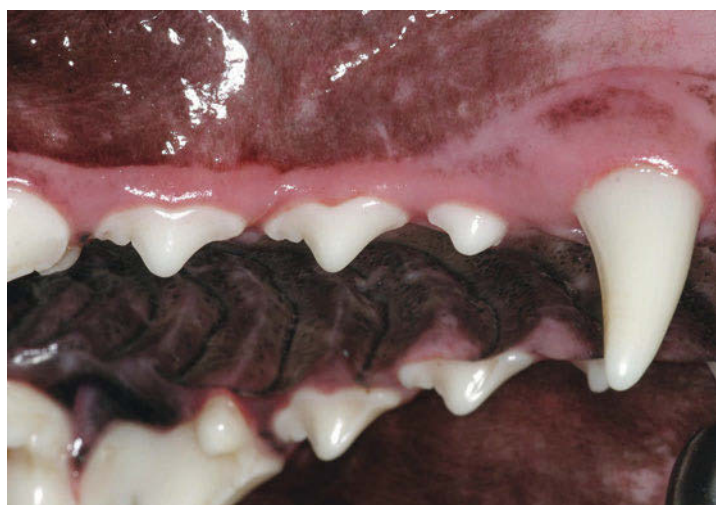
► **Fig. 2.24 Maxillary carnassial tooth.** The maxillary carnassial tooth is situated at the center of the dog's masticatory force. In conjunction with the mandibular carnassial teeth, lumps of food are bitten into pieces.

The canine teeth (► Fig. 2.26) are responsible for grasping and holding food, prey or other objects.



► **Fig. 2.26 Maxillary incisors and canine teeth.** The canine teeth are the most exposed maxillary teeth and are thus commonly predisposed to fracture. The occlusion of the canine teeth of the mandible and maxilla is very tight, ensuring their function for holding prey.

Initially, the smaller premolars (► Fig. 2.25) do not appear to be particularly important; however, in conjunction with the interaction of the mandible and maxilla, they allow objects to be immobilized. If a guard dog behaves abnormally while training with a bite sleeve, the behavior may be due to pain in the premolar region.



► **Fig. 2.25 Maxillary premolars.** The small maxillary premolars (the fourth, large maxillary premolar functions as a carnassial tooth) generally are not in contact with the mandibular dental arch. The teeth in this area are too small to completely bite through objects.

The mandibular carnassial teeth are less commonly fractured than the maxillary carnassial teeth due to their larger size and better stability (► Fig. 2.27).



► **Fig. 2.27 Mandibular carnassial.** The mandibular carnassial tooth is the first molar of the lower jaw and sits opposite the maxillary carnassial tooth. Its location is lingual to the maxillary carnassial tooth. When the dog bites, the strong shearing force often causes the tip and/or buccal lamella of the maxillary carnassial tooth to break off, since the mandibular carnassial tooth is more compact.

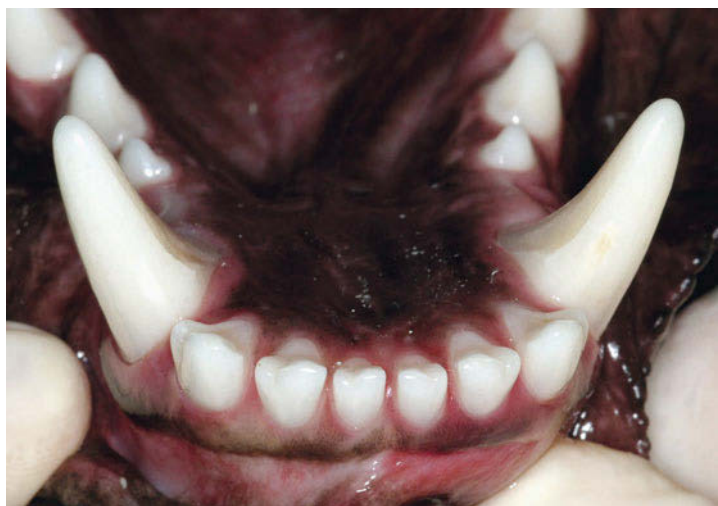


In addition to the last molars, the first premolar in the canine mandible is not always present (► Fig. 2.28). This is a continuation of evolutionary development rather than a dental abnormality.



► **Fig. 2.28 Mandibular premolars.** If the position of the jaw and teeth is normal, the mandibular premolars interdigitate with the maxillary premolars. In the context of normal evolutionary development, the first premolar is often retained, reduced in form, or not developed at all. Such variations should be radiographed to check for pathological processes in the jaw.

For many breeders a scissor bite (► Fig. 2.29) is important for meeting a breed standard. However, phenotypically correct occlusion is not always an indication of genetic perfection, and evaluating the incisors alone is insufficient.



► **Fig. 2.29 Mandibular incisors and canine teeth.** The mandibular incisors lie on a somewhat narrower arcade than the maxillary incisors, which results in a physiological scissor bite. The mandibular canine teeth occlude equidistantly between the interdental surfaces of the maxillary lateral incisor and the maxillary canine.

The tongue is a highly specialized structure that is reinforced by the hyoid bone (and contains the lyssa) in the dog. The tongue uses specialized processes, called papillae (► Fig. 2.30, ► Fig. 2.31) for protection, for grasping and tasting food, and for sensory perception.

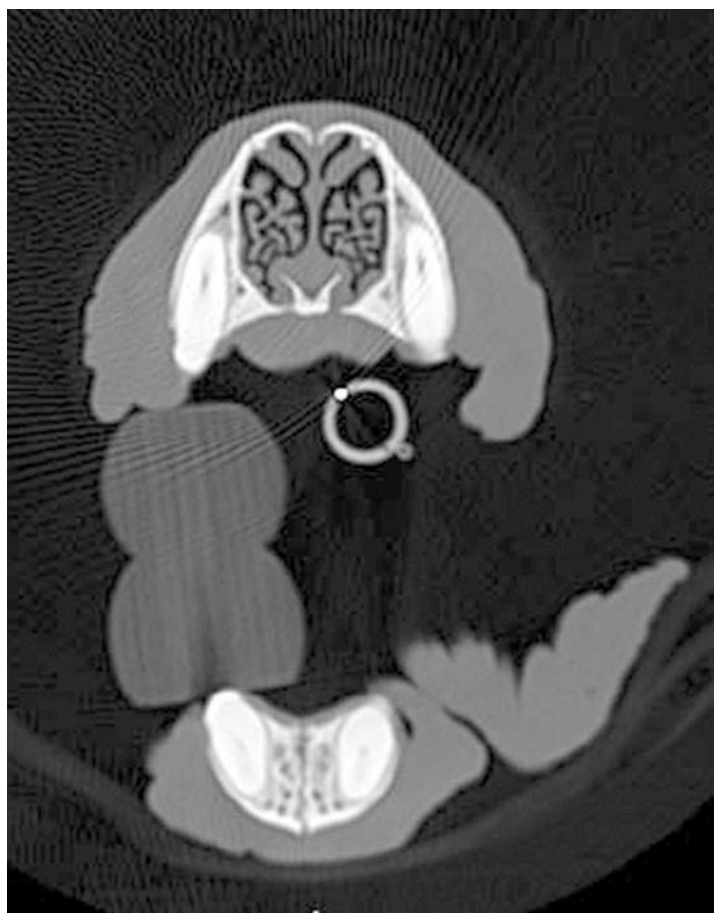


► **Fig. 2.30 Dorsal surface of the tongue.** The dorsal surface of the tongue has different types of papillae, most of which are mechanically active filiform papillae with an extended, horn-like appearance. In addition, the tongue has gustatory papillae, which are closely associated with taste buds. Other papillae are the knob-like fungiform papillae (small red projections), as well as circumvallate papillae, which appear as wide, circular red spots surrounded by a circular fossa. Sweet taste receptors are located near the tip of the tongue. Salt receptors are located on the rostral sides of the tongue. Bitter receptors are in caudal area of the tongue, as a final control prior to the intake of toxic substances, which often taste bitter.



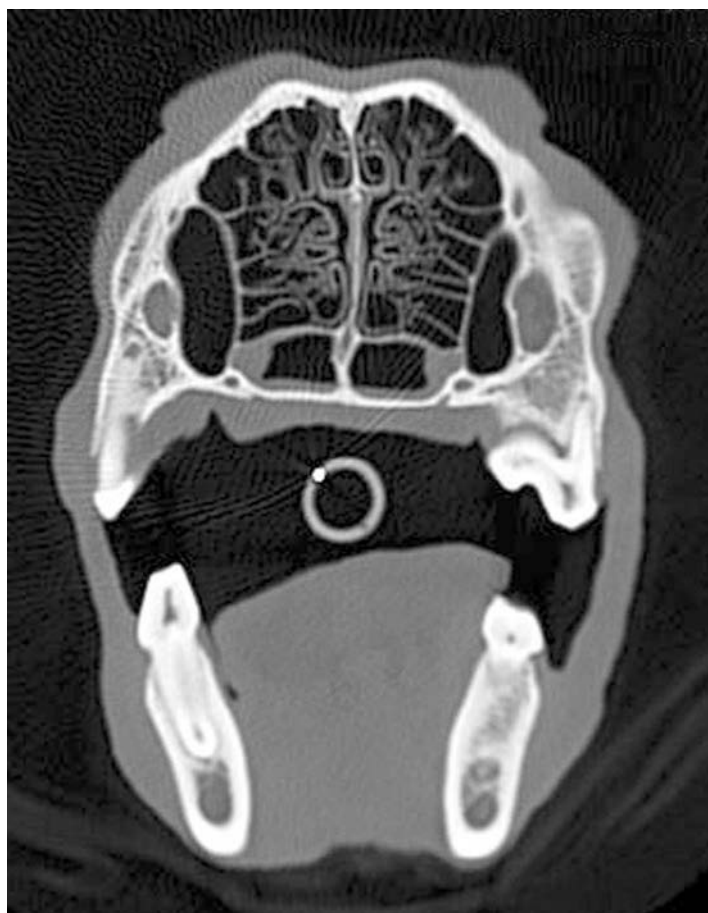
► **Fig. 2.31 Lingual papillae.** This close-up shows the horn-like extension of the filiform papillae.

Given the limits of two-dimensional radiography, computed tomography (CT) shows the spatial relations (► Fig. 2.32) and past pathological processes and permits assessment of the degree of disease.



► **Fig. 2.32 CT image of the root of the maxillary canine tooth.** The CT image clearly shows the proximity of the maxillary canine root to the nasal cavity. The only separation between the canine root and the nasal cavity is a thin bony wall that can become slightly eroded or detached in inflammatory processes; this can lead to typical unilateral nasal discharge.

CT images illustrate the critical role of the size and morphology of the teeth in forming the shape of the jaw (► Fig. 2.33).



► **Fig. 2.33 CT image of the mesial root of the mandibular carnassial tooth.** Like the roots of the maxillary canine tooth, the mesial roots of the mandibular carnassial teeth are space-occupying. The image shows the large buccolingual extent of the roots. Apical to the roots the translucent mandibular canal is visible. In smaller breeds of dog, the root extends to the ventral margin and is superimposed on the mandibular canal. This can lead to bleeding during extraction due to trauma to the inferior alveolar artery or vein. In addition, osteolysis and leverage forces during extraction can cause fracture. Thus, preoperative radiographic visualization prior to extraction helps to assess and record the current condition for forensic purposes.



Not all deviations from the norm are pathological. While elongated papillae of the tongue may appear unusual, they do not need to be treated (► Fig. 2.34).



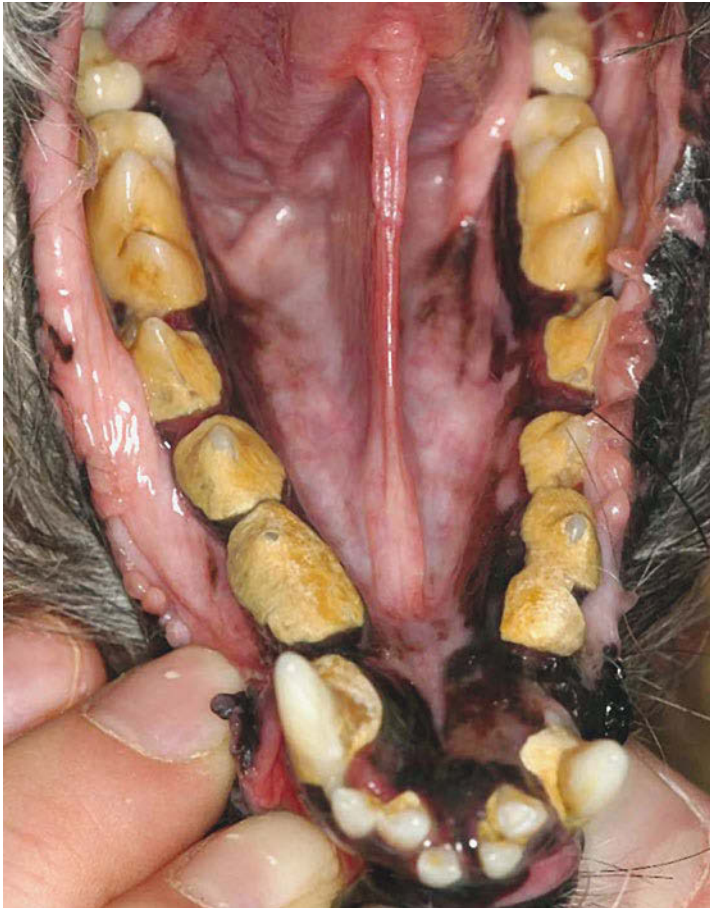
► **Fig. 2.34 Hairy tongue.** Excessive elongation of the mechanical filiform papillae can cause hairy tongue, which is characterized by dark, hair-like elongation of the papillae. It occurs predominantly in the median sulcus and does not require treatment.

During tooth exfoliation, a distinction must be made between normal resorption of the deciduous tooth roots, the loss of deciduous teeth (► Fig. 2.35), and real pathological detachment processes and fractures.



► **Fig. 2.35 Discolored deciduous canine tooth.** During exfoliation, a brownish or purple discoloration without any other apparent cause is normal, because the root becomes resorbed by the erupting permanent canine tooth.

A typical soft biofilm is not always found on the teeth. The basic properties of saliva cause calculus to form relatively quickly as a result of the precipitation of minerals in the saliva, which then create a basis for crystallization (► Fig. 2.36).



► **Fig. 2.36 Severe calculus accumulation.** The cusps of the molars just barely protrude above the massive accumulation of calculus. Whether or not this has led to periodontal disease or bone damage is not apparent from the clinical findings alone. Diagnostic radiography is required for full assessment of the situation.

Suborbital swelling is a nearly pathognomonic sign of a dental disorder (► Fig. 2.37).



► **Fig. 2.37 Suborbital swelling on the right.** The most common cause of suborbital swelling is a bony process near the maxillary carnassial teeth or molars.



## 2.3

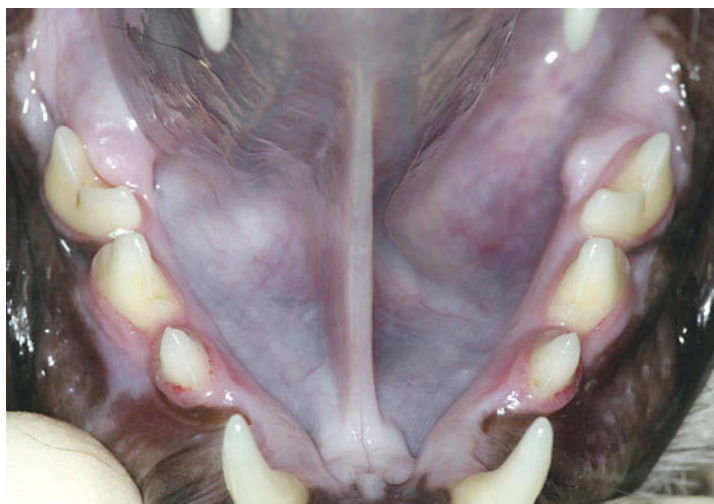
**Feline Oral Cavity**

A cat has 30 permanent teeth. Each maxillary quadrant has eight teeth (► Fig. 2.38), while each mandibular quadrant has seven teeth. The incisors are very small, surrounded by the very prominent canine teeth. The maxillary fourth premolar and the mandibular first molar are the carnassial teeth for breaking up food.



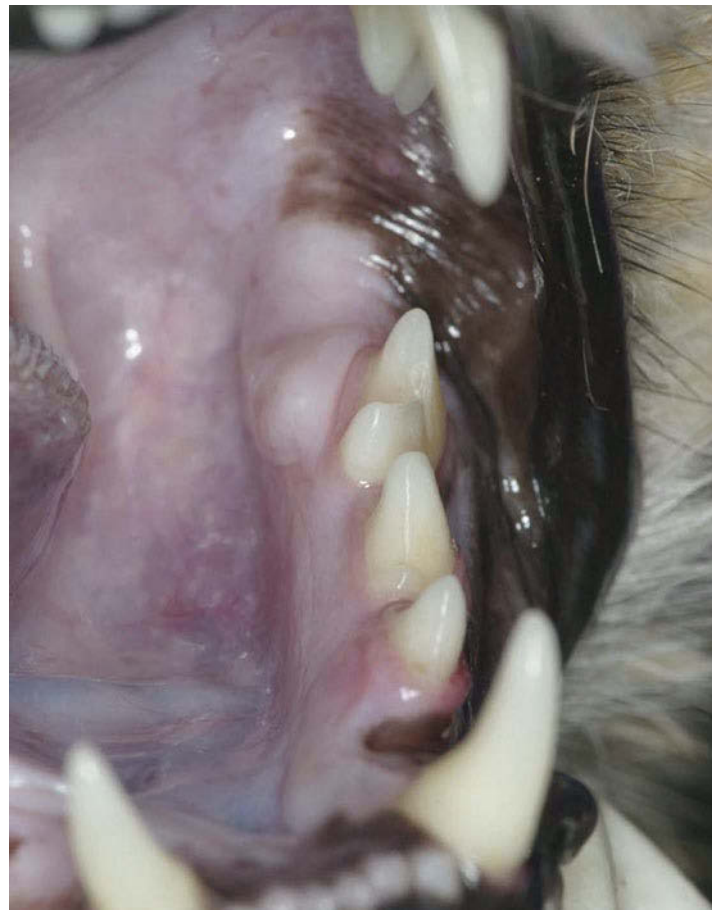
► **Fig. 2.38 Feline maxilla.** The variable dark and light-pigmented oral mucosa in this cat shows very clear palatine folds. The feline dentition consists of only cutting (secodont) teeth.

While in dogs the gingiva tends to be distinctly pink to pinkish-red-dish, the gingiva in cats is usually pale pink (► Fig. 2.39).



► **Fig. 2.39 Feline mandible.** In contrast to the firm palatine mucosa, the sublingual mucosa is very thin and fragile.

In cats, a physiological “mass” that is not present in dogs is seen in the mandibular molar area (► Fig. 2.40).



► **Fig. 2.40 Lingual molar gland.** The molar gland, which is not present in dogs, is located lingual to the mandibular carnassial tooth. After extraction of the mandibular carnassial tooth, this gland may protrude more prominently. However, as a physiological structure, it does not require treatment.

When a cat's incisors are extracted, the owner may suddenly notice a mass-like alteration at the front of the palate; however, this is normal and not pathological (► Fig. 2.41).



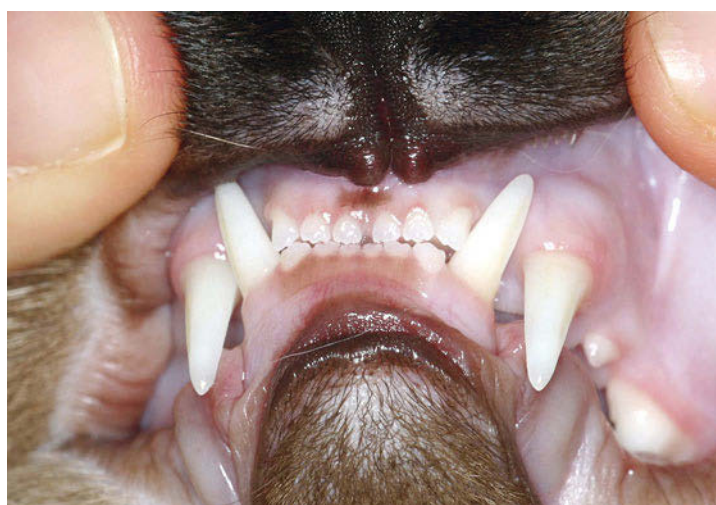
► **Fig. 2.41 Incisive papilla.** As in dogs, in cats the incisive papilla is located in the median directly caudally to the maxillary inner incisors. This is where the paired incisive ducts end and connect the oral cavity to the vomeronasal organ (Jacobson's organ), which accounts for the heightened detection of scent, especially in dogs.

In the molar area too, the teeth are also shaped for cutting (► Fig. 2.43) and there are no teeth shaped for grinding nuggets of food. The bite is designed solely for breaking up food.



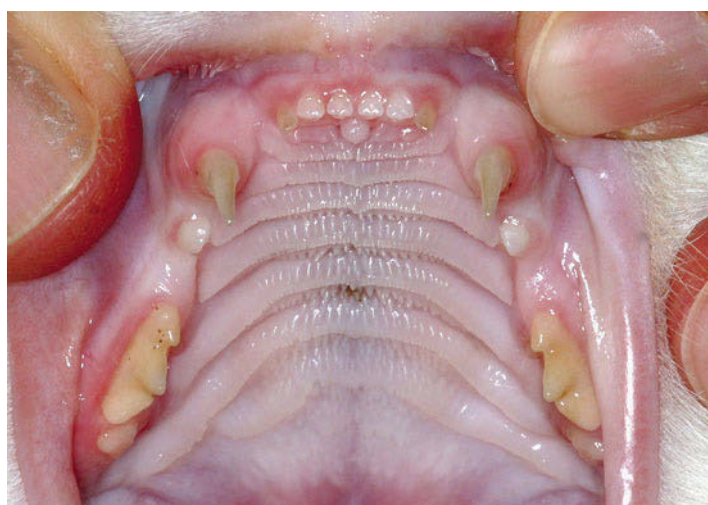
► **Fig. 2.43 Molar occlusion in cats.** The cutting effect of the molars is supported by the deep vertical occlusion.

While in dogs, a clear scissor bite is preferred, feline occlusion is different (► Fig. 2.42).



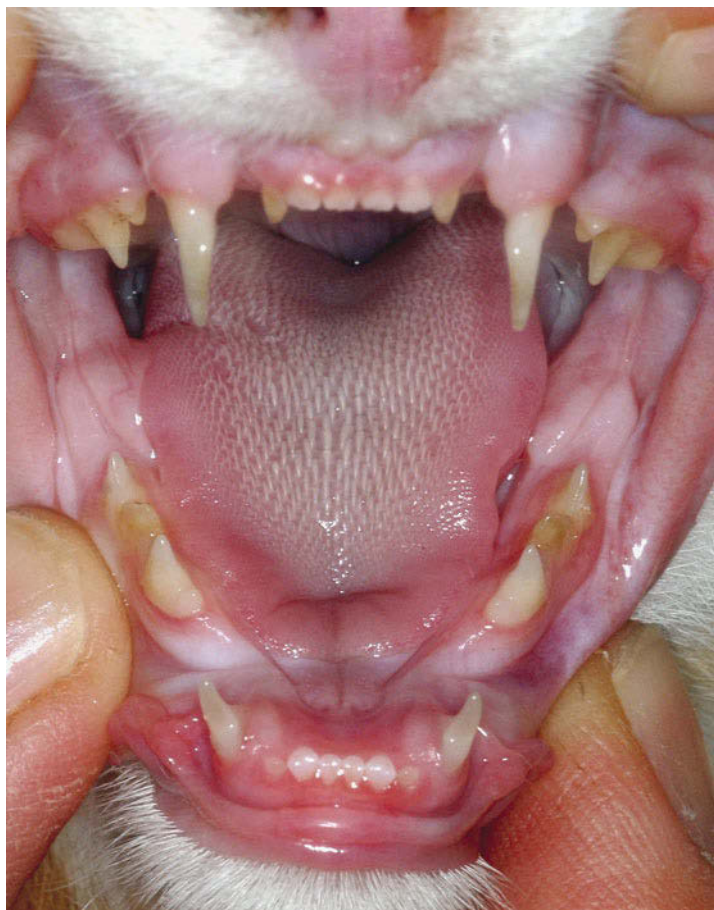
► **Fig. 2.42 Occlusion of the front teeth in cats.** The incisors generally meet in the form of a pliers. The canine teeth occlude vertically very deeply. Therefore, when the jaw is completely closed, there may be very close contact between the teeth, especially the canine teeth, and the opposing soft tissue.

Exfoliation occurs in a predetermined sequence (► Fig. 2.44, ► Fig. 2.45, ► Fig. 2.46, ► Fig. 2.47). Exceptions to this sequence are abnormal and call for further diagnostics.

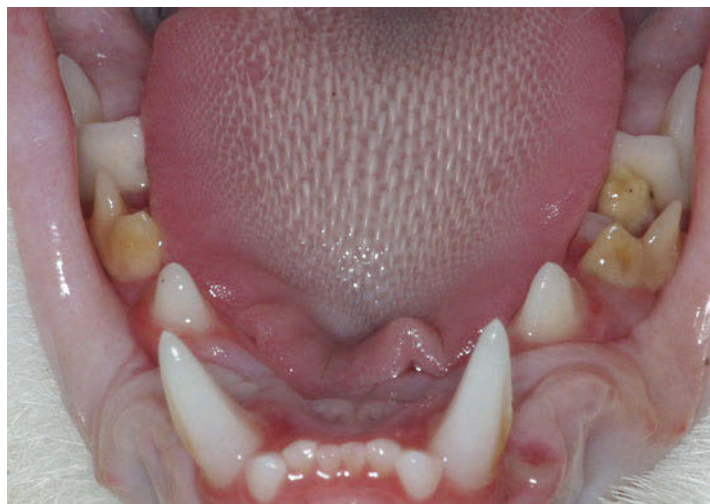


► **Fig. 2.44 Maxilla, early mixed dentition.** This mixed dentition of a cat clearly shows that the incisors are the first permanent teeth to replace the deciduous teeth.

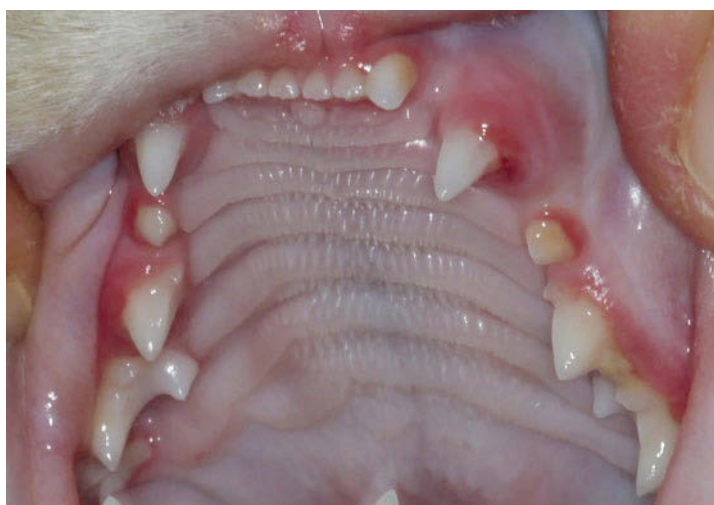
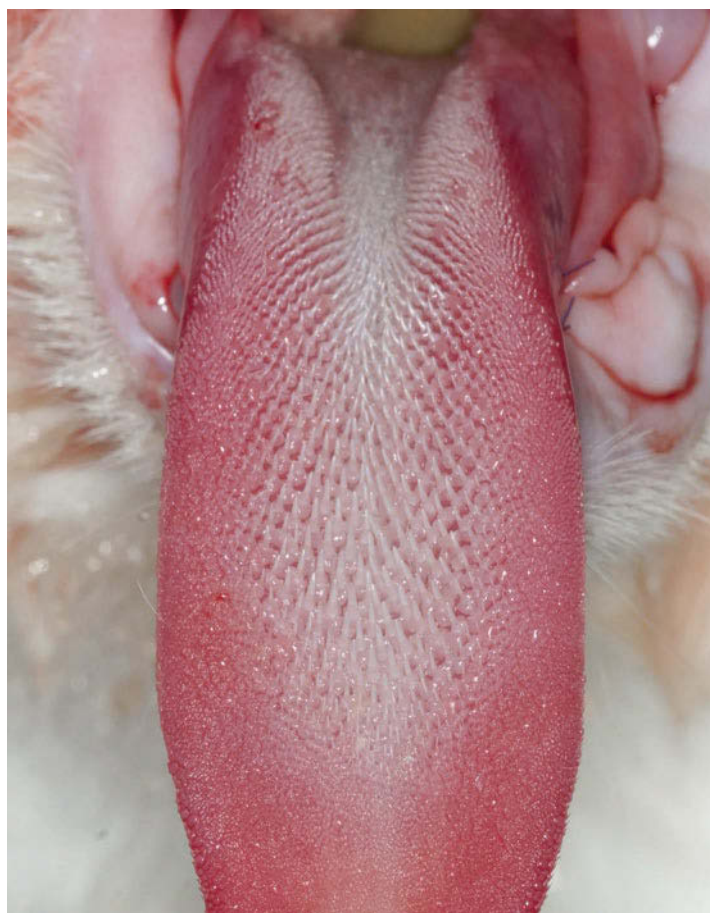




► **Fig. 2.45 Mandible, early mixed dentition.** In the mandible too, the first permanent teeth to appear are the incisors. The deciduous teeth are already discolored from root resorption.



► **Fig. 2.46 Maxilla, late mixed dentition.** In late mixed dentition of the maxilla, all of the deciduous teeth have fallen out but the permanent ones have not yet completely erupted. The gums are reddened and the teeth show multiple deposits. Exfoliation is often accompanied by inflammation of the surrounding gingiva. The associated pain prevents the cat from using its teeth properly. In most cases, once the permanent teeth fully erupt, they are used for eating, the deposits disappear, and the inflammation subsides.



► **Fig. 2.48 Feline tongue.** The feline tongue, with its pronounced filiform papillae directed toward the pharynx, is perfectly suited for grooming and for transporting food. When examining the tongue, it is very important to check the floor of the mouth. For some conditions, particularly in the case of squamous cell carcinoma at the base of the tongue, palpating the mandibular space can reveal hardening early on in the disease course. Considering the relatively high prevalence of such malignancies in older cats, the veterinarian should always check for them in hidden locations, especially if the owner reports any changes in eating habits.

## 2.4

**Intraoral Radiography**

To obtain evaluable radiographs of the teeth, intraoral radiographs are indispensable. The film or sensors are placed intraorally to ensure that the teeth, including their roots, are visualized with minimal superimposition. To ease orientation of the radiographic beams, the animal should be placed in sternal recumbancy when imaging the maxilla (► Fig. 2.49, ► Fig. 2.51) and in dorsal recumbancy when imaging the mandible (► Fig. 2.50, ► Fig. 2.54). The head should be placed such that the occlusal plane is horizontal or parallel to the table top.



► Fig. 2.49 Positioning a dog for radiography of the maxilla.



► Fig. 2.51 Position a cat for radiography of the maxilla. In this case, gauze sponges are used to hold the digital sensor in place.



► Fig. 2.50 Positioning a dog for radiography of the mandible.



The parallax technique is most commonly used in orthopedic radiology. However, given dog and cat anatomy, this technique can be used only for the mandibular molars (► Fig. 2.55). The radiographic film is placed parallel to the tooth to be imaged, and the radiographic beam hits both planes perpendicularly, thus ensuring an isometric projection. The other regions of the oral cavity do not allow this arrangement. Thus, the bisecting angle technique is required instead (► Fig. 2.52, ► Fig. 2.53, ► Fig. 2.54). With this technique, the radiographic beam is directed perpendicularly to the bisecting line between the film and long tooth axis in order to ensure an isometric projection. Using a standard position for the animal thus helps defined values to be used for applying the radiographic beam.



► Fig. 2.52 Frontal view of the setting of the radiographic beam for visualization of the maxillary molars in a cat. To prevent superimposition of the molars, the central radiographic beam must be set more horizontally when imaging the maxillary cheek teeth. In dogs, this angle is 45° and in cats, 30°.



► Fig. 2.54 Radiographic beam placement for visualization of the mandibular incisors. As a compromise, the placement is gradually shifted in the area of the mandibular front teeth in order to visualize incisors and canine teeth in the same radiograph and the values averaged.



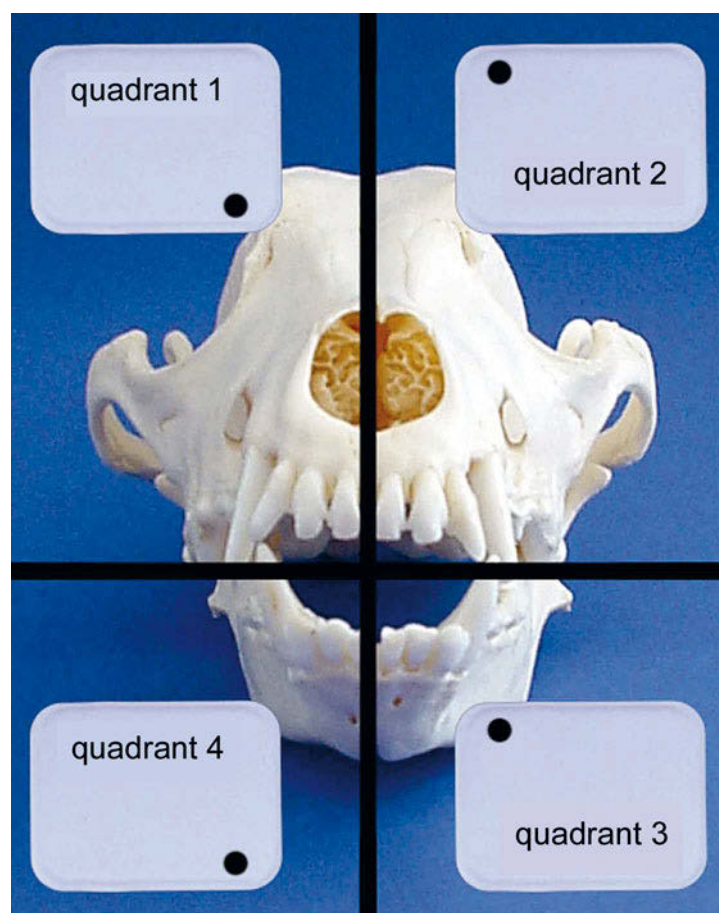
► Fig. 2.53 Radiographic beam placement for visualization of the maxillary incisors. For an isometric projection of the teeth, the radiographic beam is set perpendicular to the line bisecting the space between the film and the long tooth axis.



► Fig. 2.55 Radiographic beam placement for visualization of the mandibular cheek teeth. The root apices in the mandible can be visualized with a ventral inclination of up to 15°. Visualizing the mandibular molars is generally easiest because the parallax technique can be used.



In order to orient the images, the film is embossed with a dot or other mark. For intraoral placement, the embossed dot is always placed on the mesial side. Once the maxilla and mandible have been identified on the image, the correct side can be identified because the convex embossed dot is always oriented mesially (► Fig. 2.56).



► **Fig. 2.56 Film orientation.** Consistent placement of the film during imaging allows for correct orientation of the film. The convex embossed dot on the side to be exposed is always oriented mesially, which allows subsequent identification of the quadrants.

The following figures illustrate the radiographic visualization of the transition from deciduous dentition to permanent dentition in a dog:

► Fig. 2.57, ► Fig. 2.58, ► Fig. 2.59, ► Fig. 2.60, ► Fig. 2.61, ► Fig. 2.62, ► Fig. 2.63, ► Fig. 2.64, ► Fig. 2.65, ► Fig. 2.66, ► Fig. 2.67, ► Fig. 2.68, ► Fig. 2.69, ► Fig. 2.70, ► Fig. 2.71, ► Fig. 2.72.



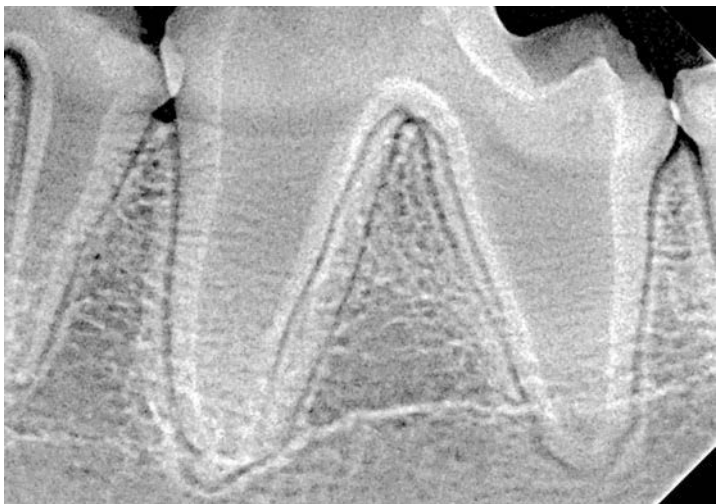
► **Fig. 2.57 Radiograph of the maxillary right carnassial tooth in a dog.** In orthogonal projection, the mesial roots are often superimposed during visualization of the maxillary carnassial tooth. To visualize the roots in the radiograph, the parallax method is used. Mesial and distal projections pull the roots apart in the image. The width of the vital pulp is a distinct sign of a young dog. Development has progressed to the point that a physiological periodontal ligament space appears as a black line around the roots.



► **Fig. 2.58 Radiograph of the maxillary right canine tooth in a dog.** The canine root apex is not yet fully developed. In young dogs, a fractured tooth cannot be treated with conventional root canal therapy because no apical stop is present and the root canal filling would be pressed onto the jawbone.



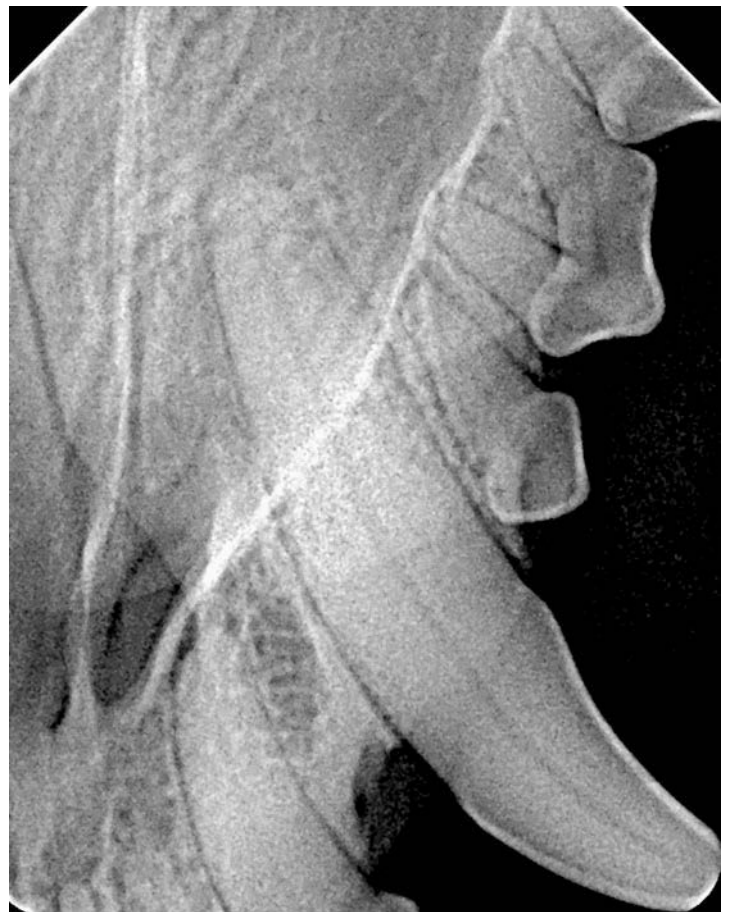
► **Fig. 2.59 Radiograph of the maxillary incisors in a dog.** The root apices of the maxillary incisors are still developing, and the apical stop is still fragile. The maxillary symphysis is located between the central incisors. The alveolar ridge line normally starts just below the cemento-enamel junction.



► **Fig. 2.60 Radiograph of the mandibular left carnassial tooth.** Directly below the root apices of the tooth, the mandibular canal can be seen as a translucent area without cancellous bone.



► **Fig. 2.61 Radiograph of the maxillary left carnassial tooth in an adult dog.** The pulp chamber has decreased in size as the dentin layer has widened due to increasing "inward" growth.



► **Fig. 2.62 Radiograph of the maxillary left canine tooth in an adult dog.** The pulp is still present, no thicker than a thread. The apex is inconspicuous and the periodontal ligament space is even. Apically, a slight translucency is visible due to the type of projection and the presence of an apical delta, and this is physiological. The vessels and nerves enter and exit the pulp via a widely ramified network rather than a central channel found in humans.

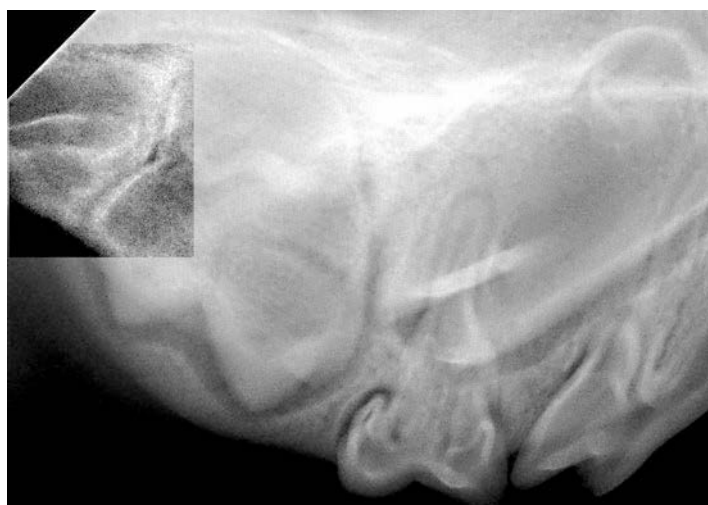




► **Fig. 2.63 Radiograph of the mandibular front teeth in a young dog.** The root apices are not yet closed and the lumen of the dental pulp of the canine teeth is very wide.



► **Fig. 2.64 Radiograph of the canine teeth in an adult dog.** In adult dogs, the same teeth (cf. ► Fig. 2.63) have significantly smaller pulpal lumen and a closed root apex. The surrounding periodontal ligament space is unremarkable.



► **Fig. 2.65 Radiograph of the maxillary right molars in mixed dentition in a dog.** The completeness of the dog's permanent dentition can be visualized radiographically by the age of 3 months. By this stage of their development, the caudal molars are not yet fully developed. The mineralization of the crown is just barely detectable (in cut-out, highlighted by the contrast medium).





► **Fig. 2.66 Radiograph of the maxillary right molar in mixed dentition in a dog.** The deciduous teeth are still visible at the alveolar ridge, and the crown of the permanent carnassial tooth is under development.



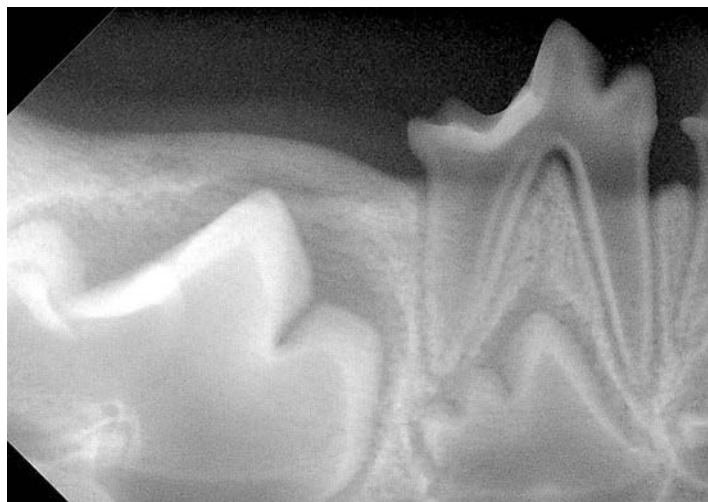
► **Fig. 2.68 Radiograph of the maxillary incisors.** The permanent maxillary incisors are located closely below the deciduous incisors. The actual dental arch cannot form until the jaw starts growing and the permanent incisors have erupted further.



► **Fig. 2.67 Radiograph of the maxillary right premolar and canine tooth.** During development, a distinct translucent space can be seen around the buds of the premolars. The cusp of the canine tooth is located as close to the deciduous root as the permanent premolar cusps are located to their deciduous precursor. The first premolar physiologically has no precursor tooth.



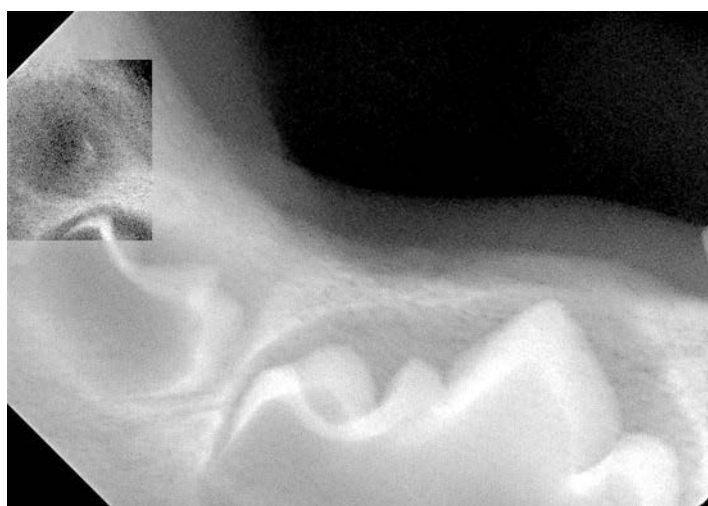
► **Fig. 2.69 Radiograph of the mandibular front teeth.** Due to the tight anatomical circumstances, the veterinarian must carefully count the number of teeth on a radiograph in order to confirm that the correct number of teeth is present.



► **Fig. 2.71 Radiograph of the mandibular right carnassial tooth.** The mandibular right carnassial tooth does not have a deciduous precursor, since it develops from a distal extension of the dental ridge.



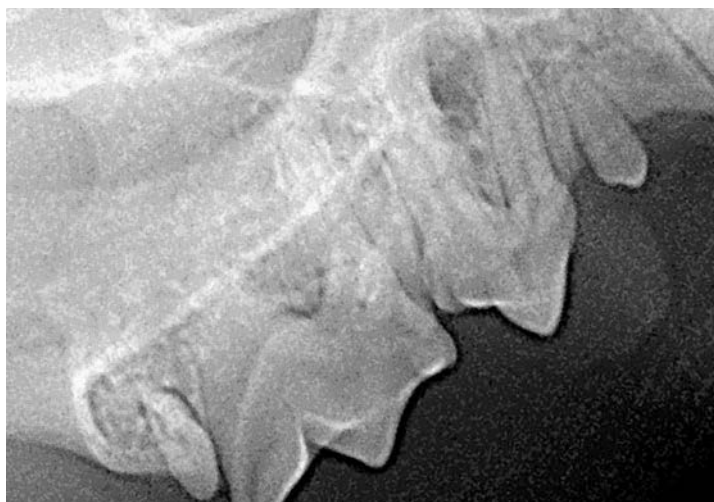
► **Fig. 2.70 Radiograph of the mandibular right premolars.** The subsequent permanent teeth are located between the widely spread roots of the deciduous teeth. The first premolar is already further developed and does not have a deciduous precursor tooth.



► **Fig. 2.72 Radiograph of the last mandibular right molars.** In this dog, at this point in time, the third molar, the last one to develop, can be identified solely by the presence of its cusp.



The following figures (► Fig. 2.73, ► Fig. 2.74, ► Fig. 2.75, ► Fig. 2.76) show radiographic visualization of individual teeth in the cat.



► **Fig. 2.73 Radiograph of the maxillary right cheek teeth in a cat.** The proximity of the molars to the zygomatic arch necessitates a more horizontal orientation of the radiographic beam in order to be able to visualize the teeth with as few superimpositions as possible.



► **Fig. 2.75 Radiograph of the mandibular left cheek teeth in a young cat.** With the parallax technique, the premolars and the molar can be visualized well. Here too, the wide pulp chamber is indicative of the cat's youth. A wide pulp chamber in a mature animal indicates that the tooth is nonvital and requires treatment.



► **Fig. 2.74 Radiograph of the maxillary right canine tooth and incisors in a cat.** Aiming the beam slightly laterally enables the canine teeth and incisors to be imaged. Imaging the left side in a similar fashion often eliminates the need to separately image the incisors.



► **Fig. 2.76 Radiograph of the mandibular front teeth in a cat.** The mandibular symphysis of the cat normally appears as a distinct, irregular translucent area at the junction of the two bodies of the mandible.

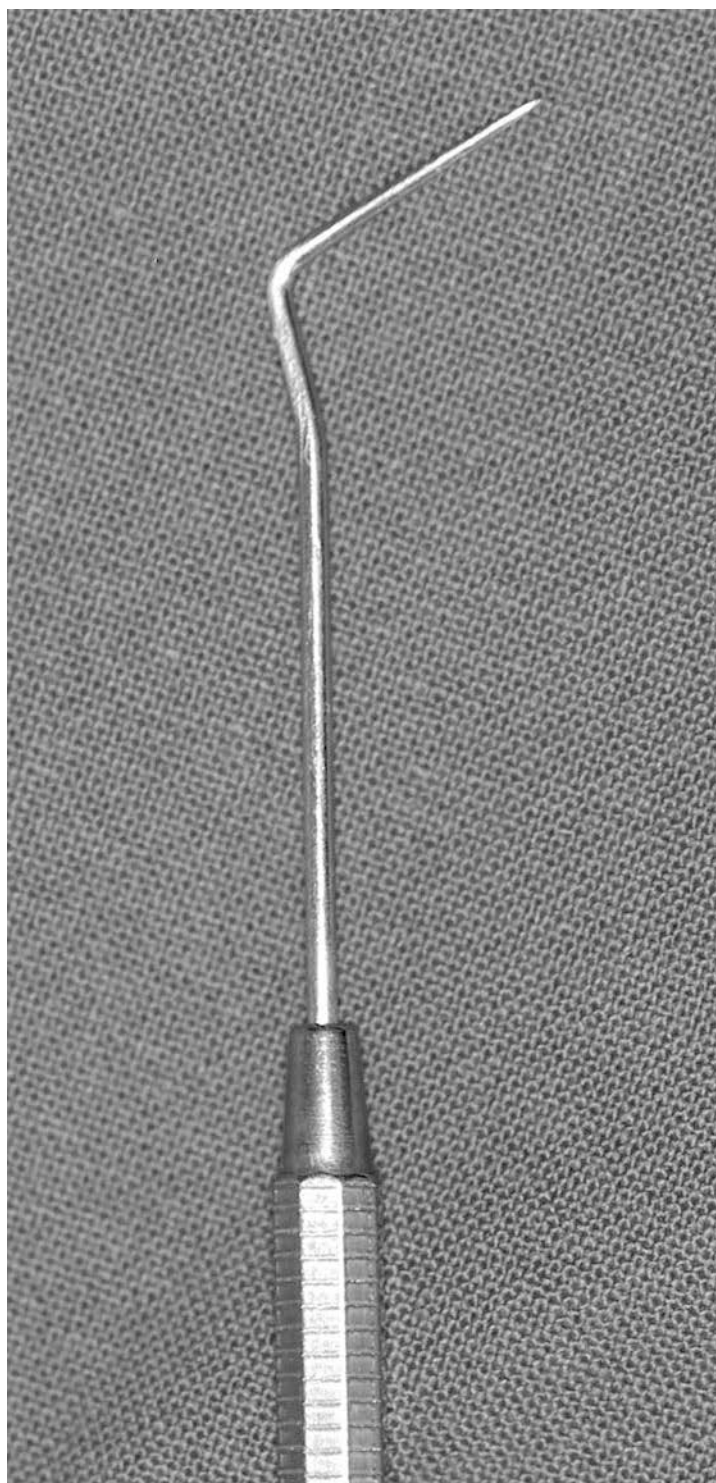


## 2.5

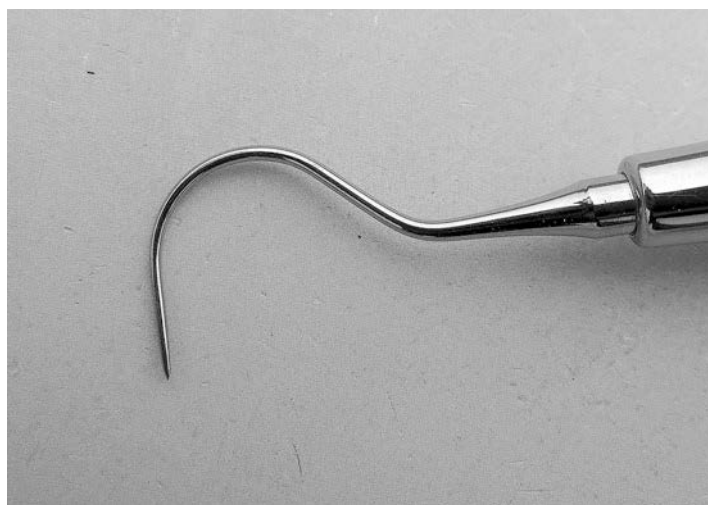
**Dental Probing**

Probing is used to supplement a visual oral examination. To detect subtle structural changes at the crown, a dental probe with a pointed tip is quite useful (► Fig. 2.77, ► Fig. 2.78, ► Fig. 2.79). In contrast to the dental probes used at the supragingival level, a periodontal probe is used in the subgingival area. It is used to measure the gingival sulcus between the tooth and the gingiva. A periodontal probe is graduated (► Fig. 2.80) and the pocket depth is read directly. The pocket depth increases as periodontal disease progresses. When choosing among the wide range of probe types, an important criterion is good readability of

the pocket depth (► Fig. 2.81). The individual measurements are recorded and taken together, they offer an assessment of periodontal health. Probing also reveals individual vertical infrabony pockets that are often overlooked during examination, particularly in the absence of inflammatory signs.



► **Fig. 2.77 Dental probe.** A dental probe has a sharp tip for detecting irregularities on the tooth surface.

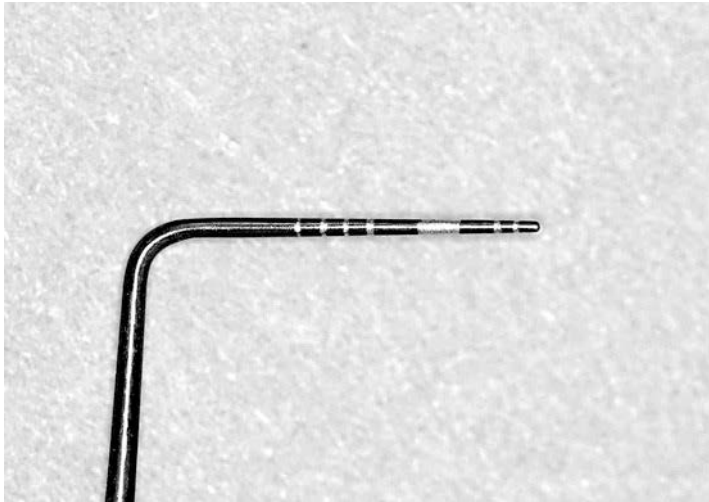


► **Fig. 2.78 IM3 dental probe.** IM3 produces a combined dental and periodontal probe. The pointed dental probe reveals defects in the area of the crown such as fissure lines, fine exposure of the pulp or resorptive defects.

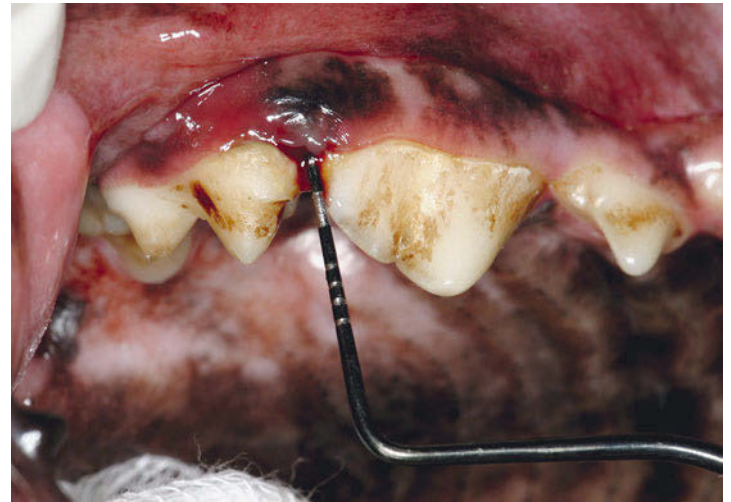


► **Fig. 2.79 Using a dental probe to diagnose a fractured tooth.** The dental probe can move the fractured buccal lamella of the mandibular carnassial tooth.

The veterinarian must practice using a periodontal probe in order to develop a feel for proper handling and be able to measure the pocket depths accurately (► Fig. 2.82). In an awake animal, deep penetration of the periodontal probe in the damaged periodontium can help to explain to the owner that the animal requires treatment (► Fig. 2.83). The situation is particularly urgent when damage to the periodontium involves other structures of the skull, such as the nasal cavity (► Fig. 2.84, ► Fig. 2.85).



► **Fig. 2.80 Periodontal probe.** A periodontal probe has graduated markings for measuring the depth of the gingival sulcus and periodontal pocket. Pathological findings about the specific surface of a tooth are noted on the dental chart.



► **Fig. 2.82 Probing at the sulcus.** The dental probe is placed with the blunt tip between the tooth and the gingival margin.

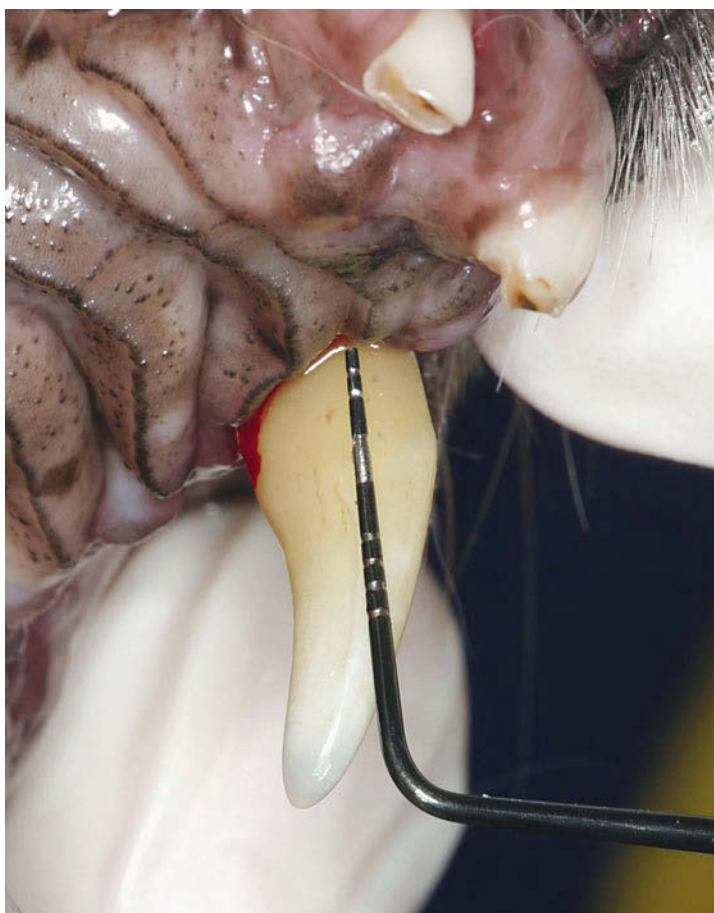


► **Fig. 2.81 iM3 periodontal probe.** The opposite end of the iM3 probe has a periodontal probe. The probe has a measuring scale in millimeters with special color markings at 5, 10, and 15 mm, making the pocket depth easy to read. The millimeter markings also make it easy to measure the pocket depths in cats.

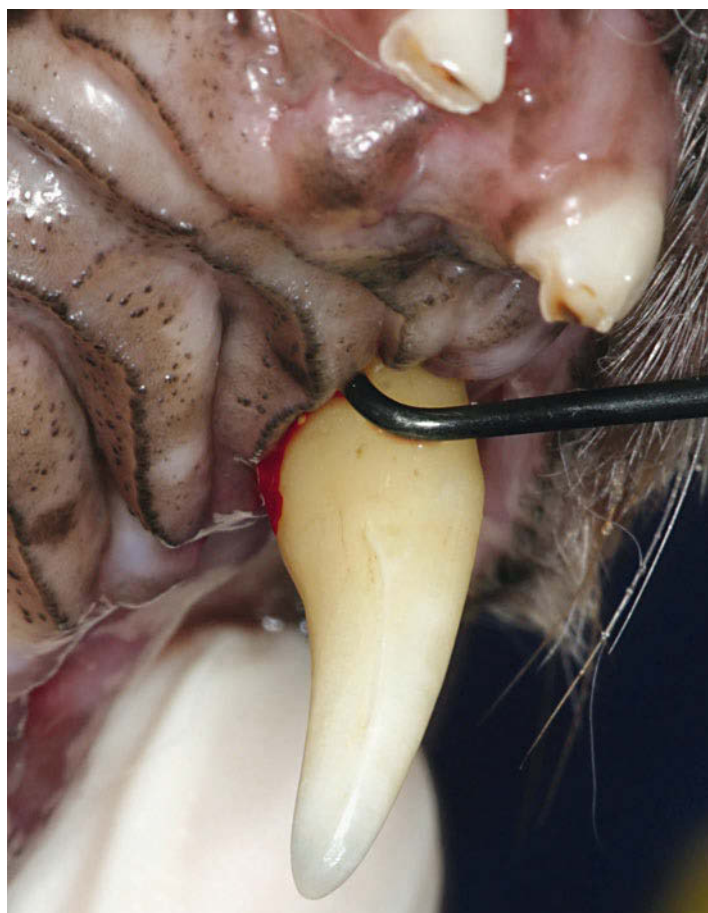


► **Fig. 2.83 Probing into the sulcus.** The probe is introduced into the periodontal sulcus of the first molar of this dog without applying pressure. The damage to the bony periodontal apparatus allows the probe to be introduced to a depth greater than the normal depth of 2 mm.





► **Fig. 2.84 Probing the periodontal pocket.** The rounded tip is placed at the free margin of the palatal gingiva adjacent to the maxillary canine tooth.



► **Fig. 2.85 Probing the periodontal pocket.** The periodontal probe is introduced on the palatal side down to the distance at which it bends. This is only possible if a massive bony defect is present. In this periodontal pocket, destruction of the attachment fibers occurs with resorption of the surrounding alveolar bone. In many cases, an opening to the nasal cavity is found because of its proximity, so probing may trigger nasal bleeding of the affected side.

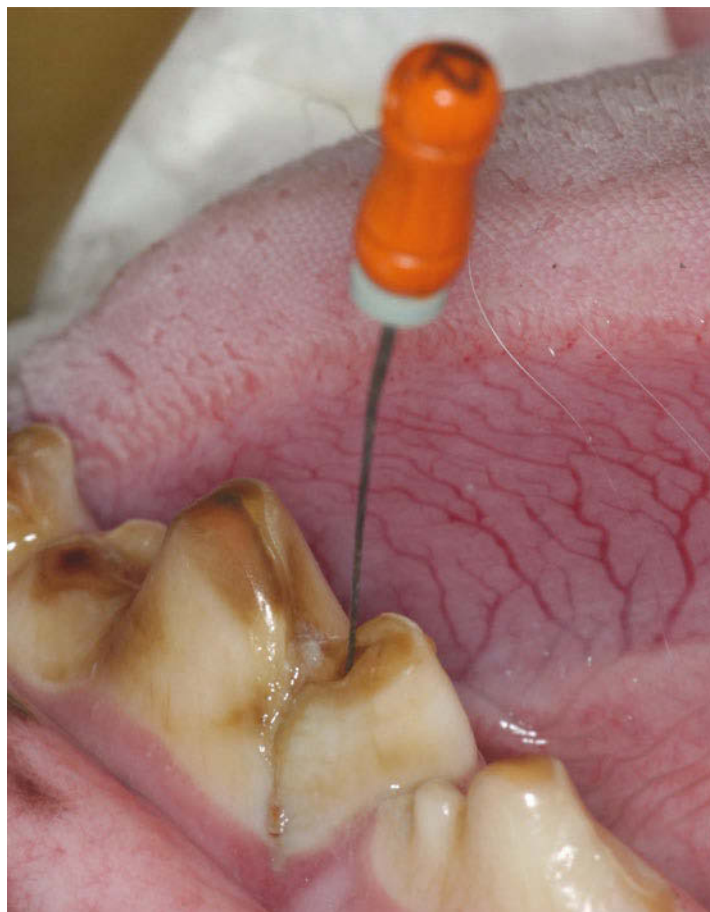


In addition to vertical insertion into a sulcus, the periodontal probe can be used to examine a furcation near the crown of a tooth (► Fig. 2.86).



► **Fig. 2.86 Using a periodontal probe to probe a furcation defect.** The periodontal probe is introduced horizontally on a dog's maxillary left premolar. Due to the bone resorption in the area of the furcation, the probe penetrates completely and reappears on the palatal side.

If a pointed dental probe is too thick to palpate an exposed pulp cavity, finer instruments are available (► Fig. 2.87).



► **Fig. 2.87 Endodontic needle as a probe.** Instead of a dental probe, an endodontic instrument is used to explore pulp involvement. An extremely fine and rigid "pathfinder" is used to verify pulp exposure that was not identified with a dental probe.

## 3 Interpreting Clinical Signs

### 3.1

### Interpreting Clinical Signs of Pediatric Disorders

Young animals may already present with conditions that require acute treatment (► Fig. 3.1) or predict certain disorders that may occur when older. Dental disorders do not start exclusively in older animals; rather, they often originate when animals are young.



► **Fig. 3.1 Median cleft palate.** Incomplete morphogenesis may result in an oronasal fistula due to failed fusion of the palate. Both the extent and location of the defect vary widely, ranging from a primary cleft lip to a secondary cleft palate. This dog's median cleft palate starts directly caudally to the incisive papilla. In the center of the palate, the palatine shelves merely touch, so the defect is continuous. Caudally, the defect continues to the soft palate. The extent of the defect was not clear until after dissection: a defect over the entire palate preventing separation between the oral and nasal cavities. This allows food to enter the nose and impair swallowing as food returns to the nose instead entering of the esophagus.

Some breeds are predisposed to certain tooth misalignments (► Fig. 3.2).



► **Fig. 3.2 Partially retained mesioverted canine tooth (lance canine tooth).** The maxillary right canine tooth does not occlude normally. Instead, only the cusp of the crown is seen; the tooth is displaced mesially and contacts the lower canine tooth. In Shetland Sheepdogs, mesioverted canine teeth are a relatively common hereditary disorder, but this disorder can generally affect any breed.

A common orthodontic problem in dogs involves linguovered mandibular canine teeth, which can result in trauma to the palate (► Fig. 3.3).



► **Fig. 3.3 Linguovered mandibular canine tooth.** Linguoversion of the mandibular right canine tooth causes painful piercing of the palate, adjacent to the periodontium of the maxillary right canine tooth. Fixed in this position, the tooth accumulates plaque inside the impression, and inflammation occurs. The teeth cannot be moved into physiological occlusion due to a lack of interdental space in the mandible.



Disturbances or trauma during the development of dental follicles may lead to anomalies detected when these teeth erupt (► Fig. 3.4).



► **Fig. 3.4 Enamel hypoplasia.** Enamel hypoplasia is a condition that affects the developing follicle but does not become evident until teeth erupt. It may affect individual teeth, or may occur as a generalized process.

To prevent problems arising from teeth developing inside the jaw, radiography is indicated to confirm the presence or absence of teeth, including nonessential teeth (► Fig. 3.6).



► **Fig. 3.6 Missing mandibular first premolar.** In contrast to the maxillary canine tooth, the mandibular first premolar is considered to be evolutionarily unimportant for the species and thus may be underdeveloped or even absent. Here, too, radiography is indicated to confirm the presence or absence of the tooth because this small premolar can cause extensive trauma to adjacent teeth and the mandible.

Some teeth, such as the mandibular first premolar, are no longer developed for evolutionary reasons. In other cases, a tooth that is not normally affected by this evolutionary reduction is missing (► Fig. 3.5). In both cases, radiography is indicated.



► **Fig. 3.5 Missing maxillary canine tooth.** A missing canine tooth is not an evolutionary advancement; thus its absence is not physiological. For this reason, further diagnostics are required to clarify the presence or absence of the tooth.



In addition to missing or retained teeth, malformed teeth are also observed (► Fig. 3.7, ► Fig. 3.8).



► **Fig. 3.7 Malformed maxillary incisor.** This malformed maxillary right intermediate incisor (102) clearly demonstrates how a nonfunctional periodontium can rapidly deteriorate. The deformity exists from the start of tooth formation, so such changes are apparent in young animals.



► **Fig. 3.8 Malformed maxillary molar.** While incisor deformities are obvious since they are easy to see, deformities such as this malformed maxillary first molar require close examination of the entire oral cavity.

### 3.2

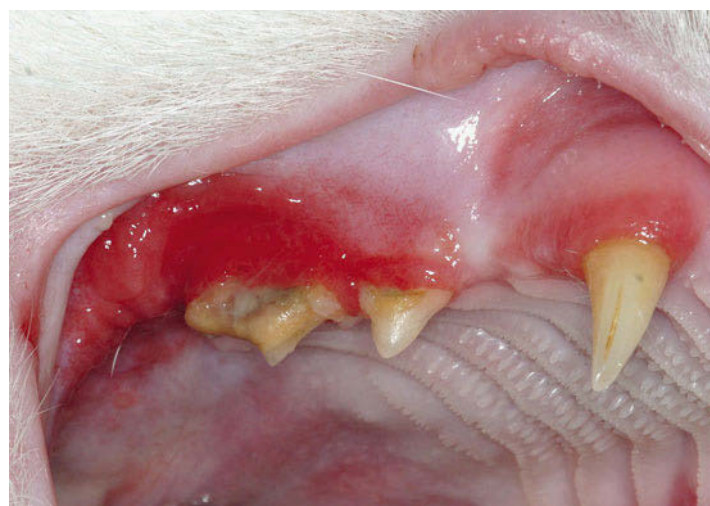
## Interpreting Clinical Signs of Periodontal Disorders

Periodontal disorders are extremely common in both dogs and cats. Nearly four out of five dogs manifest periodontal disease by middle age (► Fig. 3.9). However, sometimes it can be difficult to diagnose properly because of the lack of obvious signs in patients, particularly uncooperative ones. Due to the condition's effect on organs such as the heart, liver and kidneys, however, detecting and treating periodontal disease should be a priority.



► **Fig. 3.9 Severe dental calculus in a dog.** In both dogs and cats, an accumulation of plaque and calculus is the most obvious sign of periodontal disease. In animals affected as severely as the dog in this image, it is generally not necessary to examine the animal while awake, because further diagnosis comprising probing and radiography must be performed with the animal under general anesthesia.

Although the feline bite is generally conducive to self-cleaning during mastication due to the cutting (secodont) morphology of the teeth, many cats still develop periodontal disease (► Fig. 3.10).



► **Fig. 3.10 Severe tooth deposits in a cat.** In most cases, the extent of tooth deposits varies depending on tooth involvement in mastication. The outer surfaces of the maxillary cheek teeth are, therefore, a good indicator of the cat's overall disease progression. Extensive soft tissue involvement of the adjacent mucosa may also be observed.



All asymmetries in the oral cavity and on the teeth should be explored (► Fig. 3.11, ► Fig. 3.12).



► **Fig. 3.11 Moderate tooth deposits in the right maxilla of a dog.** The asymmetry is only apparent when the right side is compared to the left side (► Fig. 3.12).

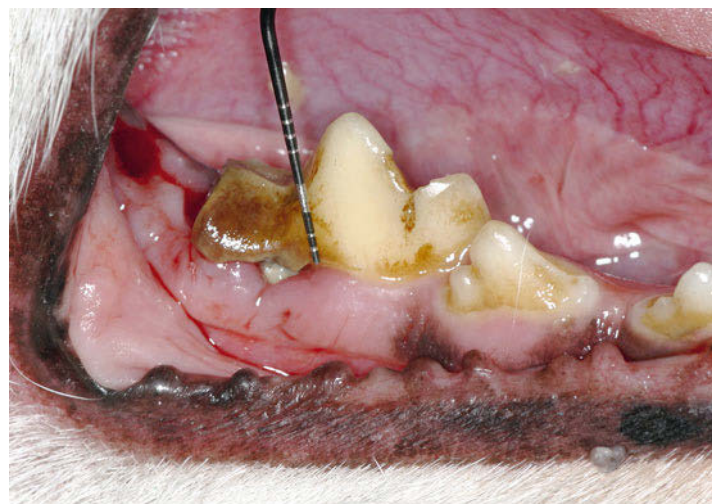


► **Fig. 3.13 Purulent exudate due to periodontitis in a dog.** Purulent exudate is an indication that periodontitis is advanced. If the bacterial accumulation overwhelms the host's immune system, the gingival sulcus serves as a response center, becoming a "war zone".

Not all parts of a bite are affected to the same extent by periodontal disease. Local periodontitis in an otherwise unremarkable bite is common. Probing (► Fig. 3.14, ► Fig. 3.15, ► Fig. 3.16, ► Fig. 3.17) and radiography allow detection of these changes and examination in detail. It is especially important to detect periodontal disease processes that can involve other anatomical structures and permanently injure the animal.



► **Fig. 3.12 Severe tooth deposits in the left maxilla of a dog.** If a dog presents with an accumulation of plaque and calculus that is unevenly and asymmetrically distributed (same dog as in ► Fig. 3.11), the reason must be determined. Typically, the more severely affected side is painful, so the dog tends to avoid chewing in this area; as a result, it tends to accumulate more deposits due to the lack of the abrasive function of food. The mandibular lymph node of the affected side can provide additional information on possible inflammatory processes because only the local lymph node of the affected area is enlarged.



► **Fig. 3.14 Periodontal probing of the infrabony pocket of a mandibular carnassial tooth.** When a periodontal abnormality is discovered, such as this abnormal gingival cover near the furcation of the mandibular carnassial tooth, the depth of the gingival sulcus or periodontal pocket can often be measured with a periodontal probe without placing the animal under general anesthesia.





► **Fig. 3.15 Periodontal probe introduced completely into the infrabony pocket** (cf. ► Fig. 3.14). The graduated markings on the probe can be used to measure the pocket depth. Pocket depths of more than 2 mm in a dog and more than 1 mm in a cat require further exploration.



► **Fig. 3.16 Palatal periodontal probing of a maxillary canine tooth.** In some breeds, such as Dachshunds, the palatal surfaces of the maxillary canine teeth appear to be predisposed to developing an infrabony pocket. In this picture, the periodontal probe is placed palatally to the gingival sulcus.



► **Fig. 3.17** Periodontal probe completely introduced into the infrabony pocket (cf. ► Fig. 3.16). The depth of the pocket and its thin palatal border with the nasal cavity may indicate an oronasal fistula.

If a maxillary canine tooth has fallen out or been extracted, an oronasal fistula may result (► Fig. 3.18, ► Fig. 3.19).



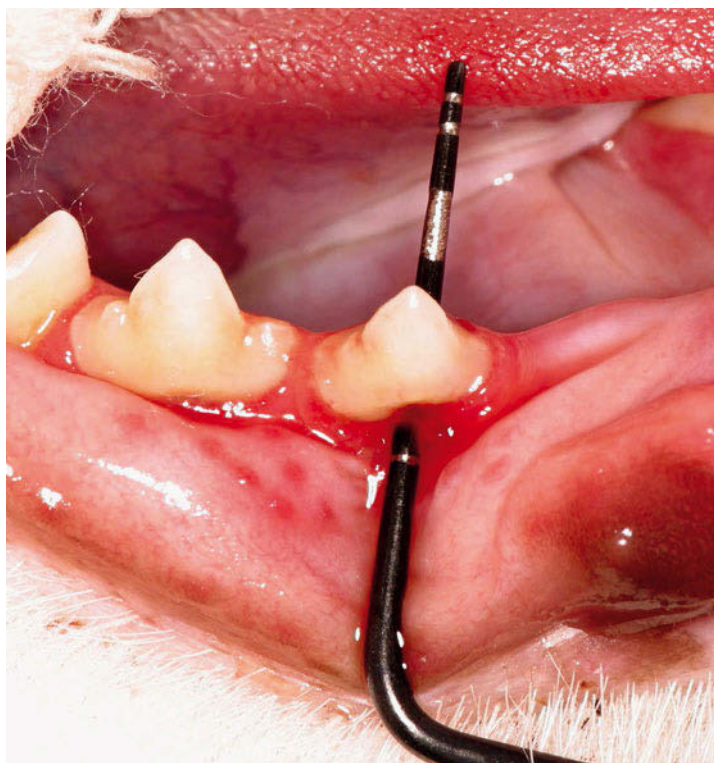
► **Fig. 3.18 Periodontal probe placed at the opening of a gingival oronasal fistula.** In this case, the maxillary canine tooth is missing and a small opening can be seen.



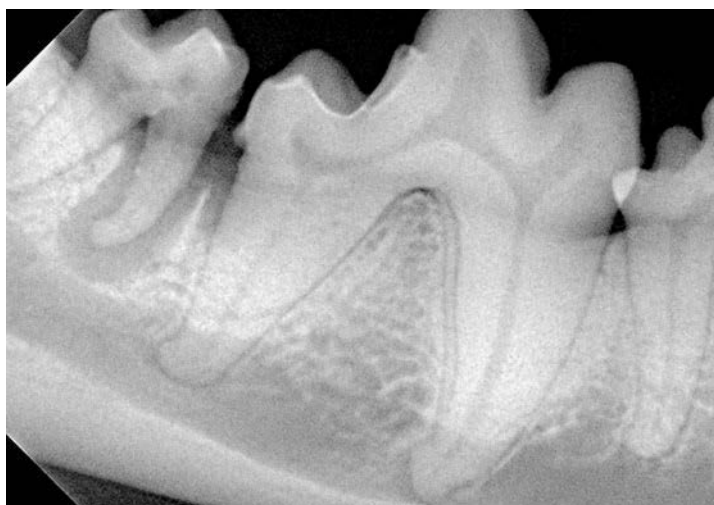
► **Fig. 3.19 Periodontal probe introduced in the fistulous tract.** The periodontal probe penetrates the nasal cavity unhindered; thus, an oronasal fistula is present.



If a probe can be advanced completely through a furcation defect, advanced periodontal disease is present. The probe findings show the clinical extent of the damage (► Fig. 3.20) and they are confirmed with radiography (► Fig. 3.21). The more caudal the periodontal pocket, the more difficult it is to explore it with a periodontal probe.



► **Fig. 3.20 Horizontal probing of furcation using a periodontal probe.** The periodontal probe can be applied horizontally to evaluate bone loss in the area of the furcation. Depending on severity, the furcation can be palpated or even penetrated.



► **Fig. 3.21 Osteolysis of the mesial root of the mandibular second molar.** The extent of bone damage can be assessed with a radiograph. If bone loss beyond the apical tip is visible, as in this dog at the mesial root of the mandibular second molar, treatment is imperative. This condition can be overlooked during a clinical examination without probing and radiography, however.

### 3.3

## Interpreting Clinical Signs of Trauma-related Conditions

Mechanical trauma to the facial skull often results in fractured teeth. But even damage to the teeth that is initially subtle can also eventually lead to later visible changes, such as suborbital swelling. This gradual, long-term process can be problematic because it is associated with inflammation and pain but is clinically inapparent for a long time (► Fig. 3.22).



► **Fig. 3.22 Abrasions of the left canine teeth.** Abnormal wear of the left canine teeth has caused significant abrasion. Tooth wear from foreign objects is referred to as abrasion, while tooth wear from mastication is referred to as attrition. The exposure of the pulp cavity cannot be verified with a probe, although the pulp at the maxillary canine tooth appears to be involved. Even without pulp exposure, abrasion can lead to pulpitis; therefore, radiography is indicated.

In addition to altered shapes, deviations in tooth color can be signs of disease (► Fig. 3.23, ► Fig. 3.24). A pathological process in the pulp can lead to a change in color and even without substantial external damage, treatment is usually indicated.



► **Fig. 3.23 Discoloration of a mandibular molar.** The normal color of a tooth is snow white, smooth, and shaped to match its function. A livid, pink, or brownish discoloration indicates a change occurring within the tooth. If deposits on the outside of the tooth are ruled out, endogenous processes that alter the normal appearance of the tooth should be considered, such as pulp canal obliteration or an inflammatory process.

Experience helps inform the veterinarian of typical dental trauma to check for (► Fig. 3.25).

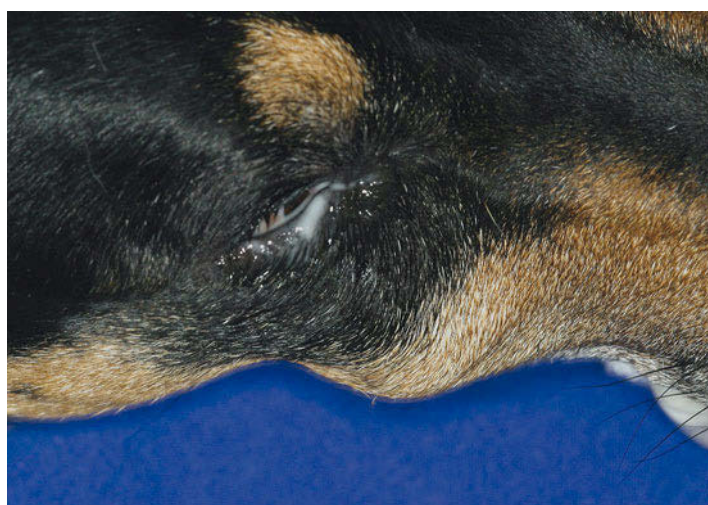


► **Fig. 3.25 Fractured maxillary carnassial tooth.** The shearing forces during mastication can overtax the maxillary carnassial tooth, causing the crown and the buccal lamella to break. In many cases, the fracture line runs below the gumline. If the entire outer wall is absent and the site is covered with plaque, it is easy to overlook this type of lesion.

If the pet owner has failed to notice the damage, the animal is often not presented until swelling of the jaw is already underway (► Fig. 3.26, ► Fig. 3.27).



► **Fig. 3.24 Discoloration of a maxillary canine tooth.** The long, exposed canine teeth are particularly predisposed to impaired pulp vitality due to the excessive load, which can lead to discoloration. Radiography should be used to verify the vitality of this tooth.

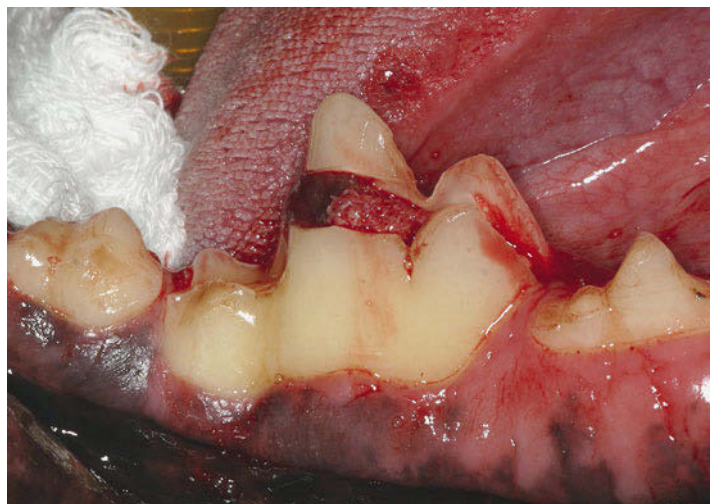


► **Fig. 3.26 Suborbital swelling on the right.** Suborbital swelling is often caused by trauma to the maxillary carnassial tooth or the first molar and is thus of dental origin.





► **Fig. 3.27 External swelling caused by abrasion of the maxillary right carnassial tooth.** As illustrated here, a tooth need not be significantly exposed or fractured to initiate an apical process of swelling in the root area.



► **Fig. 3.29 Freshly fractured mandibular carnassial tooth.** A mandibular right carnassial tooth fracture with exposed, bleeding pulp is an acute condition. Bleeding from the tooth is a pathognomonic sign of involvement of the pulp. While acute fractures are quite painful, the animal's response to this pain when playing, for instance, depends on its temperament. Not every (working) dog shows obvious signs of such a lesion, despite the strain it is subjected to.

In addition to the carnassial teeth, the long, exposed and functionally high-performing canine teeth are particular targets for trauma, which generally leads to pulp exposure (► Fig. 3.28). Bleeding from a broken tooth is always a sign of pulp involvement (► Fig. 3.29).

Even without pulp exposure, trauma to the covering enamel and dentin can cause the tooth to develop pulp inflammation (► Fig. 3.30). If no bleeding is present, the exposure of a tooth can be confirmed through probing with a sharp-tipped probe (► Fig. 3.31). The finer the exposure site and the thinner the pulp canal, the thinner the instrument used to find the defect must be (► Fig. 3.32).



► **Fig. 3.28 Fractured maxillary canine teeth.** In an obviously traumatized tooth, further diagnostics are needed to determine the best treatment options. In this case, the maxillary left canine tooth is exposed, and the pulp toward the crown is already nonvital. The fractured maxillary right canine tooth must be examined for pulp damage. Since the fractures to both teeth appear to be older, radiography is needed to determine whether the teeth can be preserved.

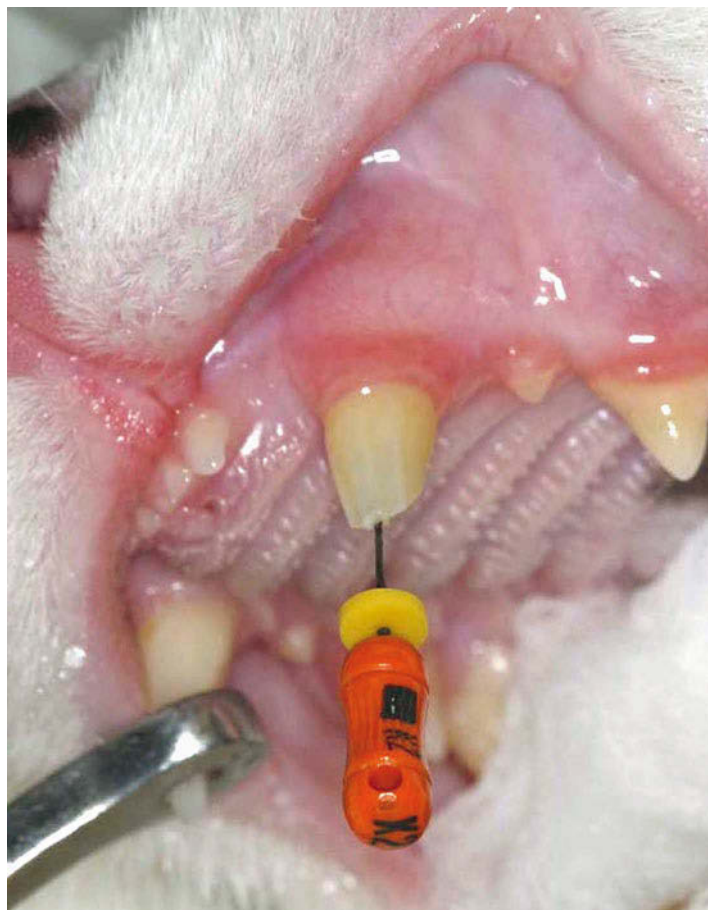


► **Fig. 3.30 Fistula on an abraded maxillary canine tooth.** Abrasion on this maxillary left canine tooth has caused pulp exposure and pulp death. The fistula opening at the level of the mucogingival junction with an inflammatory discharge shows that this is a chronic process.



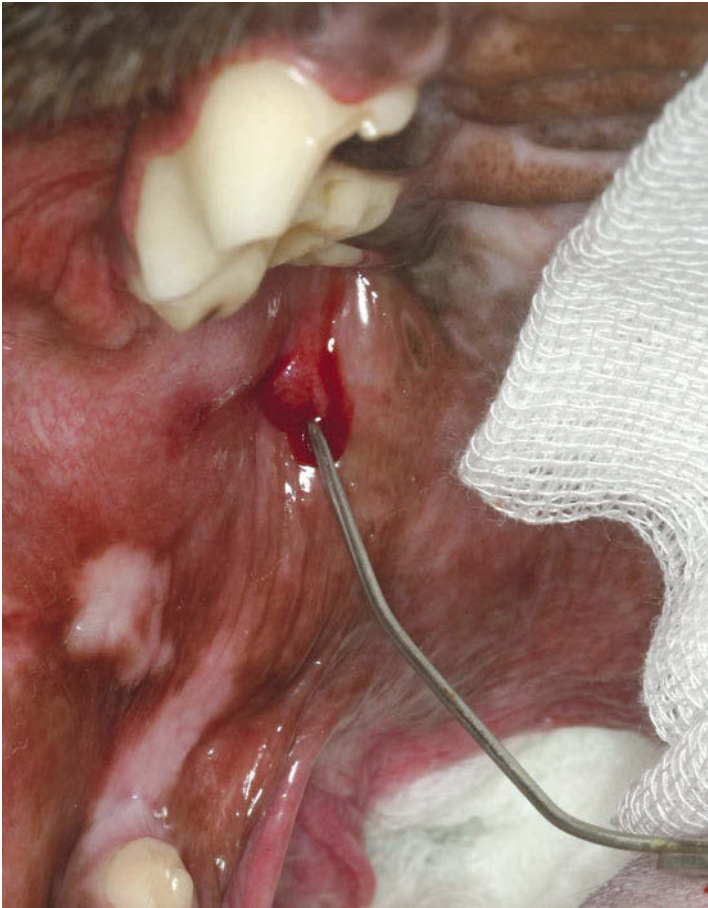


► **Fig. 3.31 Probing the exposed pulp cavity of a mandibular canine tooth.** If any uncertainty exists about whether the pulp cavity is exposed and treatment is imperative, using a dental probe is helpful. With the tip of the probe, you should be able to penetrate the pulp. In an older fracture, bleeding generally can no longer be provoked and is no longer a criterion for evaluating the damage.

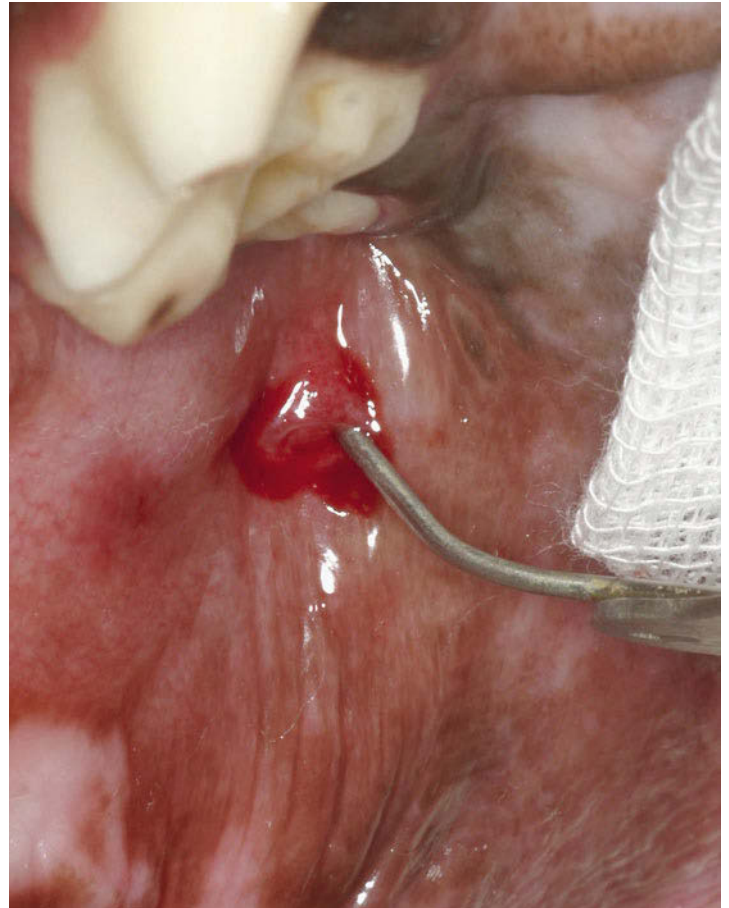


► **Fig. 3.32 Probing the exposed pulp cavity of a maxillary canine tooth in a cat.** In cats, the smaller structures make probing a fractured tooth more challenging than in dogs. A more pointed endodontic instrument permits identification of the pulp lumen at the fracture area.

In addition to the teeth, the soft tissue can be traumatized by sharp objects (twigs, needles, etc.). While dental or periodontal probes are used to detect tooth defects, a longer, blunt Bowman probe is used to examine trauma to the mucosa (► Fig. 3.33, ► Fig. 3.34).



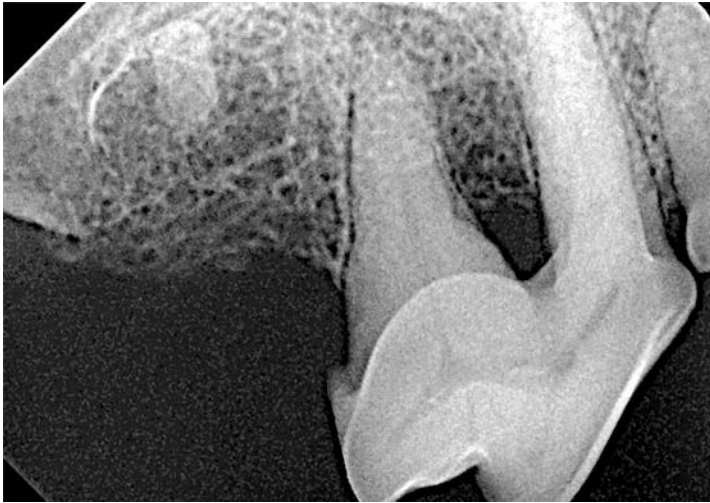
► **Fig. 3.33 Probing at a retromolar fistula opening.** Trauma in the oral cavity is not restricted to the teeth. Dogs that play with sticks unfortunately sometimes sustain retromolar stick injuries that go unnoticed due to their inconspicuous locations. Impairment does not occur until the dog has trouble opening its jaw or jaw closing is altered. In many cases, the only clinical sign of a stick injury is a residual fistula opening.



► **Fig. 3.34 Probe introduced deep into the retromolar fistulous tract from ► Fig. 3.33.** If the probe (in this case, a Bowman probe) can be introduced deeply in a retromolar fistulous tract, further diagnostics are needed (exploration, radiography).



If a tooth is missing, radiography can be used to detect any root fragments (► Fig. 3.35). Even minor damage to the crown can cause massive changes to the root and the surrounding bone (► Fig. 3.36).



► **Fig. 3.35 Radiograph of a molar root fragment.** Even in areas that appear to be clinically unremarkable and without inflammation, a retained root fragment may require treatment. If the situation is not treated, the practitioner must weigh the need for radiographic monitoring of this area, which appears to be unremarkable and free of inflammation, against the need to use anesthesia for radiography.

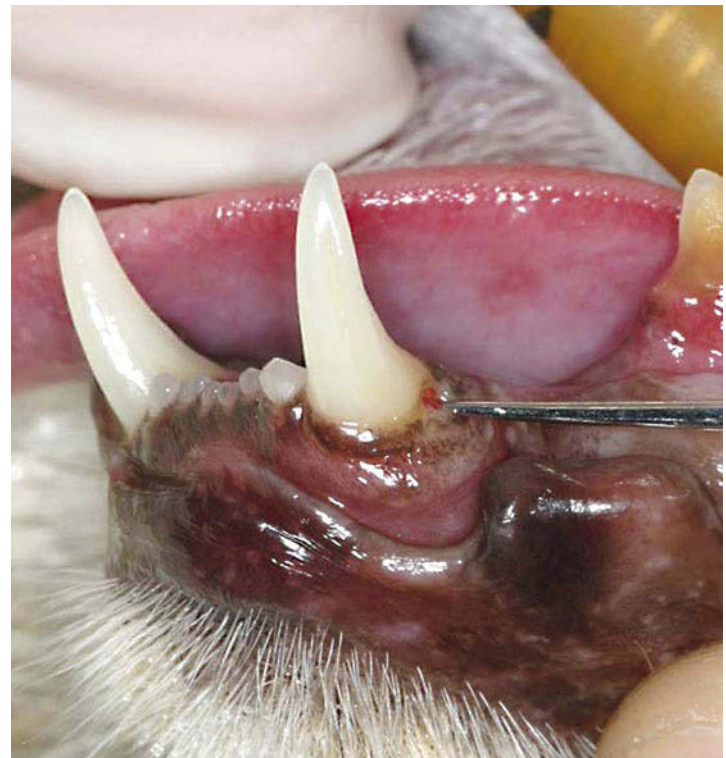


► **Fig. 3.36 Radiograph of apical osteolysis after a tooth fracture in a cat.** A pin-sized opening at the cusp of a feline canine tooth led to the severe effects of extensive osteolysis and root resorption. As in dogs, tooth fractures in cats must be treated.

### 3.4

## Interpreting Clinical Signs of Resorptive Disorders

The most familiar resorptive process in cats is tooth resorption, formerly known as feline odontoclastic resorptive lesions (FORL). To treat this complex problem properly, it is therefore worthwhile to find ways to detect the very small signs of this disorder (► Fig. 3.37). Considering the prevalence of such disorders, cats with clinical signs of the disease should always be radiographed (► Fig. 3.38). Even in cases with only moderate resorptive damage of a tooth (► Fig. 3.39), clinical and radiographic findings often correlate. If damage to a tooth is extensive, an intraoral radiograph serves to help select the optimal therapy, such as the extraction of retained root fragments (► Fig. 3.40, ► Fig. 3.41, ► Fig. 3.42).



► **Fig. 3.37 Probing a cervical defect of the mandibular canine tooth in a cat.** Given the prevalence of resorptive defects in feline teeth, a probe with a sharp tip is used to palpate for abnormalities, especially in the tooth's cervical area. A small indentation at the neck of this mandibular canine tooth may present as advanced root resorption in the radiographic image.



► **Fig. 3.38 Radiograph of early resorptive processes in a cat.** The furcation area of the cheek teeth is a fragile area that can often be palpated for lesions through horizontal probing. Radiographs can enable the practitioner to estimate the extent of bony involvement. In many cases, the osteolysis is combined with tooth resorption at the furcation site.



► **Fig. 3.40 Radiograph of advanced resorptive processes in a cat.** Cervical resorption of dental hard tissues can cause detachment of the apical roots, separating the root from the rest of the tooth. The clinical signs of the severely damaged distal root in the radiograph may have been masked by the proliferative processes of the surrounding gingiva.



► **Fig. 3.39 Radiograph of moderate resorptive processes in a cat.** In more advanced cases, the probe can often penetrate the furcation without applying any pressure. Radiography can be used to distinguish between periodontal and resorptive processes.



► **Fig. 3.41 Radiograph of a partially resorbed canine root in a cat.** Clinical evidence of a small lesion on the cusp is observed. The tooth is otherwise unremarkable. However, the radiograph shows massive root resorption, with the root replaced by bony tissue.





► **Fig. 3.42 Radiograph of severely resorbed mandibular canine roots in a cat.** Although the mandibular canine teeth present as unremarkable, the radiograph shows a nearly complete resorption of the roots.

Missing teeth in cats that are not due to extraction are usually a sign of advanced resorptive damage with loss of the tooth crown and retained root fragments (► Fig. 3.43). Retained roots can cause severe gingival inflammation (► Fig. 3.44).



► **Fig. 3.43 Mucosal response to a mandibular premolar defect in a cat.** A resorptive process at the cervical area resulted in the gingival proliferation at the mandibular second premolar. Gingival flaps forming at sites susceptible to tooth resorption may signify a need to examine the corresponding teeth in more detail.



► **Fig. 3.44 Retained root remnants after resorptive processes in a cat.** Severe inflammation of the alveolar ridge of the left, edentulous mandible and on the surrounding mucosa. Because they contribute to the inflammatory response, the protruding root fragments are the first structures to be extracted.

In contrast to pathological resorption of dental hard tissues in the context of tooth resorption, the resorption of the deciduous root is a normal part of tooth exfoliation (► Fig. 3.45).

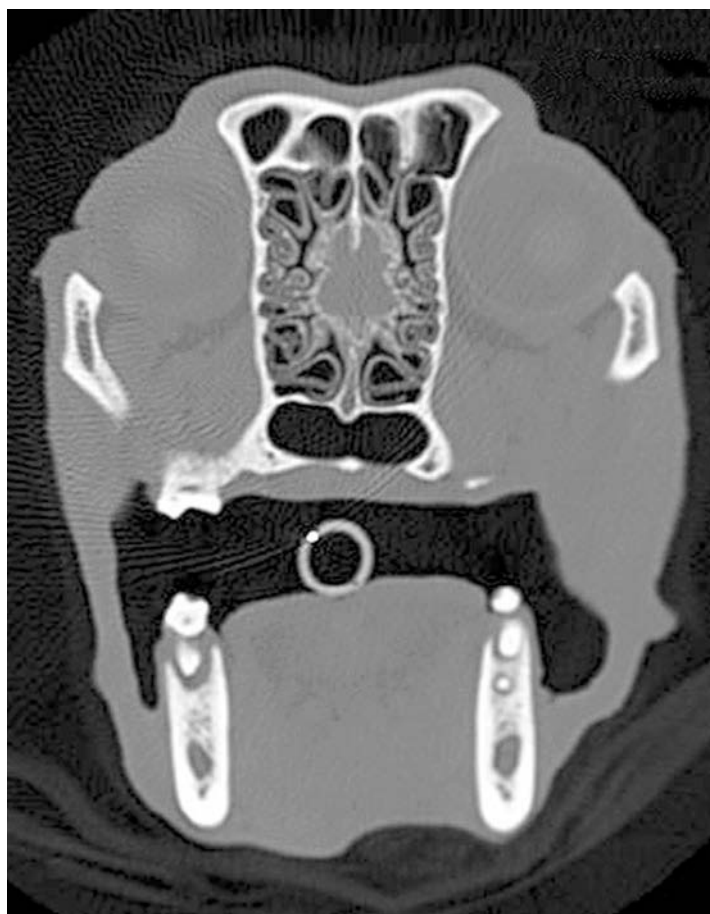


► **Fig. 3.45 Normal resorption during exfoliation of a maxillary canine tooth.** Resorptive processes are also observed during tooth exfoliation. As the permanent teeth erupt, parts of the precursor teeth are resorbed, and the deciduous tooth generally falls out as the root is resorbed.

CT scans allow for individual evaluation of roots that are otherwise superimposed, although they do not reveal details as sensitively as intraoral radiographs (► Fig. 3.46, ► Fig. 3.47).



► Fig. 3.46 CT scan showing osteolysis at the palatal root of a maxillary carnassial tooth. The two-dimensional nature of intraoral radiographs sometimes makes it difficult to visualize details in the maxilla, as the carnassial teeth and the molars have three roots each. Computed tomography can avoid this problem, because areas that are difficult to see can be visualized in the cross-sections.



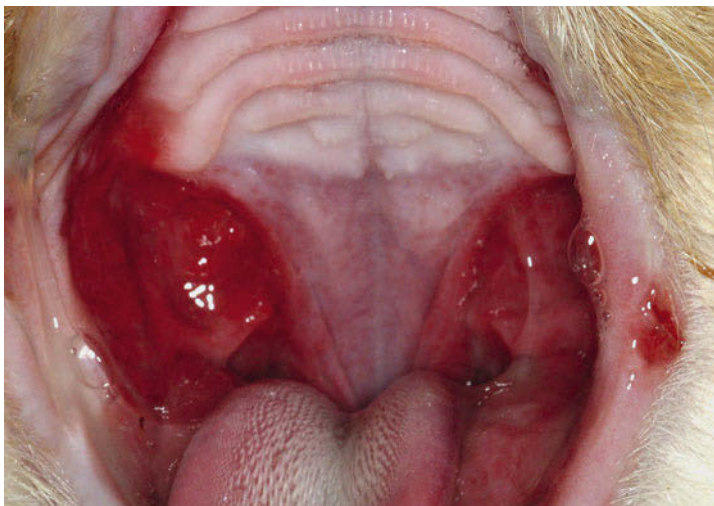
► Fig. 3.47 CT scan showing osteolysis at the roots of a mandibular molar. In the mandible, too, computed tomography can also help visualize the extent of a process affecting roots, such as here at the root of a mandibular molar.



## 3.5

## Interpreting the Clinical Signs of Mucosal Inflammatory Diseases

In addition to teeth, the oral cavity contains mucosa that may be highly sensitive and reactive. Many disorders are exacerbations of existing processes, while other disorders arise independently in the oral cavity. The variability of an organism's immunogenic response means a wide range of treatments may be necessary or available (► Fig. 3.48).



► **Fig. 3.48 Stomatitis in a cat.** If the inflammation extends to mucosal areas without direct contact to the teeth, dental treatment is still an important factor, but other exogenous causes and the cat's immune status usually play a major role.

Cause and effect are generally closely related and facilitate the choice of treatment. Assessing the mucosal inflammation alone rarely helps identify the cause (► Fig. 3.49). For example, examining the situation in the mandible of a cat (Fig 3.50) shows the origin of the inflammation (► Fig. 3.50). Considering that the opposing tooth (mandibular carnassial tooth) is missing, plaque accumulation leading to inflammation is a logical consequence. Without any functional significance, preserving the maxillary carnassial tooth is not a good idea, because it will only encourage infection. Additionally, the distal root of the maxillary carnassial tooth shows resorptive changes that for their part justify the extraction of the tooth (► Fig. 3.51). Prior to the extraction of possible retained root fragments (► Fig. 3.52), it is important to examine the area of the former opposing carnassial tooth.



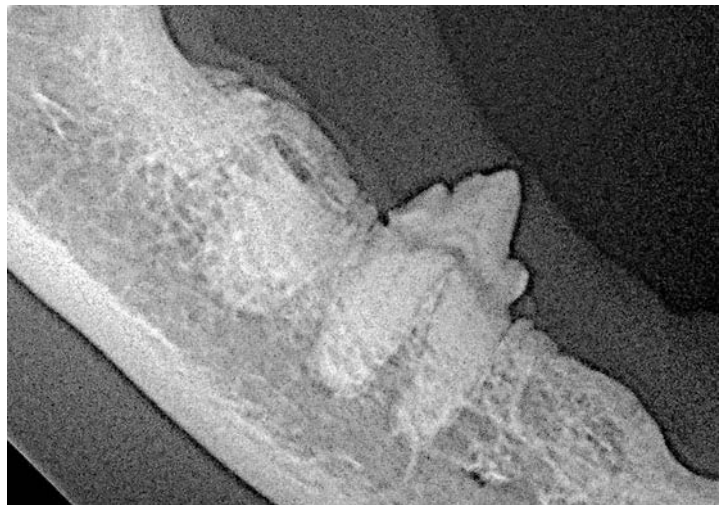
► **Fig. 3.49 Oral mass in the vestibule, right maxilla.** Not all masses in the oral cavity of a cat are actual tumors, although there is a 9 to 1 probability that an oral mass in a cat will be a malignant oral tumor. In this case, it is important to assess other clinical signs, such as the maxillary carnassial tooth with excessive plaque and calculus as in this cat.



► **Fig. 3.50 Relationship of the maxilla and mandible.** The plaque formation on the maxillary carnassial tooth in ► Fig. 3.49 can be explained by examining the mandible, where the opposing tooth is missing. It is thus impossible for the tooth to be cleaned during mastication.



► **Fig. 3.51 Radiograph showing the relationship of the maxilla and mandible.** The radiograph of the cat shown in ► Fig. 3.49 shows early resorption of the distal maxillary carnassial tooth.



► **Fig. 3.52 Radiograph showing the relationship of the maxilla and mandible.** The radiograph of the situation in ► Fig. 3.50 shows root fragments from the missing mandibular carnassial tooth. The lack of periodontal ligament space indicates a tooth fracture caused by resorptive lesions.

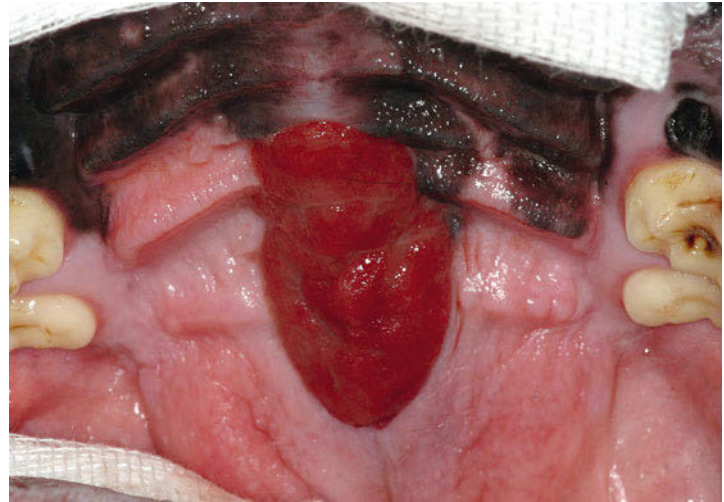


## 3.6

## Interpreting Findings in Tumor Diseases

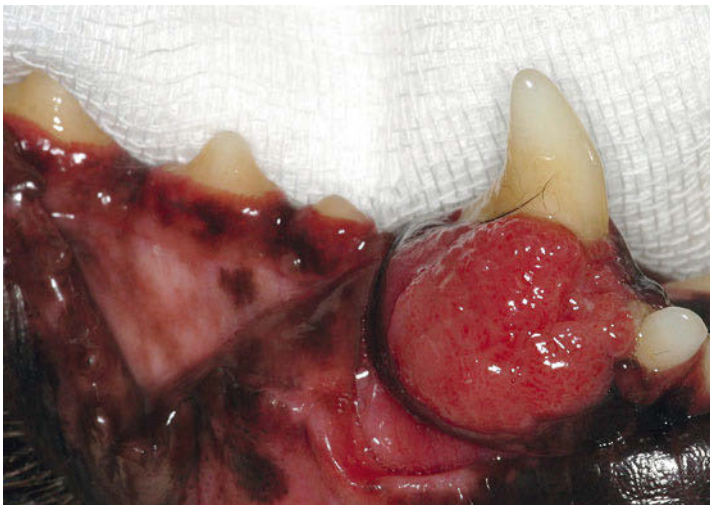
The oral cavity is the fourth most prevalent location for malignant tumors (► Fig. 3.53) and is also the site of many benign fibrous masses, especially in dogs. The probability of developing a tumor increases with life expectancy. Typical neoplastic oral tumors start to occur at around 7 years of age. The most common malignant tumor in dogs, melanoma, does not occur until older age. Cats are predisposed to squamous cell carcinoma. If an isolated oral proliferation is observed in a cat, the probability of malignancy is 9 to 1. Odontogenic tumors are a special type of tumor related to a tooth or dental tissue.

A conspicuous oral mass must not be evaluated solely on the basis of clinical factors. Further treatment must be based on histopathological evidence (► Fig. 3.54).

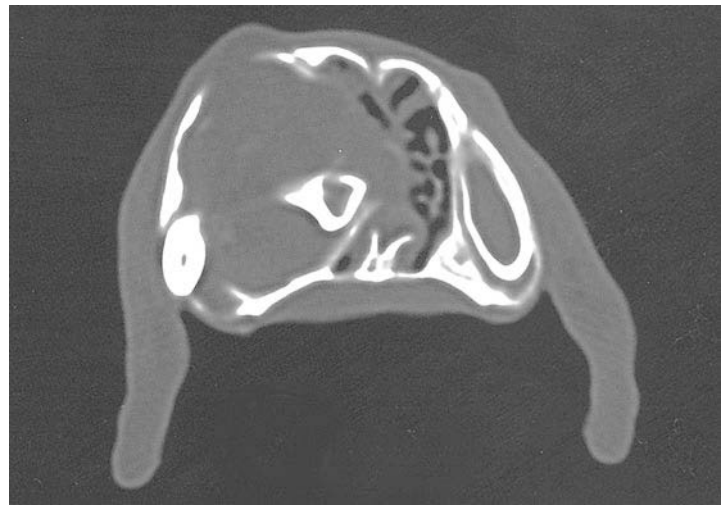


► **Fig. 3.54 Oral mass on the palate.** In dogs who play with sticks, oral masses such as this one at the transition from the hard palate to the soft palate may be difficult to distinguish visually from tumors, so further diagnostics are indispensable.

To evaluate the extent of a tumor in the jaw, especially in the maxilla, a CT scan is advisable (► Fig. 3.55).



► **Fig. 3.53 Tumor on the gingiva of a mandibular canine tooth.** Masses in the oral cavity must always be biopsied for histopathology. The distinction between benign and malignant tumors and their odontogenic and non-odontogenic etiology are important for prognosis and further diagnosis and treatment. In dogs, approximately 50% of all oral masses are tumors, while in cats, 90% of all oral masses are tumors.



► **Fig. 3.55 CT image of a maxillary tumor.** Identifying the three-dimensional structures involved in the development of a maxillary tumor is more difficult than assessing processes in the dental roots. A CT scan can be very helpful to evaluate lesions in adjacent areas such as the nasal or orbital cavity.

## 4 Treatment Aspects

### 4.1

### Instruments and Equipment

The differences between species and breeds require a broad range of veterinary equipment. In addition to possessing the necessary knowledge and expertise, the veterinarian must meet instrument and equipment requirements.

#### 4.1.1 Technical Resources

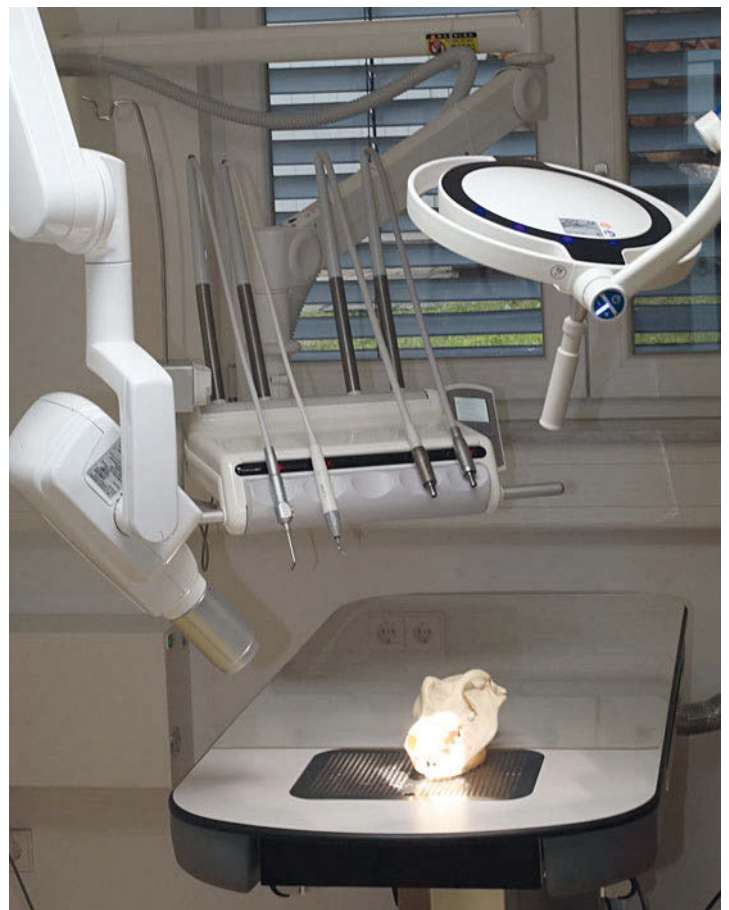
Some of the equipment required to perform comprehensive veterinary dentistry is shown in ► Fig. 4.1, ► Fig. 4.2, ► Fig. 4.3, ► Fig. 4.4, ► Fig. 4.5, ► Fig. 4.6, ► Fig. 4.7, ► Fig. 4.8, ► Fig. 4.9, ► Fig. 4.10, ► Fig. 4.11 and ► Fig. 4.12.



► **Fig. 4.2 Dental light.** The best way to illuminate the surgical area is with a dental light, which is easy to focus and adjust. Lights that permit filtering out of wavelengths that cause composite to cure prematurely are beneficial.



► **Fig. 4.1 Dental unit.** The basic prerequisite for performing comprehensive dentistry is a veterinary dental unit. To operate the rotary instruments, devices for holding the contra-angle handpieces and turbines are required. Another necessary item is a multifunctional syringe for spraying the working area with water or for drying it with air. An ultrasonic tooth scaler, a curing light, a high-frequency radiography machine or a suction device may also be integrated. Most veterinary dental devices offer a variable range of features.



► **Fig. 4.3 Work space.** A suitable “dental work space” can include the following: A treatment table with an integrated grate and an adjustable heating element for warming the table top prevents the animal from becoming hypothermic during surgery. In addition, anesthetic gases are removed through an exhaust suction device set into the table. The wall-mounted dental unit swivels and is height adjustable (Accesia). A dental x-ray unit can be used to take radiographic images at the treatment area (Accesia). A dental LED light provides a good light source for the surgical field and reduces the risk of heat build-up. This special dental LED light has frequency filters to prevent premature curing of light-curing composite (Dr. Mach).





► **Fig. 4.4 Ultrasonic scaler.** The ultrasonic scaler may be integrated into the dental unit or be operated as a standalone device.



► **Fig. 4.6 Warming mat and drainage grate.** Treatments of the oral cavity are often very time-consuming. To reduce the risks of anesthesia, the external conditions should be optimized. A warming mat can prevent the animal's body temperature from dropping. If not already integrated as part of the operating table, a collecting tray with a grate as depicted here may be useful. Cooling water and blood drain into the tray during treatment and once the procedure is completed, the equipment is easily cleaned.



► **Fig. 4.5 Curing light.** A curing light enables use of composites with photoinitiators to create directly cured fillings. With an average 20-second curing cycle the part of the filling that has been inserted can be cured. The advantage of using materials cured by halogen light is that the pliable material can be applied and modeled until the result is satisfactory, while purely chemically cured two-component paste materials can only be handled for a limited time period.



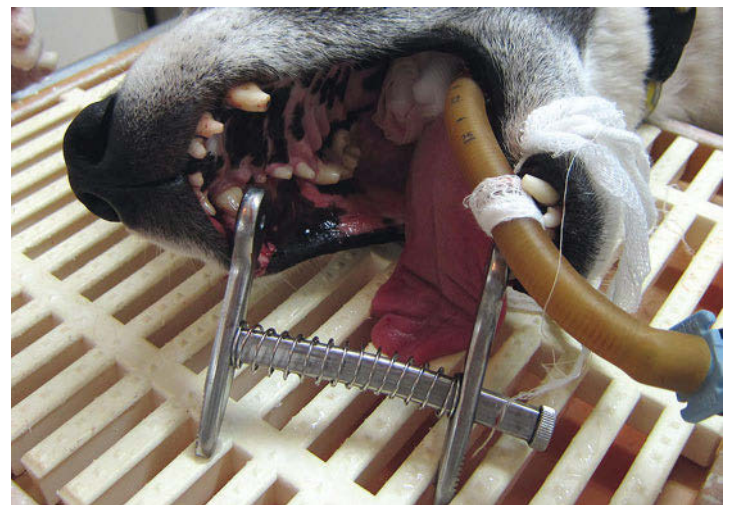
► **Fig. 4.7 Contra-angle handpieces.** Rotary instruments are required for working on tooth substance. To operate burs, drills and cutting burs, a holder is required to transfer the rotary force of the motor or turbine to the working ends. Contra-angle handpieces serve this purpose. Their speed is marked with red, blue, and green rings. Red is used for a high-speed handpiece. Blue denotes 1 to 1 force transmission, and green is used for a slow-speed handpiece. Alternatively, turbines may be used. They are operated not by a motor but are air-driven.



► **Fig. 4.8 Special contra-angle handpieces and technical handpiece.** Special contra-angle handpieces are available for special applications. On the left, a slow-speed surgical contra-angle handpiece is depicted with external water flow to the connection of sterile water coolant. The handpiece covered in green plastic has a holder for polishing cups. This handpiece is specially developed for polishing and prevents toothpaste from entering the head of the handpiece. On the right is a straight handpiece that holds rotary instruments for treating small domestic animals such as rabbits, guinea pigs, and chinchillas.



► **Fig. 4.9 Mouth gags.** Mouth gags are available in different sizes. The spring tension of the device usually sets the jaw to maximum opening. Some versions allow the desired opening to be set with a screw. Care must be taken to prevent excessive pressure from the gag causing vascular disturbances or even bony changes in the area of the symphysis.

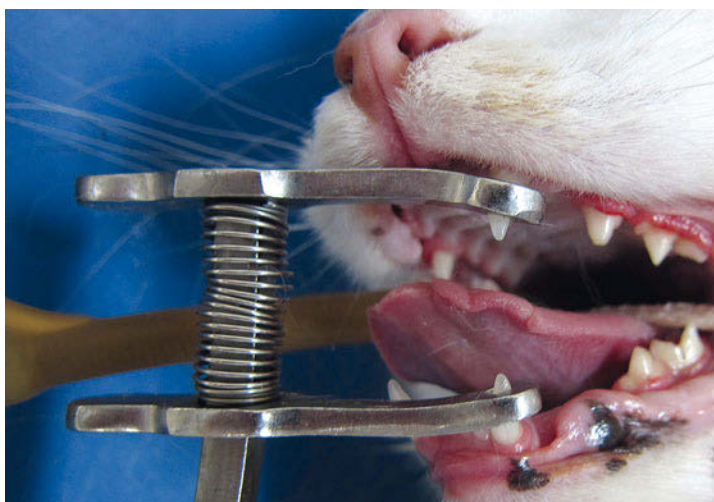


► **Fig. 4.10 Mouth gag, dog.** In order to properly visualize the oral cavity, mouth gags are placed over the canine teeth to lock the jaw open. Care must be taken to prevent jaw problems due to excessive opening.





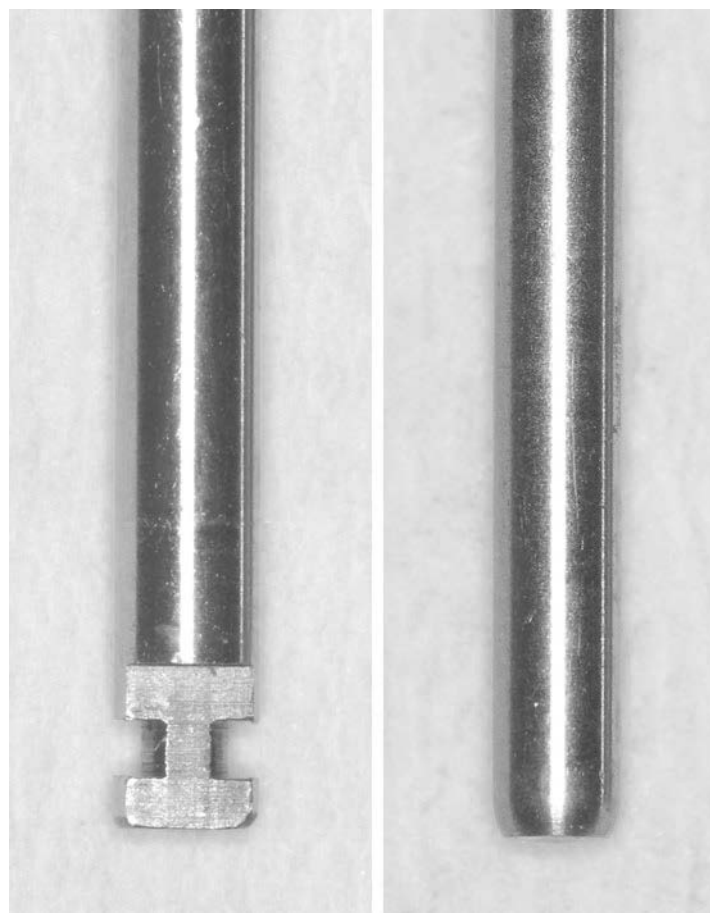
► **Fig. 4.11 Mouth wedge, dog.** Alternatively, for example, if canine teeth are missing, a mouth wedge can be placed between the maxillary and mandibular molar arcade.



► **Fig. 4.12 Mouth gag, cat.** In addition to various sizes of mouth gags for dogs, more delicate mouth gags are available for cats.

### 4.1.2 Instruments

The oral cavity structures in small animals are very fine, so that the instruments used for veterinary dentistry must be very delicate. Depending on the breed of the patient, they may need to be smaller than those used for human dentistry (► Fig. 4.13, ► Fig. 4.14, ► Fig. 4.15, ► Fig. 4.16, ► Fig. 4.17, ► Fig. 4.18, ► Fig. 4.19, ► Fig. 4.20, ► Fig. 4.21, ► Fig. 4.22, ► Fig. 4.23, ► Fig. 4.24). Some instruments require only slight adaptations and other human dental instruments can be used as is.



► **Fig. 4.13 Types of shanks used for rotary instruments.** Slow- and medium-speed rotary instruments have a shank with a latch (latch type shank, RA). High-speed rotary instruments have a thin (1.6 mm), smooth shank for insertion into a collet (friction grip shank, FG). The shank of the burs used in a handpiece is thicker (2.35 mm), longer and smooth (long straight shank, HP).



► **Fig. 4.14 Cutting diamonds.** The working part is covered with diamond grit in various sizes and shapes. The cutting diamonds are available in a wide range of shapes to meet different dental needs (from left to right: pear-shaped, cylindrical, torpedo-shaped, flame-shaped). Finishing diamonds are also available to polish the tooth surface.



► **Fig. 4.16 Finishing burs.** After the tooth substance has been contoured, a finishing bur is used to smooth any edges that have been created and remove any enamel fragments. Green stones are used for more rough finishing and white stones (Arkansas) produce a smoother surface. Here too, various shapes are available.



► **Fig. 4.15 Cutting burs.** The working part of a cutting bur has standardized, sharp blades for cutting tooth substance. A straight bur (left) is used at high speed to remove parts of the dental crown or separate roots. A rose-head bur (right) is used at slow speed for removing altered tooth substance or for cutting bone.





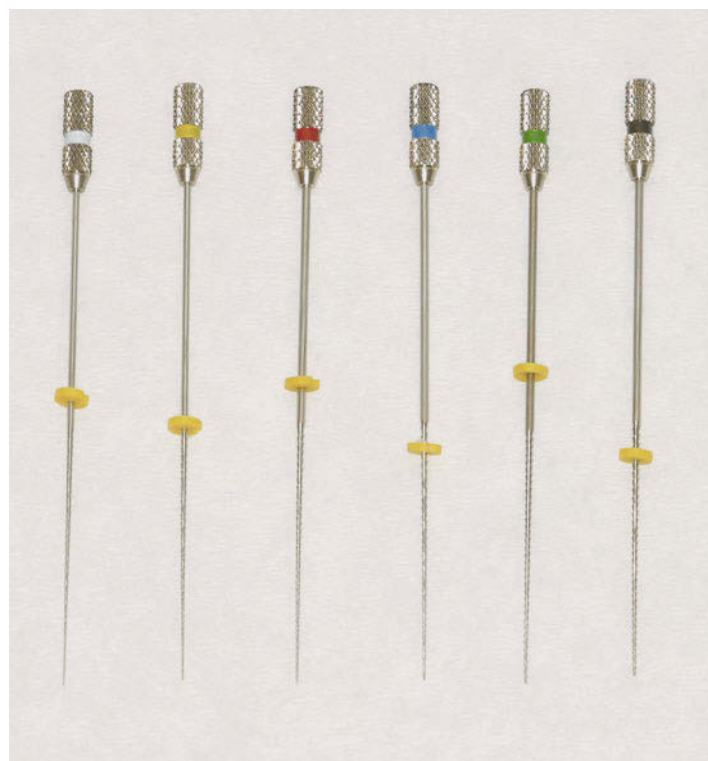
► **Fig. 4.17 Polishers.** Burs and stones are used to roughly contour the filling materials placed in the tooth. Polishers with different grain sizes are then used for finishing and smoothing.



► **Fig. 4.19 Dental composite.** Dental composite is a filling material composed of an organic matrix (usually Bis-GMA) with inorganic fillers (e.g., glass, ceramic, quartz). Since the use of amalgam is declining, dental composite is now the universal plastic filler material used in veterinary dentistry. It is available in a syringe or as composite compules, which are placed in the cavity directly. A cartridge applicator is used to place the composite in the cavity.



► **Fig. 4.18 Flexible polishing discs.** As an alternative to finishing burs and rubber polishers, flexible polishing discs with different grit sizes are used.



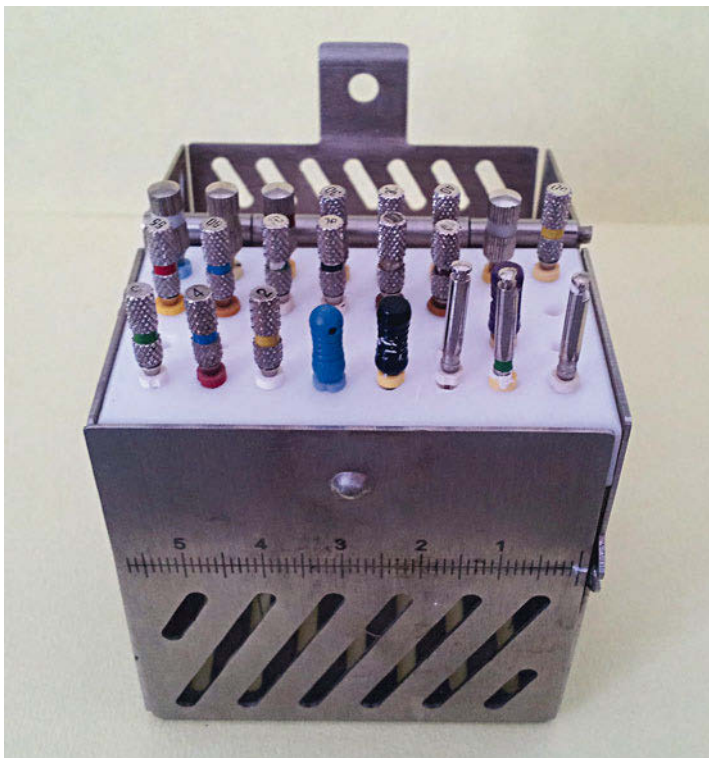
► **Fig. 4.20 Long Hedstrom files.** Special veterinary files are required to perform root canal therapy on a dog's long canine tooth. Hedstrom files are often used to debride the dentin wall of the root canal. The files are available in 40 mm and 60 mm lengths.



► **Fig. 4.21 Short Hedstrom files in an Endo Box.** For shorter teeth, human dentistry files may be used (28 mm to 31 mm). These instruments may be used to treat cheek teeth or incisors in dogs and cats as well as canine teeth in small dogs and in cats. The clear arrangement of the files in the Endo Box facilitates use.



► **Fig. 4.23 Elevators and luxators.** In veterinary dentistry, elevators and luxators are most commonly used for extracting teeth. Tools include root elevators with a relatively thick working tip (left) and luxators, which allow deeper penetration of the periodontal ligament space for loosening a tooth and/or its roots (right).



► **Fig. 4.22 Long Hedstrom files in an Endo Box.** Sterile storage in an Endo Box is especially useful for the fragile long endodontic instruments used in veterinary medicine to prevent bending. This proven storage system promotes a logical and orderly work flow.



► **Fig. 4.24 Extracting forceps.** Extracting forceps are used to remove teeth and/or roots after they have been loosened with an elevator or luxator. They are available in a wide range of sizes and shapes.



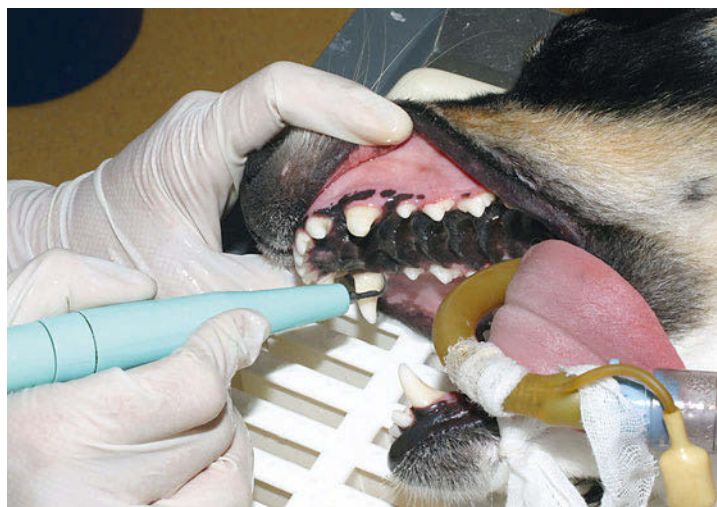
## 4.2

## Handling Instruments

While veterinarians are generally familiar with the use of surgical instruments from other areas of surgery, the handling of rotary instruments (► Fig. 4.25) is usually a new skill. However, ultrasonic dental scaling has become standard practice in veterinary medicine and is routinely performed by veterinarians (► Fig. 4.26).



► **Fig. 4.25 Holding a contra-angle handpiece.** To ensure secure guidance, a pen grip is used to hold a contra-angle handpiece. To steady the grip, the working hand can be supported on the animal's teeth or jaw.



► **Fig. 4.26 Handling ultrasonic scalers.** The pen grip should also be used to hold the working part of an ultrasonic scaler. The lateral part of the tip must be placed on the tooth surface in order for the piezoelectric impulse to remove the calculus and scale the surface without damaging the enamel.

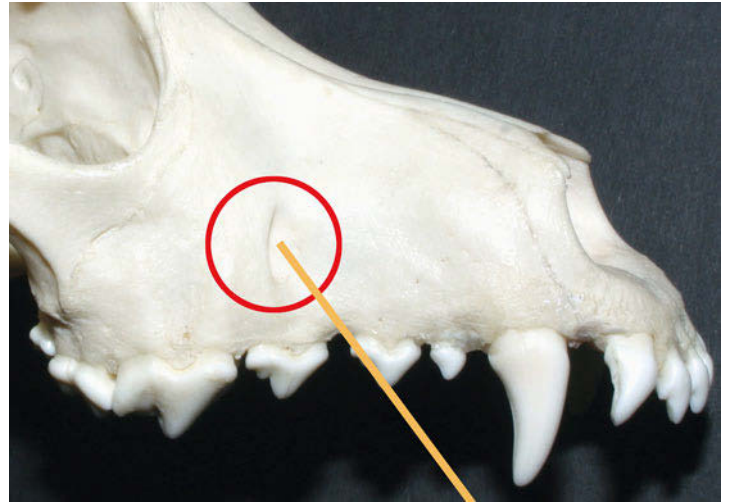
## 4.3

## Local Anesthesia

The use of local anesthesia (► Fig. 4.27) can greatly facilitate general anesthesia. Local anesthesia during the procedure provides a stable anesthetic plane and reduces the need for additional analgesia. Using a vasoconstrictor can also minimize bleeding. Depending on the location and nature of treatment, a distinction is made between infiltration anesthesia (► Fig. 4.28), block anesthesia (► Fig. 4.29, ► Fig. 4.30, ► Fig. 4.31, ► Fig. 4.32, ► Fig. 4.33, ► Fig. 4.34, ► Fig. 4.35, ► Fig. 4.36, ► Fig. 4.37, ► Fig. 4.38), and intraligamentary anesthesia (► Fig. 4.39).



► **Fig. 4.27 Local anesthetic syringe.** Local anesthesia complements the general anesthesia because it ensures sufficient analgesia during the procedure. In addition, the vasoconstrictor additive contained in the anesthetic aids hemostasis in the surgical site. Local anesthesia can be applied with a normal disposable syringe, a special cylindrical ampoule syringe, or a syringe for administering intraligamentary anesthesia, with which the anesthetic is deposited directly in the periodontal ligament space of the tooth to be extracted.



► **Fig. 4.29 Infraorbital nerve block.** To anesthetize multiple parts of the periodontium and jaw, 1 ml to 2 ml of anesthetic can be applied directly to the infraorbital nerve. The labial areas of the maxillary cheek teeth and incisors are accessed labially at the infraorbital foramen near the exit of the nerve from the skull. A cannula is inserted in the fornix of the vestibule and advanced to the infraorbital foramen, and the anesthetic is injected. The foramen is located approximately rostral to the mesiobuccal root of the maxillary carnassial tooth. It is palpable as a shallow indentation over the vestibule.

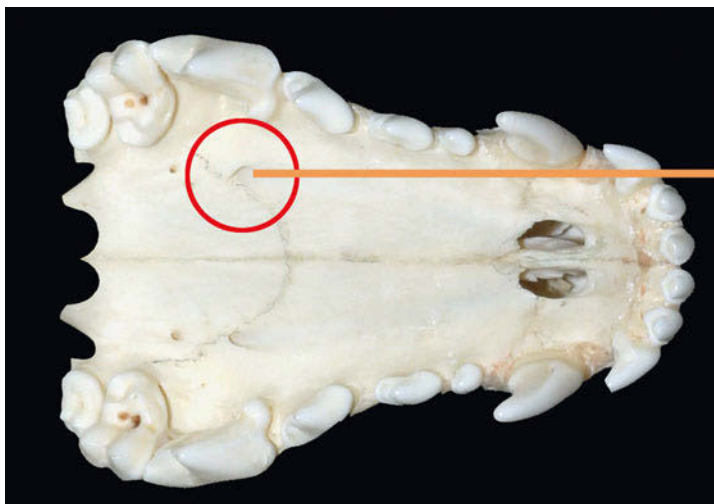


► **Fig. 4.28 Infiltration anesthesia at the maxillary molars.** Infiltration anesthesia is used primarily in the maxilla. The needle is inserted at the floor of the vestibule, and up to 1 ml of the anesthetic is injected in the area to be anesthetized. Infiltration anesthesia of the palatal mucosa is more challenging, because the palate is much firmer and presents more resistance. A volume of 0.3 ml is sufficient palatally.

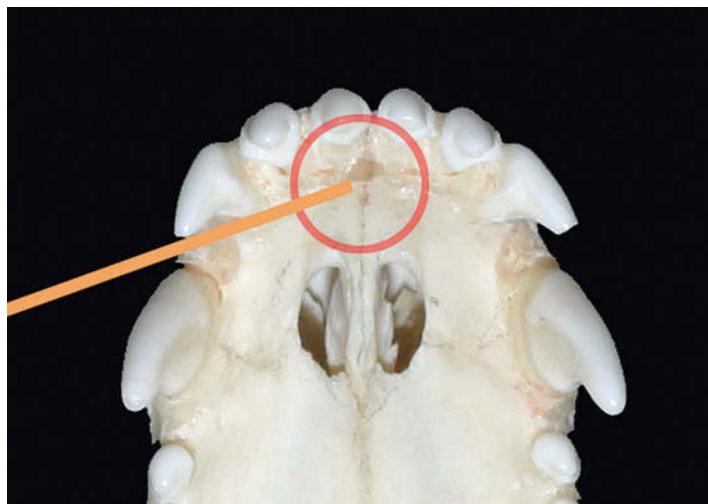


► **Fig. 4.30 Infraorbital nerve block, clinical aspects.** A small bony suborbital protuberance is palpable over the oral mucosa. The needle is directed toward this protuberance to place the nerve block at the exit of the infraorbital nerve.





► **Fig. 4.31 Palatine nerve block.** The greater palatine nerve is primarily responsible for innervation to the maxillary cheek teeth. This nerve exits at the hard palate at the greater palatine foramen, which is located approximately 1 cm palatal to the mesiopalatal root of the maxillary carnassial tooth. Given its proximity to the lesser palatine nerve, this nerve is also blocked. Due to the firm nature of the palatal mucosa, only 0.3 ml of the anesthetic is injected here.



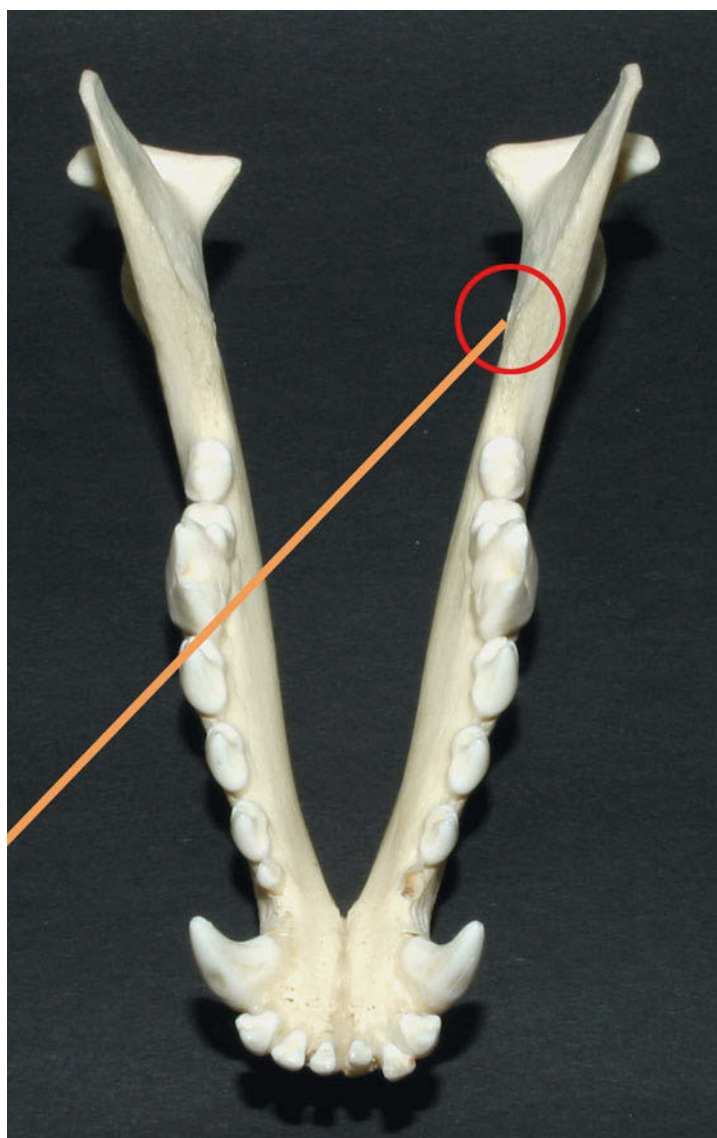
► **Fig. 4.33 Nasopalatine nerve block.** In addition to the infraorbital block, complete anesthesia of the maxillary incisors is achieved by anesthetizing the nasopalatine nerve near the incisive papilla.



► **Fig. 4.32 Palatine nerve block, clinical aspects.** The injection site for the greater palatine nerve is located palatal to the mesiopalatal root of the maxillary carnassial tooth. This nerve exits from the greater palatine foramen and runs in a rostral direction on the palatal aspect of the palatine bone. An anesthetic injection volume of 0.3 ml is sufficient because the density of the palatal mucosa prevents a larger deposit.



► **Fig. 4.34 Nasopalatine nerve block, clinical aspects.** Sensory transmission is blocked by anesthetizing the nasopalatine nerve. In dogs and cats, the incisive papilla is a highly sensitive region owing to its prominent role in the sense of smell. The vomeronasal organ is accessed through the openings of the ducts on the sides of the incisive papilla.

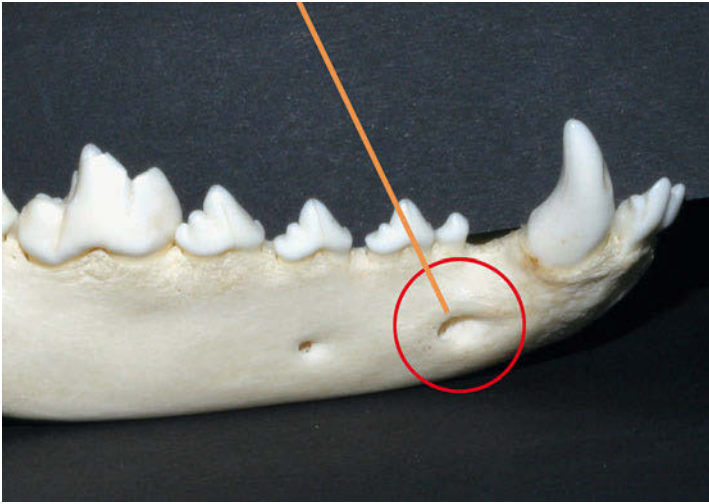


► **Fig. 4.35 Inferior alveolar nerve block.** Anesthesia of the entire right or left side of the jaw is delivered at the mandibular foramen, where the inferior alveolar nerve enters the medial aspect of the mandible. The needle is directed toward a point at the level of the occlusal plane and the midpoint of the ascending ramus of the mandible. For better diffusion, it is better to aim above the nerve than below, since it is not possible to test whether the local anesthetic has taken effect in the anesthetized animal.

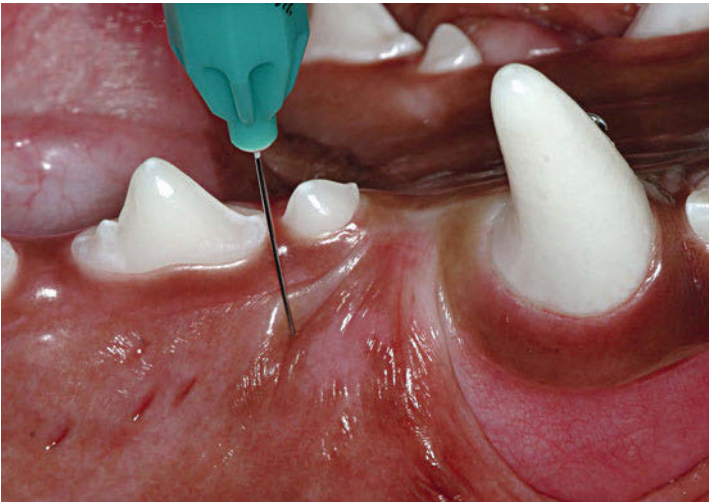


► **Fig. 4.36 Inferior alveolar nerve block, clinical aspects.** The mandibular foramen is located in the caudal extension of the mandibular arcade at the midpoint of the ascending ramus of the mandible. When locating the foramen, the needle approaches from the contralateral side and is advanced to the bone. To improve anesthesia success, it is better to inject above the nerve than below.

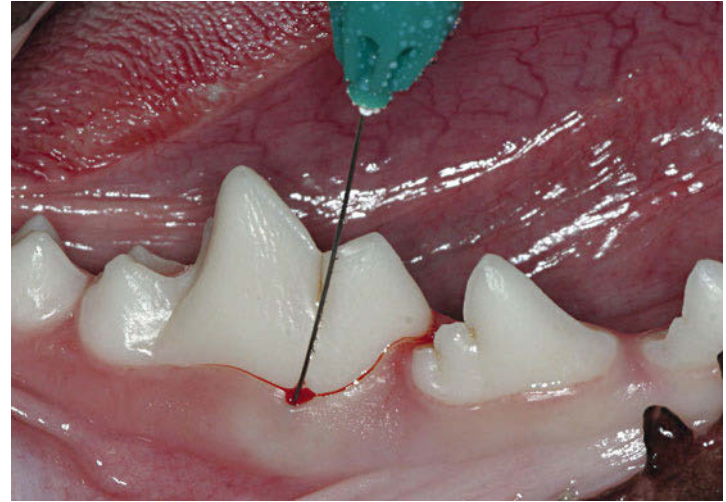




► **Fig. 4.37 Mental nerve block.** If only the rostral mandible needs to be anesthetized, anesthetic can be injected at the level of the mesial root of the mandibular second premolar. Caudal to the labial frenulum, the needle is inserted at the floor of the oral vestibule and 2 ml of the anesthetic is injected.



► **Fig. 4.38 Mental nerve block, clinical aspects.** The mental nerve can be blocked at the level of the mesial root of the mandibular second premolar.



► **Fig. 4.39 Intraligamentary anesthesia at the mandibular carnassial tooth.** The local anesthetic is injected slowly and directly into the periodontium through the sulcus. Intraligamentary anesthesia (ILA) should be delivered with a special injection device that limits the maximum injection pressure. In a single-rooted tooth, two injections are sufficient, while for a multirooted tooth, one injection per root is sufficient. It is important to administer the anesthetic slowly in order to prevent tissue necrosis. The reference value for intraligamentary injection is 0.2 ml per root.







## Part 2

# Recurring Procedures

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## 5 Dental Prophylaxis

Given the load on the teeth of dogs and cats, dental fractures are virtually impossible to avoid. However, the risk of developing gingival or periodontal inflammation can be reduced through regular dental care.

### 5.1

### Oral Hygiene Status

Histologically, all gingiva have some degree of inflammation. While the activity of the response center of the gingival sulcus varies with the bacterial load, low-grade inflammation is nearly always present; it is responsible for forming the sulcus in the first place. Nevertheless, it is possible to achieve clinical dental health by preventing the accumulation of plaque to prevent a bacterial biofilm. (► Fig. 5.1, ► Fig. 5.2, ► Fig. 5.3, ► Fig. 5.4).



► **Fig. 5.1 Young dog with noninflamed gingiva.** The bite of this young dog appears healthy and free of inflammation. The immune system easily manages the small amount of plaque, and the gingiva remains pink and flat and does not bleed.



► **Fig. 5.3 No inflammation despite calculus but without soft deposits.** Even with moderate amounts of calculus, the gingiva may lack signs of inflammation. It is not the calculus, but rather bacteria in the developing oral biofilm that cause the inflammation. This ultimately forms calculus and results in increased accumulation of plaque. However, the calculus itself is not the underlying problem. Teeth with calculus can be kept inflammation-free through ongoing removal of soft bacterial plaque.



► **Fig. 5.2 Noninflamed gingiva in a dog with good oral hygiene.** Adult dog mouths can also be kept free of inflammation. Daily brushing with a toothbrush, if possible, should remove the soft plaque that accumulates so that no inflammation can arise.



► **Fig. 5.4 Good oral hygiene status in a cat.** No bacterial plaque means no inflammation. This paradigm applies not just to dogs but also to cats. Conditioning cats to toothbrushing is therefore a useful form of prophylaxis. Feline gingiva tends to be lighter than canine gingiva. While the feline bite morphology is more conducive to cleaning than that of dogs, cats often tend to resist efforts to promote oral hygiene.



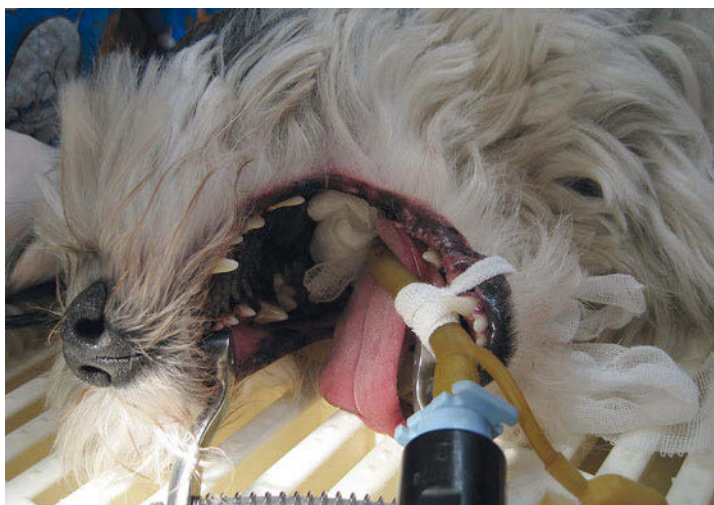
## 5.2

## Dental Cleaning

Since very few cats and dogs have fully clinically clean teeth, dental cleaning is one of the most common veterinary procedures. In animals with mucosal or periodontal diseases, dental cleaning is the primary choice for reducing infection by eliminating exogenous contaminants.

### 5.2.1 Preparation

► Fig. 5.5 and ► Fig. 5.6 show preparatory measures for professional dental cleaning.



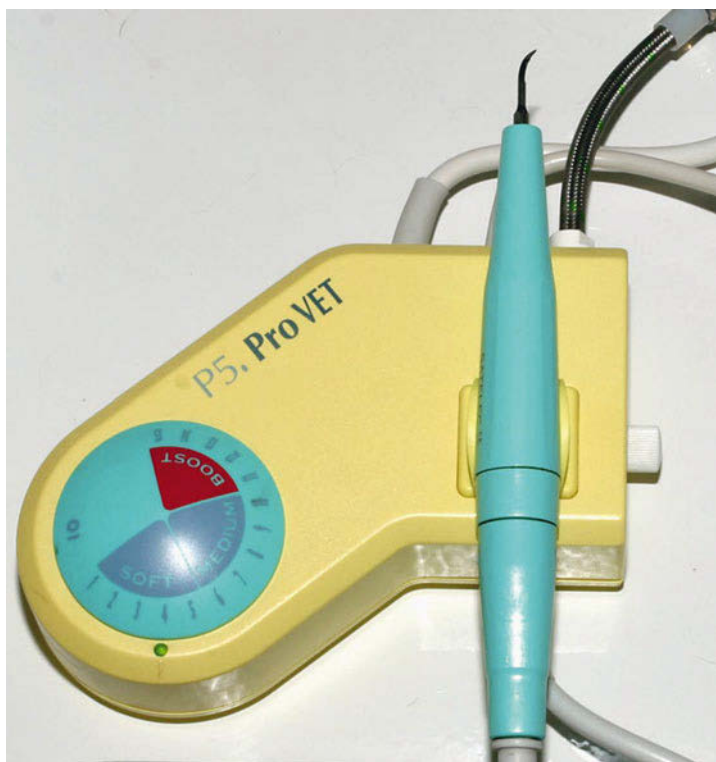
► **Fig. 5.5 Intubation and positioning.** Reliable anesthesia is critical to a stable starting situation. After the intravenous catheter is placed and anesthesia is induced, an endotracheal tube is inserted for administering gas anesthesia. The inflatable cuff of the endotracheal tube prevents aspiration of the bacteria-laden water coolant that is used during ultrasonic scaling. A mouth gag can improve visualization of the oral cavity and ease access to the lingual or palatal areas.



► **Fig. 5.6 Sponges placed in the pharynx.** In addition, sponges can be packed in the pharynx as an additional barrier.

### 5.2.2 Ultrasonic Scaling

Using an ultrasonic scaler facilitates dental cleaning in dogs and cats (► Fig. 5.7, ► Fig. 5.8). The scaler cracks off the calculus with piezoelectrically generated frequencies of 20 kHz to 45 kHz (► Fig. 5.9, ► Fig. 5.10, ► Fig. 5.11). Continuous water cooling is crucial to prevent tissue from burning (► Fig. 5.12).



► **Fig. 5.7 Ultrasonic scaling unit.** The standard method for removing calculus in dogs and cats is with an ultrasonic scaler. Piezoelectrically operated devices are most commonly used. Water coolant must be sufficient to counteract the heat that develops when scaling the teeth.



► **Fig. 5.9 Protection of the clinician when using ultrasound.** Ultrasonic scaling creates an aerosolized mist of water droplets, saliva, bacteria, and blood. Protective glasses or a protective shield and respiratory mask are recommended. Generally no suction is used, so the liquid runs into a drip tray. Gloves must be worn.



► **Fig. 5.8 Working tips of the ultrasonic scaler.** In addition to scaler-like working tips for the crown, working tips are also available for subgingival use. They closely resemble curettes but lack sharp work edges. The lateral surface of the ultrasonic working tip is placed on the tooth and the vibrations generated by the ultrasound detach the calculus. When using the subgingival working tips, the clinician must also ensure that the water conduit in the instrument provides sufficient cooling to avoid burning the tissues.



► **Fig. 5.10 Supporting the working hand on the jaw.** In order to ensure precise, safe guidance of the working tip, the working hand should rest on the immobile parts of the jaw, such as the teeth or jaw bone.



### 5.2.3 Dental Cleaning with Manual Tools

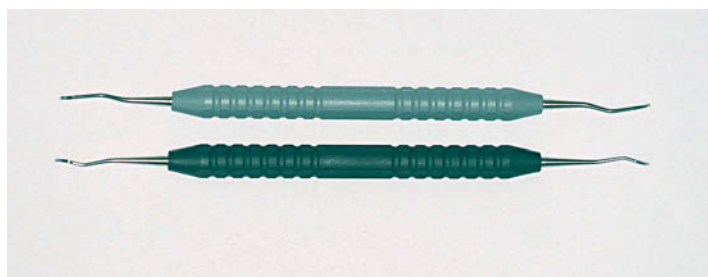
In addition to the ultrasonic scaler, different manual tools are used to remove tenacious plaque and calculus. Using manual tools to scale the tooth crown and root (► Fig. 5.13, ► Fig. 5.14, ► Fig. 5.15, ► Fig. 5.16, ► Fig. 5.17, ► Fig. 5.18, ► Fig. 5.19) is not an easy task. It is especially difficult to smooth out the nonvisible subgingival area. Proper instrument handling must therefore be learned and practiced in order to develop an efficient working method.



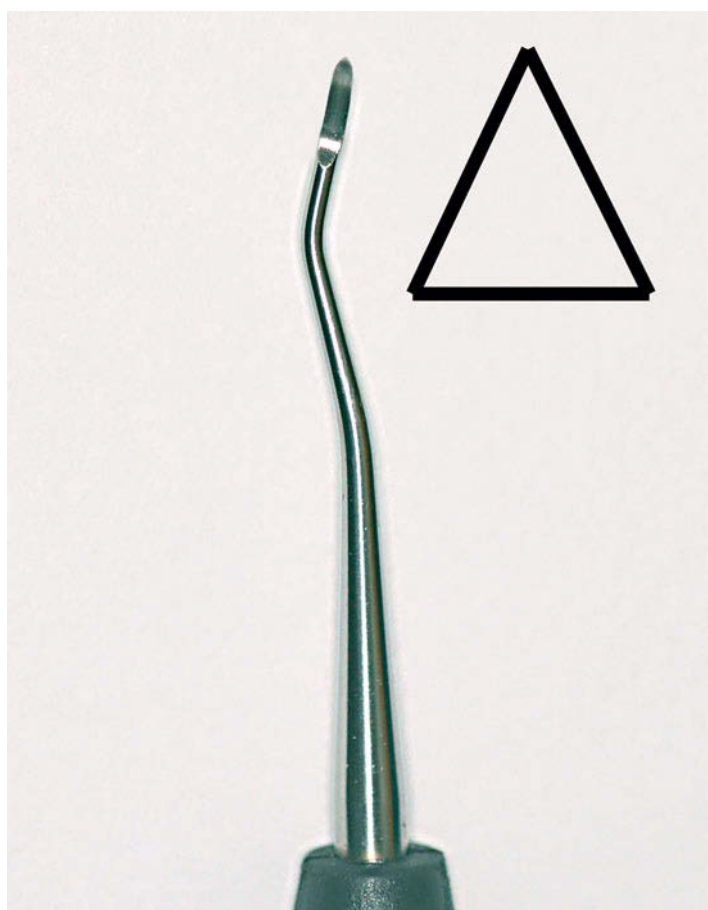
► **Fig. 5.11 Placement of the working tip on the tooth.** To transmit the vibrations to the tooth and avoid damage to the enamel, the lateral surface of the working tip must be placed against the tooth. It can also be inserted into the sulcus or the gingival pocket.



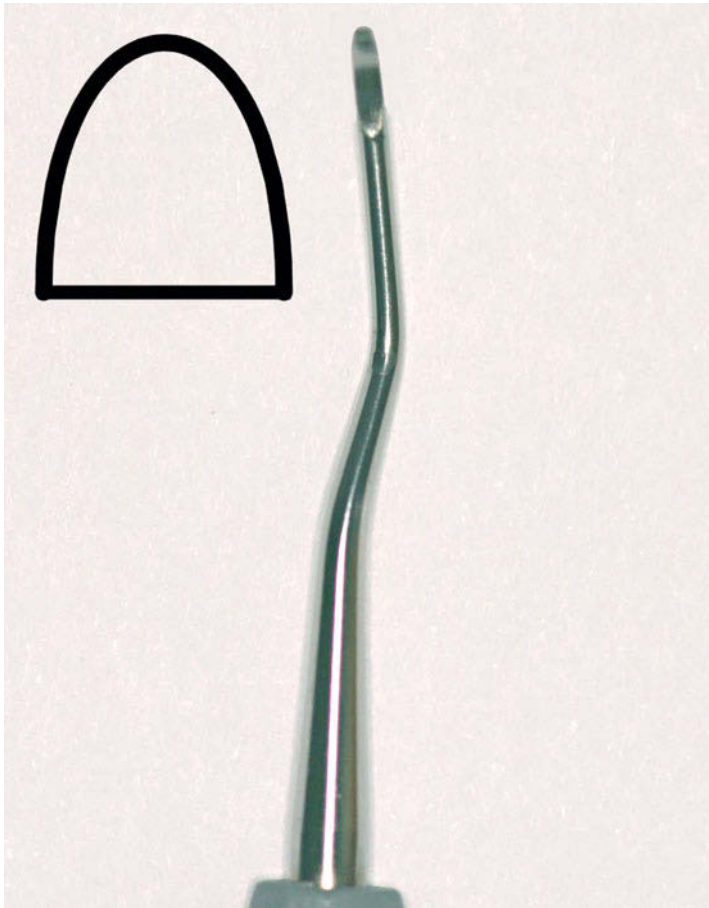
► **Fig. 5.12 Continuous water cooling of the working area.** The working area is continuously cooled with water or sterile liquid to avoid damage to the periodontal tissue and pulp.



► **Fig. 5.13 Scaler and curette.** Scalers and curettes are standard complements to the ultrasonic scaler for removing tenacious mineralized plaque. These instruments usually have two ends and are designed for use on the crown (scaler) and the root (curette).



► **Fig. 5.14 Working tip of the scaler.** A scaler has a triangular cross-section and pointed tip at the working end. A scaler is used to clean the crown.

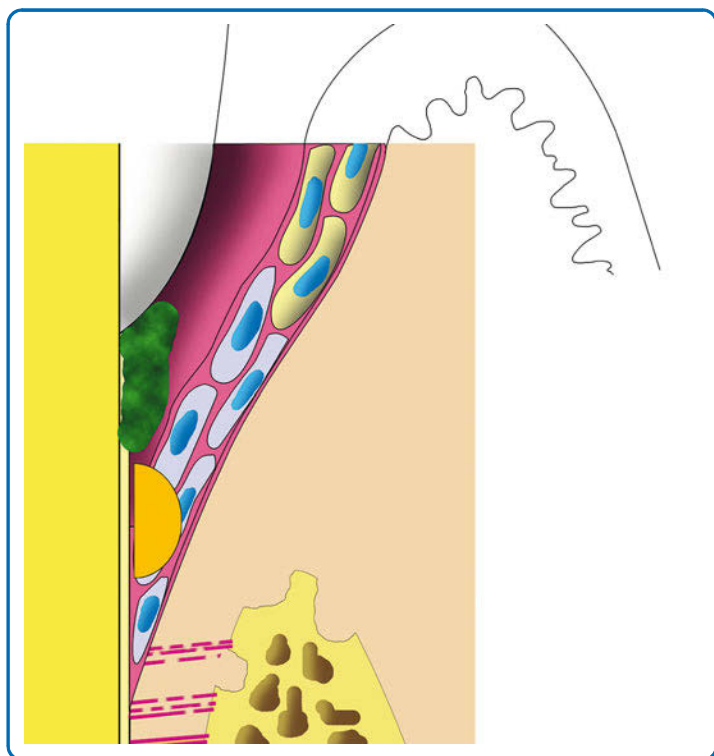


► **Fig. 5.15 Working tip of the curette.** A curette has a semicircular cross-section and is rounded at the working end. A curette is used to clean the surface of the root. Some areas and the tip of the tool are rounded in order to minimize the injury to the surrounding tissue when working on the subgingival area. The edges of the working area must be sharpened regularly to ensure effective cleaning.

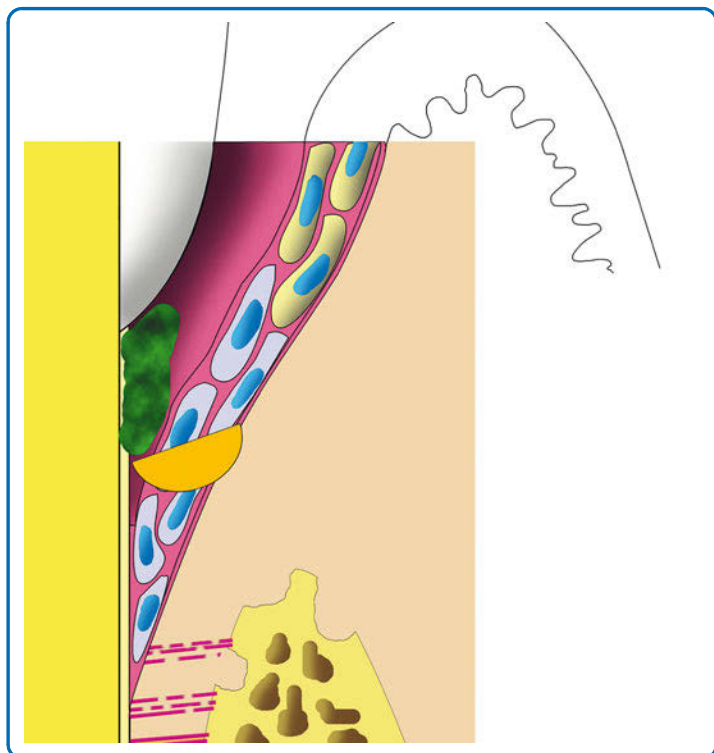


► **Fig. 5.16 Placement of the curette at the sulcus.** While the scaler relies on the clinician's vision, the curette depends on the clinician's tactile skills and proper, practiced technique. Supporting the working hand on the dental arch is recommended in order to securely guide the instrument.

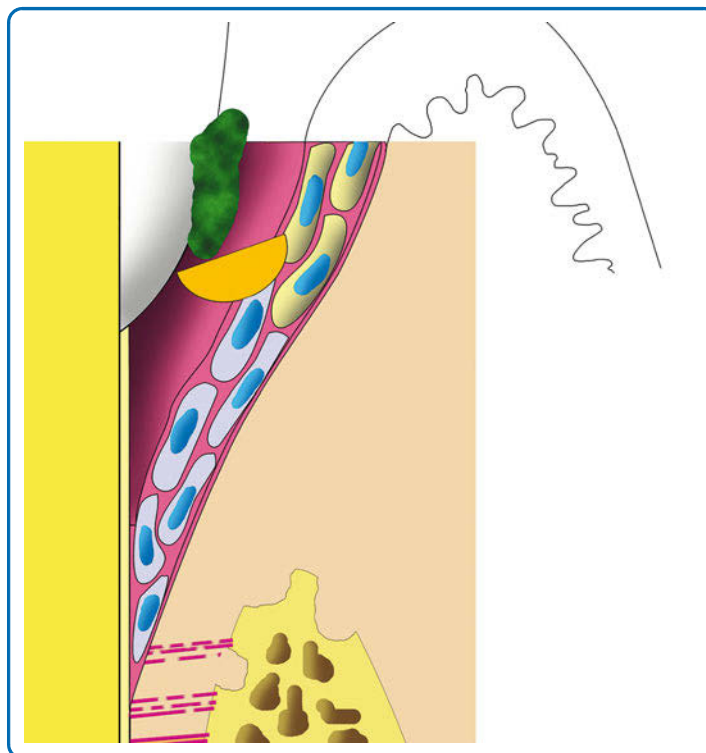




► **Fig. 5.17 Inserting the curette into the sulcus.** The curette is inserted to the bottom of the periodontal pocket with the working surface pointed toward the surface of the tooth.



► **Fig. 5.18 Technique for using the curette on the tooth surface.** When the floor of the pocket is reached, the curette is rotated and placed against the enamel at a 70° to 90° angle. This causes the sharp working edge to clean the surface of the root. If the angle is incorrect, the plaque will be polished rather than removed.



► **Fig. 5.19 Using a curette to remove calculus.** The deposits are removed coronally along the surface of the tooth.

### 5.2.4 Polishing and Antiseptic Application

Professional dental cleaning is completed by polishing the crowns (► Fig. 5.20, ► Fig. 5.21, ► Fig. 5.22, ► Fig. 5.23) and applying antiseptics to the oral mucosa and tongue (► Fig. 5.24, ► Fig. 5.25).



► **Fig. 5.20 Polishing attachment in the prophylaxis handpiece.** A full dental cleaning is completed by polishing the crowns in order to smooth out any surfaces that may have been roughened by the dental cleaning. A rubber cup can be used to pick up polishing paste and apply it to the tooth. A prophylaxis handpiece has a fixed holder for attaching a rubber cup and is hermetically sealed to block the entry of toothpaste that could damage the handpiece.



► **Fig. 5.22 Picking up toothpaste with the polishing attachment.** When the motor is running, toothpaste is picked up with the rubber cup. In order to streamline the working process, the toothpaste can be kept ready in a finger ring at the treatment location.



► **Fig. 5.21 Small brush attachment in the handpiece.** A small polishing brush often helps remove persistent, stubborn accretions. The brush is a bit more abrasive than the rubber cup.



► **Fig. 5.23 Polishing the tooth.** With the appropriate pressure, the rubber flap of the attachment moves below the gingival margin, an area that must be cleaned. This allows epithelial reattachment between the gingiva and the teeth.





► **Fig. 5.24 Antiseptic application to the oral mucosa.** In order to delay the re-colonization of bacteria on the tooth surfaces, an antiseptic such as chlorhexidine is applied to all the oral mucosa.

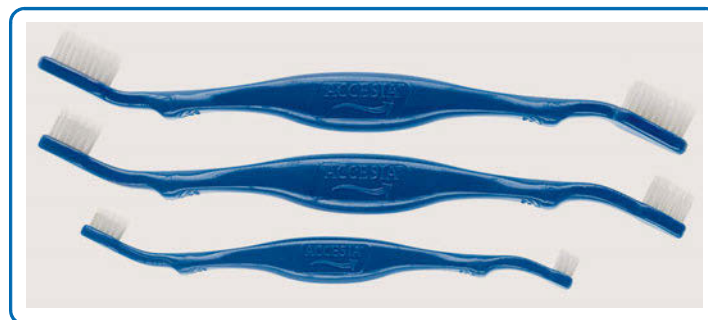


► **Fig. 5.25 Antiseptic application to the tongue.** The tongue also requires treatment. The surface of the tongue with its specialized structures and many indentations harbors numerous bacteria; in humans, cleaning the back of tongue cuts recurrence of periodontal inflammation by 50%.

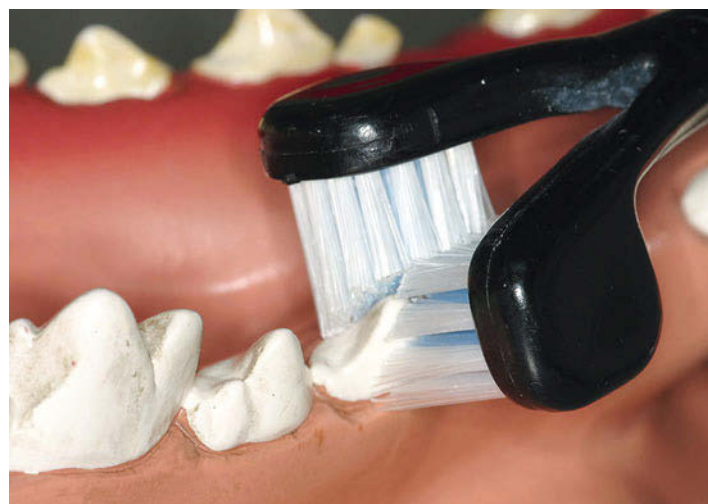
### 5.3

## Toothbrushes

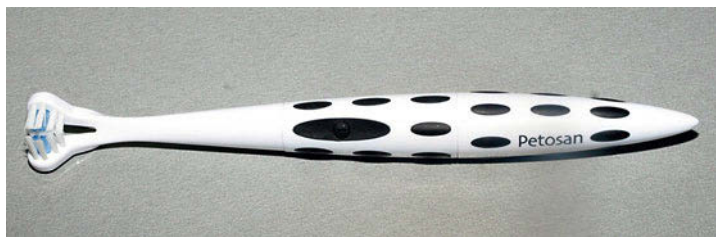
Toothbrushes are available in every shape and size (► Fig. 5.26, ► Fig. 5.27, ► Fig. 5.28, ► Fig. 5.29), along with toothpaste in a variety of flavors (► Fig. 5.31, ► Fig. 5.32). However, appropriate use is crucial. A toothbrush suitable for the animal should be selected (► Fig. 5.35) and the veterinarian must familiarize both the animal and the owner with proper use (► Fig. 5.30, ► Fig. 5.33, ► Fig. 5.34). Daily toothbrushing has proven to be ideal for oral hygiene, but the frequency can be adapted to the animal's condition.



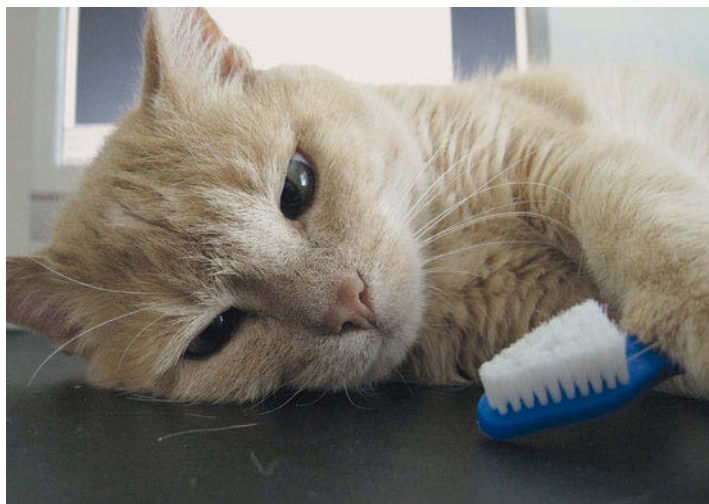
► **Fig. 5.26 Dual ended toothbrush.** The dual ended toothbrush is standard for dogs. In both large and small dogs, a dual ended toothbrush can be used to brush both large and hard-to-reach areas. The slight angle of the toothbrush heads adapts to the shape of the dog's bite. Regular single-headed toothbrushes are used for small dogs and cats. A small head makes it easier to fit the toothbrush in tight spaces. The lip can be pulled back to visualize all buccal areas from the canine teeth to the molars during brushing. The incisors can be cleaned after lifting the lips without pressing the lips over the cusps of the canine teeth. It is also possible to clean the interior surfaces of the teeth, but holding the mouth open and lifting the lip at the same time, plus the movement of the patient's very mobile tongue, complicate cleaning. (source: Accessia AB)



► **Fig. 5.27 Twin head toothbrush.** A twin head toothbrush is a suitable tool for cleaning both the exterior and interior surfaces of the teeth. In order to keep the jaw open, the brush is placed on the dental arch and it runs as if on tracks there. Here, the quality of cleaning depends more on sensation than sight.



► **Fig. 5.28 Twin head electric toothbrush.** Twin head toothbrushes are also available in electric versions for professional use by the owner. The vibration enhances the efficacy of the twin head.



► **Fig. 5.30 Conditioning the patient to the toothbrush.** Dental care starts with conditioning the patient to the toothbrush, toothpaste, and handling. Consistency combined with a playful approach has proven to be the best approach. Daily use of the toothbrush makes it routine and results in easier conditioning of the patient.



► **Fig. 5.29 Ultrasonic toothbrush.** Ultrasonic toothbrushes are now available for home use. Piezoelectric vibrations of the brush head, which remove plaque at 96 million air oscillations per minute, are transmitted to the tooth via special ultrasound toothpaste. The high frequency and low power remove soft plaque, but not calculus.

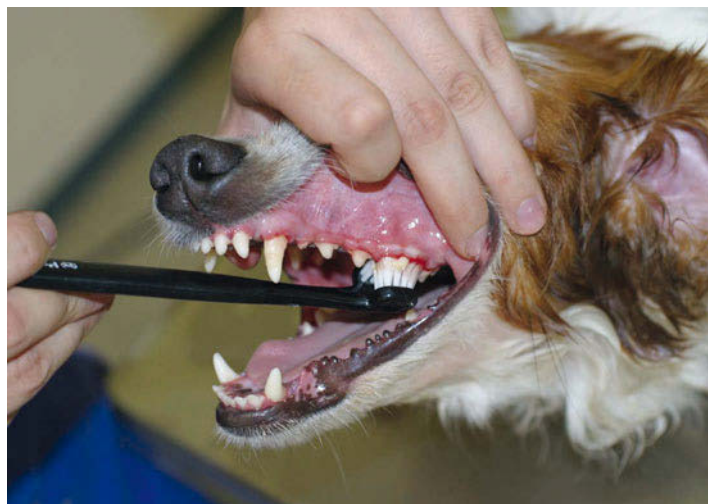


► **Fig. 5.31 Toothpastes.** Tasty, compatible, and digestible toothpaste in different flavors help reward the patient for toothbrushing. Active ingredients are less important; consistent use of the toothpaste is most important.





► **Fig. 5.32 Toothpaste for ultrasonic toothbrushes.** Special toothpaste is required to transmit ultrasound oscillations to teeth.



► **Fig. 5.34 Using a twin head toothbrush.** Twin head toothbrushes are extremely practical for cleaning the interior and exterior surfaces of the teeth at the same time. However, the patient must tolerate an opened jaw.



► **Fig. 5.33 Using a toothbrush.** After the lips are pulled back, the toothbrush with toothpaste is placed on the buccal surfaces of the teeth. Due to their function and anatomy, the buccal surfaces accumulate the largest share of plaque and calculus. Cleaning these surfaces is therefore essential to dental care in dogs and cats. The interior surfaces of the teeth are cleaned in the next step, with the jaw held open. These areas generally have less plaque. Theoretically, the toothbrush should be used to loosen the plaque on the neck of the tooth and then remove it from the gingiva toward the cusp (red-white technique). However, this is not always possible in fractious patients, for whom a simple wiping technique may be used as a compromise. This is permissible, however, because carnivore teeth are fairly easy to clean. Ultimately the teeth should be white and free of plaque and the gingiva pink. If the gums bleed during cleaning, the procedure should be performed more frequent to reduce inflammation and decrease the tendency to bleed.



► **Fig. 5.35 Oral hygiene in a hippopotamus.** This picture shows that anything is possible. The hippopotamus willingly has its teeth cleaned with its mouth wide open.

## 6 Tooth Extraction

### 6.1

### Closed Extraction – Step by Step

The closed extraction technique is the most common technique for removing a tooth. Elevators are used to extract the tooth without any further dissection of the mucosa.

#### 📌 Procedure Overview

1. Dissect the gingival cuff
2. Luxation in the periodontal ligament space, buccally and palatally
3. Luxation in the periodontal ligament space, around the tooth
4. Mobilize the tooth coronally

#### 6.1.1 Step 1

##### Dissect the Gingival Cuff

A fractured maxillary incisor must be extracted due to pulp exposure. The standard procedure for a single-rooted incisor is the closed extraction technique. In the first step, the attached gingiva is dissected in a circular fashion around the tooth, such as with a scalpel or an elevator (► Fig. 6.1).



► Fig. 6.1 Dissecting the gingival cuff.



### 6.1.2 Step 2

#### Luxation in the Periodontal Ligament Space, Buccally and Palatally

To loosen the tooth, insert the extraction elevator in an axial direction between the tooth and the gingiva in the cervical periodontal ligament space (► Fig. 6.2). The elevator can be pushed forward by slightly stretching the periodontal ligament space. A luxator is more effective than a basic elevator. A luxator has a thinner working tip that may be inserted farther into the periodontal ligament space, which facilitates luxation of the tooth. However, avoid application of excessive force, which may increase the risk of bending the tip and fracturing the root. The tip of the luxator dissects the periodontal ligaments and the tooth is loosened from the surrounding alveolus.

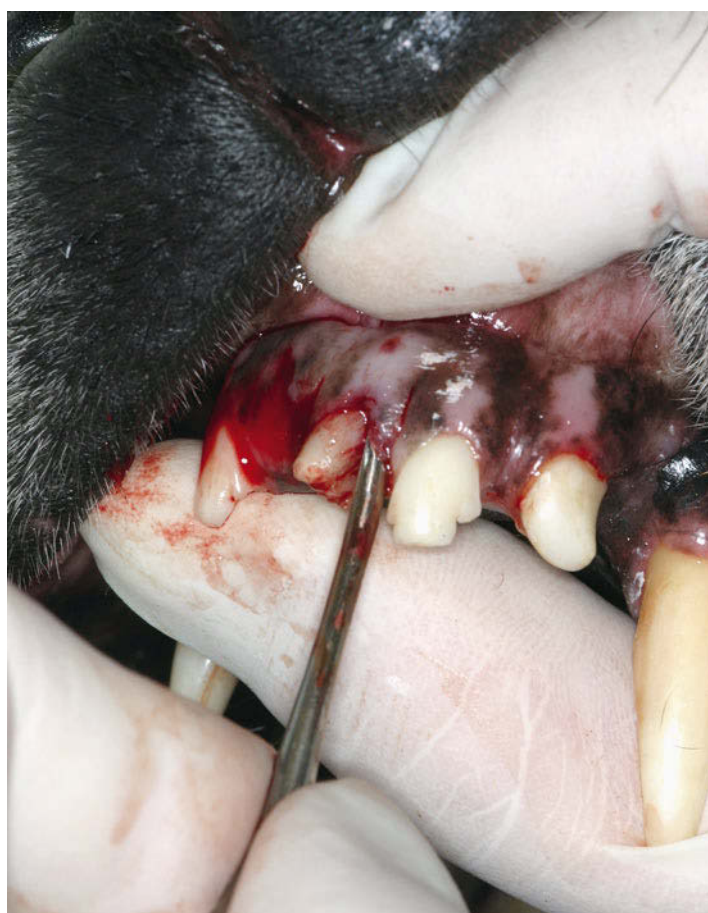


► Fig. 6.2 Luxation in the periodontal ligament space, buccally and palatally.

### 6.1.3 Step 3

#### Luxation in the Interdental Periodontal Ligament Space

The periodontal attachment is dissected in a circular fashion (► Fig. 6.3).



► Fig. 6.3 Luxation in the interdental periodontal ligament space.

**6.1.4 Step 4****Elevate the Tooth Coronally**

Further insertion of the luxator/elevator ultimately creates a kind of inclined plane on which the tooth can be mobilized coronally and extracted (► Fig. 6.4). If the height of the crown allows it to be grasped with extraction forceps, the already loosened tooth can be further mobilized and extracted.



► Fig. 6.4 Mobilizing the tooth coronally.



## 6.2

## Open Extraction of a Single-rooted Tooth – Step by Step

### Procedure Overview

1. Evaluate the current condition
2. Dissect the mucosa
3. Perform a buccal osteotomy
4. Luxate and remove the root
5. Check the extraction
6. Insert gelatin sponge
7. Close the alveolus

### 6.2.1 Step 1

#### Evaluate the Current Condition

A guard dog with a discolored mandibular right canine tooth that had already undergone root canal therapy is presented for impaired biting (► Fig. 6.5). In the radiograph, the root tip shows extensive resorption, and pronounced periapical osteolysis is present (► Fig. 6.6). A CT scan illustrates the proportions between the canine teeth and jaw bone (► Fig. 6.7). The easiest way to access a canine tooth in the dog and cat while retaining proper jaw mechanics is to remove the thin buccal bone lamellae in both the mandible and maxilla.



► Fig. 6.5 Current condition of tooth 404.



► Fig. 6.6 Radiograph of tooth 404.



► **Fig. 6.7 CT scan for visualizing the mandibular canine teeth.** A CT scan is not necessary for the extraction of the mandibular canine tooth, but illustrates the proportions of the canine tooth and surrounding jaw.

## 6.2.2 Step 2

### Dissect a gingival flap

First, the gingival margin and the buccal mucosa are dissected from the tooth via a “gingival margin cut” to the level of the second premolar (► Fig. 6.8).



► **Fig. 6.8 Dissecting a mucoperiosteal flap.**



### 6.2.3 Step 3

#### Perform a Buccal Osteotomy

Then the bone is removed over the coronal two-thirds of the root (► Fig. 6.9) with particular caution in the apical area, since the blood vessel and nerve exit the mental foramen.



► Fig. 6.9 Buccal osteotomy.

#### 6.2.4 Step 4

##### Luxate and Remove the Root

The root can now be extracted buccally without risking a mandibular fracture (► Fig. 6.10). With continued loosening, the root can also be mobilized from mesial (► Fig. 6.11).

Once the tooth is sufficiently loosened, extraction forceps are used to remove it (► Fig. 6.12).

Curette the alveolar wall to remove any remaining soft tissue and debris (► Fig. 6.13). A blood clot is conducive to further healing and for connective tissue cells to fill in the gap.



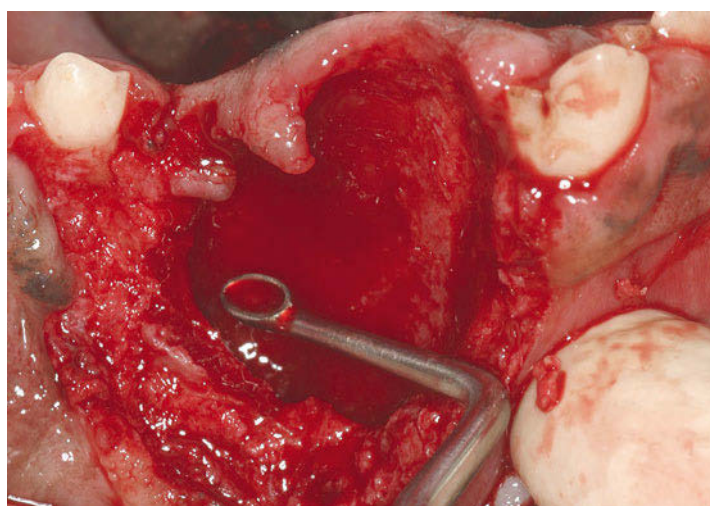
► Fig. 6.10 Buccal luxation.



► Fig. 6.11 Luxation from mesial.



► Fig. 6.12 Using extraction forceps to remove the tooth.



► Fig. 6.13 Curettage of the alveolus.



### 6.2.5 Step 5

#### Examine the Extraction

Take a radiograph to examine the extraction site before closing the alveolus (► Fig. 6.14). Examine the extracted canine tooth to confirm the clinically altered root tip and to ensure that the tooth has been fully extracted (► Fig. 6.15). A round and smooth root tip indicates complete extraction; however, this cannot be expected in cases of root resorption, so a radiograph is more reliable.



► Fig. 6.14 Radiograph after extraction of tooth 404.

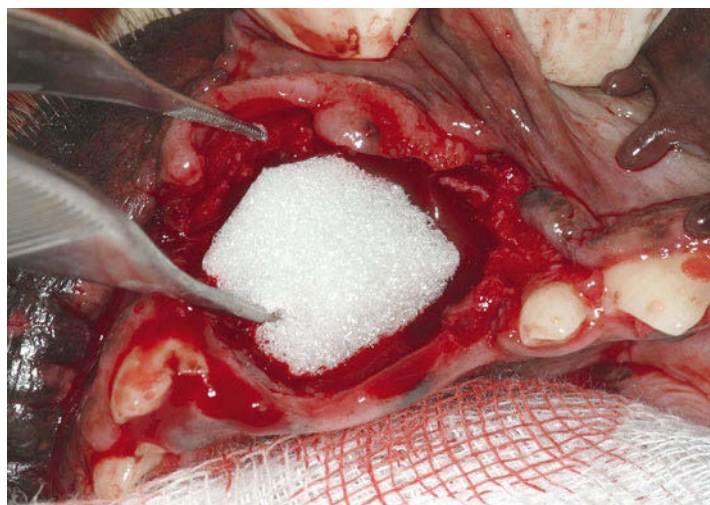


► Fig. 6.15 Extracted tooth 404.

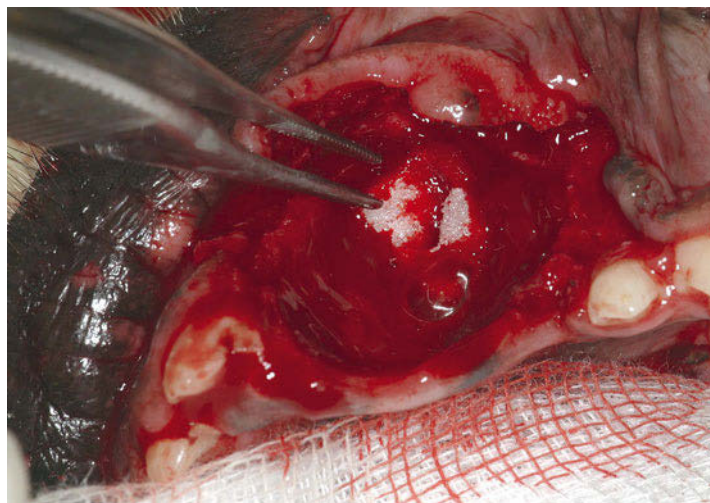
### 6.2.6 Step 6

#### Insert Gelatin Sponge

The blood clot required for healing may not form in the now-open alveolus. For a closed extraction, closure of the alveolus is desirable, but the firm mucosa of the gingiva usually prevents this. The dissection of the flap during the open extraction requires closure of the alveolus in any case. This enables a blood clot to develop in a closed alveolus and prevents impaction of food fragments, etc., which promotes healing. Inserting an absorbent gelatin sponge can additionally stabilize coagulation (► Fig. 6.16). Once the gelatin sponge becomes saturated with blood (► Fig. 6.17), it offers structural support for connective tissue cells to grow. The final goal is bony healing of the alveolus.



► Fig. 6.16 Insertion of a gelatin sponge.



► Fig. 6.17 The gelatin sponge fully saturated with blood.



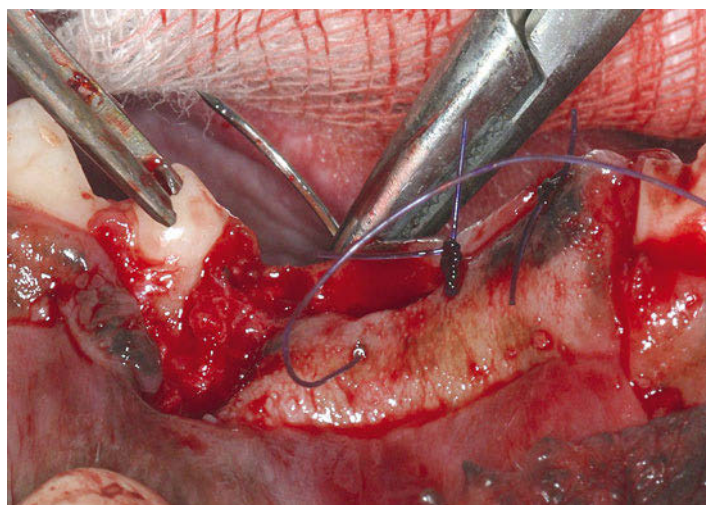
### 6.2.7 Step 7

#### Close the Alveolus

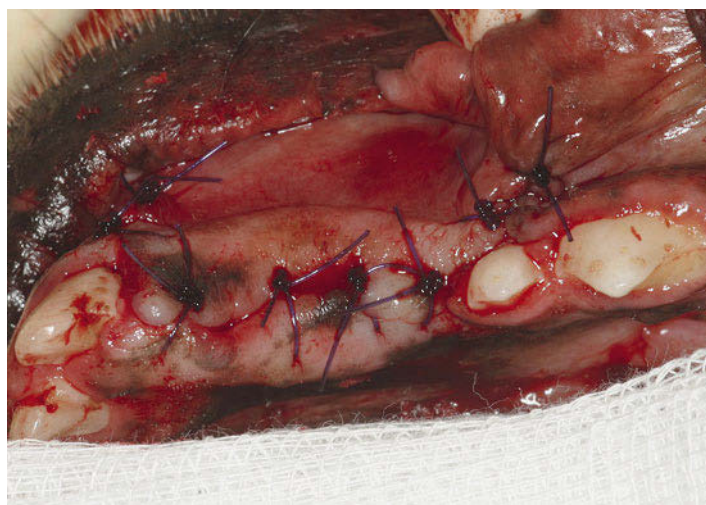
A mucosal advancement flap is made with an incision that transects the periosteum; this alters the flap's mobility. The collagenous part of the periosteum is severed and the flap becomes elastic and can be mobilized lingually (► Fig. 6.18). Simple interrupted sutures are used to reattach the mucoperiosteal flap (► Fig. 6.19, ► Fig. 6.20). USP 3-0 monofilament absorbable suture is generally used for dogs and 5-0 for cats. The animal should wear an Elizabethan collar for 7 days to protect the sutures, which the animal can easily reach. A wound check after 10 days ensures no dehiscence, which could impair healing.



► Fig. 6.18 Advancement flap.



► Fig. 6.19 Placing the sutures.



► Fig. 6.20 Completed sutures.

## 6.3

## Open Extraction of a Multirooted Tooth – Step by Step

### Procedure Overview

1. Evaluate the current condition
2. Dissect the mucosa
3. Perform a buccal osteotomy and section the roots
4. Mobilize the tooth parts
5. Luxate and remove the mesiobuccal tooth root
6. Luxate and remove the distal tooth root
7. Luxate and remove the palatal tooth root
8. Examine the extraction
9. Close the alveolus

### 6.3.1 Step 1

#### Evaluate the Current Condition

Fracture of the maxillary left carnassial tooth in a dog; the carnassial tooth is exposed and nonvital (► Fig. 6.21). A radiograph indicates whether the tooth can be maintained or if it must be extracted. In this case the radiograph shows extensive osteolysis near the root tips as well as resorption of the root tips themselves (► Fig. 6.22). The tooth cannot be preserved. The only treatment is extraction of the tooth.



► Fig. 6.21 Fractured tooth 208.



► Fig. 6.22 Radiograph of tooth 208.



### 6.3.2 Step 2

#### Dissect the Mucosa

After performing a gingival margin cut, use a periosteal elevator to lift the mucosa buccally and palatally (► Fig. 6.23, ► Fig. 6.24). In order to move the mucosal flap toward the vestibule to improve visualization, a vertical incision is placed mesially and distally to the flap (► Fig. 6.25).



► Fig. 6.23 Dissecting the buccal mucosa.



► Fig. 6.24 Dissecting the palatal mucosa.

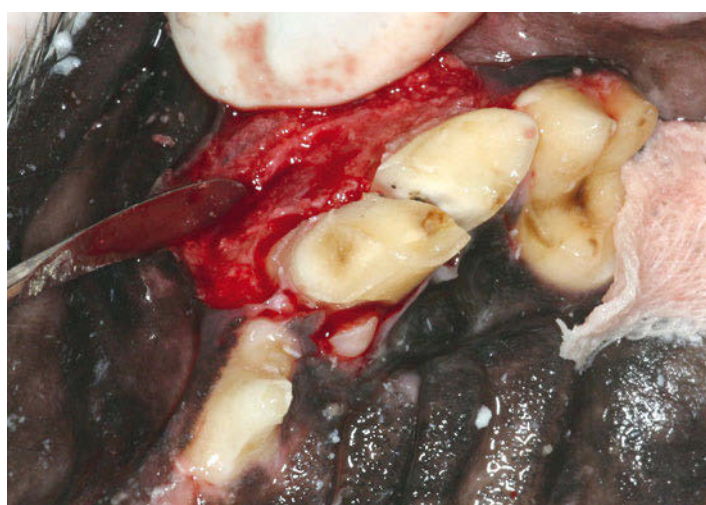


► Fig. 6.25 Vertical accessory incision.

### 6.3.3 Step 3

#### Perform a Buccal Osteotomy and Section the Roots

A buccal osteotomy is performed to expose the cervical part of the roots. Then a long cutter or diamond, etc., is used to section the three roots (► Fig. 6.26). When separating the palatal root, ensure that the cutter/grinder is sufficiently angled to achieve trifurcation. It is best to approach the furcation starting mesially.

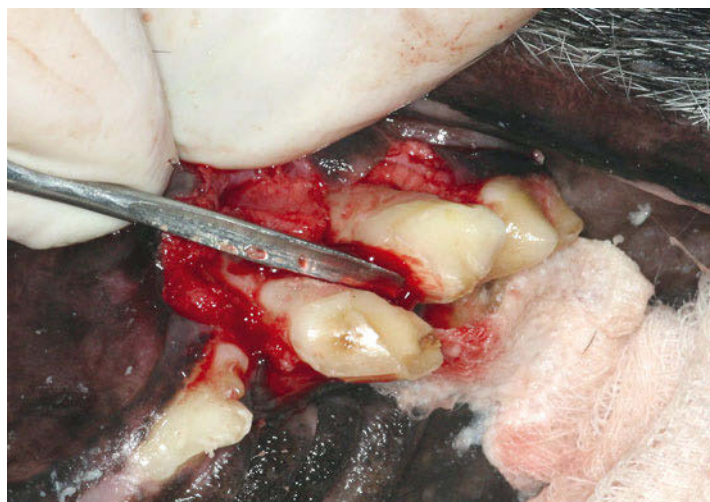


► Fig. 6.26 Situation after buccal osteotomy and sectioning of the roots.

#### 6.3.4 Step 4

##### Mobilize the Tooth Parts

All tooth parts should now be loosened, so the individual parts can be luxated as individual “teeth”. The roots are mobilized toward each other by placing the extraction elevator horizontally in the separation gap (► Fig. 6.27).



► Fig. 6.27 Using an elevator to luxate the tooth parts toward each other.

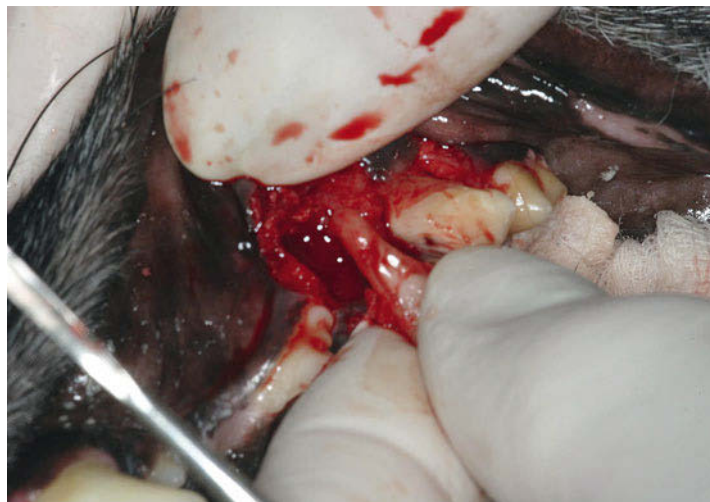
#### 6.3.5 Step 5

##### Luxate and Remove the Mesiobuccal Root

Elevating the mesiobuccal part coronally loosens the mesiobuccal root from its alveolus (► Fig. 6.28). In most cases, once the roots have been loosened, they may be removed with the fingers (► Fig. 6.29). For a better grip, extraction forceps may be used.



► Fig. 6.28 Luxation of the mesiobuccal root.



► Fig. 6.29 Using the fingers to remove the mesiobuccal root.



### 6.3.6 Step 6

#### Luxate and Remove the Distal Root

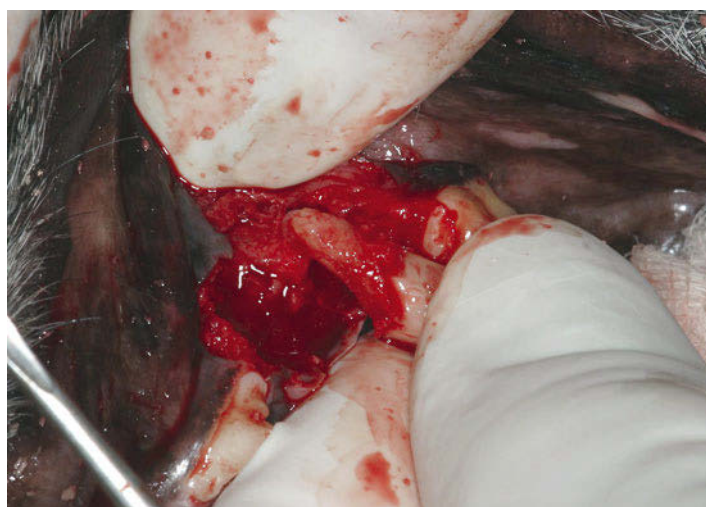
The distal root is carefully luxated in the mesial direction with support on the first molar (► Fig. 6.30). The tool is then placed on the mesial surface of the tooth, and the root is mobilized coronally and buccally (► Fig. 6.31). In this case, the extraction forceps are unnecessary for extracting the distal root (► Fig. 6.32).



► Fig. 6.30 Mesial luxation of the distal root.



► Fig. 6.31 Coronal and buccal luxation of the distal root.

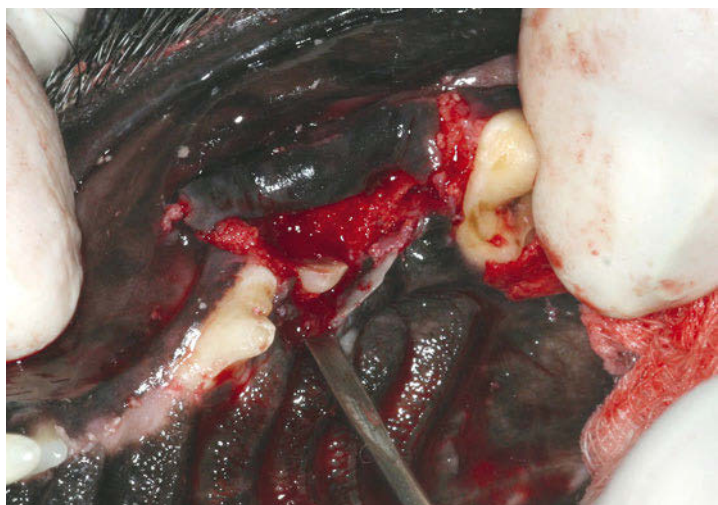


► Fig. 6.32 Extracting the distal root.

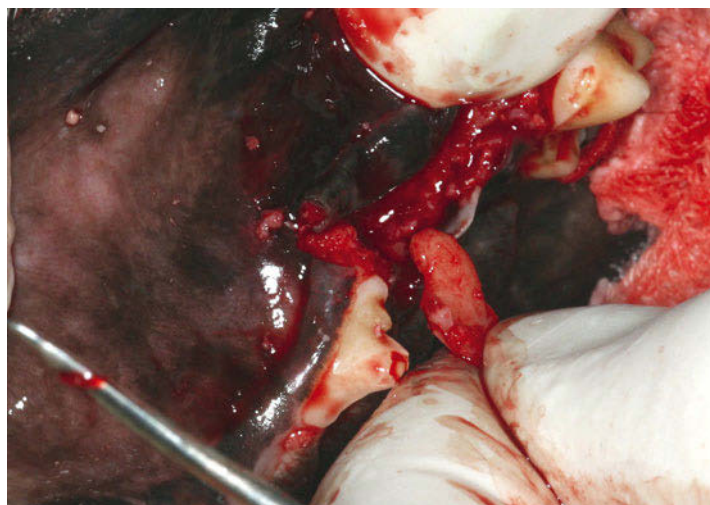
### 6.3.7 Step 7

#### Luxate and Remove the Palatal Root

The palatal root can be luxated buccally most easily given the tooth's orientation (► Fig. 6.33). A cutter can be used to further expose the palatal root in the now empty alveolus that the mesiobuccal root previously occupied. The palatal root is significantly smaller than the other roots. When attempting to remove a tooth part with the fingers, it is sometimes difficult to get a good grip (► Fig. 6.34), when no more bigger crown parts are present; an extraction forceps or clamp can be used to grip the root. All alveoli are then curetted.



► Fig. 6.33 Luxation of the palatal root.



► Fig. 6.34 Using the fingers to remove the palatal root.

### 6.3.8 Step 8

#### Examine the Extraction

The complete removal of the tooth can be verified during extraction by palpating the root tips (► Fig. 6.35). Round and flat tips suggest complete extraction. Radiography is used for confirmation (► Fig. 6.36).



► Fig. 6.35 Examining the roots after extraction.



► Fig. 6.36 Radiograph after extraction of tooth 208.



### 6.3.9 Step 9

#### Close the Alveolus

To close the wide extraction cavity, incise the buccal advancement flap by dissecting the basal periosteum and mobilizing it palatally (► Fig. 6.37). Use simple interrupted sutures to close the alveolus (► Fig. 6.38). The patient may not need to wear an Elizabethan collar after extraction of a carnassial tooth, since the surgical site is difficult to reach.



► Fig. 6.37 Incising the buccal advancement flap.



► Fig. 6.38 Completed closure with simple interrupted sutures.

## 7 Retrieving Root Fragments

### 7.1

### Retrieving Root Fragments – Step by Step

#### Procedure Overview

1. Evaluate the current condition
2. Dissect the mucosa
3. Perform a buccal osteotomy
4. Luxate and remove the mesial root
5. Luxate and remove the distal root
6. Luxate and remove the palatal root
7. Curette the alveoli
8. Examine the extraction
9. Place the sutures

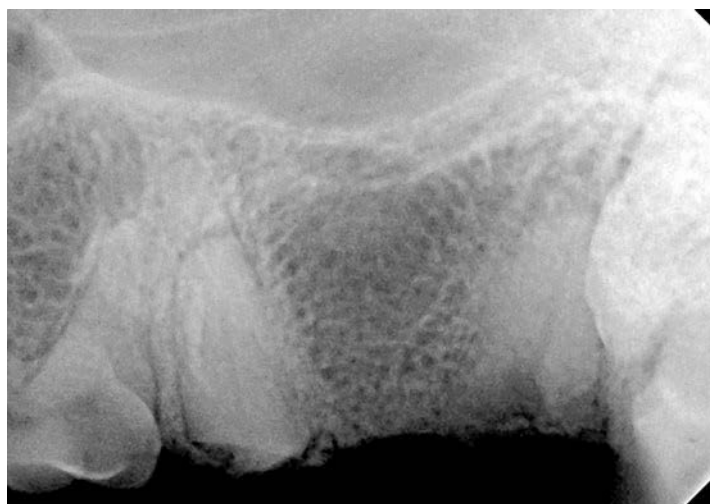
#### 7.1.1 Step 1

##### Evaluate the Current Condition

After this patient's fractured maxillary carnassial tooth is extracted, the dog's behavior and specifically its eating behavior, failed to improve. The mucosa over the extraction site is closed, but is red and inflamed in some parts (► Fig. 7.1). The radiograph shows retained fragments of all three roots (► Fig. 7.2).



► Fig. 7.1 Root fragments of tooth 208.



► Fig. 7.2 Radiograph of tooth 208.



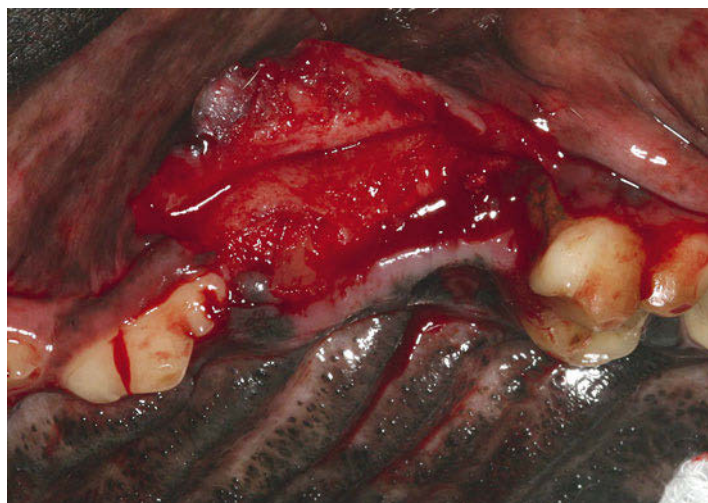
## 7.1.2 Step 2

### Dissect the Mucosa

The approach is performed directly over the roots to create a mucoperiosteal flap (► Fig. 7.3). The gingiva is dissected buccally, exposing the alveolar bone (► Fig. 7.4).



► Fig. 7.3 Incision over the root fragments.

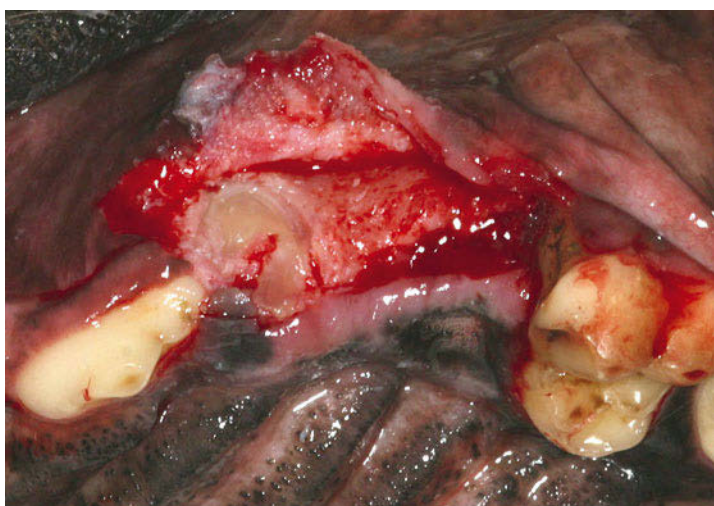


► Fig. 7.4 Dissection of a mucoperiosteal flap.

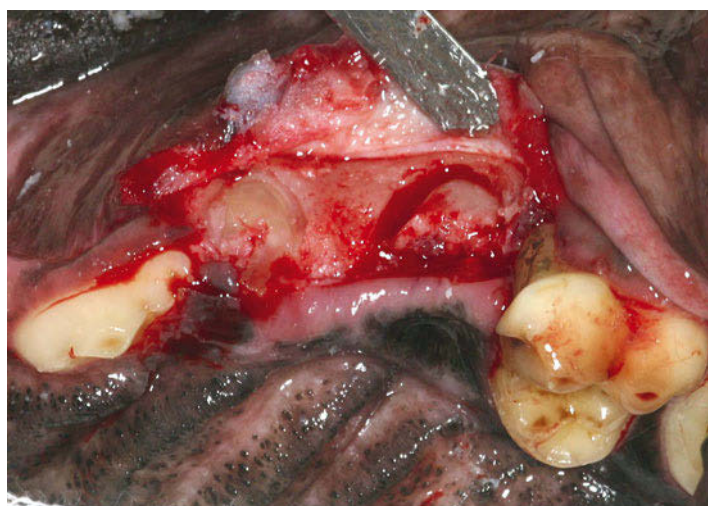
## 7.1.3 Step 3

### Perform a Buccal Osteotomy

The mesial root may be exposed with a minor osteotomy (► Fig. 7.5). The same procedure is used for the distal root (► Fig. 7.6).



► Fig. 7.5 Exposing the mesial root.

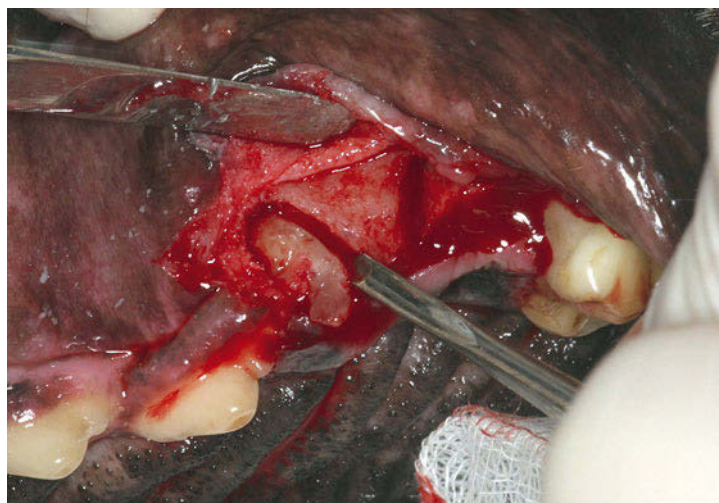


► Fig. 7.6 Exposing the distal root.

#### 7.1.4 Step 4

##### Luxate and Remove the Mesial Root

The mesial root is then loosened mesially (► Fig. 7.7). After mobilizing the root, luxate it buccally to the side of the osteotomy (► Fig. 7.8).



► Fig. 7.7 Luxation of the mesial root.

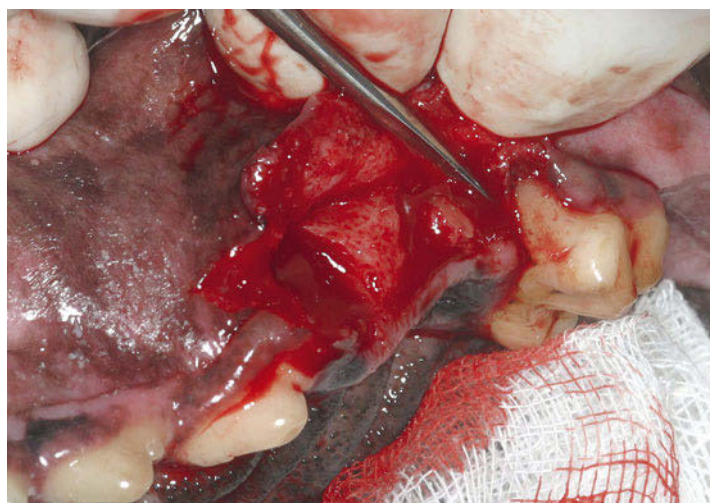


► Fig. 7.8 Buccal mobilization of the mesial root.

#### 7.1.5 Step 5

##### Luxate and Remove the Distal Root

The distal root can also be loosened and extracted under direct visualization (► Fig. 7.9).



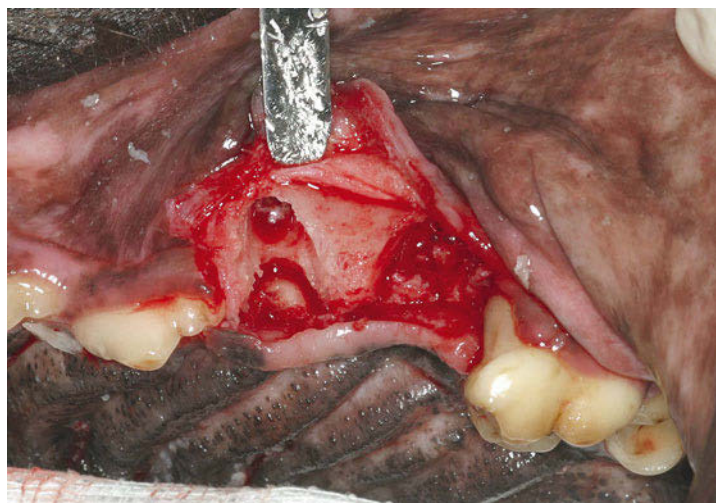
► Fig. 7.9 Luxation of the distal root.



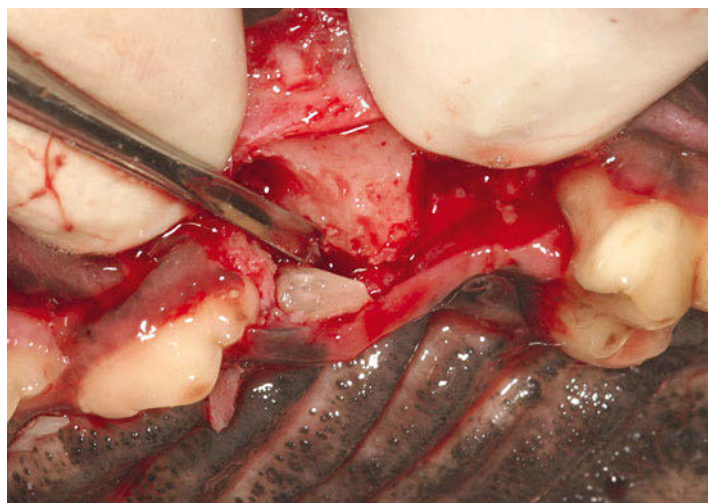
### 7.1.6 Step 6

#### Luxate and Remove the Palatal Root

The alveolus of the mesiobuccal root is used to expose the palatal root. The palatal root is exposed on the palatal wall of the alveolus (► Fig. 7.10). The root is mobilized coronally and removed (► Fig. 7.11).



► Fig. 7.10 Exposure of the palatal root.

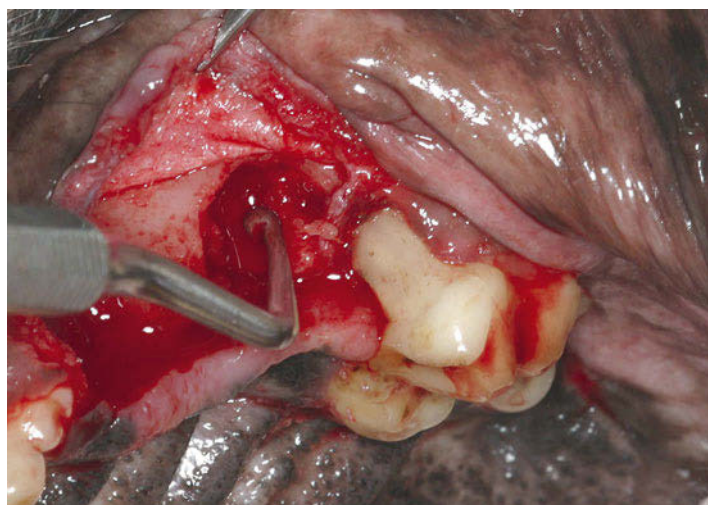


► Fig. 7.11 Luxation of the palatal root.

### 7.1.7 Step 7

#### Curette the Alveoli

Remove the soft tissue from the alveoli by curettage (► Fig. 7.12).



► Fig. 7.12 Curettage of the alveoli.

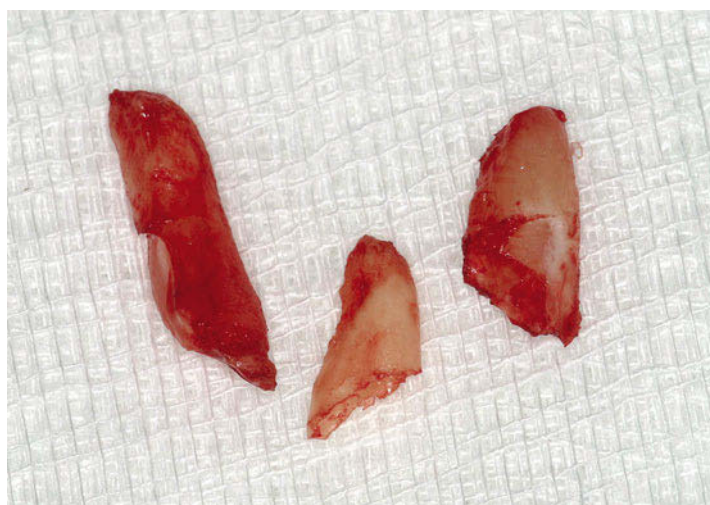
### 7.1.8 Step 8

#### Examine the Extraction

A radiograph should be taken before closing the alveoli (► Fig. 7.13). The recession of the mesiobuccal root of the first molar is acceptable and the furcation of the tooth is unimpaired. As the wound in the extraction area heals, the gingiva attached to the molar should recover and allow regular dental care. The extracted roots (► Fig. 7.14) explain the persistent inflammation and the associated pain.



► Fig. 7.13 Radiograph after retrieving the root fragments of tooth 208.



► Fig. 7.14 Removed root fragments.

### 7.1.9 Step 9

#### Sutures

The incision can be closed without major mobilization of the mucosa (► Fig. 7.15) because a complete mucosal cover was previously present.



► Fig. 7.15 Suture.



## 8 Composite Fillings

### 8.1

### Composite Fillings – Step by Step

#### ☑ Procedure Overview

1. Evaluate the current condition
2. Prepare a cavity
3. Etch the cavity
4. Apply the bonding agent
5. Apply the composite
6. Finish the filling

#### 8.1.1 Step 1

##### Evaluate the Current Condition

Chipped enamel is analogous to a wound because it exposes the pulp-dentin complex. Animals' reactions to this kind of trauma vary; painful reactions to cold water or snow are common, suggesting heightened sensitivity. Even in lesions as small as that in ► Fig. 8.1, certain conditions may lead to pulp necrosis. The radiograph of the root of the maxillary left carnassial tooth shows no current inflammation (► Fig. 8.2).



► Fig. 8.1 Local enamel defect on the mesial surface of tooth 204.



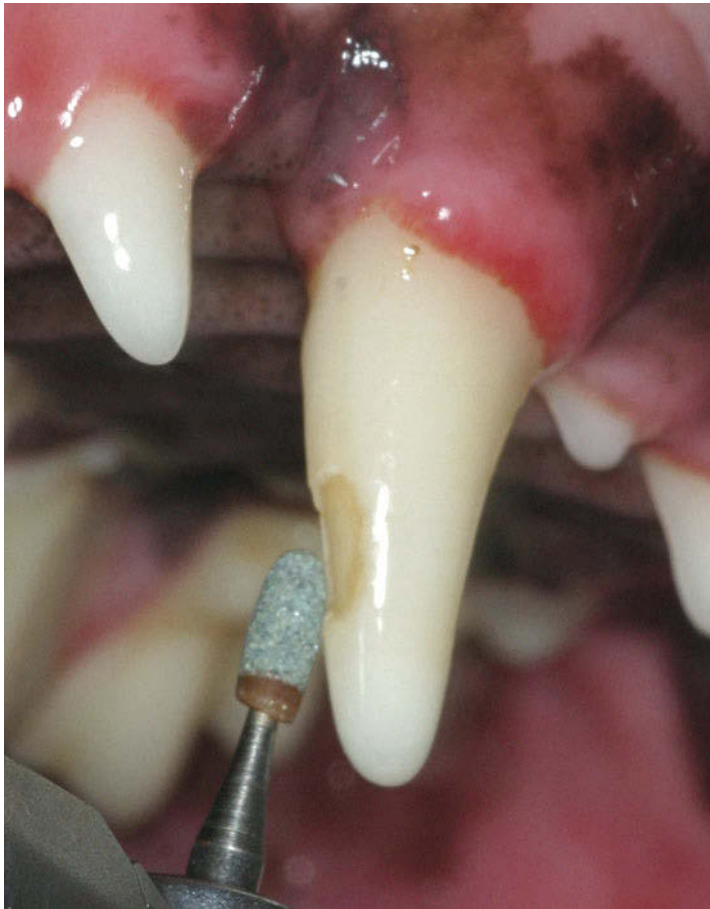
► Fig. 8.2 Radiograph of tooth 204.

### 8.1.2 Step 2

#### Prepare a Cavity

Create a cavity for placement of the bonding agent (► Fig. 8.3). In contrast to fillings used after endodontic treatment, for example, in this case the composite material cannot be mechanically anchored in a cavity with converging walls. Thus, composite is helpful for its adhesive properties.

Use finishing burs to work the edges of the cavity to achieve planing of the enamel, and taper the enamel to create a broader contact area for the composite (► Fig. 8.4).



► Fig. 8.3 Preparing a cavity with finishing burs.



► Fig. 8.4 Preparing the edges of the cavity.



### 8.1.3 Step 3

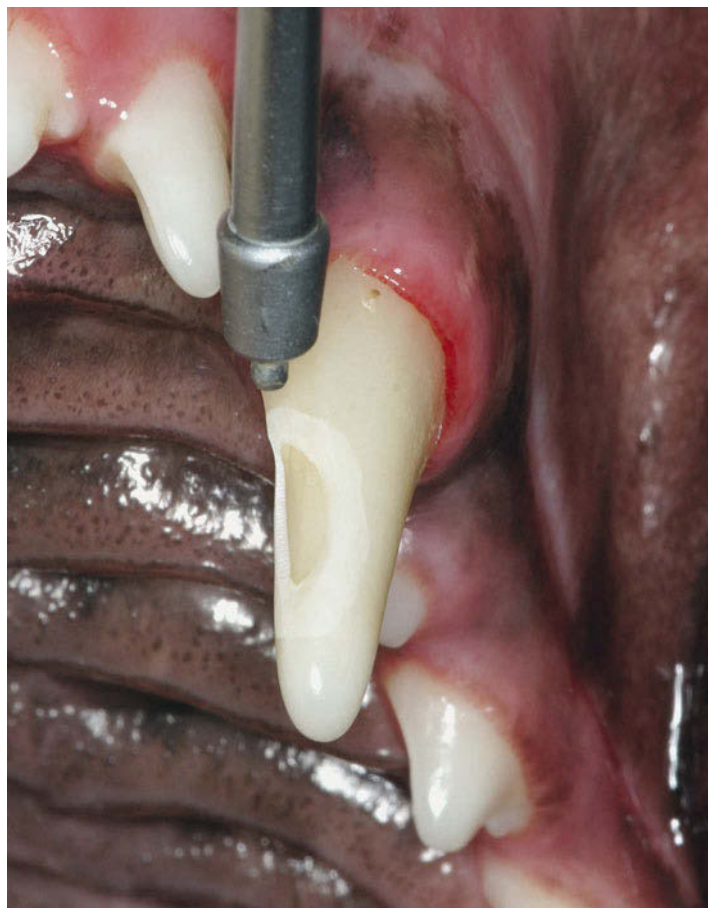
#### Etch the Cavity

Etch the surface of the cavity with 37% to 40% phosphoric acid to create a retentive surface (► Fig. 8.5). This especially improves the adhesion at the now broadened edges. While most manufacturers deem approximately 20 seconds of etching to be sufficient, physical studies suggest that an etching time of 1 minute produces a deeper and better etching structure of the enamel crystals.

The etched area appears as a frosted enamel surface after rinsing with water and then drying completely with an air syringe (► Fig. 8.6). The etched area must be completely dry to proceed. Even small amounts of saliva contamination will compromise the receptive surface.



► Fig. 8.5 Etching the cavity.



► Fig. 8.6 Etched area.

## 8.1.4 Step 4

**Apply the Bonding Agent**

Start by applying a low-viscosity bonding agent to sufficiently moisten the prepared surface and permeate the etched indentations (► Fig. 8.7). This thin layer of unfilled monomer serves as the bonding agent for the subsequent high-viscosity composite.

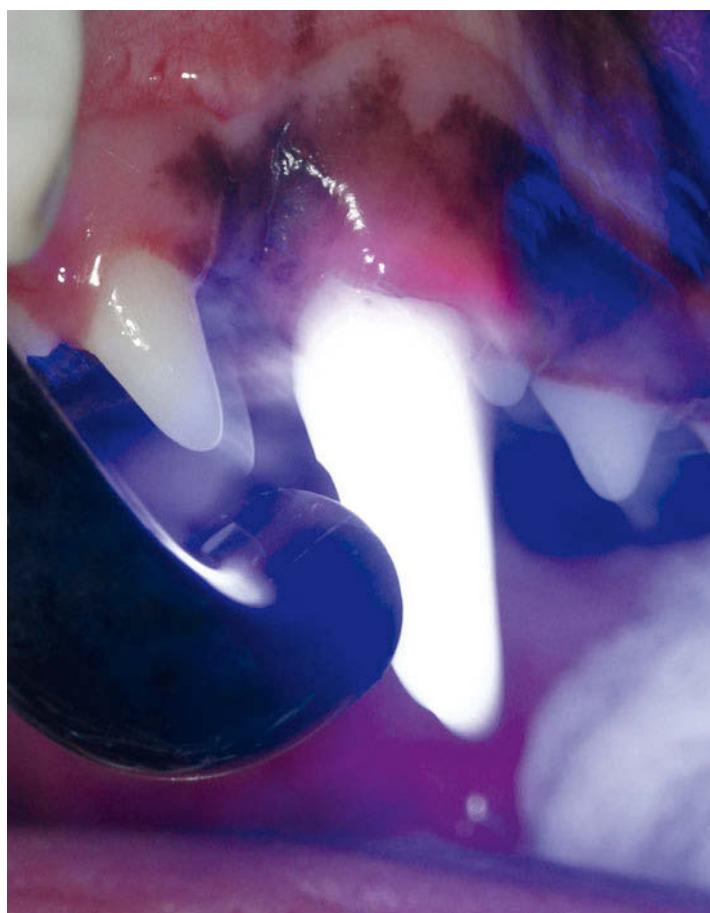
To ensure that the bonded surface is sufficiently thin, create a uniform surface thickness and remove excess material with an air syringe (► Fig. 8.8). Light-curing the bonding agent is not required by all manufacturers; a curing lamp may be used for this purpose (► Fig. 8.9).



► Fig. 8.7 Applying the bonding agent.



► Fig. 8.8 Drying the bonding agent with an air syringe.



► Fig. 8.9 Curing the bonding agent.



### 8.1.5 Step 5

#### Apply the Composite

Next, apply the high-viscosity composite (► Fig. 8.10). The composite may be shaped using a transparent film matrix (► Fig. 8.11). This solidifies the composite in the cavity. The composite may be cured with a curing lamp (► Fig. 8.12) through the transparent film matrix, and the matrix is subsequently removed.



► Fig. 8.10 Applying the composite.



► Fig. 8.11 Shaping the composite with a matrix.



► Fig. 8.12 Curing the composite.

## 8.1.6 Step 6

**Finish the Filling**

Use finishing burs, a rubber polisher or a flexible polishing disc to finish the filling. When using flexible polishing discs, start with coarse discs (► Fig. 8.13). In the final step, use a fine finishing disc to polish the surface to a high gloss (► Fig. 8.14).

The finished filling (► Fig. 8.15) renders the surface of the tooth smooth again. The filling blocks pain conduction through the dentin wound and prevents accumulation of plaque, further misalignment, and even tooth fracture.



► Fig. 8.13 Coarse finishing of the filling.



► Fig. 8.14 Fine finishing of the filling.



► Fig. 8.15 Finished filling.



## 9 Vital Pulpotomy

### 9.1

### Crown Reduction – Step by Step

In a case of mandibular distocclusion (class 2 malocclusion), the mandibular canine teeth may penetrate the palate. Since orthodontic correction is not always desired or even possible, the teeth may be shortened. The procedure is called vital pulpotomy, or partial pulpectomy and consists of removing the cusp of the tooth and the coronal part of the pulp. The created cavity receives a filling to maintain the remaining pulp vitality.

#### Procedure Overview

1. Evaluate the current condition
2. Shorten the cusp and perform a partial pulpectomy
3. Treat the pulp and place the cavity liner
4. Place composite filling
5. Check the occlusion
6. Monitor progress

#### 9.1.1 Step 1

##### Evaluate the Current Condition

A 10-year-old Miniature Bull Terrier presents with a skeletal malocclusion of the maxilla and mandible, a mandibular distocclusion, commonly referred to as an overbite. The mandibular canine teeth stand lingually at the level of the maxillary canine teeth (► Fig. 9.1). The malocclusion causes the mandibular canine cusps to contact the palate, damaging it and often the opposing maxillary teeth.

In addition, a small interdental gap between the maxillary canine and lateral incisor complicates the malocclusion of the misaligned mandibular canine teeth (► Fig. 9.2). Both mandibular canine teeth are linguoverted and distoverted and must undergo a vital pulpotomy due to a poor orthodontic prognosis.

The mandibular canine cusp penetration of the palate causes deep wounds in the palatal mucosa that sometimes extend to the bony maxilla (► Fig. 9.3). A deep impression of the mandibular canine tooth near the palatal surface of the maxillary canine tooth may cause periodontal damage to the maxillary canine teeth, and root resorption may occur.

To monitor the further development of the treated mandibular canine teeth a baseline radiograph is taken for future comparison (► Fig. 9.4).



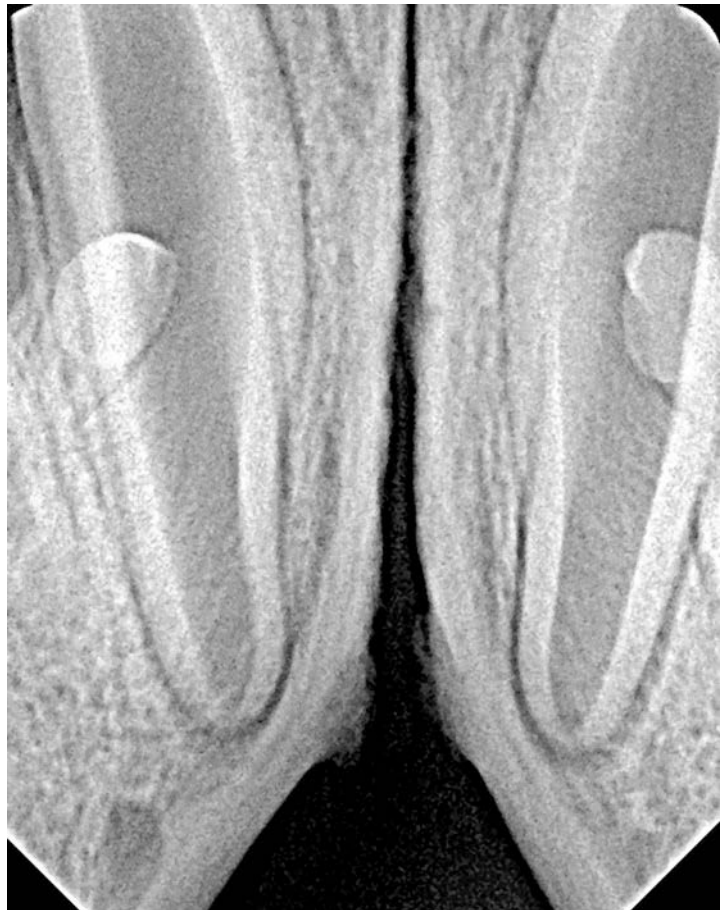
► Fig. 9.1 Linguoversion and distoversion of tooth 404.



► Fig. 9.2 Linguoversion and distoversion of tooth 304.



► Fig. 9.3 Malocclusion-induced trauma to the palate.



► Fig. 9.4 Radiograph of the mandibular canine teeth.

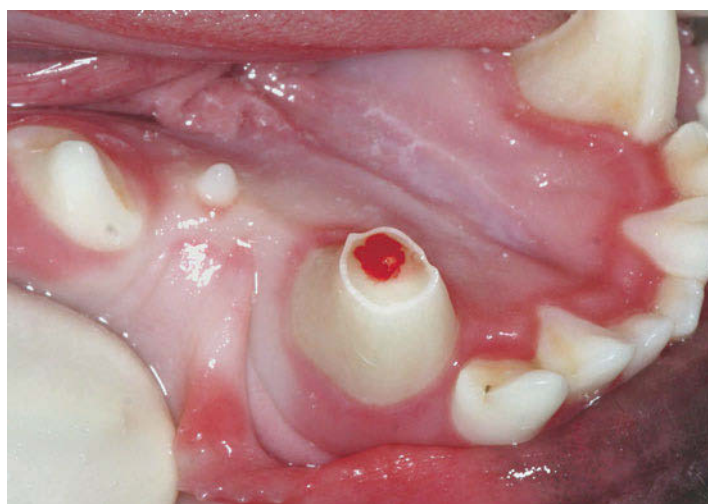


## 9.1.2 Step 2

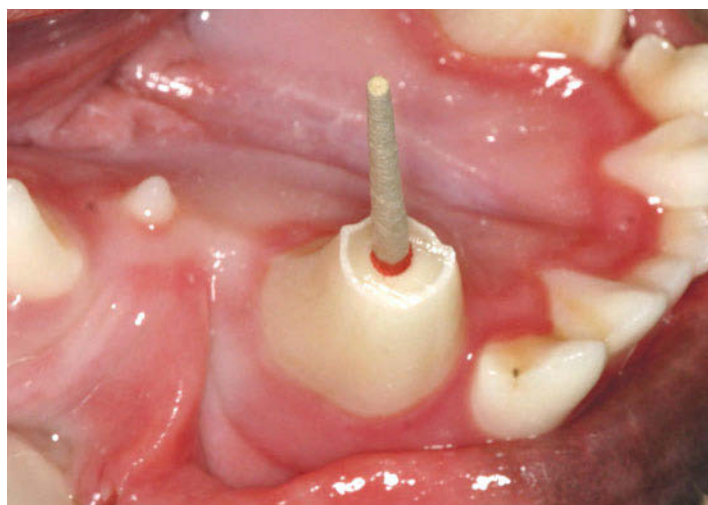
### Shorten the Cusp (Crown Reduction) and Perform a Partial Pulpectomy

Crown reduction exposes the pulp (► Fig. 9.5). A cavity is created for anchoring a filling, and a partial pulpectomy is performed. The top part of the coronal pulp is cleanly severed with a sharp cutter or grinder under sterile conditions. A cotton pellet may be used for hemostasis. A sterile paper point introduced upside down may be easier to handle, however (► Fig. 9.6).

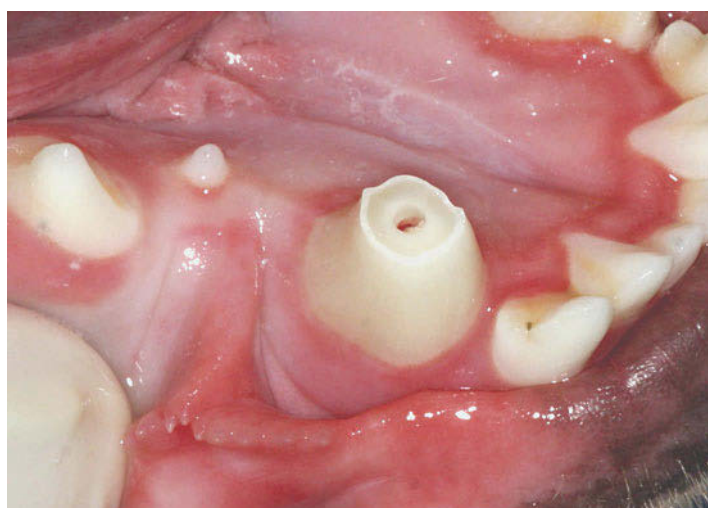
After 2 minutes, bleeding must have subsided to the extent that a substance that conserves the pulp's vitality can be inserted (► Fig. 9.7). Unstoppable bleeding may signify advanced inflammation. Advanced inflammation generally does not occur when teeth are shortened for orthodontic reasons; however, it may occur when a tooth is exposed due to trauma and treatment is delayed. If inflammation or pathology of the root tip is present, vital pulpotomy is no longer indicated. Instead, conventional root canal therapy is the treatment of choice due to the significantly better prognosis.



► Fig. 9.5 Shortened tooth 404 with pulp exposure.



► Fig. 9.6 Hemostasis of tooth 404.



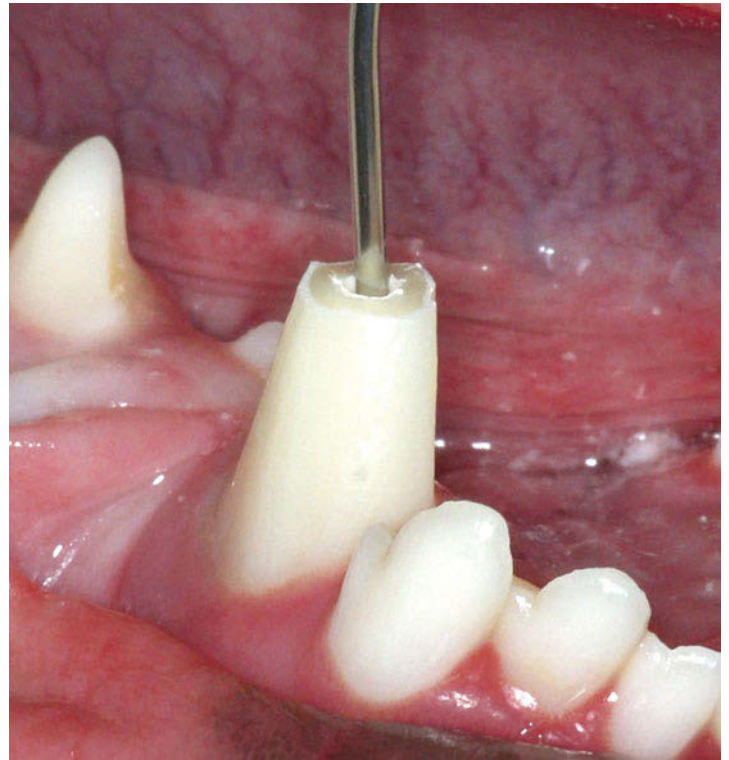
► Fig. 9.7 Cavity after hemostasis.

## 9.1.3 Step 3

**Treat the Pulp and Apply the Cavity Liner**

Treat the pulp with calcium hydroxide (► Fig. 9.8). Its alkaline character causes sterile superficial pulp necrosis for a distinct antibacterial effect. Calcium hydroxide is placed on the pulp stump to act as a medicament for the pulp. It has been replaced by mineral trioxide aggregate (MTA) in recent years as a hardening cement with more stable capabilities and an improved prognosis.

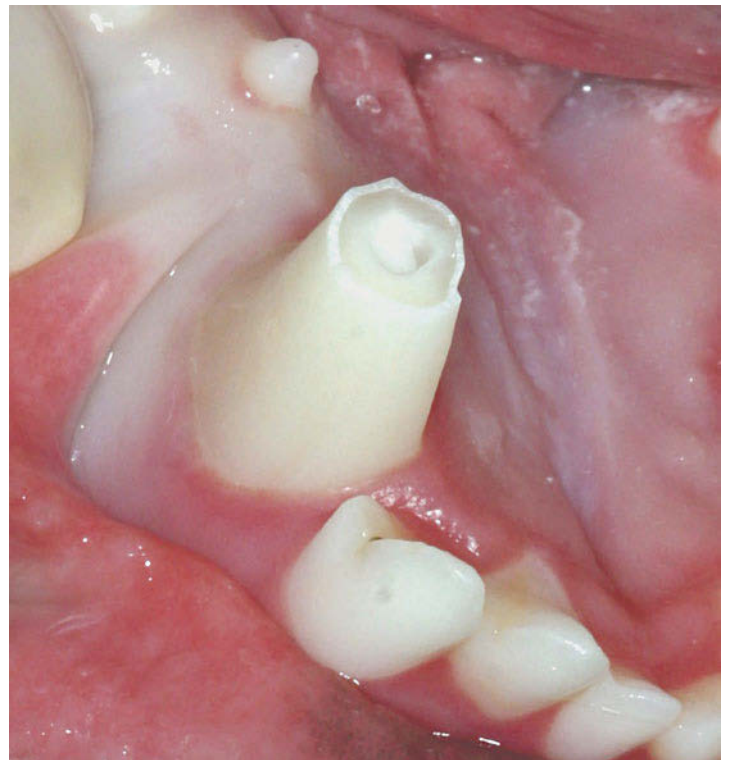
The next step is placement of cavity liner material (► Fig. 9.9, ► Fig. 9.10). Both self-curing and light-curing versions are available.



► Fig. 9.8 Introducing calcium hydroxide.



► Fig. 9.9 Placing the cavity liner.



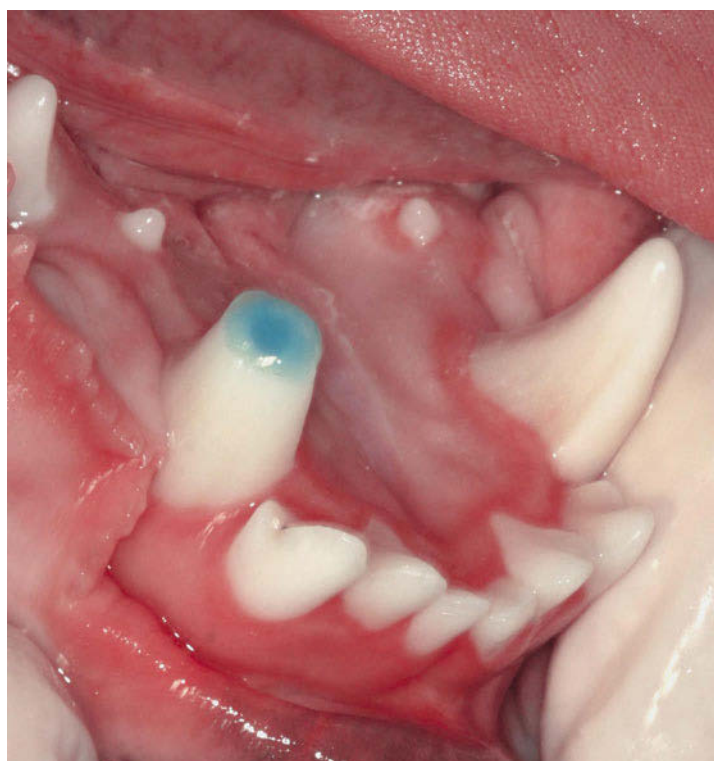
► Fig. 9.10 Cavity liner in the cavity.



#### 9.1.4 Step 4

##### Apply Restoration (Composite Filling)

Once the cavity liner has hardened, prepare the cavity for placement of the restoration. Since fillings are usually made of composite, the cavity is first etched (► Fig. 9.11). An unfilled resin (bonding agent) follows, and the composite filling material is applied to it. After inserting and compacting the composite material, use a curing lamp to cure it (► Fig. 9.12). Use a flexible polishing disc (► Fig. 9.13), burs or a polisher to finish the composite. Ensure the tooth surface is flat and smooth. The shortened teeth have a white exterior enamel border, followed by the yellowish dentin, and the composite filling is in the center (► Fig. 9.14).



► Fig. 9.11 Etching the cavity.



► Fig. 9.12 Curing the composite filling.



► Fig. 9.13 Finishing the composite filling.



► Fig. 9.14 Completed composite filling on the shortened mandibular canine teeth.

### 9.1.5 Step 5

#### Check the Occlusion

The shortened tooth should no longer injure the mucosa when the jaw is fully closed (► Fig. 9.15, ► Fig. 9.16). Possible further growth of the immature tooth should be accounted for when shortening the tooth.



► Fig. 9.15 Occlusion of tooth 404 with jaw closed.



► Fig. 9.16 Occlusion of tooth 304 with jaw closed.

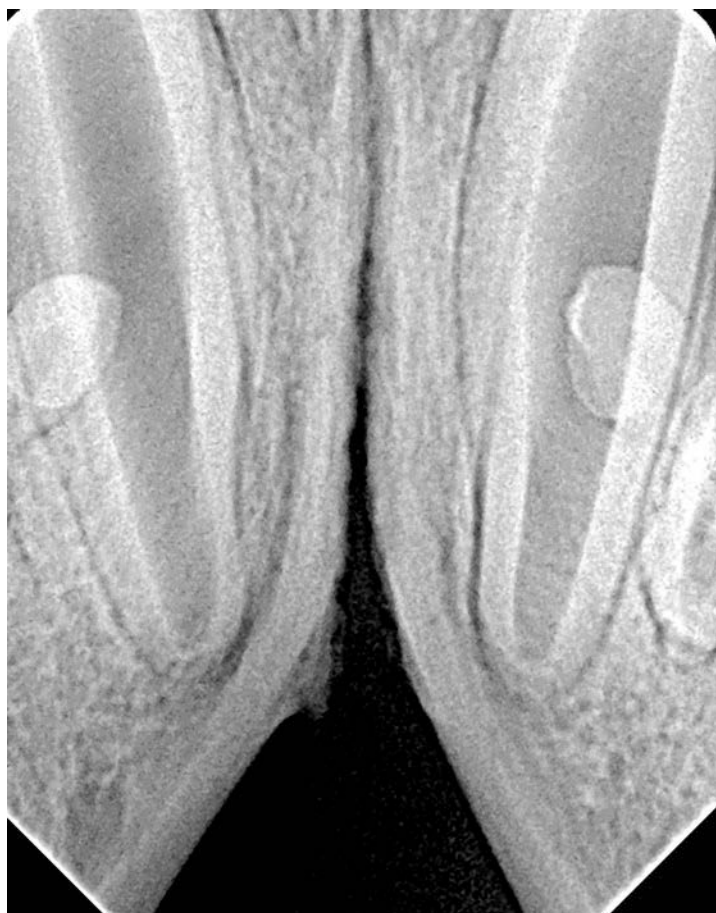


### 9.1.6 Step 6

#### Monitor Progress

The first follow-up radiograph is taken after 2 months. Both teeth show thickening of the root wall with a shrinking pulp. The root tips continue to develop without any observable pathological issues (► Fig. 9.17).

If the course is unremarkable, the second and final follow-up radiograph is taken after 12 months. The root tips show continuous unremarkable growth (► Fig. 9.18).



► Fig. 9.17 Radiograph of the mandibular canine teeth after 2 months.



► Fig. 9.18 Radiograph of the mandibular canine teeth after 12 months.

## 10 Crown Amputation

### 10.1

### Crown Amputation – Step by Step

Root fragments should remain in the jaw only in teeth affected by type 2 tooth resorption. The roots are replaced by bone-like tissue. In this case, crown amputation is a viable treatment alternative to complete extraction.

#### Procedure Overview

1. Evaluate the current condition
2. Dissect the mucosa
3. Perform a buccal osteotomy
4. Resect the crown and reduce the roots
5. Close the alveolus

#### 10.1.1 Step 1

##### Evaluate the Current Condition

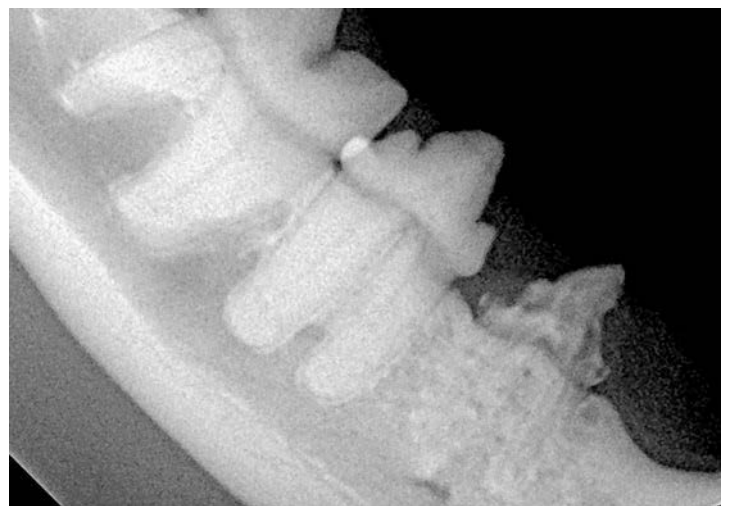
The mandibular right third premolar in this cat shows significant crown defects as a result of tooth resorption. Granulation tissue in the defect results from the surrounding inflamed gingiva and contains proliferative components from pulp exposure (► Fig. 10.1). The cat may show behavior signs of a tooth problem, such as tilting its head or grinding its teeth.

The radiograph (► Fig. 10.2) shows complete remodeling with nearly full root resorption. No translucency as a sign of inflammation is visualized. The conversion to bone-like tissue is radiologically unremarkable.

Complete extraction of a tooth under these circumstances is very difficult. In any case, an osteotomy extending to the root tips would be needed to elevate the tooth. Such traumatic access can be minimized using crown amputation as an alternative; this leaves already-remodeled tooth parts in the jaw and limits the extraction to the tooth crown and the cervical part of the roots.



► Fig. 10.1 Tooth resorption in tooth 407.



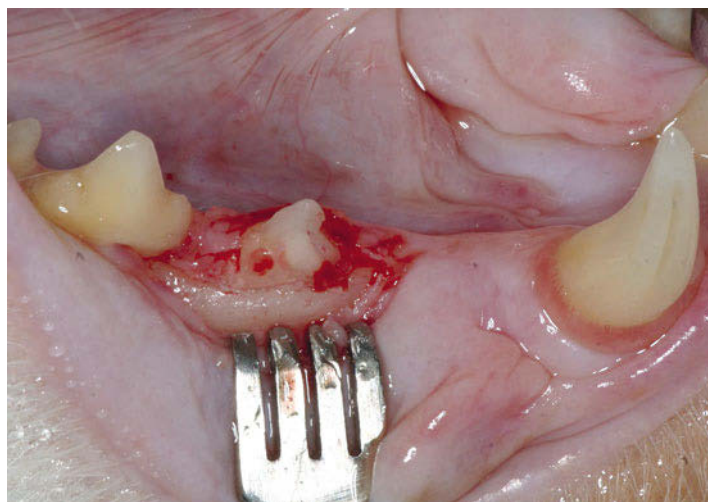
► Fig. 10.2 Radiograph of tooth 407.



## 10.1.2 Step 2

### Dissect the Mucosa

First, dissect a buccal mucoperiosteal flap (► Fig. 10.3).

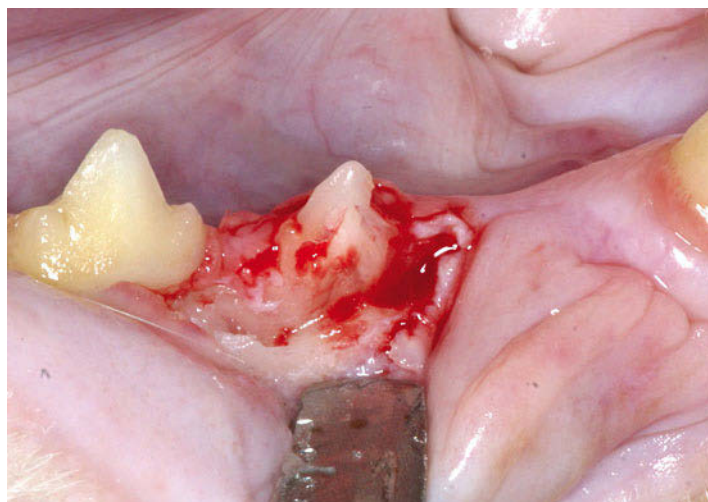


► Fig. 10.3 Dissecting a mucoperiosteal flap.

## 10.1.3 Step 3

### Buccal Osteotomy

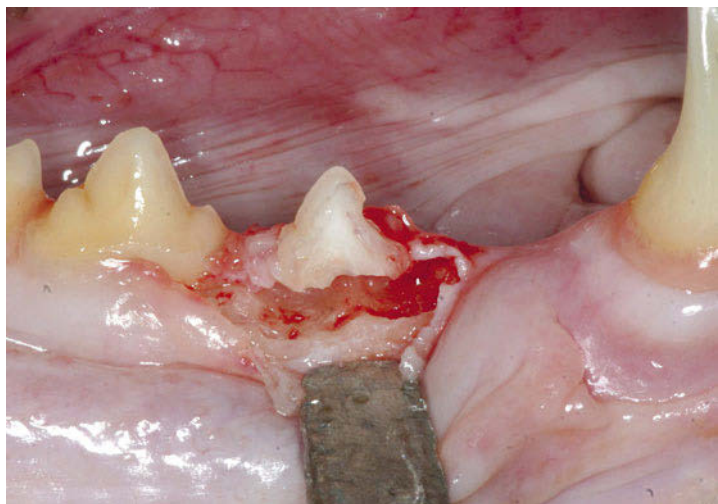
Perform a buccal osteotomy to expose the cervical parts of the root (► Fig. 10.4).



► Fig. 10.4 Buccal osteotomy in the cervical third of the root.

**10.1.4 Step 4****Resect the Crown and Reduce the Roots**

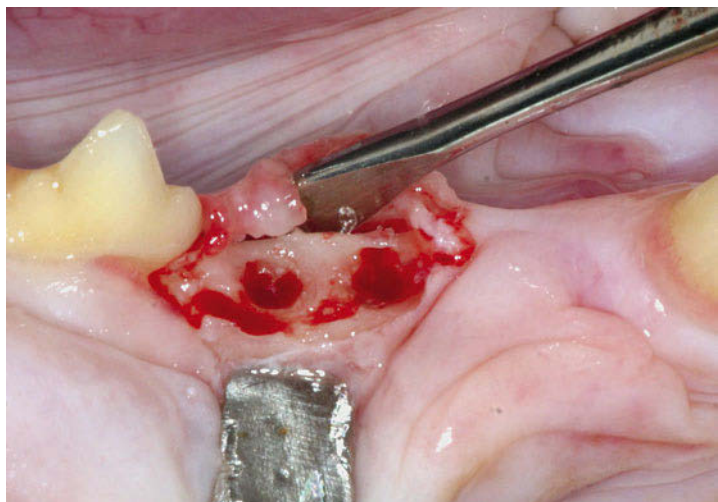
After the buccal osteotomy, the crown is separated at the cervical third of the root (► Fig. 10.5). The crown is lifted from the jaw (► Fig. 10.6). Recognizable tooth parts are removed from the sockets (► Fig. 10.7). Extraction of the tooth is confirmed with a radiograph (► Fig. 10.8).



► Fig. 10.5 Separating the crown.



► Fig. 10.6 Luxation of the crown.



► Fig. 10.7 Reduction of the roots.

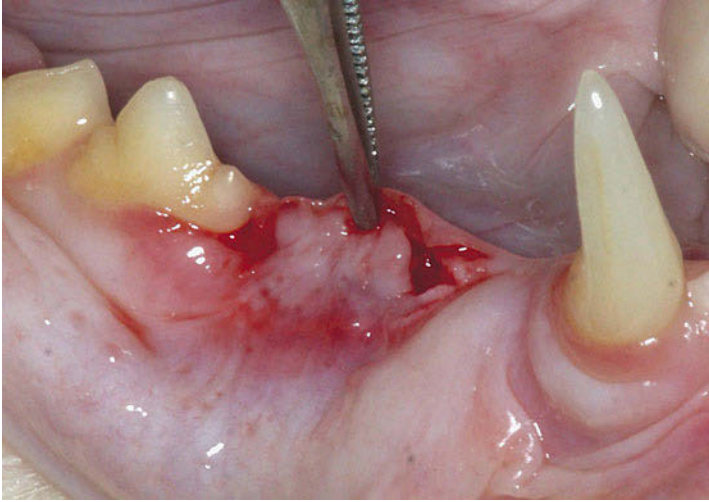


► Fig. 10.8 Intraoperative radiograph after crown amputation of tooth 407.

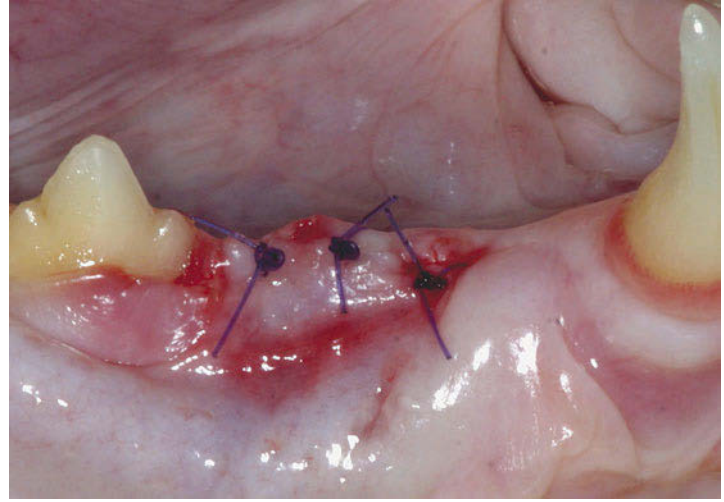


**10.1.5 Step 5****Close the Alveolus**

Incise the periosteum and mobilize the buccal mucosa until it can reach the lingual mucosa over the alveolus without tension (► Fig. 10.9). Place simple interrupted sutures (► Fig. 10.10).



► Fig. 10.9 Mucoperiosteal buccal flap.



► Fig. 10.10 Suture.

# 11 Root Canal Fillings

## 11.1

### Single-rooted Tooth – Step by Step

Contrary to popular opinion, as in humans and dogs, cats also develop periapical periodontitis from pulp death. It is not a matter of *whether* the inflammation will develop, but rather *when* the owner will notice it. Treatment is necessary to prevent root and bone resorption from persistent inflammation.

#### ☒ Procedure Overview

1. Evaluate the current condition
2. Access the root canal
3. Measure the working length
4. Prepare the root canal
5. Insert the paste filler
6. Insert the gutta percha points
7. Check the root filling
8. Prepare the cavity
9. Composite filling
10. Check the tooth filling

#### 11.1.1 Step 1

##### Evaluate the Current Condition

The cusp of the maxillary right canine of this cat is fractured. The pulp is not sufficiently exposed to allow probing. The central fracture area is dark (► Fig. 11.1).

The radiograph shows a narrow pulp chamber and periapical osteolysis caused by pulp necrosis (► Fig. 11.2).



► Fig. 11.1 Fractured tooth 104.



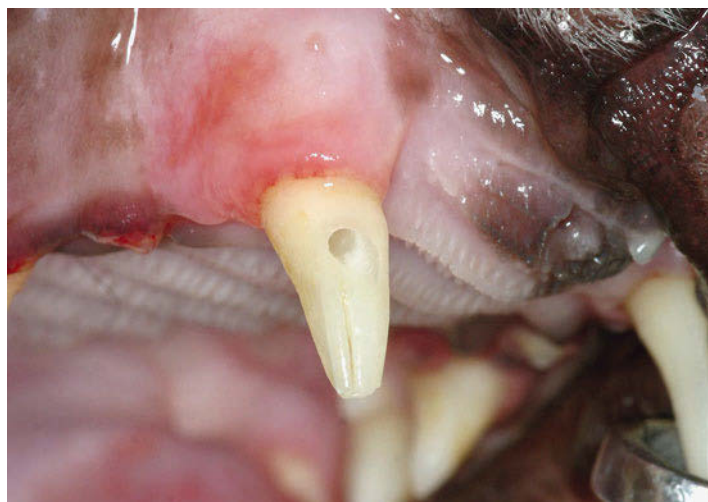
► Fig. 11.2 Radiograph of tooth 104.



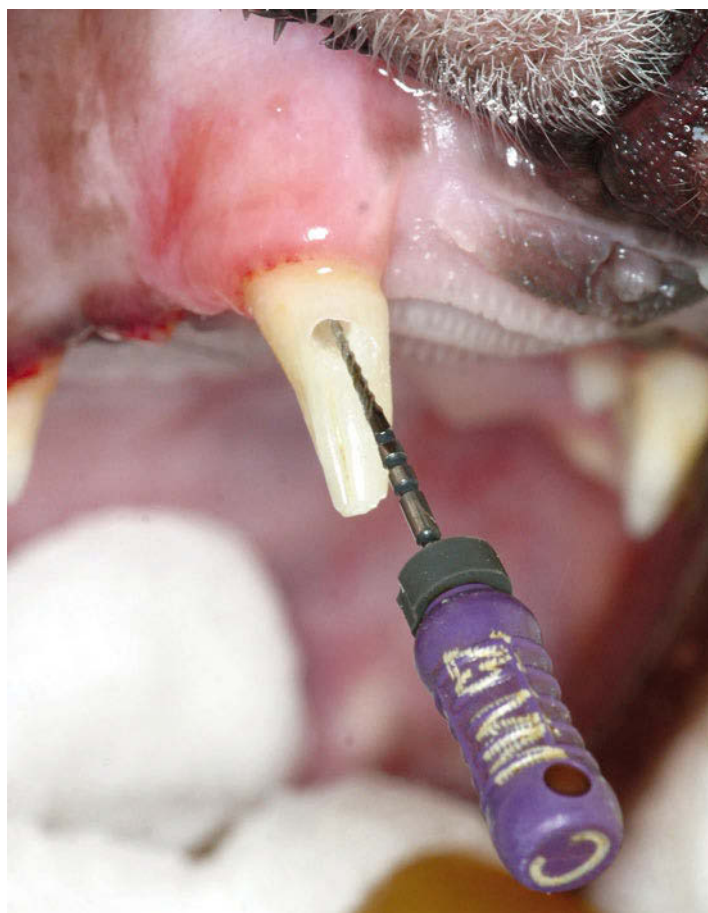
## 11.1.2 Step 2

### Access the Root Canal

The root canal is approached mesiocervically via an accessory cavity (► Fig. 11.3), since preparation via the fracture area is not possible. The exposed root canal can be probed with a thin file or a pathfinder as part of cavity preparation (► Fig. 11.4).



► Fig. 11.3 Cervical accessory cavity.

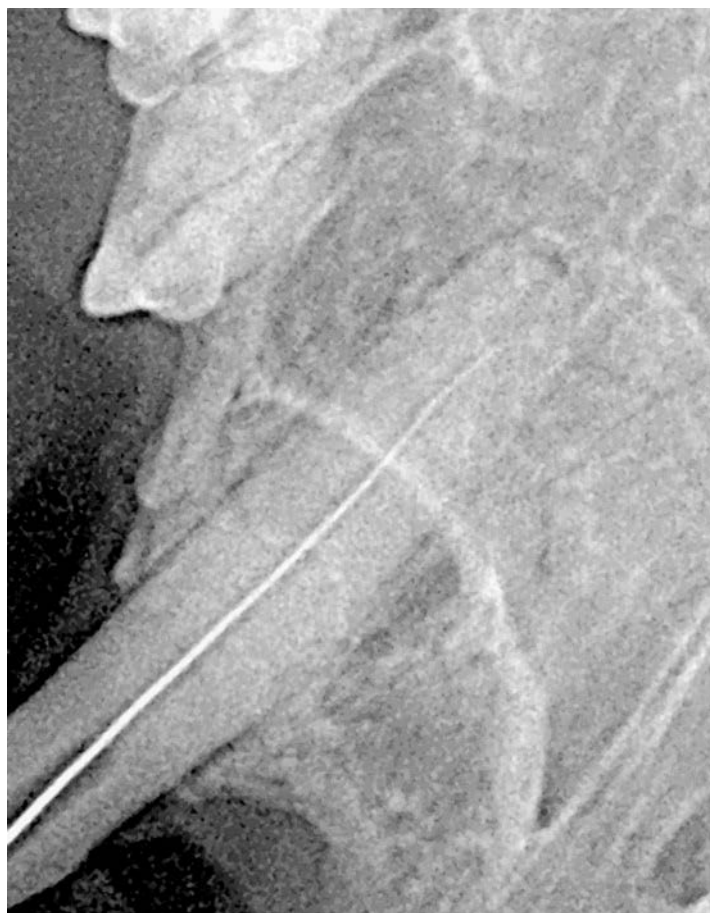


► Fig. 11.4 Probing the root canal.

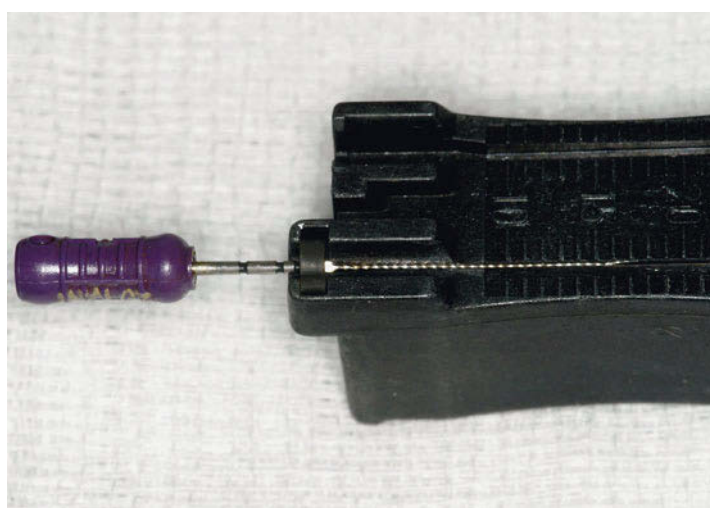
### 11.1.3 Step 3

#### Measure the Working Length

A thin file can be used to measure the entire length of the root canal (► Fig. 11.5). Coronally, a silicone stopper is placed on the file up to the accessory hole of the tooth in order to measure the length of the preparation. After the file is removed from the tooth, the distance from the silicone stopper to the instrument tip is measured (► Fig. 11.6); this corresponds to the working length that must be maintained.



► Fig. 11.5 Measurement radiograph of tooth 104.



► Fig. 11.6 Measuring the working length.



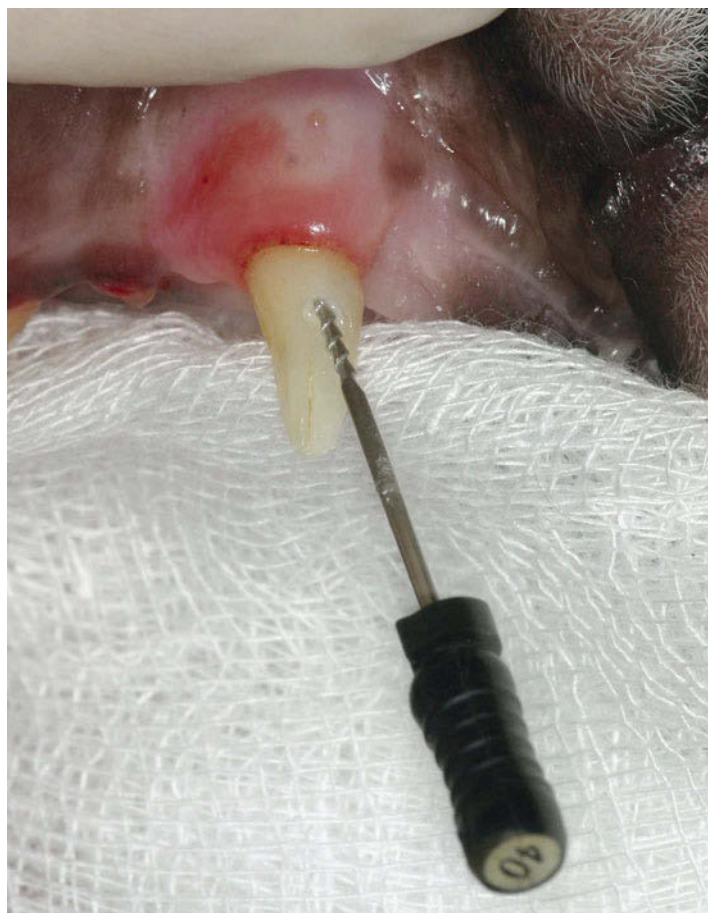
## 11.1.4 Step 4

**Prepare the Root Canal**

Hedstrom files of increasing lengths are then used to widen the root canal in a conical shape to receive the root canal filling (► Fig. 11.7). If the full length of the root canal cannot be prepared in the desired file size, once the end of the root canal has been reached, the step-back method can be used to prepare the upper parts of the root. Increasingly larger file sizes are used millimeter by millimeter in order to create enough space coronally to insert the root canal filling.

To disinfect the root canal and remove the dentin debris created during preparation, the root canal is irrigated between the use of each individual file size (► Fig. 11.8). 3% hydrogen peroxide and/or 2.5% to 5% sodium hypochlorite are most commonly used as irrigating solutions. The interaction of these irrigating substances causes oxygen release, allowing dentin particles to be rinsed out of the lumen of the root canal. Alternatively, EDTA as a chelating agent, which softens the dentin wall, is also used as irrigation.

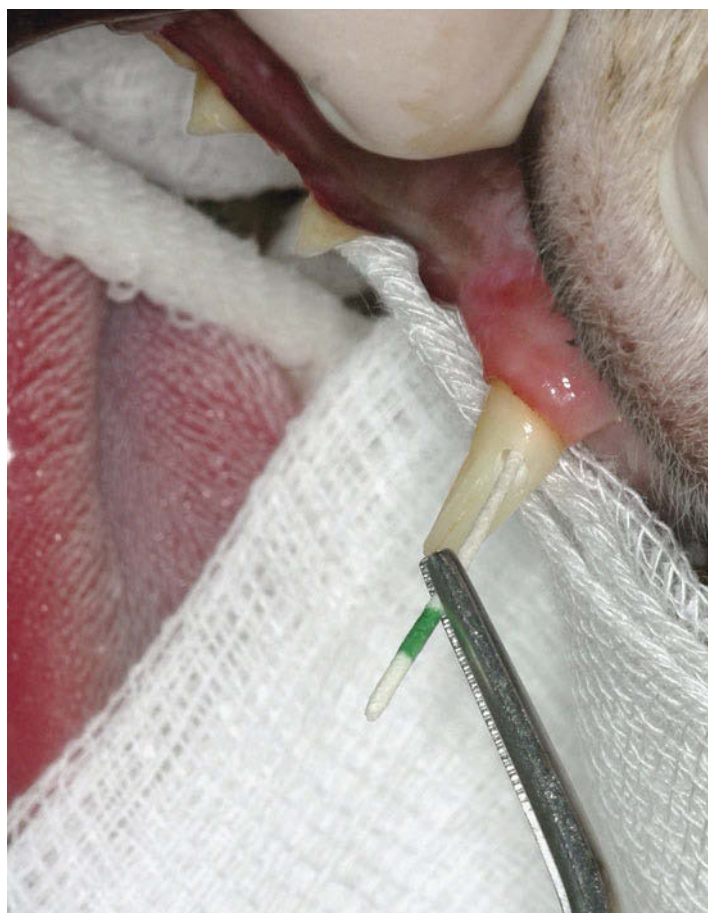
After extirpation of the pulp, and preparation, cleaning and disinfection of the canal, paper points are used to dry the root canal (► Fig. 11.9). Because the feline root canal is not very long, short (human dental) paper points are sufficient for drying. Color coding of the ring on the wide end of the file indicates the standard ISO size.



► Fig. 11.7 Flaring and shaping the root canal.



► Fig. 11.8 Intermittent irrigation of the root canal.



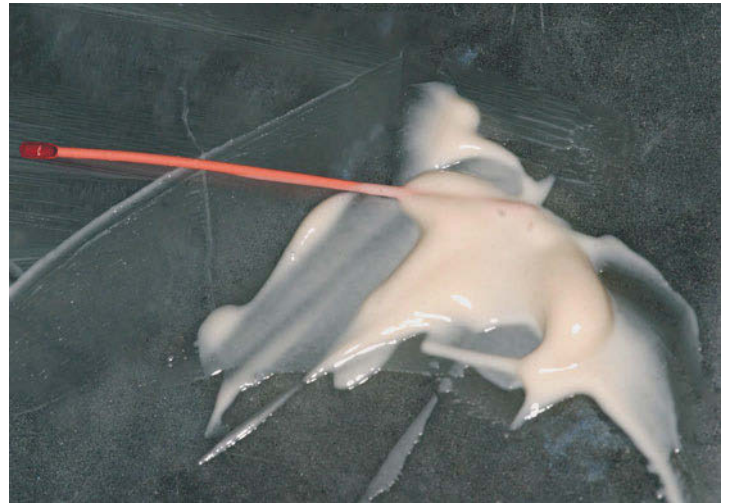
► Fig. 11.9 Drying the root canal.

### 11.1.5 Step 5

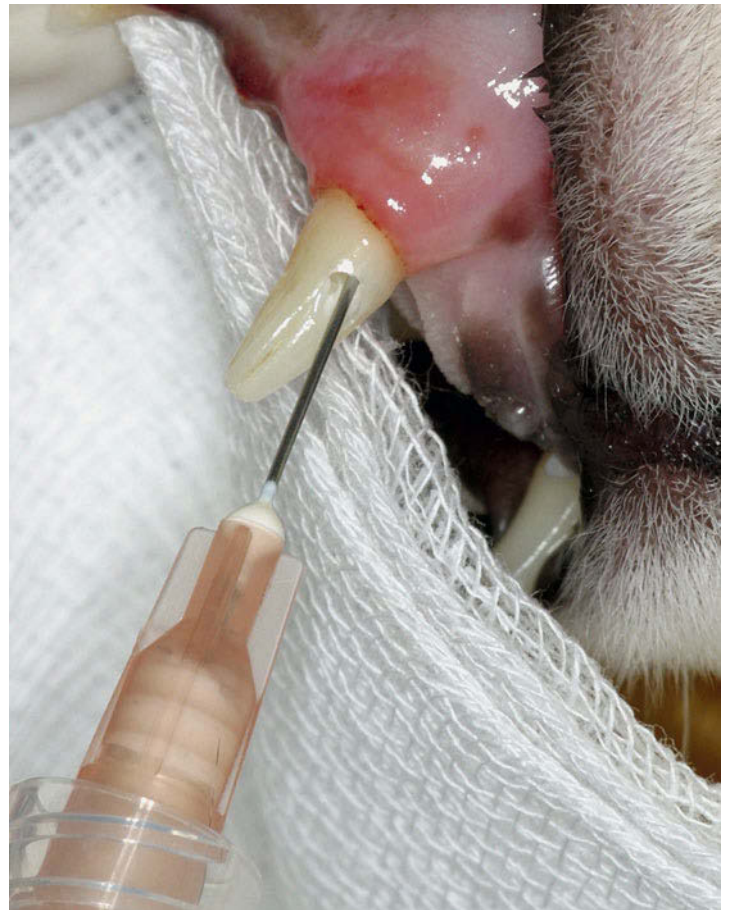
#### Insert the Filling Paste

A number of different pastes are available for filling the root canal (► Fig. 11.10). However, it has not yet been possible to achieve sufficient mechanical stability or sterility of the root canal filling with filling paste alone. Gutta percha points are therefore used to create a stable filling from the paste in close proximity to the dentin wall. Currently a gutta-percha-formulation is available that is a combination of paste and filler (Guttaflow®). It is used to ensure applicability and sealing of the root canal.

The root canal filling paste can first be inserted into the canal with a syringe (► Fig. 11.11). Application with a Lentulo spiral alone is also possible. A gutta percha point can then be used to distribute the root canal paste in the pulpal lumen (► Fig. 11.12). Color coding on the point indicates its ISO standard size. A Lentulo spiral is used to seal the paste. Clockwise rotation is used to transport inserted material to the apex (► Fig. 11.13).

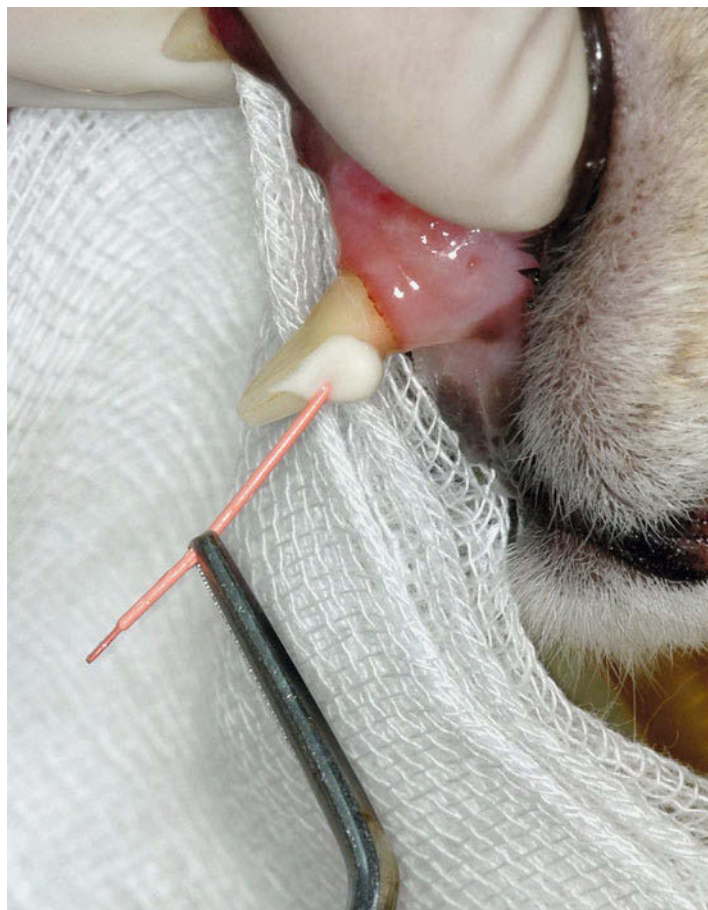


► Fig. 11.10 Mixing the root canal filling paste.



► Fig. 11.11 Using a syringe to insert the root canal filling paste.





► Fig. 11.12 Distributing the root canal filling paste.

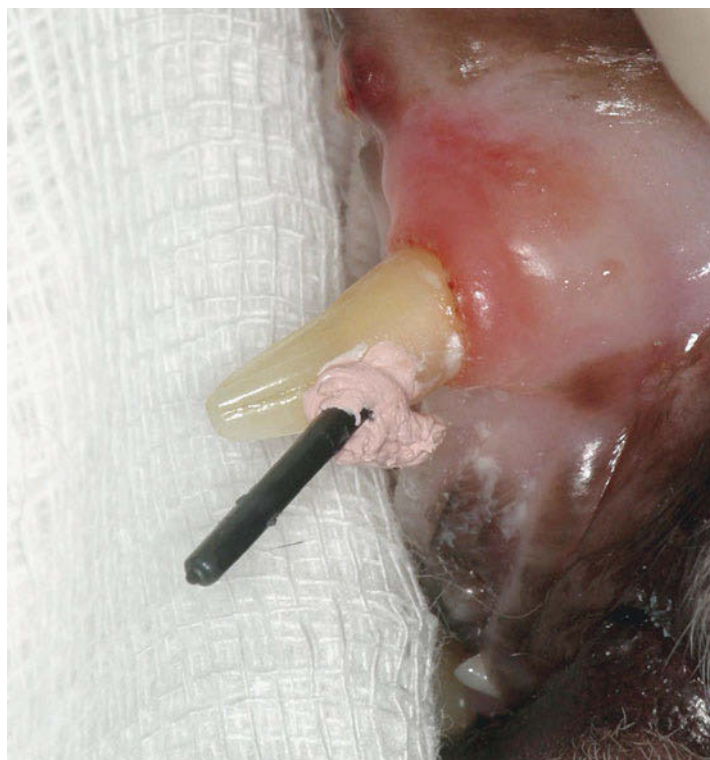


► Fig. 11.13 Rotating the root canal filling paste into the root.

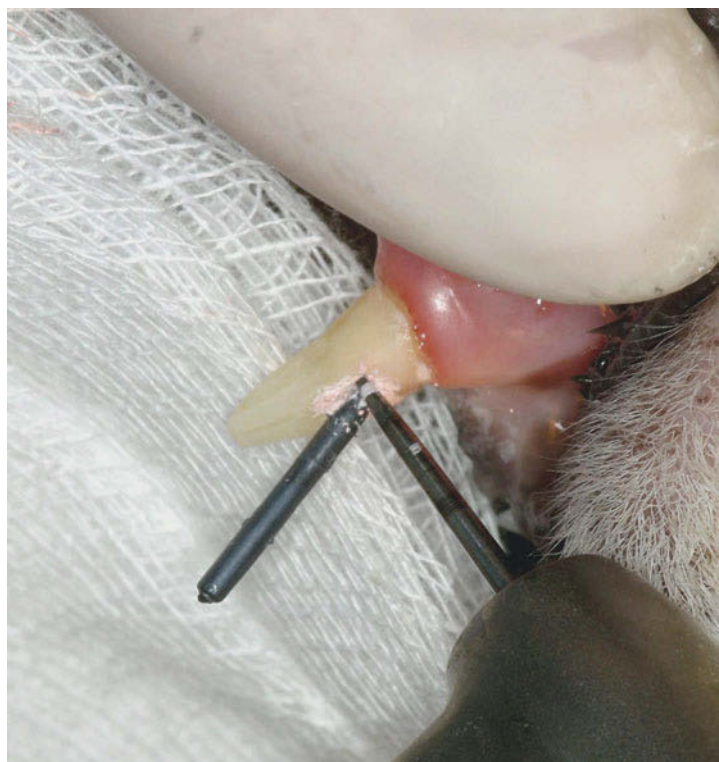
## 11.1.6 Step 6

**Insert the Gutta Percha Point**

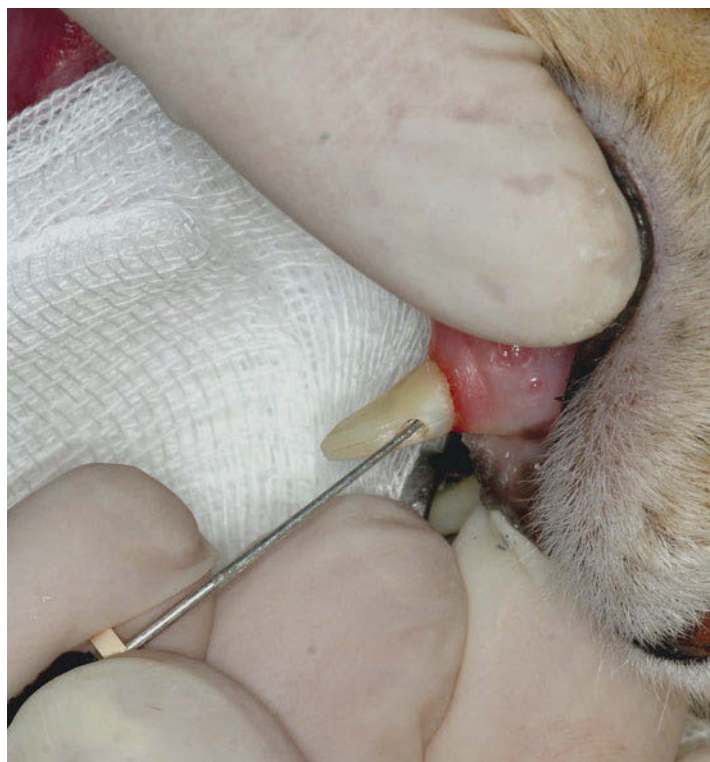
Gutta percha points are used to seal the root canal. In this case, a plastic point coated with gutta percha is heated and softened and then inserted into the root canal (► Fig. 11.14). A rotary instrument or heated instrument is used to detach the coronal end of the point (► Fig. 11.15). A spreader is used to condense the filling laterally, additional points are added as needed, and then the filling is compacted (► Fig. 11.16) further vertically from a coronal direction.



► Fig. 11.14 Inserting the gutta percha point.



► Fig. 11.15 Detaching the gutta percha point.



► Fig. 11.16 Compacting the root canal filling.



**11.1.7 Step 7****Check the Root Canal Filling**

The root canal filling is radiographed to check that it is complete (► Fig. 11.17).



► Fig. 11.17 Intraoperative radiograph of tooth 104.

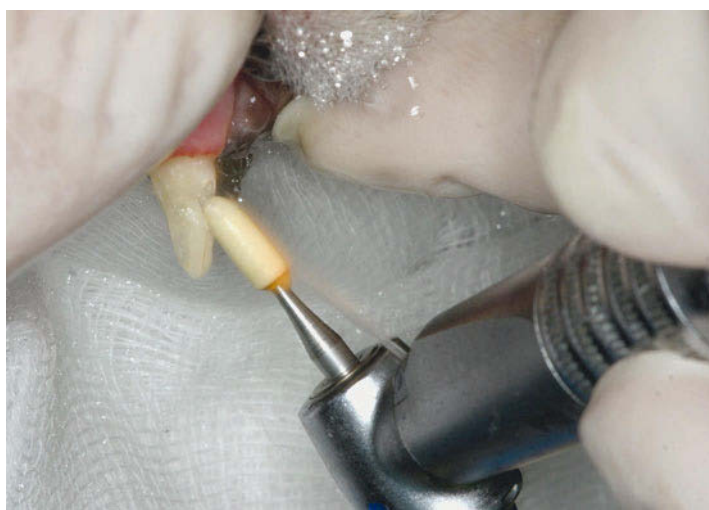
**11.1.8 Step 8****Prepare the Cavity**

Coronally, a cavity is created to receive a composite filling (► Fig. 11.18). A finishing bur is used to rework any enamel that has broken as a result of preparation with a diamond, as well as to prepare the cavity edges for adhesive attachment of the filling (► Fig. 11.19).

37% to 40% phosphoric acid is used to etch the cavity surface. It is available as a blue gel, which makes it easy to recognize and ensures stability (► Fig. 11.20). A disposable brush is used to apply the adhesive bond (► Fig. 11.21), which acts as a connective layer between two solid media (tooth surface and composite). The dentin can be pretreated differently because it differs from enamel. Composite is commonly used; other filling materials currently play only a very small role in veterinary dentistry.



► Fig. 11.18 Creating a cavity.



► Fig. 11.19 Using a finishing bur to shape the edges.



► Fig. 11.20 Etching the cavity.



► Fig. 11.21 Applying the bonding agent.



### 11.1.9 Step 9

#### Composite Filling

A filling instrument is used to insert the composite (p.107) into the cavity and shape it (► Fig. 11.22). The larger the cavity, the more single doses are polymerized separately to counteract polymerization shrinkage during curing of the material. In the curing process, a curing light (► Fig. 11.23) starts the photoinitiators of the filling material and triggers hardening. Both halogen and LED curing lights are available.

After curing, the composite filling is prepared (► Fig. 11.24) with burs, rubber polishers, or flexible polishing discs. The final result should be a smooth dental surface without any gaps in the edges (► Fig. 11.25), so as to avoid accumulations of plaque and achieve a bacteria-proof seal of the root canal filling.



► Fig. 11.22 Inserting the composite.



► Fig. 11.23 Curing the composite filling.



► Fig. 11.24 Using a grinding/polishing disc to finish the filling surface.



► Fig. 11.25 Finished composite filling.

**11.1.10 Step 10****Check the Tooth Filling**

The final step involves radiography of the definitive root canal filling with the coronal filling (► Fig. 11.26). Radiographic follow-up after 2 years shows a stable root area. There are no pathological changes and the filling is intact (► Fig. 11.27).



► Fig. 11.26 Postoperative radiograph.



► Fig. 11.27 Follow-up radiograph of tooth 104 after 2 years.



## 11.2

**Multirooted Tooth 108 – Step by Step**

Root canal therapy to preserve a maxillary carnassial tooth is a complex procedure with a number of individual steps, each of which is crucial to success.

**Procedure Overview**

1. Evaluate the current condition
2. Expose the canal access points and extirpate the pulp
3. Measure the working length
4. Prepare the root canals
5. Temporary filling
6. Definitive root canal filling
7. Coronal filling

**11.2.1 Step 1****Evaluate the Current Condition**

A fractured maxillary carnassial tooth with pulp exposure near the main cusp was treated with a partial pulpectomy to preserve the vitality of the tooth. A coronal filling was no longer observed at the time of presentation (► Fig. 11.28).

The radiograph shows blurred radiopacity in the area of the coronal pulp. Near the medial root tips, the root gap is slightly widened and the distal root exhibits distinct periapical osteolysis (► Fig. 11.29).



► Fig. 11.28 Fractured tooth 108.



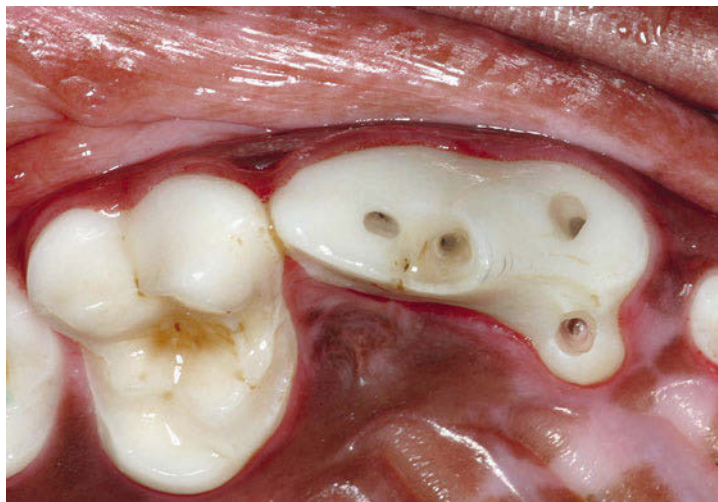
► Fig. 11.29 Radiograph of tooth 108.

### 11.2.2 Step 2

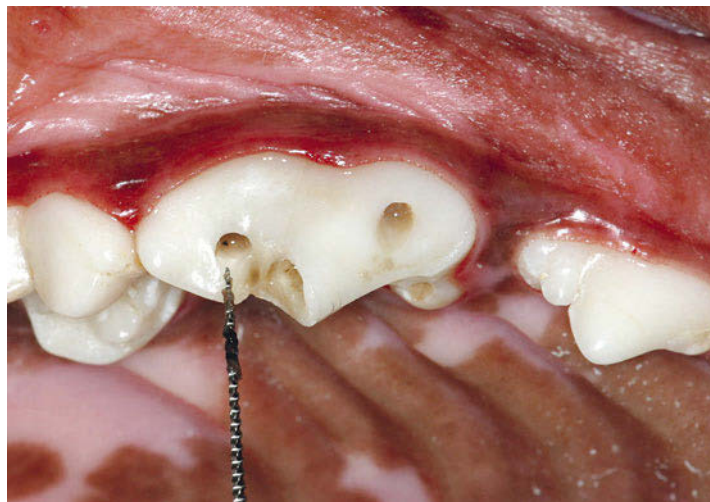
#### Expose the Root Canal Access Points and Extirpate the Pulp

Proper visualization of the root canal access points is essential for root canal therapy. Three additional accesses via the individual roots (► Fig. 11.30) can be used to expose the root canals to ensure that access is as direct as possible. Nonvital dark pulp can already be removed in this case during probing of the canals (► Fig. 11.31).

Mesial access is also basically possible via a common mesiobuccal cavity, but the curvature of the canal sometimes makes it difficult to reach the palatal canal. This variation is a good alternative when the palatal cusp or the tooth is too small for a separate access point.



► Fig. 11.30 Exposing the root canal access points of tooth 108.



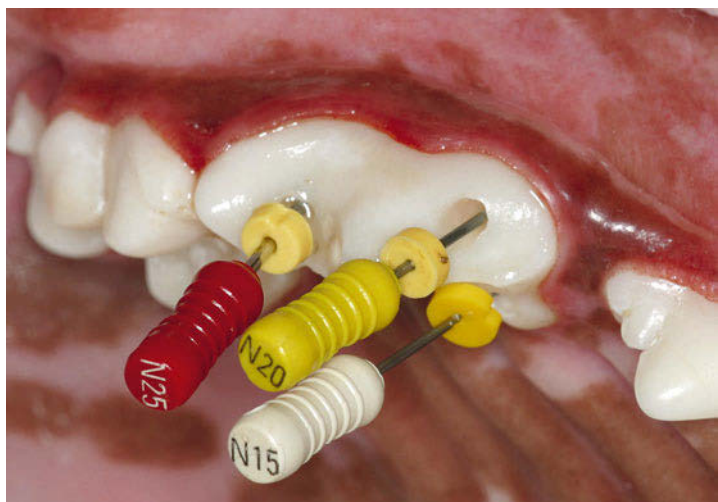
► Fig. 11.31 Extirpating the pulp.

### 11.2.3 Step 3

#### Measure the Working Length

To visualize the root canals in measurement radiography, after complete extirpation of the pulp, endodontic files are inserted into each canal. Silicone stoppers are advanced to the coronal surface in order to determine length (► Fig. 11.32).

The measurement radiograph shows the required length of the files in the root canal (► Fig. 11.33). The parallax technique is used in some cases to prevent superimposition of the mesial roots in the radiograph. A mesial or distal projection is used to displace the mesial roots in the radiograph so that the root canals can be evaluated individually.



► Fig. 11.32 Files in the root canals of tooth 108.



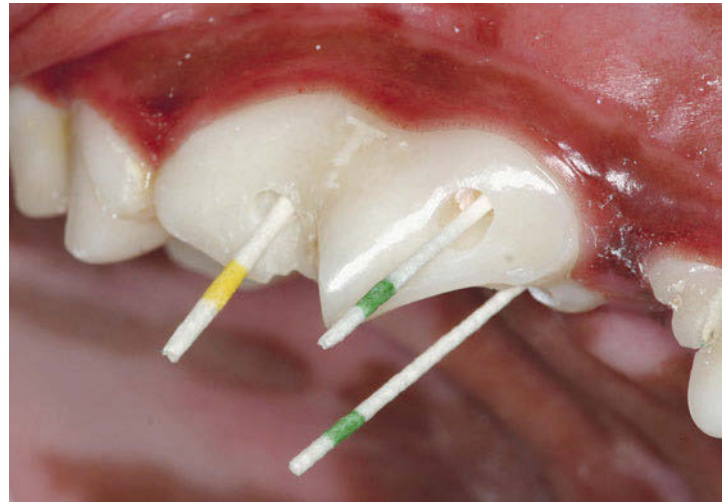
► Fig. 11.33 Measurement radiograph of tooth 108.



#### 11.2.4 Step 4

##### Prepare the Root Canals

After preparation and cleaning, paper points are used to dry the root canals (► Fig. 11.34).



► Fig. 11.34 Drying the root canals.

#### 11.2.5 Step 5

##### Temporary Filling

Given the periapical lesion and the high bacterial load of the root canals, an intracanal dressing is first inserted in the canals. The radiopaque calcium hydroxide is inserted under radiographic visualization. The seal need not be uniformly tight (► Fig. 11.35). The canals are closed with a temporary cement while the intracanal dressing is in the canals (► Fig. 11.36).



► Fig. 11.35 Radiograph of tooth 108 with intracanal dressing.



► Fig. 11.36 Temporary cement fillings in tooth 108.

### 11.2.6 Step 6

#### Root Canal Filling

Follow-up treatment is 4 to 6 weeks later. The intracanal dressing is removed and the canals are further enlarged as needed, cleaned, and filled (p. 124). The periapical osteolysis is not expected to heal within this period (► Fig. 11.37).

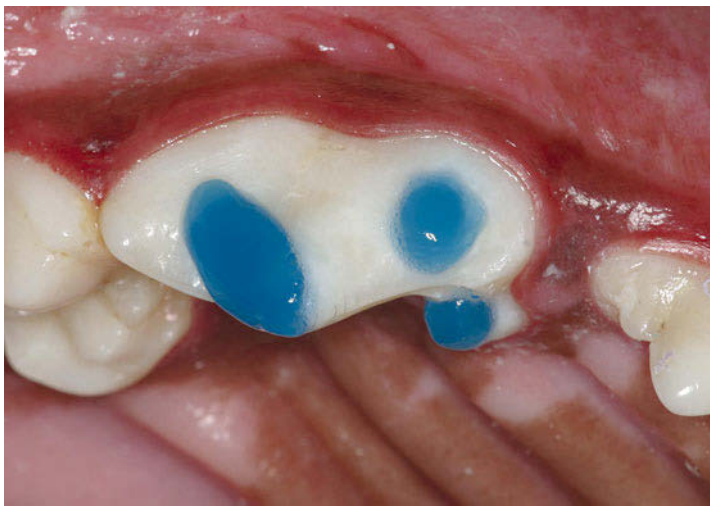


► Fig. 11.37 Follow-up radiograph of the permanent root canal filling of tooth 108.

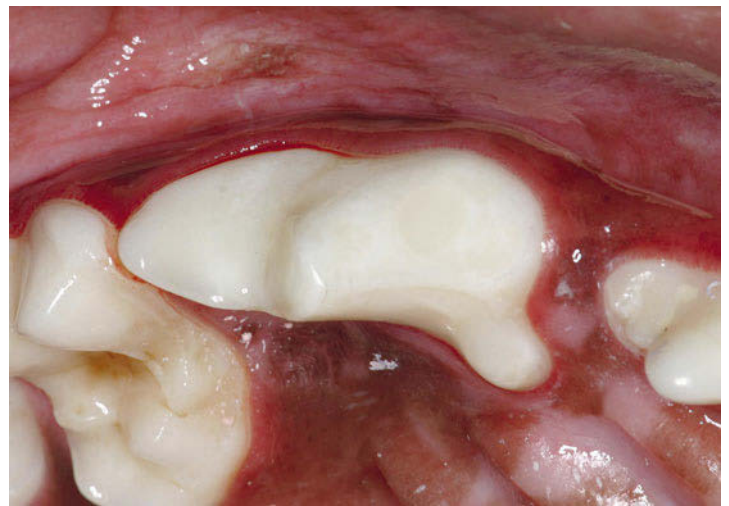
### 11.2.7 Step 7

#### Coronal filling/Composite filling

The cavities are prepared for receiving the filling material while sparing as much tooth substance as possible. To create a mechanical micro-texture, 37% to 40% phosphoric acid is used to etch the cavity, and in particular, the enamel (► Fig. 11.38). The accessory access points and the fracture cavity are then filled with composite, ultimately yielding a smooth coronal surface that is easy to care for (► Fig. 11.39).



► Fig. 11.38 Etching the cavities of tooth 108.



► Fig. 11.39 Composite fillings of tooth 108.



## 11.3

**Multirooted Tooth 208 – Step by Step****Procedure Overview**

1. Evaluate the current condition
2. Visualize the root canal access points and extirpate the pulp
3. Measure the working length and prepare the root canals
4. Temporary filling
5. Root canal filling
6. Coronal filling

**11.3.1 Step 1****Evaluate the Current Condition**

The fractured maxillary left carnassial tooth of the dog discussed in the previous section (p.135) was also treated with a vital pulpotomy (► Fig. 11.40). A radiograph shows the radiopaque substance used to treat the exposed pulp (► Fig. 11.41).



► Fig. 11.40 Fractured tooth 208.



► Fig. 11.41 Radiograph of tooth 208.

**11.3.2 Step 2****Expose the Root Canal Access Points and Extirpate the Pulp**

The canal is exposed similarly to the procedure performed on the right side (► Fig. 11.42).



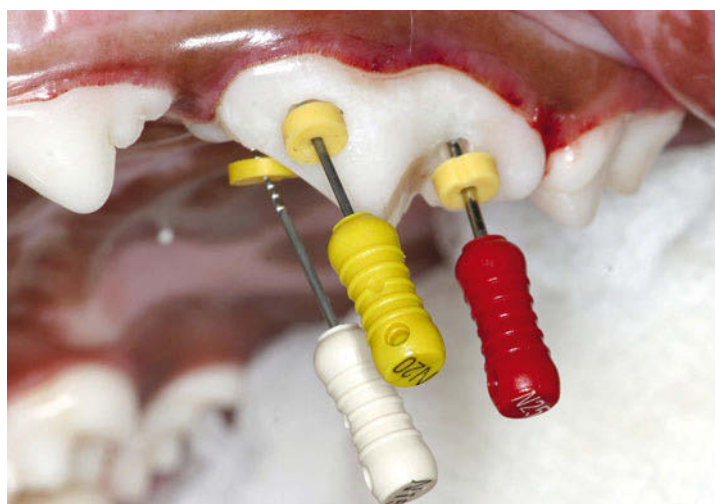
► Fig. 11.42 Exposing the root canal access points of tooth 208.

## 11.3.3 Step 3

**Measure the Working Length and Prepare the Root Canals**

Root canal files are inserted in the canals to measure working length (► Fig. 11.43) and are subsequently used, in increasing sizes, to prepare the canal.

The relatively wide pulp canals from an earlier vital pulpotomy with subsequent termination of tooth development make it easier to find the apical stops (► Fig. 11.44).



► Fig. 11.43 Files in the root canals of tooth 208.



► Fig. 11.44 Measurement radiograph of tooth 208.

## 11.3.4 Step 4

**Temporary Filling**

Here too, calcium hydroxide is inserted as a temporary filling and for disinfection of the canals (► Fig. 11.45). Temporary cement is used to close the crown. The small hematoma on the lip mucosa is from the local anesthetic, which also caused ischemia at the surgical site (► Fig. 11.46).



► Fig. 11.45 Radiograph of tooth 208 with intracanal dressing.



► Fig. 11.46 Temporary fillings in tooth 208.



### 11.3.5 Step 5

#### Root Canal Filling

An intraoperative radiograph is taken to visualize the definitive root canal filling (p.124) (► Fig. 11.47) in the subsequent treatment. Unlike the temporary filling with the intracanal dressing, the canal should now be uniformly tightly sealed.

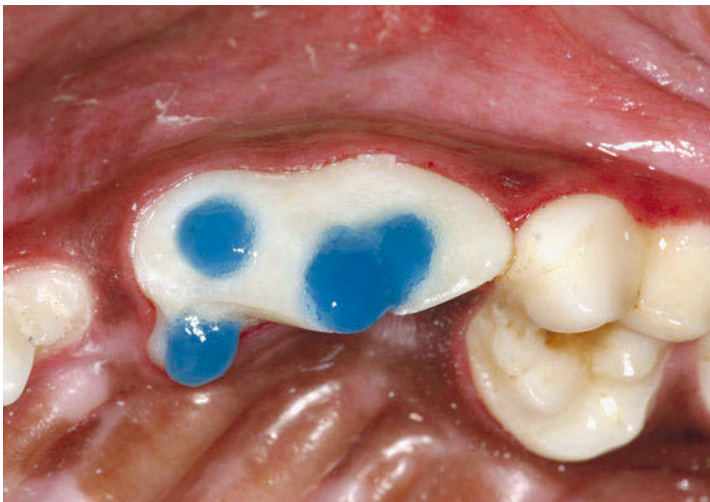


► Fig. 11.47 Intraoperative radiograph of the root canal filling.

### 11.3.6 Step 6

#### Coronal filling/Composite filling

The cavities are prepared for placement of the composite using 37% to 40% phosphoric acid while sparing as much tooth substance as possible (► Fig. 11.48). The composite fillings provide the carnassial tooth with a smooth surface. The coronal cusp that has been lost is not reconstructed because it would not have sufficient stability during mastication (► Fig. 11.49).



► Fig. 11.48 Etching the cavities of tooth 208.



► Fig. 11.49 Composite fillings of tooth 208.

## 12 Apicoectomy

### 12.1

### Apicoectomy – Step by Step

In some cases, an apicoectomy is the only way to preserve a tooth. If a conventional root canal filling is not possible, the only option is to attain retrograde access to the pulp system and remove the inflamed root tip.

#### Procedure Overview

1. Evaluate the patient's history and current condition
2. Coronal filling
3. Expose the root tip
4. Resect the root tip
5. Perform a retrograde root canal filling
6. Check the root canal filling

#### 12.1.1 Step 1

##### Evaluate the Patient's History and Current Condition

The discolored maxillary right canine tooth and altered eating behavior were the original presenting complaints for this dog (► Fig. 12.1). Apart from the discoloration, no other damage to the tooth was detected and the appearance of the other teeth was unremarkable. In the radiograph, the root was unremarkable and the pulp width was symmetrical to that of the healthy maxillary left canine tooth (► Fig. 12.2).

Upon trepanation of the tooth no bleeding occurred, showing that the pulp was nonvital (► Fig. 12.3). Previous degradation of the coronal pulp or bleeding had caused discoloration of the dentin because the degradation products of the tissue, and specifically, the blood accumulated in the dentin tubules cause purple discoloration.

During the subsequent root canal treatment, despite proper handling, one of the Hedstrom files broke off in the center of the canal (► Fig. 12.4) and could not be retrieved. To preserve the tooth, an apicoectomy was initiated. Due to the long time that elapsed between the initial treatment and the planned apicoectomy, periapical osteolysis occurred, which confirmed the need for the planned procedure (► Fig. 12.5).



► Fig. 12.1 Discolored tooth 104.

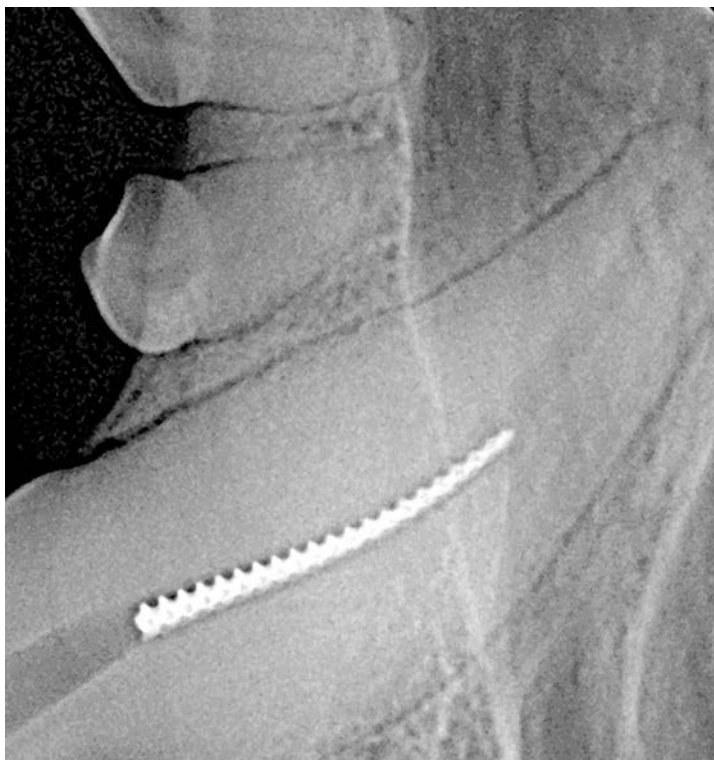




► Fig. 12.2 Radiograph of tooth 104.



► Fig. 12.3 Nonvital pulp at trepanation.



► Fig. 12.4 Broken Hedstrom file in the root canal.



► Fig. 12.5 Radiograph of tooth 108 prior to apicoectomy.

### 12.1.2 Step 2

#### Coronal Filling/Composite Filling

Before the apicoectomy, the conventional orthograde root canal therapy that was only temporarily closed can be filled (► Fig. 12.6).



► Fig. 12.6 Composite filling of tooth 104.

### 12.1.3 Step 3

#### Expose the Root Tip

The incision for exposing the root tip is performed in the loose alveolar mucosa over the apical third of the root (► Fig. 12.7). A buccal osteotomy is performed to remove the bone cover of the root tip (► Fig. 12.8).



► Fig. 12.7 Incising the mucosa over the root tip.



► Fig. 12.8 Exposing the root tip.



**12.1.4 Step 4****Resect the Root Tip**

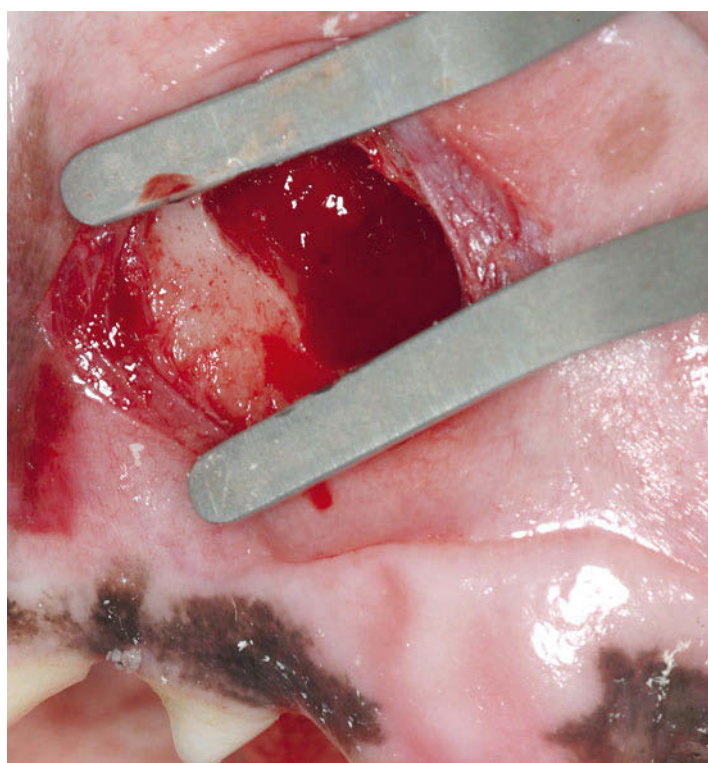
The root tip is then resected. To properly remove the dog's apical delta, 2 to 3 mm of the root tip or the resorptively altered root component must be detached (► Fig. 12.9). Bleeding obscures the visibility of the surgical field. Using wound hooks to keep away the mucosa can help improve visualization (► Fig. 12.10). A small retractor can also be helpful (► Fig. 12.11).



► Fig. 12.9 Detached root tip.



► Fig. 12.10 Wound hook for enhancing visualization of the root tip.



► Fig. 12.11 Using a retractor to improve visualization of the root tip.

## 12.1.5 Step 5

**Perform a Retrograde Root Canal Filling**

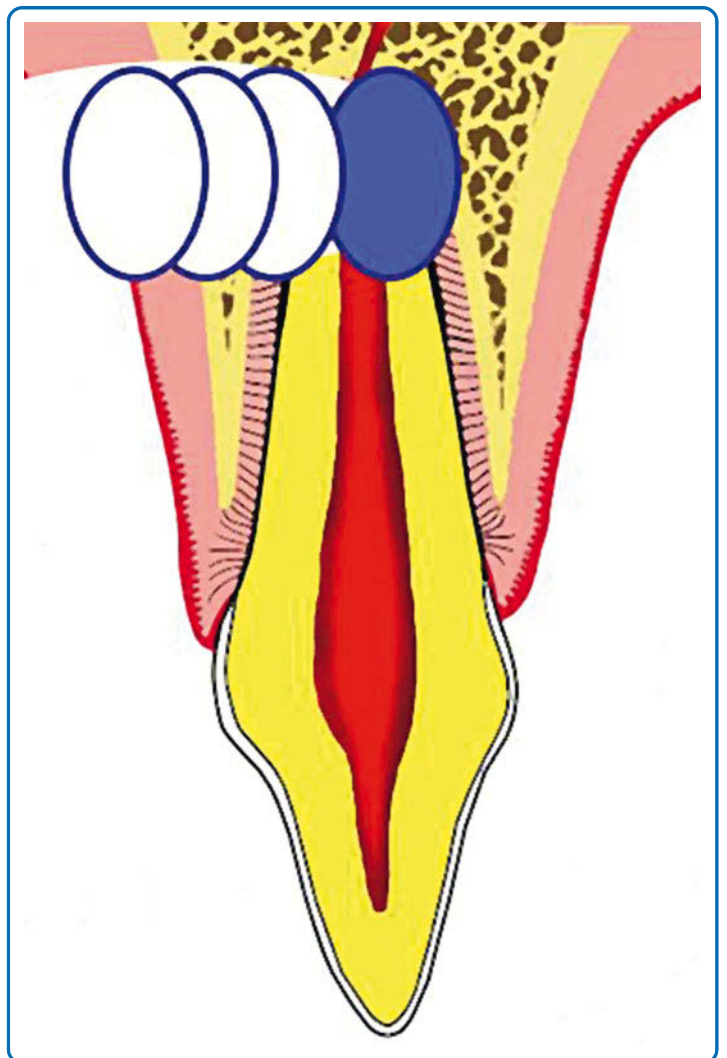
A cavity is prepared in a retrograde fashion and filled with apical root filler material. During filling, the area must be kept as dry as possible (► Fig. 12.12). The material must be bioinert and permit a tightly sealed retrograde closure. Calcium hydroxide-containing cement (mineral-tri-oxide aggregate) is a superior innovative material. The bioinert retrograde filler material inhibits the contact between the file/pulp and the periapical tissue and enables the file to stay in the root.

To improve visualization of the surgical field, cotton pellets can be placed to minimize the bleeding in the bone cavity. The first pellet is soaked in a hemostatic substance (local anesthetic with vasoconstrictor, iron-III sulfate, adrenaline) and placed temporarily in the cavity along with additional dry pellets (► Fig. 12.13).

Simple interrupted sutures are used to close the incision.



► Fig. 12.12 Performing a Retrograde Root Canal Filling.



► Fig. 12.13 Drying.



**12.1.6 Step 6****Check the Root Canal Filling**

An intraoperative radiograph is then performed (► Fig. 12.14).



► Fig. 12.14 Intraoperative radiograph of the retrograde root canal filling.

## 13 Attaching Brackets

### 13.1

### Attaching Brackets – Step by Step

Orthodontic devices may be required to apply the force required for correcting malpositioned teeth. However, orthodontics should not impair further development of the teeth and jawbones. This can be achieved with brackets. The orthodontic buttons of the brackets have a roughened base for adhesive attachment to the pretreated enamel surface using glue. A slot, hook or snap on the device may be used to anchor the active component, such as elastic bands or wire. Elastic chains are generally used to change the angle of the teeth, while elastic or inelastic prebent wire is used for complete movement of the tooth, referred to as “translation”.

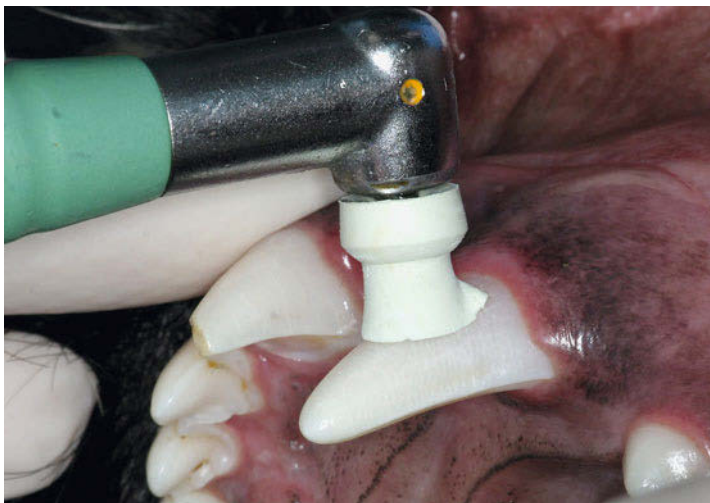
#### Procedure Overview

1. Dental cleaning
2. Etching
3. Apply the bonding agent
4. Attach orthodontic buttons
5. Measure tooth distances
6. Hook on the elastic

#### 13.1.1 Step 1

##### Dental Cleaning

Orthodontic buttons are often used with elastic chains to move and tip canine teeth. In this case, the goal is to open up the interdental space between the maxillary canine tooth and the lateral incisor to enable lateralization of a linguoverted and distoverted mandibular canine tooth. Before orthodontic buttons can be attached, the tooth must be thoroughly cleaned (► Fig. 13.1). A fluoride-free polishing paste should be used to achieve a suitable etching structure. A chip blower is then used to dry the tooth (► Fig. 13.2).



► Fig. 13.1 Dental cleaning.



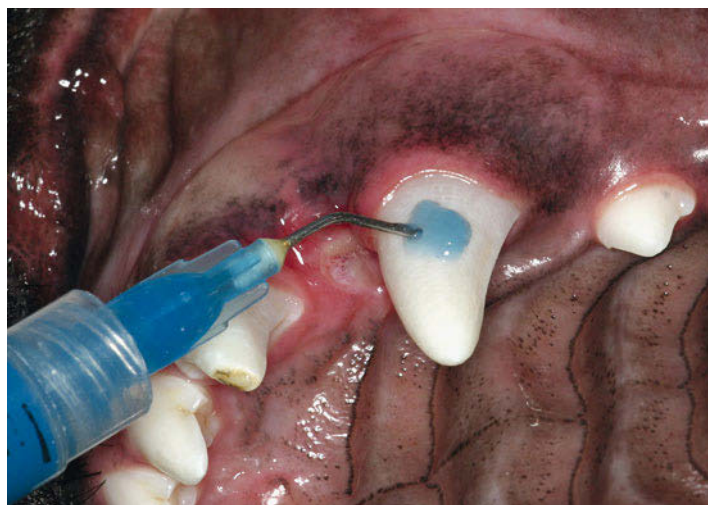
► Fig. 13.2 Drying.



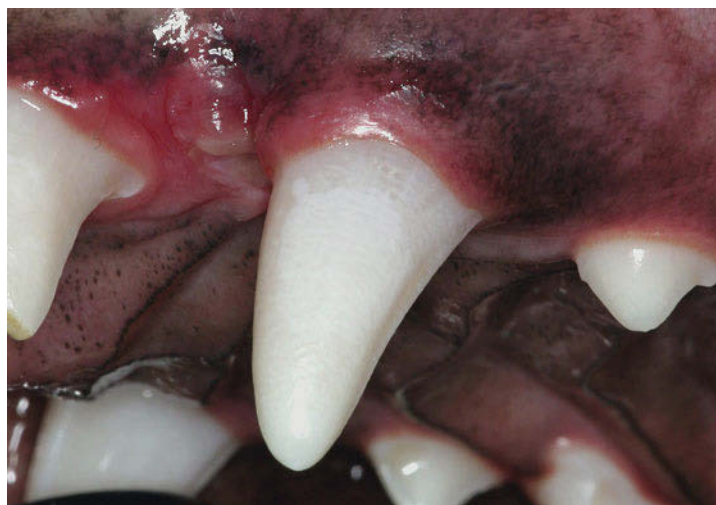
## 13.1.2 Step 2

### Etching

Etching is performed with 37% to 40% phosphoric acid, which is dyed blue to enhance visibility and has gel-like properties for secure placement (► Fig. 13.3). While the manufacturer states that 20 seconds is sufficient for etching, physical tests showed the etching paste had to be applied for longer to create the desired microtexture. After the gel is rinsed off, the round, chalk-like spot underneath is sufficient for attaching the orthodontic buttons (► Fig. 13.4). This procedure is repeated on the maxillary carnassial tooth and the first molar on the same side, which serve as two anchor teeth for the canine tooth (► Fig. 13.5). In order for the bonding agent to adhere to the teeth, the surfaces must be absolutely dry.



► Fig. 13.3 Etching.



► Fig. 13.4 Etched area on tooth 204.



► Fig. 13.5 Etched area on teeth 208 and 209.

## 13.1.3 Step 3

**Apply the Bonding Agent**

The liquid bonding agent acts as a luting agent (► Fig. 13.6) that serves as the bifunctional intermediary layer between the hydrophilic tooth surface and the hydrophobic composite. The bonding agent is then cured with a curing lamp according to the manufacturer's instructions (► Fig. 13.7). Halogen or LED curing lamps are used (► Fig. 13.8). The lamp function should be tested periodically.



► Fig. 13.6 Applying the bonding agent.



► Fig. 13.7 Using the curing lamp.



► Fig. 13.8 Using an activated curing lamp to cure the bonding agent.



### 13.1.4 Step 4

#### Attach the Orthodontic Buttons

In this case, a two-component composite mixed from basic and activator paste is used to attach the orthodontic buttons (► Fig. 13.9). It allows both chemical and light curing. Chemical curing allows curing of areas located below the buttons that the light cannot reach. The back of the button offers maximum bond strength on the basis of a retention pattern (► Fig. 13.10). Thus, a mechanical anchorage on both the tooth surface and on the button is created. The back of the button is coated with the adhesive material. Bracket tweezers are used to position the button on the prepared tooth surface (► Fig. 13.11). After the position is adjusted, a curing light is used to cure the composite immediately.



► Fig. 13.9 Fixing material.



► Fig. 13.10 Orthodontic button with retention pattern.



► Fig. 13.11 Attaching orthodontic buttons.

### 13.1.5 Step 5

#### Measuring the Tooth Distances

The distance to the maxillary carnassial tooth is measured in order to trace the movements of the canine tooth (► Fig. 13.12). To ensure anchor teeth do not move mesially, the distance between the carnassial tooth and the lateral incisor is also measured.



► Fig. 13.12 Measuring tooth distances.

## 13.1.6 Step 6

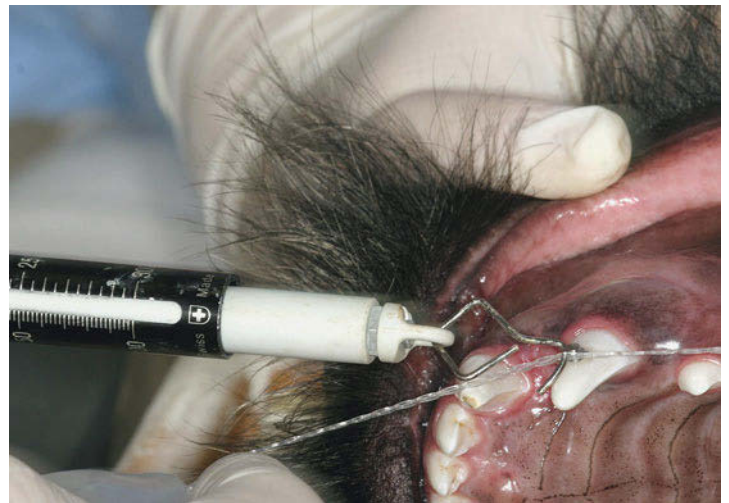
**Hook on the Elastic Chain**

The elastic chain is activated by hooking it onto the button of the appropriate tooth (► Fig. 13.13). A spring balance may be used to measure the tension in order to ensure optimal force is exerted on the tooth to be migrated (► Fig. 13.14). 25 g/cm<sup>2</sup> of root surface is the desired force for exerting sufficient tension without creating pathological compression in the periodontal ligament space of the canine tooth.

The elastic chain is hooked onto the buttons such that an extra loop remains both mesially and distally, which facilitates grasping and reinserting the elastic chain after removal. The carnassial tooth and molar together serve as the anchor for moving the canine tooth. The elastic stabilizes the two teeth against each other (► Fig. 13.15). In most cases, the malalignment problems are symmetrical, such that elastic chains are used on both sides, as is shown here (► Fig. 13.16).



► Fig. 13.13 Hooking on the elastic chain.



► Fig. 13.14 Measuring the tension.



► Fig. 13.15 Elastic chain on the right.



► Fig. 13.16 Elastic chain on the left.



## 14 Plate/Bite Plate

### 14.1

### Acrylic Plate with Screw – Step by Step

An acrylic plate can also be used to move single teeth or groups of teeth by integrating movement elements.

#### ☑ Procedure Overview

1. Evaluate the current condition
2. Etching
3. Apply the bonding agent
4. Fit the plate
5. Attach the wires
6. Activate the plate appliance
7. Attach the orthodontic buttons and elastics in the mandible
8. Monitor progress

#### 14.1.1 Step 1

##### Evaluate the Current Condition

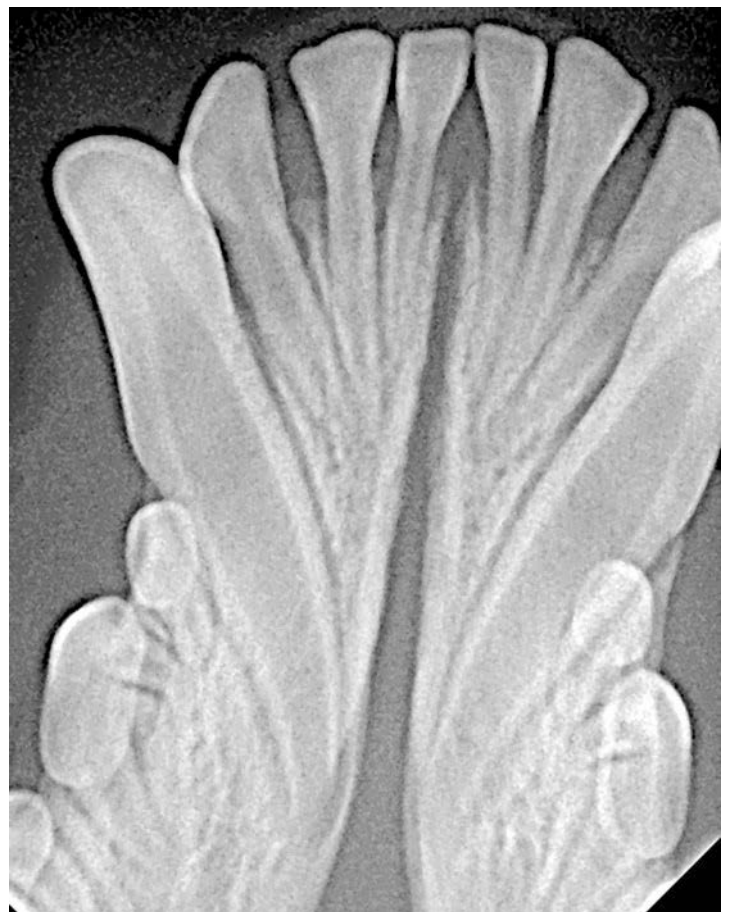
The dog depicted in this section does not exhibit a complete crossbite of the front teeth. Only the maxillary central and intermediate incisors are affected (► Fig. 14.1). No abnormalities appear in the radiograph of the maxillary incisors (► Fig. 14.2). There are also no anomalies in the root areas of the mandibular incisors (► Fig. 14.3).



► Fig. 14.1 Partial crossbite of the incisors.



► Fig. 14.2 Radiograph of the maxillary incisors before treatment.



► Fig. 14.3 Radiograph of the mandibular incisors before treatment.



### 14.1.2 Step 2

#### Etching

An impression is taken for the maxillary extension plate and the plate is produced in the dental laboratory. Then it is placed in the mouth. Placing a mouth gag over the canine teeth hinders placement of the plate, so a mouth wedge placed between the upper and lower molars can hold the jaw open (► Fig. 14.4).

The teeth used to anchor the plate are cleaned carefully but with caution to avoid bleeding and to ensure a dry working field while the plate is being placed. The first two maxillary premolars are used to additionally secure the plate (► Fig. 14.5). If a chalky pattern appears on the tooth surface, etching is determined to be successful (► Fig. 14.6).



► Fig. 14.4 Mouth wedge.



► Fig. 14.5 Etching.



► Fig. 14.6 Etched area.

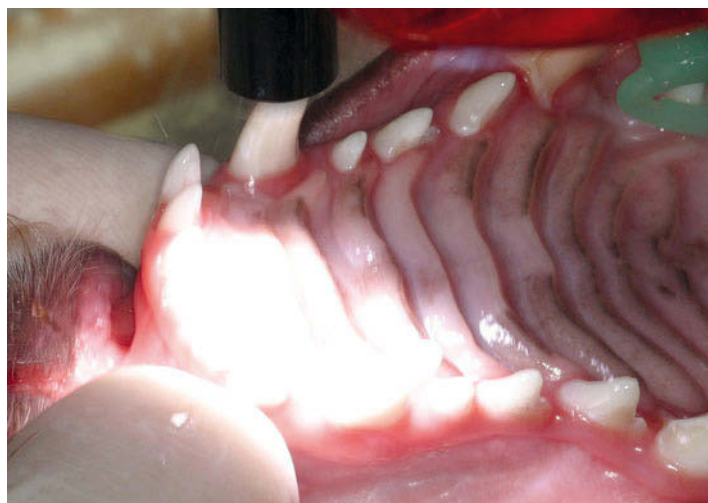
### 14.1.3 Step 3

#### Apply the Bonding Agent

Bonding agent is first applied and it ensures that the hydrophobic acrylic adheres to the hydrophilic tooth surface. A disposable brush can be used to apply the liquid to the etched surfaces (► Fig. 14.7). A curing lamp is then used to cure the bonding agent for 10 seconds (► Fig. 14.8).



► Fig. 14.7 Applying the bonding agent.



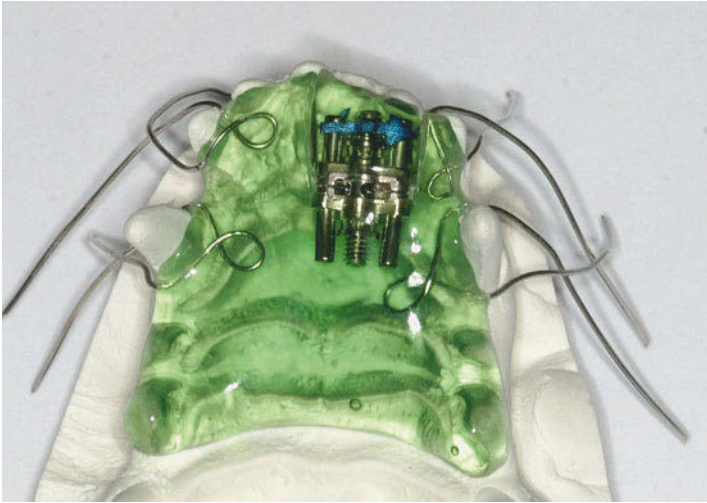
► Fig. 14.8 Curing the bonding agent.

#### 14.1.4 Step 4

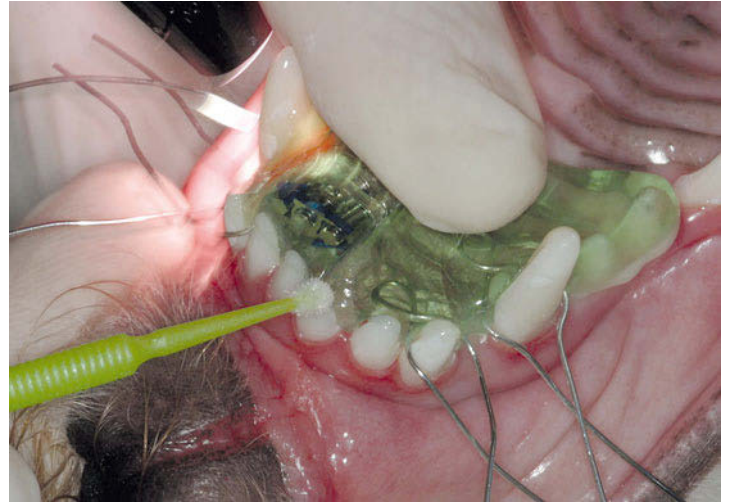
##### Fit the Plate

In this case, an expansion screw is used to mobilize part of the plate behind the left central and intermediate maxillary incisor. When the plate is activated, the small rostral independent section of the plate (► Fig. 14.9) is translated forward, with the aim of placing the retro-clined incisors into normal position.

The plate is fitted into the maxilla and coated with composite. A disposable brush can be used to remove protruding remnants of the still pliable material (► Fig. 14.10). The composite is not cured until this has occurred.



► Fig. 14.9 Plate appliance on a model.



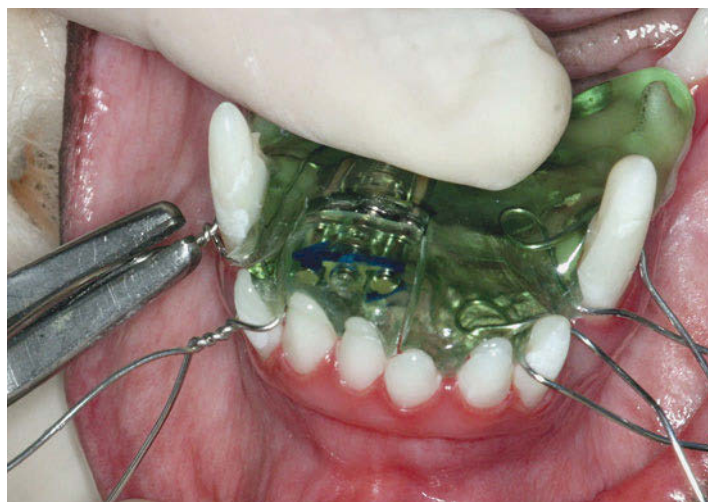
► Fig. 14.10 Fitting the plate.



### 14.1.5 Step 5

#### Attach the Wires

The wires are now placed around the teeth (► Fig. 14.11) and twisted. The wires are then shortened and bent and placed on the dental arch (► Fig. 14.12). Flowable composite is applied to attach the wires to the tooth and eliminate sharp edges (► Fig. 14.13).



► Fig. 14.11 Twisting the wires.



► Fig. 14.12 Shortening the wires.



► Fig. 14.13 Applying composite.

### 14.1.6 Step 6

#### Activate the Expansion Plate

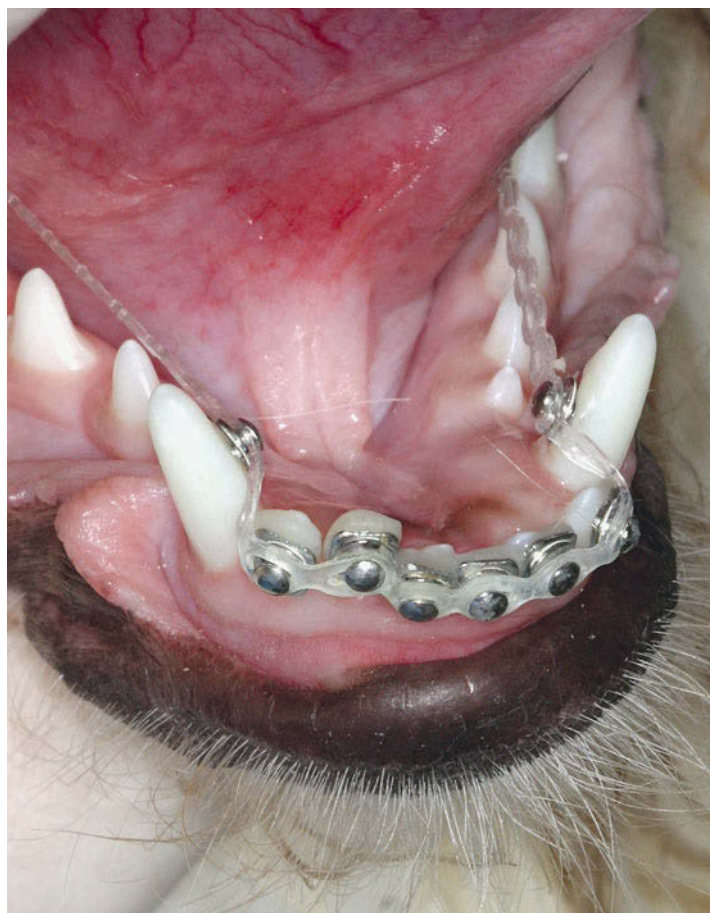
Finally, the expansion screw is activated; the adjustable wrench is placed in the designated drillhole and rotated a quarter turn in the direction of the arrow (► Fig. 14.14).



► Fig. 14.14 Activating the expansion plate

**14.1.7 Step 7****Attach the Orthodontic Buttons and Elastic Chains in the Mandible**

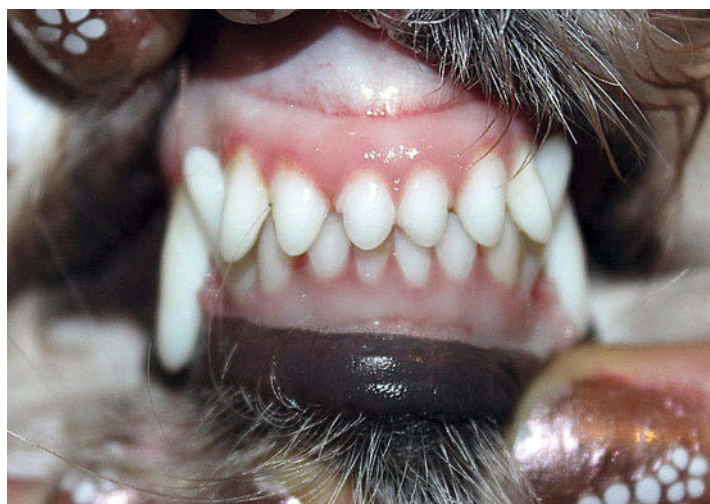
In the mandible, orthodontic buttons are placed buccally to the incisors and lingually to the canine teeth and carnassial teeth and an elastic chain hooked onto the full length of the buttons (► Fig. 14.15).



► Fig. 14.15 Orthodontic buttons and elastic chain in the mandible.

**14.1.8 Step 8****Follow-up**

Eight weeks after the orthodontic appliances are removed, the dog has a follow-up visit. The dog now has a normal scissor bite with a deep vertical bite (► Fig. 14.16). The radiographs of the incisors do not show any abnormalities.



► Fig. 14.16 Results 8 weeks after removal of the appliance.





## Part 3

### Case Studies

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## 15 Young Animals

### 15.1

### Missing Teeth

The most common reason for missing teeth (hypodontia) is a genetic predisposition for teeth not developing. The evolutionary reduction in the number of teeth means that “insignificant” teeth, such as the first mandibular premolar in dogs, are commonly absent. A disruption in development can also prevent developed teeth from erupting. Thus, it is not always possible to determine whether an anomaly is congenital or acquired.

If an animal is missing a tooth, a radiograph should always be taken to verify whether the tooth has developed. If the tooth has not developed, no action is needed. However, if the tooth is retained, it should be extracted because a cyst may develop on the tooth.

#### 15.1.1 Multiple Missing Teeth (Hypodontia) and Reduced Tooth Development in Dogs

The following images present clinical and radiographic findings of undeveloped teeth and reduced dentition in a dog (► Fig. 15.1, ► Fig. 15.2, ► Fig. 15.3, ► Fig. 15.4, ► Fig. 15.5, ► Fig. 15.6, ► Fig. 15.7, ► Fig. 15.8, ► Fig. 15.9, ► Fig. 15.10).



► **Fig. 15.1 Hypodontia in the right maxilla.** Clinically, it is notable that the permanent incisors and molars have erupted, while the permanent canine tooth and premolars are missing (see also ► Fig. 15.2).



► **Fig. 15.2 Radiograph, right maxilla.** The permanent canine tooth and permanent second and fourth premolars are absent. The first premolar is present, as well as a reduced single-rooted variant of a premolar near the third premolar. The caudal deciduous teeth show distinct root resorption.



► **Fig. 15.3 Hypodontia in the area of the incisors.** The mandibular central incisors are much smaller than the adjacent incisors and resemble deciduous teeth.



► **Fig. 15.4 Radiograph of the mandibular front teeth.** The radiograph verifies the clinical suspicion that the dog has retained deciduous central incisors and permanent central incisors are absent.





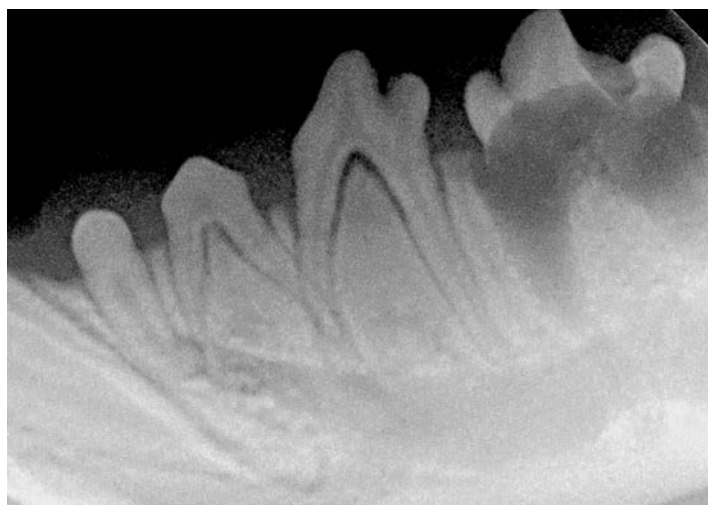
► **Fig. 15.5 Hypodontia in the left maxilla.** As on the right side (► Fig. 15.1), the left canine tooth and premolars are not observed.



► **Fig. 15.7 Hypodontia in the left mandible.** The mandibular left premolar area contains retained deciduous teeth. The permanent canine teeth are erupting and the deciduous precursors are still in place.



► **Fig. 15.6 Radiograph, left maxilla.** As on the right side (► Fig. 15.2), the first permanent premolar is developed, the third permanent premolar has a single root and is reduced in size, and the other teeth are deciduous teeth with root resorption.



► **Fig. 15.8 Radiograph, left mandible.** The only permanent cheek tooth is the first premolar. The other cheek teeth are undeveloped, and their precursors are still in place and undergoing root resorption.

### 15.1.2 Hypodontia and Dental Fracture in Cats

Cats rarely lack teeth. The shape and number of feline teeth are generally very uniform. An exception is hairless cats (e.g., the Sphynx cat), in which a mutation in embryonic development affects the teeth and skin, leading to missing or malformed teeth (► Fig. 15.11, ► Fig. 15.12, ► Fig. 15.13, ► Fig. 15.14, ► Fig. 15.15, ► Fig. 15.16).



► **Fig. 15.9 Hypodontia in the right mandible.** The right mandible matches the left depicted in ► Fig. 15.8. The deciduous molars are still in place with pink discoloration in some places.



► **Fig. 15.11 Hypodontia in the right maxilla of a cat.** Only one cheek tooth is clinically present, and both maxillary canines are significantly mesioverted. In addition, the cusps of the canine crowns show enamel loss.



► **Fig. 15.10 Radiograph, right mandible.** Only the first permanent premolar is developed. Although it is very small, it cannot be a deciduous precursor, because the first premolar does not have a precursor. The second deciduous premolar has thin, fragile roots without signs of resorption, while the third and fourth deciduous molars show severe root resorption. No permanent teeth are visualized.



► **Fig. 15.12 Radiograph, right maxilla.** The clinically present cheek tooth is the only one that remains; it has a reduced, simplified shape and only one root.





► **Fig. 15.13 Undeveloped front teeth in a cat.** No maxillary incisors and only 4 mandibular incisors are observed, with marked linguoversion of the mandibular canines. The former pulp chamber is visible in the fractured area of the maxillary right canine.



► **Fig. 15.15 Undeveloped teeth in the right maxilla of a cat.** Clinically, the left and right sides are completely symmetrical.



► **Fig. 15.14 Radiograph of the mandibular front teeth.** The radiograph for ► Fig. 15.13 also shows only the four clinically present incisors. The parallel arrangement of the canine teeth without buccal inclination is also striking.



► **Fig. 15.16 Radiograph, left maxilla.** The radiograph for ► Fig. 15.15, however, shows normal root development of the existing premolar.



### 15.1.3 Undeveloped Canines in Dogs

Unlike the absence of a first premolar, the absence of an important tooth such as the canine is a severe defect, and the animal should not be bred. However, since an undeveloped canine (► Fig. 15.17, ► Fig. 15.18, ► Fig. 15.19, ► Fig. 15.20) is rather rare, a radiograph should be taken to confirm the presence of this tooth. In many cases a traumatic incident may have occurred during the development of the tooth that caused resorption of a dental follicle or led to its deformity or displacement. However, in this case usually only one side is affected. Symmetry usually means a genetic cause.



► Fig. 15.17 **Missing maxillary right canine.** Clinically, the maxillary right canine appears absent. It likely erupted long ago.



► Fig. 15.19 **Missing maxillary left canine.** As on the right (► Fig. 15.17), the maxillary left canine tooth is missing.



► Fig. 15.18 **Radiograph of tooth 104.** No maxillary right canine tooth appears in the radiograph. Additionally, the maxillary first premolar is a double tooth.



► Fig. 15.20 **Radiograph of tooth 204.** As on the right (► Fig. 15.18), no developed canine tooth is observed on the left. Genetic tooth development abnormalities are often symmetrical.



#### 15.1.4 Retained Mandibular Premolar in a Dog and Severe Osteolysis

The osteolysis due to retained teeth may have severe consequences including atrophy of the mandible and resorption of the adjacent roots. Unfortunately, animals do not generally exhibit signs of pain as these bone lesions develop, which makes them difficult to identify. For this reason, any missing tooth should be examined radiographically (► Fig. 15.21, ► Fig. 15.22, ► Fig. 15.23, ► Fig. 15.24, ► Fig. 15.25, ► Fig. 15.26, ► Fig. 15.27, ► Fig. 15.28, ► Fig. 15.29).



► **Fig. 15.21 Retained mandibular right first premolar.** Tooth 405 is not clinically present. Palpating the area of concern does not reveal any signs of its development.



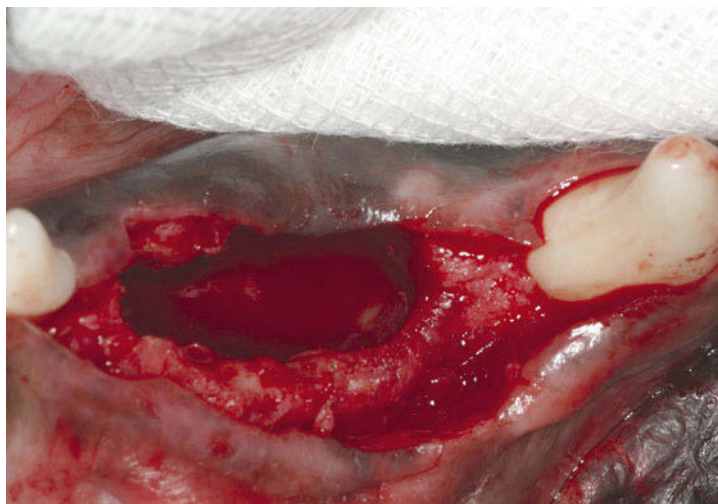
► **Fig. 15.23 Radiograph of the mandibular front teeth including the area near the first premolars.** The radiograph of the front teeth shows that the osteolysis extends to the root of the mandibular canine tooth.



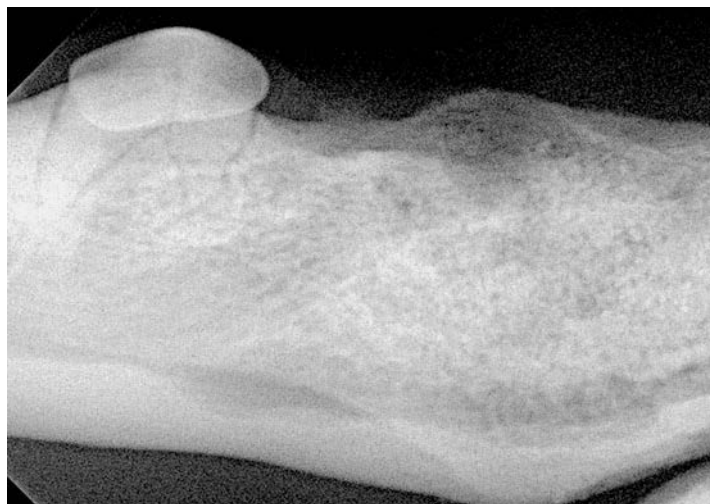
► **Fig. 15.22 Radiograph of tooth 405.** The radiograph shows extensive osteolysis around the retained first premolar. The roots of the second premolar are fully involved in the osteolysis and are damaged. The roots of the third premolars are affected and show resorptive areas.



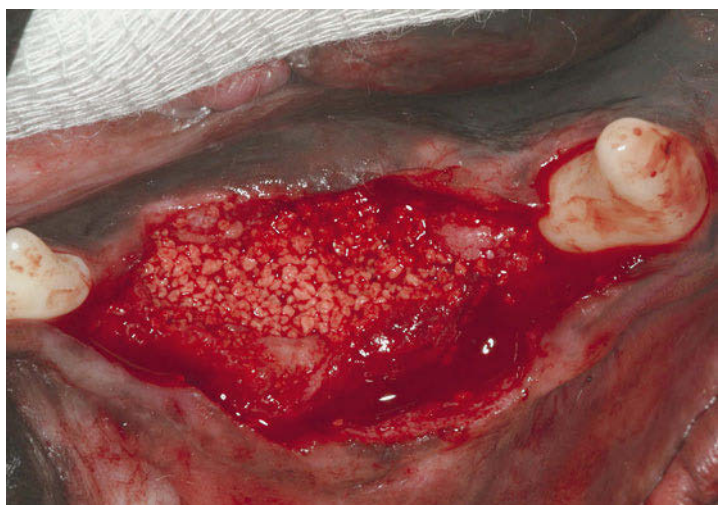
► **Fig. 15.24 Radiograph after extraction of damaged teeth.**



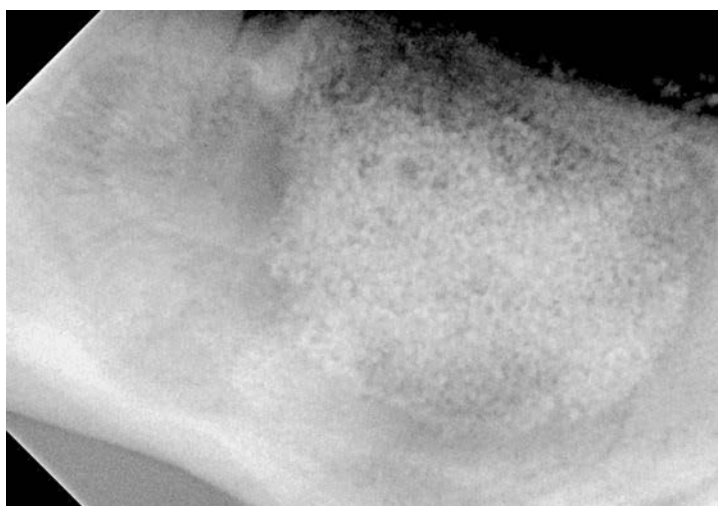
► **Fig. 15.25 Cyst lumen, clinical findings.** After the involved retained tooth and damaged tooth are removed, the large extent of the cyst is visible.



► **Fig. 15.28 Radiographic follow-up after 4 months.** After 4 months, the radiograph shows progressive remodeling of the bone replacement material.



► **Fig. 15.26 Cyst lumen with bone replacement material.** The bone cavity is filled with bone replacement material (tricalcium phosphate).



► **Fig. 15.27 Radiograph of the filled cyst lumen.** A radiograph is taken to examine the filling of the defect.



► **Fig. 15.29 Radiographic follow-up after 4 months.** The bone replacement material filling is easy to see in the radiograph



### 15.1.5 Bilateral Retained Mandibular Premolars in a Dog

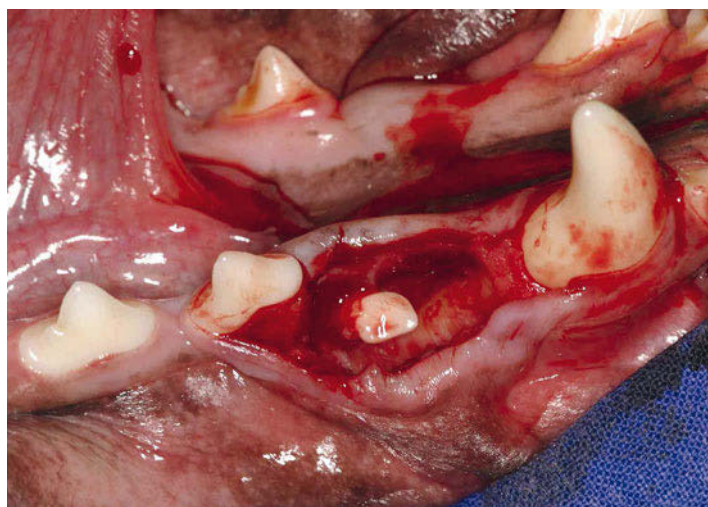
The symmetrical absence of the first mandibular premolars (► Fig. 15.30, ► Fig. 15.31, ► Fig. 15.39, ► Fig. 15.40) is usually congenital in origin. To enhance healing after extraction of the retained teeth (► Fig. 15.32, ► Fig. 15.33, ► Fig. 15.34, ► Fig. 15.41), bone replacement material may provide structural support for bone remodeling (► Fig. 15.35, ► Fig. 15.36, ► Fig. 15.37, ► Fig. 15.38, ► Fig. 15.42, ► Fig. 15.43, ► Fig. 15.44, ► Fig. 15.45, ► Fig. 15.46). This is followed by a radiological evaluation of the course of bone remodeling. (► Fig. 15.47, ► Fig. 15.48, ► Fig. 15.49, ► Fig. 15.50, ► Fig. 15.51).



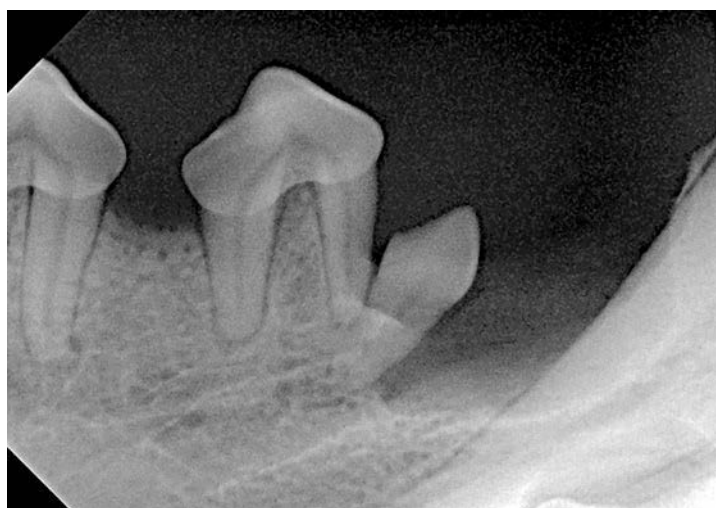
► Fig. 15.32 Opening the cyst. The cyst is opened by incising the alveolar ridge to drain the fluid.



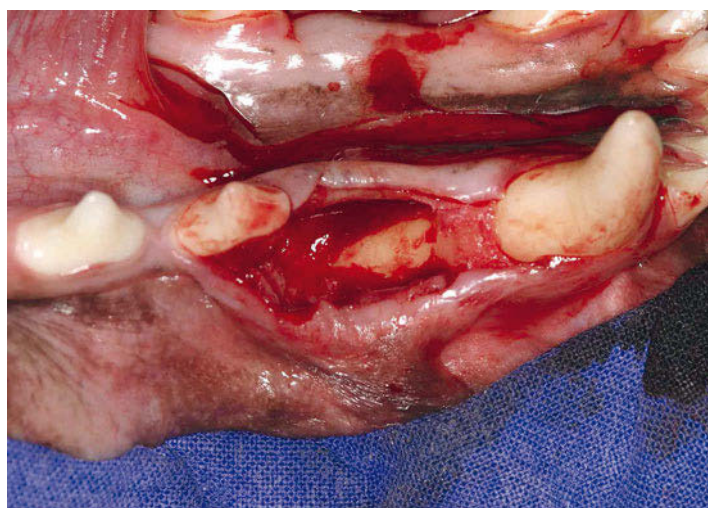
► Fig. 15.30 Swelling in the region of tooth 405. Clinically, a small swollen mass is seen in the area of the missing mandibular right first premolar.



► Fig. 15.33 Exposing tooth 405. The first step is exposure of the retained tooth in order to extract it and allow the epithelial lining to detach from the cyst lumen.

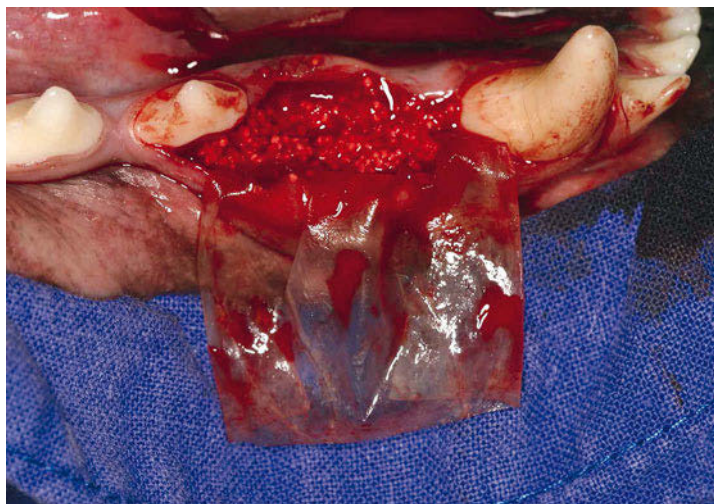


► Fig. 15.31 Radiograph of the region of tooth 405. The radiograph shows a completely retained tooth 405 with distinct osteolysis.



► Fig. 15.34 Image of the cyst lumen. After the retained tooth is extracted, the full extent of the osteolysis is apparent; it also caused root exposure of the canine

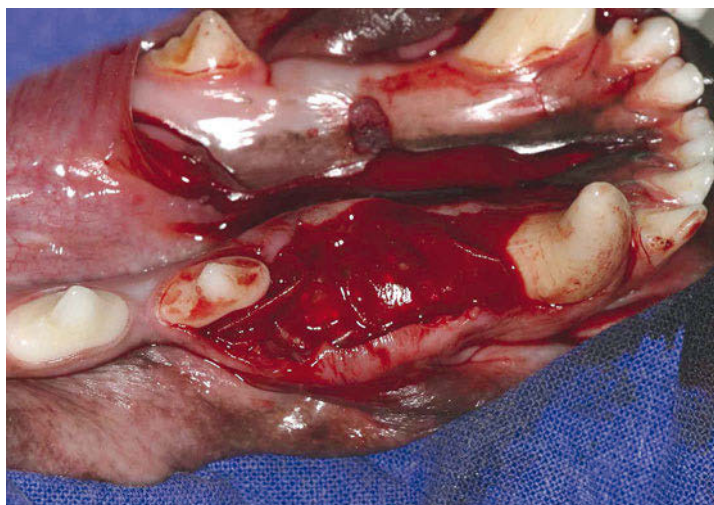




► **Fig. 15.35 Bone replacement material in the cyst lumen.** To improve bone remodeling in this region, the bone replacement material tricalcium phosphate is placed in the lumen. Growth factors derived from the blood plasma can be added to the bone replacement material to enhance the repair process.



► **Fig. 15.37 Intraoperative radiograph after placement of bone replacement material.** A radiograph is taken to check the filling of the bony defect with bone replacement material.



► **Fig. 15.36 Using a membrane to cover the bone replacement material.** Since the wound closure will be directly over the lesion, a resorbable membrane is placed for added security. It is attached below the mucosa, which is then sutured over it.

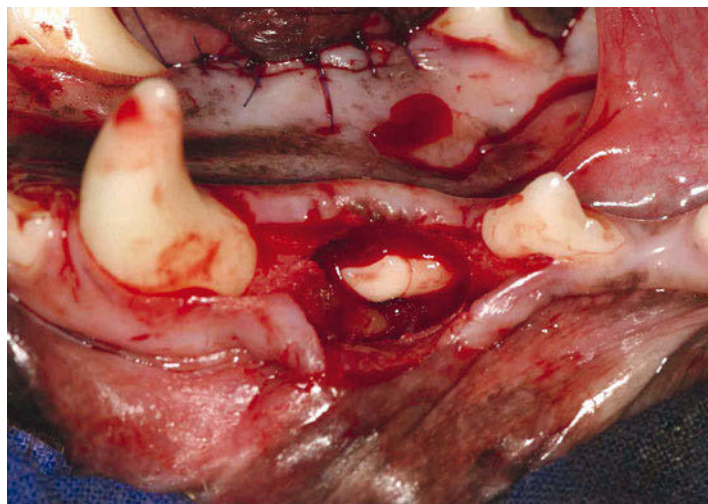


► **Fig. 15.38 Wound closure.** The mucosa is tightly closed to permit unimpaired incorporation of the bone replacement material.

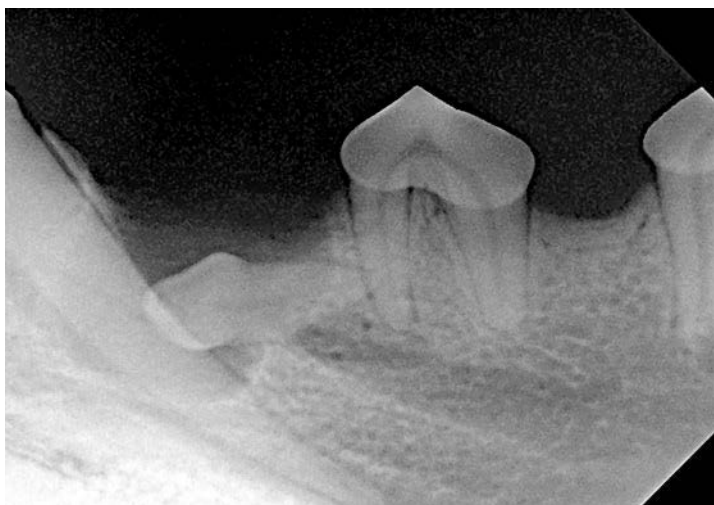




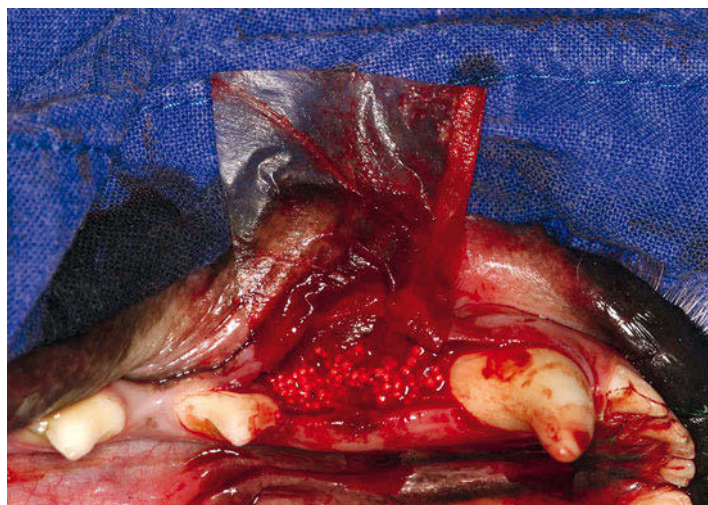
► **Fig. 15.39 Swelling in the region of tooth 305.** Symmetrically to the right side, the left side also contains a fluctuant swelling near a missing mandibular first premolar.



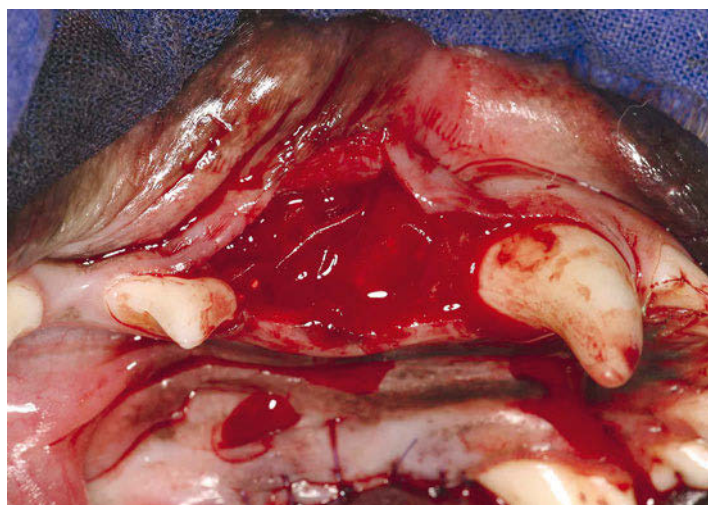
► **Fig. 15.41 Exposing tooth 305.** Incising the alveolar ridge allows access to the retained tooth. Here, too, the lesion is close to the canine root.



► **Fig. 15.40 Radiograph of the region of tooth 305.** The radiograph shows the retained tooth and the surrounding osteolysis. The axis of the retained tooth runs mesiodistally, which prevents normal eruption.



► **Fig. 15.42 Bone replacement material in the cyst lumen.** The bone replacement material is placed, after which the protective membrane is placed below the vestibular mucosa.



► **Fig. 15.43 Covering the bone replacement material with a membrane.** Finally, the membrane is folded lingually and secured below the lingual gingiva.

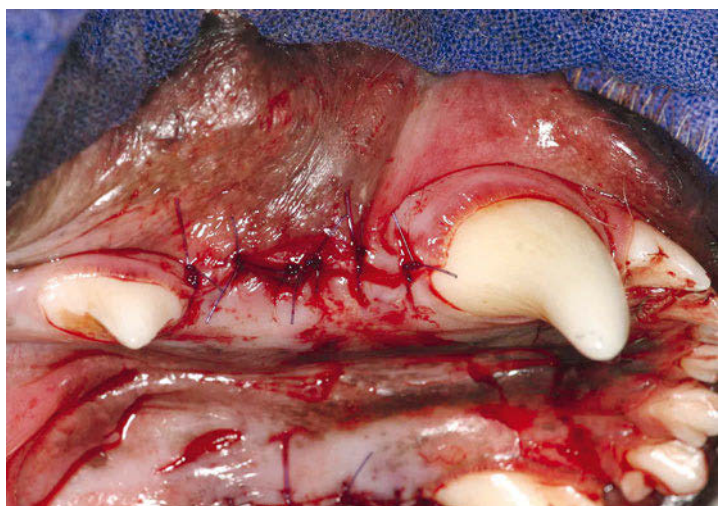




► **Fig. 15.44** Intraoperative radiograph after placement of the bone replacement material. Before the wound is closed, the filling of the defect is confirmed by radiography.



► **Fig. 15.46** Intraoperative radiograph after placement of the bone replacement material. The symmetrical defects near the canine roots are easy to see in a radiograph of the mandibular front teeth.

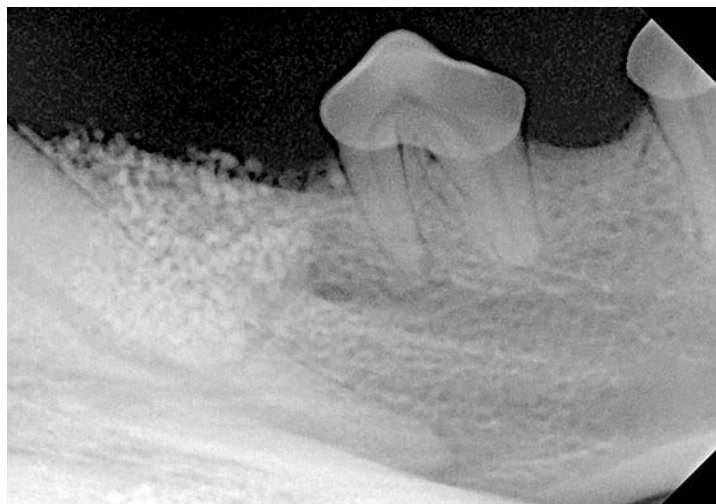


► **Fig. 15.45** Wound closure. The procedure concludes with a tight wound closure.

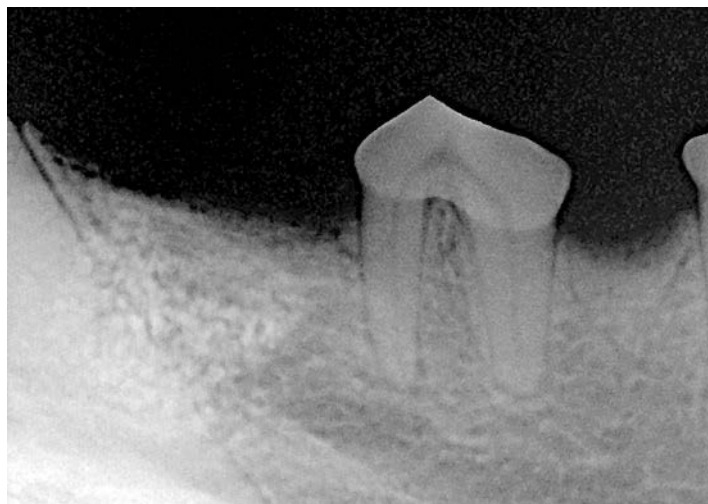


► **Fig. 15.47** Follow-up radiograph, cyst on tooth 405 after 3 months. After 3 months, the first follow-up radiograph is taken to examine the bone defects.





► **Fig. 15.48** Follow-up radiograph, cyst on tooth 305 after 3 months. The granules of the bone replacement material fill the lumen. No inflammatory response is noted, and the contours of the granules have become less distinct with increased remodeling.



► **Fig. 15.50** Follow-up radiograph, cyst on tooth 305 after 2 years. The situation is similar on the left side.



► **Fig. 15.49** Follow-up radiograph, cyst on tooth 405 after 2 years. Two years postoperatively, the follow-up radiograph shows continuing noninflammatory remodeling of the bone replacement material. The defect is still well filled. Bone height has been maintained and the adjacent roots do not show any pathological response.



► **Fig. 15.51** Follow-up radiograph, cysts on teeth 305 and 405 after 2 years. The radiograph shows normal development of a periodontal ligament space at the roots of the adjacent teeth, and the entire region is more compact.

### 15.1.6 Retained Maxillary Canine Tooth in a Dog

Retained maxillary canine teeth in dogs often appear as displacement of the canine (usually post-trauma) into the nearby nasal cavity. A common clinical sign is unilateral nasal discharge caused by irritation of the affected nasal passage. In most cases, extracting the tooth opens up the nasal cavity. The following images (► Fig. 15.52, ► Fig. 15.53, ► Fig. 15.54, ► Fig. 15.55, ► Fig. 15.56, ► Fig. 15.57, ► Fig. 15.58, ► Fig. 15.59, ► Fig. 15.60, ► Fig. 15.61, ► Fig. 15.62, ► Fig. 15.63, ► Fig. 15.64) show the procedure for surgically extracting a retained maxillary canine tooth in a dog.



► Fig. 15.53 Radiograph of region around tooth 104. The radiograph shows a misshapen maxillary canine completely retained in the jaw. The cusp appears to be no longer covered by bone, and the root apex has developed abnormally.



► Fig. 15.52 Retained tooth 104. The maxillary right canine is missing. Based on the eruption of the other teeth, the crown should have already reached its normal height.

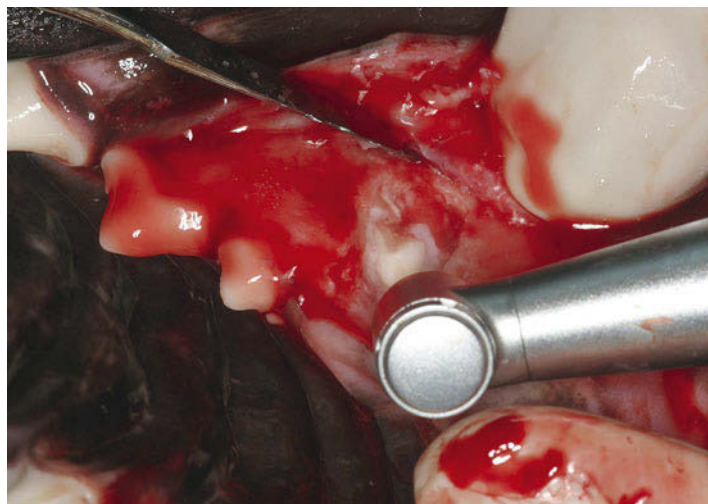


► Fig. 15.54 Incision. A generous incision is made along the anterior cheek teeth and the endentulous area to expose the area and allow the formation of sufficiently large flaps.

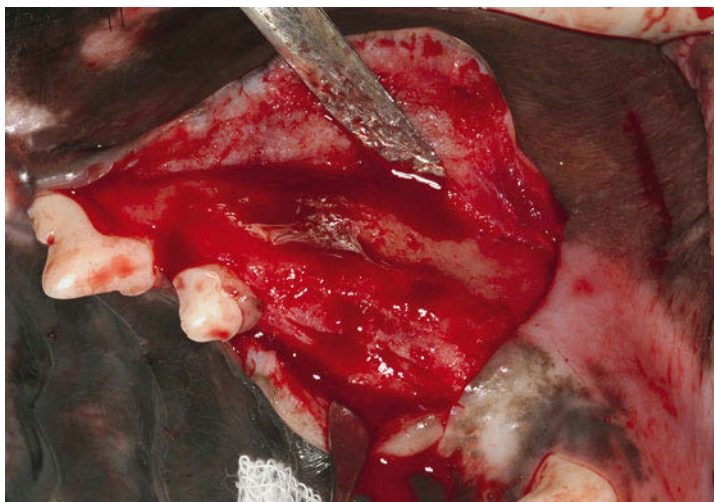




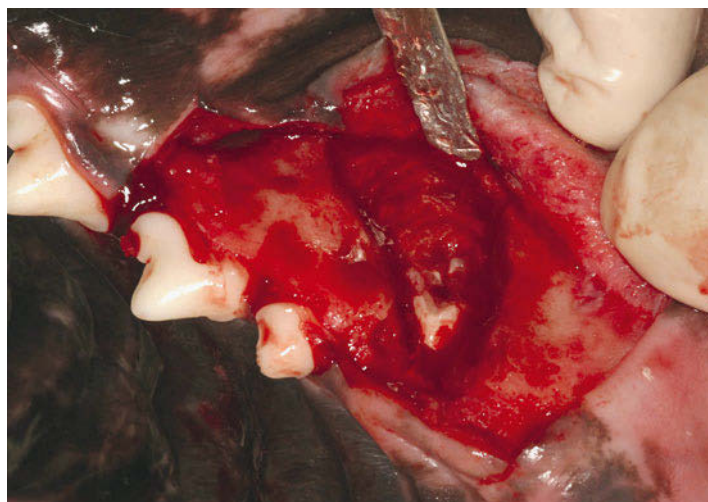
► **Fig. 15.55 Vertical accessory incision.** To ensure flaps of sufficient size, a vertical accessory incision is made to enhance visualization of the long canine root.



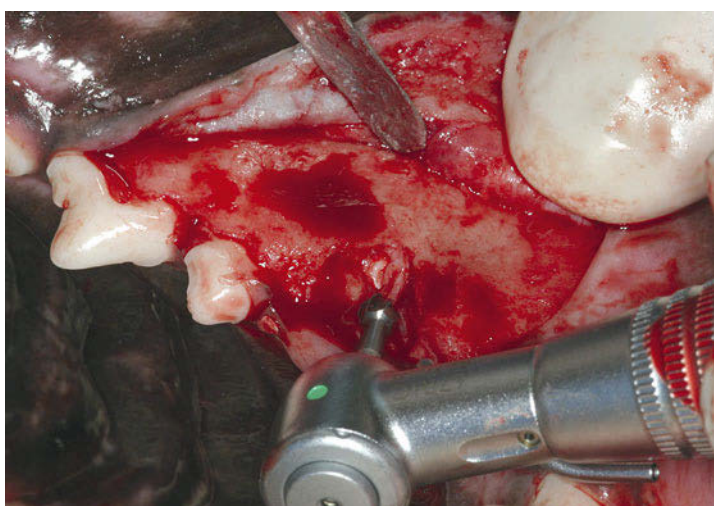
► **Fig. 15.58 Exposing the cusp.** Once the cusp is exposed, the osteotomy is extended along the crown and root.



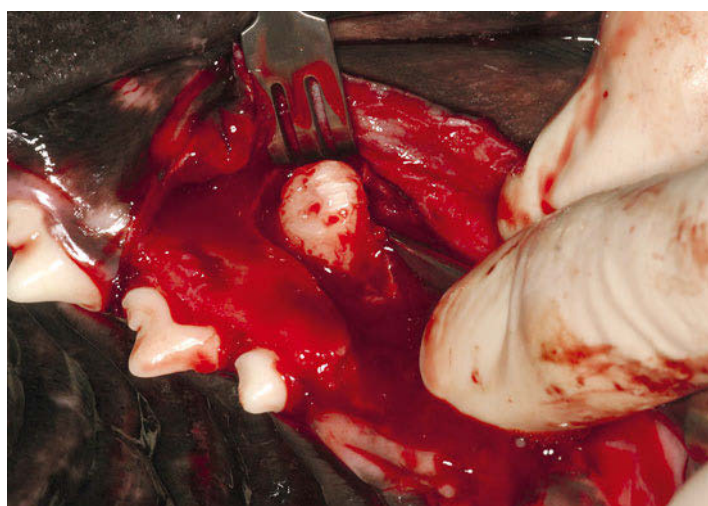
► **Fig. 15.56 Dissecting the gingiva.** A periosteal elevator is used to expose the alveolar bone, and a rotary instrument is then used to perform an osteotomy.



► **Fig. 15.59 Exposed tooth 104.** After the buccal bone lamella has been removed, the position of the retained tooth is evaluated, and an appropriate point for luxating the tooth is selected.

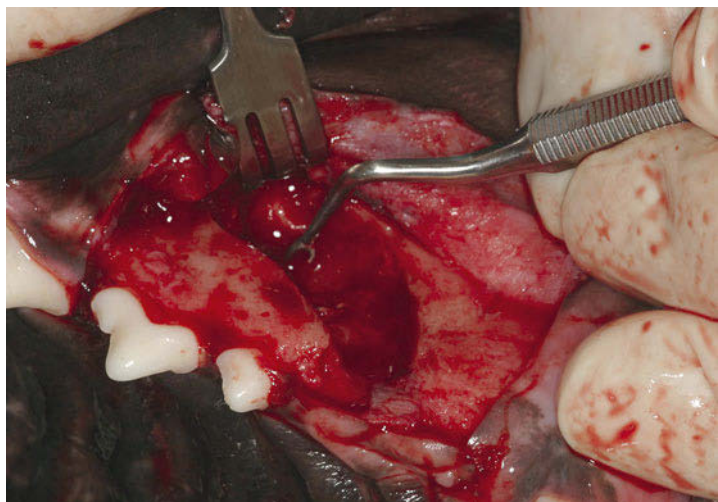


► **Fig. 15.57 Performing an osteotomy to expose the crown.** The bone covering the crown is removed with a surgical drill.

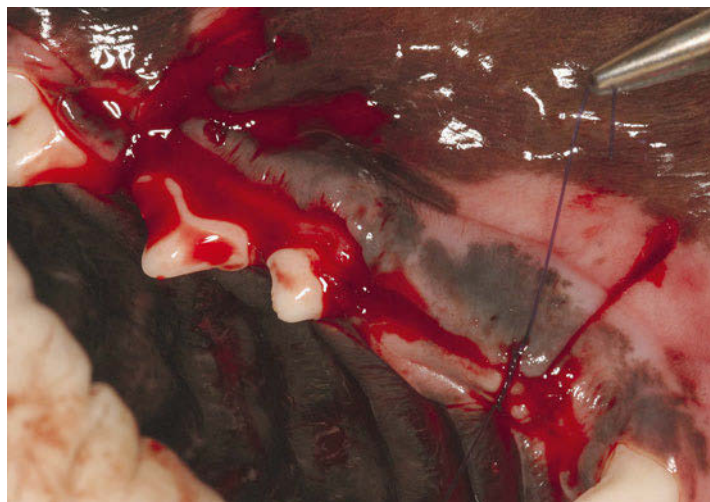


► **Fig. 15.60 Extraction of tooth 104.** A retractor enables good visualization of the tooth for performing careful luxation with an elevator. The tooth is moved in a buccal direction.





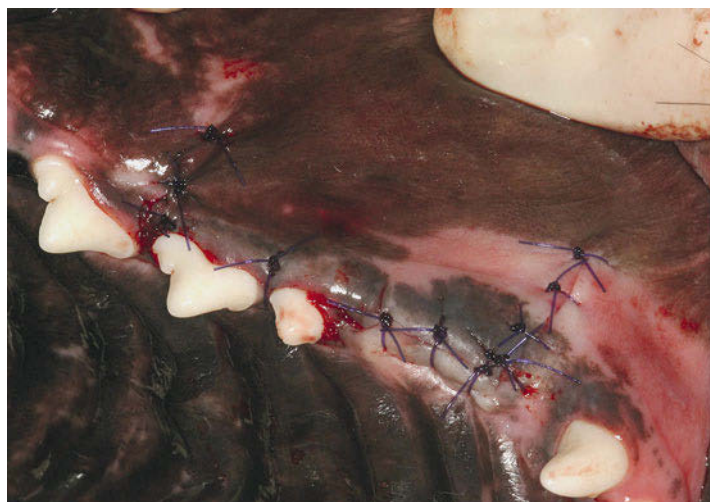
► **Fig. 15.61 Curettage of the alveolus.** Curettage with a sharp spoon-shaped surgical bone curette removes the soft tissue lining of the alveolus.



► **Fig. 15.63 Suture after extraction of tooth 104.** The mucosal flaps are replaced and closed with simple interrupted sutures. Since prior to surgery the area was covered by mucosa, no advancement flaps are necessary. It is sufficient to simply reposition and suture the flaps.



► **Fig. 15.62 Postoperative radiograph of the alveolus after extraction of tooth 104.** A postoperative radiograph is taken to confirm complete extraction of the tooth.



► **Fig. 15.64 Closed gingiva.** Complete closure of the gingiva with sutures. In dentulous areas the gingiva can be fixed with simple interrupted interdental sutures.



### 15.1.7 Orthodontic Treatment of a Retained Maxillary Canine Tooth in a Dog

If the retained tooth should be preserved, brackets and elastics can mobilize the tooth and move it into the dental arch, provided that root development is acceptable (► Fig. 15.65, ► Fig. 15.66, ► Fig. 15.67, ► Fig. 15.68, ► Fig. 15.69, ► Fig. 15.70, ► Fig. 15.71, ► Fig. 15.72, ► Fig. 15.73).



► **Fig. 15.65 Retained tooth 204.** The maxillary left canine tooth is missing from an otherwise complete set of teeth.



► **Fig. 15.66 Radiograph of retained tooth 204.** The radiograph shows that the tooth is fully retained and distally displaced.



► **Fig. 15.67 Radiograph showing the root tip of the retained tooth 204.** To evaluate the tooth's vitality, an additional radiograph must be taken to assess its root development. The width of the pulp and the development of the root sheath match the normal, healthy side.



► **Fig. 15.68 Orthodontic button (bracket) and elastic chain on retained tooth 204.** After the dental crown is exposed, an orthodontic button is attached to the tooth's buccal surface. In the mandible an orthodontic screw is inserted in the premolar area. The button and the screw are connected with an elastic chain.



► **Fig. 15.70 Wires and implants in the maxilla.** After extrusion of the tooth, a wire is placed in the maxilla. The wire is anchored distally on two orthodontic screws and then placed into a slot bracket on the maxillary canine. The wire loop that is created applies a force that further extrudes the tooth.



► **Fig. 15.69 Radiograph for examining the position of the orthodontic screw in the mandible.** A radiograph is taken to confirm the position of the anchor positioned between the roots of the mandibular second premolar.



► **Fig. 15.71 Intraoperative radiograph to check the position of maxillary implants.** As in the mandible, the position of the bone screws is confirmed in the radiograph.





► **Fig. 15.72 Follow-up radiograph after 45 days.** The radiograph shows further development of the canine root after 45 days. The root tip is more developed, and the wall is thicker. These parameters indicate that the tooth has survived the movement and is vital.

## 15.2 Supernumerary Teeth

In contrast to hypodontia, hyperdontia, meaning extra teeth, is not a contraindication for breeding. In true hyperdontia, too many teeth are present. False hyperdontia refers to deciduous teeth remaining in the jaw (persistence).

### 15.2.1 Persistent Deciduous Canines and Malpositioned Permanent Teeth in a Dog

Any persistent deciduous teeth that cause malpositioning of permanent teeth should be extracted immediately (► Fig. 15.74, ► Fig. 15.75, ► Fig. 15.76, ► Fig. 15.77, ► Fig. 15.78).



► **Fig. 15.73 Filling the adjusted tooth 204.** After completion of the orthodontic treatment, a composite filling is placed on the crown. The surface of the filling must be smoothed to facilitate cleaning.



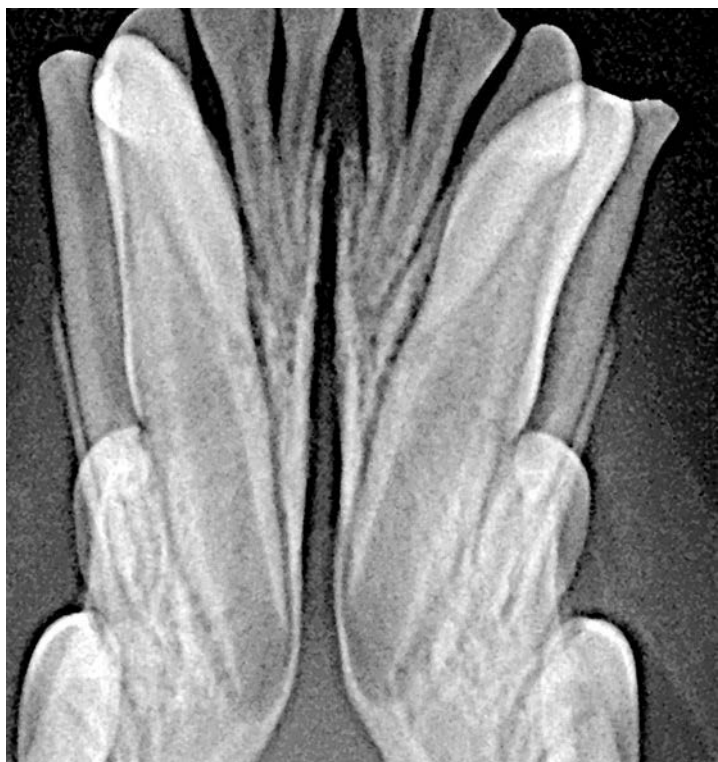
► **Fig. 15.74 Persistent teeth 604 and 704 in a dog with malpositioned teeth.** The persistent maxillary and mandibular deciduous teeth cause crowding. The lack of space prevents normal development of the permanent canines. Tooth 604 (deciduous maxillary left canine tooth) prevents distal development of tooth 204 (mandibular left canine tooth), leaving insufficient interdental space for lateralization of tooth 304 (mandibular left canine tooth). Tooth 704 (deciduous maxillary left canine tooth) prevents lateralization of permanent tooth 304 (mandibular left canine tooth), located lingually to it.



► **Fig. 15.75 Radiograph of tooth 604.** The radiograph shows only slight peripheral resorption of the deciduous root.



► **Fig. 15.77 Radiograph after extraction of tooth 604.** After extraction of the deciduous maxillary canine tooth, there is room for distal tipping of the permanent maxillary canine. This opens a gap mesial to the maxillary canine to allow lateralization of the linguoverted mandibular canine tooth.



► **Fig. 15.76 Radiograph of teeth 704 and 804.** The radiograph of the mandibular front teeth shows only minor traces of root resorption.



► **Fig. 15.78 Radiograph after extraction of teeth 704 and 804.** The extraction of the deciduous mandibular canines enables the permanent mandibular canines to develop laterally for normal occlusion.



### 15.2.2 Siblings with Hyperdontia

Skeletal anomalies of the jaw are considered to be a genetic problem that precludes breeding, while solitary dental problems are generally tolerated. However, single malpositioned teeth can also have a genetic cause (► Fig. 15.79, ► Fig. 15.80, ► Fig. 15.81, ► Fig. 15.82, ► Fig. 15.83, ► Fig. 15.84, ► Fig. 15.85, ► Fig. 15.86, ► Fig. 15.87, ► Fig. 15.88).



► **Fig. 15.79 Double maxillary incisors, sibling “Hans”.** These are images of two dogs from the same litter with very similar orthodontic anomalies of the incisors. While their bites were skeletally unremarkable, the dental anomaly likely involved a genetic component. In the maxilla of “Hans”, both maxillary intermediate incisors developed in duplicate on the distal side.



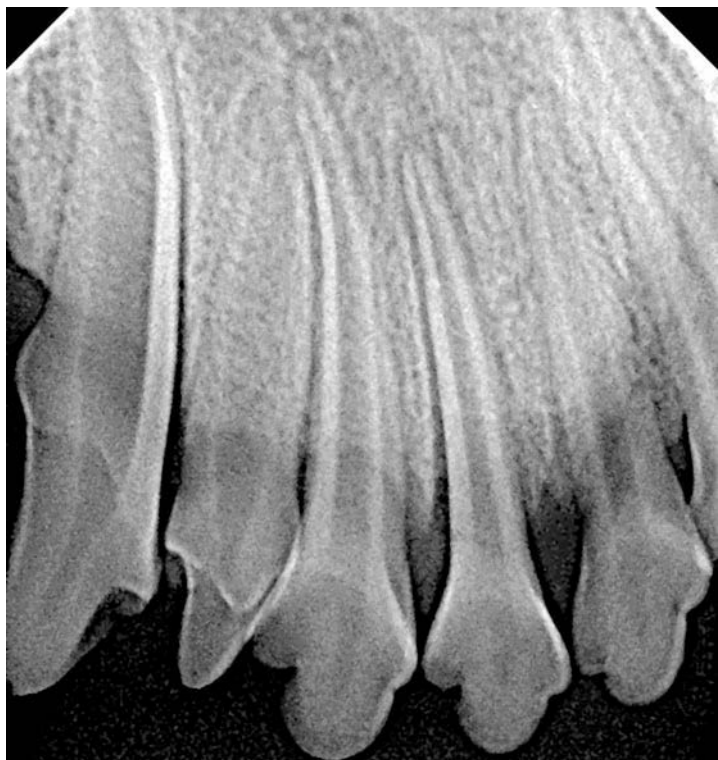
► **Fig. 15.81 Double maxillary incisor, sibling “Franz”.** The situation is similar in sibling “Franz”. As with “Hans”, here too, a supernumerary intermediate incisor is present.



► **Fig. 15.80 Double mandibular incisor, sibling “Hans”.** In the mandible of “Hans”, a smaller supernumerary tooth appears in the dental arch distal to the left intermediate incisor.



► **Fig. 15.82 Double mandibular incisor, sibling “Franz”.** “Franz” has the same duplicated tooth as “Hans”; however, it is located lingual to the dental arch.



► **Fig. 15.83 Radiograph, maxillary right incisors, sibling "Hans".** The radiograph shows a rotated double tooth 102 in "Hans".

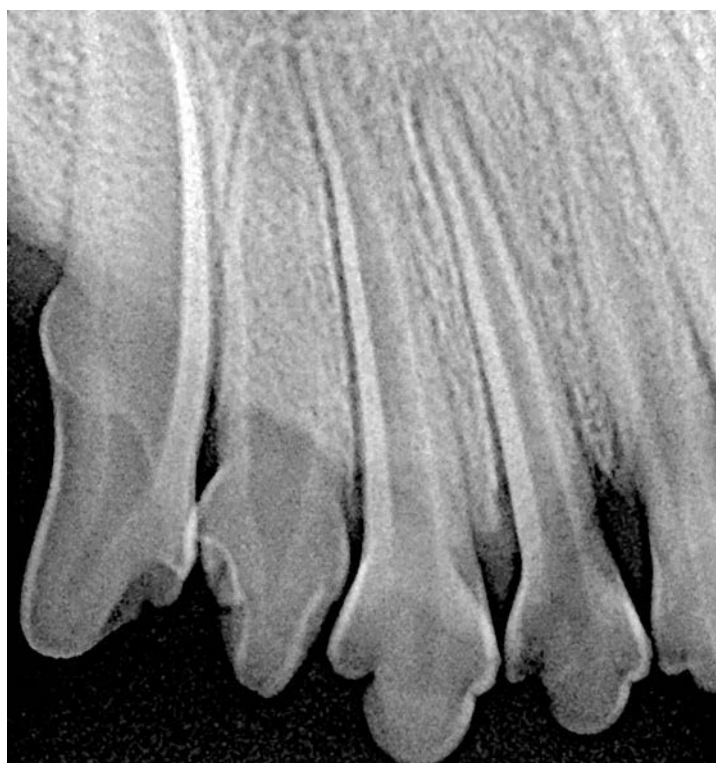


► **Fig. 15.85 Radiograph, mandibular incisors, sibling "Hans".** The radiograph also shows an abnormal crown of supernumerary tooth 302. The root is smaller than normal and deformed.

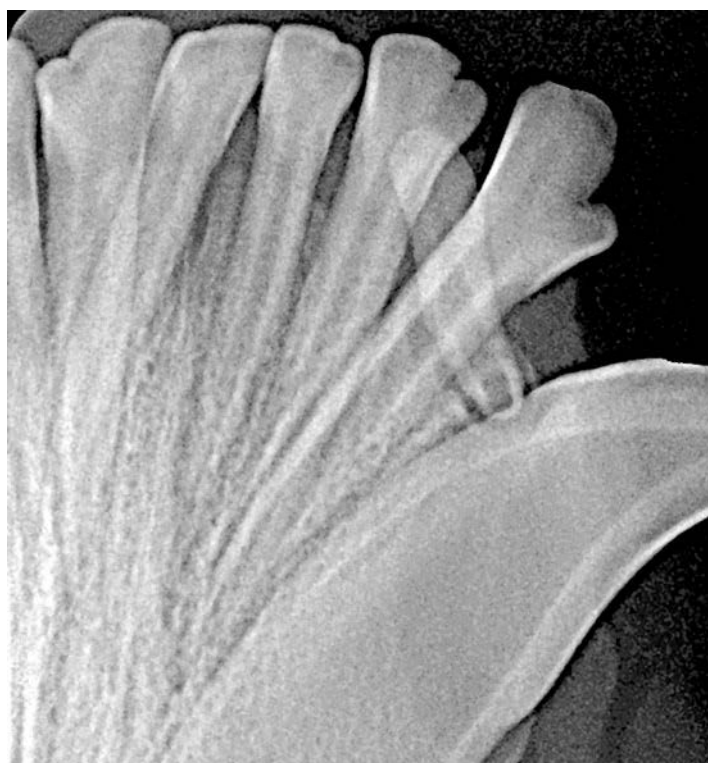


► **Fig. 15.84 Radiograph, maxillary left incisors, sibling "Hans".** Tooth 202, on the left side, is rotated and shows delayed root development.

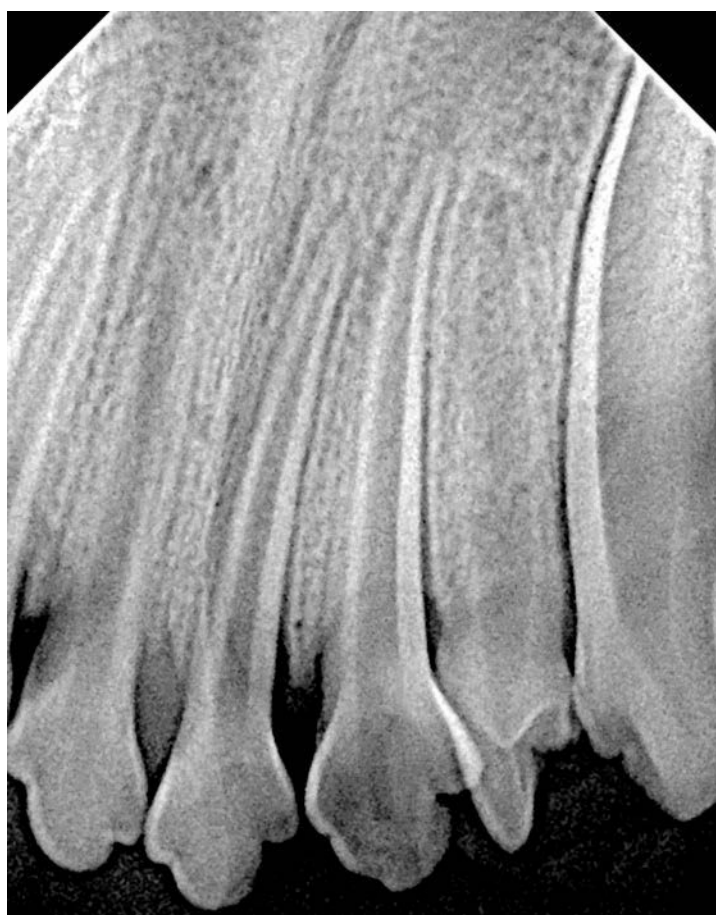




► **Fig. 15.86 Radiograph, maxillary right incisors, sibling “Franz”.** Double tooth 102 is unremarkable in the radiograph of “Franz”.



► **Fig. 15.88 Radiograph, mandibular left incisors, sibling “Franz”.** The root of double tooth 302 is abnormally positioned, showing additional osteolytic processes around the root.



► **Fig. 15.87 Radiograph, maxillary left incisors, sibling “Franz”.** The rotation of double tooth 202 is apparent, however.

### 15.2.3 Double Maxillary Canines in a Cat

In cats, supernumerary teeth, like missing teeth, are much less common than in dogs (► Fig. 15.89, ► Fig. 15.90, ► Fig. 15.91, ► Fig. 15.92, ► Fig. 15.93).



► **Fig. 15.89 Double crown of tooth 104 in a cat.** Clinically, this cat appears to have a double maxillary right canine.



► **Fig. 15.91 Double crowns of teeth 104 and 204 in a cat.** In the image, the right interdental space is more distinct.



► **Fig. 15.90 Double crown of tooth 204 in a cat.** The left side is similar.



► **Fig. 15.92 Radiograph, double tooth 104.** The radiograph shows two completely separately developed right canine teeth.





► **Fig. 15.93 Radiograph, incomplete double tooth 204.** On the left, while two crowns are clinically present, the radiograph reveals a common root. The tooth has 1 root and a divided crown. Root development is still incomplete and commensurate with the cat's age. Radiographic imaging is required to decide whether extraction is feasible and/or expedient. On the right, extraction of the supernumerary tooth may be considered. On the left, the functionally important canine tooth should be preserved rather than extracted

#### 15.2.4 Malpositioned Incisors Due to Odontoma in a Dog

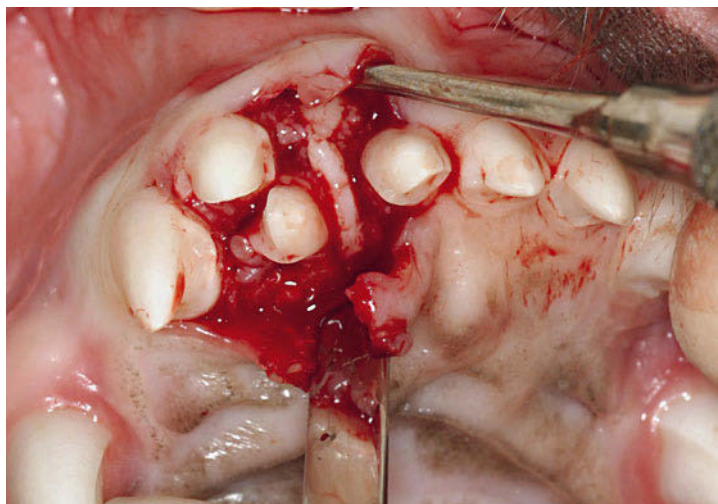
Supernumerary teeth can also be caused by tumor-like changes. In a compound odontoma, tiny "teeth" (denticles) form. Odontomas may form just a few denticles or so many that they occupy the entire jaw. This is referred to as a hamartoma (meaning an error on the part of the body, not a real neoplasm). Full extraction of the denticles prevents recurrence (► Fig. 15.94, ► Fig. 15.95, ► Fig. 15.96, ► Fig. 15.97, ► Fig. 15.98, ► Fig. 15.99, ► Fig. 15.100, ► Fig. 15.101, ► Fig. 15.102, ► Fig. 15.103, ► Fig. 15.104). However, it is important to distinguish compound odontomas from others such as complex odontomas with irregular dental substance particles, because complex ones are significantly more likely to recur.



► **Fig. 15.94 Malpositioned maxillary incisors.** In this case, the maxillary incisors in a dog are malpositioned due to hyperdontia.



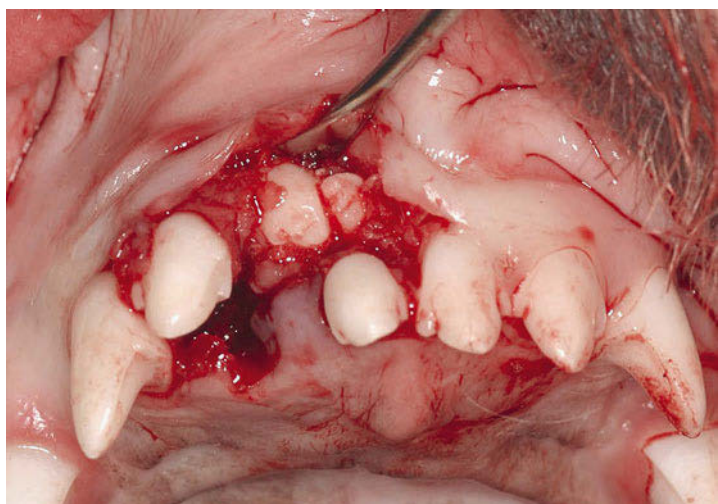
► **Fig. 15.95 Radiograph of the supernumerary teeth.** The radiograph of the maxillary front teeth shows the supernumerary teeth on the right side.



► **Fig. 15.96 Exposed supernumerary teeth.** A scalpel and rasp are used to expose the supernumerary teeth.



► **Fig. 15.98 Sutures after extraction of supernumerary teeth.** After extraction of the supernumerary teeth and tooth-like formation, the incision is reclosed with resorbable simple interrupted sutures.



► **Fig. 15.97 Additional supernumerary teeth located buccally.** Extensive dissection also exposes a small supernumerary tooth buccally.

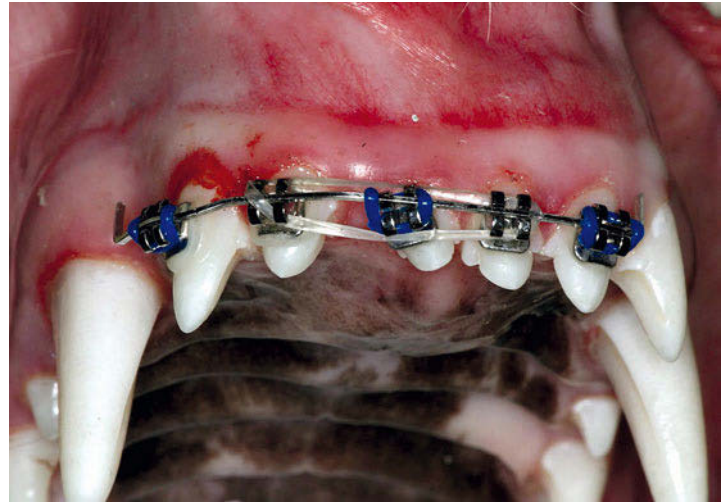


► **Fig. 15.99 Intraoperative radiograph after extraction.** The intraoperative radiograph taken after extraction shows that the small supernumerary teeth are absent, but the space between the central and intermediate incisors is widened. The root of tooth 101 (maxillary right central incisor) appears shorter than that of tooth 201 (maxillary left central incisor).





► **Fig. 15.100 Dental arch after healing.** The widened interdental space is still clinically observed in the healed gingiva.



► **Fig. 15.102 Brackets and wire.** Slot brackets are attached to the maxillary incisors and connected with an arch wire. Elastic bands exert forces that move the teeth along the wire.



► **Fig. 15.101 Etching the incisors in preparation for placement of brackets.** The dental surfaces of the incisors are prepared. After cleaning, the teeth are etched with phosphoric acid to create a retentive microtexture.



► **Fig. 15.103 Tooth position after removal of the brackets.** After the brackets are removed, the teeth are more evenly spaced, and the widened interdental space has been closed. The margin of the gingiva is inflamed due to the irritation from the brackets and the movement.



► **Fig. 15.104** Follow-up radiograph of the incisors 2 months post-extraction. The follow-up radiograph shows increased root development of the treated teeth. The interdental space between teeth 101 and 102 is smaller due to the movement of the teeth.

### 15.3

## Dental Anomalies

Tooth deformity can affect both individual tooth components or the entire tooth, causing malformation or impaired development. Local trauma can cause local dental anomalies, while generalized processes such as infection can affect the entire dentition (e.g., canine distemper). Most of the causes are exogenous. Congenital deformity is less common.

The most common dental anomaly in dogs is enamel hypoplasia. A disturbance of the ameloblasts causes flawed enamel production, which destroys the integrity of the crown. Areas affected by enamel hypoplasia appear as surface defects in the enamel. The ensuing roughness makes the surface susceptible to discoloration.

Another anomaly involves division of a tooth germ, which forms a “double tooth” that appears either as a supernumerary twin tooth or remains connected with its twin in a variable form. Radiography is often the only means of differentiation.

### 15.3.1 Enamel Hypoplasia of Canines and Molars in a Dog

In enamel hypoplasia, an impairment in the ameloblasts disrupts enamel formation; this can be of systemic or local origin. A systemic disturbance affects all teeth at the particular stage of development. Local trauma may induce hypoplasia only in the area that undergoes the trauma. A genetic predisposition to enamel hypoplasia affects all of the teeth, regardless of their developmental stage. In addition to the enamel, the dentin and possibly even the entire tooth may be damaged (► Fig. 15.105, ► Fig. 15.106, ► Fig. 15.107, ► Fig. 15.108, ► Fig. 15.109, ► Fig. 15.110, ► Fig. 15.111, ► Fig. 15.112, ► Fig. 15.113, ► Fig. 15.114, ► Fig. 15.115).



► **Fig. 15.105** Enamel hypoplasia of teeth 109 and 110. Starting with the distal part of the maxillary right carnassial tooth, massively malformed crowns of the molars are seen. A deformity of the enamel has caused partly brownish and partly pink discoloration of the crown of the first molar. The second molar appears only as a small tooth particle.





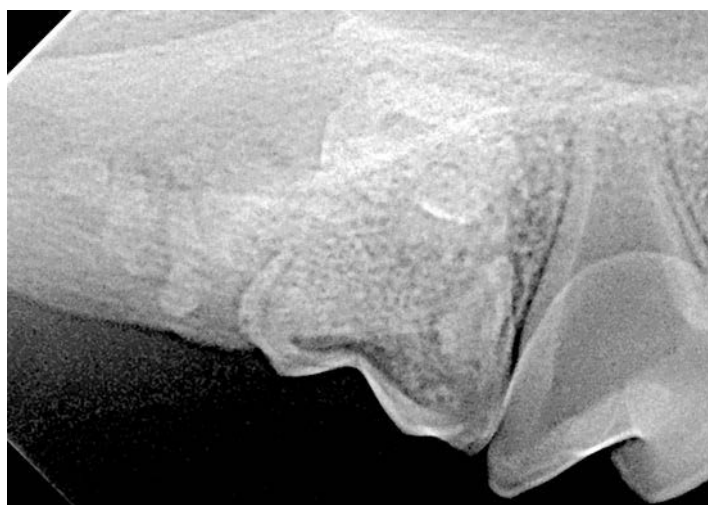
► **Fig. 15.106 Enamel hypoplasia on tooth 104.** On the maxillary right canine tooth, the enamel defect is limited to a round lesion on the buccal surface. The enamel is absent, and the underlying dentin is brownish due to the accumulation of colorants on the rough surface.



► **Fig. 15.108 Enamel hypoplasia on teeth 209 and 210.** The surface of the maxillary left cheek teeth is also damaged, although the defects are not as pronounced as on the right. The cusps show particular signs of enamel hypoplasia.



► **Fig. 15.107 Enamel hypoplasia on tooth 204.** The maxillary left canine tooth appears identical.



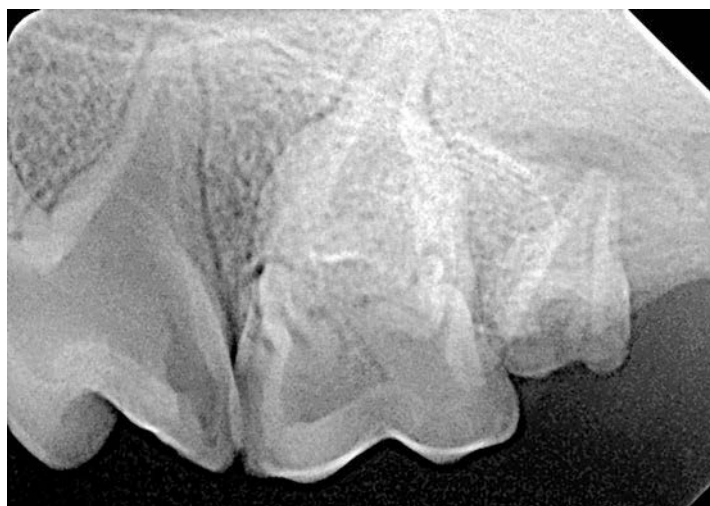
► **Fig. 15.109 Radiograph of teeth 109 and 110.** The radiograph of the maxillary right molars shows root deformity. Tooth 109 lacks normal root development, while tooth 110 comprises only disorganized dental hard substance particles.



► **Fig. 15.110 Radiograph of tooth 104.** The root development of the maxillary right canine is unremarkable.

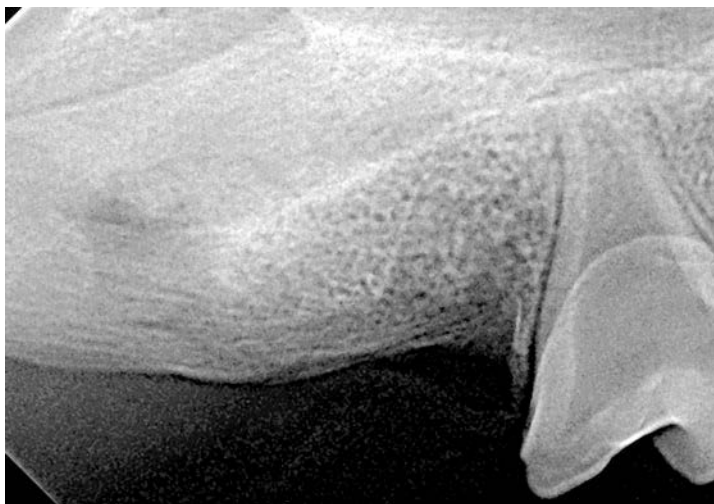


► **Fig. 15.111 Radiograph of tooth 204.** The root development of the maxillary left canine is also normal.



► **Fig. 15.112 Radiograph of teeth 209 and 210.** An effect of the disrupted tooth development is a deformity of the buccal roots of the left molars.





► **Fig. 15.113** Radiograph after extraction of teeth 109 and 110. The only possible treatment on the right is extraction of the damaged molars.



► **Fig. 15.114** Filling of tooth 104. The small enamel hypoplasia defect of the maxillary right canine tooth is filled with a composite filling. Before placing the filling, the damaged enamel must be removed to create an intact surface to which the filling may adhere. Thus, the surface is etched to create a microtexture.



► **Fig. 15.115** Filling of tooth 204. The same procedure is used for the maxillary left canine tooth. The fact that the defect is encircled by healthy enamel means that the composite filling has a suitable receiving bed.

### 15.3.2 Generalized Enamel Hypoplasia with Root Deformity in a Dog

When a dental crown is deformed, abnormal development of the root is also possible (► Fig. 15.116, ► Fig. 15.117, ► Fig. 15.118, ► Fig. 15.119, ► Fig. 15.120, ► Fig. 15.121, ► Fig. 15.122, ► Fig. 15.123, ► Fig. 15.124, ► Fig. 15.125, ► Fig. 15.126, ► Fig. 15.127). For this reason, the crown cannot be treated until normal root development has been verified radiographically.



► **Fig. 15.116 Enamel hypoplasia on the right side.** In this dog, enamel hypoplasia of the crowns is extensive, and the visible defects are wider and extend to the gingival margin in some places.



► **Fig. 15.118 Radiograph of tooth 108.** The radiograph of the maxillary right carnassial tooth shows distinctly impaired root development. While all roots are malformed and shrunken, the periodontal ligament space is unremarkable. No inflammation is observed. Aside from the changes in root shape, there are no signs of a progressive inflammatory process.

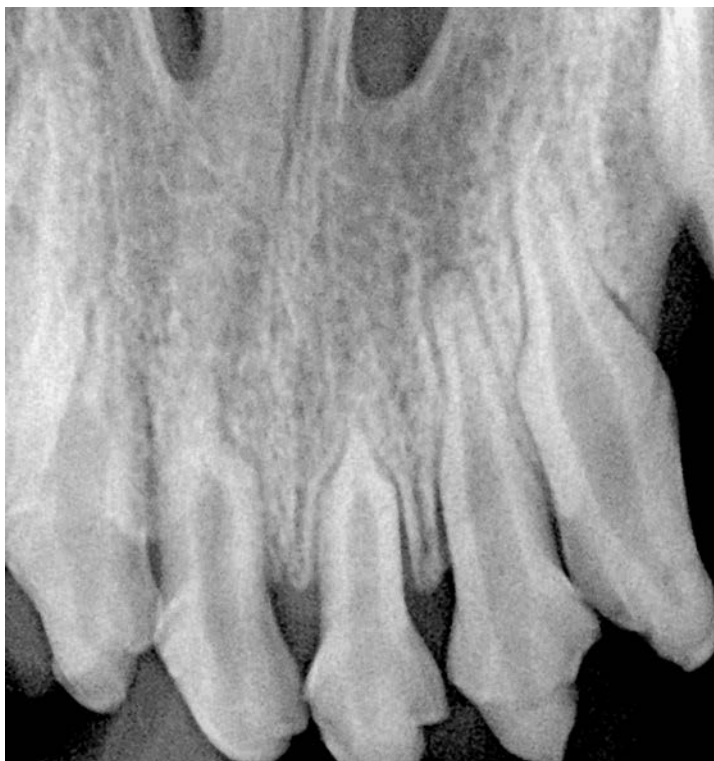


► **Fig. 15.117 Enamel hypoplasia on the left side.** The left side resembles the right side.



► **Fig. 15.119 Radiograph of tooth 104.** The root of the maxillary right canine tooth is also malformed. It is much smaller than a normal canine root, although the development is age-appropriate and unremarkable.





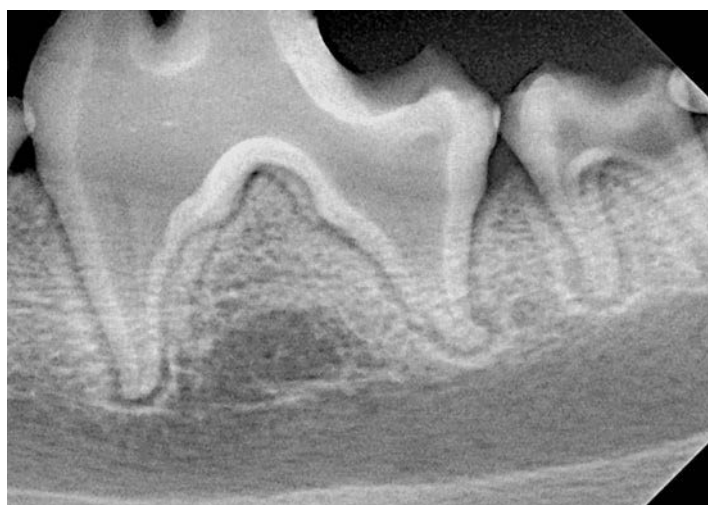
► **Fig. 15.120 Radiograph of the maxillary incisors.** The maxillary incisors taper atypically near the apex, creating a shorter root; this is especially notable with the central incisors.



► **Fig. 15.122 Radiograph of tooth 208.** The roots of the maxillary left carnassial tooth are malformed, and the roots of the adjacent molars are also abnormal. However, no translucencies indicating an osteolytic process appear.



► **Fig. 15.121 Radiograph of tooth 204.** The maxillary left canine tooth is similar to the maxillary right canine tooth.



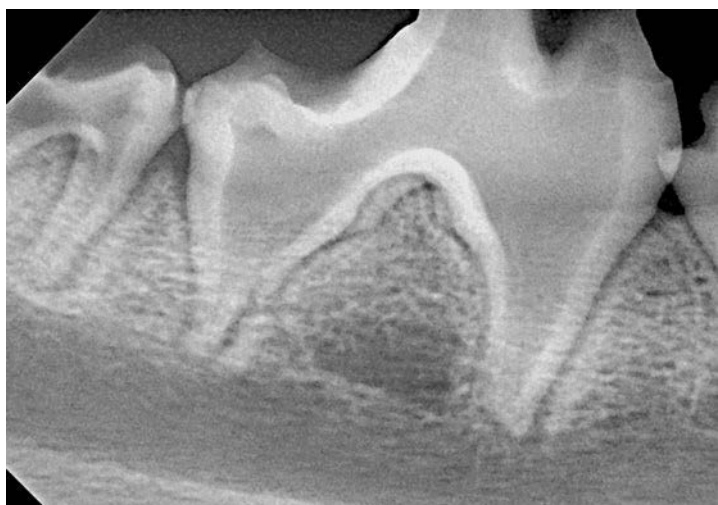
► **Fig. 15.123 Radiograph of tooth 309.** The roots of the mandibular left carnassial tooth taper drastically in an apical direction. The root tips barely reach the level of the mandibular canal.



► **Fig. 15.124 Radiograph of the mandibular front teeth.** The roots of the mandibular canine teeth resemble those of the maxillary canines. They are similarly underdeveloped.



► **Fig. 15.126 Composite fillings on the right.** Due to the lack of inflammatory changes and functional impairments, treatment involves the placement of composite fillings.



► **Fig. 15.125 Radiograph of tooth 409.** Irregularly formed roots of the mandibular right carnassial tooth are noted, with irregular periodontium that cannot always be clearly visualized.



► **Fig. 15.127 Composite fillings on the left side.** Caring for the damaged bite helps to postpone the extraction of the affected teeth from the oral cavity.



### 15.3.3 Dental Anomaly in a Dog

In addition to classic enamel hypoplasia with brown defects on the dental crowns, substance-related changes in the tooth composition or defects in the maturation of the enamel and dentin may occur (► Fig. 15.128, ► Fig. 15.129, ► Fig. 15.130, ► Fig. 15.131, ► Fig. 15.132, ► Fig. 15.133, ► Fig. 15.134, ► Fig. 15.135). These changes may not be immediately detectable. They may not be apparent until the animal attempts to use its teeth.



► **Fig. 15.128 Dental anomaly, maxillary incisors.** Unlike “normal” dental dysplasia with insufficient enamel, the appearance of this dog’s teeth is also abnormal. The surface itself is barely altered, although the reddened gingival margin represents gingivitis next to the apparently smooth surface.



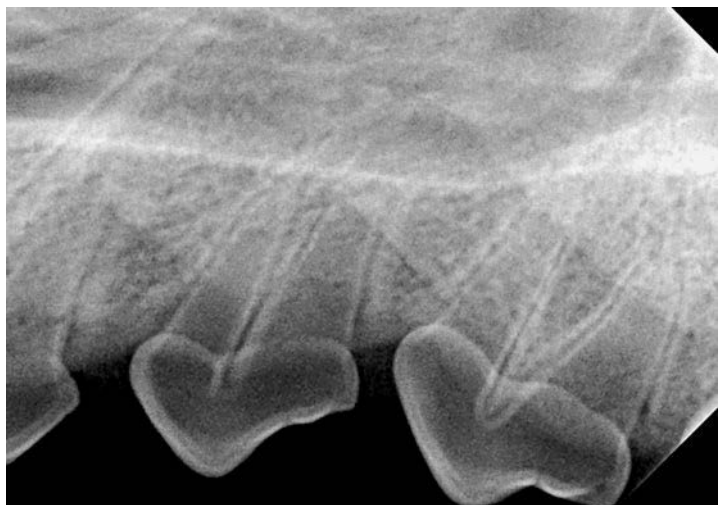
► **Fig. 15.130 Dental anomaly, tooth 208.** The damage to the tooth wall is particularly apparent on the maxillary carnassial tooth. The pink color may be the pulp visible through the surface enamel. This dog may have congenital amelogenesis imperfecta, dentinogenesis imperfecta, or a developmental disturbance that affects both the enamel and the dentin. The fact that it is not a matter of typical amelogenesis or dentinogenesis imperfecta can be seen in the following radiographs.



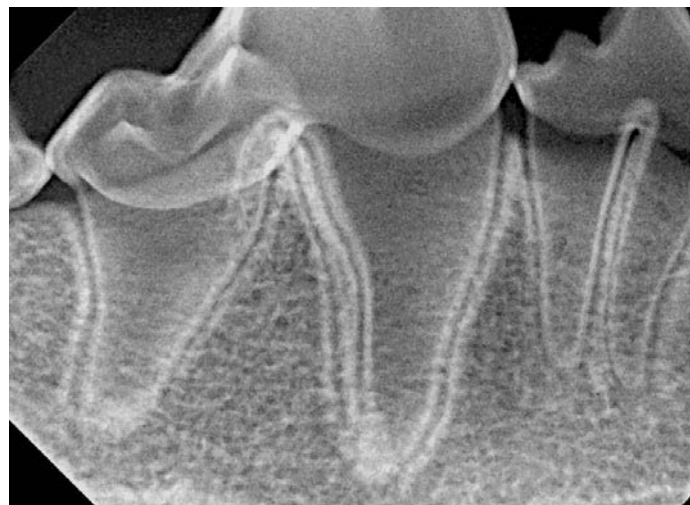
► **Fig. 15.129 Dental anomaly, tooth 204.** The maxillary left canine crown’s translucency and opacity are altered. The crown has a light pink background color with spidery white lines covering the entire surface. The horizontal lines represent the successive appositions of enamel crystals on the crown. The meeting of the striae of Retzius (growth lines in tooth enamel) on the surface causes circular indentations (imbrication lines), delimited by slight bulges of the enamel (perikymata).



► **Fig. 15.131 Right mandible of a dog with dental anomaly.** The pink color of the mandibular cheek teeth is striking.



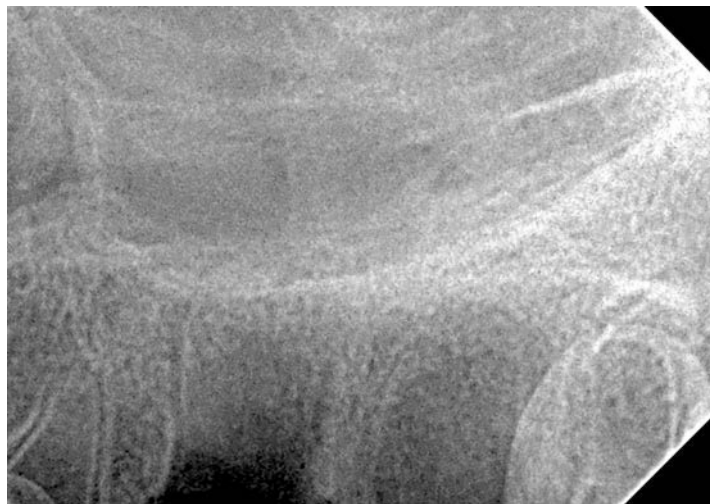
► **Fig. 15.132 Radiograph of the maxillary left premolars in a dog with dental anomalies.** The radiograph shows that the abnormal production of dental hard tissues also affects the wall thickness in the root area. The Hertwig epithelial root sheaths are very thin below a thin crown, and the tooth development lags far behind normal.



► **Fig. 15.134 Radiograph of tooth 409.** The mandibular carnassial tooth is transparent. The roots show no inflammation.



► **Fig. 15.133 Radiograph of tooth 208.** The fragile teeth massively impair the stability of all of the teeth. The distal root tip of the maxillary carnassial tooth shows an osteolytic process. The tooth cannot be preserved because it is missing a root tip. Extracting a tooth in this condition is not easy given its instability. In many cases, such a tooth only can be removed in fragments after osteotomy.



► **Fig. 15.135 Intraoperative radiograph after extraction of tooth 208.** In particular, because fragments of the very soft tooth root may remain, a radiograph is taken to confirm complete extraction.

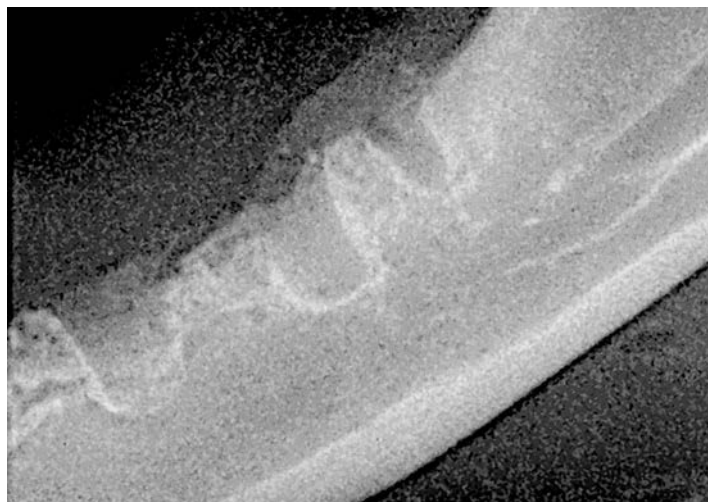


### 15.3.4 Double Crown of the Mandibular Premolars in a Cat

In some cases, not just the enamel layer but the entire tooth develops abnormally (► Fig. 15.136, ► Fig. 15.137, ► Fig. 15.138). For both congenital (e.g., amelogenesis imperfecta, dentinogenesis imperfecta) and acquired (e.g., trauma, infection) reasons, teeth may undergo minor deviations that can even culminate in the death of the tooth germ.



► **Fig. 15.136 Fusion of the mandibular premolars.** In this cat, the atypical shape of the mandibular left fourth premolar results from either attempted embryonic tooth division or the fusion of the third and fourth premolars. The normally mesially located third premolar is not seen, unlike the normal teeth on the right. Severe gingivitis has resulted from the unphysiological fissures and gingival line. The inflammation extends labially to above the mucogingival junction.



► **Fig. 15.138 Radiograph after extraction.** Extraction is the only practical treatment given the periodontal damage.



► **Fig. 15.137 Radiograph of tooth 308.** The tooth has three roots. The mesial and distal parts of the crown "share" the center root. The absence of a separate third premolar suggests the earlier fusion of the third and fourth premolars.

## 15.4 Malocclusions

A malocclusion is an abnormal occlusion of the teeth due to either a basoskeletal or dentoalveolar cause. In the case of a basoskeletal cause, a bony disparity between the maxilla and the mandible incites the condition. In the case of a dentoalveolar cause, the individual teeth are malpositioned on an unremarkable jawbone. Due to the uniformity of the feline jaw, orthodontic problems are much less common in cats than in dogs. In dogs, various combinations of skeletal and dentoalveolar factors frequently lead to an overbite or underbite; in many cases, an associated large, exposed, malpositioned canine tooth can cause trauma to the jaw.

When treating malocclusions, the goal is creating or preserving functionality, with aesthetic concerns playing a lesser role. It is often impossible to determine whether a malocclusion in an individual animal is congenital or acquired. The treatment should allow the animal to lead a pain-free life without inflammation.

### 15.4.1 Linguoversion and Mandibular Distoclusion

#### Using Orthodontic Appliances and Inclined Planes to Correct Linguoverted Mandibular Canines in a Dog

In dogs, successful therapy requires sufficient anchoring of functional orthodontic appliances in the oral cavity, since the dog will likely attempt to remove what it perceives as a “foreign body” from its mouth, especially in the early stages. For this reason, a removable activator that advances the mandible, as is used in humans, cannot be used in dogs. On the other hand, a modified activator in the form of an inclined plane can be attached to the maxillary teeth. However, in most cases this achieves only tipping of teeth rather than advancement of the mandible. Nevertheless, linguoverted canines that cause trauma to the palate can be moved out of the “danger zone”, which helps improve occlusion without the need to shorten or extract teeth (► Fig. 15.139, ► Fig. 15.140, ► Fig. 15.141, ► Fig. 15.142, ► Fig. 15.143, ► Fig. 15.144, ► Fig. 15.145, ► Fig. 15.146, ► Fig. 15.147, ► Fig. 15.148).



► Fig. 15.140 Linguoverted tooth 304. The left is similar, because the skeletal anomaly affects the entire jaw rather than only one tooth. The rows of incisors are not in contact, which prevents correct function. However, the dog can compensate for this lack of function, and pathological changes do not generally occur in the mucosa if the incisors do not deeply penetrate the palate.



► Fig. 15.139 Linguoverted tooth 404. This dog's pronounced skeletal malocclusion causes the mandibular canines to penetrate the palate opposite to it.



► Fig. 15.141 Inclined plane on the right. After an initial treatment with brackets, inclined planes are placed for the movement of the mandibular canine teeth. An inclined plane made of a material such as methacrylate is attached to the lateral incisor and the canine with adhesive. The surface of the inclined plane is aligned to allow 3-dimensional motion of the mandibular canine tooth. When the jaws are closed, the mandibular canines are guided to the outside over the inclined plane.





► **Fig. 15.142 Inclined plane on the left.** To prevent unilateral movement of the mandible, an inclined plane must also be placed on the left side. The two inclined planes may sometimes be fabricated as a single plastic block. The shape of the inclined planes should be as small as possible in order to prevent gingival inflammation while the inclined planes are worn. To prevent abrasion of the cusps, the occlusal surface of the planes must be as smooth as possible. Additionally the cusps of the mandibular canine teeth can be protected with composite knobs. If abrasion of the mandibular canine cusps occurs, pulp exposure may result. Therefore, in this case a different therapy option must be selected.



► **Fig. 15.144 Final situation of tooth 304.** The occlusion on the left side is similar to the right side. During treatment, the mandibular canine teeth have not been abraded, and the cusps are intact. The distance between the two dental arches has not changed because only tipping of the mandibular canines was performed.



► **Fig. 15.143 Final position of tooth 404.** Once treatment is completed, occlusion is functional on the right. Due to the large skeletal misalignment, occlusion of the mandibular canine tooth with the opposing tooth is very tight, and the distance between the maxillary canine tooth and the lateral incisor is very large.



► **Fig. 15.145 Radiograph of tooth 104.** The initial radiograph of the maxillary right canine tooth at the outset of treatment shows a thin-walled root with a huge pulp lumen and no root tip.

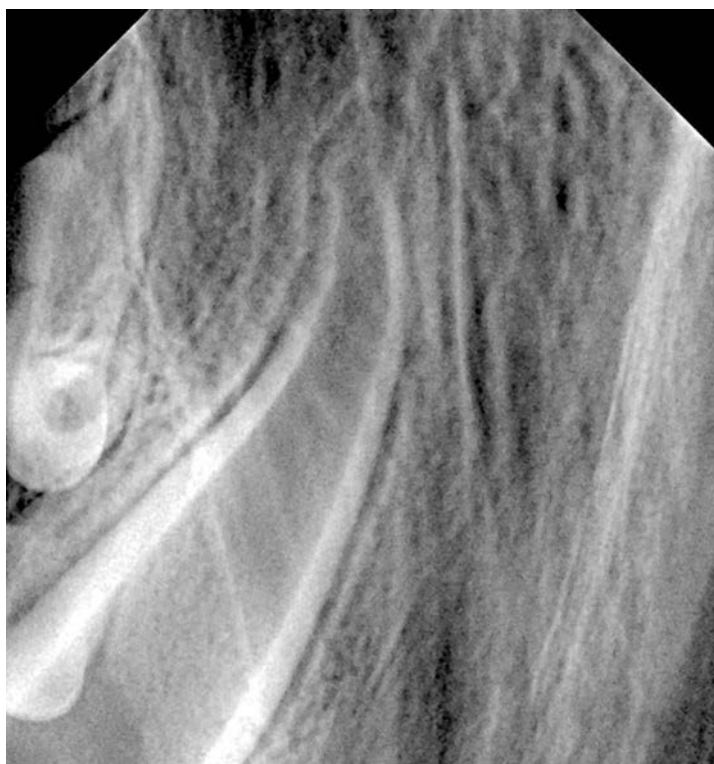




► **Fig. 15.146 Radiograph of tooth 204.** The maxillary left canine tooth is similar to the right one.



► **Fig. 15.148 Radiograph of tooth 204 at the end of treatment.** Curvature of the root tip is also observed on the left. The root tip shows age-appropriate normal development and increasing wall thickness. No further action is required.



► **Fig. 15.147 Radiograph of tooth 104 at the end of treatment.** The radiograph after removal of all appliances shows the curvature of the root tip of the maxillary canine tooth; this resulted from distal tipping of the canine tooth by elastic bands placed during distalization of the maxillary canine teeth to widen the mesial interdental space.



### Partial Pulpectomy/Vital Pulp Therapy Due to Malocclusion-induced Trauma in a Dog

If orthodontic correction is not possible or desired, shortening the mandibular canine teeth (crown reduction) is a proven option to resolve malocclusion-induced trauma of the palate in a single treatment (► Fig. 15.149, ► Fig. 15.150, ► Fig. 15.151, ► Fig. 15.152, ► Fig. 15.153, ► Fig. 15.154, ► Fig. 15.155). In addition to the local inflammation of the palatal mucosa, the inclination or position of the mandibular canines can disturb the development of permanent teeth during deciduous dentition. The maxillary permanent teeth are located palatally to their deciduous precursors, so the trauma from the mandibular canine teeth can negatively impact the development of the tooth germs. This can range from a small defect in enamel development to complete destruction of the tooth.



► **Fig. 15.149 Occlusion of tooth 804 with tooth 103.** The mandibular right deciduous canine tooth is significantly linguoverted, causing abnormal development of the maxillary permanent lateral incisor. The incisor presents with abnormal distal tipping and brownish discoloration, and its deciduous precursor is still present.



► **Fig. 15.150 Malocclusion-induced trauma to the palate.** The rostral view shows the traumatic defect created by the deciduous mandibular canine tooth penetrating the palate adjacent to the erupting maxillary lateral incisor.



► **Fig. 15.151 Radiograph, deformity of tooth 103.** The radiography shows curvature of the crown of the maxillary lateral incisor. Its pulp cavity and the pulp cavity of the adjacent intermediate incisor are abnormally wide. The root of the deciduous maxillary lateral incisor shows apical resorption.



► **Fig. 15.152 Radiograph after extraction of teeth 103 and 102.** In addition to extracting the deciduous mandibular canine tooth that is causing trauma to the palate, the two affected permanent maxillary incisors must also be extracted.



► **Fig. 15.154 Radiograph of root development of tooth 404 after 2 months.** After 2 months, the first follow-up radiograph is taken to examine root development. In case of pulp death, the root will not develop further. However, if the root continues to develop normally, the root wall will thicken, the pulp cavity will shrink, a root tip will develop, and no pathological inflammatory processes will occur; these would appear as apical translucency due to osteolytic processes.



► **Fig. 15.153 Radiograph of the root development of tooth 404.** In this case, malocclusion of the permanent teeth requires treatment of the mandibular right canine. The tooth is shortened with a partial pulpectomy/vital pulp therapy. The coronal third of the dental crown is removed and a cavity is prepared, which entails sterile excision of the part of the crown pulp located there. Direct pulp capping is performed and the pulp is then closed with a composite filling.



► **Fig. 15.155 Radiograph of root development of tooth 404 after 5 months.** In this dog, another follow-up radiograph was taken after 5 months to check the progress. It is generally sufficient to take the second follow-up radiograph 1 year postoperatively, although this obviously applies only if a previous radiograph was unremarkable. Wall thickness has significantly increased, the root tips are closed, and the healthy left side and the treated right side have developed symmetrically.



### Crown reduction and Root Canal Filling of Linguoverted Mandibular Canines in a Dog

If a dog with linguoverted canines presents at adulthood or after completion of root growth, shortening of the teeth is usually a better solution than orthodontic treatment. The growth of the tooth root, the maturation and therefore higher bone stability are much poorer for the prognosis of orthodontic tooth movement. At this stage, crown reduction should no longer be performed via partial pulpectomy, but instead as conventional root canal therapy with complete obturation of the pulp and the placement of a root canal filling (► Fig. 15.156, ► Fig. 15.157, ► Fig. 15.158, ► Fig. 15.159, ► Fig. 15.160, ► Fig. 15.161, ► Fig. 15.162, ► Fig. 15.163, ► Fig. 15.164, ► Fig. 15.165, ► Fig. 15.166). This minimizes the uncertainty over the apical process development, and follow-up radiographs are not absolutely necessary.



► Fig. 15.158 Malocclusion-induced trauma to the palate. The trauma to the palate is severe, with deep penetration causing impaction of foreign material.



► Fig. 15.156 Linguoverted tooth 404. Despite the normal skeletal structure, the linguoverted mandibular right canine tooth deeply penetrates the palate. The mesioverted maxillary canine tooth makes the interdental space for lateralization of the tooth so tight as to preclude normal occlusion.



► Fig. 15.157 Linguoverted tooth 304. The situation on the left side is identical.



► Fig. 15.159 Radiograph of a bony defect on tooth 104. In the radiograph, the maxillary right canine tooth shows distinct osteolysis affecting up to half of the root length.



► **Fig. 15.161 Preoperative radiograph of teeth 304 and 404.** Prior to shortening, the apical areas of the mandibular canines are radiographed. The radiograph does not show any pathological processes, and a sufficient apical stop is present on both sides.



► **Fig. 15.160 Radiograph of a bony defect on tooth 204.** The same situation is present in the area where the mandibular left canine tooth penetrates the palate. Mesially, an infrabony pocket has developed, comprising half the root length.



► **Fig. 15.162 Measurement radiograph of teeth 304 and 404.** The measurement radiograph shows the working length required to prepare the two canals.

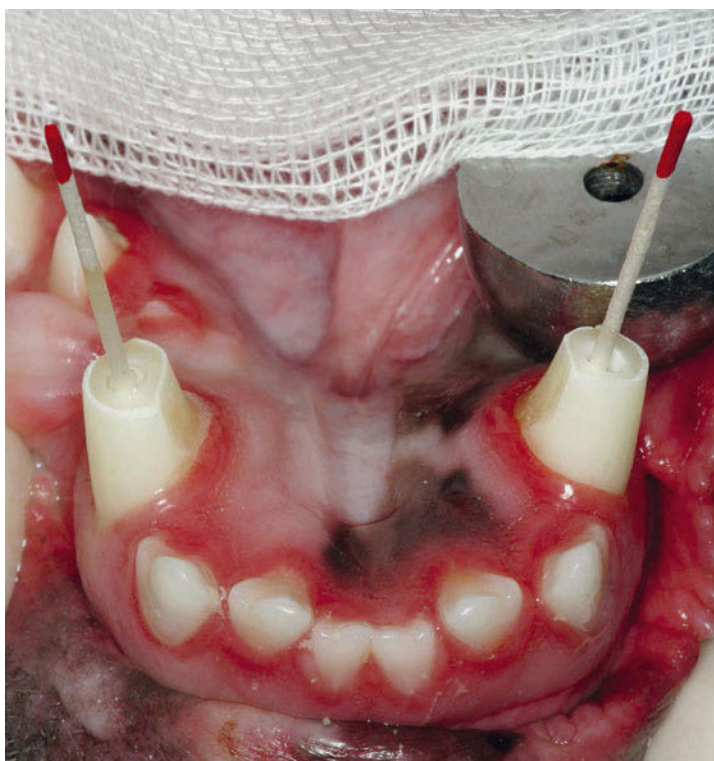




► **Fig. 15.163 Preparation of teeth 304 and 404.** In this case, Hedstrom files are used to take the measurement radiograph and prepare the canals.



► **Fig. 15.165 Temporary root canal filling.** The root canal must be absolutely dry for placement of a root canal filling. In a young dog with a wide pulp cavity, despite full removal of the pulp, apical bleeding often occurs, precluding a tight root canal filling. For this reason, an intracanal dressing containing calcium hydroxide is placed, and a temporary filling is placed on the crown of the tooth.



► **Fig. 15.164 Drying of teeth 304 and 404.** After the canals are prepared, they are dried with paper points before placing the root canal filling. The root canal should be dry, clean, and odor-free. If not, further preparation is required.



► **Fig. 15.166 Permanent root canal filling.** 4 to 6 weeks later. After the intracanal dressing is removed, the root canal is cleaned and dried, after which a permanent root canal filling is placed. The root canal filling must be sufficiently long and uniform on the radiograph.



### Expansion Screw for Lateralization of the Mandibular Canines in a Dog

An expansion screw can be used to lateralize unilateral or bilateral linguovertebral mandibular canines. An expansion screw may be used only to move the teeth laterally; moving them mesially or distally is impossible. Thus, an expansion screw may be used to treat Class 1 or 2 penetration of the palate. It may also be used to treat Class 4 penetration of the palate to create distal occlusion of the canine teeth with the mandibular canine teeth occluding distal to the opposing maxillary teeth. The expansion screw is placed between the mandibular canine teeth and is attached with cerclage wire and composite (► Fig. 15.167, ► Fig. 15.168, ► Fig. 15.169, ► Fig. 15.170, ► Fig. 15.171, ► Fig. 15.172, ► Fig. 15.173, ► Fig. 15.174, ► Fig. 15.175, ► Fig. 15.176).



► **Fig. 15.167 Etching of teeth 304 and 404.** Phosphoric acid is applied to both mandibular canines at the level of the intended screw position to etch the area for placement of the composite.



► **Fig. 15.169 Integrating the screw.** In the next part of the procedure, a bonding agent is first applied as a luting agent. Then the screw is placed and attached to the teeth, with the wires guided by the screw. Finally, the solid composite is applied.



► **Fig. 15.168 Etched area on teeth 304 and 404.** After thorough rinsing and drying of the teeth, the chalky etched surface of the canine teeth is visible. At this point, the etched area must remain completely dry for the composite to adhere.

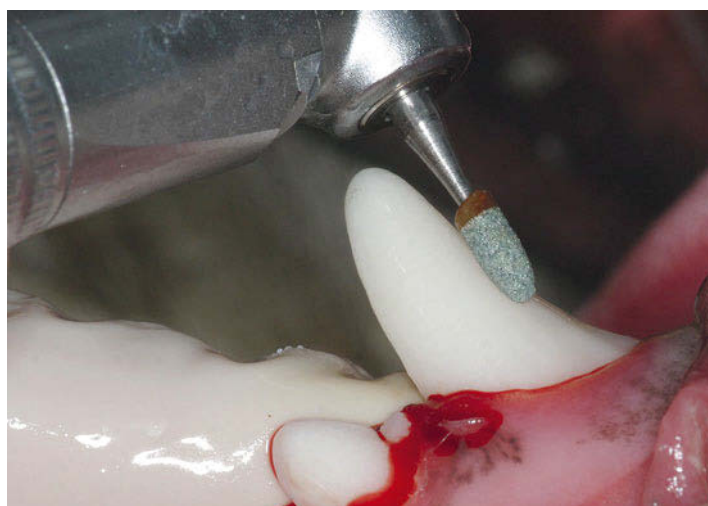


► **Fig. 15.170 Occlusion with screw, right side.** Upon completion of the treatment and sufficient lateralization of the mandibular canine teeth, the following should be noted when attaching the screw with composite. On the one hand, the attachment must be stable enough to prevent detachment of the screw when it is activated. On the other hand, the screw must be small enough that the counterbite does not block lateralization. The screw is activated at variable time intervals based on the size of the dog. It is activated with a wrench that is introduced into the designated hole in the center of the spindle. This is facilitated by placing the screw such that the wrench can be introduced rostrally and rotated one-quarter of a turn toward the pharynx. Afterward, the wrench is simply removed.





► **Fig. 15.171 Occlusion with screw, left side.** The lateralization on the left also meets requirements. The screw is adequately tight and in place.



► **Fig. 15.173 Using a green stone to smooth the tooth.** Residues of the adhesive attachment are removed, and a green stone is used to smooth the surface.



► **Fig. 15.172 Removing the expansion screw with forceps.** Bone rongeur forceps can be used to remove the composite. The cerclage wire can then be loosened and the screw removed.



► **Fig. 15.174 Using a flexible polishing disc to smooth the tooth.** Flexible polishing discs can be used to further smooth the final finishing.

### Extraction of the Maxillary Lateral Incisors for Lateralization of the Mandibular Canine Teeth in a Dog

The “ad hoc solution” for malocclusion of protruding mandibular canine teeth involves extracting the maxillary lateral incisors so that they do not restrict movement of the mandibular canine teeth. A single operation creates space for the lateral development of the mandibular canine teeth (► Fig. 15.177, ► Fig. 15.178, ► Fig. 15.179, ► Fig. 15.180).



► **Fig. 15.175 Final check on the right.** In the final position after orthodontic treatment, the occlusion on the right is unremarkable, despite the fact that the crown of the mandibular canine tooth is just tall enough to touch the alveolar ridge of the maxilla. In animals with malocclusion-induced trauma, impaired growth during eruption often prevents the crown from reaching its maximum height. This is only problematic if the crown is not tall enough to stabilize the tooth in its intended position, risking renewed malalignment.



► **Fig. 15.177 Linguoversion and mesial position of tooth 404.** A mesial position of mandibular canines or skeletal prognathism can cause the mandibular canine teeth to contact the lateral maxillary incisors. This limits the growth of the mandibular canine teeth, and the maxillary lateral incisors often grow labially.



► **Fig. 15.176 Final check on the left.** A functional occlusion has also been achieved on the left. The height of the mandibular canine tooth means there is no danger of malalignment recurring.



► **Fig. 15.178 Linguoversion and mesial position of tooth 304.** The abnormality usually occurs on both sides.



### Distal Occlusion of the Mandibular Canine Teeth in a Dog

In the best case of severe skeletal distocclusion, the mandibular canines occlude distally rather than mesially with the maxillary canine teeth lateral of the maxilla (► Fig. 15.181, ► Fig. 15.182).



► **Fig. 15.179** Condition after extraction of tooth 103. The easiest single treatment is extraction of the maxillary lateral incisors, thereby removing the restriction on the functionally important mandibular canine teeth.



► **Fig. 15.181** Distal occlusion on the right. Combined with a severe skeletal distocclusion, the mandibular right canine tooth occludes distally to the opposing tooth. Occlusion is functional and does not require treatment. If a tooth located so far caudally were linguoverted, this type of distal contact position would be desirable.



► **Fig. 15.180** Condition after extraction of tooth 203. The mere creation of space often causes labial tipping of the mandibular canines. The owner may support the proper growth of the mandibular canine teeth by applying gentle pressure to them in a labial direction.



► **Fig. 15.182** Distal occlusion on the left. While the occlusion is very tight, no mechanical impairment is expected.



### 15.4.2 Rostral and Caudal Crossbite

The mandibular incisors often show increased periodontal damage in dogs with a rostral crossbite. The abnormal mechanical wear on the incisors in reverse occlusion appears to accelerate the progression of periodontal disease. For this reason, if a periodontal process is suspected, the malocclusion should be corrected or the owner should be shown how to brush the teeth with a toothbrush and toothpaste to maintain oral health.

#### Severe Rostral Crossbite with Periodontitis in a Dog

The following images (► Fig. 15.183, ► Fig. 15.184, ► Fig. 15.185, ► Fig. 15.186, ► Fig. 15.187) show the findings and treatment for a dog with ensuing advanced periodontitis.



► **Fig. 15.184 Damaged mandibular incisors.** The malocclusion-induced trauma from the maxillary incisors has severely damaged the mandibular incisors. Necrotic bone parts are seen in the lingual periodontium.



► **Fig. 15.183 Rostral crossbite.** A skeletal mandibular mesiocclusion has led to a reverse scissor bite of the incisors, which causes the maxillary incisors to contact the lingual surface of the mandibular incisors. In addition, a fractured maxillary right canine tooth and periodontal damage are apparent.

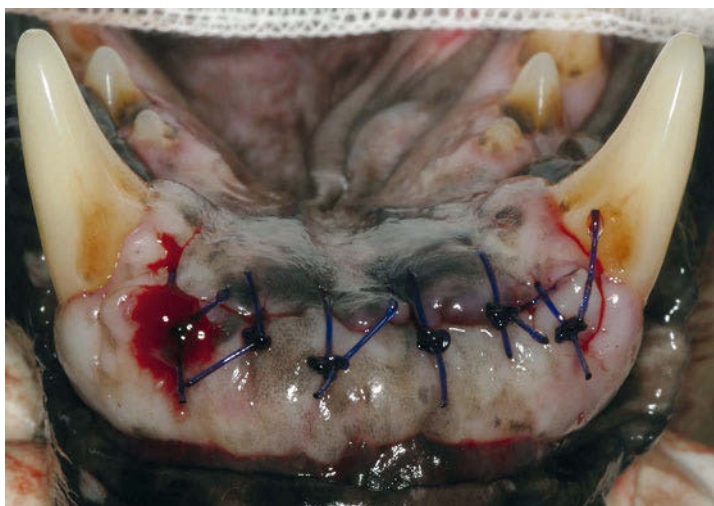


► **Fig. 15.185 Radiograph of the mandibular incisors.** The radiograph shows the full extent of the bony destruction around the incisors. In addition, root resorption areas are apparent, and the radiopacity in the area of tooth 301 (mandibular left central incisor) is a sign of impaction of foreign material.

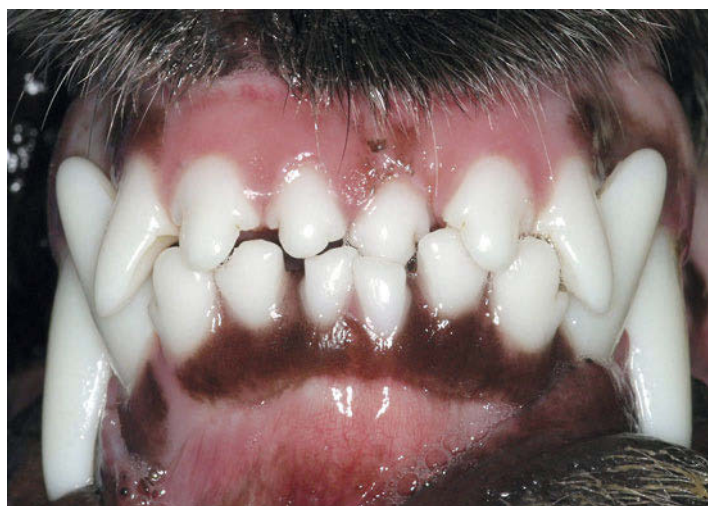


### Moving a Single Tooth in a Dog Using a Screw

In addition to moving whole groups of teeth, a plate appliance with a secure base can serve as an anchor to move an individual tooth, for example, by inserting a small screw or a spring bolt (► Fig. 15.188, ► Fig. 15.189, ► Fig. 15.190, ► Fig. 15.191, ► Fig. 15.192, ► Fig. 15.193).



► **Fig. 15.186 Mandibular front teeth after extraction.** Extraction of the mandibular incisors and osteoplasty have flattened the alveolar ridge of the mandibular front teeth, so the maxillary front teeth can be left as is.



► **Fig. 15.188 Partial crossbite of the front teeth.** The retroclination of the maxillary left central incisor and the labial occlusion and infraocclusion of the mandibular left central incisor have caused a partial crossbite of the front teeth, with a slight vertical overbite.

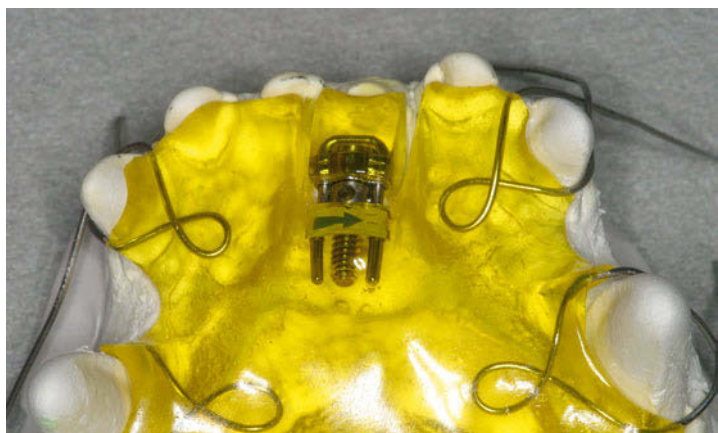


► **Fig. 15.187 Follow-up after 3 months.** A follow-up examination after 3 months shows a normal rostral mandible. The mucosa is intact and shows only small, non-inflamed impressions from the maxillary incisors.



► **Fig. 15.189 Preoperative radiograph of the maxillary incisors.** In the radiograph, the maxillary incisors, including the malpositioned left central one, are unremarkable.

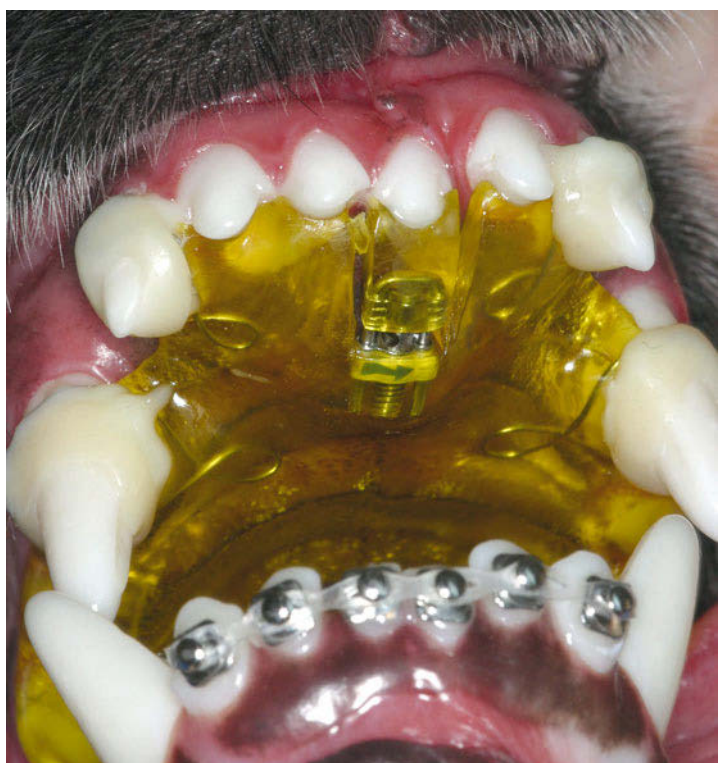




► **Fig. 15.190 Plate appliance on a plaster model after impression of the maxilla.** A small screw integrated in a plastic maxillary plate is suitable for labialization of the retroinclined maxillary incisor.



► **Fig. 15.192 Occlusion of the incisors after correction.** After removal of the plate, occlusion of the incisors is normal. The vertical overbite is now deeper, improving the durability of the achieved occlusion. The mandibular left central incisor is now integrated into the dental arch.



► **Fig. 15.191 Plate appliance in situ.** Since the orthodontic appliance blocks complete closure of the jaw, elastic bands are used to secure the position of the mandibular incisors. In this case, the mandibular incisor that has deviated from the dental arch is shifted back into alignment.



► **Fig. 15.193 Follow-up radiograph after labialization.** The radiograph shows no signs of pathological impairment of the maxillary incisors after treatment.



### Correction of Rostral Crossbite Using Slot Brackets and Wire in a Dog

Instead of moving some of the maxillary front teeth from a palatal to a labial position, metal wires may be placed directly on the labial surface of the incisors in less severe cases of a rostral crossbite (► Fig. 15.194, ► Fig. 15.195, ► Fig. 15.196, ► Fig. 15.197).



► **Fig. 15.194 Rostral crossbite.** This dog has a very tight rostral crossbite. Some of the incisors show an edge-to-edge bite.



► **Fig. 15.196 Buttons and elastics on the mandibular incisors.** An elastic is placed on the mandibular incisors to exert pressure on the dental arch in a lingual direction.



► **Fig. 15.195 Brackets and wire on the maxillary incisors.** Instead of an appliance fabricated in a dental laboratory, a metal wire was placed on the maxillary incisors and attached to slot brackets in a single treatment. The treatment is relatively fragile because only the maxillary lateral incisors serve as an anchor for the movement of the other incisors. The elastic metal wire is formed into a suitable shape and small elastics anchor it in the slots of the brackets attached to the buccal surface of the teeth.



► **Fig. 15.197 Occlusion at the end of therapy.** After removal of the orthodontic appliances, the animal has a normal scissor bite with a distinct vertical overbite. The occlusal interference of the incisors in the rostral crossbite had prevented a complete vertical scissor bite. Lingualization of the incisors eliminated this problem.

### Caudal Crossbite

Caudal crossbites are rare in dogs. Reverse occlusion can occur near the carnassial teeth and the other premolars (► Fig. 15.198). Jumping the bite is generally functionally unnecessary and difficult to achieve given that movement of the teeth would require a block in jaw closure.



► Fig. 15.198 Caudal crossbite in occlusion. This dog has a reverse scissor bite in the right cheek teeth area. The maxillary carnassial tooth is located lingually to the mandibular carnassial tooth, rather than buccally.

### 15.4.3 Mesioverted Canine (Lance Canine)

A mesioverted (or lance) canine is a maxillary canine in which the cusp erupts mesially to that of its opposing tooth. The ensuing occlusal interference often leads to significant mesial inclination and a partially retained crown. The malocclusion promotes the development of recesses that collect debris, accelerating periodontal disease. The malocclusion impairs the function of the canines as well as jaw closure due to the occlusal interference of the opposing tooth. In addition, the mesioverted canine may only partially erupt, causing periodontal pockets of debris to develop around the unerupted crown. Shetland Sheepdogs are predisposed to mesioverted canines. The origin of the defect is hereditary in this breed, although developmental alterations can also contribute to this condition.

### Mesioverted Canine 204 in a Dog

In addition to mesial inclination of the maxillary canine, the occlusal interference with the opposing canine often causes partial retention because the tooth is unable to develop in the oral cavity. Orthodontic treatment can eliminate these problems (► Fig. 15.199, ► Fig. 15.200, ► Fig. 15.201, ► Fig. 15.202, ► Fig. 15.203, ► Fig. 15.204, ► Fig. 15.205, ► Fig. 15.206, ► Fig. 15.207, ► Fig. 15.208, ► Fig. 15.209). Alternatively, the tooth may be extracted.

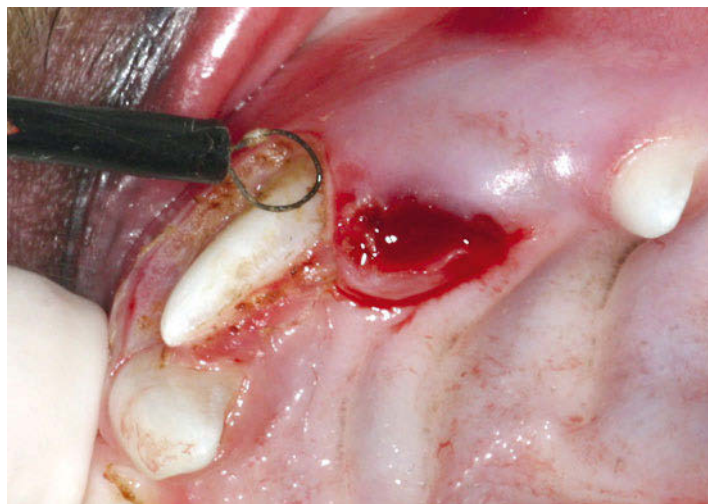


► Fig. 15.199 Mesioverted maxillary left canine tooth in occlusion. The cusp of the maxillary left canine tooth erupts through the gingiva mesially to the mandibular canine tooth, and occlusal interference of the mandibular opposing tooth prevents it from moving forward into the oral cavity. The deciduous maxillary left canine persists because the mesial development of the permanent successor prevents normal root resorption. A mesially inclined maxillary canine tooth is referred to as a mesioverted (lance) canine and is particularly prevalent in Shetland Sheepdogs.





► **Fig. 15.200 Mesioverted maxillary left canine tooth with a persistent deciduous tooth 604.** A large space exists between the permanent and deciduous maxillary canine teeth. The cusp of the mandibular canine tooth contacts the distal surface of the cusp of the maxillary canine tooth.



► **Fig. 15.202 Gingivoplasty of tooth 204.** The deciduous tooth is extracted to create space for distal development of the still retained maxillary canine tooth. To make room for a bracket, electrosurgery is used to expose the crown. There is no buccal bone cover.



► **Fig. 15.201 Radiograph of teeth 504 and 204.** The intraoral radiograph shows the mesial inclination of the permanent canine tooth. The root of the deciduous canine tooth does not show any resorption.



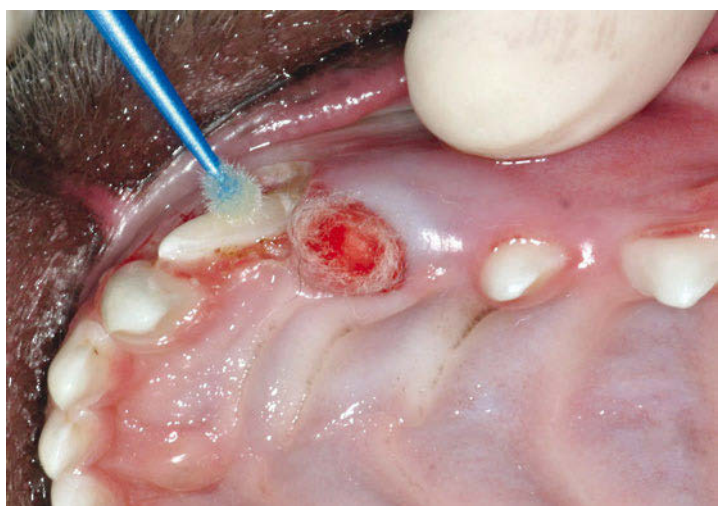
► **Fig. 15.203 Radiograph after extraction of tooth 604.** A radiograph is taken to examine the maxillary canine tooth after the extraction of its deciduous precursor.



► **Fig. 15.204 Etching.** The buccal crown surface is etched to permit attachment of an orthodontic button. The carnassial tooth and first molar serve as anchor teeth.



► **Fig. 15.206 Attaching the orthodontic button.** Adhesive composite is applied to the button, and the button is placed on the tooth with a bracket tweezer.



► **Fig. 15.205 Bonding agent.** A disposable brush is used to apply the bonding agent, which acts as a luting agent between the tooth and the composite. A cotton pellet prevents bleeding from the post-extraction alveolus of the deciduous tooth.



► **Fig. 15.207 Hooking on the elastic.** After the composite base of the button has hardened, an elastic is hooked onto the button to exert distal tension on the tooth. If necessary, the elastic can be hooked on again after it has been removed or the elastic can be replaced in order to ensure proper function during the treatment period. A spring balance shows the amount of force needed, and the required elastic length is recorded.





► **Fig. 15.208 Post-treatment occlusion.** After the completion of treatment, the tooth has erupted distally into its intended position and increased in height in the oral cavity. The occlusal interference with the mandibular canine tooth has been eliminated. The mesial inclination of the maxillary canine tooth is still observed in the corrected position but will not significantly hinder further function.

### Mesioverted Canine (Lance Canine) 104 with Bite Block in a Dog

As in the case of distalization of deeply occluded incisors in a dog with a rostral crossbite (p.211), blocking jaw closure can also be helpful for distalization of a mesioverted maxillary canine (► Fig. 15.210, ► Fig. 15.211, ► Fig. 15.212, ► Fig. 15.213, ► Fig. 15.214, ► Fig. 15.215). This can prevent outward movement of the mandibular canine that might otherwise occur when returning the maxillary canine to its normal position.



► **Fig. 15.209 Radiograph of tooth 204 after removal of the orthodontic appliances.** The radiograph shows the distal development of the tooth. Apically, dilaceration has resulted from the distal development; however, it does not impair further tooth development. The wall thickness of the tooth and its root tip development indicate the preserved vitality of the tooth.



► **Fig. 15.210 Mesioverted canine 104.** The maxillary right canine tooth erupts far mesially to its normal position, and its distal surface contacts the mandibular canine tooth, which is in turn labially inclined. As a result of the mesial inclination, the interdental gap to the lateral upper incisor is too small. The contamination recess created is filled with debris.



► **Fig. 15.211 Pre-treatment radiograph of the mesioverted canine tooth 104.** The radiograph shows the mesial inclination of the mesioverted canine and the narrowing of the interdental space toward the lateral incisor.



► **Fig. 15.212 Orthodontic buttons, elastic, and bite block.** Orthodontic buttons and an elastic chain are used to activate the mesioverted canine in a distal direction, with the elastic chain placed over the tooth and attached between the button and the plastic wall to improve alignment. A bite block is placed on the palatal side of the incisors to prevent the mandibular canine tooth from blocking the distal movement of the maxillary canine tooth.



► **Fig. 15.213 Post-treatment occlusion of tooth 104.** The distalization of the maxillary canine tooth has widened the interdental space to the lateral incisor and provoked a physiological lateral movement of the mandibular canine tooth. After the bite block is removed, complete jaw closure is often temporarily prevented by small adjustments of the cheek teeth. The jaw closure normalizes in the following weeks.



► **Fig. 15.214 Follow-up radiograph of tooth 104 after removal of the orthodontic appliances.** The interdental space is easy to see in the radiograph. The maxillary canine is still very straight, and root development is otherwise unremarkable.





► **Fig. 15.215 Follow-up examination of occlusion after 3 months.** After 3 months, jaw closure is more distinct. The vertical occlusion of the incisors is improved, and the cusps have moved closer to the opposite alveolar ridge.



► **Fig. 15.217 Double tooth 204 in a cat.** On the left side, there is a double maxillary canine tooth with distinct mesial inclination of the tooth located distally.

### **Bilateral Mesioverted Canine Teeth with a Double Tooth 204 in a Cat**

A double maxillary canine tooth can cause mesioversion of one of the teeth (► Fig. 15.216, ► Fig. 15.217, ► Fig. 15.218, ► Fig. 15.219, ► Fig. 15.220),



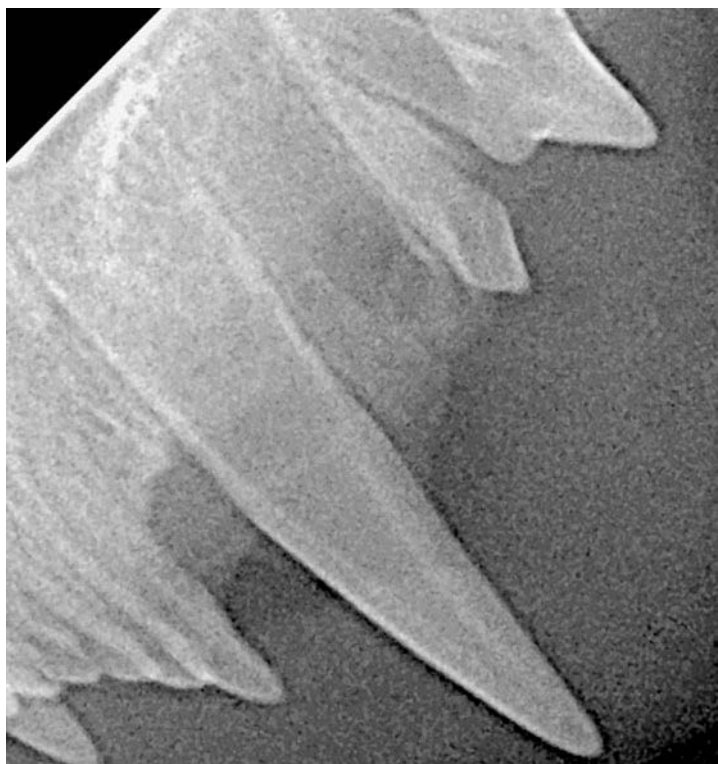
► **Fig. 15.216 Mesioverted tooth 104 in a cat.** This cat has bilateral abnormal canine teeth. The maxillary right canine tooth is inclined mesially and lingually.



► **Fig. 15.218 Rostral view of mesioverted canines.** Here too, jaw closure is impaired by the mesioverted maxillary right canine tooth.



► **Fig. 15.219 Radiograph of double tooth 204.** The radiograph shows a very tightly developed double tooth. The distal tooth is narrower.



► **Fig. 15.220 Radiograph of tooth 204 after extraction of the double tooth.** Like the double tooth on the right, the distal double tooth on the left was extracted to enable normal jaw closure.

## 15.5

### Abrasions in a Young Animal

Abrasion refers to wear on the dental crown due to abnormal use of the tooth on an object. In abrasion of deciduous teeth, the primary concern is proper development of the permanent successor teeth. If abrasion of the crown leads to pulpitis, the development of the successor teeth may be impaired, so the affected teeth should be extracted.

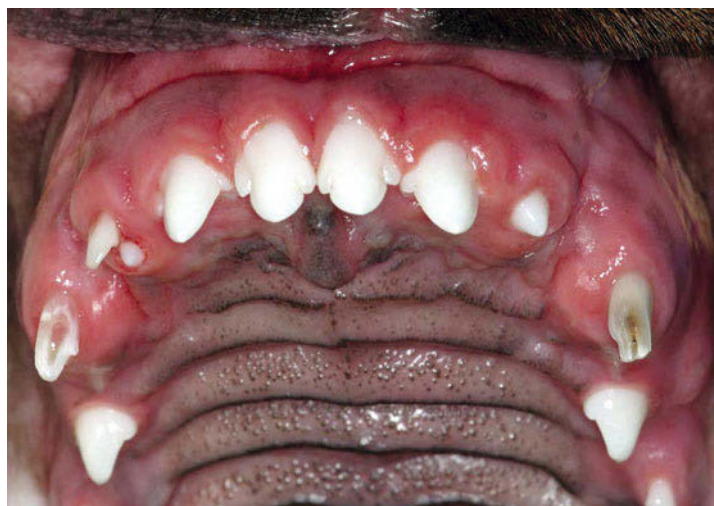
## 15.6

### Tooth Fractures in Young Animals

Tooth fractures are a significant problem in young animals. If a deciduous tooth is fractured, the development of the permanent successor tooth may be disturbed. If an immature permanent tooth is affected by the fracture of a deciduous tooth it cannot be preserved by conventional root canal therapy because it lacks a root tip.

#### 15.6.1 Fractured Teeth 504 and 604.

When a deciduous tooth fractures, the development of the permanent successor tooth is likely to be disturbed. Therefore, the fractured tooth should be extracted (► Fig. 15.221, ► Fig. 15.222, ► Fig. 15.223, ► Fig. 15.224, ► Fig. 15.225).

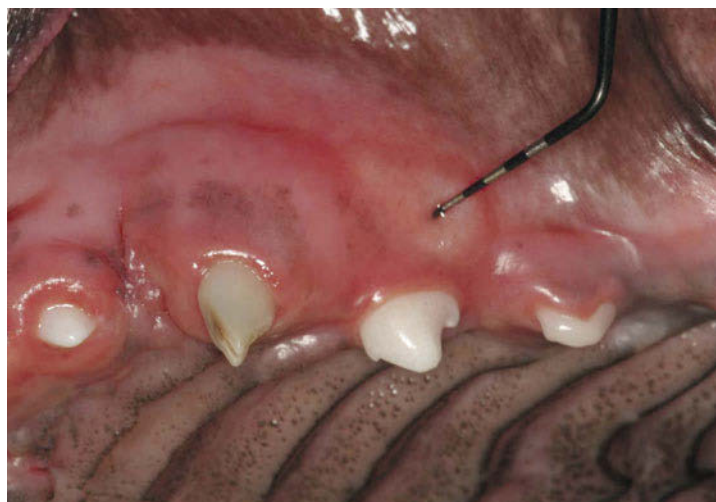


► **Fig. 15.221 Fractured teeth 504 and 604.** This dog has mixed dentition with bilateral fractured deciduous maxillary canines. The fractures have resulted in pulp exposure. Tooth 504 shows still reddish pulp while tooth 604 appears to be nearly completely nonvital.





► **Fig. 15.222 Fractured tooth 604, lateral view.** The lateral view of the deciduous maxillary left canine tooth shows dark discoloration of the remaining crown. A small raised spot appears above the erupted permanent first premolars.



► **Fig. 15.223 Fistula over the root of tooth 604.** A periodontal probe can be introduced into the raised spot, which is actually a fistula opening.



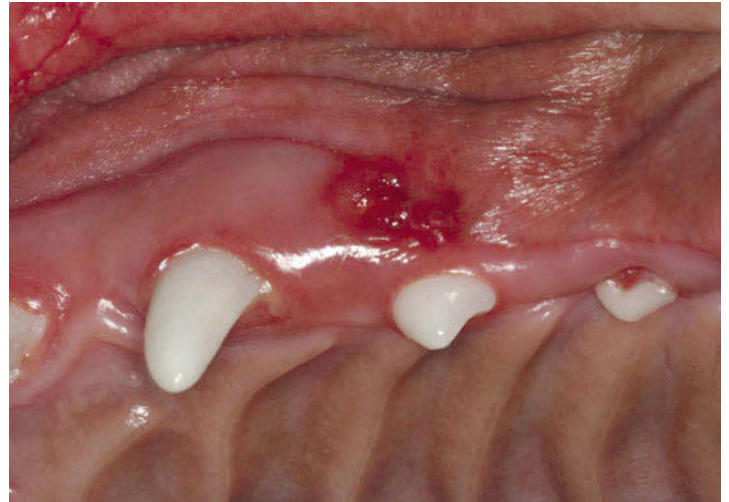
► **Fig. 15.224 Radiograph of tooth 604.** The radiograph shows osteolysis around the root tip of the fractured deciduous tooth. The permanent tooth germ is unremarkable in the radiograph. The deciduous root shows peripheral resorption mesially through the advancing permanent tooth. The inflammatory process at the root tip is producing an exudate that drains along the path of least resistance, creating a fistulous tract in the surrounding gingiva.



► **Fig. 15.225 Radiograph after extraction of tooth 604.** The postoperative radiograph confirms the complete extraction of the deciduous tooth. When the permanent teeth erupt, their crowns should be examined for damage caused by the fractured deciduous tooth.

### 15.6.2 Fractured Tooth 504

If a fractured tooth goes untreated, both the deciduous and permanent teeth will develop apical inflammation to different extents. This inflammation will remain invisible as it continues to develop within the bone. The problems will not become evident until swelling or a fistula develops (► Fig. 15.226, ► Fig. 15.227, ► Fig. 15.228, ► Fig. 15.229, ► Fig. 15.230).



► **Fig. 15.226 Fistula over the root of tooth 204.** The gingiva is inflamed over the left first premolar.

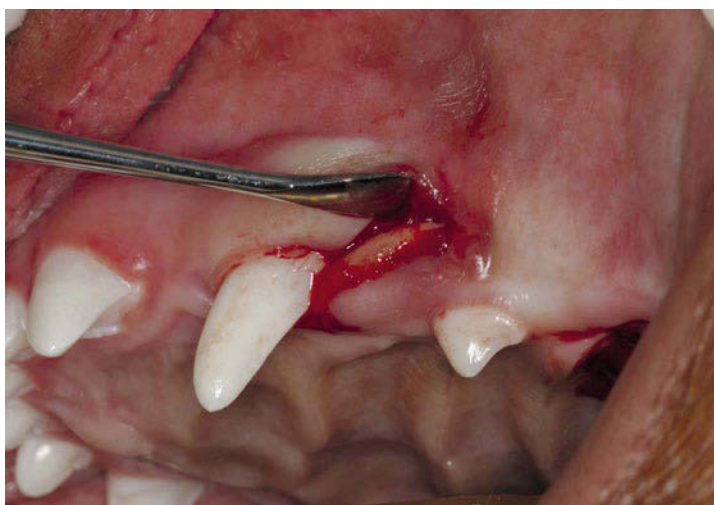


► **Fig. 15.227 Drying of the fistula opening.** After the fistula is dried, the gingival defect is apparent and a retained deciduous root tip can be directly observed. The bony cover of the root that is usually present can no longer be seen.

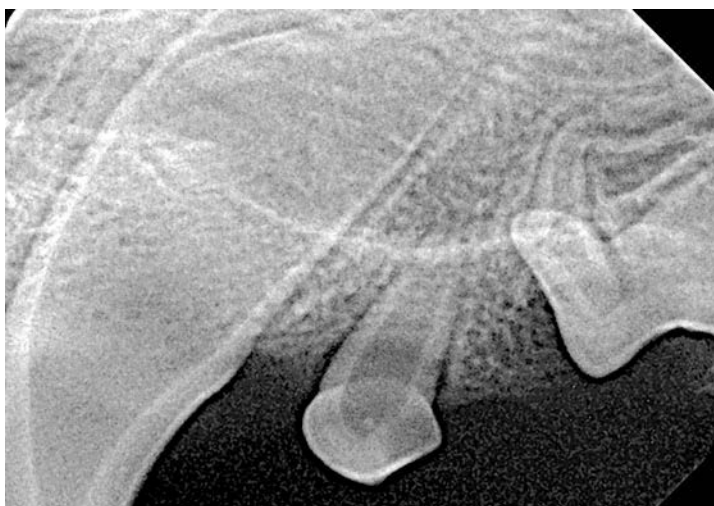




► **Fig. 15.228** Radiograph of the root fragment of tooth 604. The radiograph shows the deciduous root causing the inflammation.



► **Fig. 15.229** Extraction of the root fragment of tooth 604. Due to the pronounced osteolysis around the deciduous root, the root can be extracted after a gingival approach without an osteotomy.



► **Fig. 15.230** Radiograph after retrieving the root fragment of tooth 604. A radiograph is taken to verify that extraction is complete. The small mucosal flap should be closed. The fistulous tract does not need to be resected separately.

## 15.7

### Persistent Deciduous Teeth

Persistent deciduous teeth are a common problem in small breeds in which the deciduous precursors remain far beyond the normal period of mixed dentition. Mixed dentition usually occurs from the third to the sixth month. Due to the often slightly delayed eruption of the permanent teeth in small breeds, mixed dentition until the seventh or even eighth month is acceptable. However, if tooth or jaw misalignments are present or anticipated or if inflammatory changes are present, immediate action – extraction of the deciduous teeth – is imperative.

#### 15.7.1 Persistent Deciduous Teeth

The following images (► Fig. 15.231, ► Fig. 15.232, ► Fig. 15.233, ► Fig. 15.234, ► Fig. 15.235, ► Fig. 15.236, ► Fig. 15.237, ► Fig. 15.238, ► Fig. 15.239, ► Fig. 15.240, ► Fig. 15.241) present clinical and radiographic findings of a dog with persistent deciduous teeth.



► **Fig. 15.231** Persistent deciduous teeth, right maxilla. In a 6-month-old Miniature Pinscher, all of the deciduous teeth had to be extracted due to a severe skeletal underbite in order to prevent further deterioration of the tooth position during eruption of the permanent teeth.





► Fig. 15.232 Persistent deciduous teeth, left maxilla.



► Fig. 15.235 Radiograph of the persistent deciduous cheek teeth in the right maxilla.



► Fig. 15.233 Persistent deciduous teeth, left mandible.



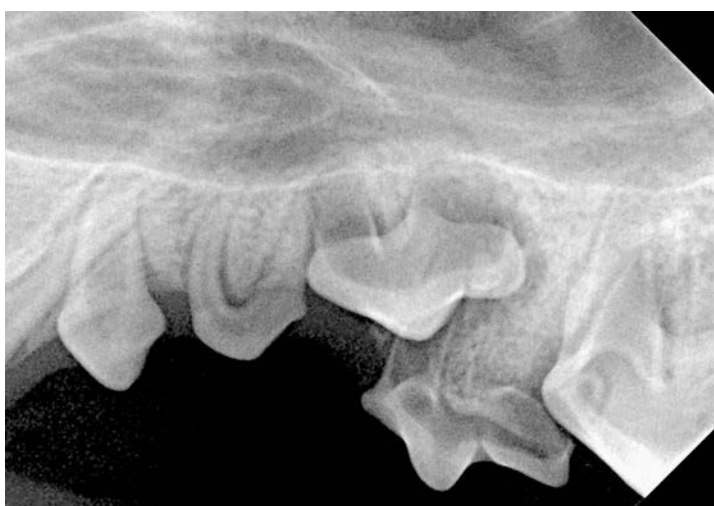
► Fig. 15.234 Persistent deciduous teeth, right mandible.

► Fig. 15.236 Radiograph of the persistent deciduous maxillary right canine tooth.





► Fig. 15.237 Radiograph of the persistent deciduous left maxillary canine tooth.



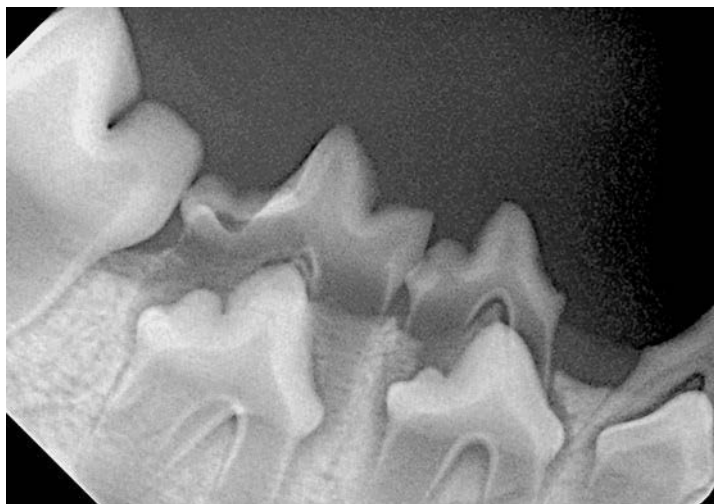
► Fig. 15.238 Radiograph of the persistent deciduous cheek teeth in the left maxilla.



► Fig. 15.239 Radiograph of the persistent deciduous cheek teeth in the left mandible.



► Fig. 15.240 Radiograph of the persistent deciduous mandibular canine teeth.



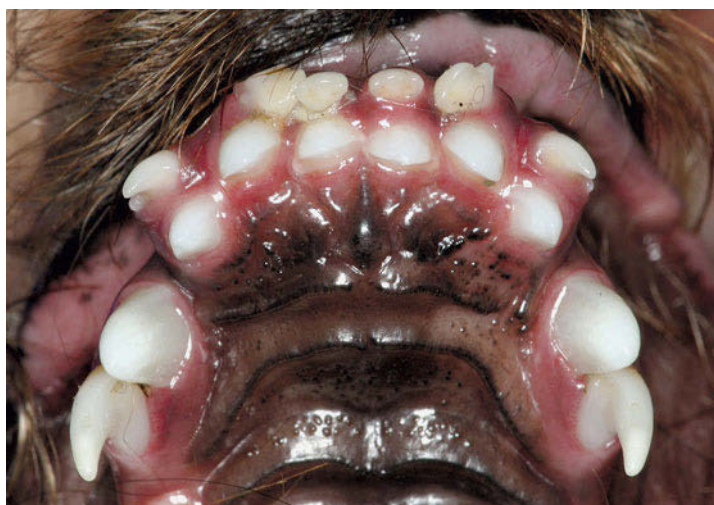
► **Fig. 15.241** Radiograph of the persistent deciduous cheek teeth in the right mandible.



► **Fig. 15.243** Shark teeth, mandible. In the mandible, the permanent teeth also erupt on a narrower lingual arch, while the deciduous teeth erupt on a wider labial arch. Depending on the dog's size, a physiological row of permanent teeth is prevented from developing, and individual teeth may be forced labially. During extraction of the deciduous teeth, the permanent teeth must be recognized and left in place.

### 15.7.2 Shark Teeth in a Small Dog

Small dogs are prone to develop two parallel rows of teeth. The transition from deciduous to permanent teeth is often impaired. Due to the generally slow development, treatment can often be performed somewhat later. However, if there is a risk that the permanent teeth will be malpositioned, action must be taken immediately (► Fig. 15.242, ► Fig. 15.243, ► Fig. 15.244, ► Fig. 15.245, ► Fig. 15.246, ► Fig. 15.247, ► Fig. 15.248).



► **Fig. 15.242** Shark teeth, maxilla. The persistence of multiple deciduous teeth in a small dog is referred to as "shark teeth". Most of the deciduous teeth are not resorbed and remain intact in front of the permanent incisors. They are smaller, and often show traces of wear and deposits of plaque and calculus.

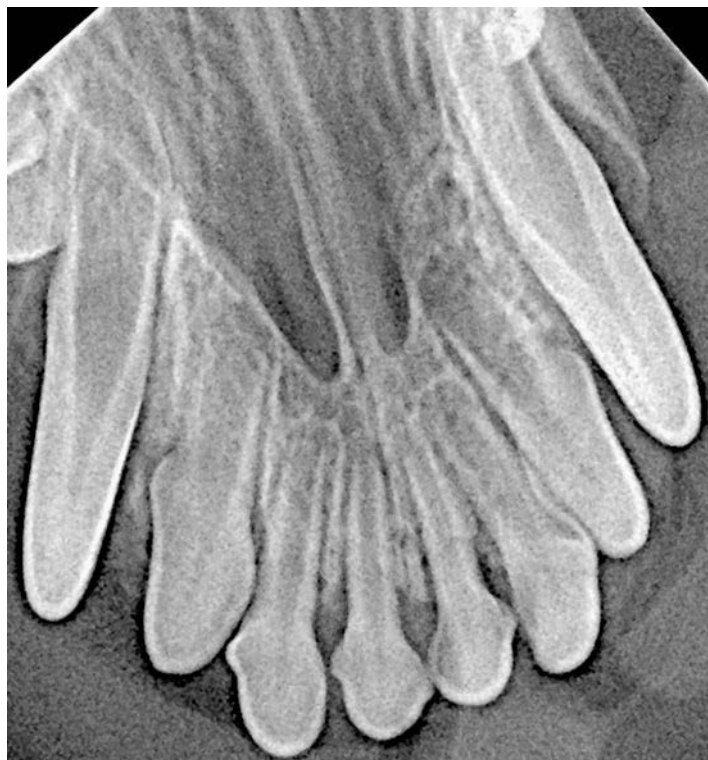


► **Fig. 15.244** Radiograph of tooth 504. The radiograph shows no root resorption in the deciduous maxillary right canine or the deciduous lateral incisor.





► **Fig. 15.245 Radiograph of tooth 604.** The radiograph of the left deciduous maxillary canine is similar.



► **Fig. 15.247 Radiograph of the maxillary front teeth after extraction.** After extraction of all deciduous teeth a radiograph is taken to confirm that the permanent teeth are undamaged.



► **Fig. 15.246 Radiograph of teeth 704 and 804.** The roots of the deciduous mandibular canines are also not affected by the eruption of the permanent successor teeth. The roots are completely preserved.



► **Fig. 15.248 Radiograph of the mandibular front teeth after extraction.** After extraction of the deciduous mandibular canines, space is created for lateralization of the permanent canines.

## Cleft Palate

A disturbance during fetal development leads to incomplete morphogenesis that affects the lips, jaws and/or palate in various combinations. The condition can be hereditary or result from exogenous factors such as infection or metabolic disorders of the mother. While cleft palate can occur solely in the soft tissue around the lips, the jaw bone is usually involved as well. Due to the failure of development and orientation of the maxillary bones, an opening remains, usually in the medial area. The defect may range from a small gap to complete separation of the hard and soft palate. Aspiration of objects such as food may cause infection in the respiratory tract, which can lead to early death of the animal. If the puppies can be fed to an age at which surgical intervention is possible (around 3 months), surgical closure of the soft tissue of the defect may be attempted.

### 15.8.1 Complete Cleft Palate in a Dog

A cleft palate extending from the beginning of the hard palate to the end of the soft palate is problematic. The wide connection between the oral and nasal cavity quickly leads to impaction, including of larger foreign bodies, so closure should be attempted promptly (► Fig. 15.249, ► Fig. 15.250, ► Fig. 15.251, ► Fig. 15.252, ► Fig. 15.253, ► Fig. 15.254, ► Fig. 15.255, ► Fig. 15.256, ► Fig. 15.257, ► Fig. 15.258). In some cases, however, a compromise between age, the size of the animal, and the incidence of infection must be found.



► Fig. 15.249 Complete cleft palate in a 14-week-old dog. This 14-week-old dog is presented with severe difficulties with eating and breathing and ongoing recurring infection. The soft and hard palates are completely separated and a wide passage to the nasal cavity exists in the medial palate. Through this opening, foreign bodies such as food remnants are repeatedly impacted.

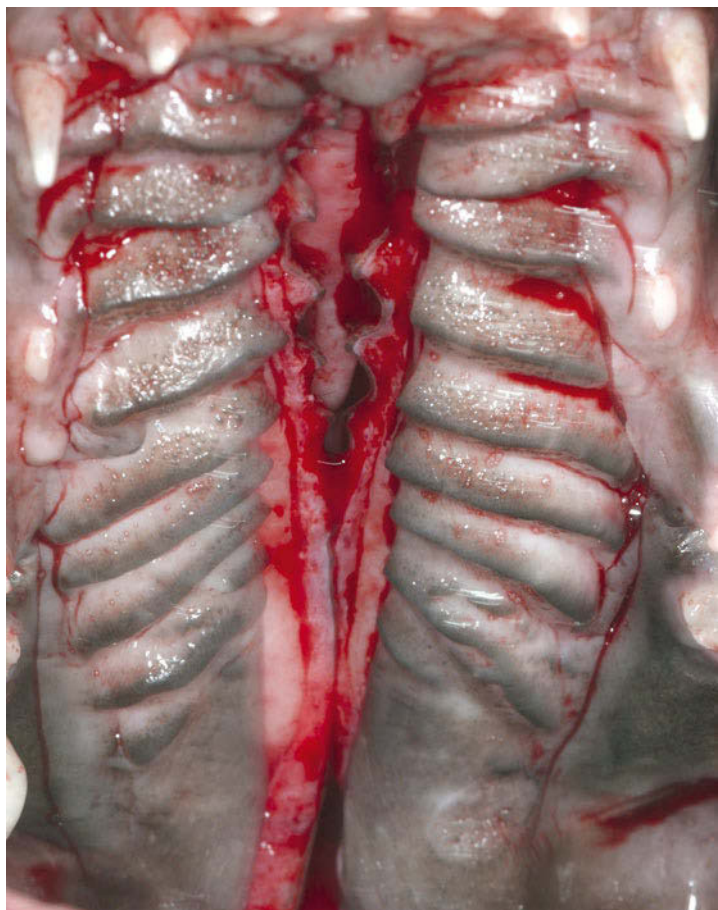




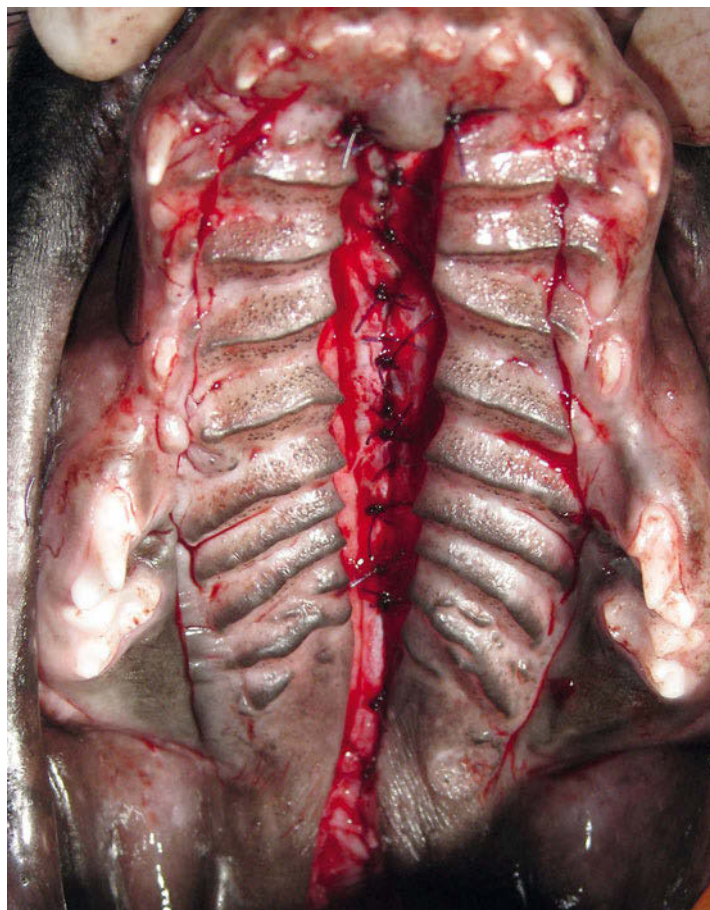
► **Fig. 15.250 Foreign body in cleft palate.** A small stick was removed from the cleft palate.



► **Fig. 15.251 Additional foreign bodies in the nasal cavity.** After curettage, the accumulation of foreign material is apparent.

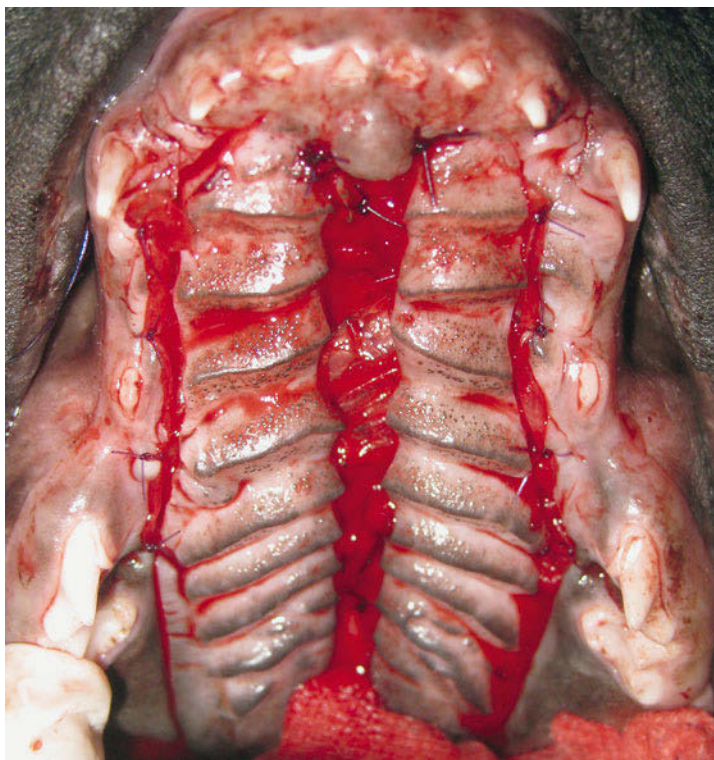


► **Fig. 15.252 Incisions for dissection of mucosal flaps.** In the area of the palatal defect, the tissue is subdivided into a nasal and a palatal layer. Laterally, an incision is performed on each side parallel to the dental arch (cf. also ► Fig. 15.260, ► Fig. 15.261).



► **Fig. 15.253 Closure of the nasal mucosa.** The two sides of the nasal mucosa are the first layer to be sutured.

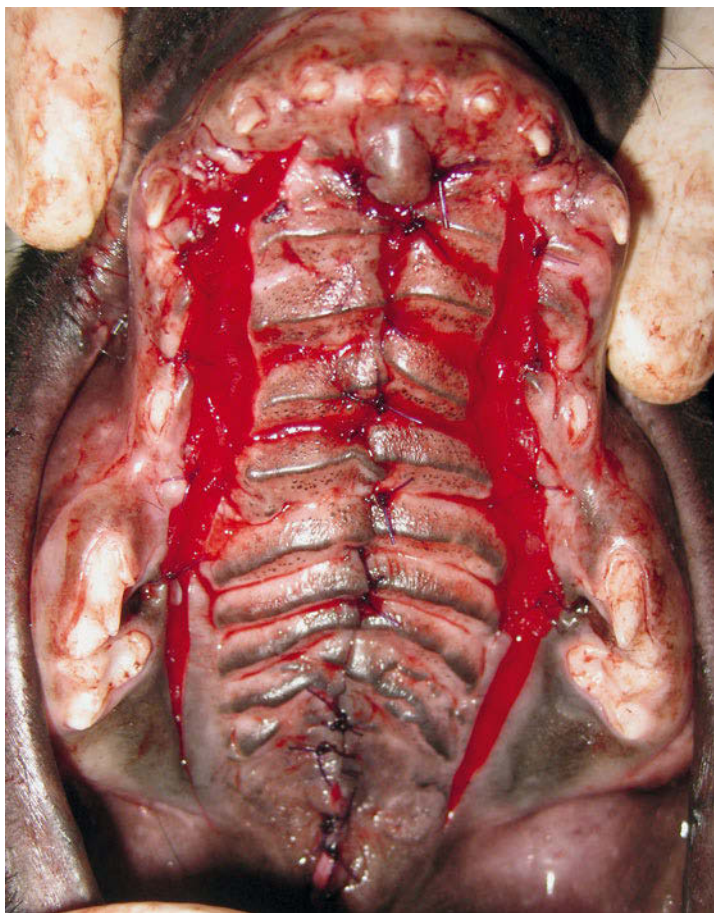




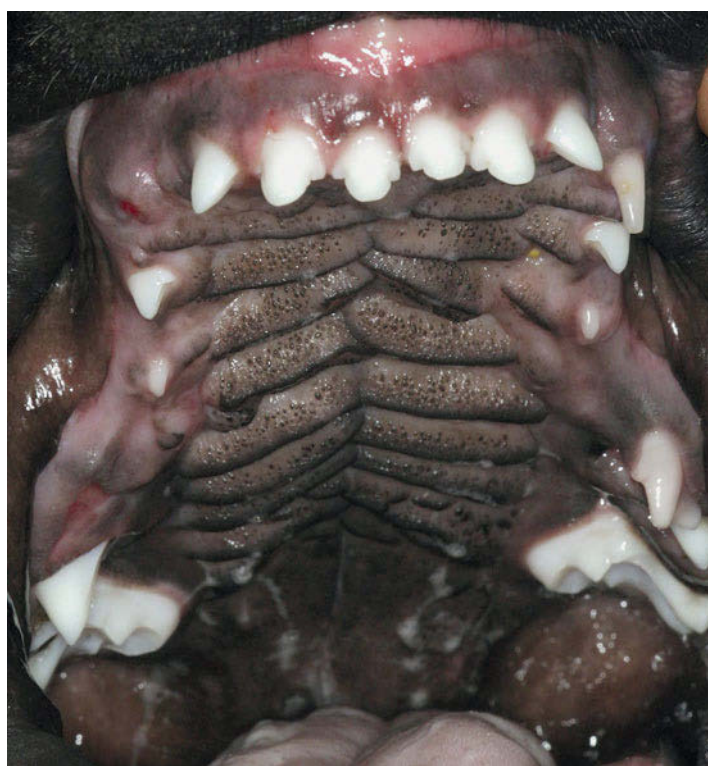
► **Fig. 15.254 Membrane.** As the second layer, a resorbable membrane is placed below the mobilized bipedicle flaps and sutured laterally close to the teeth.



► **Fig. 15.256 Follow-up after 2 weeks.** The 2 week follow-up shows intact sutures, and the tissue around the residual sutures is noninflamed. The lateral areas covered by the membrane are already nearly completely healed.



► **Fig. 15.255 Closure of the palatal mucosa.** For the third layer, the bipedicle flaps that have been mobilized in a medial direction are sutured at the midline. The soft palate is closed in two layers without a membrane (see also ► Fig. 15.262).

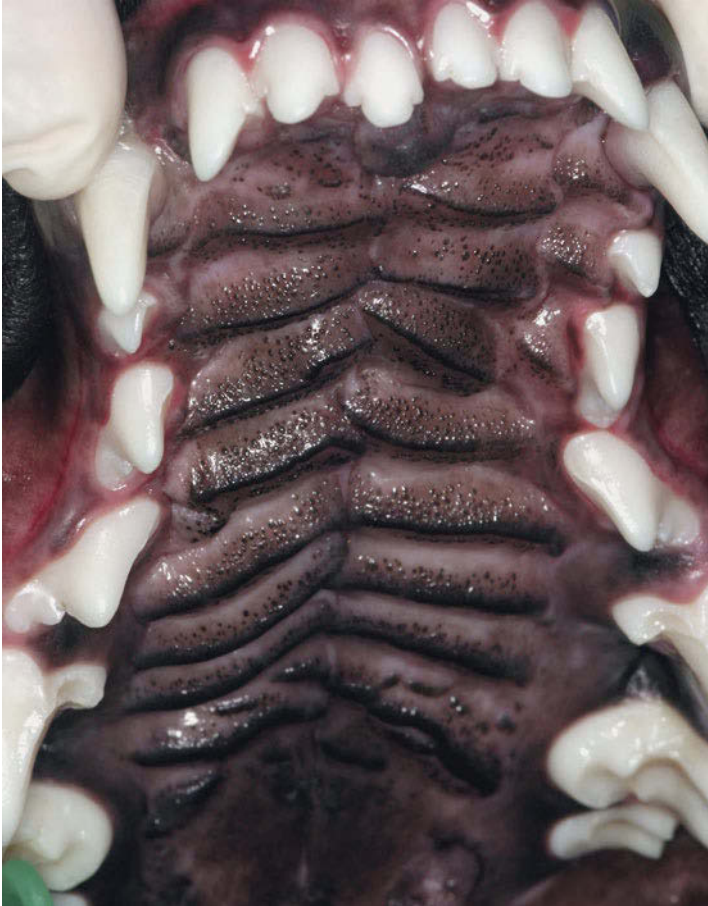


► **Fig. 15.257 Follow-up after 2 months.** After 2 months, no residual sutures can be detected and the palate is fully closed. Sneezing and aspiration of food are no longer observed. Eating is unremarkable.

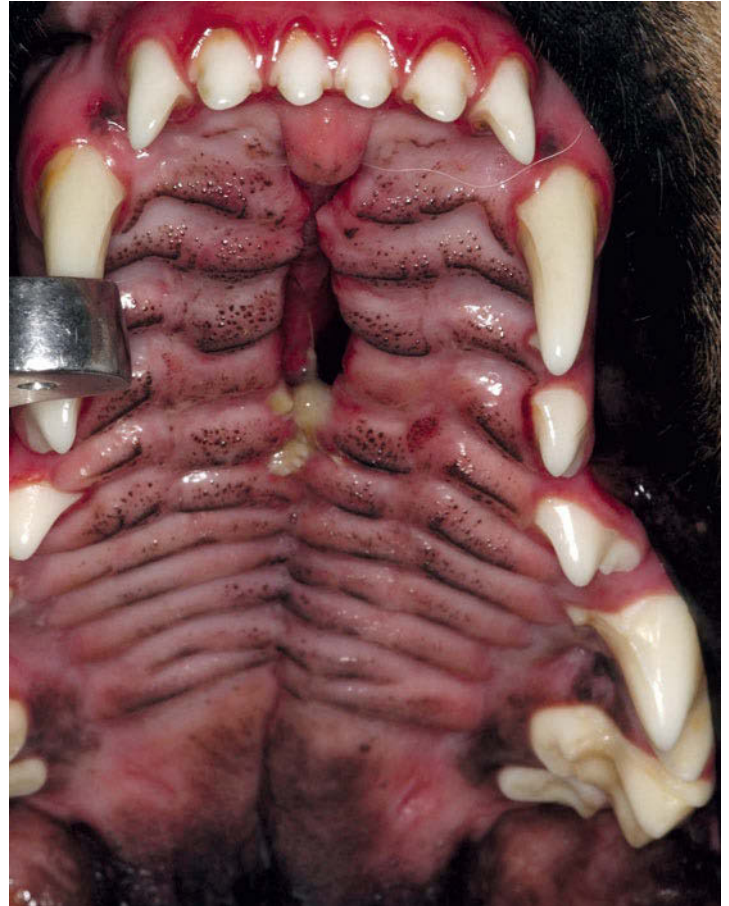


### 15.8.2 Complete Cleft Palate Closure in a Dog, Two-stage Procedure

Depending on the case, a two-stage procedure can significantly improve the prognosis of cleft palate closure. This was true for the following case, in which different procedures were used to close the hard and soft palate (► Fig. 15.259, ► Fig. 15.260, ► Fig. 15.261, ► Fig. 15.262, ► Fig. 15.263, ► Fig. 15.264, ► Fig. 15.265, ► Fig. 15.266, ► Fig. 15.267, ► Fig. 15.268, ► Fig. 15.269, ► Fig. 15.270, ► Fig. 15.271, ► Fig. 15.272, ► Fig. 15.273, ► Fig. 15.274).

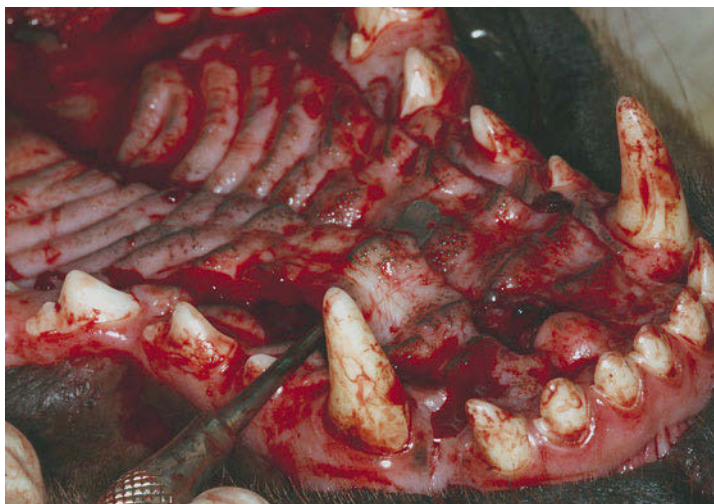


► **Fig. 15.258 Follow-up after 4 months.** After 4 months, the palate is completely unremarkable and the dog's general condition is significantly improved.

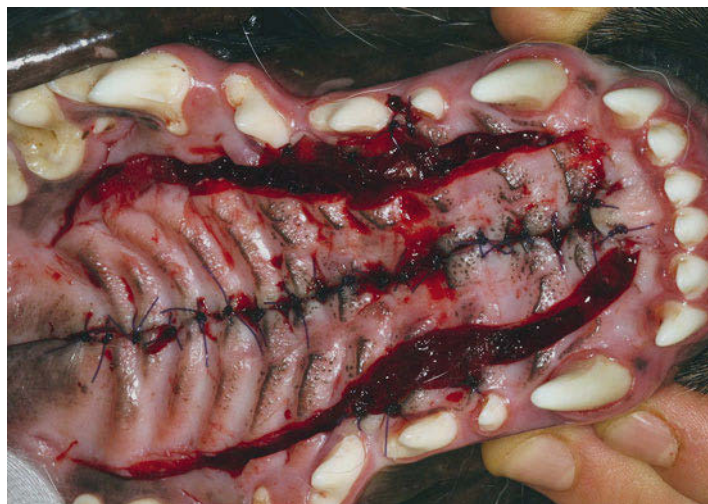


► **Fig. 15.259 Complete cleft palate.** This male Labrador was presented at 4.5 months of age with eating difficulties due to a cleft palate. Contrary to the clinical appearance, the dog had a complete continuous medial gap in the hard and soft palate.

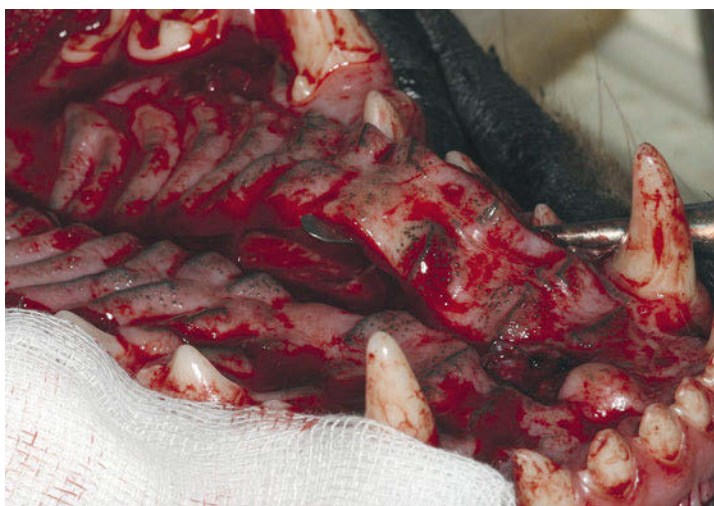




► **Fig. 15.260 Dissecting the mucosal flaps on the left palate.** The bipedicle flaps remain attached to the palatal mucosa rostrally and caudally and are fully undermined. At the cleft palate itself a palatal and a nasal mucosal flap are created. When dissecting this area, the palatal artery which supplies blood to the area must be preserved to prevent necrosis of the mucosal flap.



► **Fig. 15.262 Cleft palate covered with membrane and mucosa.** The nasal mucosal flap is closed, the resorbable membrane is placed, and the palatal mucosal flap is closed, protecting the defect in three layers. The exposed lateral bone areas are covered by fixation of the membrane along the dental arch. Initially, the soft palate is not closed because the gap is large and a better dissection technique can be used in the next step.



► **Fig. 15.261 Dissecting the mucosal flaps on the right palate.** The two sides of the mucosal flaps must be completely lifted and movable before the gap can be closed.

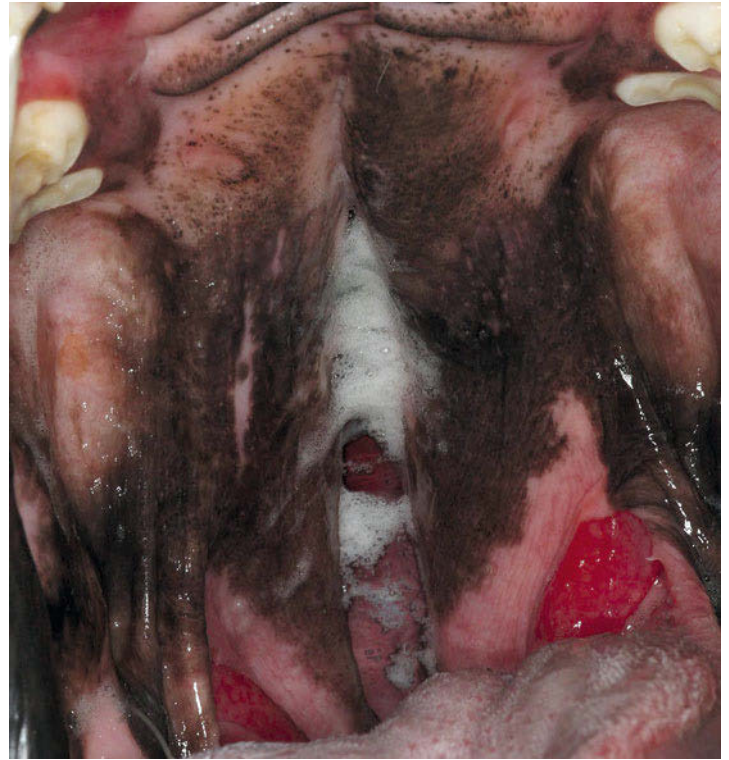


► **Fig. 15.263 Healing of the hard palate 4 weeks after the first closure.** After 4 weeks, the palatal mucosa is healing well. The medial gap is mostly closed. A small defect has remained caudal to the incisive papilla and detritus is visible in the recess. The slight accumulation of plaque near the former median suture is superficial, and there is no opening to the nasal cavity.

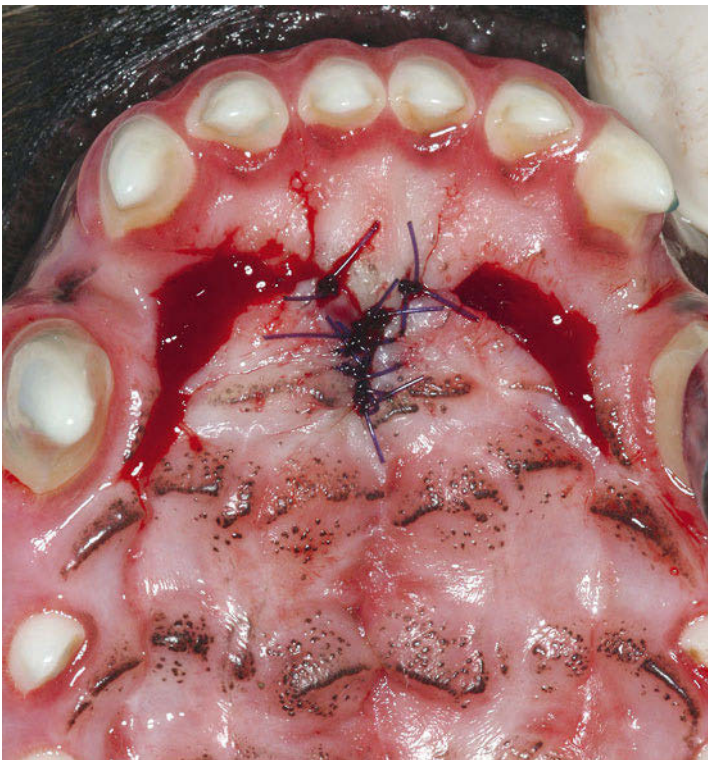




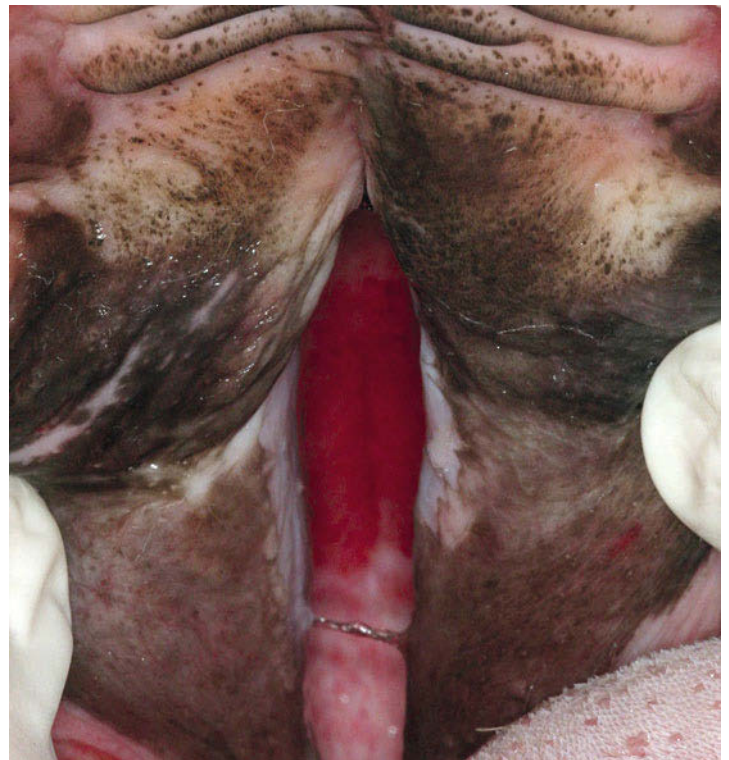
► **Fig. 15.264 Defect near the incisive papilla.** After cleaning the mucosa, the defect caudal to the incisive papilla is much easier to see. Due to the rostrally advanced bipedicle flaps, this is not unusual postoperatively.



► **Fig. 15.266 Cleft soft palate.** Depending on the soft palate position during breathing or swallowing, a soft cleft palate may be more or less visible. Mucous congestion is typical, because the tongue's piston motion presses saliva and food into the nasal cavity during swallowing.

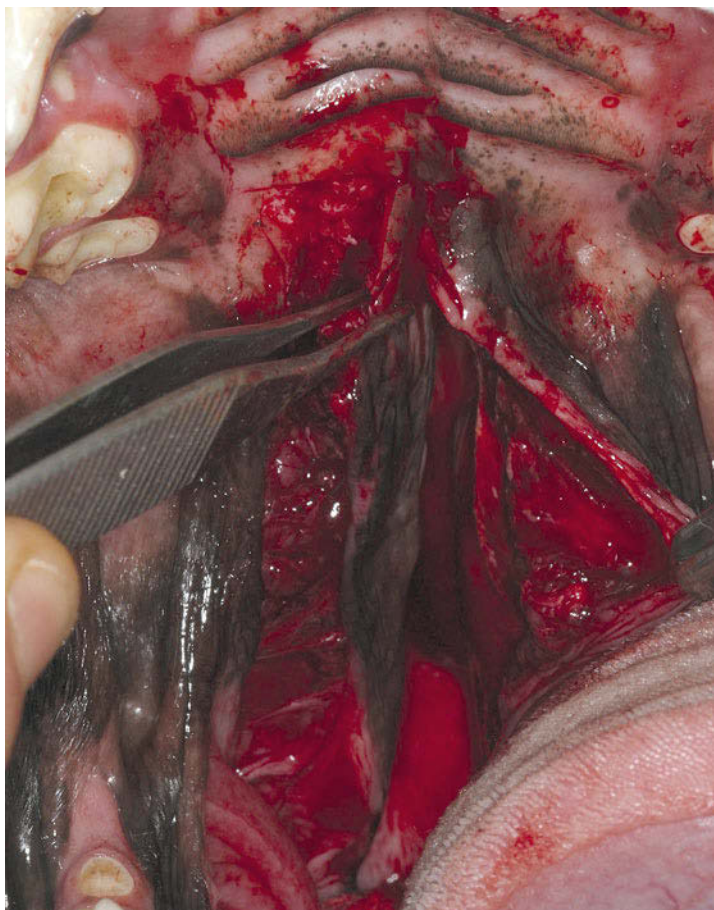


► **Fig. 15.265 Closure after placement of rotational flaps at the incisive papilla.** The gap can be closed rostrally in a second operation using two rotational flaps, since no rostral attachment such as a bipedicle flap is required. This enables the flaps to be adapted with much less tension, which is conducive to the healing process.

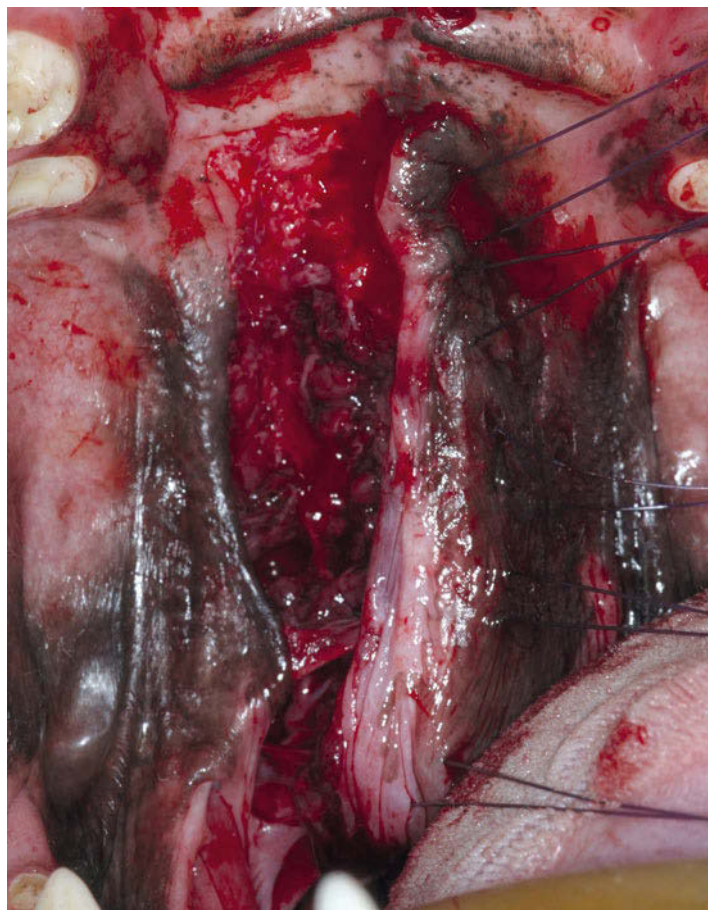


► **Fig. 15.267 Cleaned and retracted cleft soft palate.** After the pharynx is cleaned, the extent of the cleft palate is visible. The reddish background is the roof of the pharynx.





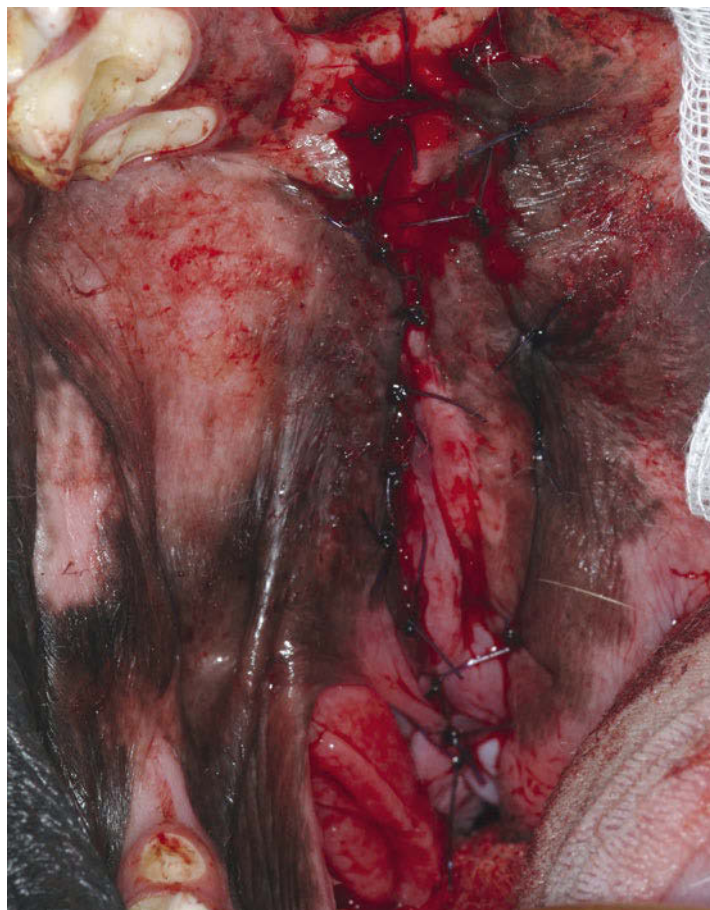
► **Fig. 15.268 Dissecting the soft palate.** The soft palate is dissected in a different way to allow the suture of two layers of mucosa over a wide area. The posterior wall of the left part is folded over and spread apart, transforming it into the anterior wall of the closure. The anterior wall of the right part is folded over caudally, turning it into the wide posterior wall of the closure. The wound closure areas lie offset from each other. This prevents medial suturing of two mucosal margins. The fresh undersides of the mucosa lie on top of each other, which is more conducive to healing under reduced tension.



► **Fig. 15.269 Placing the suture material for the suture on the left.** Placing the suture material on the left side causes the right part to move to the left. It serves as the posterior wall of the soft cleft palate closure.



► **Fig. 15.270 Sutures on the left side of the soft palate.** The sutures are closed after the entire flap is positioned.



► **Fig. 15.271 Complete closure of the soft palate.** The anterior wall is then positioned.





► **Fig. 15.272** Rechecking the rostral cleft palate wound after 14 days. After 14 days, there are no healing complications caudal to the incisive papilla, and the wound closure shows no dehiscence.



► **Fig. 15.273** Checking the caudal cleft palate wound after 14 days. The sutures are still visible, but the defect is fully closed.

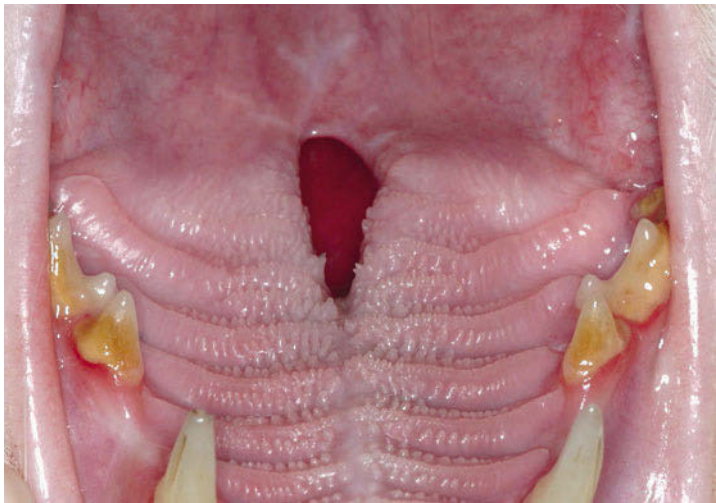


► **Fig. 15.274** Checking the caudal cleft palate wound after 6 weeks. After 6 weeks, the remaining sutures have been absorbed. Small granulation areas remain visible. The right tonsillar fossa is slightly enlarged due to the mucosal movement; however, no defects are observed in the palate. The dog's breathing and eating are unremarkable, and it no longer sneezes.

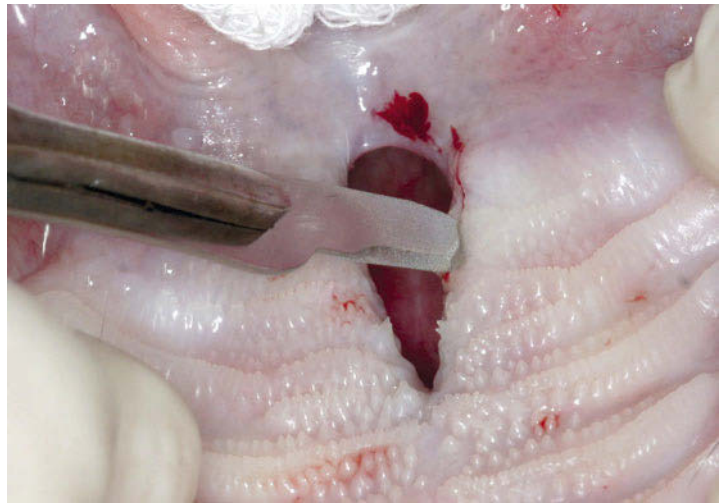


### 15.8.3 Trauma-induced Cleft Palate in a Cat

The following case study concerns a cat with a trauma-induced medial cleft palate at the transition from the soft to the hard palate; surgical repairs have been previously attempted (► Fig. 15.275). The cat's small size and the fragile tissue to be dissected make closing the cleft palate in a cat very challenging for the surgeon.

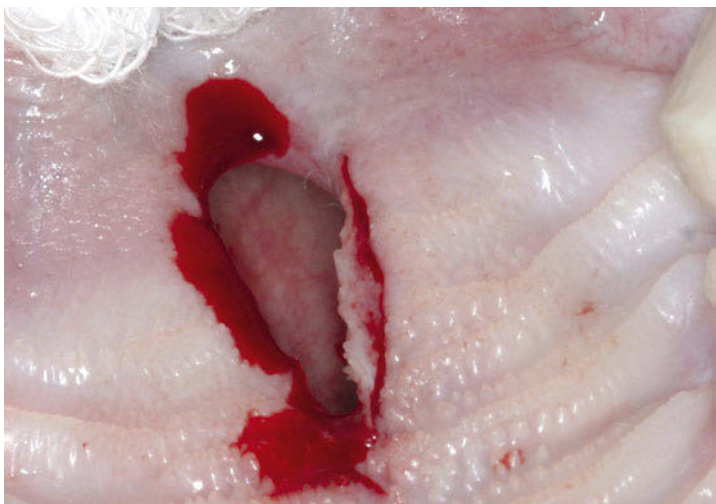


► **Fig. 15.275 Trauma-induced cleft palate in a cat.** A defect at the transition from the hard to the soft palate in a cat shows traces of past surgical repair attempts as scarred, depigmented stripes. The defect is large but not inflamed. The condition requires treatment because of recurring infections of the respiratory tract from aspirated food.

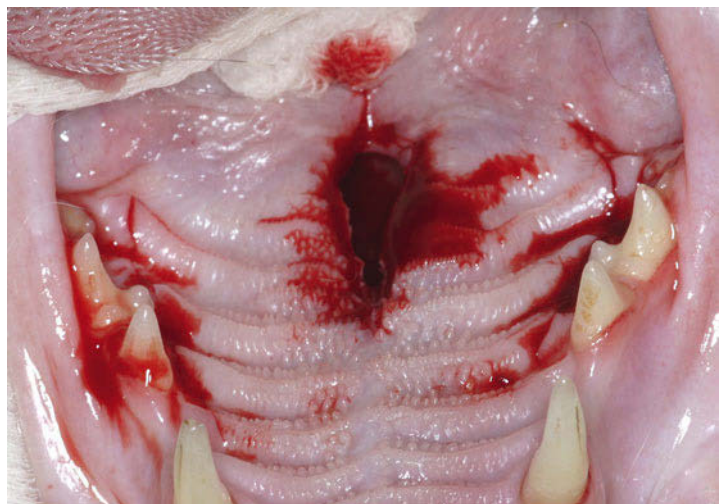


► **Fig. 15.276 Dividing the palatal mucosa.** The palatal mucosa is split into palatal and nasal layers at the margins of the defect.

First, a circular incision is made in the palatal mucosa around the area of the defect with a scalpel (► Fig. 15.276, ► Fig. 15.277, ► Fig. 15.278). The incision should extend so far to the palatal surface that a suture of the nasal layer will be possible after the mucosa is separated.



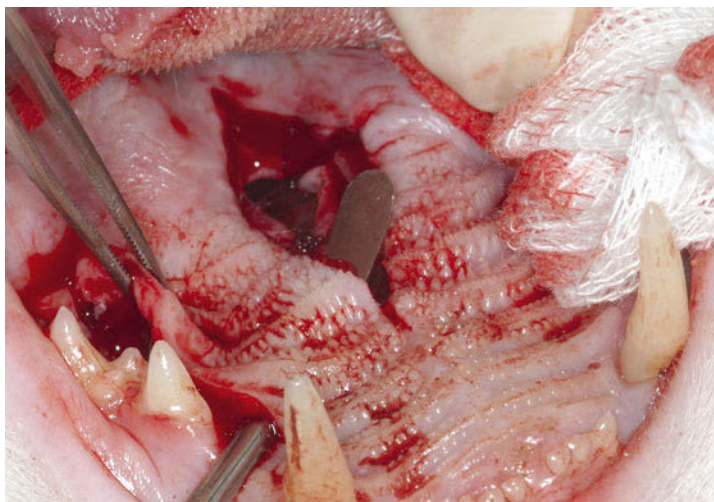
► **Fig. 15.277 Incisions around the cleft palate.** The entire defect is then fully incised.



► **Fig. 15.278 Lateral accessory incisions in the palatal mucosa.** Incisions near the dental arches should be placed at the level of the defect without damaging the palatine vessels.

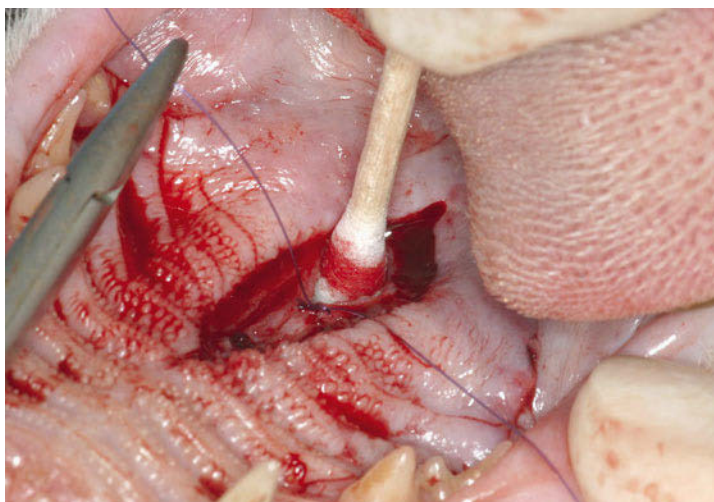


Complete dissection of the bipedicle flap from the hard palate follows (► Fig. 15.279). The soft palate is divided into a nasal and an oral layer. A periosteal elevator can be used to lift the mucosa to ensure that it has been fully dissected and is adequately mobile. The palatine vessels are elastic enough that the flap can be lifted after dissecting the surrounding connective tissue, including at the palatine foramen.



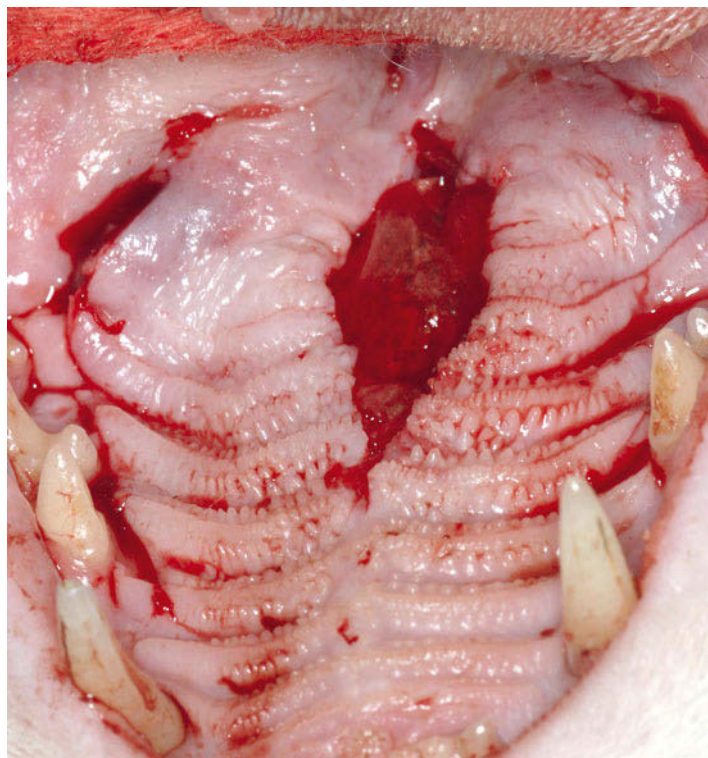
► **Fig. 15.279 Mobilized mucosal flaps.** Passage of a periosteal elevator under the flaps without any resistance confirms the complete dissection of the palatal mucosa.

The first step in closing the cleft palate is to create the first layer from the nasal mucosa (► Fig. 15.280). The very fragile nasal mucosa including the mucosa of the defect margin is carefully dissected and sutured in the midline. Both simple interrupted sutures and mattress sutures are possible. The mucosal surfaces should not lie on top of each other to prevent them from fusing. Using cotton swabs usually enables a good view of the surgical field while achieving adequate hemostasis. Swabs can also be used to staunch bleeding toward the nose.



► **Fig. 15.280 Suturing the nasal mucosa.** Cotton swabs allow a clear view of the surgical field and ensure adequate hemostasis, which allows the nasal mucosal flap to be sutured.

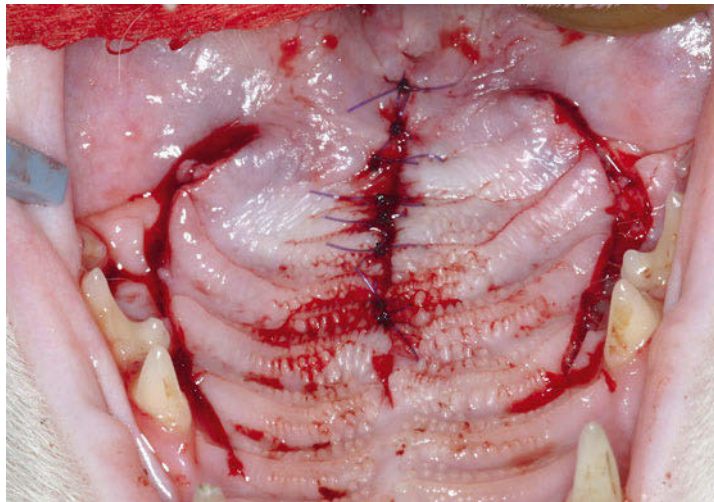
A resorbable membrane is placed as the second layer of the closure (► Fig. 15.281). In this case, porcine intestinal submucosa (BioSIS<sup>®</sup>) is used. After the membrane has been adjusted to fit, it is placed below the palatal mucosa laterally via the accessory incision and guided across the palatal defect to the accessory incision on the other side where simple interrupted sutures are used to adapt it to the margin of the palatal mucosa. Using the membrane achieves two positive effects: First, the defect closure is enhanced through the placement of an additional layer. Second, the exposed parts of the bony palate are covered in the area of the accessory incisions, which promotes wound healing and enhances the dog's recovery.



► **Fig. 15.281 Placing the membrane.** The second layer is a resorbable membrane that is attached laterally.



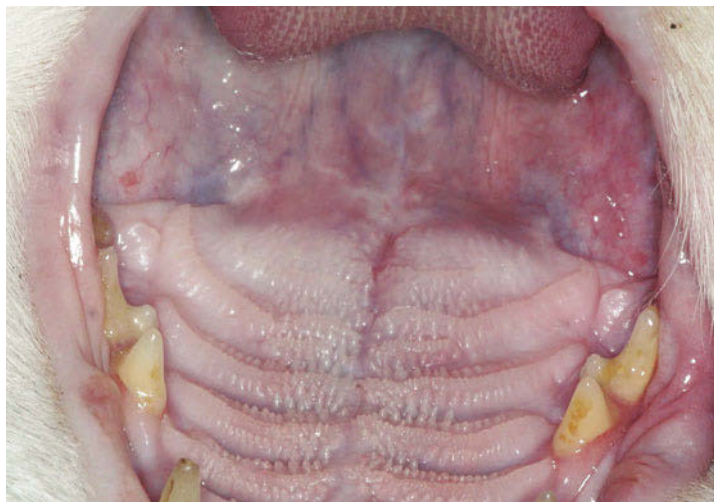
The palatal mucosa serves as a third layer for the separation of nasal and oral cavity (► Fig. 15.282). The two lateral bipedicle flaps are mobilized medially and sutured over the membrane in the midline. The bipedicle flap apposition must be tension-free. If necessary, the bipedicle flaps can be further released by lengthening the accessory incisions.



► **Fig. 15.282 Suturing the palatal mucosa.** Finally, the palatal mucosa is sutured at the midline.

The cat's postoperative condition was good. The cat sneezed out blood clots over the first two days, but after that, sneezing stopped. The cat was fed soupy food.

After two months, the palate was completely healed (► Fig. 15.283). Neither oronasal defects nor inflammatory signs were present. The separation of the oral and nasal cavity was complete.



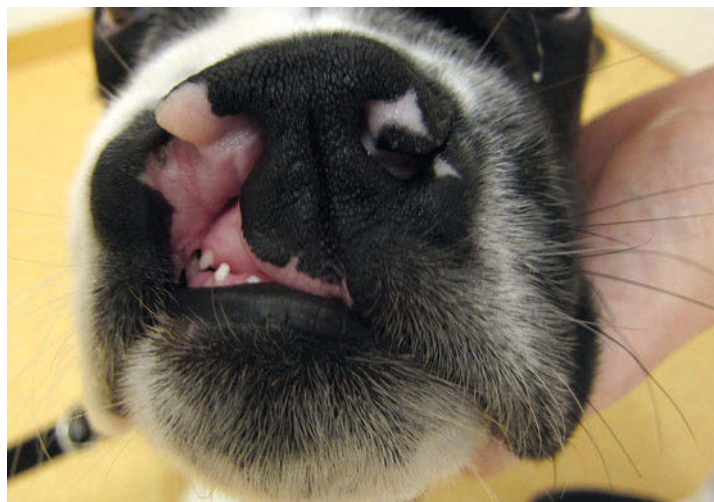
► **Fig. 15.283 Follow-up after 2 months.** After unremarkable wound healing, the cat has a closed palate with no signs of inflammation.

#### 15.8.4 Cleft Lip and Palate in a Dog

A complicated cleft may involve the lips, jaw and palate. In addition to separating the oral and nasal cavity, soft tissue parts such as the lips may require reconstruction in order to enable the animal to eat (► Fig. 15.284, ► Fig. 15.285, ► Fig. 15.286, ► Fig. 15.287, ► Fig. 15.288, ► Fig. 15.289, ► Fig. 15.290, ► Fig. 15.291, ► Fig. 15.292).



► **Fig. 15.284 Cleft lip and palate in a 2-week-old dog.** A 2-week-old Boxer puppy was presented with a lateral cleft lip and palate. The puppy was regularly fed by the owner so that surgical treatment could be performed when the puppy was 12 weeks old.



► **Fig. 15.285 Cleft lip and palate at 12 weeks.** The lateral cleft is distinct. The right nasal passage and the oral cavity are not separated, and the deciduous teeth are outwardly visible.

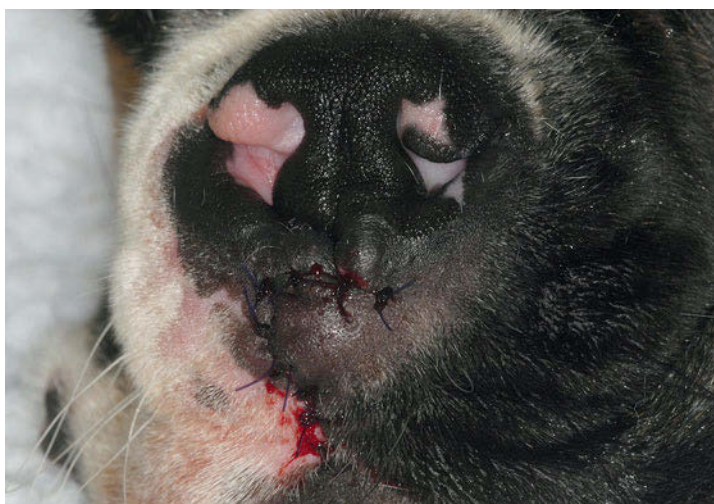




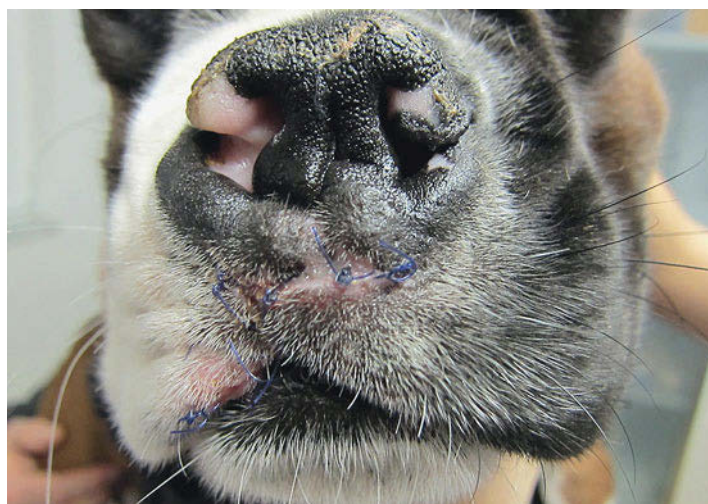
► **Fig. 15.286** Intraoral view of the cleft lip and palate at 12 weeks. A defect is present between the intermaxillary bone and the right maxilla, with involvement of the deciduous teeth; the alveolar ridge is distended and bulges.



► **Fig. 15.288** Closure of the cleft palate at 12 weeks. Taking care not to damage the deciduous teeth and the already developed permanent successor teeth, a gingival closure is performed, which creates a vestibule and closes the passage to the nose.

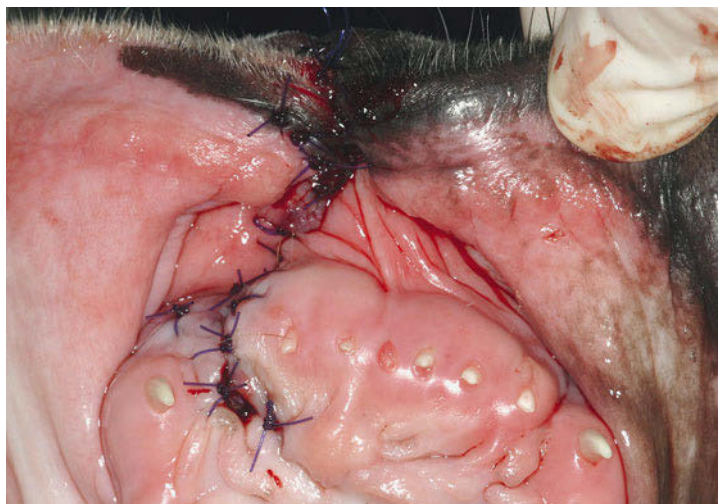


► **Fig. 15.287** Closure of the cleft lip and palate at 12 weeks. After the alveolar parts of the jaw are closed, advancement flaps are used to close the cleft lip. Several layers are used to form the right nasal passage, the mucosa of the oral cavity and the skin of the lips.

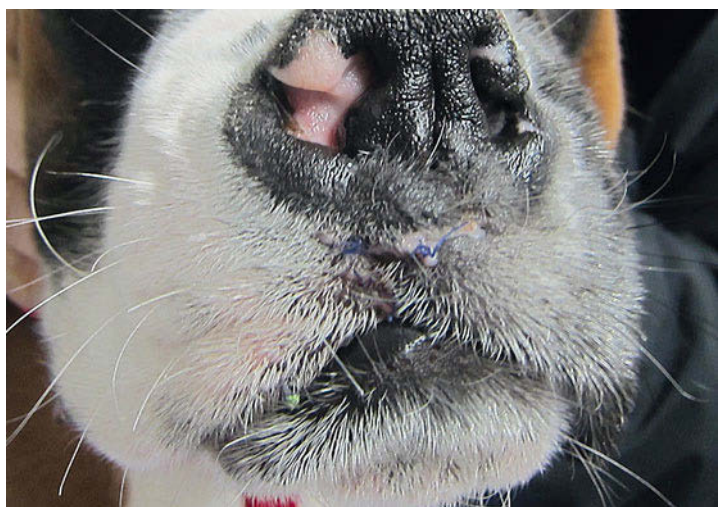


► **Fig. 15.289** Extraoral appearance after 1 week. After 1 week, the skin remains closed with fibrinous plaques at the site of the residual sutures.





► **Fig. 15.290 Intraoral follow-up after 1 week.** Intraorally, no dehiscence has developed.



► **Fig. 15.291 Extraoral follow-up after 5 weeks.** After 5 weeks, residual sutures are still present and the new position of the lips is stable.



► **Fig. 15.292 Intraoral follow-up after 5 weeks.** The defect in the area of the alveolar ridge has healed without any complications, and the permanent incisors are erupting. While an indentation can be observed in the area of the former defect, no continuous opening is present.

## 15.9

## Craniomandibular Osteopathy (CMO)

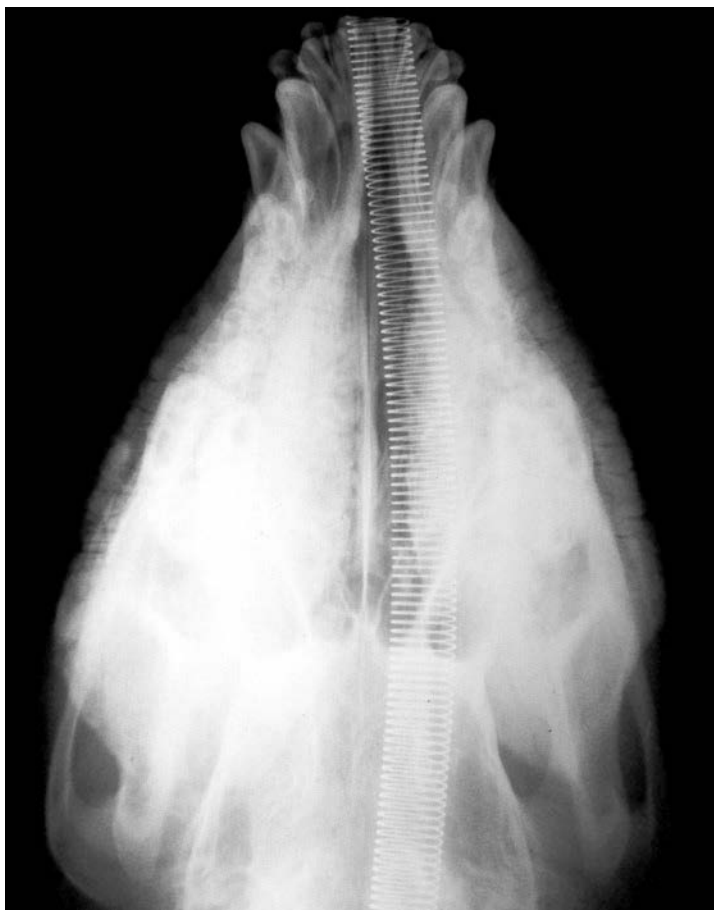
Craniomandibular osteopathy (CMO) occurs in terrier breeds in particular (West Highland White Terrier, Cairn Terrier, Scottish Terrier) in the first year of life, although all dog breeds can be affected. It involves bilateral proliferative-sclerotic reactions with periosteal remodeling, which usually causes significant deformation of the dog's jaw (► Fig. 15.293, ► Fig. 15.294, ► Fig. 15.295, ► Fig. 15.296). Since the craniomandibular joint is also often affected, jaw opening can be painful and impaired, and the animal may have a fever and swollen lymph nodes. The symmetrical mandibular exostoses in a young dog are a sign of the disease. It is a genetic disease caused by the exchange of a base in exon 15 on chromosome 5. Cortisone and an analgesic may be given to bridge the period of impairment and limit the progression of the disease. In most cases, surgical intervention is not required. Upon maturation, the pain subsides along with the episodic course. A remission of the exostoses is possible, although even permanent bony abnormalities do not require treatment if functionality is not impaired.



► **Fig. 15.293 Profile of a dog with craniomandibular osteopathy.**

A 6-month-old male Labrador is presented with pronounced head pain. The dog is reluctant to open its mouth and cries out when eating. The dog can no longer yawn. In the lateral view, the massive swelling in the caudal mandibular area is seen.

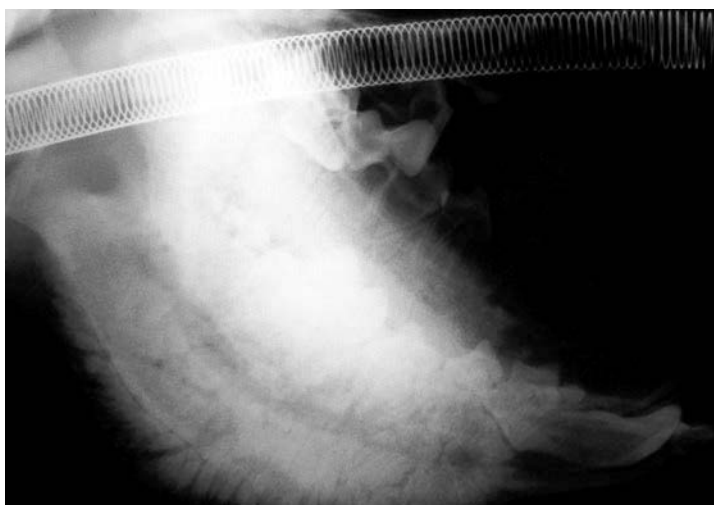




► **Fig. 15.294 Craniomandibular osteopathy in the ventrodorsal projection.** The pathognomonic changes of the mandible in a dog with CMO appear in the radiograph. Bone-like growths are seen on the jaw along the mandible up to the craniomandibular joint.



► **Fig. 15.296 Craniomandibular osteopathy, mandibular front teeth.** Despite the bony changes, both the deciduous and the permanent teeth are radiographically unremarkable.



► **Fig. 15.295 Craniomandibular osteopathy in the laterolateral projection.** In the laterolateral projection, the extensive growth in a ventral direction is seen; this gives the mandible its swollen appearance.

## 16 Teeth

### 16.1

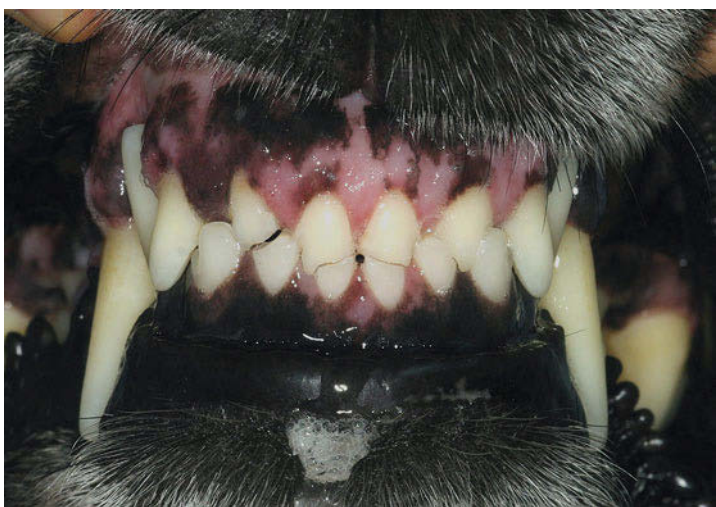
### Abrasion and Attrition

Abrasions may occur in dogs when they play with hard or abrasive objects. Tennis balls are a leading source of abrasion. When rolled in sand, the balls act like sandpaper, sanding down the crowns depending on how roughly the dog plays with the ball. If the abrasion occurs gradually, the pulp responds by producing additional dentin to shrink the pulp chamber to create distance to the surface that is becoming closer. This can be seen radiographically. Pulpitis can also result from pulp exposure from too rapidly progressing abrasion. An inflammatory process can also occur in the tooth or jaw if the tooth surface is closed. For this reason, the clinician should employ radiography to examine abrasions. The additional dentin produced in response to abrasion is usually atypical and lacks dentinal tubules, thus preventing communication with the pulp. Instead, the disorganized structure of the dentin mechanically protects the pulp's sensitivity. This is a major difference from a fractured tooth, where dentinal tubules are exposed and pain sensitivity is heightened as a consequence.

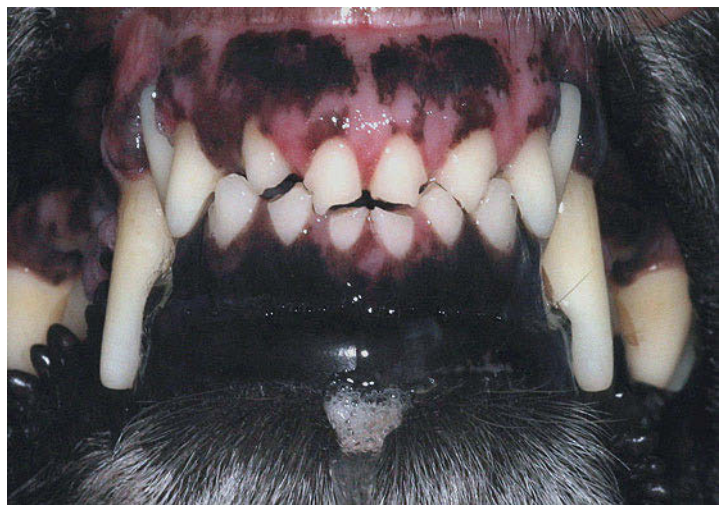
In contrast to abrasion, attrition is not caused by wear from biting foreign objects, but by tooth-to-tooth contact as a result of malpositioned teeth, such as in malocclusions.

#### 16.1.1 Severe Attrition of the Incisors

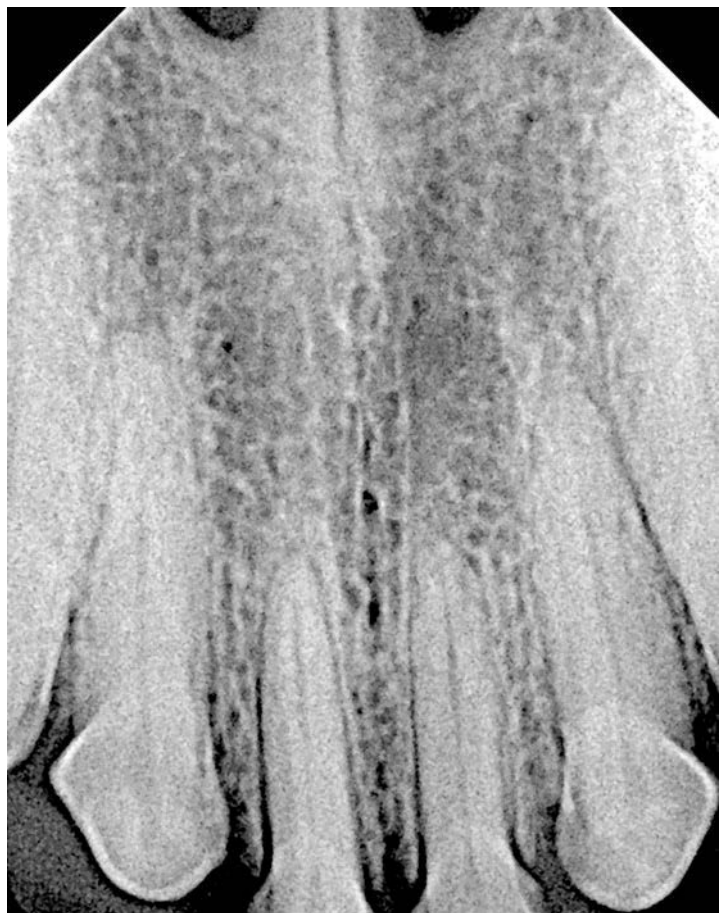
Teeth may be affected by attrition differently depending on how the teeth are used. Tooth-to-tooth contacts show interdigitating complementary patterns of wear (► Fig. 16.1, ► Fig. 16.2, ► Fig. 16.3, ► Fig. 16.4) so tooth-to-tooth attrition can be differentiated from abrasion.



► Fig. 16.1 Severe attrition of the incisors with a closed jaw. The areas of attrition on the maxillary and mandibular incisors fit together to form a closed dental arch. The changes are manifested by an edge-to-edge bite instead of the normal scissor bite.

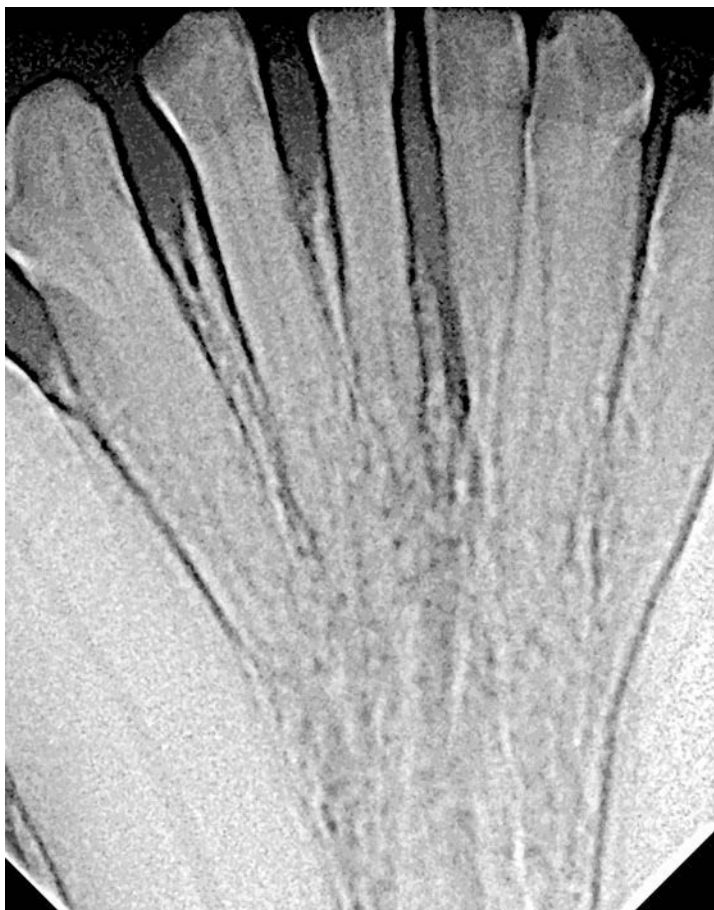


► Fig. 16.2 Appearance of wear with a slightly opened jaw. The exact "fit" of the wear is even more apparent in the slightly opened jaw.



► Fig. 16.3 Radiograph of the maxillary incisors. No abnormalities appear in the roots in the radiograph of the maxillary incisors.





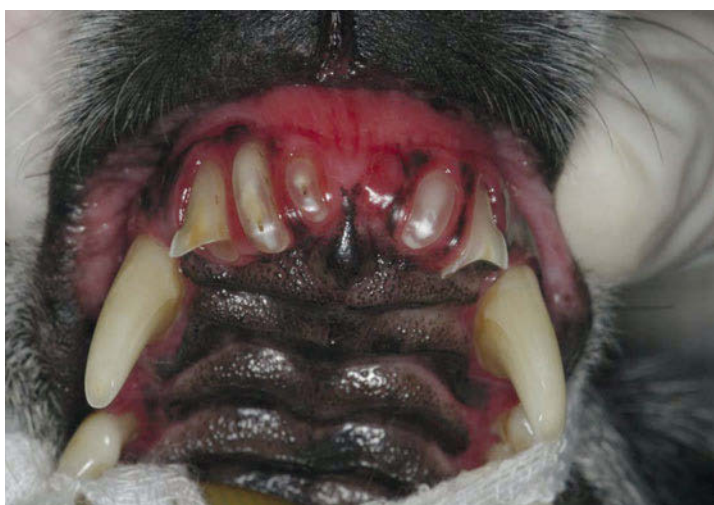
► **Fig. 16.4 Radiograph of the mandibular incisors.** The mandibular incisors are also unremarkable. Treatment is not indicated at this point because the condition does not show any pathological consequences; moreover, the causes cannot be addressed



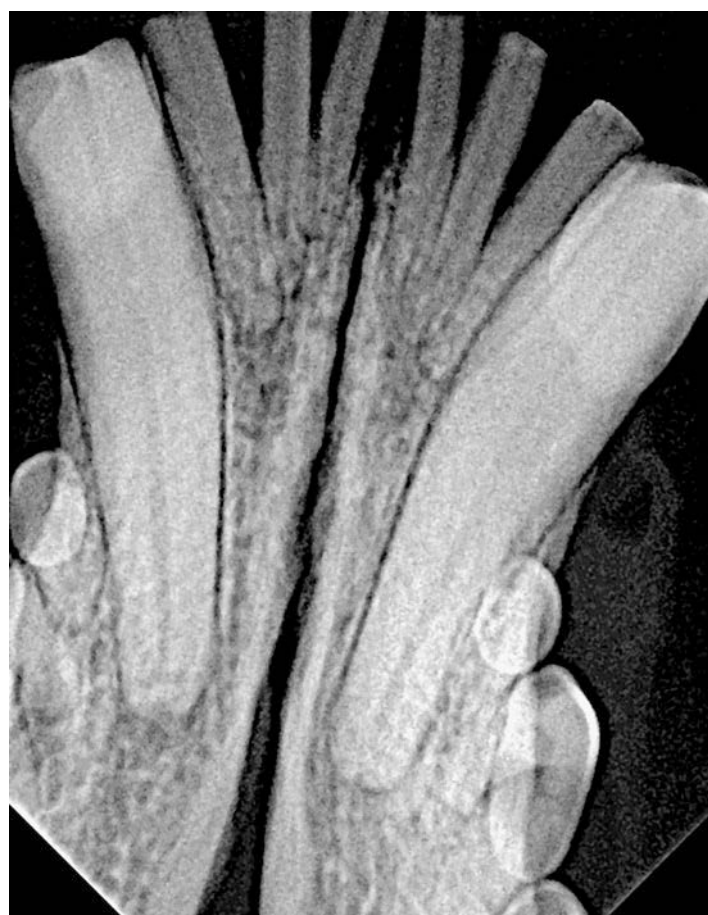
► **Fig. 16.6 Severe abrasion of the mandibular incisors and canines.** In the mandible, all incisors are also worn down to the gingiva. The incisors show no signs of pulp exposure. In addition, the canines are severely worn down, which has resulted in distinct exposure of the pulp chamber.

### 16.1.2 Severe Abrasion of the Front Teeth

The following figures (► Fig. 16.5, ► Fig. 16.6, ► Fig. 16.7, ► Fig. 16.8, ► Fig. 16.9, ► Fig. 16.10) illustrate the findings and approach used to treat severe abrasion.



► **Fig. 16.5 Severe abrasion of the maxillary incisors.** The maxillary incisors of this dog are worn down to the gingival level. The dark spots on the maxillary right central and intermediate incisors can be palpated as an opening with a sharp-tipped probe.



► **Fig. 16.7 Radiograph of teeth 304 and 404.** Preserving the mandibular canine teeth is the declared goal of the treatment because they oppose the maxillary canine teeth even when they are reduced. The teeth can be preserved only with root canal therapy; they would otherwise have to be extracted. The roots of the affected teeth are mostly unremarkable, so endodontic therapy is a good option. The roots of the mandibular incisors are unremarkable. No treatment is required if the pulp chamber is closed and there are no signs of inflammation or nonvital teeth in the radiograph.



► **Fig. 16.8 Measurement radiograph of teeth 304 and 404.** The working length is determined in the measurement radiograph. Depending on the position of the teeth, both canines may fit in one radiograph.



► **Fig. 16.9 Intraoperative radiograph of teeth 304 and 404.** The follow-up radiograph shows two uniformly sealed root canal fillings.



► **Fig. 16.10 Radiograph of the maxillary incisors.** The radiograph of the maxillary incisors shows a distinct periapical process. The roots have partially grown past their former alveolus. Only the crown of tooth 102 is present, and tooth 201 is missing. The maxillary incisors must therefore be extracted.

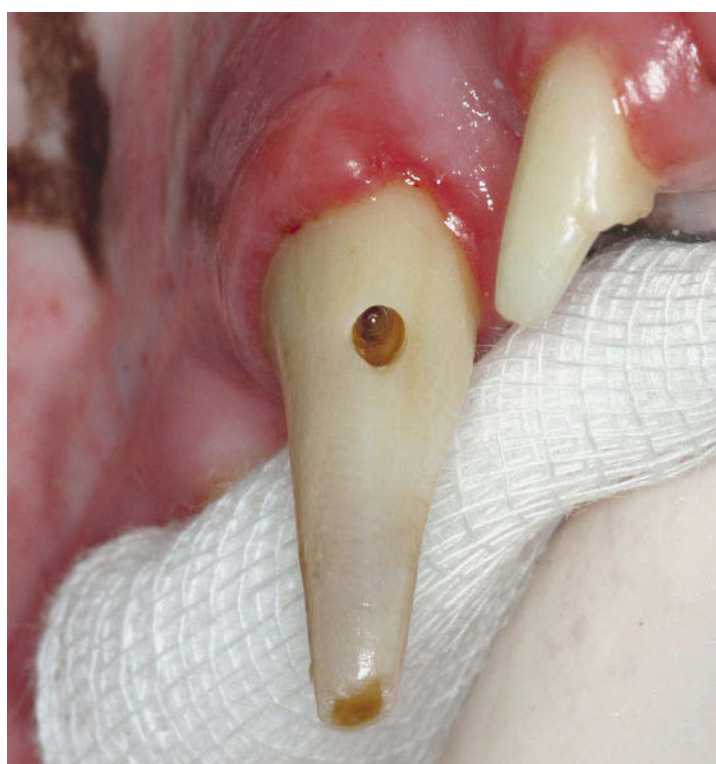


### 16.1.3 Discoloration of the Maxillary Canine after Abrasion

A complicated tooth fracture causes pulp necrosis. However, excessive wear on the tooth can also lead to pulpitis even if the pulp is not exposed (► Fig. 16.11, ► Fig. 16.12, ► Fig. 16.13, ► Fig. 16.14).



► **Fig. 16.11 Discoloration of tooth 104.** If an abraded tooth also shows dark discoloration, pulp necrosis is very likely; this can result in decomposition products becoming incorporated into the dentin and causing discoloration. Even if the wear of the tooth seems minimal, radiographic diagnostics and treatment are required due to the discoloration.



► **Fig. 16.12 Nonvital pulp after trepanation of tooth 104.** Pulp necrosis can be proven via trepanation. After exposing the pulp chamber, if no bleeding can be provoked, the existing tissue is nonvital.



► **Fig. 16.13 Radiograph of tooth 104.** The radiograph of this 7-year-old dog shows no distinct periapical abnormalities.



► **Fig. 16.14 Radiograph of tooth 204.** Compared to the healthy left side, the pulp chamber of the discolored right canine tooth appears to be wider due to the lack of further dentin production. The treatment consisted of root canal therapy of the maxillary right canine tooth.

#### 16.1.4 Periapical Osteolysis of the Maxillary Carnassial Tooth after Abrasion

An unremarkable intraoral clinical examination may not reveal the actual underlying cause of the disease. If the owner reports behavioral changes or expressions of pain, even minor abnormalities of the teeth or oral mucosa should be examined (► Fig. 16.15, ► Fig. 16.16, ► Fig. 16.17, ► Fig. 16.18).



► **Fig. 16.15 Lateral view of tooth 108.** Maxillary carnassial tooth with calculus and plaque as well as moderate gingivitis.



► **Fig. 16.16 Occlusal view of tooth 108 with abrasion of the cusps.** In this view, slight abrasion can be seen on the cusps.



### 16.1.5 Abrasion of the Maxillary Canine with Fistula Formation

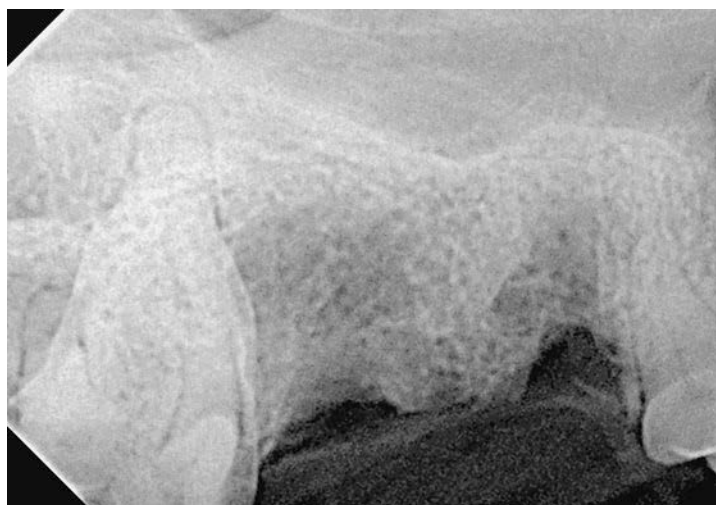
If the apical inflammatory process does not remain at the root tip and causes swelling of the jaw, fistulas often form. While this can result in an apparent fistula opening on the skin, the signs can also develop less clearly, manifesting as a fistulous tract to the oral mucosa in any part of the vestibule (► Fig. 16.19, ► Fig. 16.20, ► Fig. 16.21, ► Fig. 16.22, ► Fig. 16.23).



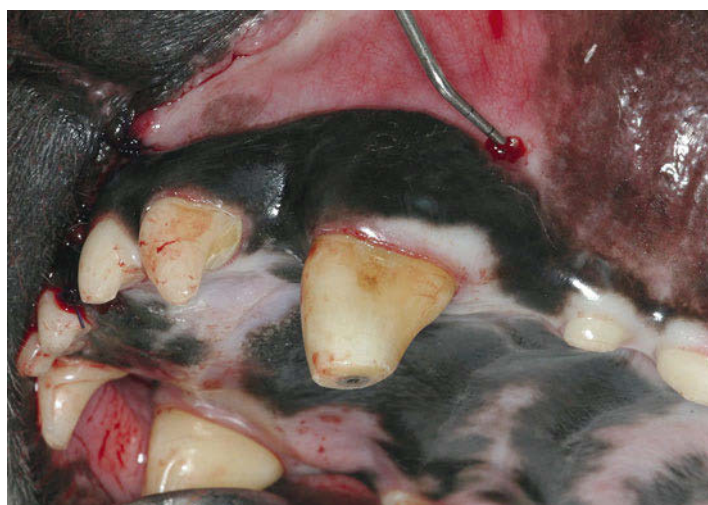
► **Fig. 16.17 Radiograph of tooth 108.** The radiograph shows extensive osteolysis of the distal root. While no severe damage is visible, this tooth shows a high-grade bony process with slight crown abrasion.



► **Fig. 16.19 Periodontal probing of the fistula opening after abrasion of the maxillary left canine tooth.** An abraded maxillary canine tooth with a dark abraded surface and an opening that can be probed shows reddened gingiva in the root area above the mucogingival junction.



► **Fig. 16.18 Intraoperative radiograph after extraction of tooth 108.** Treatment involves extracting the tooth.



► **Fig. 16.20 Periodontal probing of the fistulous tract.** A periodontal probe can be introduced into the fistulous tract via the fistula opening that leads to the root tip of the abraded maxillary canine tooth.



► **Fig. 16.21 Radiograph of tooth 204.** In the radiograph, the maxillary canine tooth shows extensive resorption of its root and osteolysis in the apical area.



► **Fig. 16.22 Radiograph after extraction of tooth 204.** The tooth cannot be preserved. A radiograph is taken to verify full extraction.



► **Fig. 16.23 Suture after extraction of tooth 204.** A vestibular mucoperiosteal flap is prepared, placed over the alveolus, and sutured to the palatal mucosa without tension. Closing the alveolus improves the postoperative outcome, preventing impaction and promoting faster healing than in open granulation.



## 16.2

**Tooth Fractures and Related Conditions**

In contrast to abrasion or attrition, a tooth fracture always results in a wound. The wound varies from an opening of a single or multiple dentinal tubules or even direct pulp exposure. Due to the anatomical interconnections of the pulp and dentin, the term pulp-dentin complex is used. Therefore, chipping of the enamel with exposure of dentin is considered a wound. In this case, treatment may be required or optional. In the event of pulp exposure, treatment is imperative.

**16.2.1 Tooth Discoloration**

Discoloration of the tooth is sometimes apparent even if no damage to the tooth substance is seen (► Fig. 16.24, ► Fig. 16.25, ► Fig. 16.26, ► Fig. 16.27, ► Fig. 16.28).



► **Fig. 16.25 Radiograph of tooth 104.** No pathological changes can be detected radiographically. Depending on the timing of the damage, the inflammatory process with a loss of mineralization in the bone still takes time to see radiographically, so acute inflammation sometimes cannot be seen immediately.



► **Fig. 16.24 Discoloration of the maxillary right canine tooth.** Blunt trauma without tooth fracture can still result in its necrosis. Loss of the blood supply to the apex resulting from trauma and dislocation of the tooth can provoke pulp necrosis of this tooth. This often appears as an increasingly dark discoloration of the tooth resulting from decomposition products depositing in the pulp.



► **Fig. 16.26 Trepanation of tooth 104.** After trepanation of the tooth, only non-vital tissue is obturated from the pulp chamber using a barbed broach. As suggested by the discoloration, the tooth was already nonvital.



► **Fig. 16.27 Measurement radiograph of tooth 104.** The measurement radiograph shows that conventional root canal therapy is an option.



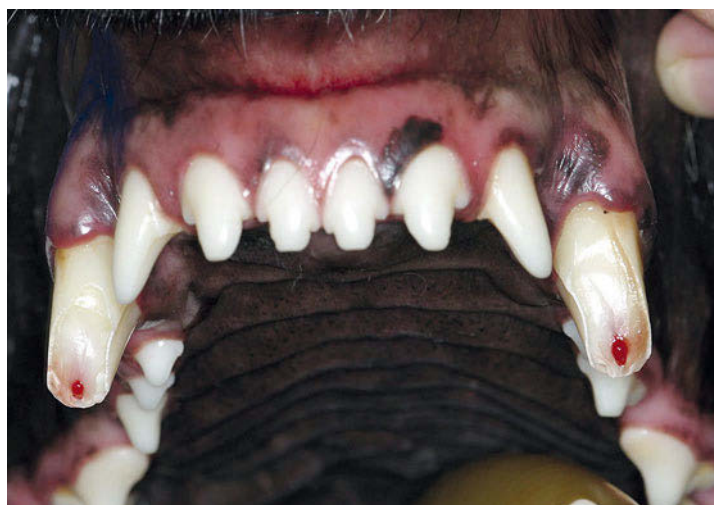
► **Fig. 16.28 Intraoperative radiograph of the root canal filling of tooth 104.** The intraoperative radiograph shows a homogeneous and tightly sealed root canal filling up to the end of the root canal. The tight sealing of the filling is crucial for the prognosis of the tooth. In the event of a defective apical filling, chronic inflammation with osteolysis generally occurs. Unfortunately, without radiographic follow-up, this inflammation is usually inconspicuous due to the coronal filling of the tooth.

## 16.2.2 Tooth Fracture

True fractured teeth are easier to diagnose. If a tooth is fractured as a result of trauma and the pulp is exposed, further treatment is required. If only chipping of enamel and/or dentin occurs, further diagnostic steps are needed.

### Freshly Fractured Maxillary Canine Teeth

A freshly fractured maxillary canine tooth with bilateral pulp exposure is shown in ► Fig. 16.29.



► **Fig. 16.29 Freshly fractured maxillary canine teeth.** A striking and pathognomonic characteristic of a fractured tooth with pulp exposure is bleeding from the pulp chamber. If the animal is not seen promptly after the trauma, the coronal part may already be nonvital; pulp exposure nevertheless always requires treatment. The only possible treatment options are root canal therapy or the extraction of both maxillary canine teeth.



### Old Fractures of Both Maxillary Canines

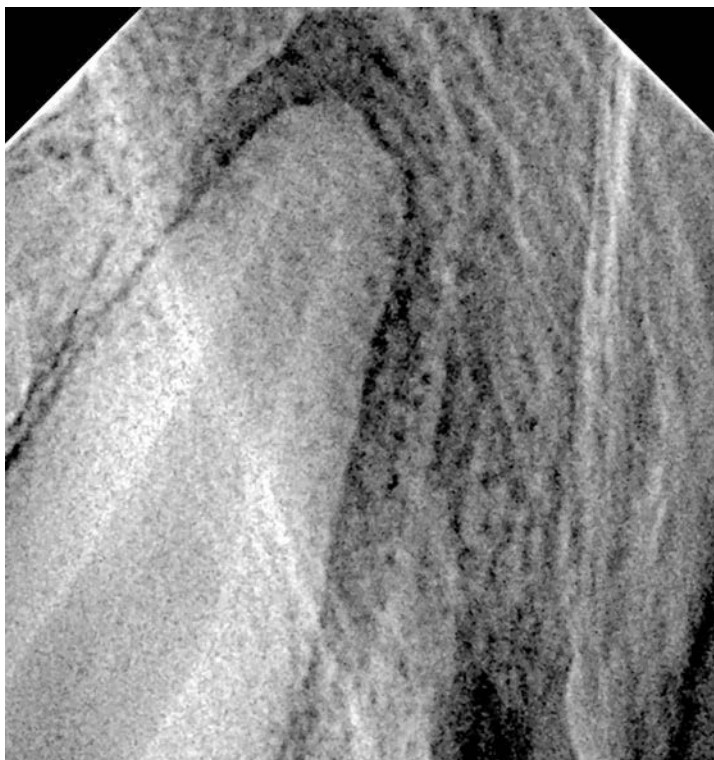
The following figures illustrate findings and the approach used for treating old tooth fractures using the maxillary canine teeth as an example (► Fig. 16.30, ► Fig. 16.31, ► Fig. 16.32, ► Fig. 16.33, ► Fig. 16.34, ► Fig. 16.35, ► Fig. 16.36, ► Fig. 16.37, ► Fig. 16.38).



► **Fig. 16.30 Fractured maxillary canine teeth.** In this 2-year old dog, both maxillary canine teeth have fractured cusps. The maxillary right canine tooth is not exposed, and the pulp cavity cannot be probed. The maxillary left canine tooth is exposed, and the pulp is dark and nonvital.



► **Fig. 16.32 Radiograph of the region around tooth 204.** Interestingly, the periapical changes on the exposed maxillary left canine tooth in the radiograph are minor.



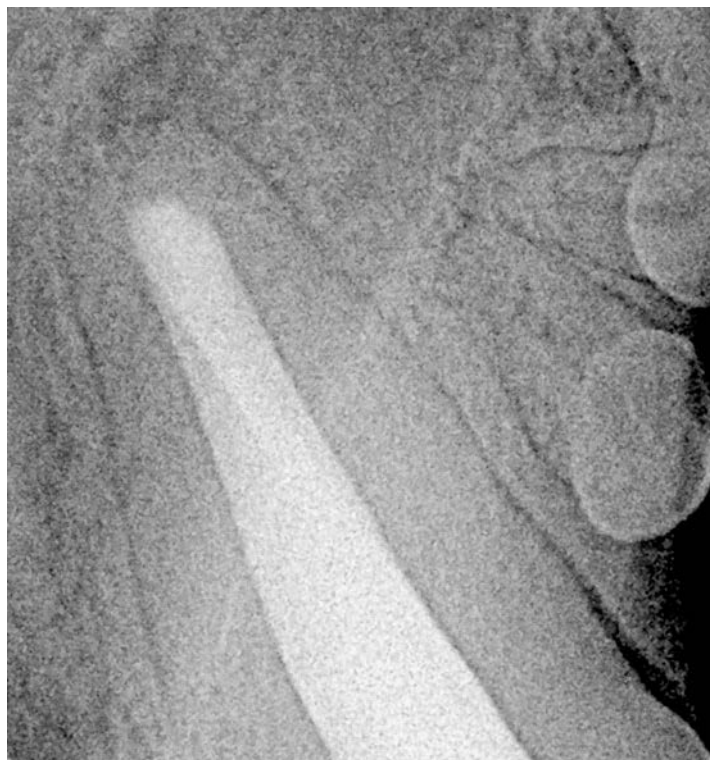
► **Fig. 16.31 Radiograph of tooth 104.** The radiograph of the maxillary right canine tooth shows an advanced periapical osteolytic process despite a lack of pulp exposure.



► **Fig. 16.33 Measurement radiograph of tooth 104.** A Hedstrom file is used to determine the working length. The file is inserted into the pulp canal until the apical stop is reached.



► **Fig. 16.34 Measurement radiograph of tooth 204.** The length of the pulp canal on the maxillary left canine tooth is measured in the same manner. The shape of the wide pulp channel of the young animal and the position of the file show that the canal wall cannot be cleaned with the largest file that fits, as in standard root canal preparation. Instead, the canal must be prepared in a circular motion using flexible and thinner files to remove pulp remnants, odontoblasts, and infected dentin. To ease access, the files are not inserted coronally via the fractured area but by way of an additional, mesiocervically positioned cavity approximately 2 mm above the gingival margin.



► **Fig. 16.36 Intraoperative radiograph of the root canal filling of tooth 204.** The left canine tooth also shows a tightly sealed root filling that reaches the apex.



► **Fig. 16.35 Intraoperative radiograph of the root canal filling of tooth 104.** After placing the root canal filling, a radiograph is used to verify that it is tightly sealed and homogeneous, especially in the apical area.



### Leaking Root Canal Fillings in All Canines

In addition to an intact restoration, successful root canal therapy requires a tightly sealed root filling. The homogeneity and impermeability in the apical third of the root determines the course of the inflammatory process.

#### Current Condition

A dog was presented with abrasions on all canine teeth, and the maxillary canines had previous root canal fillings (► Fig. 16.39, ► Fig. 16.40, ► Fig. 16.41, ► Fig. 16.42, ► Fig. 16.43).



► **Fig. 16.37 Composite filling of tooth 104.** The fracture and the accessory access are closed with composite fillings. The broken-off cusp is not reconstructed since it would likely be broken again given the forces at play in the dog's bite.



► **Fig. 16.39 Fillings of the maxillary canine teeth.** The fillings are clearly visible on the abraded maxillary canine teeth.



► **Fig. 16.38 Composite filling of tooth 204.** The crown on the left side is treated in the same manner. Due to the larger fracture on the left cusp, the filled tooth is slightly shorter.



► **Fig. 16.40 Abraded mandibular canine teeth.** The abrasions of the mandibular canines extend to the former pulp cavity without apparent pulp exposure.



► **Fig. 16.41 Radiograph of the root canal filling of tooth 104.** The radiograph of the maxillary right canine tooth shows a leaking root canal filling. The gutta percha points used can be clearly distinguished. Periapically, this has resulted in a severe periapical osteolytic process.



► **Fig. 16.43 Radiograph of the mandibular canine teeth.** The involvement of the pulp resulted in a periapical process in the mandible as well. However, the result is significantly less pronounced than in the maxilla.



► **Fig. 16.42 Radiograph of the root canal filling of tooth 204.** The radiograph of the maxillary left canine tooth shows a defective root canal filling similar to the one on the right.



### Measurement Radiographs

The measurement radiographs taken to prepare the necessary root canal treatments show the varied extent of the periapical processes (► Fig. 16.44, ► Fig. 16.45, ► Fig. 16.46, ► Fig. 16.47).



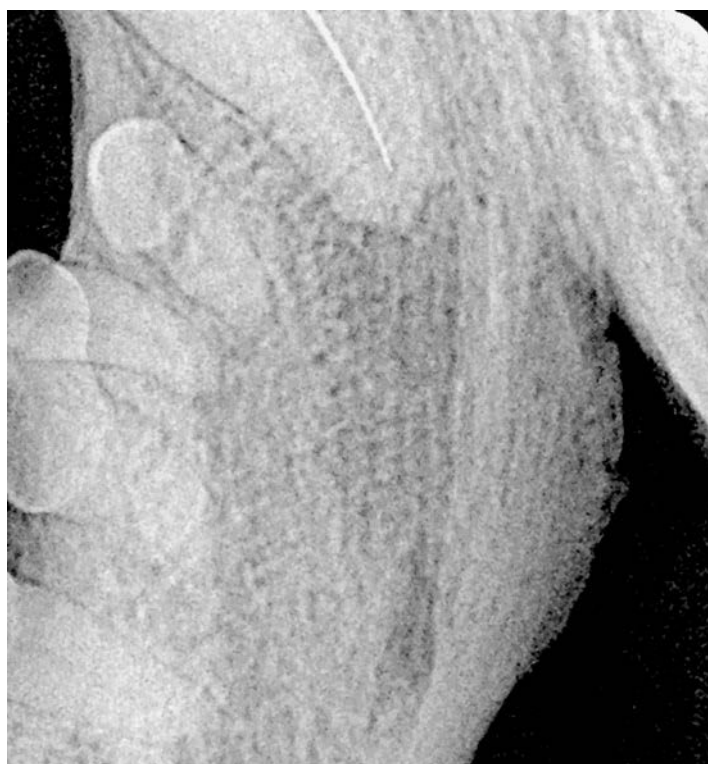
► **Fig. 16.44** Measurement radiograph of tooth 104. The measurement radiograph shows the very thin apical stop on the maxillary right canine tooth due to progressive resorption.



► **Fig. 16.46** Measurement radiograph of tooth 304. The measurement radiograph of the mandibular left canine tooth is unremarkable.



► **Fig. 16.45** Measurement radiograph of tooth 204. A distinct root tip remains on the left side.



► **Fig. 16.47** Measurement radiograph of tooth 404. The measurement radiograph of the mandibular right canine tooth is also unremarkable.



### Root Canal Filling

► Fig. 16.48, ► Fig. 16.49, ► Fig. 16.50, ► Fig. 16.51, ► Fig. 16.52 and ► Fig. 16.53 illustrate the procedure used and findings for root canal fillings.



► **Fig. 16.48 Radiograph of tooth 104 after cleaning the canal.** First, the pulp lumen is cleaned thoroughly, which is confirmed radiographically.



► **Fig. 16.50 Intraoperative radiograph of the root canal filling of tooth 104.** A radiograph is taken to verify that the new root canal filling is tightly sealed. Because the apical wall is thin, the root canal filling should be introduced carefully to avoid overpacking the material or causing a tooth fracture.



► **Fig. 16.49 Radiograph of tooth 204 after cleaning.** The same procedure is performed on the left side.



► **Fig. 16.51 Intraoperative radiograph of the root canal filling of tooth 204.** The root canal in the maxillary left canine tooth is less likely to be overfilled.



### Follow-Up of the Maxillary Right Canine

The periapical development of the maxillary right canine tooth is illustrated in ► Fig. 16.54, ► Fig. 16.55, ► Fig. 16.56, ► Fig. 16.57, ► Fig. 16.58 and ► Fig. 16.59.



► Fig. 16.52 Intraoperative radiograph of the root canal filling of tooth 304. The root canal filling in the mandibular left canine tooth is unremarkable.



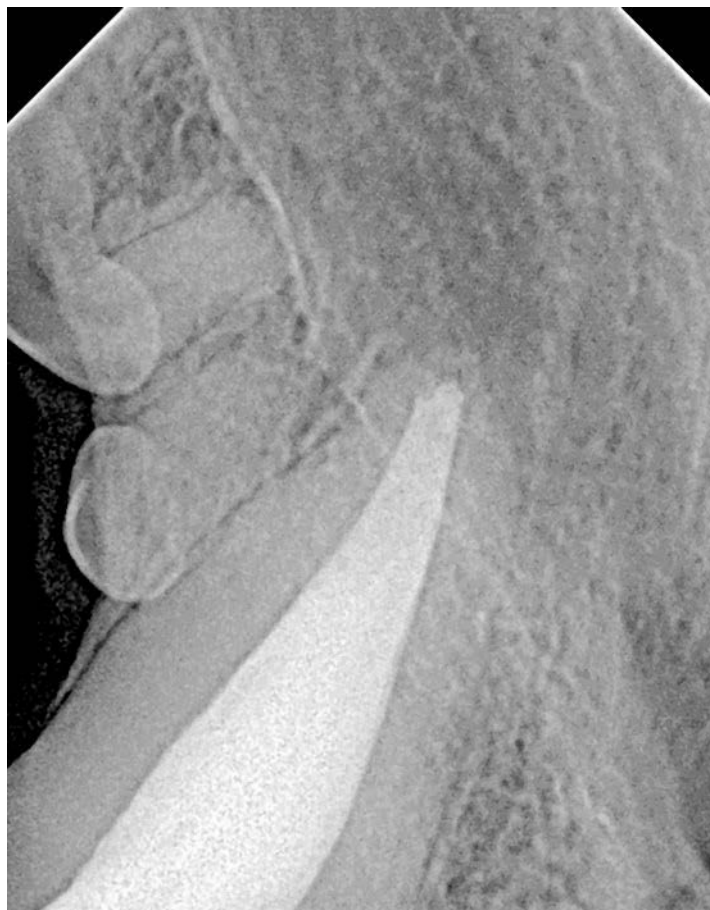
► Fig. 16.53 Intraoperative radiograph of the root canal filling of tooth 404. The periapical translucency in the intraoperative digital radiograph is more distinct than in the original baseline radiograph because the root canal filling material acts as a new contrast medium.



► Fig. 16.54 Radiograph of tooth 104 after 6 weeks. After 6 weeks, the first follow-up radiograph is taken to assess the periapical development of the treated teeth. At this point, the maxillary right canine tooth shows no bony healing processes or progressive inflammation.



► **Fig. 16.55 Fillings in the maxillary canine teeth after 9 months.** After 9 months, no further wear on the teeth has occurred, and while the incisors are at the level of the gingiva, they are not clinically exposed. The fillings of the canine teeth show signs of use, and the edge of the maxillary right canine filling has a microcrack.



► **Fig. 16.57 Radiograph of tooth 104 after 2 years.** After 2 years, an unremarkable periapical area surrounds an irreversibly thinned root tip.



► **Fig. 16.56 Radiograph of tooth 104 after 9 months.** The radiograph shows increasing bony healing of the periapical region. Radiopacity is increasing and cancellous bone structures can be seen.



► **Fig. 16.58 Renewed abrasion of endodontically treated tooth 104 filling after 2.5 years.** Severe abrasion of the tooth with exposure of the root canal filling occurs 6 months later. In order to create a bacteria-tight seal, a deeper-lying composite filling must be prepared coronally.





► **Fig. 16.59 Radiograph after 2.5 years.** In the radiograph, the exposure of the root canal filling did not result in any visible deterioration.



► **Fig. 16.61 Radiograph of tooth 204 after 9 months.** The periapical process has healed considerably after 9 months.

#### Follow-up of the Maxillary Left Canine Tooth

The following figures (► Fig. 16.60, ► Fig. 16.61, ► Fig. 16.62, ► Fig. 16.63, ► Fig. 16.64) show the subsequent periapical development of the maxillary left canine tooth.



► **Fig. 16.60 Radiograph of tooth 204 after 6 weeks.** The root tip on the maxillary left canine tooth is unremarkable after 6 weeks, and no positive or negative changes appear.



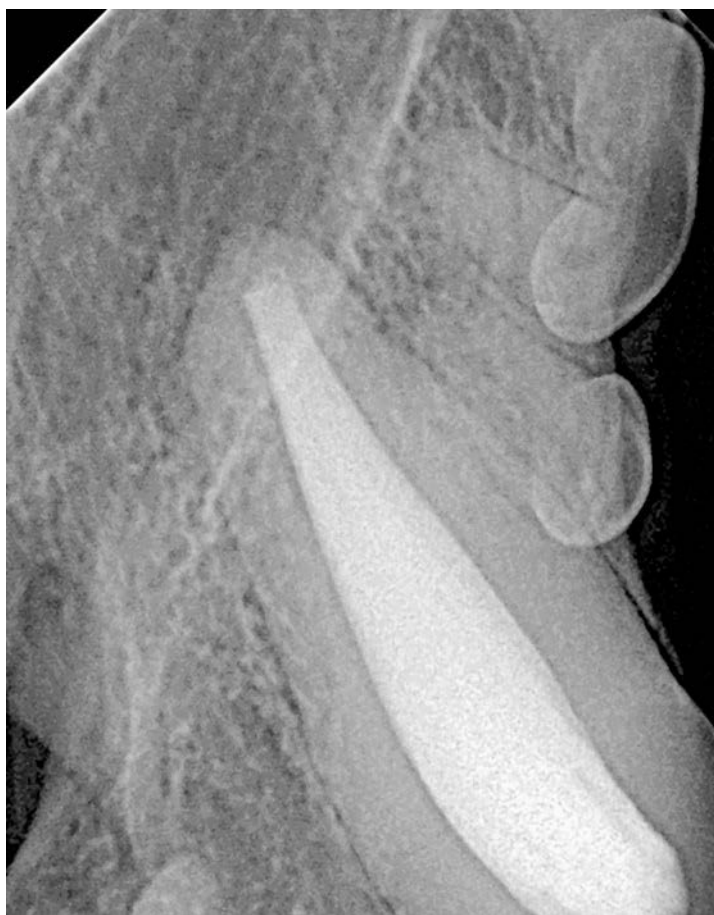
► **Fig. 16.62 Radiograph of tooth 204 after 2 years.** The periapical translucency has decreased significantly after 2 years.



► **Fig. 16.63** Recurrent abrasion on endodontically treated tooth 204 after 2.5 years. As on the right side, further abrasion has occurred on the left side, resulting in broad exposure of the root canal filling.

### Follow-Up of Mandibular Canines

The further periapical development of the mandibular canine teeth is shown in ► Fig. 16.65.



► **Fig. 16.64** Radiograph of tooth 204 after 2.5 years. The root area is radiographically unremarkable.



► **Fig. 16.65** Radiograph of teeth 304 and 404 after 9 months. After 9 months, the mandibular canines show good periapical healing with diminished translucency.

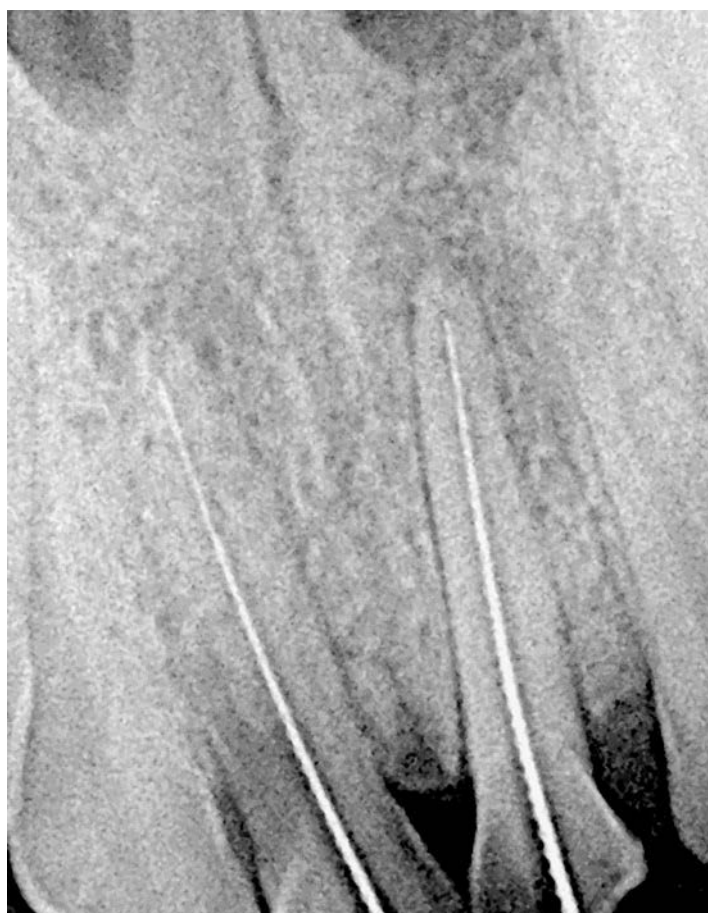


## Fractured Incisors

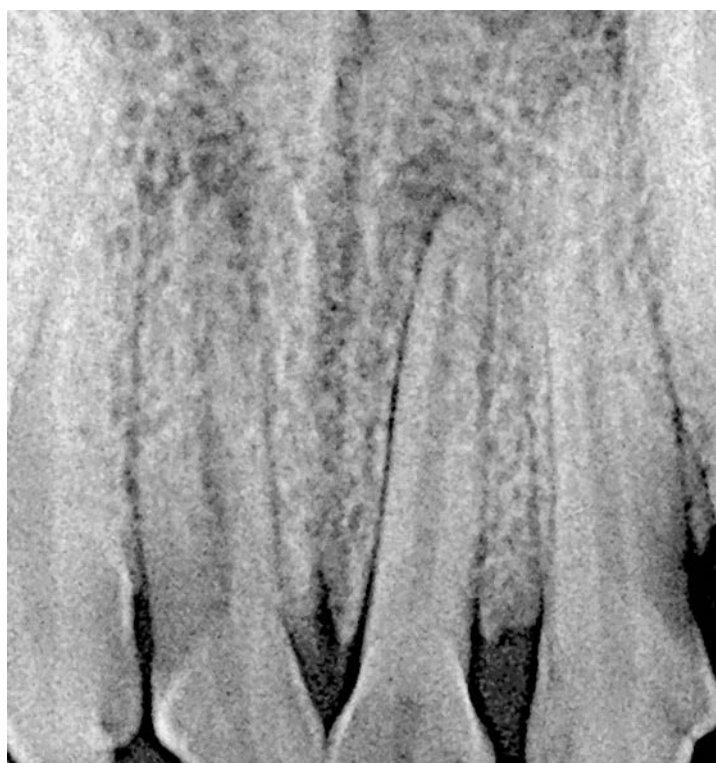
In addition to canines and carnassial teeth, which are subjected to a heavy functional load, other teeth can fracture. These teeth must also be treated (► Fig. 16.66, ► Fig. 16.67, ► Fig. 16.68, ► Fig. 16.69).



► **Fig. 16.66 Fractured maxillary central incisors.** Even though the incisor crowns are not as exposed as the long canine crowns, they are nevertheless prone to fracture. The exposure or necrosis of the pulp requires treatment regardless. The treatment options consist of extraction of the tooth or root canal therapy, depending on the radiological findings and the owner's wishes.



► **Fig. 16.68 Measurement radiograph of teeth 101 and 201.** The root canals can be visualized up to the apical stop. Root canal therapy is possible despite osteolytic periapical processes.



► **Fig. 16.67 Radiograph of fractured teeth 101 and 201.** The radiograph shows established periapical bone lesions on both fractured teeth.



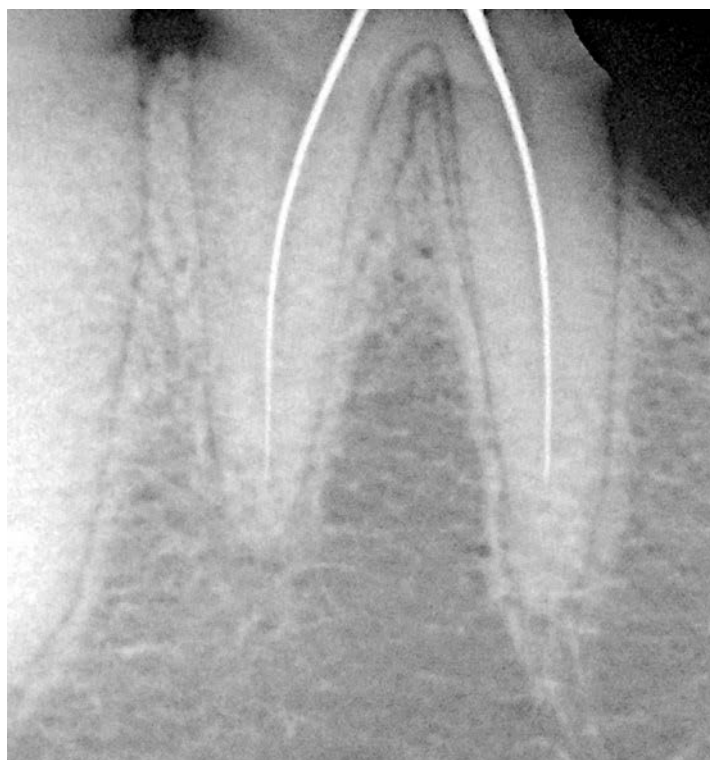
► **Fig. 16.69 Radiograph of the root canal filling of teeth 101 and 201.** A tightly sealed root canal filling is a prerequisite for periapical healing.

### Small Premolar Fracture in a Dog

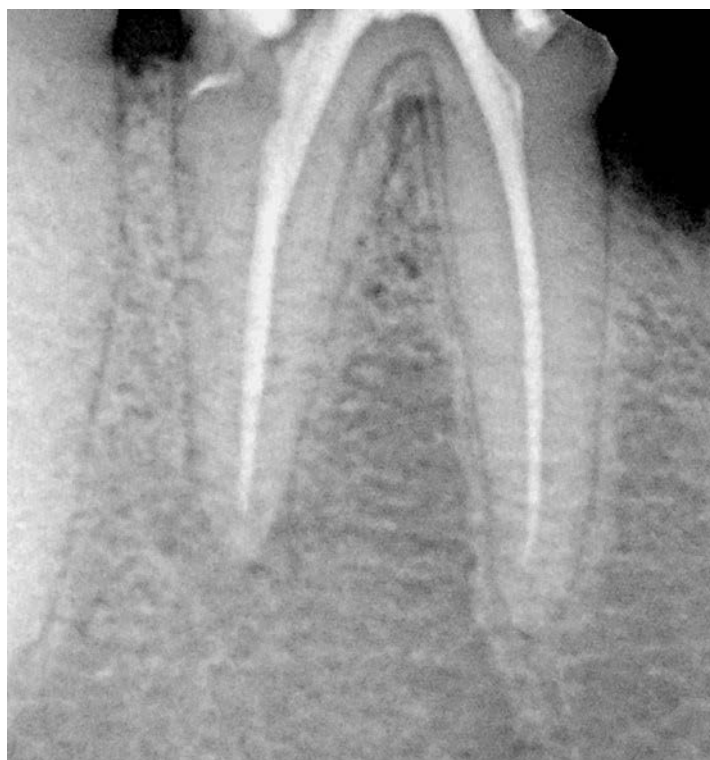
Restoring an incisor or small premolar is sometimes more technically challenging than restoring a canine tooth. In addition to achieving straight access to the root canal, the aim should be to optimize preservation of the dental crown (► Fig. 16.70, ► Fig. 16.71, ► Fig. 16.72).



► **Fig. 16.70 Fractured tooth 408 with measurement tools.** Whether or not a fractured small premolar should be preserved is debatable, but treatment is indicated in any case. Root canal therapy and extraction are the only options for preventing uncontrollable periapical inflammation with osteolysis and root resorption. The two root canals of this fourth mandibular premolar can be accessed via the central fracture. No further weakening of the crown is required for creating separate accesses.



► **Fig. 16.71 Measurement radiograph of tooth 408.** In the measurement radiograph, the file in the distal canal reaches the apical stop. The mesial working length must be extended by 1 mm to prepare the canal to the end.



► **Fig. 16.72 Intraoperative radiograph of the root canal filling of tooth 408.** The intraoperative radiograph shows that full root length has been reached in both canals. In multirooted teeth, all root canals must be treated since they have a common pulp system.



### Fractured Carnassial Teeth with Pulp Exposure

The three roots of a maxillary carnassial tooth significantly increase the difficulty of achieving an adequate root canal filling. While in young animals the canals are still relatively wide, in older animals, the palatal root canal is often particularly difficult to see. If preservative therapy is not possible, the tooth must be extracted.

#### Fractured Maxillary Carnassial Teeth

► Fig. 16.73, ► Fig. 16.74, ► Fig. 16.75 and ► Fig. 16.76 show the clinical findings for fractured maxillary carnassial teeth.



► **Fig. 16.73 Buccal view of an unremarkable tooth 108.** A dog is presented with little calculus and plaque and moderate gingivitis. At first glance, the maxillary right carnassial tooth appears to be unremarkable. Only upon closer examination, which is not always possible depending on the dog's behavior, can thin vertical lines running mesially and distally across the crown be seen.



► **Fig. 16.75 Buccal view of tooth 108 with cusp loss.** Minor cusp loss appears in the lateral view of this maxillary right carnassial tooth.



► **Fig. 16.74 The buccal part of tooth 108 is mobile.** With a sharp dental probe, the entire buccal part of the tooth can be lifted. The area is merely attached to the gingival margin with soft tissue. This is a typical fracture of the maxillary carnassial tooth, called a slab fracture. Due to the scissor occlusion of the carnassial teeth, great lateral forces are applied to the crowns. The maxillary carnassial tooth can fracture when the object located interocclusally is too hard. In addition to cusp loss, the buccal wall is usually involved. Depending on the thickness of the fracture fragment, pulp exposure may occur simultaneously.



► **Fig. 16.76 Fractured palatal cusp of tooth 108.** The fracture that runs palatally has already resulted in palatal exposure of the central cusp. The entire palatal crown is lost as well.



### Fractured Mandibular Carnassial Teeth

Clinical and radiographic findings for fractured mandibular carnassial teeth are presented in ► Fig. 16.77, ► Fig. 16.78, ► Fig. 16.79, ► Fig. 16.80 and ► Fig. 16.81.



► Fig. 16.79 Case 2: Mesial cusp loss on tooth 309. The slightly pink discoloration of the cusp indicates the involvement of the pulp. The mesial part of the crown shows a missing part.



► Fig. 16.77 Case 1: Fractured tooth 309 with destruction of the mesial crown area. In very early trauma to a tooth followed by pulp necrosis, the tooth does not develop further, and only a thin enamel-dentin wall is present. This type of fracture often results in the impaction of foreign material in the gaping pulp cavity.



► Fig. 16.80 Case 2: Pulp exposure of the mesial cusp of tooth 309. The occlusal view of the fracture of the mesial cusp shows exposure of the nonvital pulp.



► Fig. 16.78 Case 1: Radiograph of fractured tooth 309. The disturbance of further development of the tooth is apparent in the radiograph. Root development stopped at the time of trauma. The roots have a soft Hertwig epithelial root sheath.

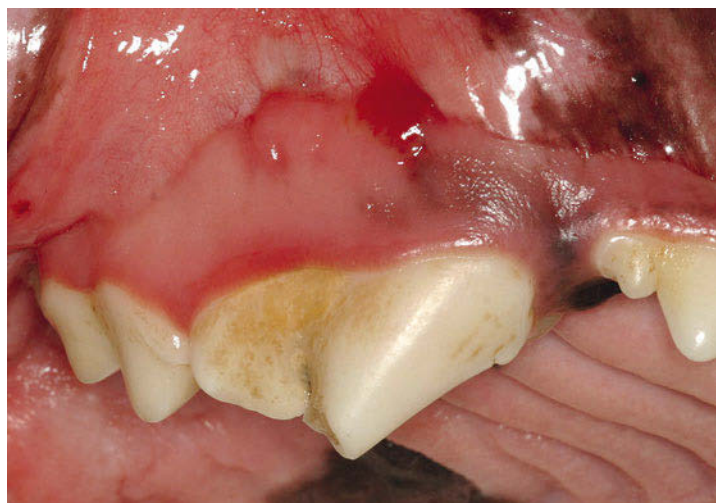


► Fig. 16.81 Case 2: Radiograph of tooth 309 with severe resorption. The continuation of the inflammatory process into the jaw via the pulp system is manifested by the severe periapical osteolysis.



### Multiple Carnassial Tooth Fractures and Severe Periapical Inflammation

When it rains, it pours. When a key tooth fractures because teeth are used inappropriately, symmetrical defects are quite common (► Fig. 16.82, ► Fig. 16.84, ► Fig. 16.86, ► Fig. 16.83, ► Fig. 16.85, ► Fig. 16.87, ► Fig. 16.88).



► **Fig. 16.82 Fractured tooth 108 without pulp exposure.** A relatively clinically unremarkable cusp fracture is found on the maxillary right carnassial tooth. However, there is distinct reddening at the mucogingival junction over the roots.



► **Fig. 16.84 Fractured tooth 208 without pulp exposure.** The pulp exposure of the maxillary left carnassial tooth is initially uncertain, and probing is also inconclusive. The fracture area is dark.



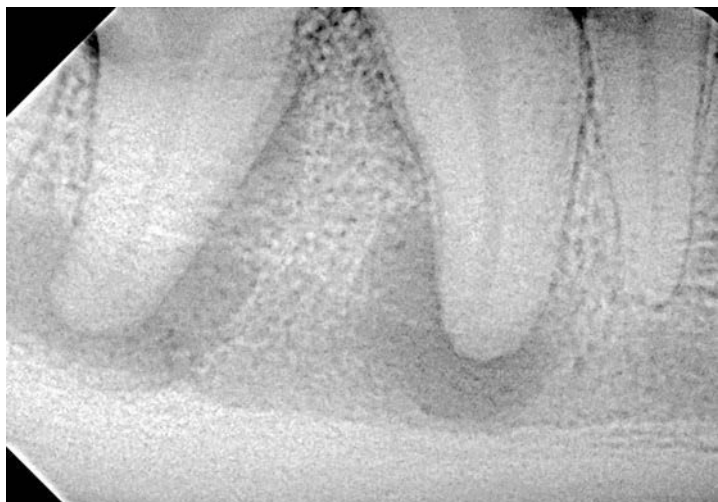
► **Fig. 16.83 Radiograph of fractured tooth 108.** The radiograph of the maxillary right carnassial tooth shows severe osteolysis with root resorption, which explains the reactions of the alveolar mucosa at the mucogingival junction. The wide pulp cavity in this young dog contributes to the fact that even minor trauma can provoke pulpitis.



► **Fig. 16.85 Radiograph of fractured tooth 208.** The maxillary left carnassial tooth fracture occurred later on as a smaller pulp cavity is revealed, but it has resulted in a massive periapical osteolytic process. In contrast to abrasions, dark discoloration of the fractured area is often a sign of pulp involvement.



► **Fig. 16.86 Fractured tooth 409 without pulp exposure.** On the mandibular right carnassial tooth, on the other hand, the cusp shows a slight fracture without visible pulp involvement.



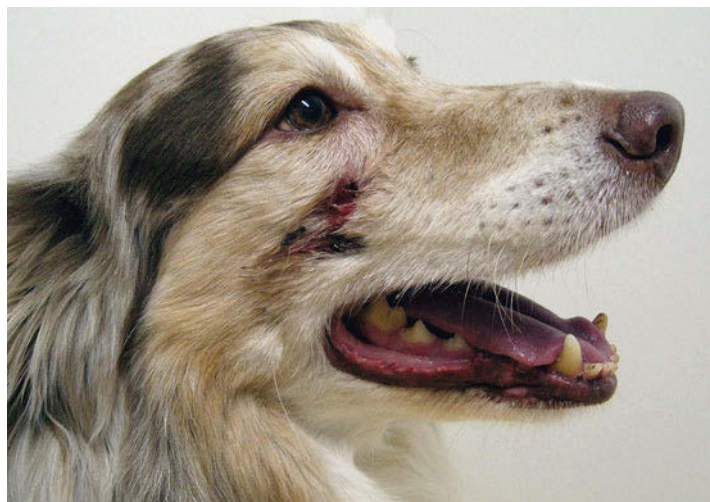
► **Fig. 16.87 Radiograph of fractured tooth 409.** The unremarkable fracture of the mandibular right carnassial tooth shows the most pronounced periapical resorption process. Even the distal root is affected in a retrograde fashion, almost up to the furcation area.



► **Fig. 16.88 Intraoperative radiograph after extraction of tooth 208.**

### **Fistula Formation after Fracture of the Maxillary Right Carnassial Tooth**

In dogs, 9 out of 10 cases of suborbital swelling are attributed to dental issues. The trigger usually is a fractured maxillary carnassial tooth (► Fig. 16.89, ► Fig. 16.90, ► Fig. 16.91, ► Fig. 16.92, ► Fig. 16.93, ► Fig. 16.94). Alternatively, trauma to the maxillary first molar may be responsible. In terms of etiology, this is not necessarily a fracture, since extensive periodontal inflammation of the maxillary cheek teeth may also cause suborbital swelling.

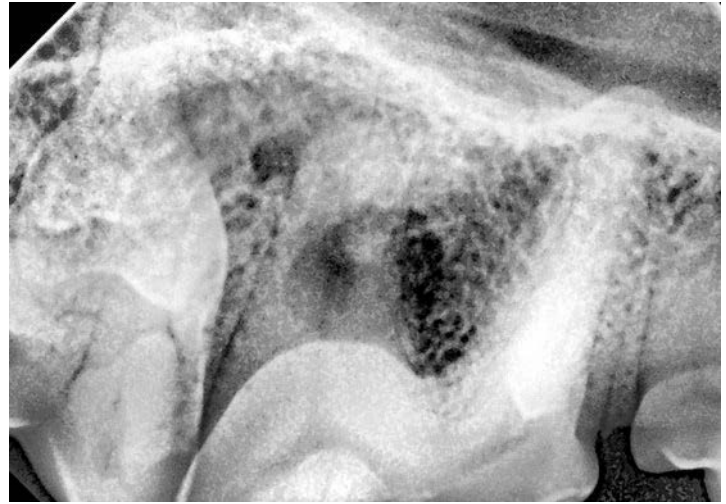


► **Fig. 16.89 Chronic fistula over the right maxilla.** 9 out of 10 cases of suborbital swelling or fistula formation are a manifestation of a dental process. After a maxillary cheek tooth fractures – particularly, a maxillary carnassial tooth – intraosseous periapical inflammation develops. The inflammatory process often remains undetected until it reaches the skin surface. The shortest path is lateral expansion on the maxilla under the skin (suborbital swelling), or the inflamed exudate is discharged via a suborbital fistulous tract. Alternatively, a fistula into the oral cavity vestibule may occur. Unfortunately, intraoral discharge of the inflammatory exudate may further mask this issue.

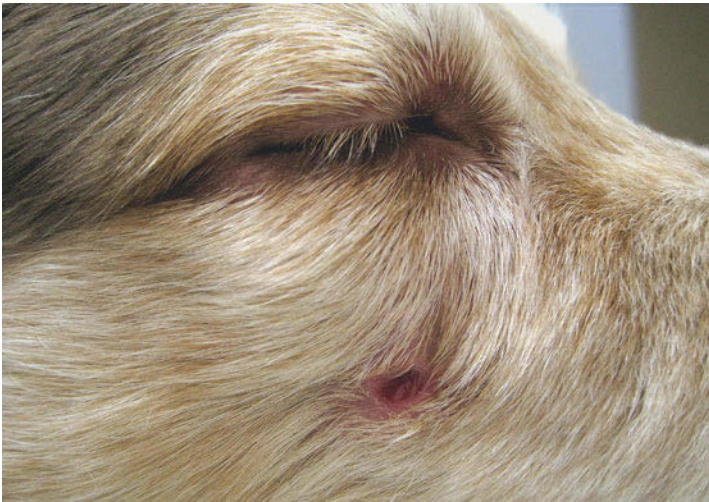




► **Fig. 16.90** **Fistula, covered by a scab.** Upon presentation for surgery, the fistula opening was covered by a scab, which in turn conceals the extent of the damage. In addition, antibiotic treatment can temporarily suppress severe clinical findings.



► **Fig. 16.93** **Radiograph of fractured tooth 108.** The radiograph reveals osteolytic processes around the roots. There is even translucency in the center third of the distal root, in which the internal and peripheral resorptive processes meet.



► **Fig. 16.91** **Clear fistula after cleaning.** A distinct long-existent fistulous tract is visualized after the fistula opening is cleaned.



► **Fig. 16.94** **Radiograph after extraction of tooth 108.** Here too, only the extraction of the affected tooth can remedy this situation. Excising the fistulous tract is usually not necessary, and curettage is generally sufficient. Extracting the fractured tooth as the underlying cause heals the inflammation.



► **Fig. 16.92** **Fractured tooth 108.** Intraorally, the maxillary right carnassial tooth has a deep fracture. Calculus covers the actual opening of the pulp cavity.



### 16.2.3 Isolated Apical Process

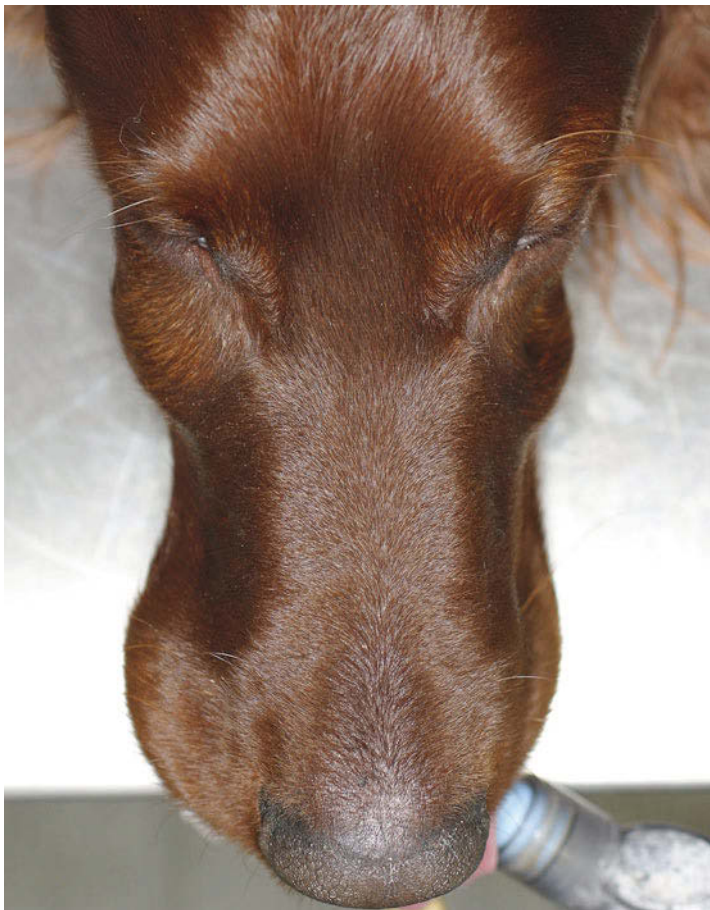
The presence of an apical process does not necessarily correspond with clinical findings in the oral cavity. In 25% of dogs with clinically unremarkable teeth, changes requiring treatment were found on radiographic examination, and in cats even 41% of the teeth were radiographically remarkable.

#### Suborbital Swelling on the Right

The findings and the approach in an Irish Setter with suborbital swelling on the right are presented in the following figures (► Fig. 16.95, ► Fig. 16.96, ► Fig. 16.97, ► Fig. 16.98, ► Fig. 16.99, ► Fig. 16.100, ► Fig. 16.101).



► **Fig. 16.96 Tooth 108 covered in calculus.** Because exogenous trauma (e.g., insect bite, blunt trauma) is less likely than a dental cause, the maxillary right premolar area is carefully examined. The cheek teeth are covered in calculus and plaque with moderate gingivitis. No fractured teeth are observed.

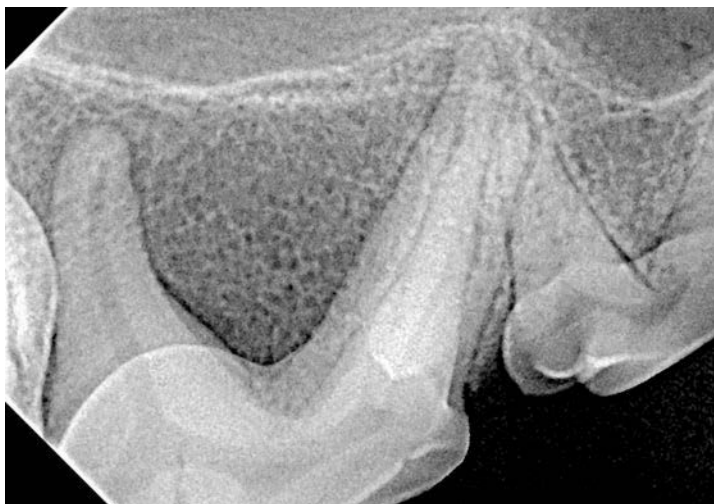


► **Fig. 16.95 Suborbital swelling on the right.** An Irish Setter with recurring suborbital swelling on the right is presented. This dorsal view shows that a physiological structure such as the infraorbital foramen shows a bony suborbital protuberance on both sides. Even if the sides of an animal's face are never symmetrical, an enlargement of the swelling in direction of the orbit should facilitate assessment.

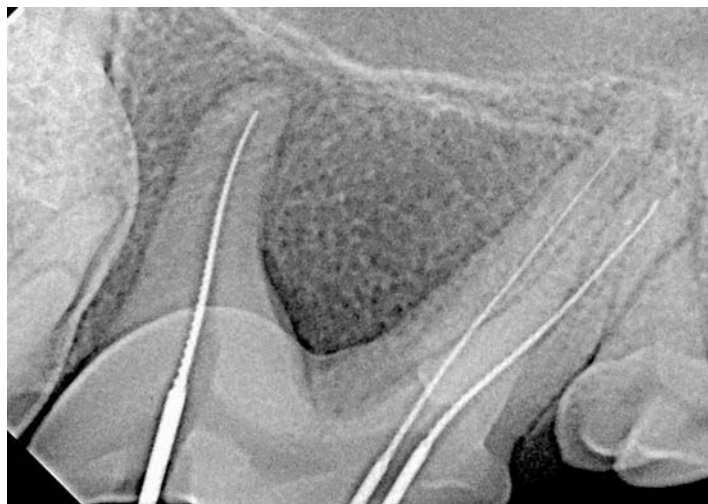


► **Fig. 16.97 Cleaned tooth 108.** Even after cleaning the maxillary carnassial tooth, which is the most common source of suborbital swelling, the clinical situation remains unremarkable.





► **Fig. 16.98 Radiograph of tooth 108 with apical processes.** The radiograph shows apical processes with osteolysis. Without apparent damage to the dental substance of the crown, some unknown trauma has resulted in pulp necrosis with a periapical process. A thin translucent corona appears on all three roots.



► **Fig. 16.100 Measurement radiograph of tooth 108.** The tooth can be preserved with root canal therapy because each root has an acceptable degree of osteolysis and a good apical stop.



► **Fig. 16.99 Necrotic pulp after trepanation.** With trepanation of the tooth, the inflammatory process is confirmed. The necrotic, decomposed pulp is discharged through the cavities.



► **Fig. 16.101 Radiograph of the root canal filling of tooth 108.** A tightly sealed root canal filling is required for complete healing of the involved bone.

### 16.2.4 Root Remnants

Root remnants represent a potential site of infection. Visible root fragments in dogs and cats should be removed. Only for feline teeth with type 2 resorption or in cases in which retrieving the root fragment would cause more damage than keeping it may the root fragment be left.

#### Root Fragments in a Cat

Findings and approach used in a cat with root fragments are shown in ► Fig. 16.102, ► Fig. 16.103, ► Fig. 16.104, ► Fig. 16.105, ► Fig. 16.106, ► Fig. 16.107, ► Fig. 16.108, ► Fig. 16.109, ► Fig. 16.110, ► Fig. 16.111, ► Fig. 16.112 and ► Fig. 16.113.



► **Fig. 16.102 Root fragments, right maxilla.** The cheek teeth of this cat were extracted due to constant gingivitis. Massive inflammation remains on the alveolar ridge mucosa. In addition, a root fragment can be seen in the extraction area of tooth 108.



► **Fig. 16.104 Root fragments, left mandible.** In addition, the inflammation extends to the surrounding loose mucosa in the mandible.

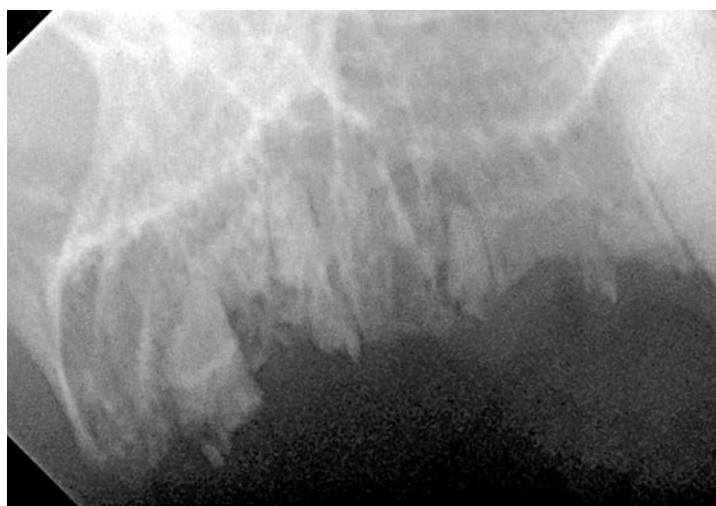


► **Fig. 16.103 Root fragments, left maxilla.** In the maxilla, the visible root fragments are the cause of the chronic gingivitis.



► **Fig. 16.105 Root fragments, right mandible.** On the right, the lingual molar salivary gland stands out prominently after extraction of the mandibular carnassial tooth that usually covers it.





► **Fig. 16.106 Radiograph of the root fragments in the right maxilla.** The remaining roots can be seen radiographically, with root fragments of teeth 108, 107 and 106 preserved in the maxilla.



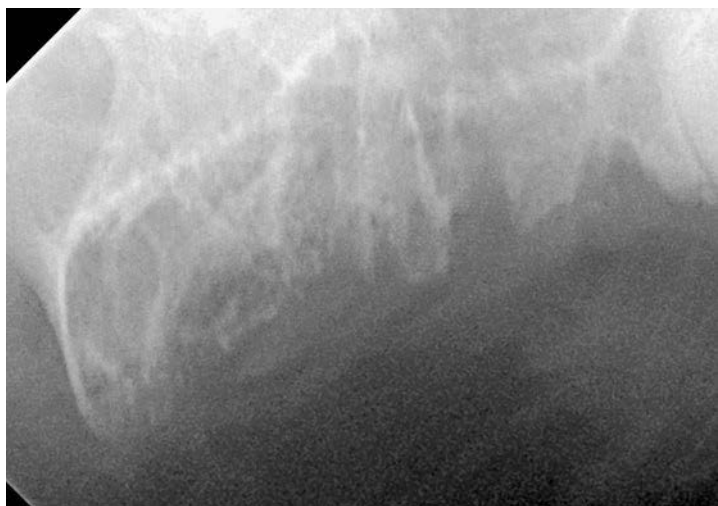
► **Fig. 16.108 Radiograph of the root fragments in the left mandible.**



► **Fig. 16.107 Radiograph of the root fragments in the left maxilla.** The left side appears similar. Tooth 206 is still complete.



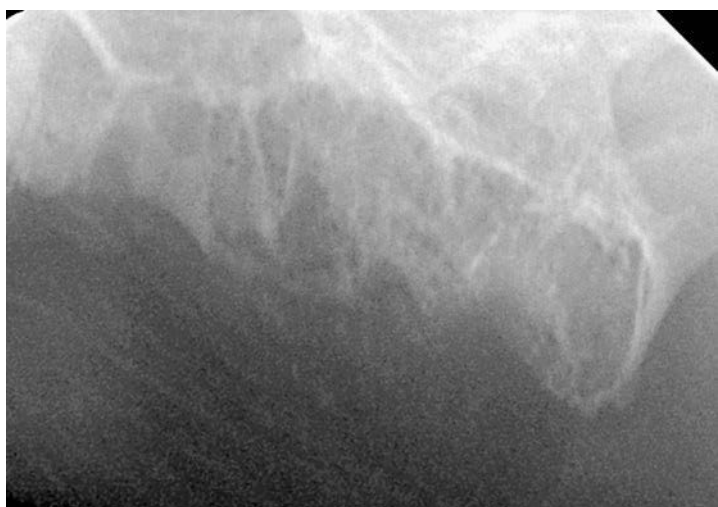
► **Fig. 16.109 Radiograph of the root fragments in the right mandible.** All roots in the right mandible appear in the radiograph.



► Fig. 16.110 Radiograph after extraction of the root fragments in the right maxilla.



► Fig. 16.112 Radiograph after extraction of the root fragments in the left mandible.



► Fig. 16.111 Radiograph after extraction of the root fragments in the left maxilla.



► Fig. 16.113 Radiograph after extraction of the root fragments in the right mandible. The mucosa located above and often adjacent to the root fragments can only heal after all root fragments have been extracted. When all root fragments have been removed and there is no other trigger for inflammation, drug therapy must help minimize or eliminate the inflammation.



### 16.2.5 Vital Pulpotomy

Vital pulpotomy is a vital tooth treatment used only in exceptional situations. Iatrogenic shortening of a tooth, e.g., that performed during correction of a malocclusion, carries a good prognosis. On the other hand, the prognosis of a fractured tooth with pulp exposure is much poorer and worse the longer the pulp is exposed.

#### Repeat Treatment of a Failed Vital Pulpotomy

If the pulp cannot be preserved with a vital pulpotomy, conventional root canal therapy – if possible – can be performed later. Radiographic follow-up of a vital pulpotomy is therefore required to trace the further development and integrity of the root (► Fig. 16.114, ► Fig. 16.115, ► Fig. 16.116, ► Fig. 16.117, ► Fig. 16.118, ► Fig. 16.119, ► Fig. 16.120, ► Fig. 16.121).



► Fig. 16.115 Defects of the fillings in the mandibular canine teeth. The dog is presented again at age 2, and the canine teeth are treated with a vital pulpotomy and a filling. The fillings can no longer be seen at this time. Both teeth have dark discolorations and signs of pulp necrosis.



► Fig. 16.114 Radiograph of the mandibular canines in a 5-month-old dog. At 5 months, the pulp of the mandibular canine teeth is wide, without a root tip, in line with the patient's age.



► Fig. 16.116 Radiograph of the periapical process on teeth 304 and 404. The radiograph shows periapical inflammation on both canine teeth, with no functional root tip.



► **Fig. 16.117 Radiograph with distinct osteolysis around the root tip of tooth 404.** The periapical osteolysis on the mandibular right canine tooth is particularly pronounced.



► **Fig. 16.118 Measurement radiographs in the region around teeth 304 and 404.** Despite careful probing, the file tip slightly penetrated the periapical space of the mandibular left canine when the measurement radiograph was taken because no apical stop was present due to a missing root tip.



► **Fig. 16.119 Intraoperative radiograph of the root canal filling.** The root canal filling must occur without heavy compression to avoid overfilling that leaks into the periapical space. Ultimately, however, this compromises the procedure, which requires the filling to be fully sealed and sufficiently long. In the mandibular left canine tooth, the root canal filling material extends slightly beyond the root tip.





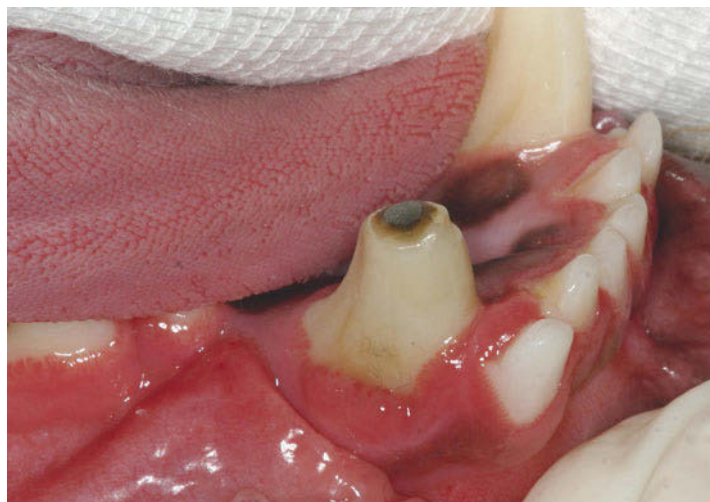
► **Fig. 16.120** Follow-up radiograph of tooth 404 after 6 months. After 6 months, the apical process has clearly healed.



► **Fig. 16.121** Follow-up radiograph of tooth 304 after 6 months. The over-filled root canal filling on the mandibular left canine did not cause a pathological reaction. An unremarkable periapical trabecular bone structure is observed.

### Fistula Formation after Vital Pulpotomy

Without radiographic follow-up, intraosseous root processes often remain undetected until swelling or a fistula occurs (► Fig. 16.122, ► Fig. 16.123, ► Fig. 16.124, ► Fig. 16.125, ► Fig. 16.126, ► Fig. 16.127, ► Fig. 16.128, ► Fig. 16.129).



► **Fig. 16.122** Amalgam filling after shortening of tooth 404. A 3.5-year-old Jack Russell Terrier is presented with chronic problems in the mandibular front teeth. When the dog was 8 months of age, the mandibular right canine was shortened. No treatment was necessary since the pulp was not exposed. At 12 months, the tooth was further shortened and treated with a vital pulpotomy, resulting in recurrent swelling and fistula formation on the rostral mandible. No relationship to the root of the mandibular right canine was observed, and the fistula was treated multiple times. The owner rinsed the tooth over a long period without any improvement.



► **Fig. 16.123** Fistula opening ventrally over the root region of tooth 404. The skin on the mandible is reddened ventrally, with exudation occurring via a fistula opening.





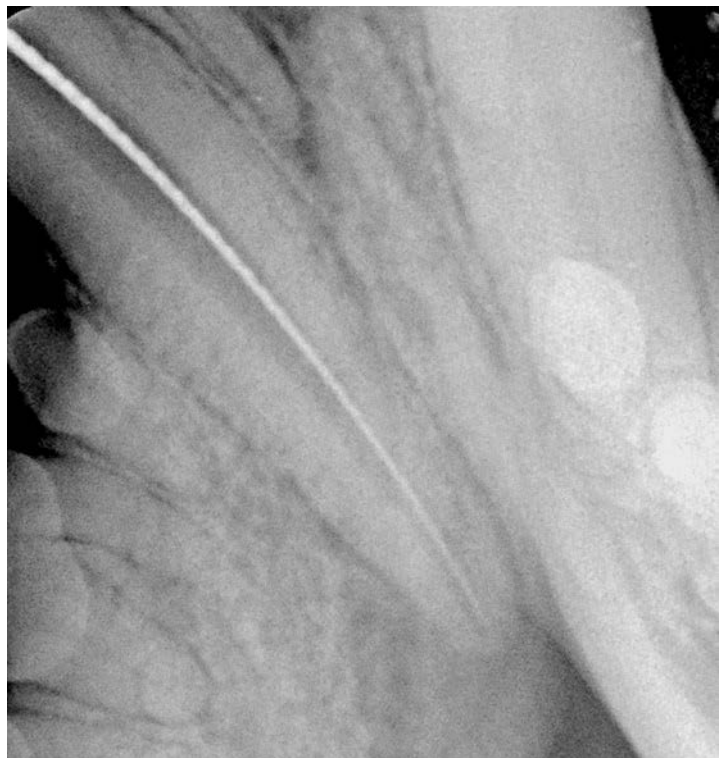
► **Fig. 16.124 Probe placed on the fistula opening.** A periodontal probe can be used to assess the course and depth of the canal.



► **Fig. 16.125 Probe inserted into the fistula canal.** The probe can be inserted deep into the canal and pointed directly toward the root tip of the mandibular right canine tooth.



► **Fig. 16.126 Radiograph of tooth 404 with periapical osteolysis.** The mandibular right canine tooth shows distinct periapical osteolysis. The pulp is significantly wider than on the left side, which indicates pulp necrosis and the subsequent suspended production of dentin. The tooth is nonvital.

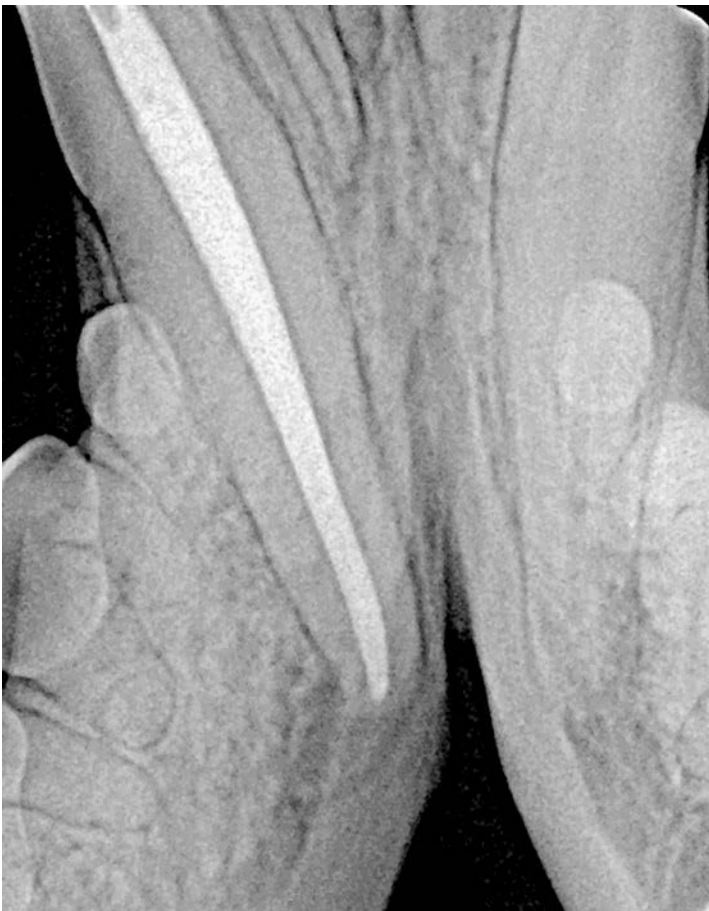


► **Fig. 16.127 Measurement radiograph of tooth 404.** The thin apical stop is distinctly visualized in the measurement radiograph.





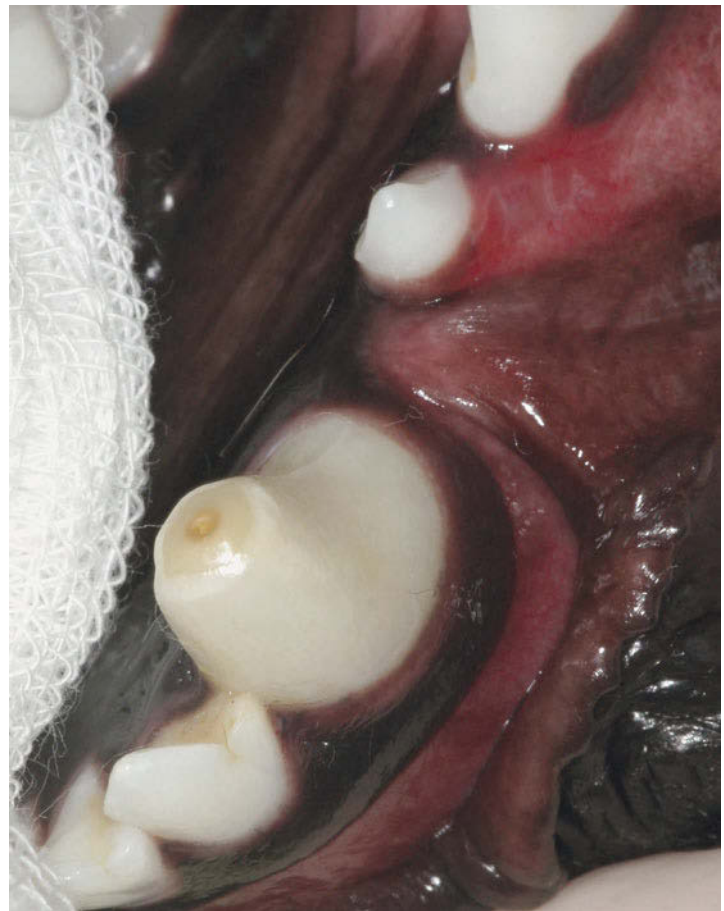
► **Fig. 16.128 Radiograph of the temporary root canal filling of tooth 404.** In order to assess the possibility of preserving the tooth, a temporary root canal filling containing calcium hydroxide is first applied.



► **Fig. 16.129 Follow-up radiograph of the root canal filling.** After 4 weeks, the fistula is no longer observed and the definitive root canal filling is performed. The root canal filling is homogeneously tightly sealed and sufficiently long; it creates a noninflamed and functional tooth in a position that was previously swollen and fistulated.

### 16.2.6 Apexification

If pulp necrosis has occurred without incomplete root formation, a normal root canal filling is not an option. As a last resort, apexification induces hard-tissue closure of the root by placing an intracanal dressing in the pulp canal (► Fig. 16.130, ► Fig. 16.131, ► Fig. 16.132, ► Fig. 16.133, ► Fig. 16.134, ► Fig. 16.135, ► Fig. 16.136, ► Fig. 16.137, ► Fig. 16.138, ► Fig. 16.139, ► Fig. 16.140, ► Fig. 16.141, ► Fig. 16.142, ► Fig. 16.143).



► **Fig. 16.130 Tooth 304 after past crown reduction due to malocclusion-induced trauma.** Crown reduction requires treatment of the exposed pulp. Otherwise, the tooth dies and the root becomes inflamed.



► **Fig. 16.131 Pulp exposure that can be palpated with a probe.** Using a probe to explore the opening shows the involvement of the pulp. The animal is unlikely to react, since the shortening was performed quite some time ago leading to pulp death.



► **Fig. 16.133 Radiograph of the crown of tooth 304.** The pulp exposure and lack of treatment appear in the radiograph of the crown.



► **Fig. 16.132 Radiograph of the roots of tooth 304.** Radiographically, the mandibular canine roots are asymmetrical. The mandibular left canine tooth is underdeveloped, the root walls are thinner, and the root appears shortened and apically radiolucent.



► **Fig. 16.134 Creating a cervical cavity.** A cervical accessory cavity improves access to the walls of the very wide root canal.





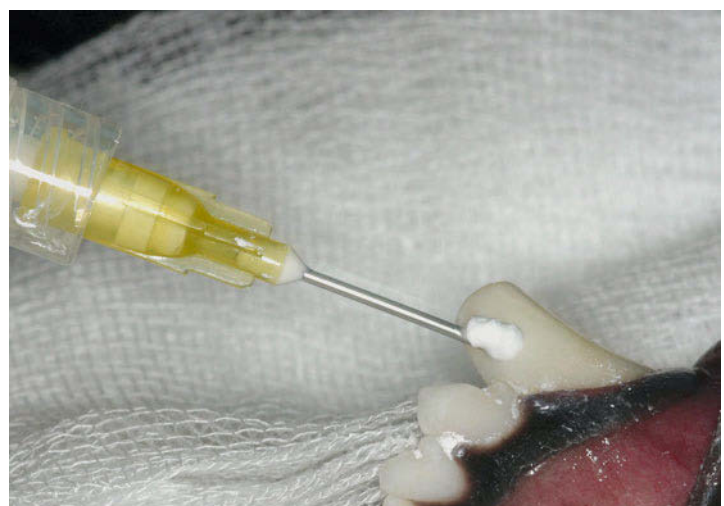
► **Fig. 16.135 Extirpation of nonvital pulp.** The extirpated pulp appears necrotic and brown.



► **Fig. 16.137 Root canal preparation with Hedstrom files.** The pulp cavity is cleaned and the walls are prepared with a Hedstrom file, sparing the apical area. The wide pulp canal and the open apex often induce bleeding. Irrigation is performed not with antiseptic solutions, but with normal saline solution only.



► **Fig. 16.136 Measurement radiograph of the region around tooth 304.** The measurement radiograph is performed carefully under radiographic guidance or with calculation so as not to damage the periapical tissue. The damaged tooth's attempt to prematurely complete hard tissue development is visible in this radiograph.



► **Fig. 16.138 Introducing calcium hydroxide.** Once the canal is dried, it is filled with a calcium hydroxide dressing.



► **Fig. 16.139 Radiograph of the intracanal dressing.** Intraoperative radiographs must be taken to ensure that the apical area is sufficiently filled.



► **Fig. 16.141 Radiograph of the intracanal dressing after 6 months.** After three changes of the intracanal dressing, the radiograph shows a mostly stable situation with apexification and simultaneous resorption of the apical part of the intracanal dressing.



► **Fig. 16.140 Temporary filling of tooth 304.** The tooth is closed with temporary cement until the next intracanal dressing change.





► **Fig. 16.142 Intraoperative radiograph of the permanent root canal filling.** The permanent root canal filling must in turn be placed under low pressure to avoid jeopardizing the integrity of the apical area. The periodontal ligament space of the root tip is unremarkable.



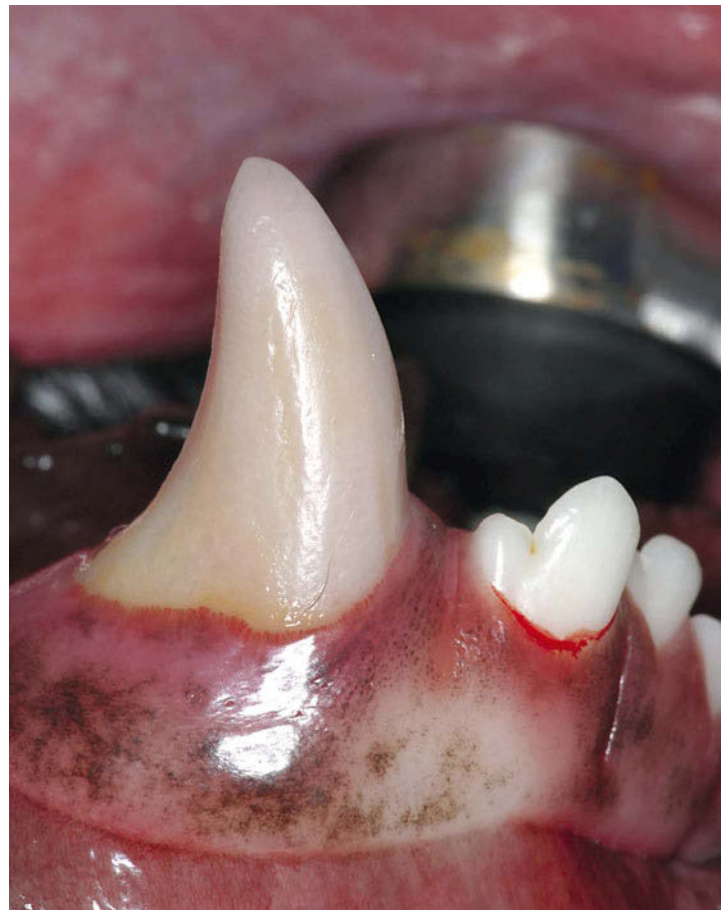
► **Fig. 16.143 Coronal fillings of tooth 304.** The procedure is completed with coronal fillings.

### 16.2.7 Bleaching

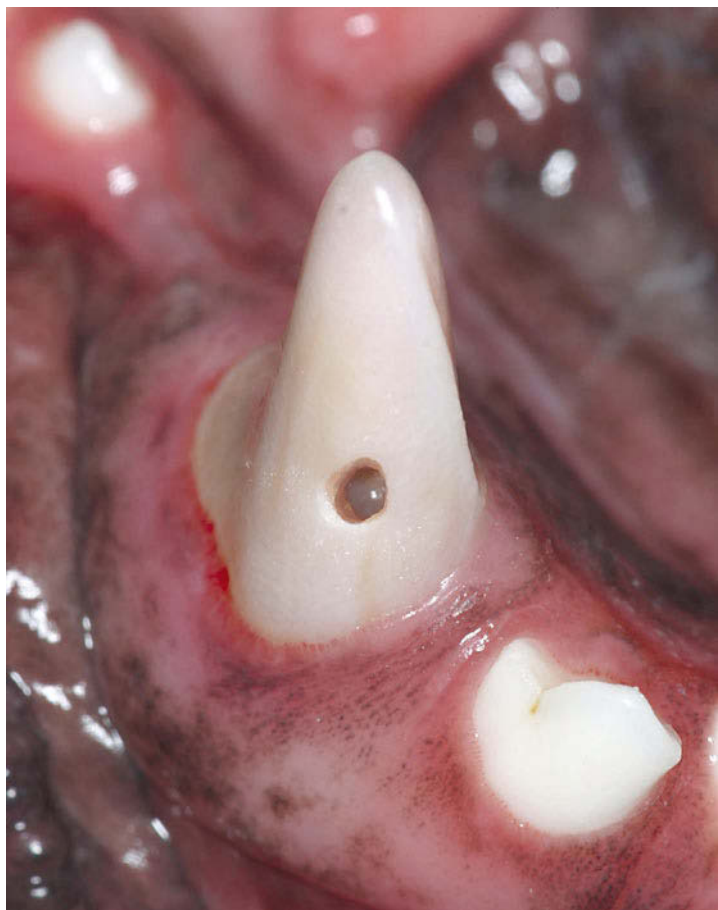
The teeth can be optionally be bleached while the animal is under anesthesia.

#### Bleaching After Shortening of Tooth 404.

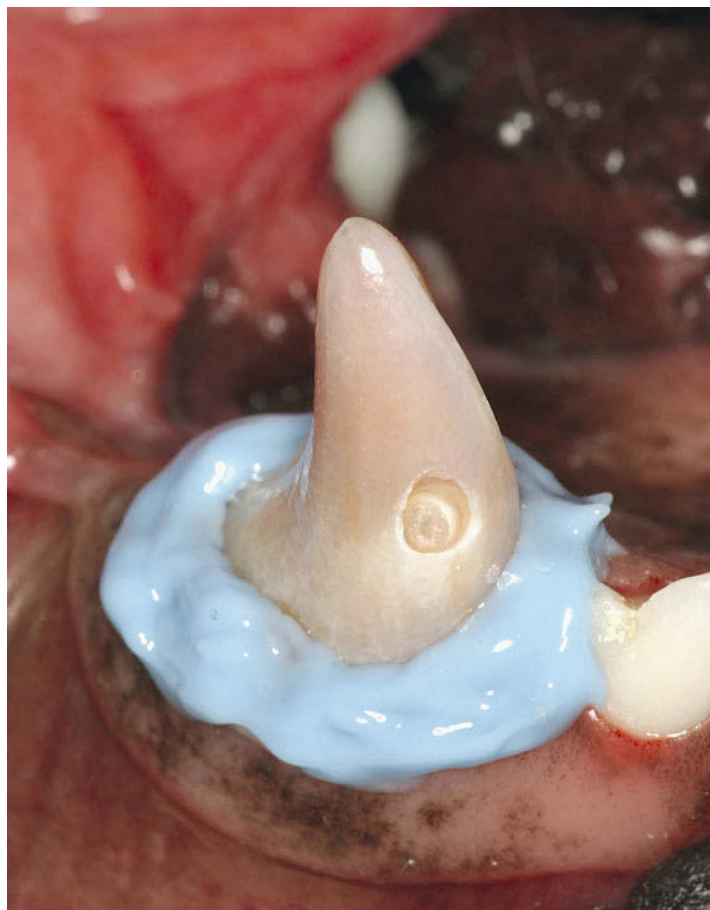
Dental bleaching is often part of root canal therapy (► Fig. 16.144, ► Fig. 16.145, ► Fig. 16.146, ► Fig. 16.147, ► Fig. 16.148, ► Fig. 16.149, ► Fig. 16.150).



► **Fig. 16.144 Discoloration of tooth 404.** Pulp necrosis with bleeding can cause detritus to penetrate the dentin, which discolors the tooth.



► **Fig. 16.145 Trepanation via the cervical cavity.** Endodontic treatment must be carried out prior to bleaching.



► **Fig. 16.147 Covering the gingiva with silicone.** After the root canal therapy, the gingiva is protected with silicone before bleaching.

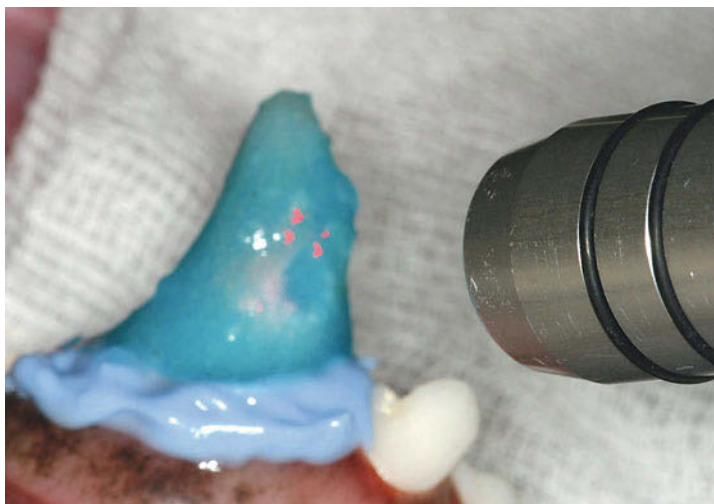


► **Fig. 16.146 Extirpating the pulp.** The tooth is discolored due to the poor pulp condition, which is visible upon extirpation. It is not yet nonvital but is already starting to be inflamed and is dark red in color.



► **Fig. 16.148 Etching on tooth 404.** Hydrogen peroxide gel is used for bleaching.





► **Fig. 16.149 Activation of bleach with a defocusing handpiece.** The effect of the bleaching gel is enhanced with the defocused diode laser.

### 16.3 Caries

Caries is rare in dogs (3% to 5% incidence), and it does not occur in cats. Caries manifest on occlusal surfaces and affect fissures and fossa in the grinding parts of the bite. Therefore, the focus is on the cheek teeth, which have occlusal surfaces.

#### 16.3.1 Caries on the Maxillary Cheek Teeth with Filling and Extraction

Findings and the approaches used for caries on the maxillary cheek teeth are shown in ► Fig. 16.151, ► Fig. 16.152, ► Fig. 16.153, ► Fig. 16.154, ► Fig. 16.155, ► Fig. 16.156, ► Fig. 16.157 and ► Fig. 16.158.



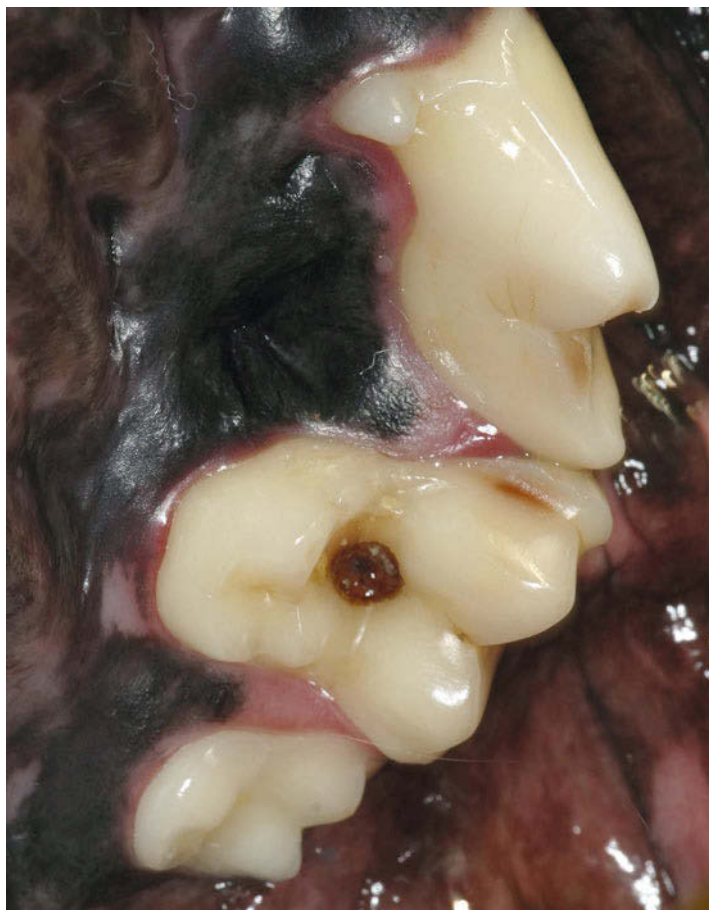
► **Fig. 16.150 Results after bleaching.** The tooth becomes much lighter after several minutes of bleaching.



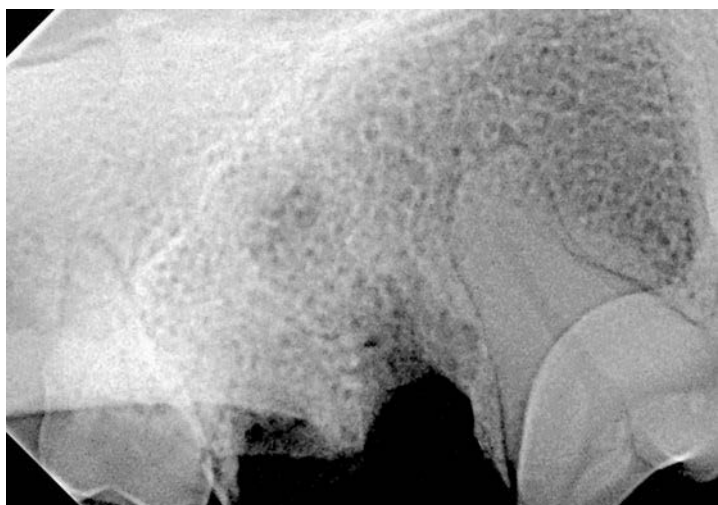
► **Fig. 16.151 Caries on tooth 109.** The development of caries in the cheek teeth is often not apparent to the owner; the owner is more likely to notice behavioral changes that correlate with the degree of damage and the associated increased pain sensation. The maxillary right first molar crown is almost fully destroyed. Instead of the dental crown, broad areas of exposed pulp and/or inflamed granulated tissue appear. A common sign of the patient's pain is avoidance of contact with the head.



► **Fig. 16.152 Radiograph of the caries on tooth 109.** The radiograph illustrates the full destruction of the tooth extending into the root area. The continued inflammation has caused periapical osteolysis. The rapid progression of caries often results in pulp involvement. At that point, preserving the pulp is no longer possible, and the tooth can only be preserved by root canal therapy. The root morphology of the maxillary first molar does not always permit root canal therapy, and the process is usually so destructive that the tooth, or whatever remains of it, must be extracted. The maxillary first molar is already fully destroyed, the roots are separated by the caries in the furcation, and periapical osteolytic processes are occurring.



► **Fig. 16.154 Caries on tooth 209.** Bacterial metabolism of carbohydrates in an increasingly thick plaque film promotes the production of acids (lactic acid, acetic acid, formate acid, propionic acid) that demineralize the enamel, making it more permeable. Once the lesion reaches the dentin, it spreads more quickly due to the lower inorganic share, which also explains the insidious growth of the caries undermining the enamel. While some caries penetrate directly into the pulp, the undermining variant is more common. Histopathologically, caries is layered, but the thin wall in the area of the fossa and the acute nature of the disease complicate microscopic evaluation and separation into the individual zones. If softening of the tooth substance is found, radiography is required to determine further treatment.



► **Fig. 16.153 Radiograph after extraction of tooth 109.** The destroyed and separated tooth may only be extracted surgically, which also allows for secure closure of the wound with a suture after extraction.



► **Fig. 16.155 Radiograph of the caries on tooth 209.** New dentin is produced in an attempt to protect the tooth against the impending bacterial attack to avoid bacterial infiltration of the pulp. Caries can be detected in the radiograph only as mild central translucencies on the crown. The other parts of the teeth are unremarkable and no apical processes are present.





► **Fig. 16.156 Excavation of tooth 209.** The abnormal soft brownish spots are first removed with cutting diamonds, and closer to the pulp with a rose-head bur. In order to avoid penetration into the pulp, brown spots can be left alone as long as no softening is detected.



► **Fig. 16.158 Filling of tooth 209.** Finally, the restoration is placed with tooth-colored composite and the occlusion checked.



► **Fig. 16.157 Indirect capping of tooth 209.** In order to prevent the filling material from inducing pulp necrosis, the areas close to the pulp are capped indirectly with calcium hydroxide-containing material.

## Fillings

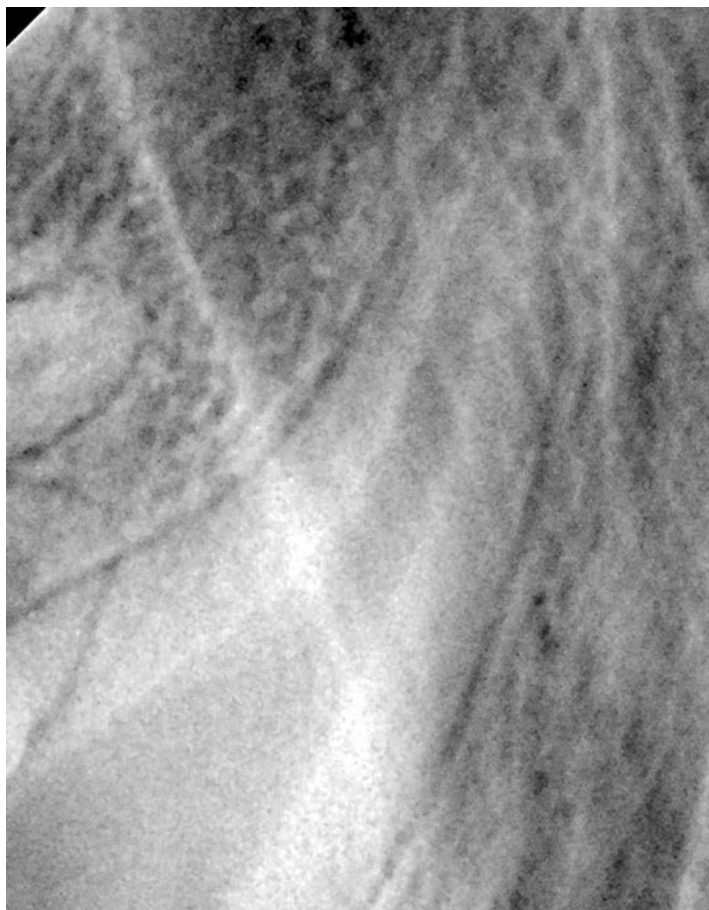
Tooth-colored filling materials are usually used as a bacteria-proof completion of root canal therapy or for covering an enamel defect due to enamel hypoplasia or an uncomplicated tooth fracture. Certain principles of preparation and for the procedure are critical to ensure sufficient stability and durability of the filling.

### 16.4.1 Deformed Maxillary Canine Crown

Even more difficult than filling a small cavity in an otherwise intact tooth is treatment of a fully deformed tooth (► Fig. 16.159, ► Fig. 16.160, ► Fig. 16.161, ► Fig. 16.162).



► **Fig. 16.159 Deformity of tooth 104.** Local trauma to a growing tooth may not only disturb enamel formation, but also result in deformation of the crown and/or the root. This maxillary right canine tooth shows defects in enamel formation across the entire crown. Cervically, a horizontal “step” is seen, and reactive gingival hyperplasia has occurred on the mesial tooth surface.



► **Fig. 16.160 Radiograph of tooth 104.** The tooth root is unremarkable in the radiograph.



### 16.4.2 Chipping of the Cusp and Buccal Surface on a Maxillary Carnassial Tooth

The following figures illustrate the findings and approach used to treat chipping of a maxillary carnassial tooth (► Fig. 16.163, ► Fig. 16.164, ► Fig. 16.165, ► Fig. 16.166, ► Fig. 16.167, ► Fig. 16.168, ► Fig. 16.169, ► Fig. 16.170, ► Fig. 16.171, ► Fig. 16.172, ► Fig. 16.173, ► Fig. 16.174).



► **Fig. 16.161 Tooth 104 after preparation.** All apparently changed and brownish tooth areas are prepared to create an area receptive to the composite. The hyperplastic gingiva in the mesial area is removed.



► **Fig. 16.163 Crown fracture of tooth 108.** The normal load placed on the carnassial teeth in the cutting carnivore bite due to their function unfortunately often results in particular damage to the maxillary carnassial teeth. If the dog bites down on hard interocclusal material, the tip of the maxillary carnassial tooth can fracture, and in some cases the buccal enamel wall can also break off. The patient is fortunate if pulp exposure does not occur. In this case, the tip and part of the buccal wall are missing, but the pulp chamber is not affected. The wound must be treated in order to prevent pulpitis in cases of clinically apparent and painful impairment.



► **Fig. 16.162 Finished filling of tooth 104.** Most of the crown surface can be restored with composite, which should prophylactically counteract recurrent gingival hyperplasia as well as increased plaque accumulation

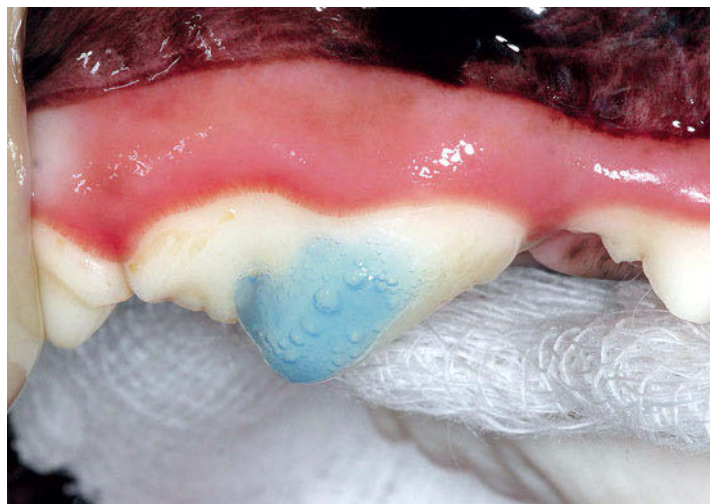


► **Fig. 16.164 Radiograph of tooth 108.** The radiograph shows unremarkable roots.

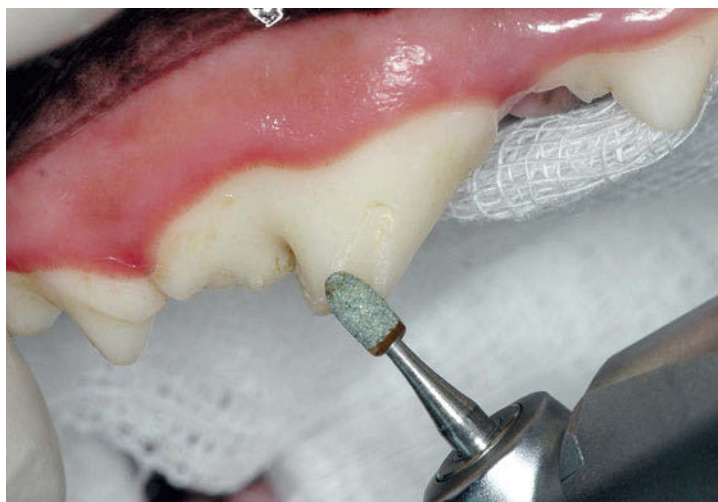




► **Fig. 16.165 Cleaned crown.** The crown is cleaned.



► **Fig. 16.168 Etching the cavity.** Etching with 37% to 40% phosphoric acid creates a microretentive surface.



► **Fig. 16.166 Coarse finishing of the fracture cavity.** The cavity is prepared with coarse stones.



► **Fig. 16.169 Applying the bonding agent.** A bonding agent is brushed on; it acts as a luting agent for the high-viscosity composite. Residual plaque that is not in the direct vicinity of the cavity, but close to the gingival margin, may be left in order to avoid gingival bleeding.

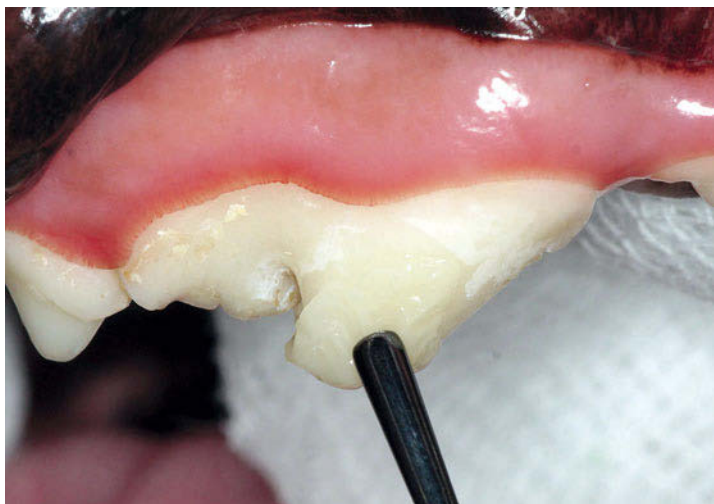


► **Fig. 16.167 Fine finishing of the fracture cavity.** Fine white Arkansas stones are used to remove the chipped enamel for better edge shaping.



► **Fig. 16.170 Applying the composite.** A cartridge applicator can also be used to apply composite directly to the tooth.

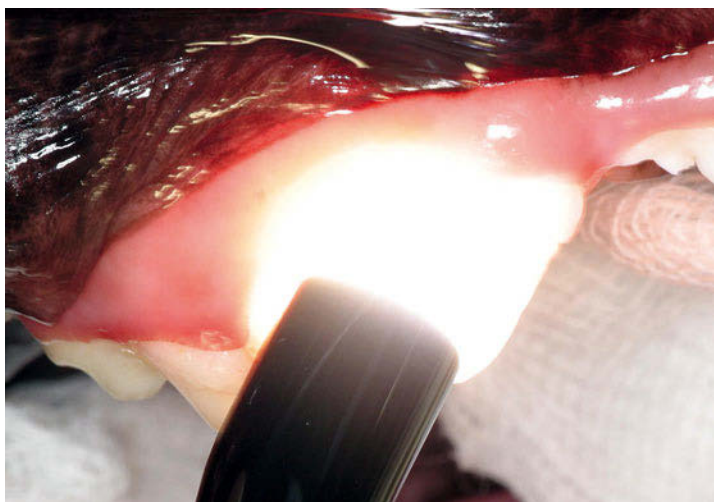




► **Fig. 16.171 Modeling of the composite.** Numerous tools can be used to give the filling the desired shape. A surface coating prevents the composite from adhering to the instrument.



► **Fig. 16.173 Finishing the filling.** Diamonds, stones, polishing rubbers and/or flexible polishing discs are used to finish the filling.



► **Fig. 16.172 Curing the composite.** A curing light is used to cure the composite.



► **Fig. 16.174 Finished filling.** The finished filling replaces the lost tooth substance and restores the integrity of the crown.

## 16.5

**Crown Replacement**

If the crown of a tooth is too heavily damaged for a composite filling, an artificial crown can be fabricated.

16.5.1 **Metal Crown for Canine Tooth****Current Case**

The following figures show a case in which a crown replacement is indicated (► Fig. 16.175, ► Fig. 16.176, ► Fig. 16.177).



► **Fig. 16.176 Loss of the mesial crown.** The lateral view clearly shows the loss of the mesial crown section.



► **Fig. 16.175 Rupture of the coronal filling.** In many cases, after root canal therapy of a canine tooth, composite may be used to seal it coronally. Considering that a dog can fracture a healthy canine tooth, however, it can obviously also re-fracture a tooth that had previous root canal therapy or is brittle. The fracture runs mesially up into the subgingival area. The root canal filling is exposed.



► **Fig. 16.177 Radiograph of the old root canal filling of tooth 404.** Radiographically, a leaking root canal filling is shown.



## Root Canal Therapy

In order to fit a tooth with a metal crown, the tooth must be healthy. Thus, the root canal filling must first be restored (► Fig. 16.178, ► Fig. 16.179, ► Fig. 16.180).



► Fig. 16.179 Measurement radiograph of tooth 404. A measurement radiograph is used to verify the working length.



► Fig. 16.178 Radiograph after the old root canal filling is removed. A radiograph ensures that all residual parts of the filling have been removed.



► Fig. 16.180 Postoperative radiograph of the root canal filling of tooth 404. Finally, a radiograph is taken of the root canal filling.

## Preparation of the Crown

The following figures and schematics show the procedure for preparing the tooth stump (► Fig. 16.181, ► Fig. 16.182, ► Fig. 16.183, ► Fig. 16.184, ► Fig. 16.185, ► Fig. 16.186).



► **Fig. 16.181** Mesial view of the crown preparation of tooth 404. The tooth is prepared in a circular manner for receiving the metal crown. The white margin of the prepared border should stand out visually from the remaining stump.

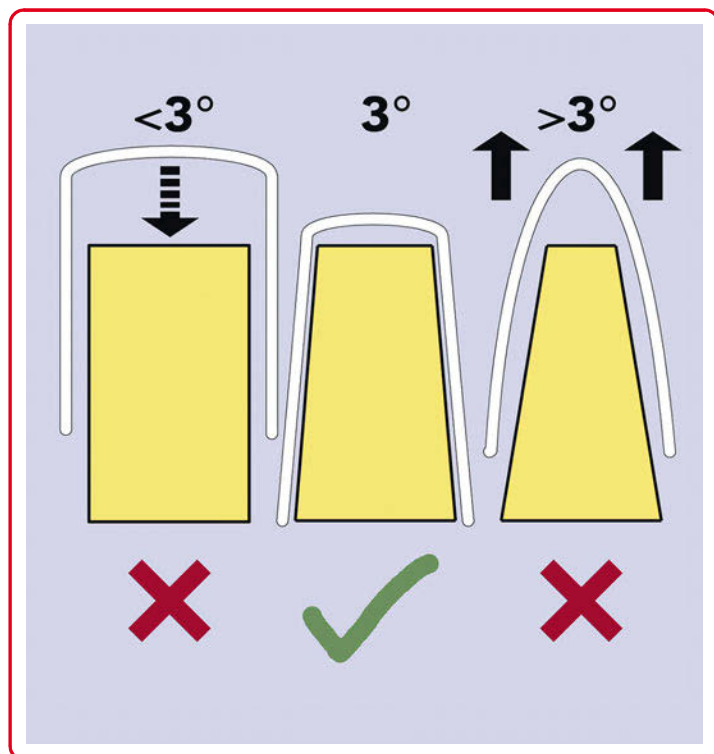


► **Fig. 16.182** Lateral view of the crown preparation of tooth 404. A vertical buccal cavity that counteracts the rotational forces is additionally prepared on the very round stump.



► **Fig. 16.183** Occlusal view of the crown preparation of tooth 404. In the occlusal view, the entire preparation border should be visible because it converges at the cusp. In the mesial area, the border cannot be seen clearly due to the subgingival fracture.

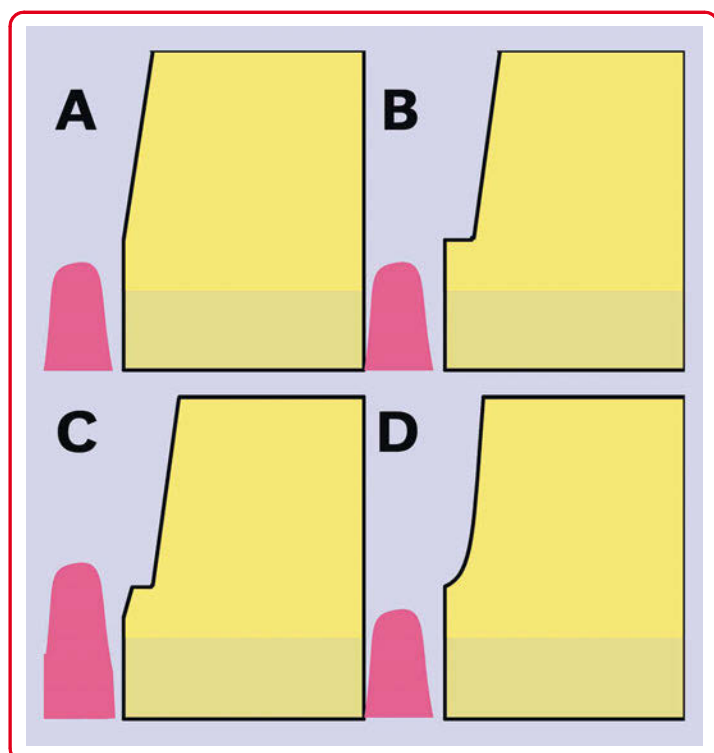




► **Fig. 16.184 Wall inclination of the crown.** The tooth wall requires a certain angle of inclination for receiving a crown, as shown in this schematic diagram. A wall inclination of  $3^\circ$  enables a crown to be fitted and cemented. However, in the case of parallel wall preparation, it cannot be placed on the stump up to the preparation border. When the inclination angle is too great, the friction of the crown is reduced and a risk of a premature crown loss arises.



► **Fig. 16.186 Cutting diamond instrument set for preparation.** Different cutting diamond designs are available for shaping the crown stump. Based on the frequently used chamfer, a torpedo (medium form) is most convenient.



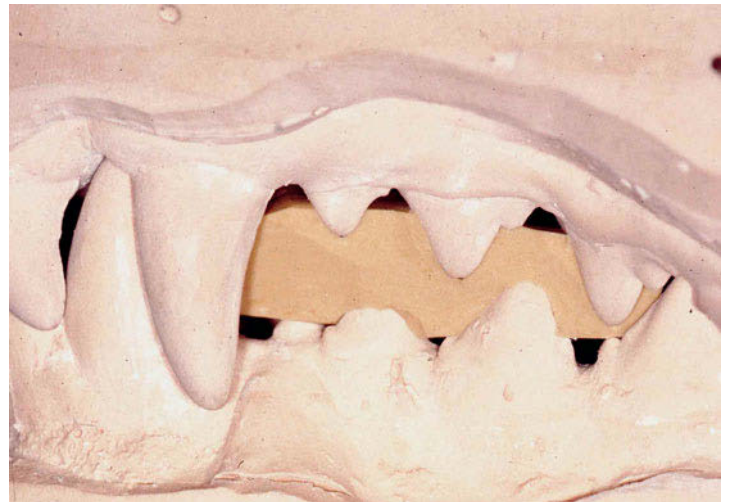
► **Fig. 16.185 Shaping the preparation border.** The crown margin may be shaped in various ways. Variant D is preferred. Chamfer preparation enables both metal and ceramic preparation. The edge is thick enough, the cement gap is thinned out in the area of the coronal margin, and the preparation border can be clinically visualized more clearly than in tangential preparation (variant A), for example.

## Producing the Dental Cast

An impression is taken of the teeth to make a dental cast, which is used as a model to create an artificial crown (► Fig. 16.187, ► Fig. 16.188, ► Fig. 16.189, ► Fig. 16.190).



► **Fig. 16.187 Retraction cord.** A retraction cord can be inserted into the gingival sulcus to dry and, if needed, separate the gingiva from the preparation border. The cord is removed just before introducing the impression material.



► **Fig. 16.189 Silicone bite registration.** The position of the maxilla and mandible between the openly interdigitating premolars can be registered with a silicone bite registration. In the laboratory, the bite registration is used to fix the maxilla and mandible against each other to simulate the relative positions of the teeth when modeling the crown.



► **Fig. 16.188 Impression tray.** Since canine bites vary widely in size and shape, standardized impression trays are difficult to use. Instead, it is preferable to use impression trays that are fabricated individually for different bites. Multiple models are required to cover the entire range of variation. The tray is filled with impression silicone, the preparation edge is covered with low-viscosity silicone, and the tray and the silicone are placed in the oral cavity. After hardening, the crown impression and the impression of the counter-bite are taken to a dental laboratory for further processing.

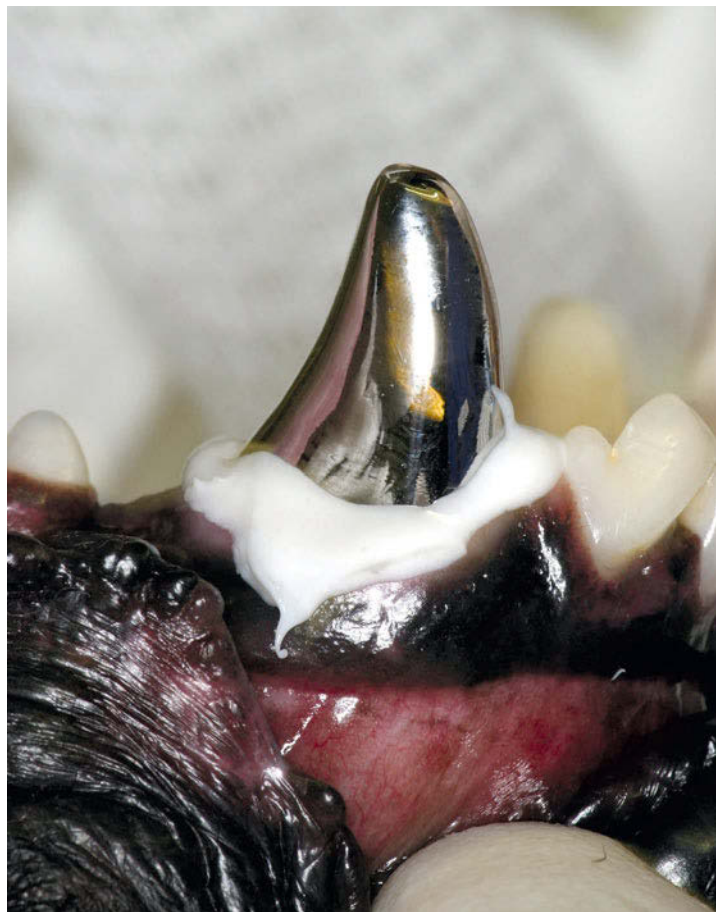


► **Fig. 16.190 Articulated dental casts.** To avoid incorrect points of contact for the very tight occlusion in the canine bite, after molding, the dental casts are mounted in an articulator, which simulates occlusion in the dog's head during movement. The bite registration enables the dental casts to be placed against each other in their natural position in the articulator, and the opening of the maxilla and mandible is simulated to avoid tooth-to-tooth contact in the occlusion.



## Fitting of the Crown

In the last step, the crown is fitted onto the tooth stump (► Fig. 16.191, ► Fig. 16.192, ► Fig. 16.193, ► Fig. 16.194).



► **Fig. 16.191 Fitting of the crown.** The fit of the crown on the stump is tested with special low-viscosity silicone.



► **Fig. 16.192 Checking the crown fit.** An evenly thin silicone layer shows appropriate placement of the crown on the stump. Interruption of the silicone film indicates contact between the inside of the crown and the tooth stump that must be eliminated.



► **Fig. 16.193 Cemented crown on tooth 404.** After fitting, the crown is permanently cemented to the tooth. Residual cement must be removed, the crown margin must be polished, and the occlusion must be checked.



► **Fig. 16.194 Follow-up presentation, crown in use.** At the 6-month follow-up, the crowned mandibular canine tooth is unremarkable.

### 16.5.2 Ceramic Canine Crown

A tooth-colored ceramic or a veneer crown can be used instead of a metal crown for aesthetic reasons while supporting a functional load. (► Fig. 16.195, ► Fig. 16.196, ► Fig. 16.197, ► Fig. 16.198, ► Fig. 16.199, ► Fig. 16.200, ► Fig. 16.201). Ceramic can usually withstand a load, while composite veneer crowns cannot provide sufficient stability.



► **Fig. 16.195 Tooth 304 after root canal therapy.** Appearance of the fractured mandibular left canine tooth. Root canal therapy was performed through the fracture cavity.

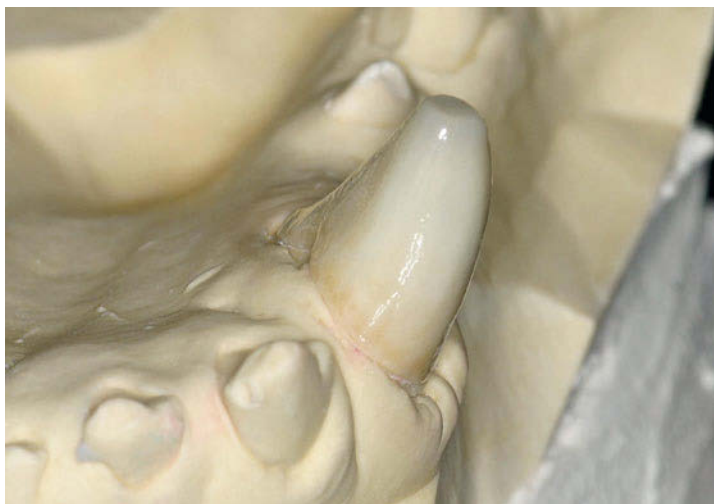


► **Fig. 16.196 Preparation of the crown, mesial view.** From the mesial direction, a good cervical chamfer and the preparation border can be seen at the same time.



► **Fig. 16.197 Preparation of the crown, occlusal view.** The entire preparation border can be seen from the occlusal direction.





► **Fig. 16.198 Ceramic crown for tooth 304 on a model.** Ceramic material is used for the crown for aesthetic reasons. The new canine crown is deliberately shorter than the original dental crown in order to optimize leverage and mitigate the loss of the artificial crown. While the crown is slightly smaller and stubbier, the abrasion of the mandibular right canine fortunately creates a visual balance.



► **Fig. 16.200 Ceramic crown of tooth 304 in situ, lingual view.** The abrasion on the mandibular right canine fortunately makes the artificial crown of the left canine tooth appear more symmetrical.



► **Fig. 16.199 Ceramic crown of tooth 304 in situ, close-up lateral view.** A ceramic crown is more visually appealing than a metal crown. The gingiva obscures the crown edge due to its cervical position.



► **Fig. 16.201 Occlusion of tooth 304 with ceramic crown.** The occlusion with the maxillary teeth is unremarkable as well, since the way the carnassial tooth is guided in dogs causes the canines to lose contact immediately when the jaw is opened.

## 16.5.3 Carnassial Tooth Crown

**Current Case**

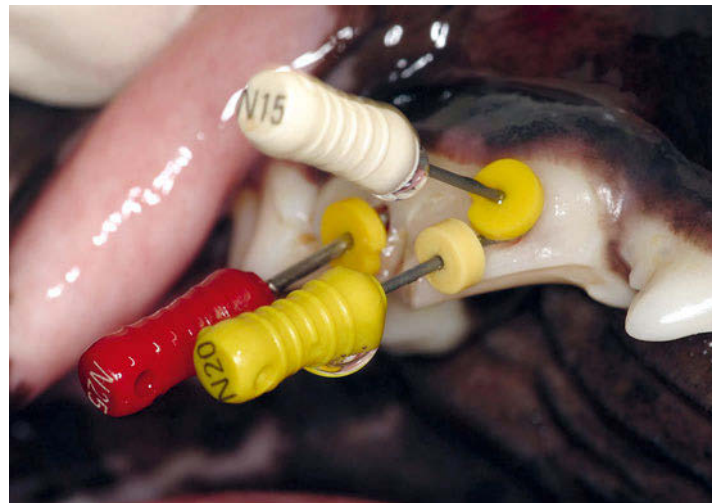
In contrast to the canine crown, in which pulling and rotational forces are most significant, the focus for a carnassial tooth crown is on shearing forces during mastication (► Fig. 16.202, ► Fig. 16.203).



► **Fig. 16.202 Fractured tooth 108.** A cusp fracture on the maxillary right carnassial tooth has caused pulp exposure. The calculus on the fracture area indicates that this is an older fracture. The visible pulp tissue has undergone polypoid changes.

**Root canal therapy**

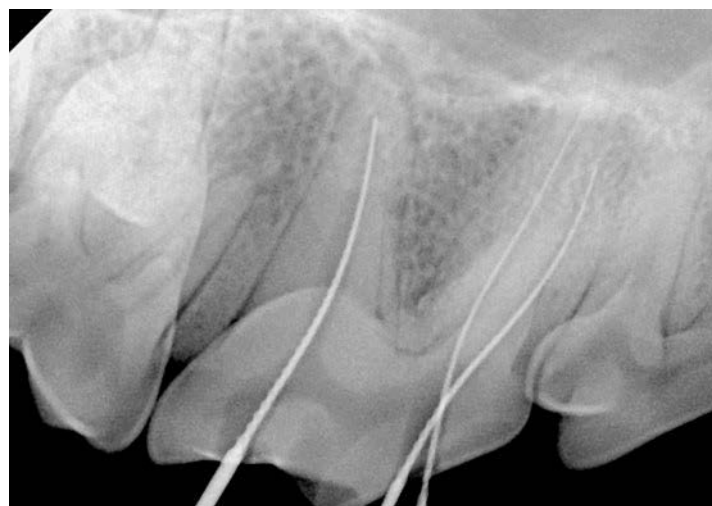
Proper root canal therapy is needed to ensure that a filling can be placed on the crown of the tooth (► Fig. 16.204, ► Fig. 16.205, ► Fig. 16.206).



► **Fig. 16.204 Exploration of the root canals of tooth 108.** All three root canal access points are visualized with a combined approach and files are placed in the canals for the measurement radiograph. Combined access on the maxillary carnassial tooth means that the distal canal is visualized separately and the two mesial canals are visualized by way of a common buccal cavity. No palatal access is provided via the very small palatal cusp.



► **Fig. 16.203 Radiograph of tooth 108.** The distal root shows a low-grade osteolysis process.



► **Fig. 16.205 Measurement radiograph of tooth 108.** In the measurement radiograph, all files reach the end of their respective root canal. A distal projection allows the two mesial root canals to be visualized independently of one another (parallax method).





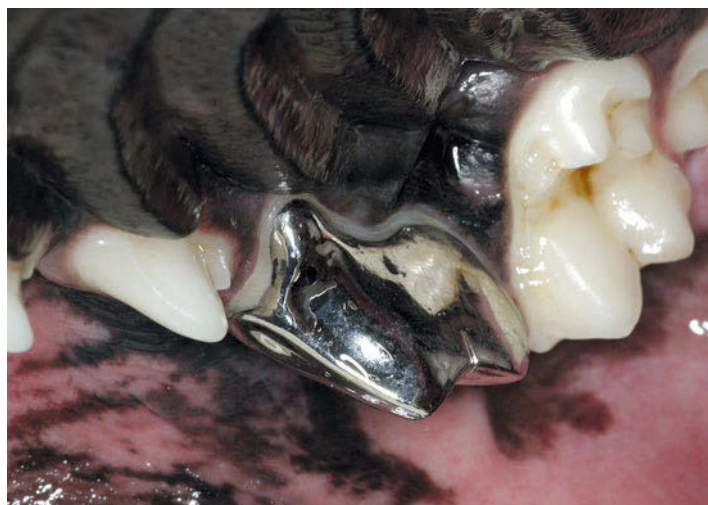
► **Fig. 16.206** Postoperative radiograph of the root canal filling of tooth 108. The root canal filling is homogeneous in the intraoperative radiograph and provides a base for applying a crown.



► **Fig. 16.208** Crown in situ from the mesiolateral direction. The crown margin runs parallel to the gingival margin. If possible, the crown margin should be placed supragingivally in order to keep the gingiva healthy and prevent inflammation.

### Coronal Filling

► Fig. 16.207, ► Fig. 16.208, ► Fig. 16.209 and ► Fig. 16.210 show the final coronal filling.



► **Fig. 16.209** Crown in situ from the palatal direction. The course of the gingiva is also followed palatally.



► **Fig. 16.207** Crown preparation. The preparation of the crown includes the entire circumference of the tooth and the small palatal cusp.

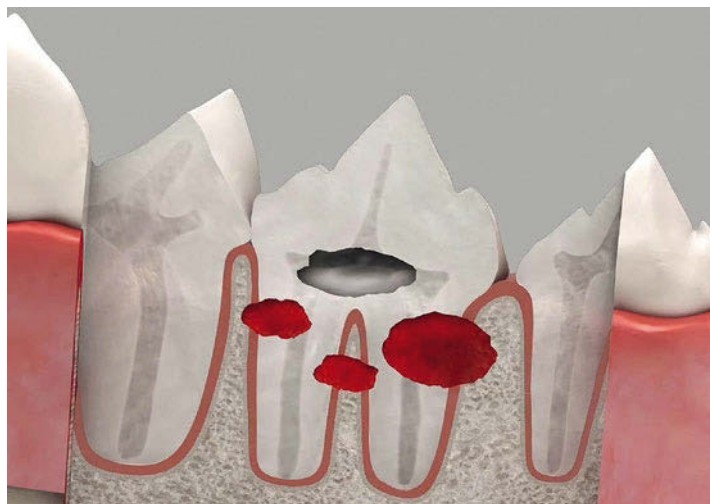


► **Fig. 16.210** Crown in occlusion. With the teeth in terminal occlusion, the jaw should be checked for proper closing to eliminate possible interfering contacts on the crown.

## 16.6

**Feline Tooth Resorption****16.6.1 Schematics for Feline Tooth Resorption**

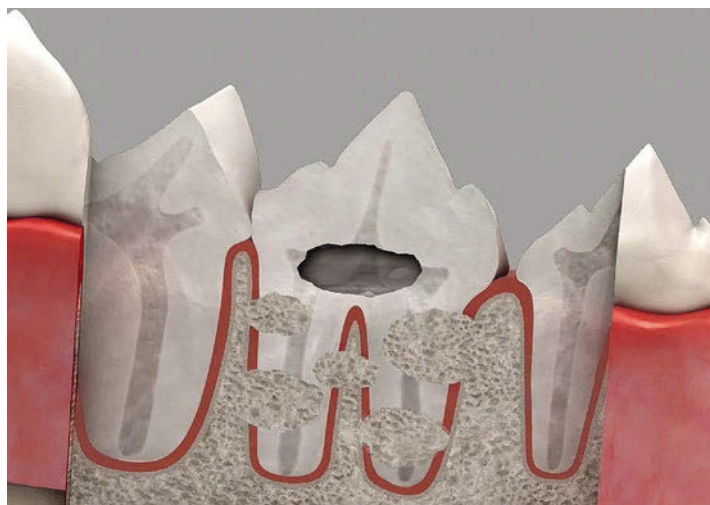
Feline tooth resorption, formerly referred to as “feline odontoclastic resorptive lesions” (FORL), is a debilitating and painful chronic process that is unfortunately often overlooked in clinical oral examinations. Approximately half of all cats are affected starting in middle age. When a resorptive lesion is found on a tooth, it is likely that other teeth have been affected. The process starts in the root area due to changes in cellular activities. While the cause of this disease is still unknown, the subsequent pathogenic processes are better understood. Activated multinuclear phagocytic cells (odontoclasts) overcome the periodontal ligament space and degrade the tooth substance (► Fig. 16.215, ► Fig. 16.216, ► Fig. 16.217). The categories of tooth resorption are based on the type of remodeling that occurs. There are currently three different types of tooth resorption (► Fig. 16.211, ► Fig. 16.212, ► Fig. 16.213, ► Fig. 16.214).



► **Fig. 16.212 Type 1 tooth resorption.** In type 1 tooth resorption, inflammatory changes characterize the clinical and radiographic presentation. Root fragments are phagocytosed, and the cavitation defects are filled with inflamed granulation tissue. In the radiograph, defects appear translucent, and the periodontal ligament space remains intact. Once the base of the crown has been damaged and thus structurally weakened, the tooth may break off, often leaving behind root fragments. (source: Mars Petcare GmbH)

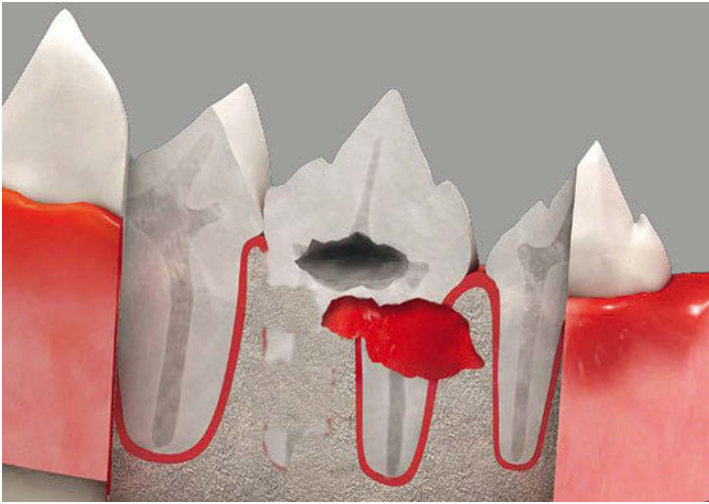


► **Fig. 16.211 Healthy premolar with periodontium.** Because they develop below the alveolar ridge, feline tooth resorptions are best illustrated with a diagram. A healthy feline tooth is surrounded by the periodontal ligament space (red) in the healthy alveolar bone. (source: Mars Petcare GmbH)

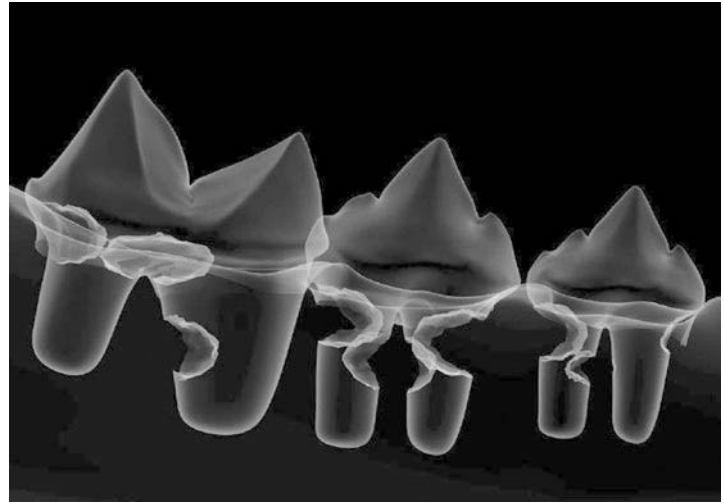


► **Fig. 16.213 Type 2 tooth resorption.** Type 2 tooth resorption involves a remodeling process that is initially noninflammatory. In the root area, the cementum and dentin deteriorate, and the tooth is weakened. Lost tissue is replaced by a bony substance. The tooth “fuses” with the surrounding bone, and the periodontal ligament space is lost. (source: Mars Petcare GmbH)

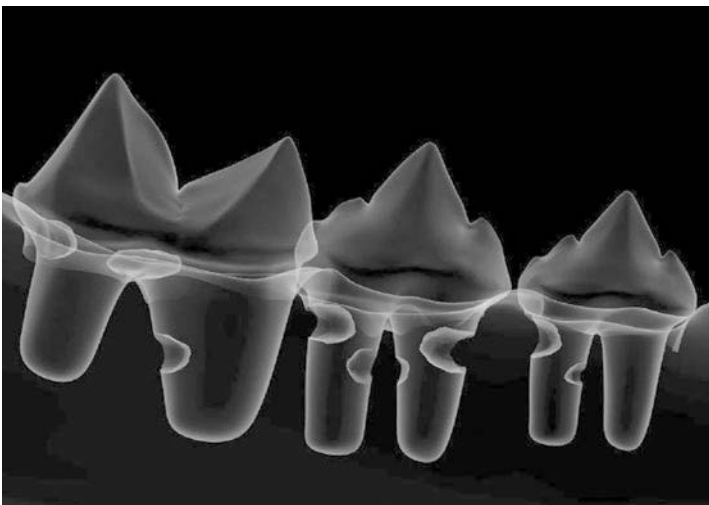




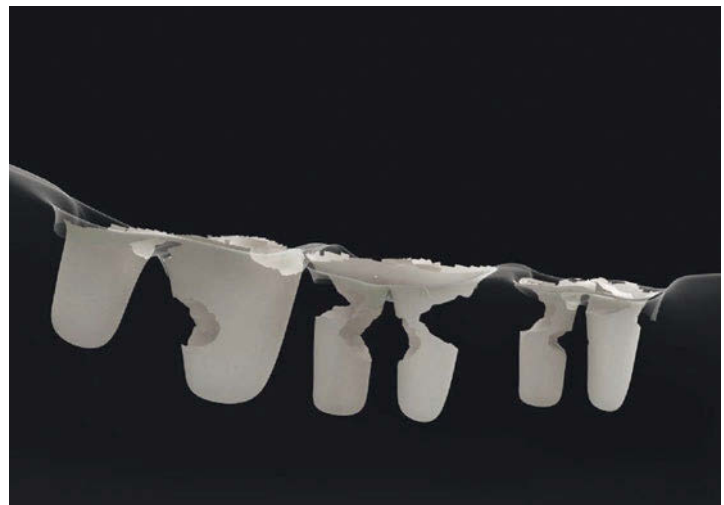
► **Fig. 16.214 Type 3 tooth resorption.** Type 3 tooth resorption represents combined changes to a tooth. Type 1 and 2 defects appear simultaneously on a tooth. (source: Mars Petcare GmbH)



► **Fig. 16.216 Advanced resorption.** If the resorptive lesions enlarge, they can fuse and promote tooth breakage. (source: Mars Petcare GmbH)



► **Fig. 16.215 Initial resorption.** Tooth resorption starts as small peripheral defects that penetrate the tooth from the periodontium. (source: Mars Petcare GmbH)



► **Fig. 16.217 Root fragments in a cat with tooth resorption.** Root fragments of the affected teeth often remain in the jaw as the end stage of feline tooth resorption. (source: Mars Petcare GmbH)

### 16.6.2 Multiple Feline Resorptive Lesions

When tooth resorption is seen on a tooth, the other teeth must also be examined clinically and radiographically for the presence of resorptive changes (► Fig. 16.218, ► Fig. 16.219, ► Fig. 16.220, ► Fig. 16.221, ► Fig. 16.222, ► Fig. 16.223, ► Fig. 16.224, ► Fig. 16.225, ► Fig. 16.226, ► Fig. 16.227, ► Fig. 16.228, ► Fig. 16.229), since this is a generalized disease.



► **Fig. 16.218 Tooth resorption, right maxilla.** In type 1 tooth resorption, inflammatory signs often predominate. The gingiva is reddened due to inflammation, and it may be hyperplastic and bleed more easily when probed. In this case, large-scale crown breakage cannot be detected, but the second premolar can barely be visualized in the inflamed gingiva, and the distal root of the third premolar shows a small distal recession.



► **Fig. 16.220 Tooth resorption, left mandible.** The left mandible shows pathognomonic tooth defects in the furcation area of the premolars for the first time. The mandibular carnassial tooth crown also has a grayish discoloration.

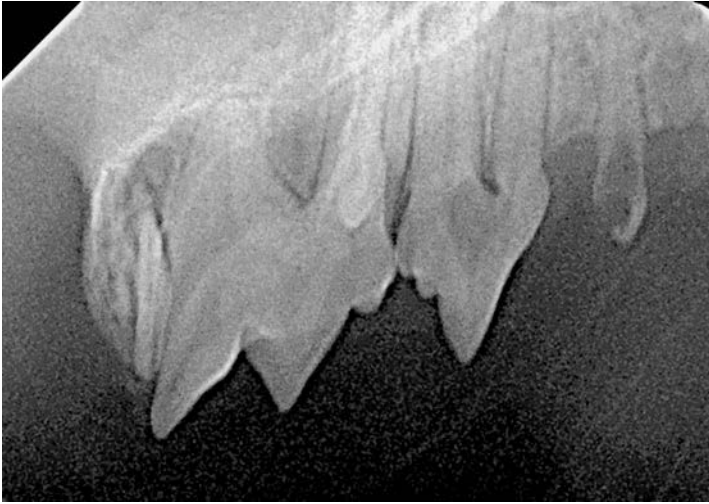


► **Fig. 16.219 Tooth resorption, left maxilla.** Distinct gingivitis is also present in the left maxilla. In contrast to the right side, the left side shows involvement of the labial mucosa; it has developed a kind of kissing ulcer.



► **Fig. 16.221 Tooth resorption, right mandible.** On the right side, the predominant gingivitis is suggestive of tooth defects.

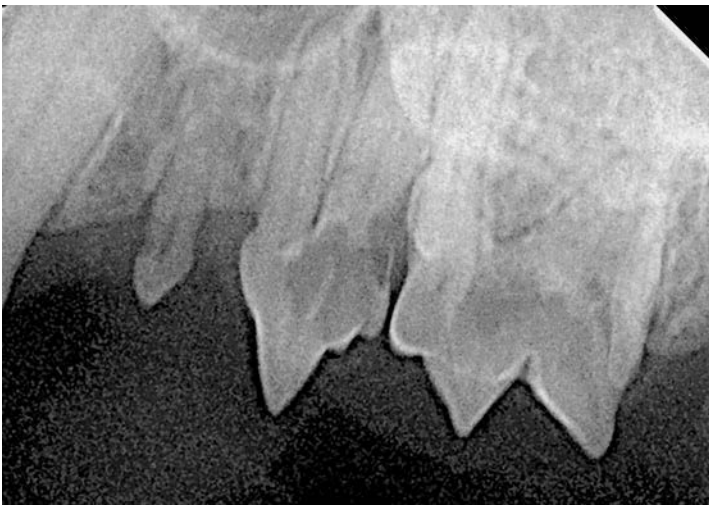




► **Fig. 16.222 Radiograph of the right maxilla.** The tooth resorption can only be verified with radiography. The crowns of teeth 106 and 107 show translucency. The periodontal ligament space of the teeth is unaffected.



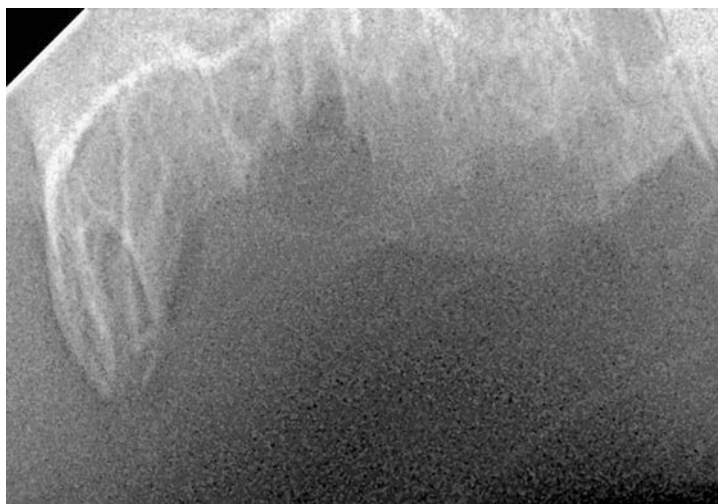
► **Fig. 16.224 Radiograph of the left mandible.** The clinically observed defects in the furcation area appear radiographically as defects in the cervical third of the roots of the cheek teeth. The roots of the teeth show defects only in the cervical third of the root; the apical areas are not affected by the resorptions and have a clearly recognizable periodontal ligament space. Therefore, no root resorption is expected, which explains why full extraction is required for type 1 resorption.



► **Fig. 16.223 Radiograph of the left maxilla.** On the left side, all cheek teeth except the molar clearly show locally reduced radiopacity in the crown area, which is the radiographic sign of resorption.



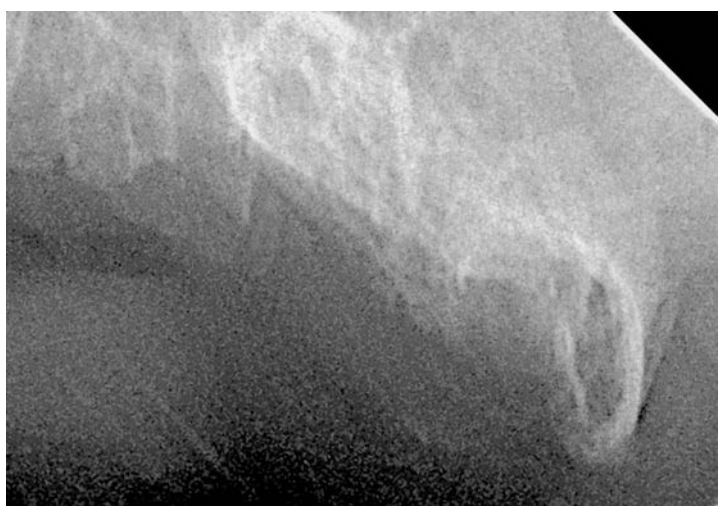
► **Fig. 16.225 Radiograph of the right mandible.** The defects in the cervical area of the tooth or in the cervical third of the root are significantly less pronounced in the right mandible. The decreased radiopacity can be noted in the furcation area of the carnassial tooth, however.



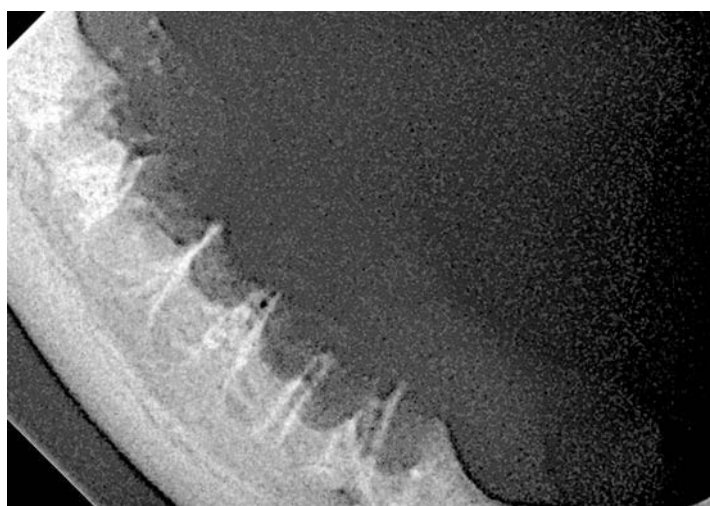
► **Fig. 16.226 Post-extraction radiograph, right maxilla.** Treatment consists of the extraction of all cheek teeth and the affected front teeth. If all cheek teeth must be extracted from the left mandible, for example, the opposing teeth likely should be as well. While they would be no longer be functional, they would collect debris and encourage inflammation.



► **Fig. 16.228 Post-extraction radiograph, left mandible.** A surgical procedure should be performed to extract all teeth from the jaw. Once the teeth have been removed, the alveolar bone margins can be smoothed and the wound can be sutured over the alveoli.



► **Fig. 16.227 Post-extraction radiograph, left maxilla.** In order for the jaw to heal, all tooth parts must be completely extracted.

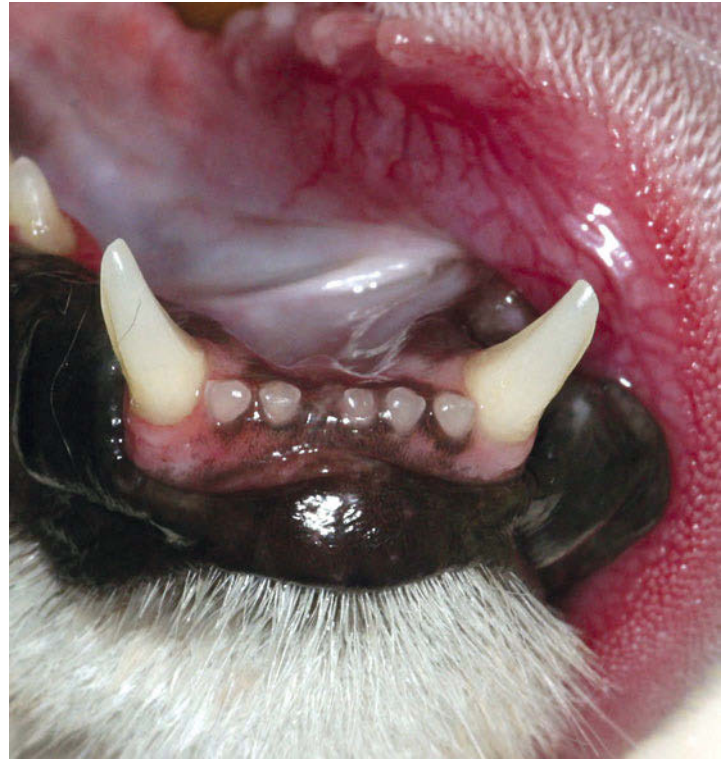


► **Fig. 16.229 Post-extraction radiograph, right mandible.** The suture after the extraction hastens recovery and allows the animal to eat relatively soon postoperatively without risking impaction of debris in the alveoli.



### 16.6.3 Tooth Resorption on Canine Roots

Advanced remodeling is visible on the roots of the canines in the radiograph without any apparent changes to the crowns (► Fig. 16.230, ► Fig. 16.231, ► Fig. 16.232, ► Fig. 16.233). Not every case of ankylosis or apical remodeling in older cats requires treatment, since the periodontal ligament space around the root narrows with age. For this reason, in older cats an apical radiographic abnormality on the canines can be considered an age-related change; without clinical signs, it does not necessarily require treatment.



► **Fig. 16.231 Mandibular canine teeth, clinical findings 3 years later.** There are also no clinical abnormalities of the mandibular canine teeth 3 years later. The mandibular right central incisor is missing, which prompts a follow-up radiograph.



► **Fig. 16.230 Radiograph of the mandibular canine teeth.** In an earlier radiograph of the mandibular front teeth, the roots of the mandibular canines are unremarkable.



► **Fig. 16.232 Radiograph of the mandibular canine teeth 3 years later.** The radiograph shows the extent of the resorptive remodeling processes on the canine teeth. Similar in translucency to the surrounding bone, the mandibular canine roots disappear into the bony tissue. It is impossible to distinguish the root from the bone on the basis of the periodontal ligament space, since it is no longer present.



► **Fig. 16.233 Radiograph of the mandibular canine teeth after crown amputation.** A highly invasive procedure to remove the replaced tooth substance of the entire root is usually not necessary. Crown amputation is a viable option in these cases. After dissecting a mucoperiosteal flap, the cervical third of the root of the tooth is severed, and all recognizable tooth substance is removed. This avoids further weakening of the mandible by avoiding a buccal osteotomy with extraction of all tooth remnants. The mucoperiosteal flap is then sutured over the alveolus without tension. The animal is given an Elizabethan collar for the duration of the recovery process. Radiographs must be taken to further monitor the remodeling in the root area, which is generally clinically unremarkable and painless.

#### 16.6.4 Development of Feline Tooth Resorption after Crown Amputation

Radiographs must be taken to confirm that remodeling of the root area after a crown amputation is clinically unremarkable.

##### Current Case

A cat with abnormal behavior, in particular during or after eating, is presented; the underlying cause is unknown. ► Fig. 16.234, ► Fig. 16.235, ► Fig. 16.236 and ► Fig. 16.237 show the clinical findings.



► **Fig. 16.234 Maxillary canine teeth.** The maxillary front teeth are clinically unremarkable.



► **Fig. 16.235 Lateral view of the maxillary canine teeth.** In addition, in the lateral view of the buccal area, the right canine tooth, and the lingual area of the contralateral canine tooth, no abnormalities can be detected.





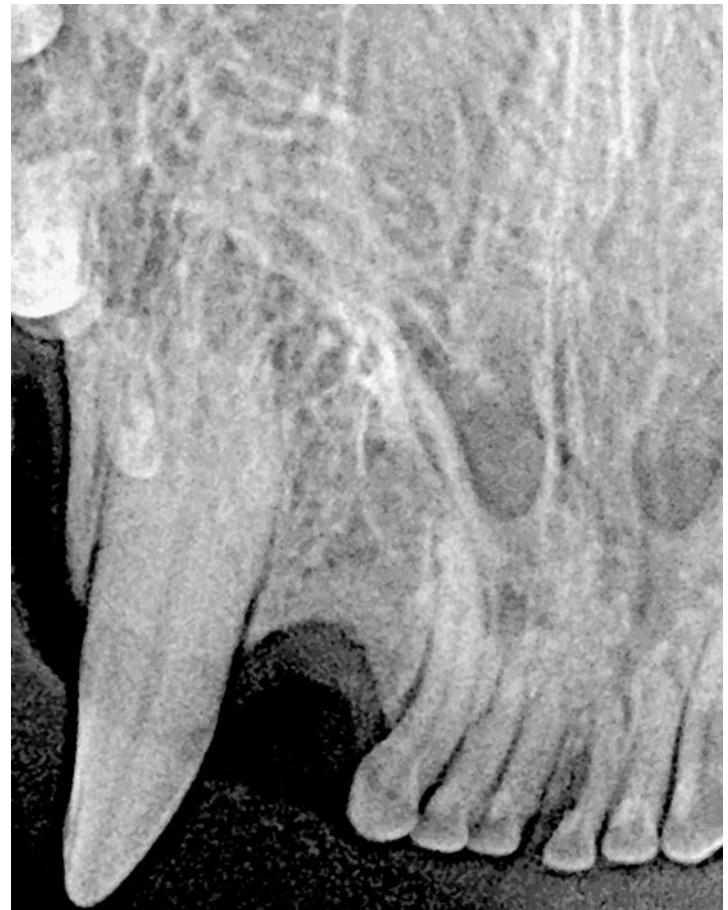
► **Fig. 16.236 Mandibular canine teeth.** The mandibular canine teeth present similarly: There are no clinical signs of a pathological process.



► **Fig. 16.237 Lateral view of the mandibular canine teeth.** As with the maxillary canine teeth, the lateral view offers no additional information.

### Radiography

The radiographic findings appear in ► Fig. 16.238, ► Fig. 16.239 and ► Fig. 16.240. All canine crowns will be amputated. The coronal part of the tooth is then detached in the cervical third of the root (► Fig. 16.241, ► Fig. 16.242, ► Fig. 16.243).



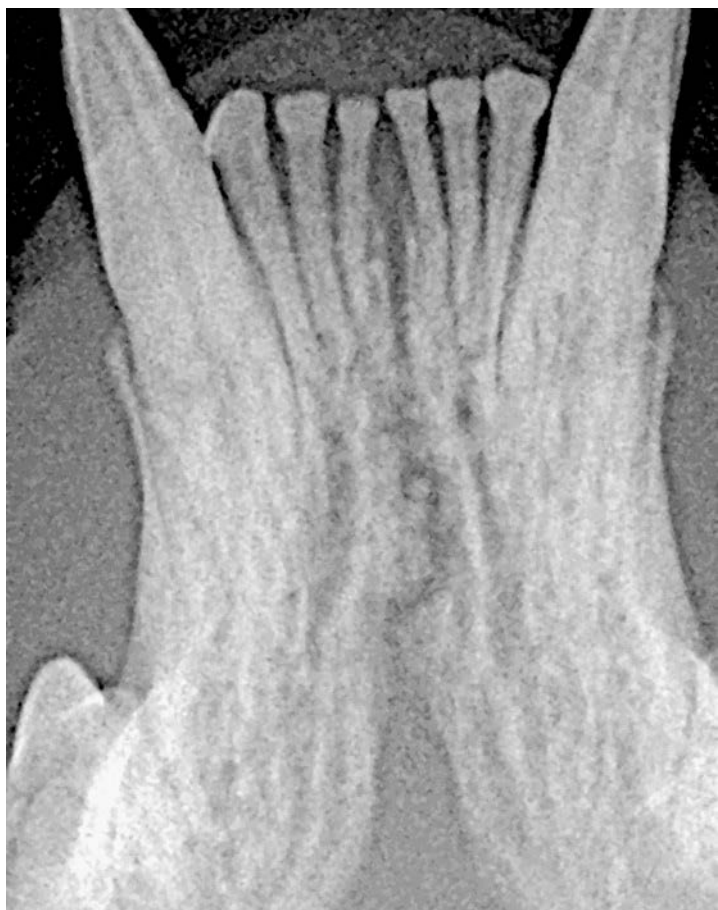
► **Fig. 16.238 Radiograph of tooth 104.** The radiograph of the maxillary right canine tooth shows full remodeling of the apical half of the tooth root. The lack of translucency indicates that the dental tissue has been replaced by bony structures. No periodontal ligament space is seen. By definition, this defect is classified as type 2 tooth resorption.



► **Fig. 16.239 Radiograph of tooth 204.** The maxillary left canine tooth also lacks an apical root segment. Instead, the horizontal translucency is consistent with internal resorption with distal extension.



► **Fig. 16.241 Radiograph after crown amputation of tooth 104.**



► **Fig. 16.240 Radiograph of teeth 304 and 404.** The resorption has affected about two-thirds of the length of the canine roots apically. The remodeling process almost reaches the alveolar margin coronally.

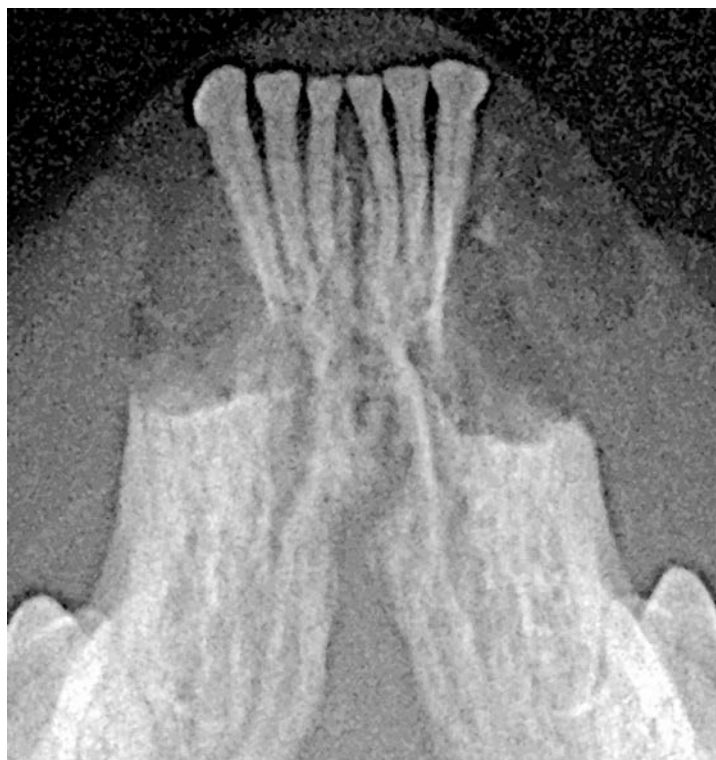


► **Fig. 16.242 Radiograph after crown amputation of tooth 204.**



### Radiographic Follow-up after Crown Amputation

The follow-up radiographs appear in the following figures (► Fig. 16.244, ► Fig. 16.245).



► Fig. 16.243 Radiograph after crown amputation of teeth 304 and 404.



► Fig. 16.244 Follow-up radiograph of teeth 104 and 204 after 7 years. In a follow-up radiograph after 7 years, the canine area of the jaw is unremarkable. The maxilla shows no signs of residual tooth substance.



► Fig. 16.245 Follow-up radiograph of teeth 304 and 404 after 7 years. The mandible is also unremarkable.

## Canine Tooth Resorption

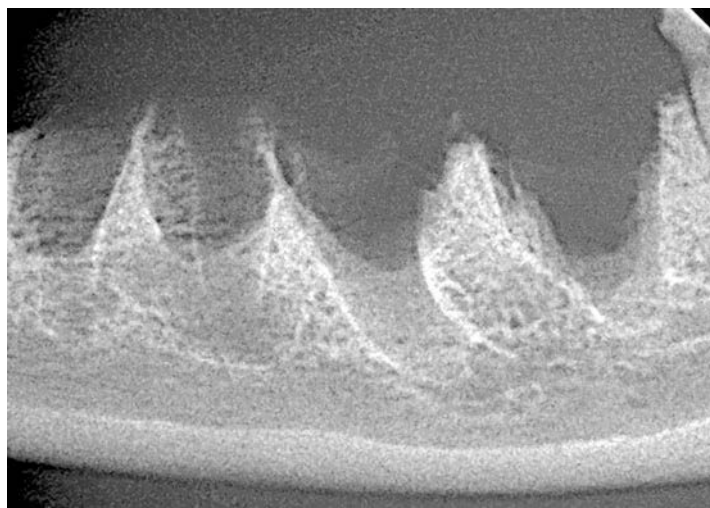
The counterpart to tooth resorption in cats is tooth resorption in dogs. Based on the feline disease, this is called canine tooth resorption. While tooth resorption is very common in cats, the canine version is rather rare.

### 16.7.1 Canine Tooth Resorption on Tooth 309

No statistics are available on the incidence of canine tooth resorption. The resorptive lesions initially occur in the root area in dogs (► Fig. 16.246, ► Fig. 16.247, ► Fig. 16.248). Instead of clinical signs on the teeth, behavioral anomalies are generally the first indication of such problems.



► **Fig. 16.246 Tooth 309.** The mandibular left carnassial tooth in this dog shows no abnormalities except for abrasions of the cusps. There is no pulp exposure.



► **Fig. 16.248 Radiograph after extraction of teeth 308 and 309.** The only treatment option is to extract both affected teeth.



► **Fig. 16.247 Radiograph of tooth 309.** The radiograph shows remodeling of the distal root as well as periapical osteolysis. The fourth premolar also shows distal osteolysis and apical resorption.



## 16.8

**Tooth Displacement**

Tooth displacement is a permanent change to tooth position as a result of trauma. The maxillary canines are often affected. They are displaced from their alveoli along with the root and buccal bone lamella. Usually, in lateral displacement, the soft tissue is torn and a clear gap is created palatally between the tooth and bone. Occlusion is usually unimpaired. This is different for medial displacement, where the jaw cannot be closed. A radiograph is taken to examine the root area. When the root is intact and repositioning is possible, the tooth may be preserved by fixation. Root canal therapy is usually necessary since displacement with shearing in the apical area often leads to pulp necrosis.

The most severe variant of tooth displacement is tooth avulsion. A tooth is fully displaced from its alveolus. Depending on the situation, it may be possible to preserve the tooth in this case.

**16.8.1 Displacement of the Maxillary Left Canine**

The long canines are generally affected in the dog. Here, the position of the maxillary canine tooth can change due to the leverage forces (► Fig. 16.249, ► Fig. 16.250, ► Fig. 16.251, ► Fig. 16.252, ► Fig. 16.253, ► Fig. 16.254, ► Fig. 16.255).



► **Fig. 16.250 Radiograph of tooth 204.** A radiograph is taken to confirm that the tooth can be preserved.



► **Fig. 16.249 Displacement of tooth 204.** A scuffle with another dog resulted in lateral displacement of the maxillary left canine tooth. Palatally, a deep infrabony pocket can be probed, and the gingiva is torn distally.

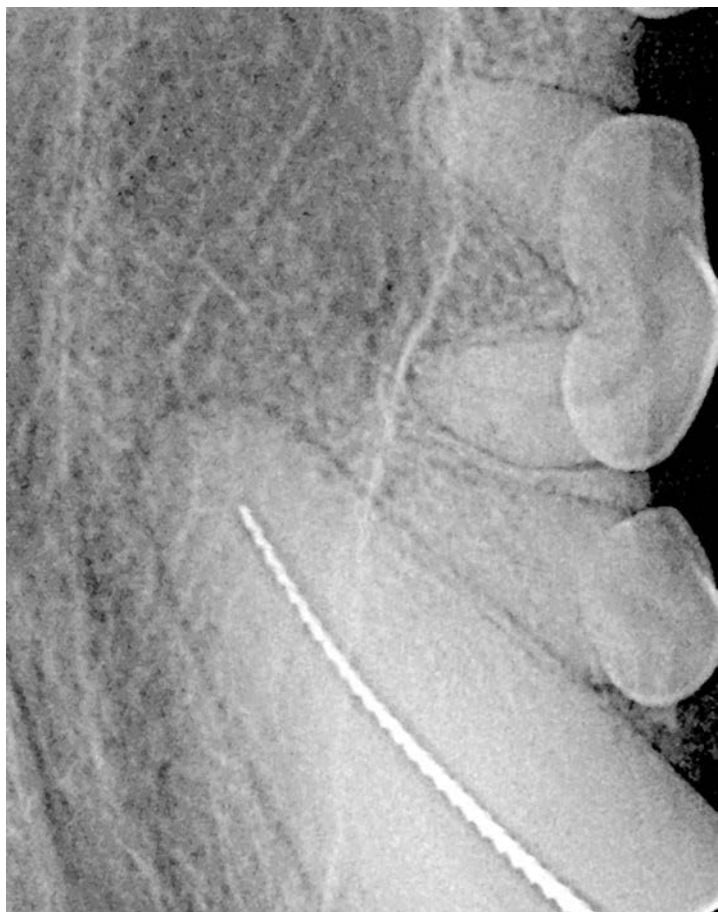


► **Fig. 16.251 Radiograph of tooth 204 after repositioning.** The tooth is placed back in its original position and the new position is checked via radiography.





► **Fig. 16.252 Tooth 204 after repositioning with fixation.** The position of the canine tooth is fixed after ensuring correct repositioning and unrestricted jaw closure. One fixation option involves placing an interdigital splint over the adjacent teeth. Slight impairment to jaw closure is acceptable. The direction of force of the lower canine tooth fixes the maxillary canine tooth in its alveolus.



► **Fig. 16.253 Measurement radiograph of tooth 204.** After 2 weeks, the splint can usually be removed, and the tooth position is stable. Then, root canal therapy is performed via a cervical cavity since pulp impairment is very likely. Regular radiographic monitoring of the tooth with the animal under anesthesia is more difficult than performing a reliable treatment immediately.



► **Fig. 16.254 Radiograph of the root canal filling of tooth 204.** Once the root canal filling is completed, an intraoperative radiograph is taken.



► **Fig. 16.255 Composite filling of the repositioned tooth 204.** Clinically, after placing the composite filling, the maxillary canine tooth shows virtually no signs of the previous trauma. Since the access to the root canal was mesiocervical, the natural contour of the cusp was maintained. If possible, a follow-up radiograph should be taken to identify possible root resorption areas after a few months.



### 16.8.2 Avulsion of the Maxillary Right Canine Tooth

The final stage of displacement of a tooth is its complete loss, called avulsion. If the avulsed tooth is intact, the original occlusion can be restored via replantation (► Fig. 16.256, ► Fig. 16.257, ► Fig. 16.258, ► Fig. 16.259, ► Fig. 16.260, ► Fig. 16.261, ► Fig. 16.262, ► Fig. 16.263, ► Fig. 16.264, ► Fig. 16.265, ► Fig. 16.266, ► Fig. 16.267, ► Fig. 16.268).



► **Fig. 16.256 Avulsion of tooth 104.** A Siberian Husky avulsed its maxillary right canine tooth after it caught on the chain collar of another dog while playing. The alveolus is empty, and the distal gingiva is torn.



► **Fig. 16.257 Avulsed tooth 104.** The owner found the tooth and brought it to the veterinarian with him. After careful cleaning of the tooth while sparing the periodontal ligament, the tooth turns out to be intact. When a tooth is brought in dry, the periodontium has a survival time of approximately 30 min. In water, this time is extended to 60 min., and in saliva to 90 min. The periodontal cells can survive for up to 4 hours immersed in milk or saline solution. The periodontium can survive up to 1 day in special tooth rescue boxes (e.g., Dentosafe). Intact periodontal cells are required for tooth reattachment to the alveolar bone after replantation.



► **Fig. 16.258 Radiograph of tooth 104.** The radiograph shows an empty alveolus without further abnormalities.



► **Fig. 16.260 Repositioning of tooth 104.**



► **Fig. 16.259 Repositioning of tooth 104.** The tooth is repositioned in its socket.



► **Fig. 16.261 Repositioned tooth 104.** The gingival trauma has been treated.





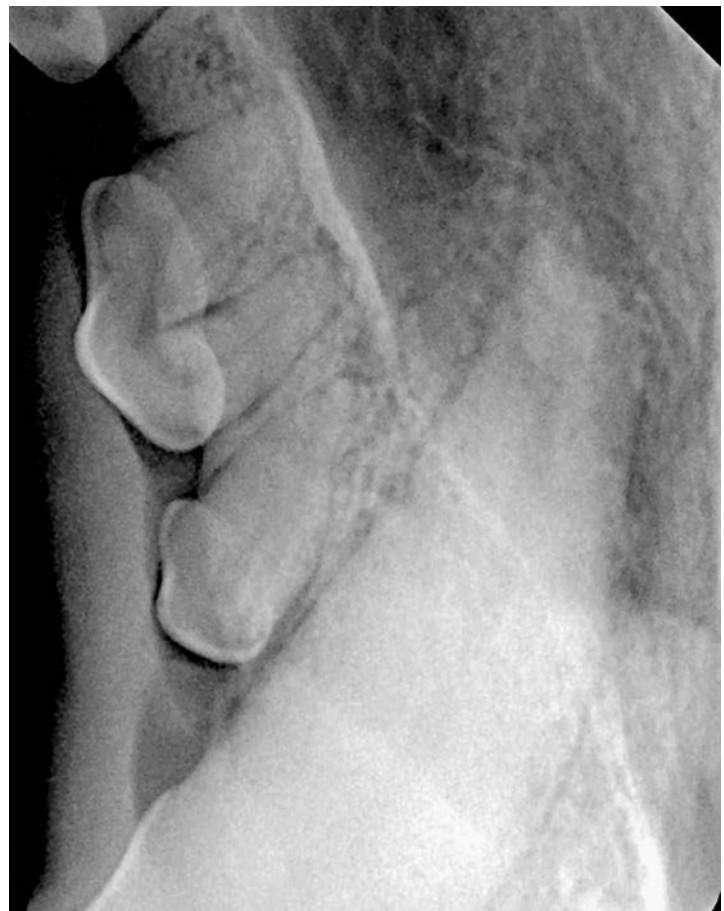
► **Fig. 16.262 Radiograph of repositioned tooth 104.** A radiograph is used to verify the correct position of the tooth.



► **Fig. 16.264 Stabilized tooth 104 in final occlusion.** The fit of the interdental splint with the jaw closed is checked, and the cusp of the opposing canine is released as much as possible to avoid abrasion.



► **Fig. 16.263 Stabilization of tooth 104.** Due to the severe loosening of the tooth, the neighboring teeth and the contralateral maxillary canine tooth are used as anchors in an interdental splint.



► **Fig. 16.265 Radiograph of tooth 104 after removal of the interdental splint.** The interdental splint is removed after 3 weeks. The radiograph shows slight remodeling around the root tip. The remaining periodontal ligament space appears essentially normal.



► **Fig. 16.266 Measurement radiograph of tooth 104.** The pulp is extirpated through a cervical cavity, and a measurement radiograph is taken.



► **Fig. 16.267 Intraoperative radiograph of the root canal filling.** The tooth may only be preserved with a tightly sealed root filling. Since root resorption may occur in the periodontal ligament space due to ankylosis, the future progression should be monitored radiographically.



► **Fig. 16.268 Composite filling of tooth 104 with a root canal filling in final occlusion.** The final examination with a closed jaw is unremarkable, there are no interfering contacts, and the maxillary canine is in a stable position.



## 16.9

**Tooth Extraction**

Tooth extraction in dogs and cats differs in many aspects from that in humans. While closed extraction is predominantly used in humans, this procedure is only appropriate for small single-rooted teeth in dogs and cats. With practice, access under direct visualization as part of an open extraction with advancement flap formation and osteotomy for exposing the root is a gentler and safer procedure.

**16.9.1 Open Extraction of the Maxillary Canine Tooth in a Dog**

If a closed extraction cannot be performed due to the size or morphology of the root, open tooth extraction with surgical access is a viable option (► Fig. 16.269, ► Fig. 16.270, ► Fig. 16.271, ► Fig. 16.272, ► Fig. 16.273, ► Fig. 16.274, ► Fig. 16.275).



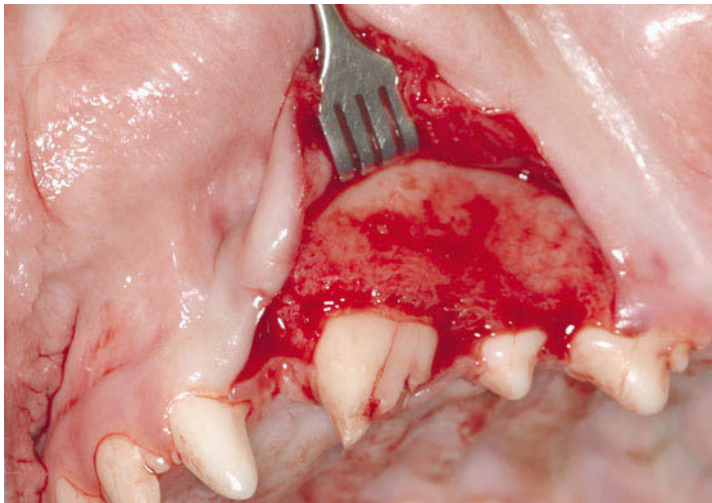
► **Fig. 16.270** Using a dental probe to detect a fractured lamella. An additional fracture of the remaining stump can be palpated with a sharp dental probe. Due to the infraalveolar fracture, the only treatment option is to remove the tooth.



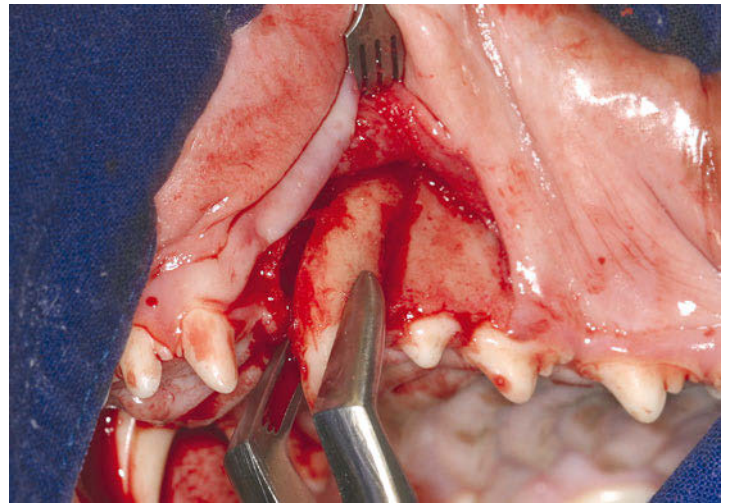
► **Fig. 16.269** Current condition of tooth 204. Closed extraction is impractical for multirooted teeth and for teeth with massive roots. The root area can be directly visualized and accessed, and the tooth can be loosened with an osteotomy. One such tooth is the maxillary canine tooth, which has a very massive root. The maxillary left canine shown here is deeply fractured, and the pulp is exposed. The treatment options are tooth-preserving root canal therapy or extraction of the tooth.



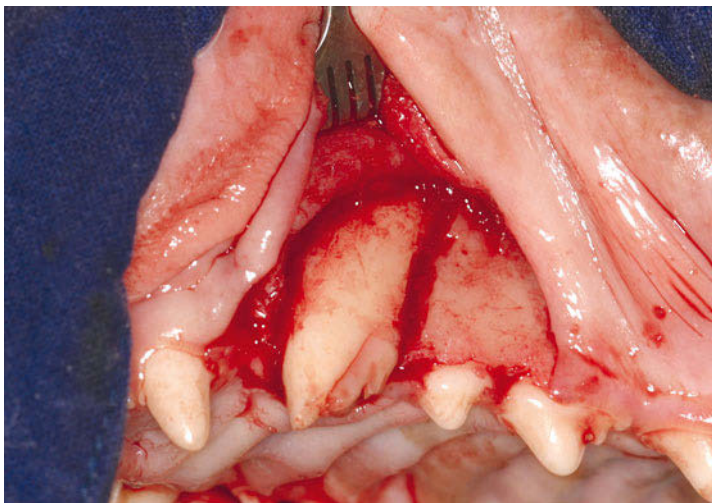
► **Fig. 16.271** Incision position. First, a horizontal incision is made in the gingival margin; it runs mesially from the maxillary canine to the level of the second premolar. To facilitate dissection of the mucoperiosteal flap and to enhance visualization of the root, a vertical accessory incision is also made over the second premolar.



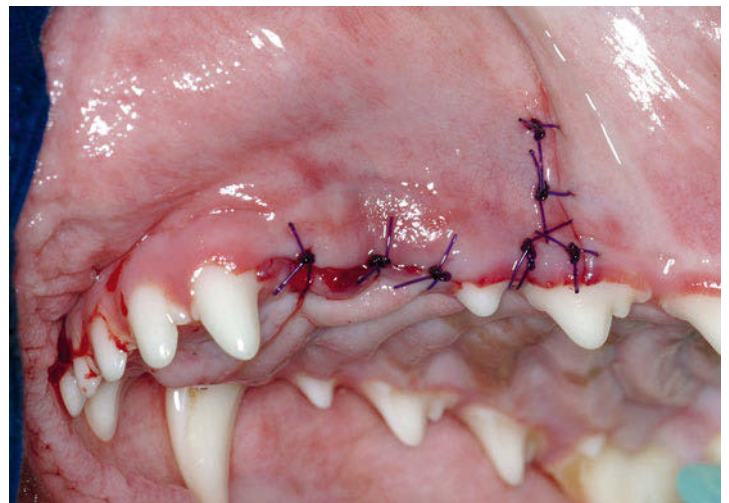
► **Fig. 16.272 Dissecting the mucoperiosteal flap.** The flap is detached buccally and dissected over the apical area with a periosteal elevator. A small retractor is used to hold the mucoperiosteal flap away from the bone.



► **Fig. 16.274 Removing the tooth with extraction forceps.** After the root is luxated, it can be further mobilized and removed with extraction forceps.



► **Fig. 16.273 Buccal osteotomy.** The bone lamella covering the buccal area is removed in order to place the elevator into the periodontal ligament space and allow buccal mobilization of the root.

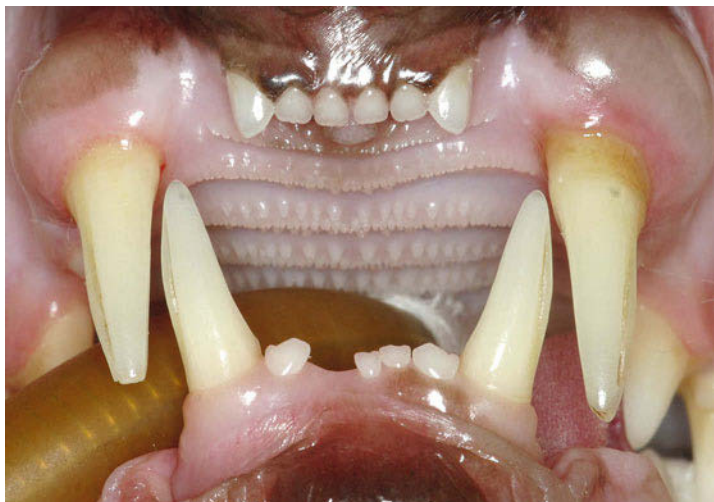


► **Fig. 16.275 Suture.** The mucoperiosteal flap is incised by dissecting the basal periosteum, pulled over the alveolus, and sutured onto the palatal mucosa.

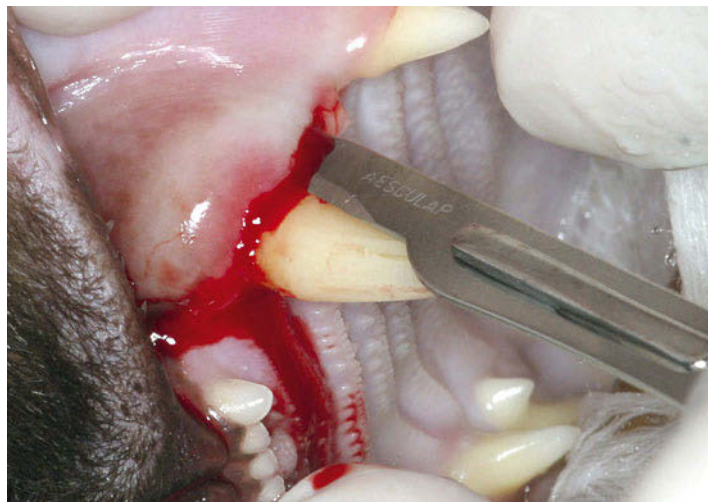


### 16.9.2 Open Extraction of the Maxillary Canine Tooth in a Cat

The following figures illustrate an open extraction of a maxillary canine tooth in a cat (► Fig. 16.276, ► Fig. 16.277, ► Fig. 16.278, ► Fig. 16.279, ► Fig. 16.280, ► Fig. 16.281, ► Fig. 16.282, ► Fig. 16.283, ► Fig. 16.284, ► Fig. 16.285, ► Fig. 16.286, ► Fig. 16.287, ► Fig. 16.288, ► Fig. 16.289, ► Fig. 16.290, ► Fig. 16.291).



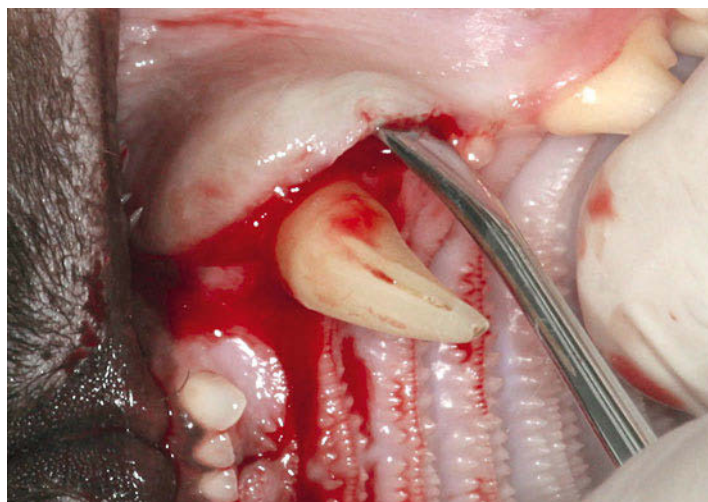
► **Fig. 16.276 Extrusion of tooth 204.** In the rostral view, the maxillary left canine protrudes beyond the right by about 2 mm. This has caused gingival recession. Due to the severe periodontal damage, the tooth is removed similarly to an open extraction of a maxillary canine in dogs.



► **Fig. 16.278 Incision.** A scalpel is used to detach the gingiva marginally from the tooth by incising it toward the tip of the alveolar ridge.

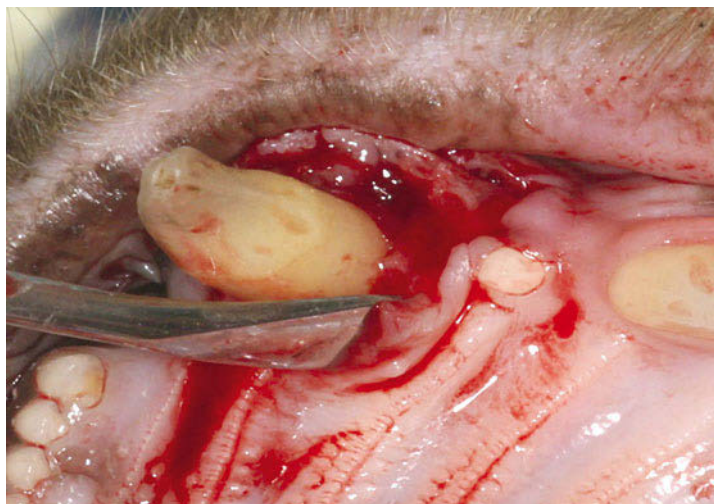


► **Fig. 16.277 Radiograph of tooth 204.** Radiographically, osteolysis extends up to half of the root length.

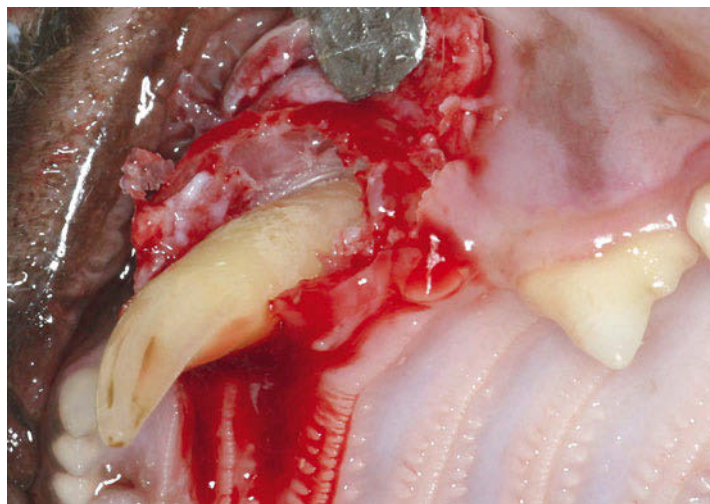


► **Fig. 16.279 Using the periosteal elevator.** The gingiva is dissected with a periosteal elevator, taking care not to damage the fragile mucosa of the cat mouth.

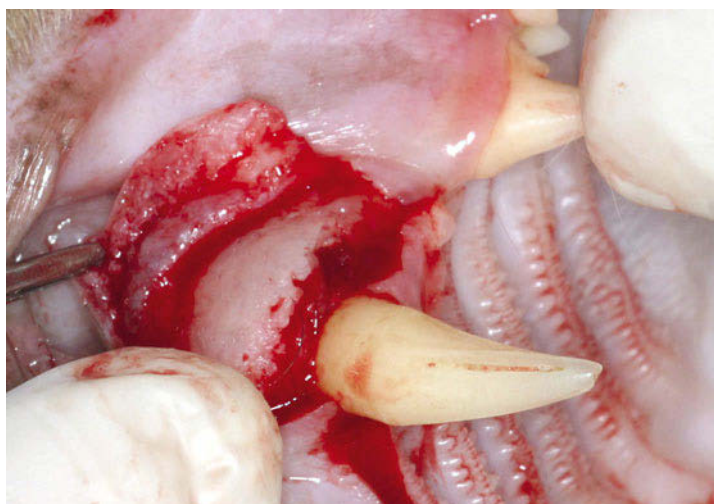




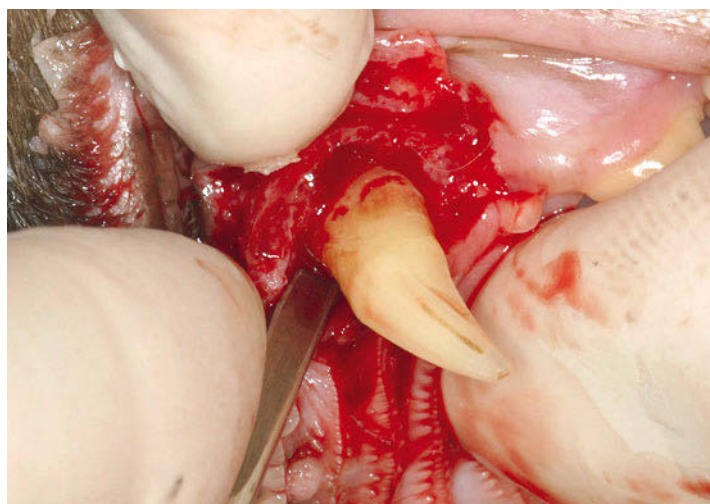
► **Fig. 16.280 Dissecting the mucosa palatally.** Just as on the buccal aspect, the mucosa is dissected in a circular fashion in the mesial, palatal and distal area.



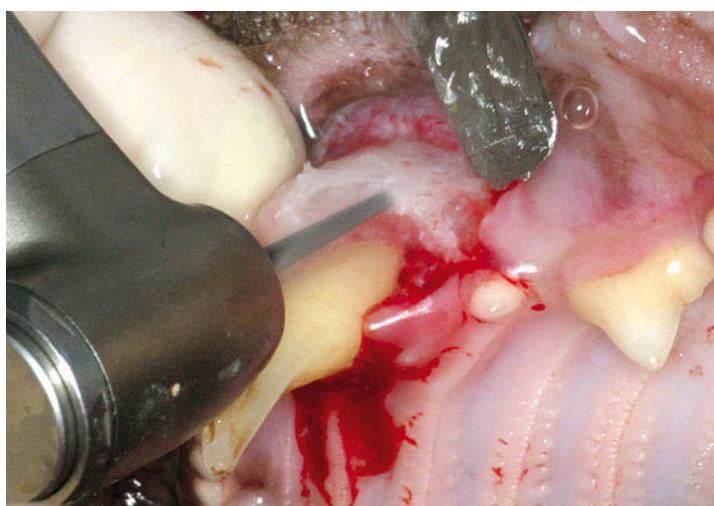
► **Fig. 16.283 Buccally exposed root.** If the osteotomy is sufficient, the cervical and center thirds of the root can be viewed.



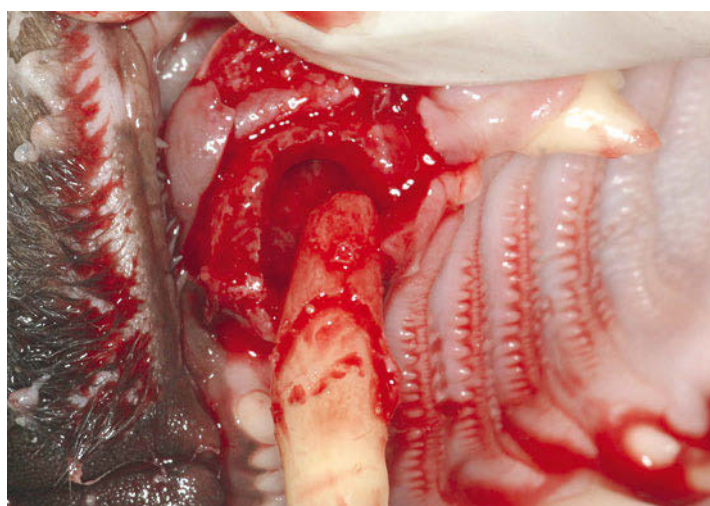
► **Fig. 16.281 Buccal mucoperiosteal flap.** A buccal mucoperiosteal flap is mobilized up over the mucogingival junction to create sufficient space for later palatal movement.



► **Fig. 16.284 Luxation of tooth 204.** The buccal osteotomy now allows the tooth to be luxated in a buccal direction by introducing the elevator mesially, palatally and distally.

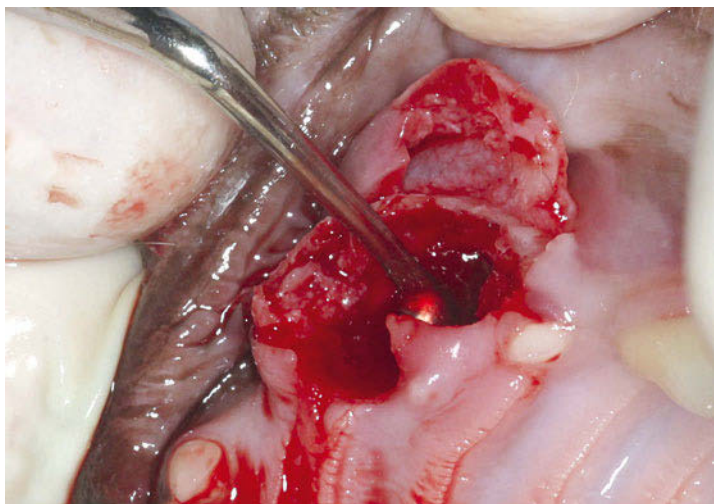


► **Fig. 16.282 Buccal osteotomy.** The bone is removed buccally from over the root surface, starting in the cervical area.

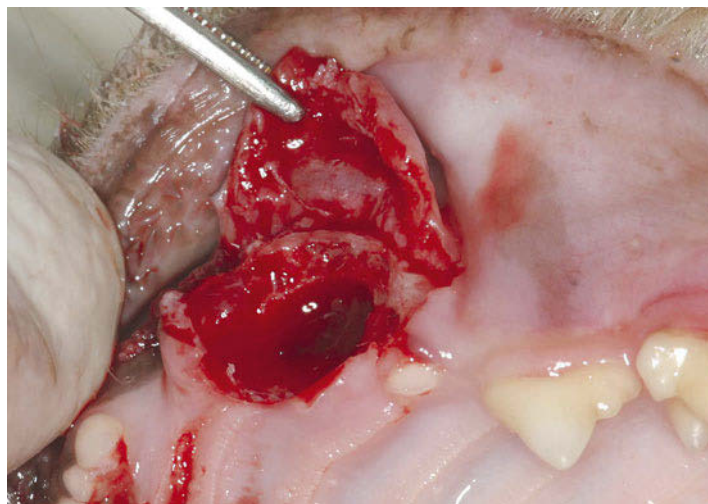


► **Fig. 16.285 Removal of tooth 204.** The loosened tooth can usually be removed with the fingers, but extraction forceps may allow easier removal at this stage.





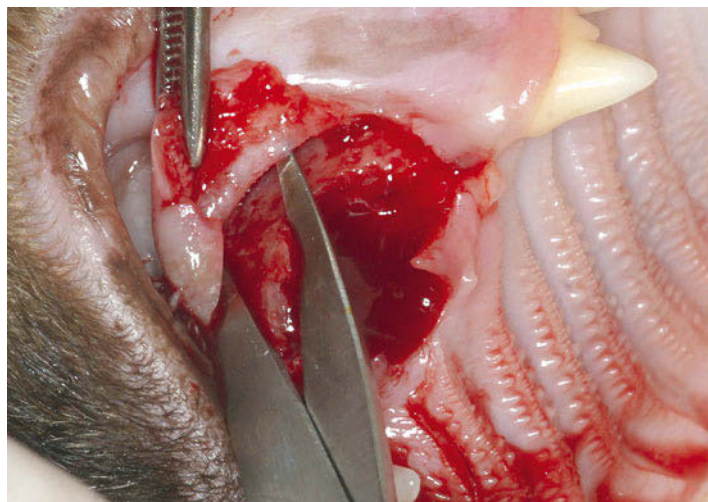
► **Fig. 16.286 Curettage of the alveolus.** The periodontal dental fibers and any inflamed granulation tissue are removed via curettage.



► **Fig. 16.288 Osteoplasty.** An osteoplasty is performed using a surgical drill or rongeurs to prevent the sharp bone edges from damaging the very delicate gingiva of the cat.



► **Fig. 16.287 Radiograph after extraction of tooth 204.** The full extraction is confirmed radiographically before closing the alveolus.

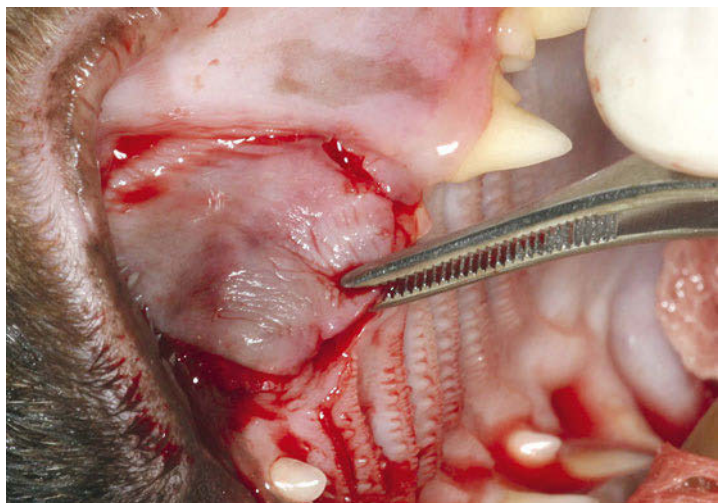


► **Fig. 16.289 Incising the basal periosteum.** In order to ensure tension-free mobilization and adaptation of the mucoperiosteal flap, the basal periosteum is dissected to access the elastic area of the oral mucosa.

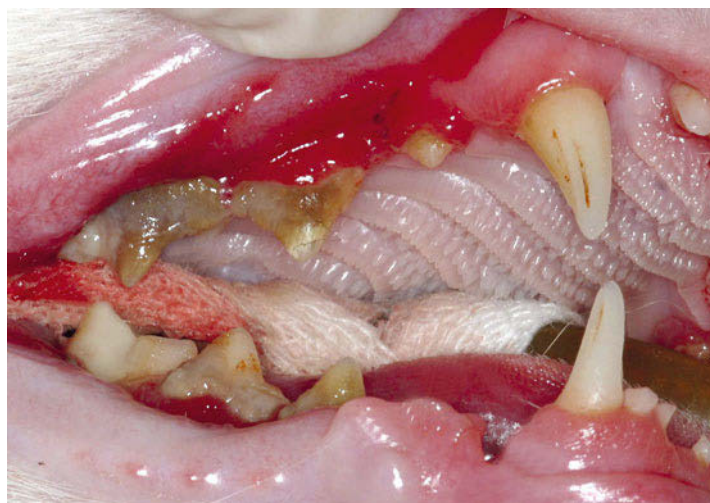


### 16.9.3 Extraction of Multiple Maxillary Cheek Teeth in a Cat

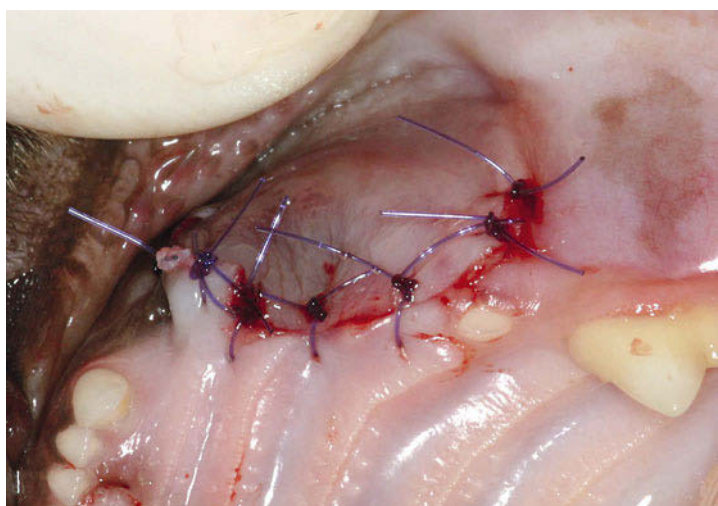
If all the teeth must be removed from a quadrant, a gingival incision across the entire length of the jaw permits buccal access to the roots under good direct visualization (► Fig. 16.292, ► Fig. 16.293, ► Fig. 16.294, ► Fig. 16.295, ► Fig. 16.296, ► Fig. 16.297, ► Fig. 16.298, ► Fig. 16.299, ► Fig. 16.300, ► Fig. 16.301, ► Fig. 16.302, ► Fig. 16.303, ► Fig. 16.304, ► Fig. 16.305, ► Fig. 16.306).



► **Fig. 16.290 Mobilizing the buccal advancement flap.** Before suturing, the advancement flap should be placed loosely over the gingival mucosa.



► **Fig. 16.292 Severe periodontitis on the right side.** A cat with severe inflammation of the oral cavity and decreased food intake is presented for extraction of damaged teeth. The cheek teeth on the right are inflamed and covered with calculus and plaque.

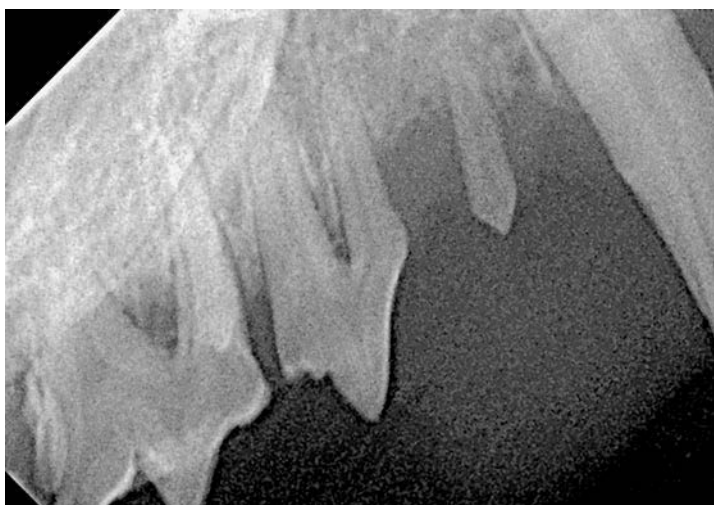


► **Fig. 16.291 Suture.** A prerequisite for good wound healing is a tension-free vestibular advancement flap. Closed extraction sites recover significantly better overall than alveoli that are left open.

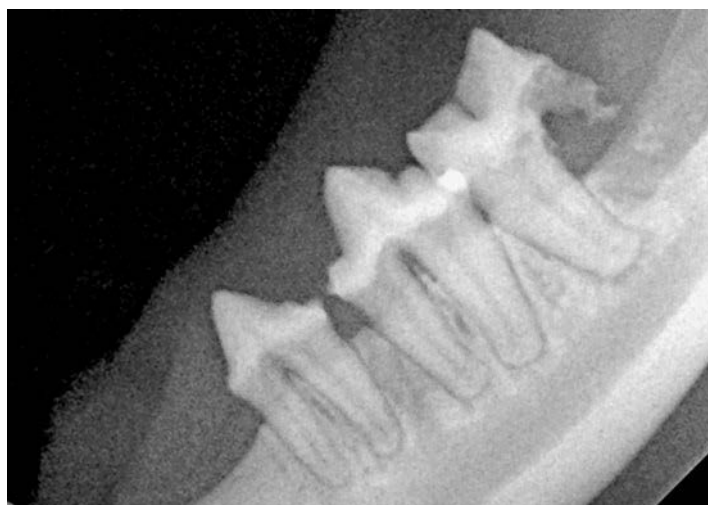


► **Fig. 16.293 Severe periodontitis on the left.** The left side appears symmetrical to the right.

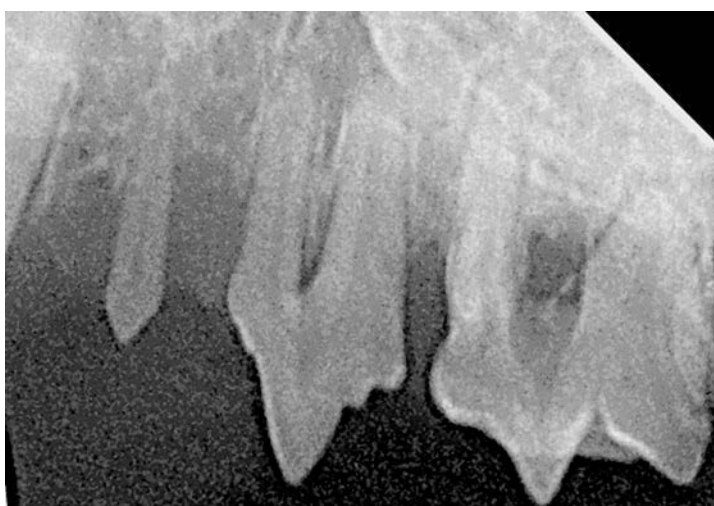




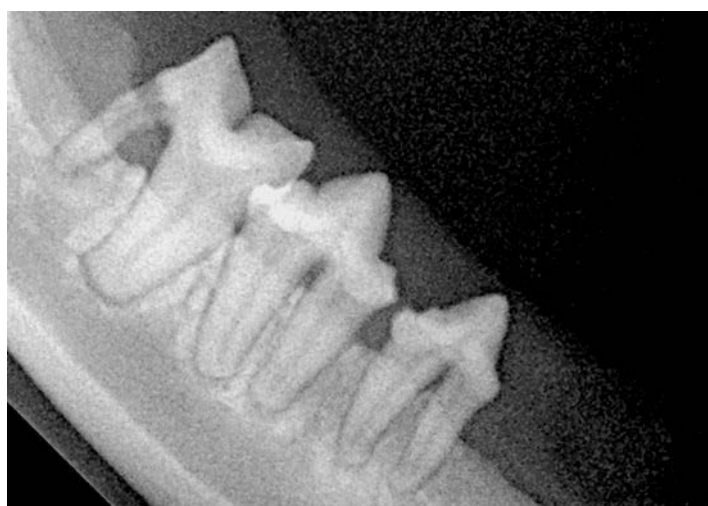
► **Fig. 16.294 Radiograph, right maxilla.** The horizontal osteolysis in the right maxilla extends into the apical third of the second premolar root. The bisecting angle radiography technique required for visualization of the maxillary cheek teeth obscures the view of the osteolysis of the other cheek teeth. Clinically, all furcations of the cheek teeth can be probed more than halfway or are completely open (stage 2 and 3 furcation involvement).



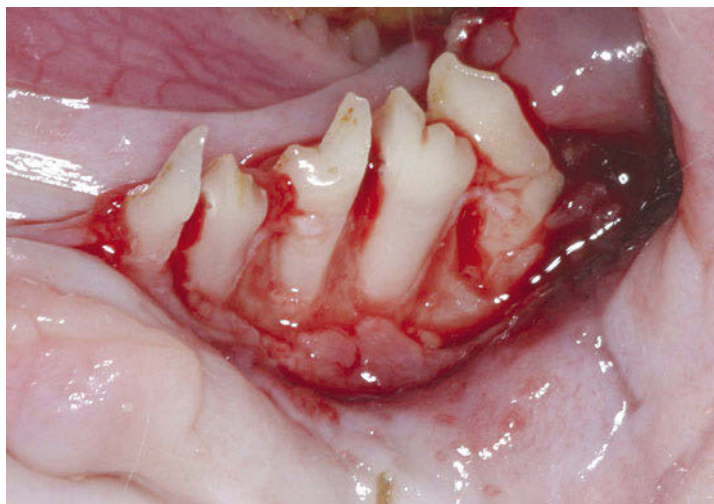
► **Fig. 16.296 Radiograph, left mandible.** The right angle technique in the mandibular cheek teeth shows the osteolysis more clearly. The distal root of the mandibular carnassial tooth is already largely resorbed.



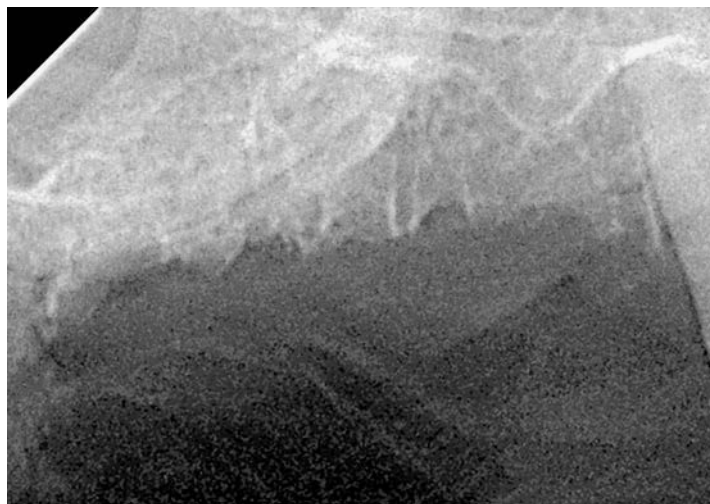
► **Fig. 16.295 Radiograph of the left maxilla.** In the left maxilla, the advanced osteolysis with exposure of the furcations and the resorptive lesion on tooth 208 are clearly visible.



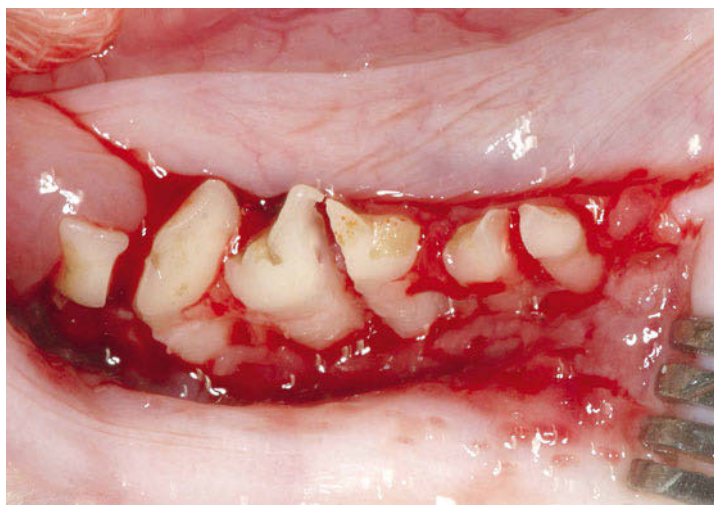
► **Fig. 16.297 Radiograph, right mandible.** The bone loss on the distal root of the mandibular carnassial tooth is particularly striking. Extraction of all of the cheek teeth is warranted due to the advanced periodontal disease and the associated gingival inflammation.



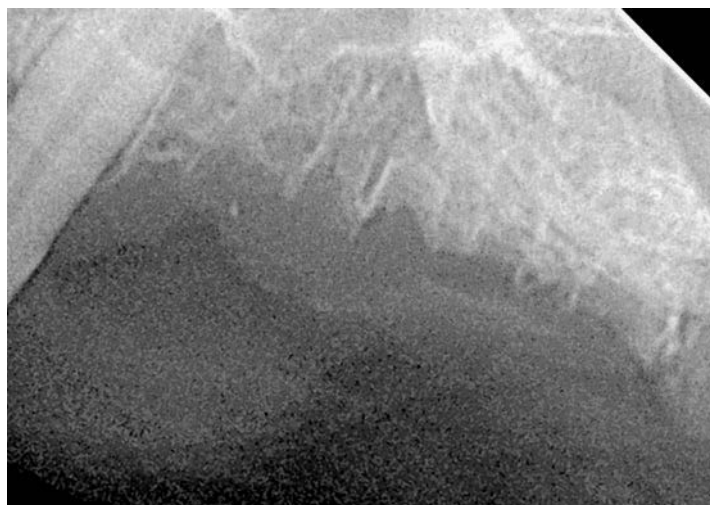
► **Fig. 16.298 Separated tooth roots in the left mandible.** Direct visualization of the roots is again the key to targeted extraction. In the cat, a buccal advancement flap, buccal osteotomy and separation of the roots across the entire row of cheek teeth allow a good view.



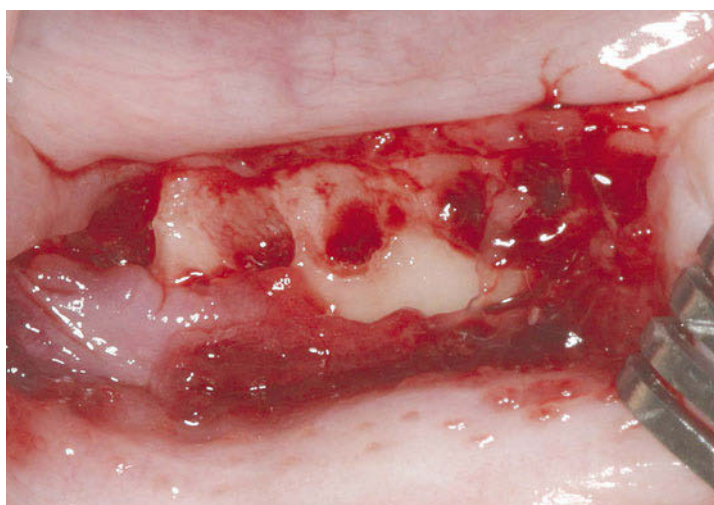
► **Fig. 16.301 Radiograph after extraction of the cheek teeth from the right maxilla.** No tooth fragments should be visible radiographically after extraction of the teeth.



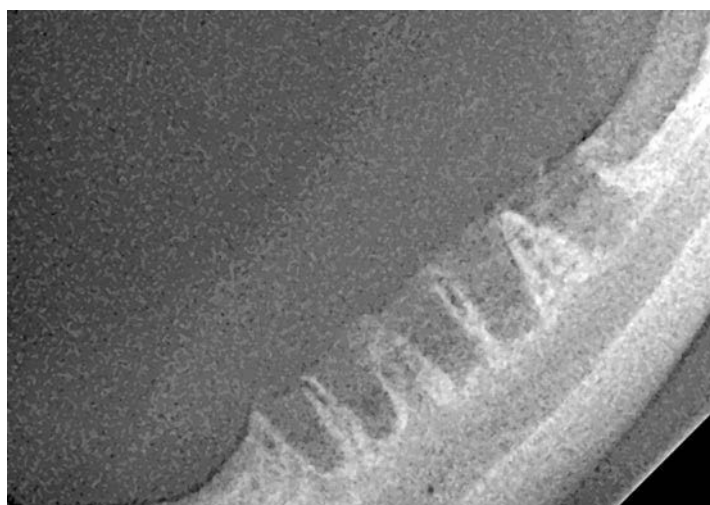
► **Fig. 16.299 Separated tooth roots in the right mandible.**



► **Fig. 16.302 Radiograph after extraction of the cheek teeth from the left maxilla.**



► **Fig. 16.300 Empty alveoli after extraction from the right mandible.** After extraction, empty alveoli should be seen. Coagulation can be promoted in the alveoli by inducing bleeding with curettage.



► **Fig. 16.303 Radiograph after extraction of the cheek teeth from the left mandible.**

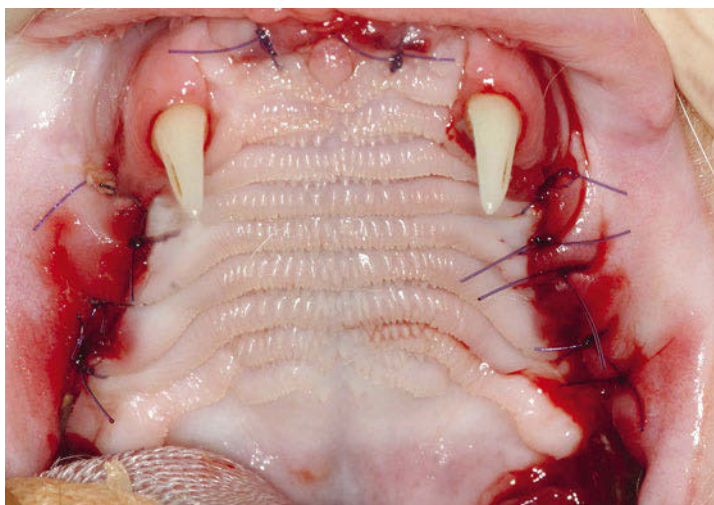




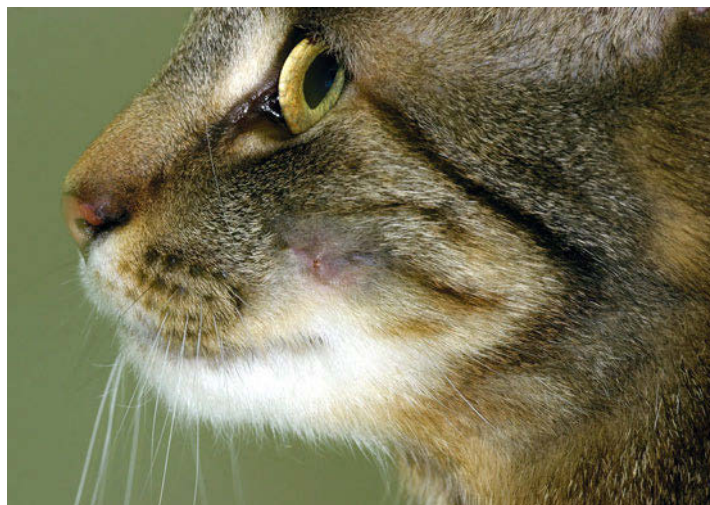
► Fig. 16.304 Radiograph after extraction of the cheek teeth from the right mandible.

#### 16.9.4 Extraction of a Root Fragment of a Maxillary Carnassial Tooth in a Cat

► Fig. 16.307, ► Fig. 16.308, ► Fig. 16.309, ► Fig. 16.310 and ► Fig. 16.311 show the extraction of a root fragment of the maxillary carnassial tooth in a cat.



► Fig. 16.305 Sutured maxilla. The entire dental arch is closed without tension using a vestibular advancement flap and simple interrupted sutures.



► Fig. 16.307 Fistula on the left maxilla. This cat was presented due to poor eating and discharge of fluid from an opening in the left cheek. A fistula is draining suborbitally on the left.



► Fig. 16.306 Sutured mandible.



► Fig. 16.308 Probe in the fistulous tract. The probe could be advanced more than 1 cm in the direction of the maxillary bone.

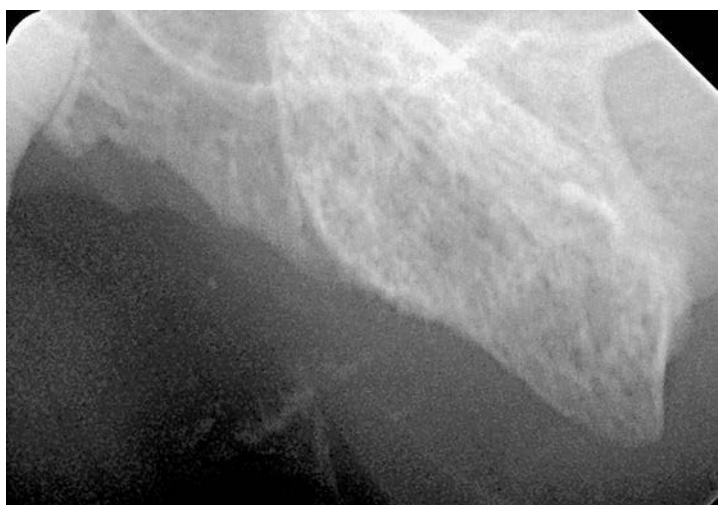




► **Fig. 16.309 Edentulous maxillary alveolar ridge on the left.** Intraorally, no inflammatory process is apparent. All of the cheek teeth in the left maxilla were previously extracted.



► **Fig. 16.310 Radiograph with root fragment of tooth 208.** Radiographically, a carnassial tooth root remnant can be visualized.



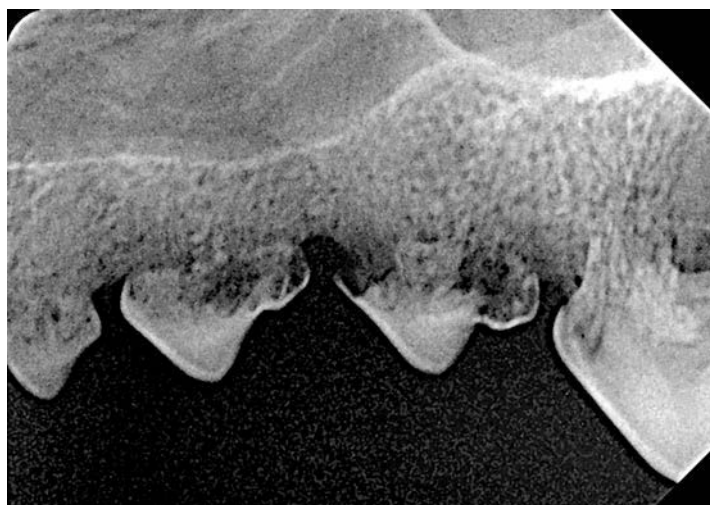
► **Fig. 16.311 Radiograph after removing the root fragment of tooth 208.** Extracting the root fragment eliminated the cause of fistula formation. Healing occurred without complications, and the patient's overall health improved.

### 16.9.5 Extraction of Teeth with Root Resorption in a Dog

It is particularly difficult to remove a tooth when the roots have fused with the jawbone following ankylosis due to resorptive processes (► Fig. 16.312, ► Fig. 16.313, ► Fig. 16.314, ► Fig. 16.315, ► Fig. 16.316, ► Fig. 16.317, ► Fig. 16.318, ► Fig. 16.319, ► Fig. 16.320).



► **Fig. 16.312 Resorptive lesions on the mandibular left cheek teeth.** Severe cervical defects were discovered on the cheek teeth of this dog presented for behavioral anomalies. Lingually, the mandibular left carnassial tooth is fractured, with sharp edges seen near the gingiva.

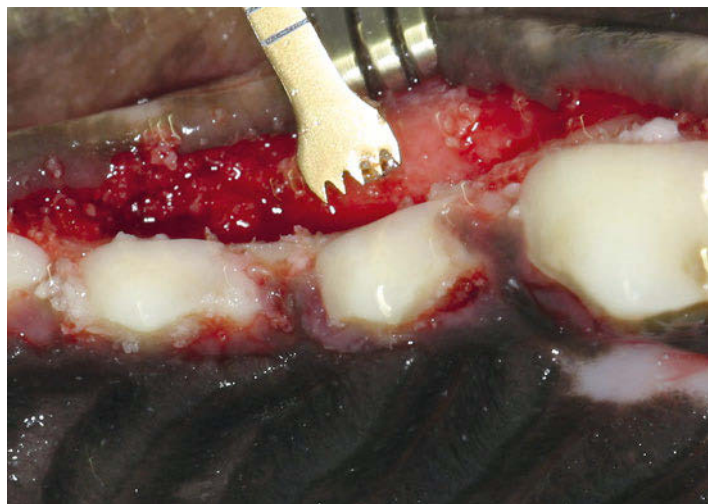


► **Fig. 16.313 Radiograph showing root resorption on the small maxillary left premolars.** Radiographically, the maxillary premolars lack a functional periodontium. Translucency in the cervical areas of the teeth mirror clinically visible defects, with mostly unremarkable alveolar bone and no discernible tooth roots.





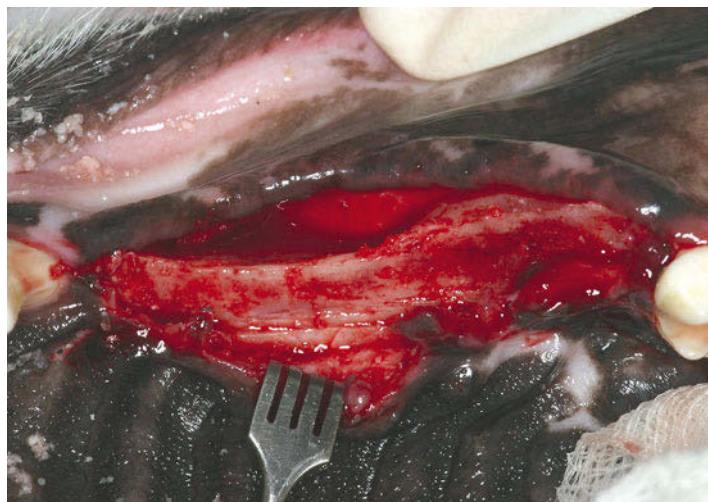
► **Fig. 16.314 Radiograph with root resorption on tooth 208.** In addition, roots are not seen on the maxillary left carnassial tooth, and the roots of the molars are unremarkable.



► **Fig. 16.316 Piezo saw for detaching the crown.** The close-up view shows the teeth of the piezo workpiece that cuts the bone.



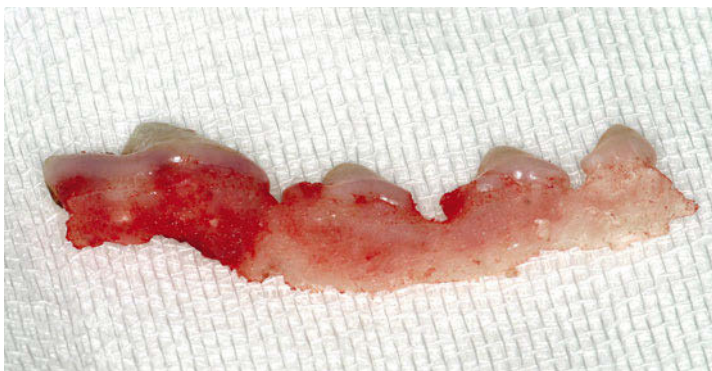
► **Fig. 16.315 Piezo saw on the alveolar ridge.** Since surgical exposure of the root is not required, a piezo saw is used to sever the teeth horizontally at the cervical root. Piezoelectric ultrasound waves enable selective cutting of bone tissue.



► **Fig. 16.317 Alveolar ridge after the teeth are cut.** In this dog, the cut area is smooth. As visualized in the radiograph, roots and alveoli are not present.



► **Fig. 16.318 Lateral view of the detached cheek teeth.** When the cheek teeth are extracted through a single cut in the cervical third of the root, they remain connected via a bony bridge.



► **Fig. 16.319 Apical view of the detached cheek teeth.** The cut edge of the detached dental arch shows the lack of deep attachment of the tooth roots in their alveoli; instead, the crowns were anchored at the gingiva and bones.



► **Fig. 16.320 Radiograph after extraction of the teeth in the left maxilla.** Radiographically, an unremarkable alveolar ridge can be seen after extracting the tooth remnants.

## 16.10

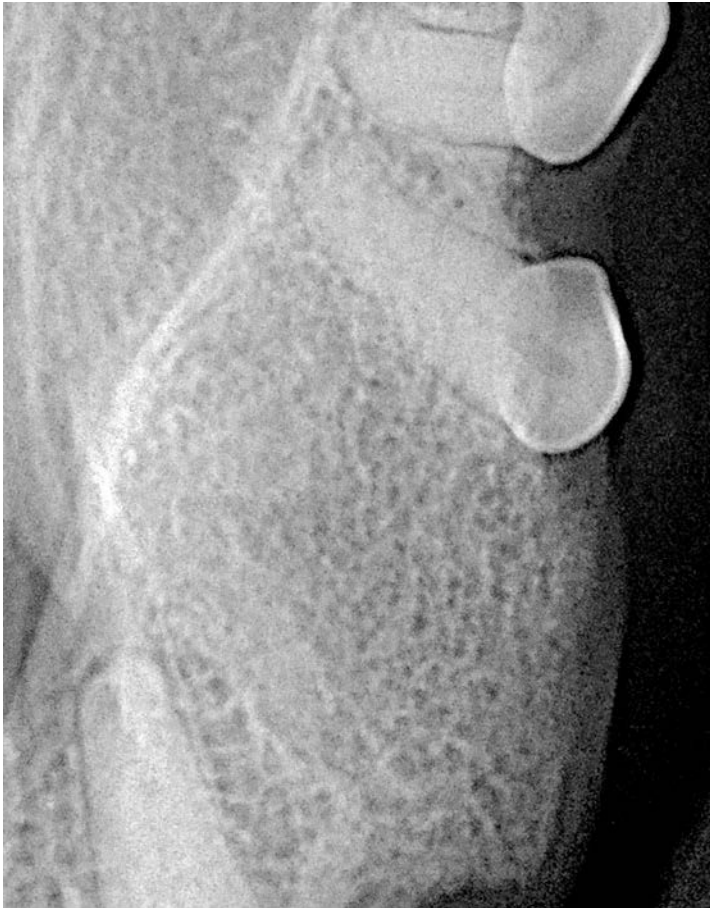
### Dental Implant of a Canine Tooth

Replacing a lost canine tooth is much more challenging in terms of mechanics than replacing a largely nonfunctional small premolar. The crown height of the canine tooth requires significantly longer anchoring in the jaw. The curvature of the physiological canine root precludes an implant of a similar length. Furthermore, sufficiently long human dental implants are unavailable. If the root is straight, the proximity to the nasal cavity is also a consideration. For this reason, a sufficiently long implant compatible with the jaw is necessary. The crown height should be reduced in accordance with the physical conditions to improve leverage (► Fig. 16.321, ► Fig. 16.322, ► Fig. 16.323, ► Fig. 16.324, ► Fig. 16.325, ► Fig. 16.326, ► Fig. 16.327, ► Fig. 16.328, ► Fig. 16.329, ► Fig. 16.330, ► Fig. 16.331, ► Fig. 16.332, ► Fig. 16.333, ► Fig. 16.334, ► Fig. 16.335, ► Fig. 16.336, ► Fig. 16.337, ► Fig. 16.338, ► Fig. 16.339, ► Fig. 16.340).

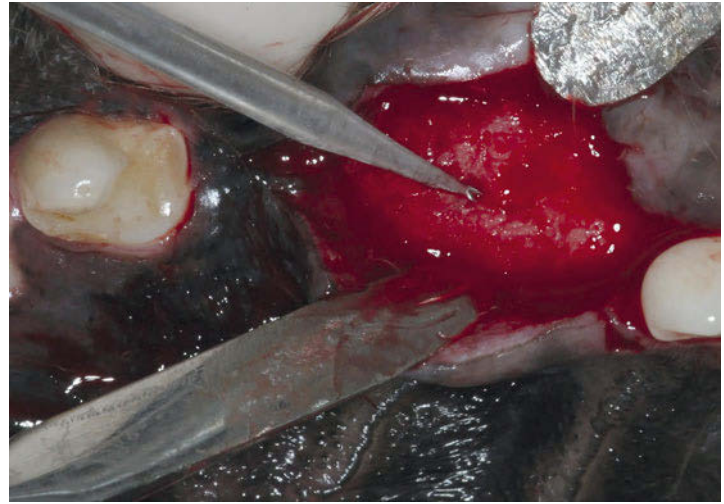


► **Fig. 16.321 Loss of the maxillary canine tooth.** This Fox Terrier lost its maxillary left canine tooth after a bite injury. At the time of presentation, the dog's tooth had already been absent for 6 months.

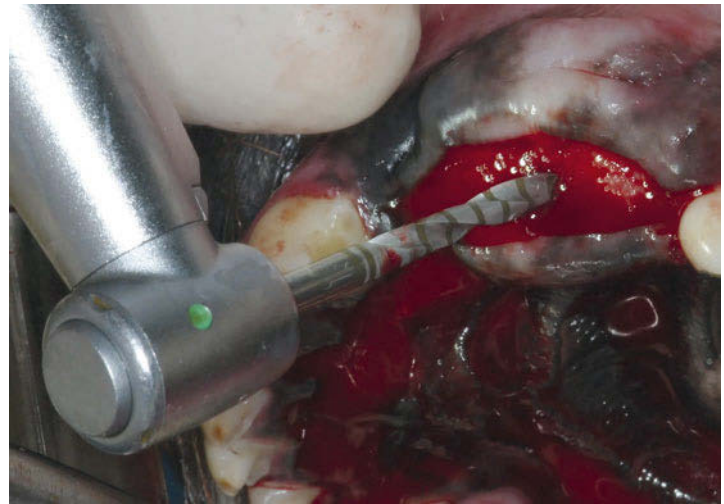




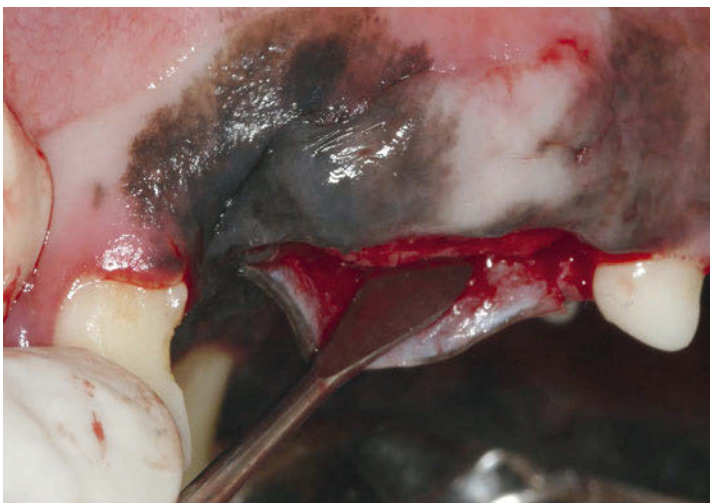
► **Fig. 16.322 Radiograph of the current condition.** The radiograph shows a healed alveolar ridge without any irritation.



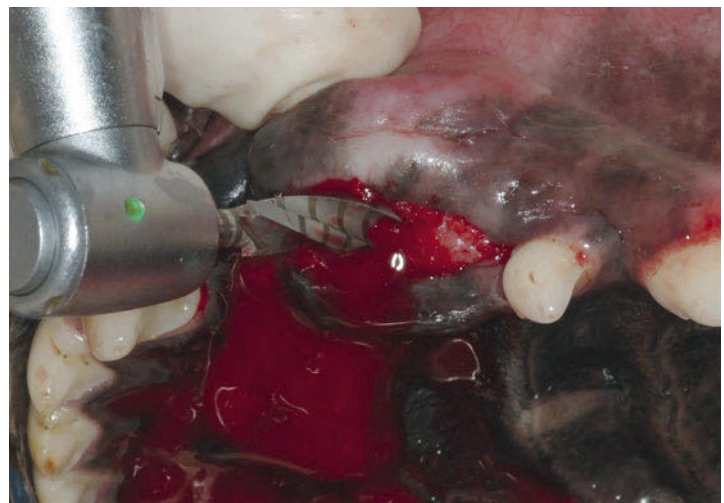
► **Fig. 16.324 Punching the alveolar ridge.** The designated position of the "implant alveolus" in the alveolar ridge is punctured with a rose-head bur.



► **Fig. 16.325 Drilling the implant bed.** Then the alveolar bed is drilled in the nearby jawbone.

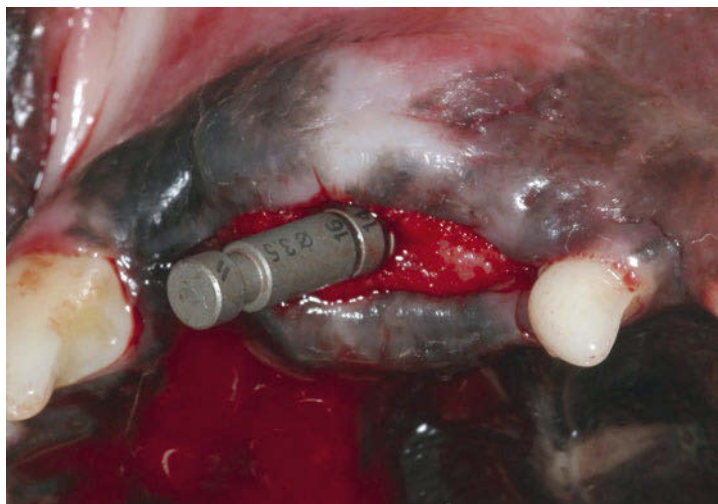


► **Fig. 16.323 Dissecting the mucosa.** A scalpel and periosteal elevator are used to dissect the bone part to be exposed.

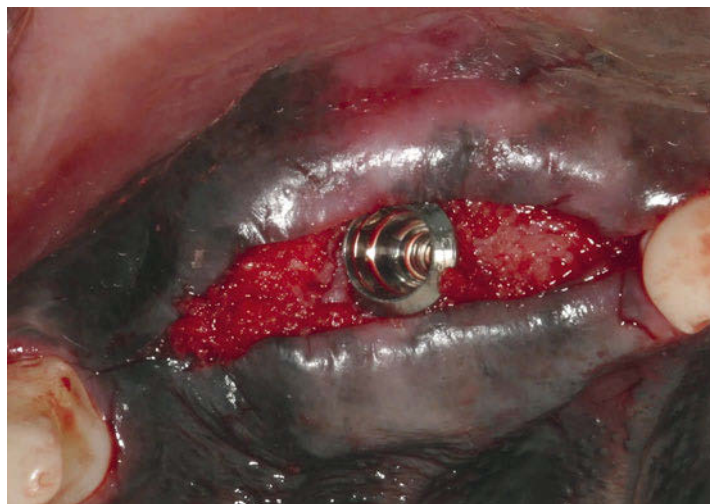


► **Fig. 16.326 Drilling the implant bed, depth check.** There is a depth indicator on the drill so that the drillhole can be made as deep as measured in the radiograph.





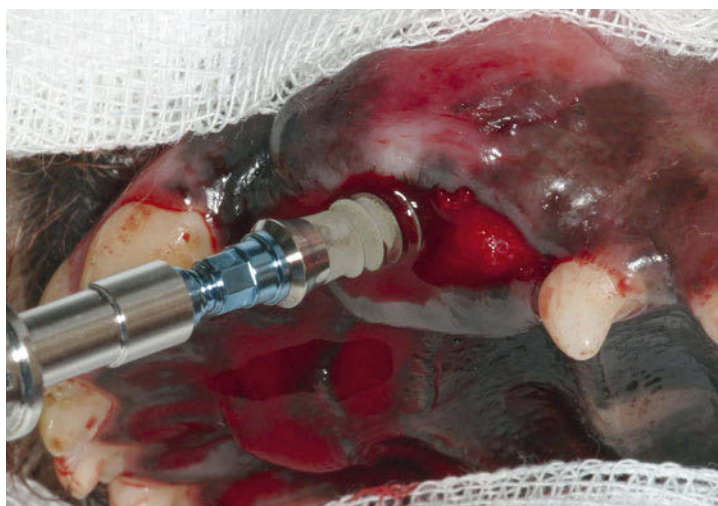
► **Fig. 16.327 Checking the depth of the implant bed.** A test pin indicates the exact depth required for the drillhole.



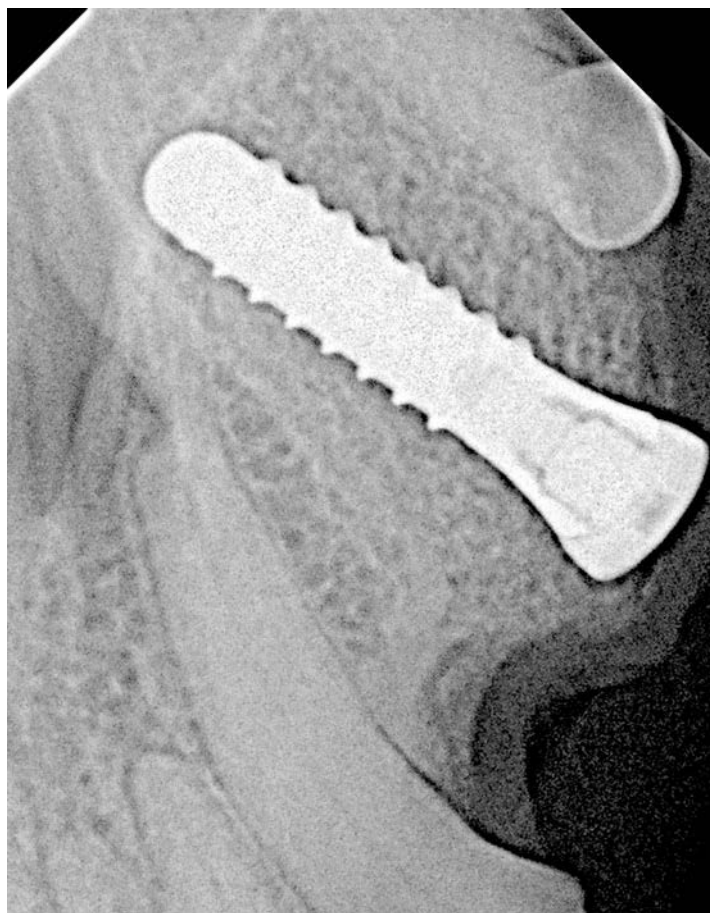
► **Fig. 16.330 Screwed-in implant.** When the transfer part is removed, only the smooth coronal opening of the implant on the alveolar ridge can be seen.



► **Fig. 16.328 Implant before insertion.** The implant has a self-tapping thread, so no thread cutter is required.

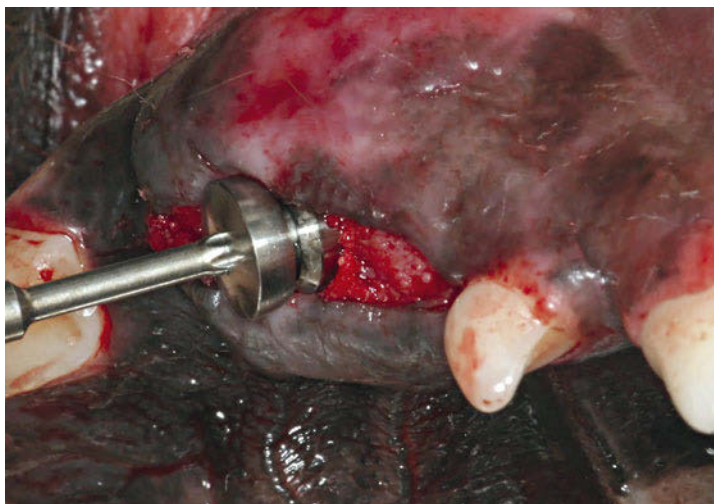


► **Fig. 16.329 Screwing in the implant.** In this case, the implant is screwed in manually. Automatic screwing is also possible, with preset torque to avoid damage to the bone.



► **Fig. 16.331 Intraoperative radiograph of the implant.** A radiograph is taken to check the position of the implant. The available space was used without contacting the nasal cavity. The distance to the surrounding tooth roots is also sufficient.

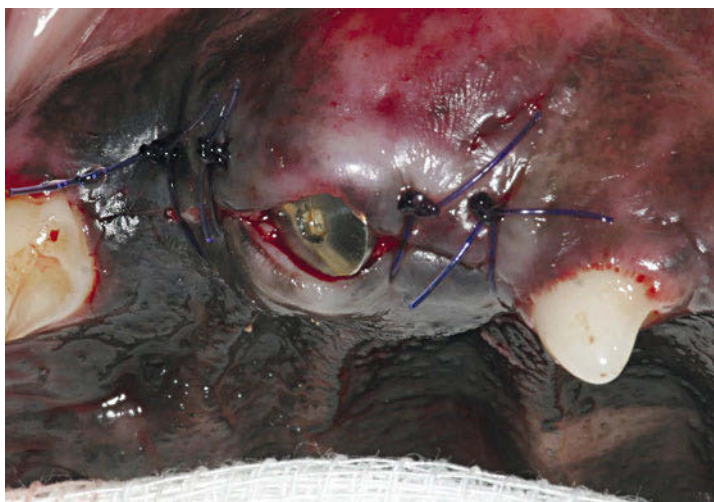




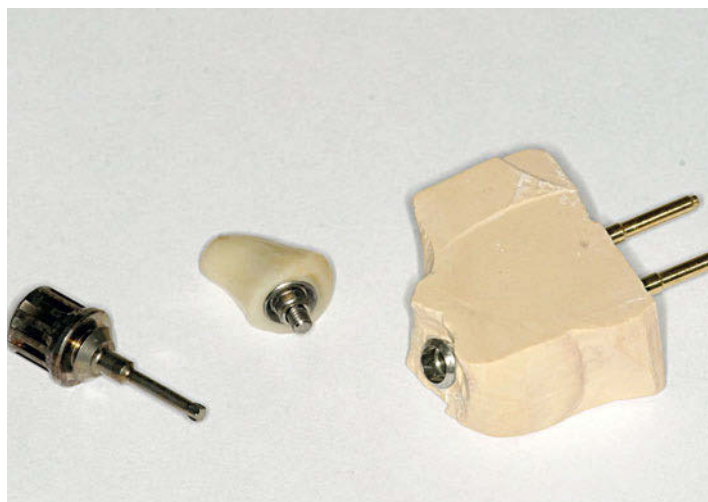
► **Fig. 16.332 Placing the dental healing cap.** For the duration of the healing process, a healing cap is screwed into the implant; this also functions as the gingival former.



► **Fig. 16.335 Screw connection of the implant crown on a model.** The ceramic crown is screwed onto the body of the implant.



► **Fig. 16.333 Suture.** The mucoperiosteal flaps are adapted with simple interrupted sutures. Healing of the implant takes 3 months in this case.



► **Fig. 16.336 Individual parts of the implant.** In the saw cut model, the individual parts can be worked on separately.



► **Fig. 16.334 Crown on the implant on a model.** The dental laboratory fabricates the implant crown, in this case, from zirconium dioxide.



► **Fig. 16.337 Gingiva former in place.** In the oral cavity, the gingiva former contributes to the attachment of the gingiva; slightly inflamed granulation is the only complication.



► **Fig. 16.338 Connecting the implant crown.** The crown is screwed into the implant.



► **Fig. 16.339 Implant crown with composite filling.** The coronal access is sealed with composite.



► **Fig. 16.340 Maxillary canine crown in occlusion.** For aesthetic reasons, the tooth color is varied to approximate the natural color. In order to improve leverage, the artificial crown is shorter than the former anatomical crown.



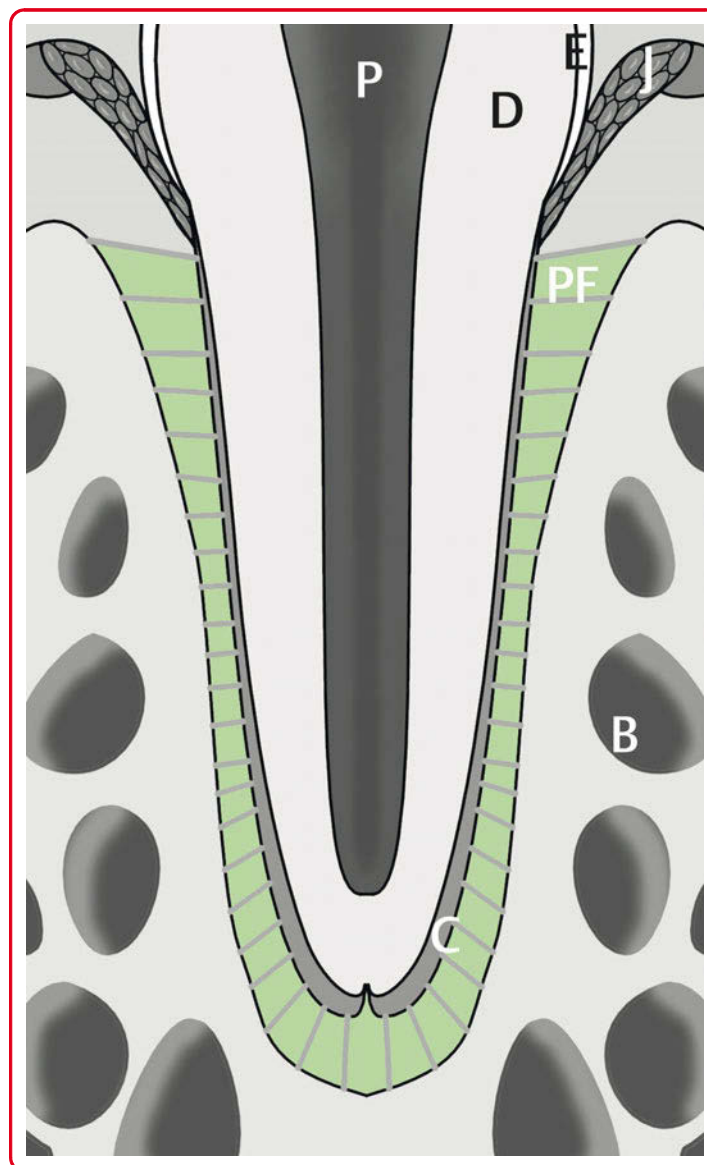
## 17 Periodontium

Periodontal disease and dental fractures are the most common problems in feline and canine dentistry. In contrast to a freshly fractured tooth, however, periodontitis develops insidiously and covertly. The owner often does not notice changes in behavior over the long disease course or attributes them to their pet aging. In many cases, the disease's overall effects on the animal are apparent only after the disease is treated.

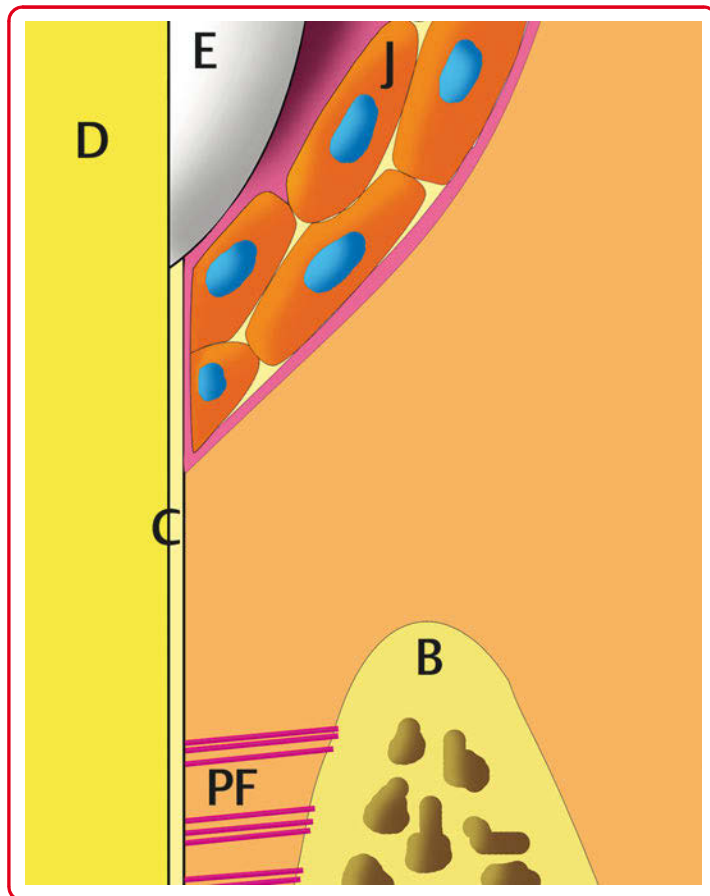
### 17.1

### Periodontium: Physiology and Pathology

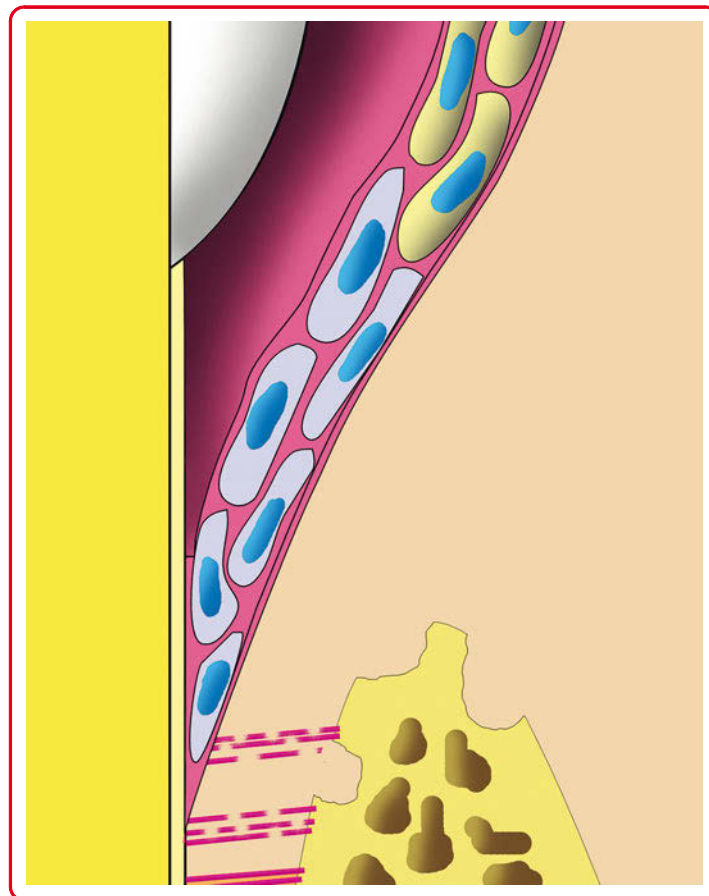
The following images show the physiological structure of the periodontium and the pathophysiology of the processes that damage it (► Fig. 17.1, ► Fig. 17.2, ► Fig. 17.3, ► Fig. 17.4).



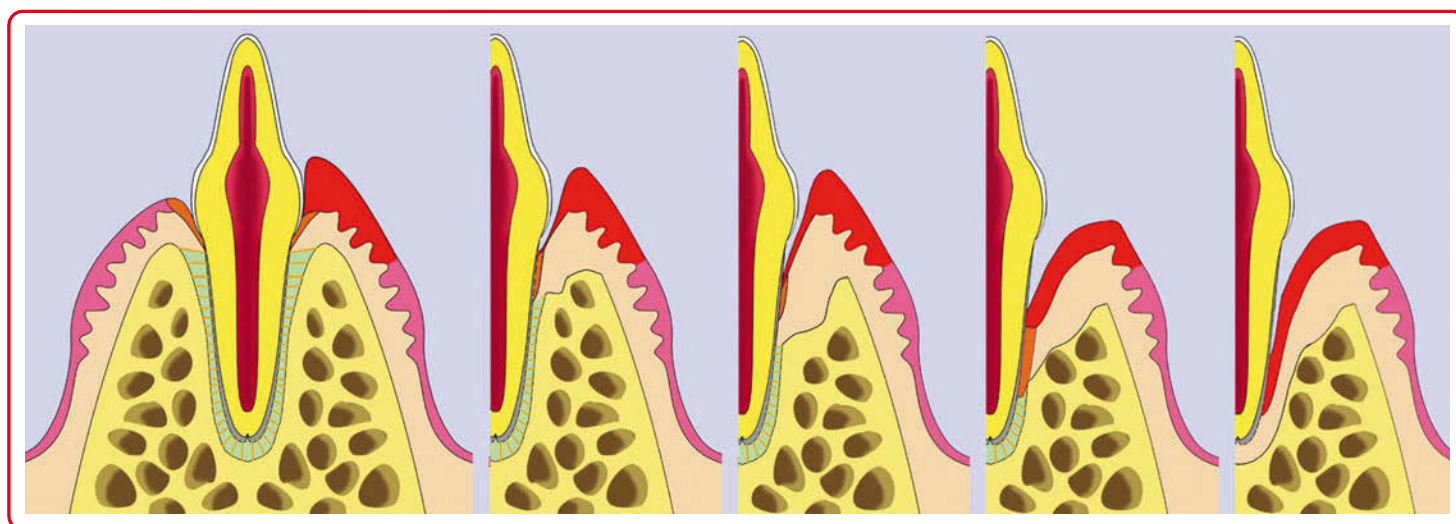
► **Fig. 17.1 Periodontium.** This diagram shows the composition of the periodontium. It consists of circular gingiva, the root, the alveolar bone, and the periodontal fibers, which connect the tooth to the bone in the periodontal ligament space. The teeth and periodontium are a combination of different structures into a functional unit. E = Enamel, D = Dentin, J = Junctional gingival epithelium, C = Cementum, B = Bone, P = Pulp cavity, PF = Periodontal fibers.



► **Fig. 17.2 Junctional gingival epithelium.** The junctional gingival epithelium is the first barrier to bacterial infiltration of deeper-lying tissue. The interior of the gingival sulcus is lined with junctional epithelial cells; there is no stratum corneum, but this semi-permeable layer permits fluid movement toward the sulcus (epithelial attachment). In this diagram, the interface between the junctional gingival epithelium and the tooth is the cemento-enamel junction. The junctional gingival epithelium does not fuse with the enamel; rather, hemidesmosomes attach the epithelial cells to the surface of the enamel. This composite structure that is “glued together” rather than “fused” is highly susceptible to exogenous trauma. This makes the underlying tissue with periodontal fibers, root, and alveolar bone vulnerable. E = Enamel, D = Dentin, J = junctional gingival epithelium, C = Cementum, B = Bone, PF = periodontal fibers.



► **Fig. 17.3 Destroyed marginal periodontium.** The damage to the epithelial attachment from bacteria and the host defense mechanisms in turn damages deeper-lying parts of the periodontium (periodontal attachment). The junctional gingival epithelium recedes from the tooth and grows in an apical direction. The normal keratinized gingival epithelium grows from the side of the oral cavity. This pocket's probing depth increases as the periodontitis worsens (dog > 2 mm, cat > 0.5 to 1 mm). Periodontal fibers are destroyed, the root is exposed to toxic factors, and the alveolar bone is destroyed. Bone loss causes a true periodontal pocket to form.



► **Fig. 17.4 Course of periodontitis.** The left side of the tooth shows healthy gingiva and periodontium; the structures are normal height. The right side, however, shows progressive periodontal destruction with a deepening pocket. Periodontal destruction is irreversible. Periodontal prophylaxis is therefore imperative so that any early periodontal disease can be addressed. Pure gingivitis is reversible, whereas true periodontitis requires management of permanently damaged structures.



### 17.1.1 Evaluating the Periodontium in a Dog

The prognosis of periodontal disease depends on the evaluation of individual parameters. In human medicine, many evaluation methods are available. They can be adapted to the needs of veterinary medicine and are presented in a simplified and systematic form in the diagrams below.

The model presented in ► Fig. 17.5, ► Fig. 17.6, ► Fig. 17.7 and ► Fig. 17.8 is useful for the evaluation of **plaque and calculus**.



► **Fig. 17.5 Teeth without plaque or calculus.** Appearance of a healthy mandibular carnassial tooth. The tooth has no plaque or calculus. (source: Mars Petcare GmbH)



► **Fig. 17.7 Teeth with plaque and calculus (stage 2 periodontal disease).** In teeth with moderate periodontal disease (stage 2), a moderate layer of plaque is present that appears as a line in the sulcus. At this stage, moderate supragingival or subgingival calculus can be observed. (source: Mars Petcare GmbH)



► **Fig. 17.6 Teeth with plaque and calculus (stage 1 periodontal disease).** Teeth with minor periodontal disease (stage 1) have a thin plaque film that can be detected with a probe at the neck of the tooth. At this stage, small amounts of supragingival plaque can be observed. (source: Mars Petcare GmbH)



► **Fig. 17.8 Teeth with plaque and calculus (stage 3 periodontal disease).** In teeth with advanced periodontal disease (stage 3), a thick layer of plaque is present in the sulcus and on the tooth. At this stage, supragingival or subgingival calculus can be observed. (source: Mars Petcare GmbH)

The model presented in ► Fig. 17.9, ► Fig. 17.10 and ► Fig. 17.11 is used to evaluate **gingivitis**.



► **Fig. 17.9 Stage 1 gingivitis.** Minor gingivitis (stage 1) involves slight redness and swelling. The gums do not bleed when probed. (source: Mars Petcare GmbH)



► **Fig. 17.10 Stage 2 gingivitis.** Moderate gingivitis (stage 2) involves moderate redness and swelling, and the gums bleed when probed. (source: Mars Petcare GmbH)



► **Fig. 17.11 Stage 3 gingivitis.** Advanced gingivitis (stage 3) involves severe redness and swelling and spontaneous bleeding without probing. (source: Mars Petcare GmbH)

The models presented in ► Fig. 17.12, ► Fig. 17.13 and ► Fig. 17.14 are used to evaluate **furcation involvement**.



► **Fig. 17.12 Stage 1 furcation involvement.** In a dog with minor furcation involvement (stage 1) a probe can be placed 1 to 3 mm into the furcation but less than halfway under the crown. (source: Mars Petcare GmbH)



► **Fig. 17.13 Stage 2 furcation involvement.** In a dog with moderate furcation involvement (stage 2) a probe can be placed further than 3 mm into the furcation; the defect extends more than halfway under the crown. (source: Mars Petcare GmbH)



► **Fig. 17.14 Stage 3 furcation involvement.** In a dog with severe furcation involvement (stage 3) a probe can completely penetrate the furcation. (source: Mars Petcare GmbH)



The models presented in ► Fig. 17.15, ► Fig. 17.16 and ► Fig. 17.17 are used to evaluate **recession**.



► **Fig. 17.15 Stage 1 gingival recession.** In a dog with minor gingival recession (stage 1), 1 to 2 mm of the root surface is visible. (source: Mars Petcare GmbH)



► **Fig. 17.16 Stage 2 gingival recession.** In a dog with moderate gingival recession (stage 2), 5 mm of the root surface is visible. (source: Mars Petcare GmbH)

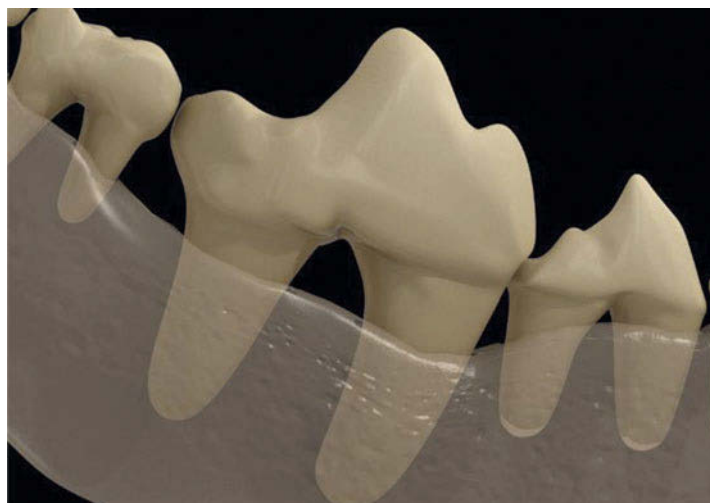


► **Fig. 17.17 Stage 3 gingival recession.** In a dog with advanced gingival recession (stage 3), more than 5 mm of the root surface is visible. (source: Mars Petcare GmbH)

The models presented in ► Fig. 17.18, ► Fig. 17.19 and ► Fig. 17.20 are used to evaluate **osteolysis** in the radiograph.



► **Fig. 17.18 Stage 1 osteolysis.** In low-grade osteolysis (stage 1), the loss of bone height in the radiograph is equivalent to less than 25% of the root length. (source: Mars Petcare GmbH)

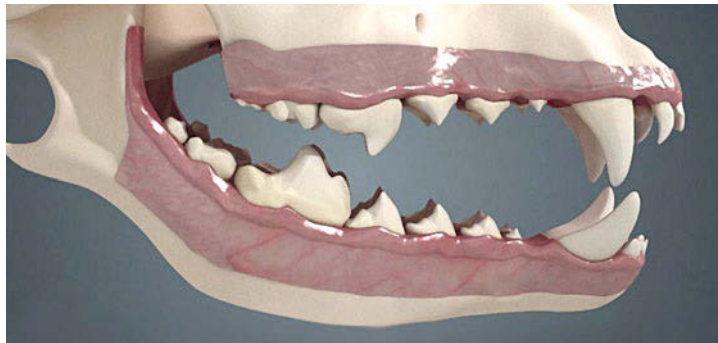


► **Fig. 17.19 Stage 2 osteolysis.** In moderate osteolysis (stage 2), the loss of bone height in the radiograph is equivalent to 25 to 50% of the root length. (source: Mars Petcare GmbH)

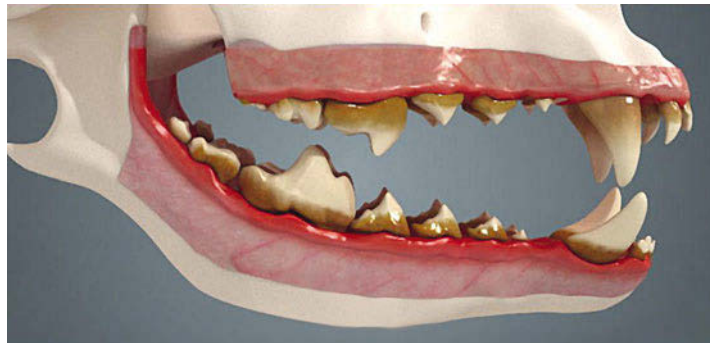


► **Fig. 17.20 Stage 3 osteolysis.** In advanced osteolysis (stage 3), the loss of bone height in the radiograph is equivalent to more than 50% of the root length. (source: Mars Petcare GmbH)

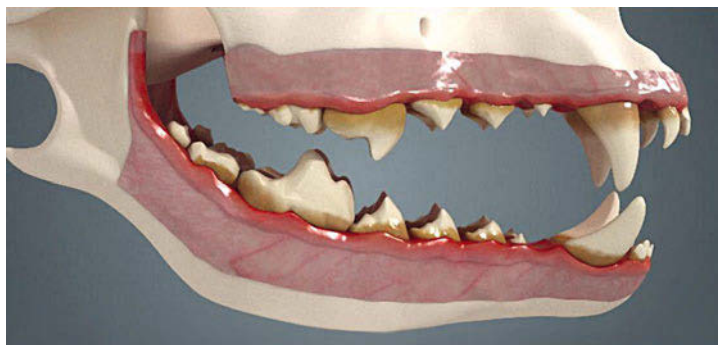
The periodontal parameters for each individual tooth are important for evaluating periodontitis. However, the crucial factor for evaluation is the **overall condition of the periodontium**. Here too, a model may be used for classification into three stages (► Fig. 17.21, ► Fig. 17.22, ► Fig. 17.23, ► Fig. 17.24).



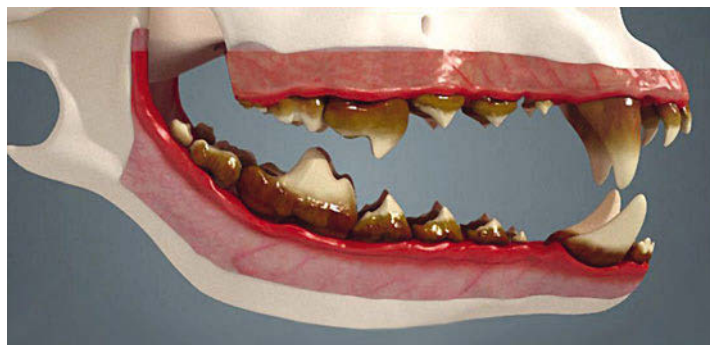
► **Fig. 17.21 Healthy periodontium on the right side.** In healthy periodontium, the gingiva lacks redness and signs of inflammation. (source: Mars Petcare GmbH)



► **Fig. 17.23 Moderate periodontal disease on the right side.** Moderate periodontal disease is characterized by moderate recession of the periodontal attachment with increasing osteolysis and furcations that can be probed to a greater depth. (source: Mars Petcare GmbH)



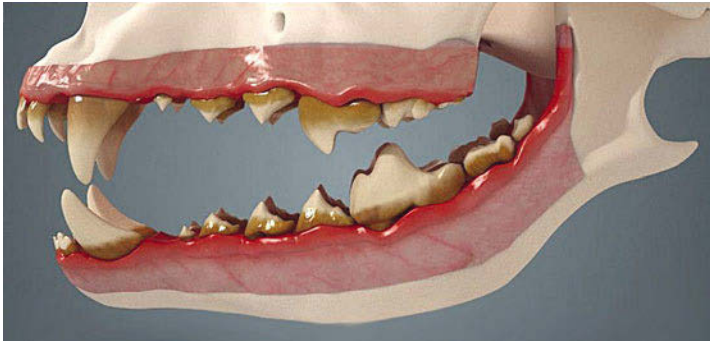
► **Fig. 17.22 Early-stage periodontal disease on the right side.** Signs of gingivitis include redness, swelling and a variable tendency to bleed without gingival recession. The periodontal attachment of the alveoli and the height of the alveolar bone are normal. In early-stage periodontitis, the remaining periodontium begins to change. The periodontal attachment begins to recede and osteolysis starts; the furcations become much easier to palpate. (source: Mars Petcare GmbH)



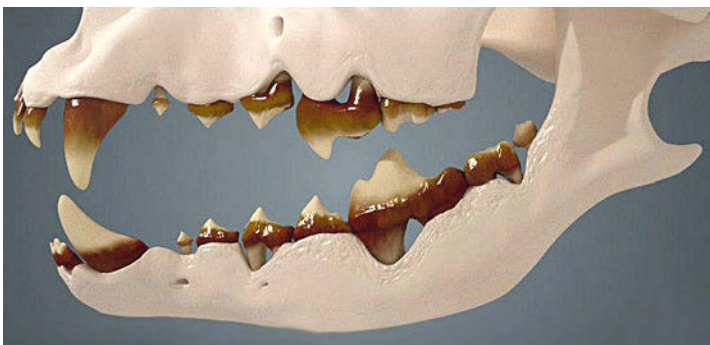
► **Fig. 17.24 Advanced periodontitis on the right side.** Advanced periodontal disease is characterized by severe recession of the periodontal attachment with advanced osteolysis and furcations that can be probed from one side to the other. (source: Mars Petcare GmbH)



No standard course of periodontitis exists; rather, there is a wide range of different forms. In comparison to generalized periodontal disease causing **horizontal bone loss** in particular (► Fig. 17.27) periodontal disease can also cause individual infrabony pockets to develop (► Fig. 17.25 and ► Fig. 17.26). In most cases, only individual parts of the periodontium are affected, and the clinical signs of the process are not as striking as in a generalized condition.



► **Fig. 17.25 Moderate periodontal disease on the left side.** In the case of individual infrabony pockets, the osteolysis is often limited to individual areas. The gingiva does not lose as much height as in horizontal bone loss. In some cases, a very deep bony pocket is present only at a single tooth. Because the defects can be small or hard to see, the process may persist for a longer period. (source: Mars Petcare GmbH)



► **Fig. 17.26 Individual infrabony pockets.** In the bone model, it is apparent that periodontal bone loss has already occurred at individual parts of the periodontium and is likely concealed in a live animal due to the nature of the osteolysis and the response of the gingiva. (source: Mars Petcare GmbH)



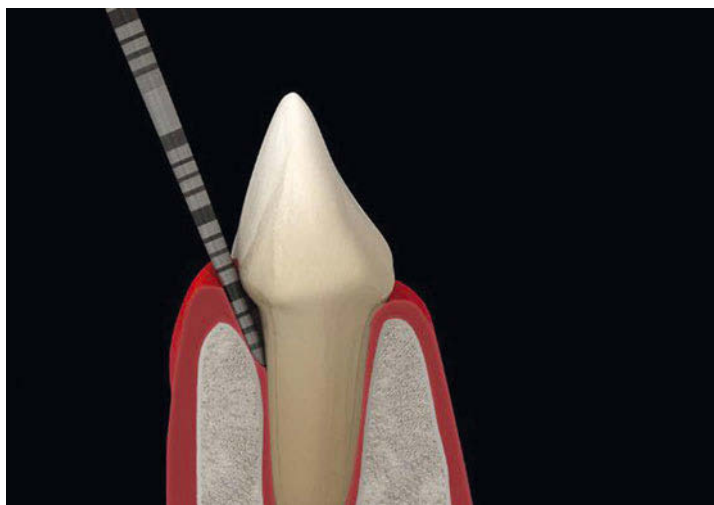
► **Fig. 17.27 Horizontal bone loss.** This model depicts only the bony changes in the periodontium; the extent of the horizontal bone loss often causes the damage to be clinically apparent. (source: Mars Petcare GmbH)

**Probing the gingival sulcus** is crucial to clinical evaluation of the periodontal status. In some dogs and cats, the extent of periodontal damage can be observed in the conscious animal. Because radiography under general anesthesia is required to obtain further details, the clinical examination may aid in screening animals to undergo such diagnostics.

The probe is introduced into the sulcus between the tooth and the gingiva without exerting pressure, and the probe depth is measured using the indicators on the probe (► Fig. 17.28, ► Fig. 17.29, ► Fig. 17.30).



► **Fig. 17.28 Probing a 2 to 4 mm pocket.** Clinically, probing the sulcus or pocket depth gives the practitioner an indication of what will appear in the radiograph. A pocket measuring 2 to 4 mm in an average 20 kg dog is designated early stage periodontal disease. (source: Mars Petcare GmbH)



► **Fig. 17.29 Probing a 4 to 6 mm pocket.** A 4 to 6 mm pocket in a 20 kg dog generally indicates moderate periodontitis (true periodontal pockets, not pseudo-pockets). In toy breeds, however, this pocket depth is considered to be advanced periodontitis. For this reason, using absolute values for classification of the individual stages of periodontitis is not a good idea, because they must be interpreted in association with the size of the animal in question. (source: Mars Petcare GmbH)



► **Fig. 17.31 Roots of the canine teeth and cheek teeth in a transparent skull.** The roots can be seen clearly in a transparent skull. (source: Mars Petcare GmbH)

The periodontal findings can be clearly recorded on a record chart for dogs (► Fig. 2.11, ► Fig. 2.13) or cats (► Fig. 2.12). ► Fig. 17.32 illustrates the importance of interpreting the results of each examination in the context of their significance for the organism.



► **Fig. 17.30 Probing a pocket measuring more than 6 mm.** Starting from a pocket depth of 6 mm, conservative therapy is generally no longer viable. A surgical approach can improve the prognosis in such advanced cases of periodontal disease. (source: Mars Petcare GmbH)



► **Fig. 17.32 Bacteremia in a transparent dog.** A transparent dog can illustrate more clearly that an oral problem may produce bacteremia that extends beyond the oral cavity and affects the entire organism and its organ function. (source: Mars Petcare GmbH)



### 17.1.2 Evaluating the Periodontium in a Cat

The model presented in ► Fig. 17.33, ► Fig. 17.34, ► Fig. 17.35 and ► Fig. 17.36 is used for the evaluation of **plaque and calculus**.



► **Fig. 17.33 Teeth without plaque or calculus.** In cats, a healthy tooth in healthy periodontium presents clinically with a white, intact crown in unremarkable, bright red gingiva. The gingiva is usually not as intensely red in cats as in dogs. (source: Mars Petcare GmbH)



► **Fig. 17.35 Teeth with plaque and calculus (stage 2 periodontal disease).** In teeth with moderate periodontal disease (stage 2), a moderate layer of plaque is seen as a line in the sulcus. At this stage, moderate supragingival or subgingival calculus can be observed. (source: Mars Petcare GmbH)



► **Fig. 17.34 Teeth with plaque and calculus (stage 1 periodontal disease).** Teeth with early-stage periodontal disease (stage 1) have a thin plaque film that can be detected by probing the neck of the tooth. At this stage, small amounts of supragingival plaque can be observed. (source: Mars Petcare GmbH)



► **Fig. 17.36 Teeth with tartar (stage 3 periodontal disease).** In teeth with advanced periodontal disease (stage 3), a thick layer of plaque is present in the sulcus and on the tooth. At this stage, severe supragingival or subgingival calculus can be observed. (source: Mars Petcare GmbH)

The model presented in ► Fig. 17.37, ► Fig. 17.38 and ► Fig. 17.39 is used to evaluate **gingivitis**.



► **Fig. 17.37 Stage 1 gingivitis.** Minor gingivitis (stage 1) involves slight redness and slight swelling. The gums do not bleed when probed. (source: Mars Petcare GmbH)

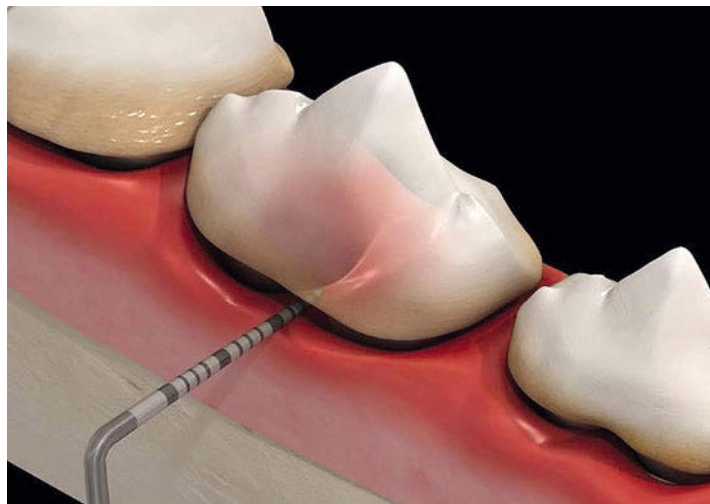


► **Fig. 17.38 Stage 2 gingivitis.** Moderate gingivitis (stage 2) involves moderate redness and swelling, and the gums bleed when probed. (source: Mars Petcare GmbH)

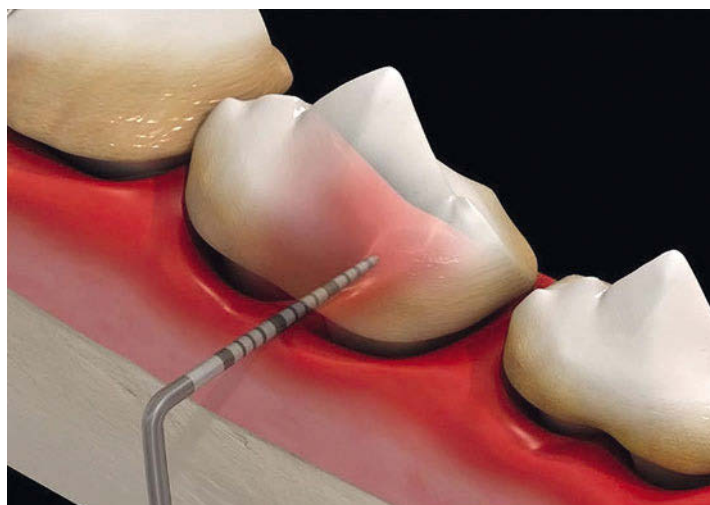


► **Fig. 17.39 Stage 3 gingivitis.** Advanced gingivitis (stage 3) involves severe redness and swelling and spontaneous bleeding of the gingiva. (source: Mars Petcare GmbH)

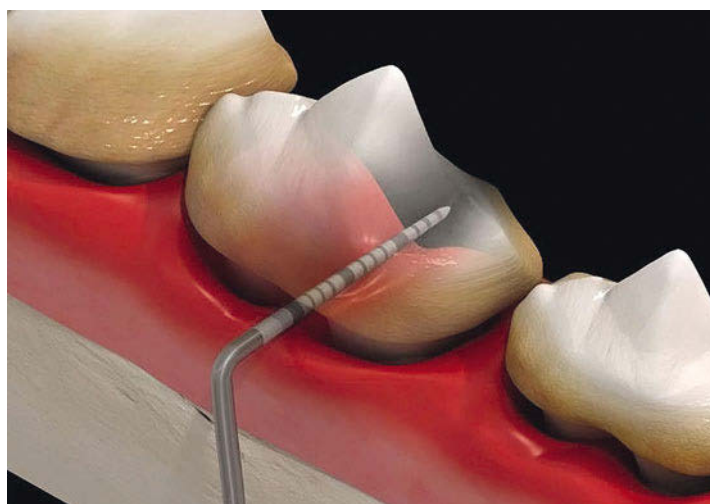
The model presented in ► Fig. 17.40, ► Fig. 17.41 and ► Fig. 17.42 is used to evaluate **furcation involvement**.



► **Fig. 17.40 Stage 1 furcation involvement.** In a cat with minor furcation involvement (stage 1) a probe can be inserted 1 to 2 mm into the furcation, but less than halfway under the crown. (source: Mars Petcare GmbH)



► **Fig. 17.41 Stage 2 furcation involvement.** In a cat with moderate furcation involvement (stage 2) a probe can be placed deeper than 2 mm into the furcation; the defect extends more than halfway under the crown. (source: Mars Petcare GmbH)



► **Fig. 17.42 Stage 3 furcation involvement.** In a cat with severe furcation involvement (stage 3), the probe can be passed completely under the furcation. (source: Mars Petcare GmbH)



The model presented in ► Fig. 17.43, ► Fig. 17.44 and ► Fig. 17.45 is used to evaluate **gingival recession**.



► **Fig. 17.43 Stage 1 gingival recession.** In a cat with minor gingival recession (stage 1), 1 mm of the root surface is visible. (source: Mars Petcare GmbH)

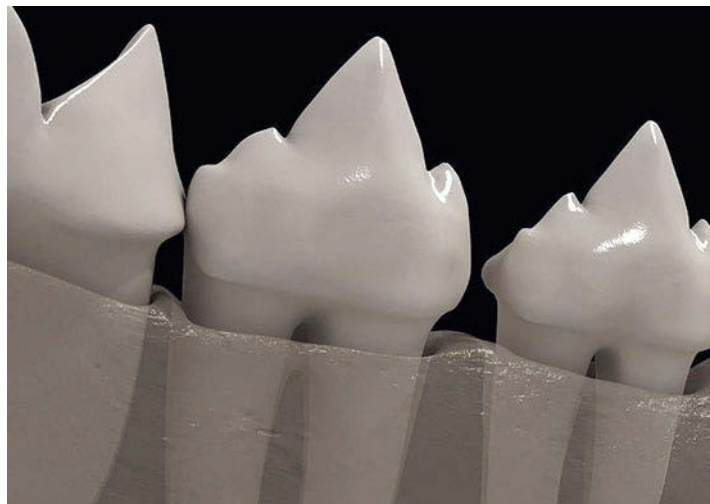


► **Fig. 17.44 Stage 2 gingival recession.** In a cat with moderate gingival recession (stage 2), up to 2 mm of the root surface is visible. (source: Mars Petcare GmbH)



► **Fig. 17.45 Stage 3 gingival recession.** In a cat with severe gingival recession (stage 3), more than 2 mm of the root surface is visible. (source: Mars Petcare GmbH)

The model in ► Fig. 17.46, ► Fig. 17.47 and ► Fig. 17.48 is used to evaluate **osteolysis** in the radiograph.



► **Fig. 17.46 Stage 1 osteolysis.** In low-grade osteolysis (stage 1), the loss of bone height in the radiograph is equivalent to less than 25% of the root length. (source: Mars Petcare GmbH)



► **Fig. 17.47 Stage 2 osteolysis.** In moderate osteolysis (stage 2), the loss of bone height in the radiograph is equivalent to between 25 and 50% of the root length. (source: Mars Petcare GmbH)



► **Fig. 17.48 Stage 3 osteolysis.** In advanced osteolysis (stage 3), the loss of bone height in the radiograph is equivalent to more than 50% of the root length. (source: Mars Petcare GmbH)

The periodontal parameters for individual teeth are important. However, the crucial factor for evaluation is the **overall condition of the teeth**. Here too, the model may be used for classification into three stages (► Fig. 17.49, ► Fig. 17.50, ► Fig. 17.51, ► Fig. 17.52).



► **Fig. 17.49 Healthy periodontium.** The gingiva is pink, and the slight redness is clinically insignificant. A sulcus is never necessary for histological reasons. However, bacteria are ubiquitous and often create a sulcus, so a 1 mm sulcus with slight redness of the marginal gingiva is considered clinically healthy. The cervical gingiva is normal. (source: Mars Petcare GmbH)



► **Fig. 17.51 Advanced periodontitis with horizontal bone loss.** The periodontitis has severely damaged the fibrous and bony attachments. Distinct infrabony pockets are found. Individual infrabony pockets may be overlooked, however, because the gingiva does not always clearly recede and individual pockets can be hidden. Periodontal probing and radiography of the roots may rule out horizontal bone loss. (source: Mars Petcare GmbH)



► **Fig. 17.50 Early stage periodontitis with horizontal bone loss.** The periodontium shows early damage: The gingiva has reddened. The furcations can be more distinctly palpated due to the crestal bone loss. In horizontal bone loss, all teeth in the area are uniformly affected. In many cases, the height of the periodontium is reduced, including at the gingiva. (source: Mars Petcare GmbH)



► **Fig. 17.52 Advanced periodontitis in the bone window.** If the gingival cover is removed from the model, the bony defects are more distinctly visible. The discrepancy between clinically detectable and actual damage must be clearly illustrated to the owner in order to explain the need for treatment. (source: Mars Petcare GmbH)



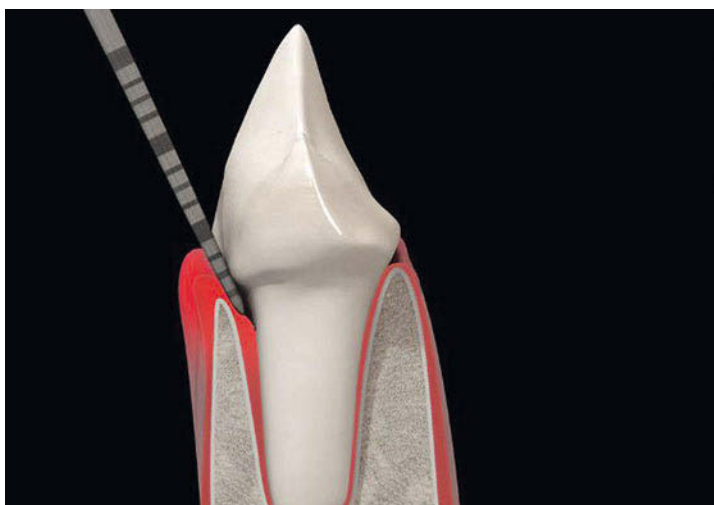
**Probing the dental sulcus** provides information about the extent of periodontal damage (► Fig. 17.53, ► Fig. 17.54, ► Fig. 17.55).



► **Fig. 17.53 Probing a shallow pocket.** In a cat, a probing depth of 1 mm is considered a shallow periodontal pocket. Due to the delicate feline anatomy, the periodontium is considered to be damaged at a much earlier stage than in dogs. (source: Mars Petcare GmbH)



► **Fig. 17.55 Probing a deep pocket.** A periodontal pocket is considered to be deep starting at 3 mm. (source: Mars Petcare GmbH)



► **Fig. 17.54 Probing a pocket of moderate depth.** In cats, a periodontal pocket between 2 and 3 mm is considered to be of moderate depth. (source: Mars Petcare GmbH)

## Periodontitis

Inflammation of the gingiva, which is part of the periodontium, may be reversible. If the inflammation is limited to the gingiva and there is no loss of periodontal fibers or alveolar bone, it may represent an isolated inflammatory process of the gingiva rather than periodontitis. In contrast to periodontitis, gingivitis is completely reversible.

### 17.2.1 Gingivitis in the Dog

During treatment, it is important to distinguish between reversible gingivitis (► Fig. 17.56, ► Fig. 17.57, ► Fig. 17.58, ► Fig. 17.59, ► Fig. 17.60, ► Fig. 17.61, ► Fig. 17.62, ► Fig. 17.63) and clearly irreversible periodontitis.



► **Fig. 17.56 Plaque, right maxilla.** Soft plaque on the maxillary teeth has resulted in significant inflammation of the gingiva in the right maxilla. In addition, the calculus provides a bonding foundation for the accumulation of additional soft plaque. It does not, however, itself trigger inflammation.



► **Fig. 17.57 Plaque, left maxilla.** The situation is similar in the left maxilla. The inflammation is very symmetrical.



► **Fig. 17.58 Plaque, left mandible.** Calculus and plaque also appear on the mandibular cheek teeth, although the gingivitis is not quite as pronounced. In dogs, periodontitis tends to be more severe in the maxilla. The cutting function of the cheek teeth means the active surfaces of these teeth are cleaned more thoroughly (lingual surface of the maxillary cheek teeth, buccal surface of the mandibular cheek teeth), while inactive areas (especially the buccal surfaces of the maxillary cheek teeth) may be quite dirty. The situation is different for the inactive surface of the mandibular cheek teeth. The very mobile tongue generally creates enough friction to remove more calculus and plaque than it does from the buccal surfaces of the maxillary cheek teeth.



► **Fig. 17.59 Plaque, right mandible.** For this reason, the mandibular right cheek teeth present similarly.





► **Fig. 17.60 Right maxilla after cleaning.** After unremarkable radiographic diagnostics and cleaning of the teeth with both an ultrasonic scaler and manual instruments (scaler, curette), the teeth are again pearly white.



► **Fig. 17.62 Left mandible after cleaning.** If the owner can clean the teeth with a toothbrush following the professional cleaning, the plaque-free and uninflamed condition of the teeth can be maintained.



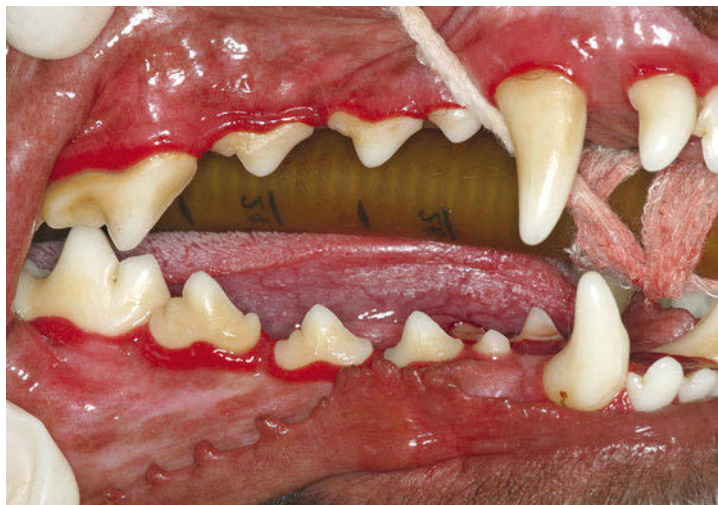
► **Fig. 17.61 Left maxilla after cleaning.** The gingivitis will significantly improve over the following days.



► **Fig. 17.63 Right mandible after cleaning.** If home dental cleaning is impossible, the veterinarian must determine the appropriate time interval between professional cleanings under anesthesia.

### 17.2.2 Effect of Dental Cleaning on the Canine Gingiva

The teeth's bacterial biofilm variably affects oral health, depending on predisposition, and effects vary from minor to dramatic. Since the body's own defenses can be modified to only a limited degree, the initial focus is on the careful prevention of plaque accumulation (► Fig. 17.64, ► Fig. 17.65, ► Fig. 17.66).



► **Fig. 17.64 Gingivitis before dental cleaning.** This dog has severe gingivitis due to calculus and plaque buildup.



► **Fig. 17.66 Antiseptic application of the oral cavity.** Antiseptic application to the mucosa is a very effective supplementary measure for dental cleaning. It reduces the pathogen reservoir and minimizes the risk of renewed infection of the gingiva. Chlorhexidine digluconate is a suitable oral antiseptic for mucosa with extensive gingival inflammation or in preparation for a surgical procedure.



► **Fig. 17.65 Reduced inflammation after cleaning.** Dental cleaning under anesthesia clearly reduces the inflammation after 2 weeks.

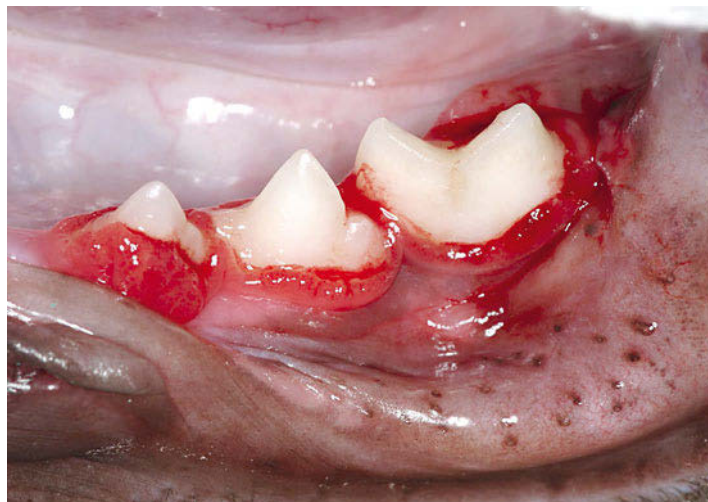


### 17.2.3 Gingivectomy in a Cat with Gingival Hyperplasia

In addition to recession, the gingiva might also respond with reactive tissue proliferation, which initially produces pseudopockets without damage to the alveolar bone (► Fig. 17.67, ► Fig. 17.68, ► Fig. 17.69, ► Fig. 17.70, ► Fig. 17.71, ► Fig. 17.72, ► Fig. 17.73, ► Fig. 17.74, ► Fig. 17.75, ► Fig. 17.76).



► **Fig. 17.67 Severe gingival hyperplasia in the maxilla of a cat.** A special form of gingivitis occurs in cats. Maine Coon and British Shorthair cats may present with severe gingivitis shortly after exfoliation of deciduous teeth; it is characterized by massive hyperplasia and development of pseudopockets.



► **Fig. 17.69 Gingival hyperplasia in the left mandible.** The hyperplasia is less pronounced in the mandible, consistent with the generally lower levels of plaque on the teeth than in the maxilla. This is due to the function of second teeth in that the mandible has more active areas with better cleaning than the maxilla does.



► **Fig. 17.68 Gingival hyperplasia in the left maxilla.** The maxillary left cheek teeth are almost completely covered by the hyperplastic gingiva. It extends fully across the attached gingiva to the mucogingival junction. The gingiva of the canine tooth is less affected, while pronounced hyperplasia occurs at the incisors.



► **Fig. 17.70 Gingival hyperplasia in the right mandible.** The volume of calculus and plaque seems insignificant relative to the severity of the disease. Even a small accumulation of plaque can result in significant reactions of the host organism at the weak point, the gingival sulcus, where the oral cavity bacteria directly oppose the immunological defenses. These signs occur in young, immature cats and represent a reactive process rather than autonomous growth of the gingiva. Eliminating exogenous factors (plaque, bacteria) can reduce the reaction of the host. The inflammatory response stabilizes after maturation of the immune system. If the teeth can be preserved via ongoing home dental care, the periodontal condition should improve significantly in the following years.



► **Fig. 17.71 Condition after electro-surgical gingivectomy in the right maxilla.** Eliminating hyperplastic gingiva is critical in feline dental care and generally not possible with medication. Surgical resection can provide a foundation for dental care. The hyperplastic tissue can be removed with a scalpel, electro-surgery or laser.



► **Fig. 17.73 Left maxilla after gingivectomy via diode laser.** As described above, the critical aspect is not the manner by which excess gingiva is removed but the removal of all pockets.



► **Fig. 17.72 Right mandible after electro-surgical gingivectomy.** All altered soft tissue should be resected up to the neck of the tooth to prevent the preservation of pseudopockets. Before a gingivectomy, the periodontium must be radiographed to exclude bone damage and ensure that the condition is a purely inflammatory process of the gingiva.



► **Fig. 17.74 Left maxilla after gingivectomy via diode laser.** In cats, a diode laser (p.370) can be used to remove the tissue very precisely.

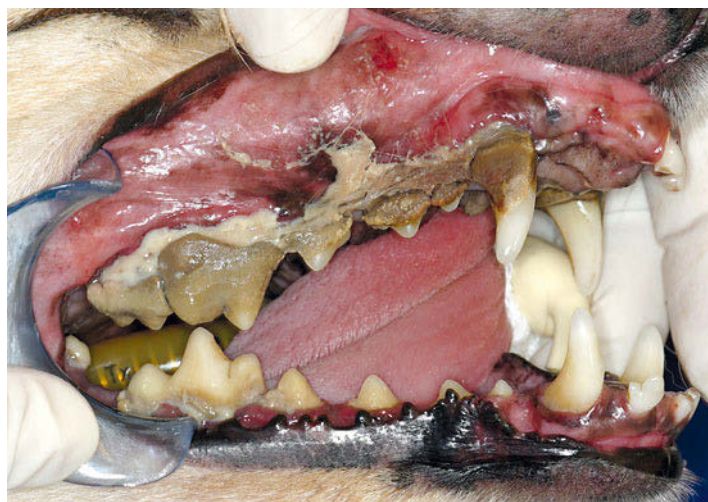


### 17.2.4 Generalized Periodontitis in a Dog

Once the dog's oral cavity shows periodontal disease, severe, persistent inflammation will occur. Often, by the time animals are presented for treatment, the original healthy condition can no longer be restored (► Fig. 17.77, ► Fig. 17.78, ► Fig. 17.79, ► Fig. 17.80, ► Fig. 17.81, ► Fig. 17.82, ► Fig. 17.83, ► Fig. 17.84, ► Fig. 17.85, ► Fig. 17.86, ► Fig. 17.87, ► Fig. 17.88). Other organs are often affected; statistics show that abnormal heart valves and myocardial tissue, as well as liver and kidney damage, can be attributed to periodontitis.



► **Fig. 17.75 Right side 4 weeks after gingivectomy via electrosurgery.** The owner will start to brush the teeth with a toothbrush after a few days in order to prevent tissue accumulation again. During this period, an antibiotic and analgesic dressing helps to avoid an inflamed periodontium.



► **Fig. 17.77 Advanced periodontitis on the right side.** The cheek teeth are covered entirely by a layer of calculus, plaque, hair, and food. The gingiva is bright red with purulent deposits at the gingival margin.



► **Fig. 17.76 Left side 4 weeks after laser gingivectomy.** A light red margin remains visible on the gingiva. Otherwise, the condition of the oral cavity has improved significantly. With ongoing daily dental care, this condition can be controlled and the teeth preserved in a young cat with this particular periodontal disease. The condition of the animal often significantly improves only a few days after the procedure.

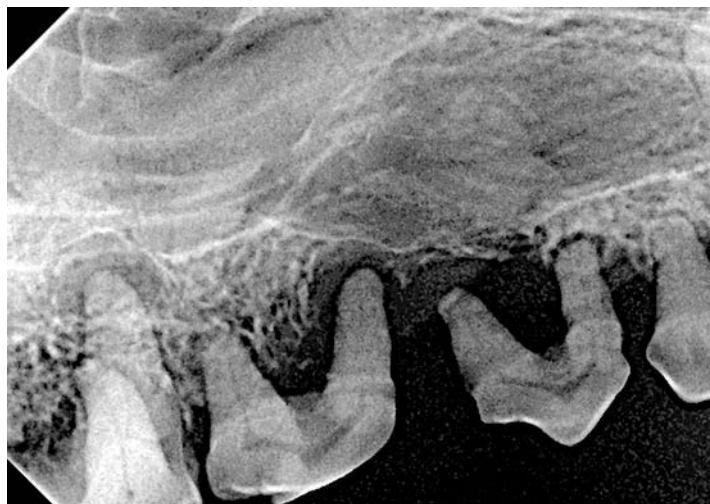


► **Fig. 17.78 Advanced periodontitis on the left side.** As expected, the same signs appear on the left side. In some cases, calculus is found on the teeth up to the mucogingival junction, causing gingival recession and alveolar bone loss with exposure of the tooth roots.





► **Fig. 17.79 Rough scaling, right maxilla.** After rough scaling of the calculus, the cheek teeth, including large areas of their exposed roots, are visible. The root furcations can all be fully probed.



► **Fig. 17.82 Radiograph of the region around tooth 106.** Some premolars appear to be floating in the radiograph due to severe osteolysis.



► **Fig. 17.80 Rough scaling, left maxilla.** The cervical areas of the maxillary canine tooth roots are also affected. Even without radiography, it is obvious that the cheek teeth cannot be preserved.



► **Fig. 17.81 Radiograph of the region around tooth 108.** Osteolysis is visible up to the apex of the tooth roots in the radiograph.



► **Fig. 17.83 Radiograph of the region around tooth 104.** A deep infrabony pocket is visible on the maxillary canine tooth. The proximity to the nasal cavity is problematic in this case. The thin bony lamellae between the tooth root and nasal cavity may be involved in this persistent inflammatory process.





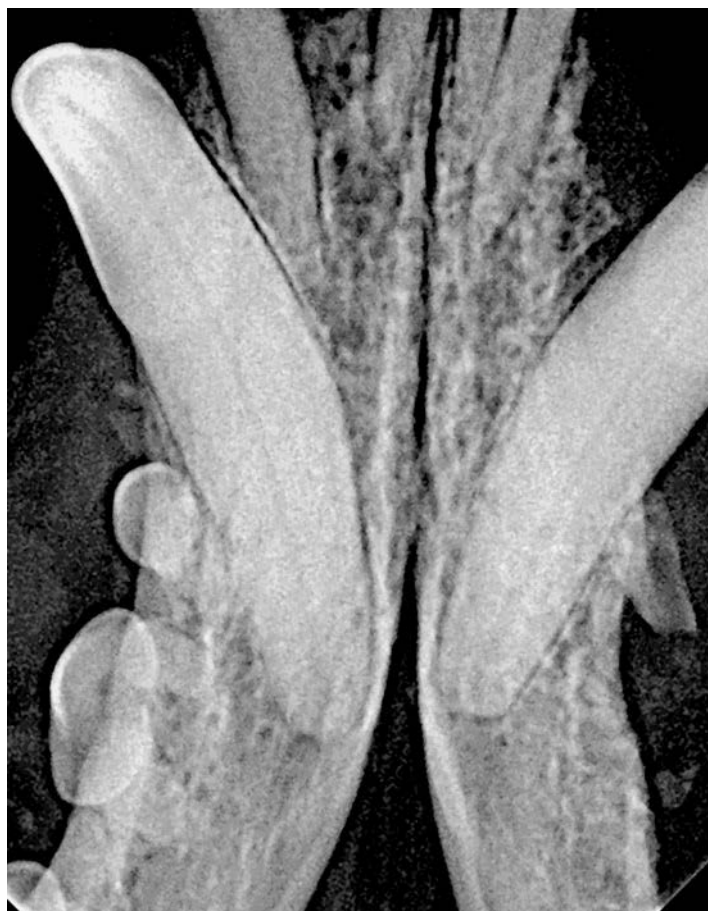
► **Fig. 17.84 Radiograph of the region around tooth 204.** The osteolysis of the palatal wall is even more pronounced on the maxillary left canine tooth. If the lamellar bone separating the tooth root and nasal cavity is affected, the nasal cavity is also likely to be involved. A maxillary canine tooth may “mask” an oronasal fistula.



► **Fig. 17.85 Radiograph of tooth 208.** The osteolysis of the maxillary left cheek teeth has progressed irreversibly. Apical translucency represents periapical osteolysis resulting from a root tip process.



► **Fig. 17.86 Radiograph of the region around tooth 309.** The mesial root of the mandibular carnassial tooth is surrounded by severe osteolysis. Most of the distal root remains in the bone, maintaining the bone's rigidity. The apical processes, including inflammatory processes in both the maxilla and mandible, hinder the patient's use of the teeth for mastication and cause significant pain.

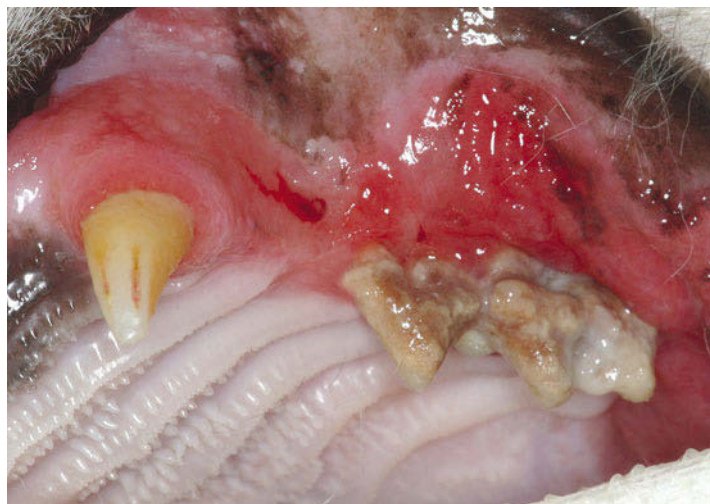


► **Fig. 17.87 Radiograph of the mandibular front teeth.** The mandibular canine teeth have lost their bony buccal lamellae; this condition was clinically apparent as recession covered by calculus.





► **Fig. 17.88 Radiograph of the region around tooth 409.** The mandibular right carnassial tooth also shows bone loss and an exposed furcation. However, no holistic process has developed around the roots. All nonfunctional affected teeth were removed, and the extraction sites were examined radiographically. A follow-up examination 10 days later shows uncomplicated healing of the area and significantly improved condition overall.



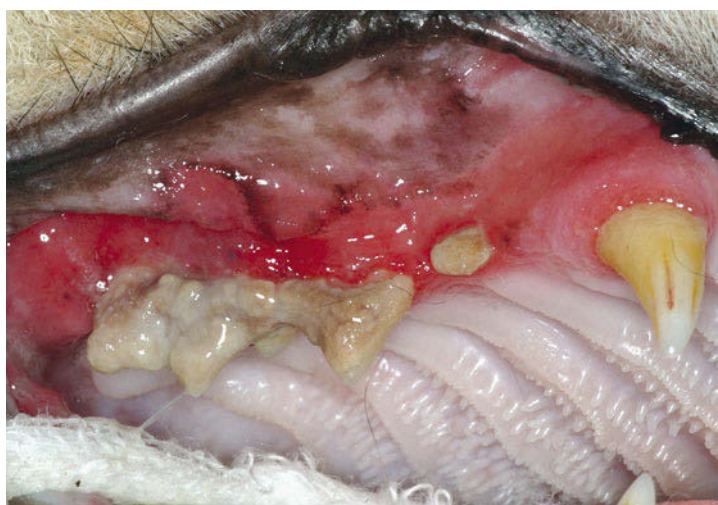
► **Fig. 17.90 Periodontitis, left maxilla.** The teeth have generalized massive accumulation of calculus and plaque. The gingiva is severely inflamed.

### 17.2.5 Generalized Periodontitis in a Cat

Periodontal diseases in cats are comparable in incidence and severity to those in dogs (► Fig. 17.89, ► Fig. 17.90, ► Fig. 17.91, ► Fig. 17.92, ► Fig. 17.93, ► Fig. 17.94, ► Fig. 17.95, ► Fig. 17.96, ► Fig. 17.97, ► Fig. 17.98, ► Fig. 17.99, ► Fig. 17.100, ► Fig. 17.101, ► Fig. 17.102).



► **Fig. 17.91 Periodontitis, left mandible.** Normally, the mandibular cheek teeth accumulate less calculus and plaque than the maxillary cheek teeth. In this dog, however, the mandibular cheek teeth are covered with heavy calculus and plaque. The patient's impaired mastication prevents functional abrasion of the active areas.

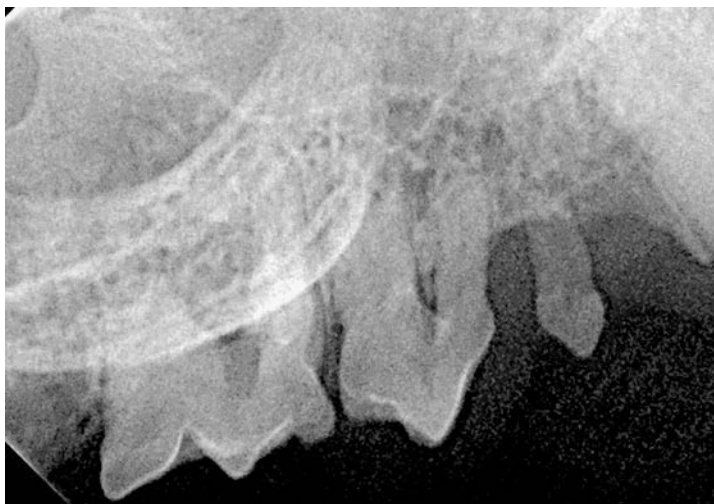


► **Fig. 17.89 Periodontitis, right maxilla.** Like dogs, cats can also show signs of detrimental periodontal inflammation due to advanced dental disease.



► **Fig. 17.92 Periodontitis, right mandible.** The inflammation is not limited to the gingiva. The loose vestibular mucosa also has a contact ulcer ("kissing ulcer").





► **Fig. 17.93 Radiograph of the right maxilla.** The bisecting angle technique makes it difficult to visualize the absolute height of the bone.



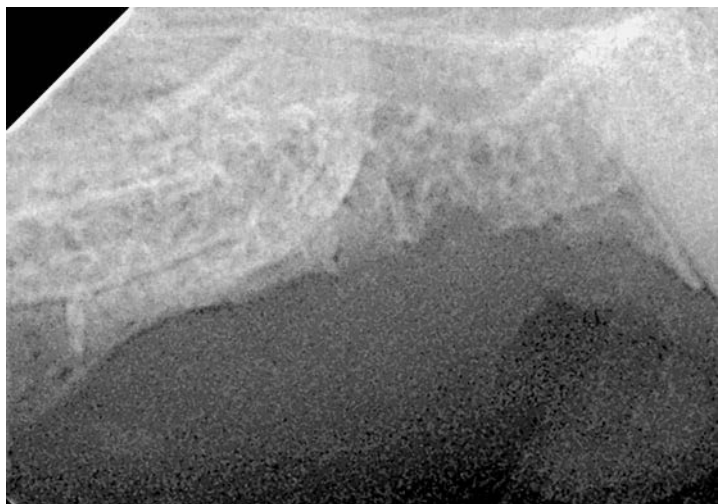
► **Fig. 17.95 Radiograph of the left mandible.** The root resorption and severe osteolysis of the mandibular cheek teeth are clearly visible. In addition to the notable inflammation, the tooth defects can be addressed as tooth resorptions, possibly as a separate disease.



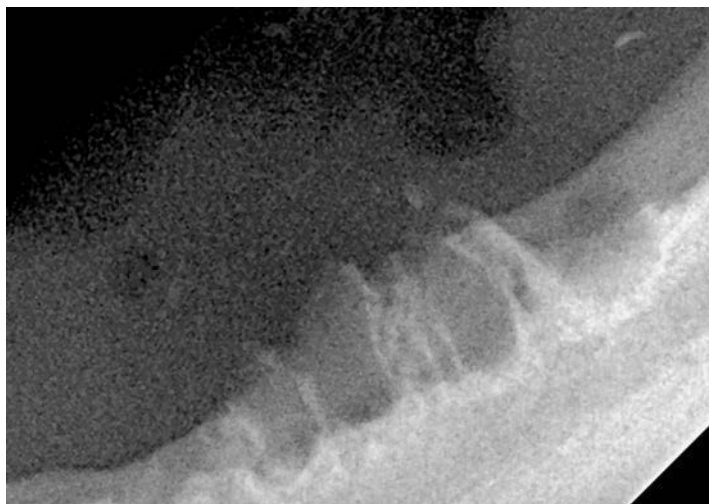
► **Fig. 17.94 Radiograph of the left maxilla.** These radiographs show that all root furcations can all be completely probed due to osteolysis. The root morphology shows resorptive areas due to inflammation.



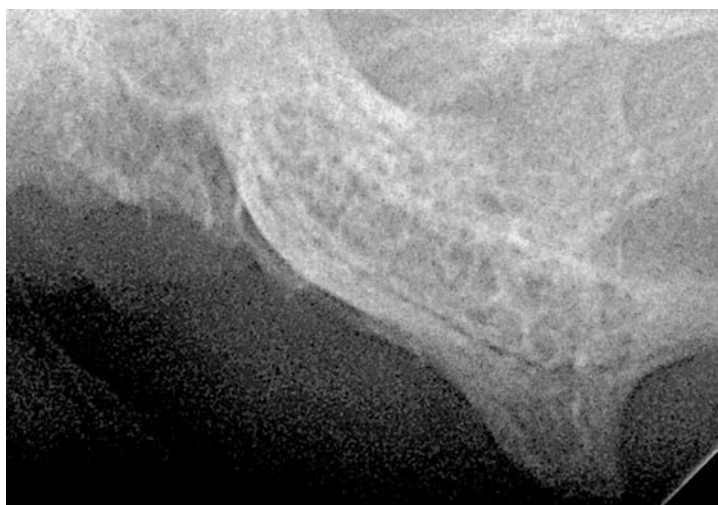
► **Fig. 17.96 Radiograph of the right mandible.** If all cheek teeth of the maxilla and mandible are simultaneously affected, as shown here, it may be impossible to preserve them. All irreversibly damaged mandibular cheek teeth in this radiograph must be extracted. Extraction will leave the opposing maxillary teeth without any function. They will thus only collect debris and serve as foci for inflammation. Even if the maxillary cheek teeth had still been intact in the periodontium and had not suffered massive damage as in this case, they would still have had to be extracted.



► **Fig. 17.97 Radiograph after extraction, right maxilla.** Due to root resorption, the teeth should be examined radiographically to ensure complete extraction.



► **Fig. 17.99 Radiograph after extraction, left mandible.**

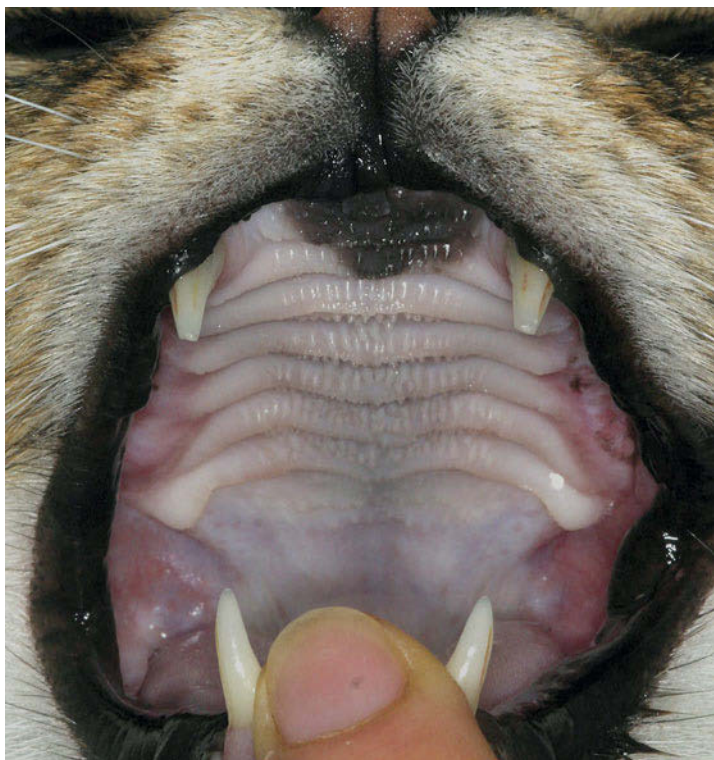


► **Fig. 17.98 Radiograph after extraction, left maxilla.**

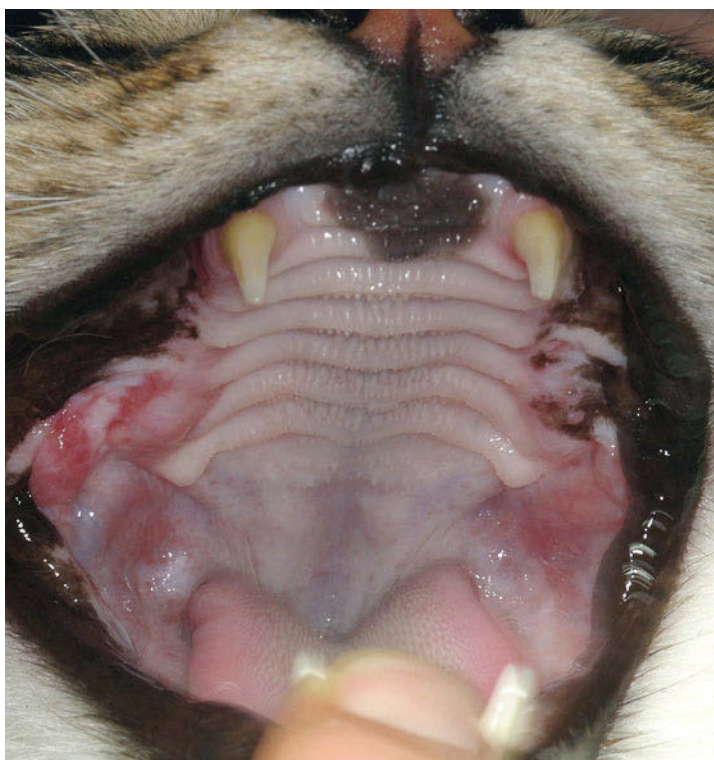


► **Fig. 17.100 Radiograph after extraction, right mandible.**





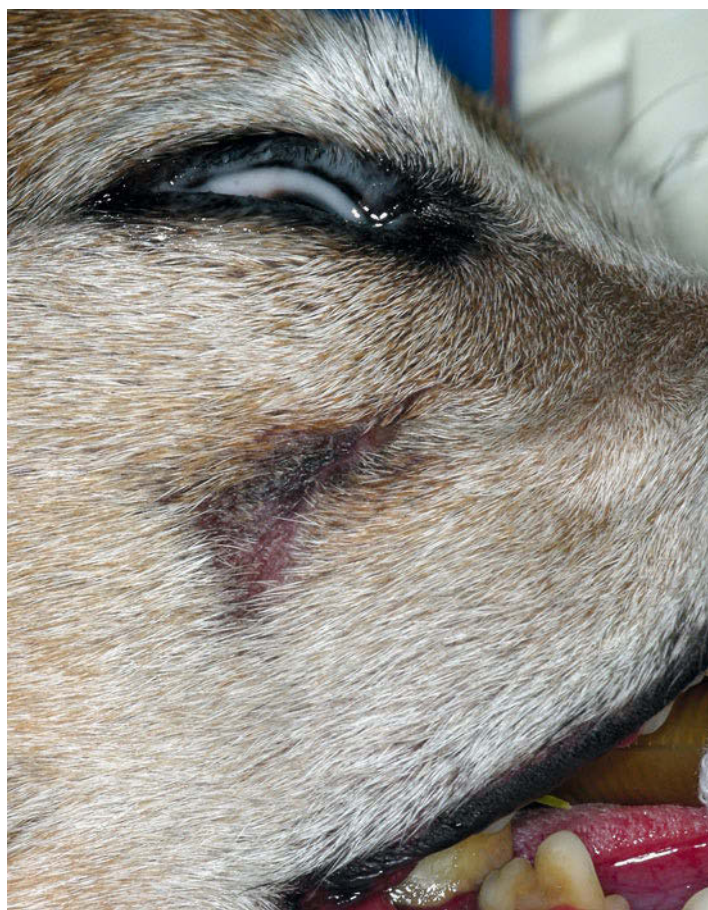
► **Fig. 17.101 Follow-up examination of the oral cavity 3 months later.** After extraction of the teeth and healing of the mucosa, the inflammation is reversed and the patient's condition significantly improves. It is notable that the patient's eating improved so soon after the operation. Although the postoperative recovery was certainly challenging, the tooth extraction alone already seems to have provided great relief.



► **Fig. 17.102 Follow-up examination of the oral cavity 10 months later.** Inflammation is not only always restricted to the gingiva. Other areas of the oral cavity may also be involved. Locally limited, persistent slight redness in the oral cavity postoperatively is acceptable because the patient is in overall good condition and eating well; complete extraction was also confirmed radiographically. The inflammation in the area of the alveolar ridges has almost fully subsided, and redness is visible only in the former caudal cheek tooth area of the right maxilla as well as in the retromolar space.

### 17.2.6 Fistula Formation in Association with Periodontitis

The following figures (► Fig. 17.103, ► Fig. 17.104, ► Fig. 17.105, ► Fig. 17.106, ► Fig. 17.107, ► Fig. 17.108, ► Fig. 17.109) illustrate the findings and approach used to treat fistula formation due to periodontitis.



► **Fig. 17.103 Fistula formation in the right maxilla.** Recurrent discharge of fluid under the right eye prompted the owner to present the animal for diagnosis. A clear, chronic fistula opens in the right suborbital area.

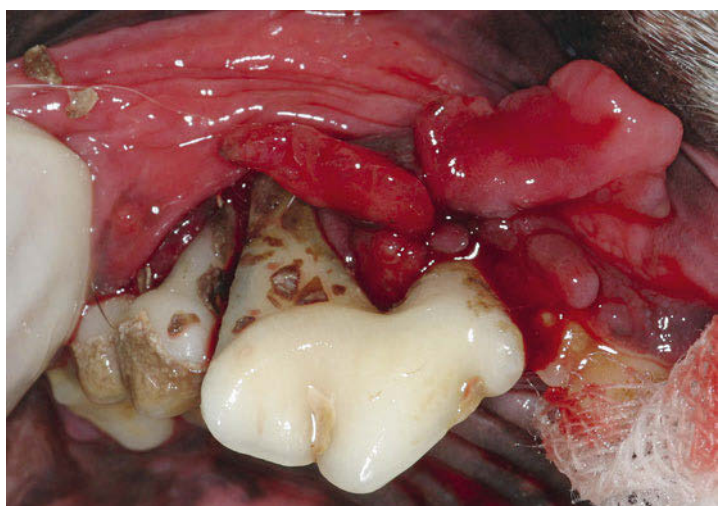




► **Fig. 17.104 Periodontitis, right maxilla.** Clinically, the right maxillary periodontium appears to be the cause of the persistent lesion. The teeth themselves are obscured by the calculus deposits.



► **Fig. 17.106 Radiograph of the right maxilla.** As with the clinical findings, the radiograph shows severe osteolysis around the carnassial tooth and first molar. Starting with periapical osteolysis, a fistulous tract developed along the shortest available path. This fistula opens suborbitally at the skin on the right.



► **Fig. 17.105 Right maxilla after rough scaling.** Removal of the calculus reveals both the crowns and the exposed roots of the maxillary right carnassial tooth and the first molars. The covering gingiva can be lifted since it no longer has a bony attachment.

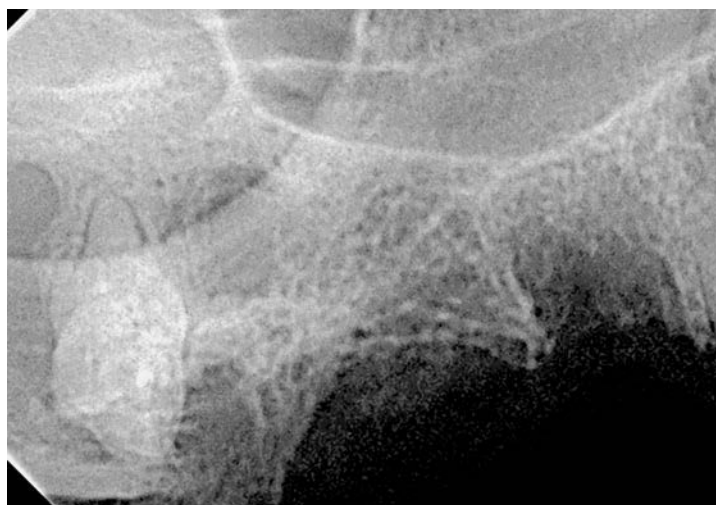


► **Fig. 17.107 Radiograph of the right mandible.** The pain caused by the maxillary inflammation prevented the patient's use of the right half of its jaw. Consequently, the mandibular cheek teeth also developed periodontal inflammation. The mandibular carnassial tooth and the second molar show severe periapical osteolysis.



### 17.2.7 Symmetrical Advanced Periodontitis at the Maxillary Cheek Teeth

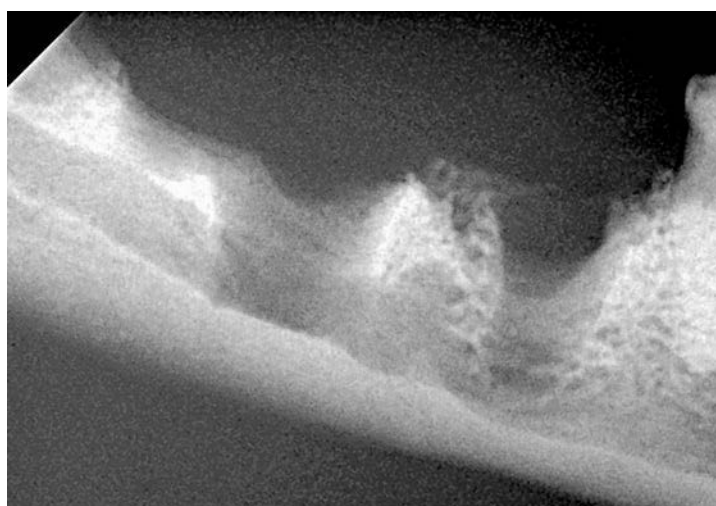
In cats and dogs, periodontitis presents in a variety of ways. In many cases, periodontitis is generalized, and the front teeth and cheek teeth present with similar clinical features. In addition, different groups of teeth often show similar degrees of inflammation. Localized periodontal disease is less common; interestingly, however, the right and left sides are often affected symmetrically (► Fig. 17.110, ► Fig. 17.111, ► Fig. 17.112, ► Fig. 17.113, ► Fig. 17.114).



► **Fig. 17.108 Radiograph after extraction, right maxilla.** Extraction of the affected maxillary cheek teeth and curettage of the fistulous tract stimulate the healing process.



► **Fig. 17.110 Advanced periodontitis around tooth 109.** Here, in particular, the caudal maxillary cheek teeth are especially affected. Severe calculus and inflammation of the gingiva begin at the maxillary carnassial tooth. The plaque and calculus are so extensive on the roots of the affected teeth that they are likely already severely affected.



► **Fig. 17.109 Radiograph after extraction, right mandible.** The mandibular carnassial tooth and the second molar must also be extracted. These teeth are no longer functional when the opposing maxillary carnassial tooth is extracted, and they cannot be preserved due to the advanced inflammation.



► **Fig. 17.111 Advanced periodontitis around tooth 209.** The same situation appears on the left side. The buccal surfaces of the maxillary cheek teeth are functionally inactive, which explains the increased deposits of plaque and calculus.



► **Fig. 17.112 Radiograph of tooth 109.** The maxillary right carnassial tooth and first molar show advanced periodontitis. Infrabony pockets have resulted in the involvement of the root tips of the first molar and exposed the furcation of the carnassial tooth.



► **Fig. 17.113 Radiograph of tooth 209.** The advanced pocket on the distal root of the maxillary carnassial tooth with exposure of the furcation cannot be treated. Neither the molar nor the carnassial tooth can be preserved. Osteolysis around the roots of the maxillary molar cannot be treated in an effort to preserve the tooth.



► **Fig. 17.114 Tooth 209 after extraction.** The maxillary left molar was completely extracted. The apical part of the mesiobuccal root had an inflamed granulo-  
ma. The dark surface of the entire root system illustrates that the tooth could not have been preserved.



### 17.2.8 Local Interdental Periodontitis

Some tooth regions are predisposed to periodontitis. The creation of niches that can collect debris and contamination promotes plaque formation. This new “ecological niche” for bacteria facilitates a local periodontal process. Points of contact between the maxillary carnassial tooth and the first molar (► Fig. 17.115), between the mandibular carnassial tooth and second molar (► Fig. 17.116, ► Fig. 17.117), and in the area of the incisors are predisposed to develop periodontitis.



► **Fig. 17.115 Local periodontitis between teeth 409 and 410.** In addition to selective involvement of the caudal maxilla, the caudal mandible may be affected. The space between the mandibular carnassial tooth and second molar, in particular, can easily develop an infrabony pocket.



► **Fig. 17.116 Radiograph of tooth 409.** The entire short mesial root of the second molar is affected. In an advanced process, however, the distal root of the carnassial tooth is also involved, which destroys the periodontium. The only option here is to extract both teeth.



► **Fig. 17.117 Radiograph of tooth 309 for comparison.** In contrast, the left side appears normal. Given that only a relatively hidden location was severely inflamed, the entire bite should be examined to rule out any dental problems.

### 17.2.9 Labial Gingivoplasty in a Dog with Local Periodontitis

What options are available to the veterinarian when a functionally important tooth such as a carnassial or canine tooth develops periodontitis? Before treatment, both clinical and radiographic examinations should be performed to determine whether the tooth can and/or should be preserved. These examinations can inform treatment options (► Fig. 17.118, ► Fig. 17.119, ► Fig. 17.120, ► Fig. 17.121, ► Fig. 17.122, ► Fig. 17.123, ► Fig. 17.124).



► **Fig. 17.119 Periodontal pocket on tooth 204 with fistula.** Removing the hair reveals a dark, hard surface. Isolated parts of the gingiva are missing slightly below the mucogingival junction over the root of the canine tooth. The crown has a pink discoloration without any visible defect of the dental substance.



► **Fig. 17.118 Hair on the mucogingival junction of tooth 204.** Owners are more likely to notice abnormalities in the visible part of the mouth. Inflammation of the gingiva of a canine tooth may therefore prompt the owner to present the animal to a veterinarian. Reddened gingiva and hair impacted in the gingiva were the presenting complaints for this dog.



► **Fig. 17.120 Visualization of tooth 204 after cleaning.** After removal of the deposits, the yellowish color of the root becomes visible.





► **Fig. 17.121 Radiograph of tooth 204.** When considered without the clinical findings, the root appears unremarkable. The ability to preserve the tooth must therefore be determined radiographically. The clinical discoloration of the tooth is due to the obliteration of the root canal, which has resulted in necrosis of the coronal pulp. Given the sterile pulp necrosis without a periapical process, root canal therapy is unnecessary.



► **Fig. 17.123 Polishing the root of tooth 204 with a polishing disc.** Finally, the root is polished with a polishing disc to make it flush with the crown.



► **Fig. 17.122 Planing the root of tooth 204 with an Arkansas stone after gingival resection.** The fenestration of the gingiva makes dental care impossible. For this reason, the gingiva is removed from the gingival defect to the crown, and the alveolar bone is resorbed in this area. The buccal area of the canine tooth root becomes visible. The root surface is planed with an Arkansas stone in order to facilitate home dental care.



► **Fig. 17.124 Tooth 204 after resection, cleaning and planing.** The new situation removes foci for calculus formation and facilitates brushing of the patient's teeth. This new situation and tooth brushing can also reduce the inflammation of the gingiva, and the dental care should reduce the dog's defense reactions due to reduced inflammation.

### 17.2.10 Malocclusion-induced Local Periodontitis

Malocclusion may encourage plaque accumulation and calculus formation as well as periodontitis due to the creation of new niches that can collect debris. In addition, malocclusion may result in parts of teeth reaching unintended areas of the mucosa and forming abnormal epithelial attachments (► Fig. 17.125, ► Fig. 17.126, ► Fig. 17.127, ► Fig. 17.128, ► Fig. 17.129).



► **Fig. 17.125 Impaction of hair in the right maxillary premolar area.** In Boxers and other brachycephalic breeds, in particular, the maxilla may develop problems that are very difficult to treat. Rotation of the premolars to fit into a short maxilla creates new foci for accumulating calculus and plaque. The rotation prevents normal use of the tooth, and the calculus deposits encourage the creation of periodontal pockets. The thick palatal mucosal epithelium does not securely attach to the distal root. With the development of infrabony pockets, an increasing amount of hair and food becomes impacted in the periodontium.



► **Fig. 17.126 Draining pockets in the maxillary right premolar area.** The extent of the lesion becomes apparent after curettage of the impacted foreign material.



► **Fig. 17.127 Impaction of hair in the maxillary left premolar area.** The left side presents similarly. In addition, the attached gingiva is very thin in the area of the second and third premolars. Gingival inflammation and recession often cause the periodontitis to spread to the area of the mobile vestibular mucosa, which encourages further development.



### 17.2.11 Local Periodontitis due to a Crossbite of the Front Teeth

Treatment of a crossbite of the front teeth is indicated due to the risk of developing advanced periodontitis of the incisors (► Fig. 17.130, ► Fig. 17.131, ► Fig. 17.132, ► Fig. 17.133).



► Fig. 17.128 Radiograph of the maxillary right premolars. The radiograph shows osteolysis of the first premolar extending to the canine tooth.



► Fig. 17.129 Radiograph of the maxillary left premolars. In malocclusion-induced periodontitis, the extraction of damaged teeth as well as misaligned teeth that promote pockets of debris may allow the preservation of functionally important teeth such as carnassial teeth.



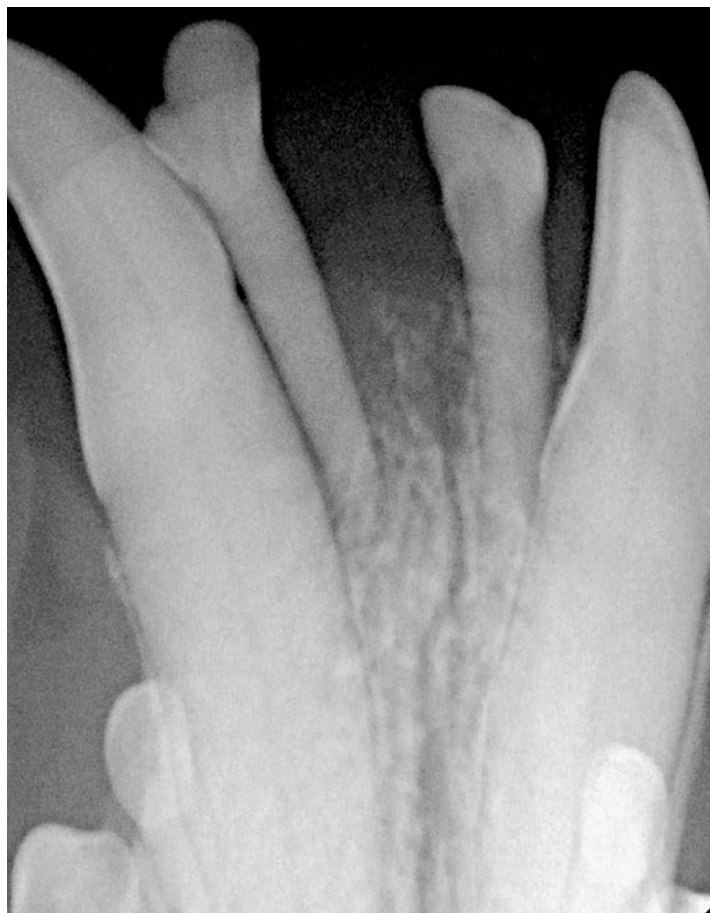
► Fig. 17.130 Advanced periodontitis at the maxillary and mandibular front teeth. The impact of orthodontic problems on the development of periodontitis is very clear in a dog with an anterior crossbite. The malocclusion of the front teeth results in increased calculus deposits and the improper mechanical loading of the incisors as the maxillary incisors contact the lingual surface or the cervical root area of the mandibular incisors; this promotes periodontitis. There is gingival recession and severe inflammation, the teeth are loosened, and all of the front teeth are covered with debris.



► **Fig. 17.131 Skeletal underbite (mandibular mesiocclusion = class 2 malocclusion).** The skeletal malocclusion is particularly clear in the lateral view.



► **Fig. 17.132 Radiograph of the maxillary front teeth.** The periodontitis is clear in the radiograph. The alveolar bone of the maxillary incisors has been reduced to the apical third of the root.



► **Fig. 17.133 Radiograph of the mandibular front teeth.** The damage to the mandibular front teeth has already caused extraction or loss of the first and second incisors. Once the incisors are extracted, the front tooth area heals without complications. Since the incisors were nonfunctional from the start, no function is lost.



### 17.2.12 Local Periodontitis and Kissing Ulcers

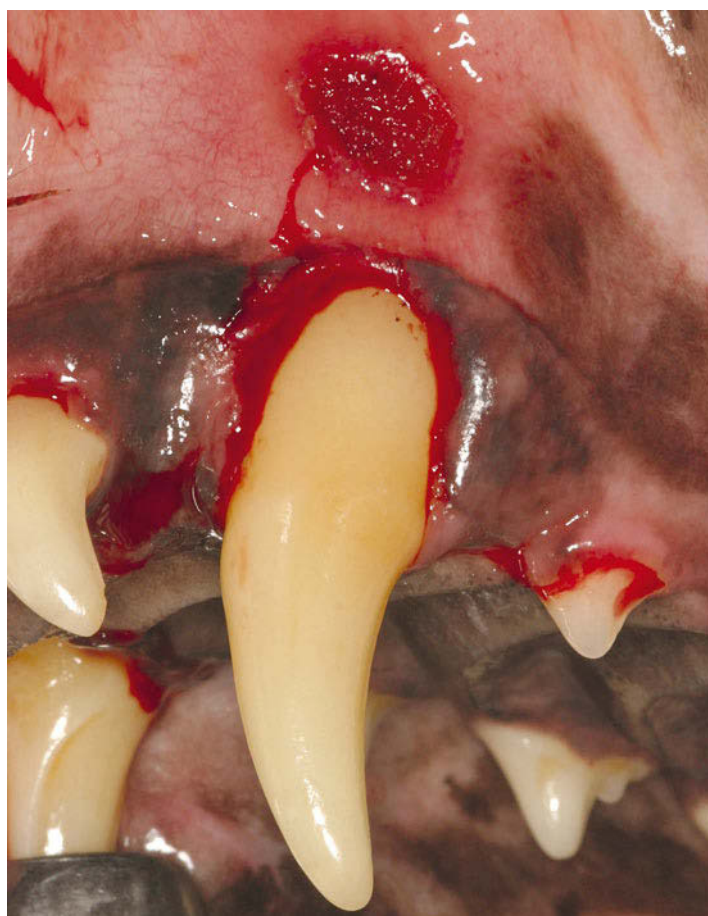
In predisposed animals, the bacterial biofilm on the teeth encourages periodontitis (► Fig. 17.134, ► Fig. 17.135, ► Fig. 17.136, ► Fig. 17.137, ► Fig. 17.138).



► **Fig. 17.134 Contact inflammation in the region around tooth 104.** Due to recession, such as that of the canine gingiva in this figure, new areas for increased plaque deposits are created. Contact inflammation occurs on the maxillary mucosa, due not to roughness of the root surface, but rather to new attachment areas for plaque; these inflamed areas are referred to as kissing ulcers.



► **Fig. 17.135 Recession near tooth 104 after cleaning.** After radiographic confirmation that the canine teeth can be preserved, their surface is cleaned, planed and polished.



► **Fig. 17.136 Recession near tooth 204 after cleaning.** The same procedure is performed on the left side because the process is symmetrical.



► **Fig. 17.137 Region around tooth 104 4 weeks later.** Since the owner brushes the patient's teeth at home, the inflamed gingiva and the labial mucosa have clearly improved. The contact defect on the labial mucosa is epithelialized and no longer painful.



► **Fig. 17.138 Tooth 204 4 weeks later.** This condition can be maintained only if the owner continues the dental care at home. Otherwise, the teeth must be extracted to relieve pain in the animal's mouth.

### 17.2.13 Lasers

Diode lasers with a frequency of 800 to 1000 nm are used for different indications in dentistry, e.g., dissecting mucosa or disinfecting periodontal pockets or pulp chambers (► Fig. 17.139, ► Fig. 17.140, ► Fig. 17.141, ► Fig. 17.142, ► Fig. 17.143). A thin laser can be used to access hard-to-reach places.



► **Fig. 17.139 Diode laser.** Diode lasers have a wide range of applications in the oral cavity. In veterinary dentistry, they are used for disinfection in periodontology, resection in mucogingival surgery, and disinfection in endodontics.

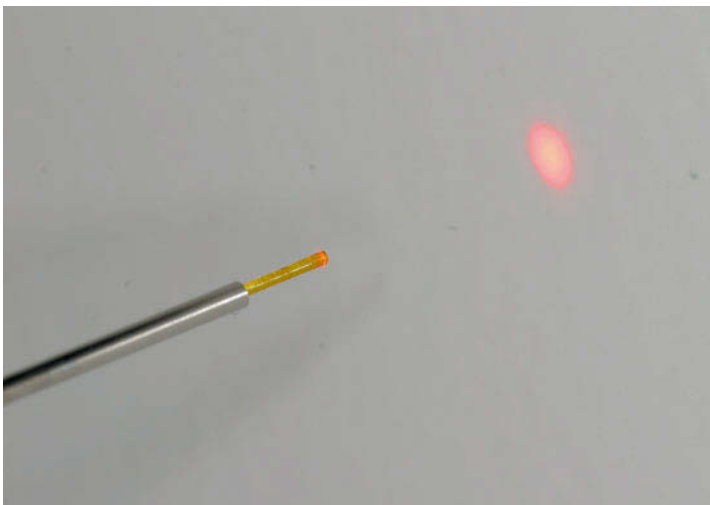




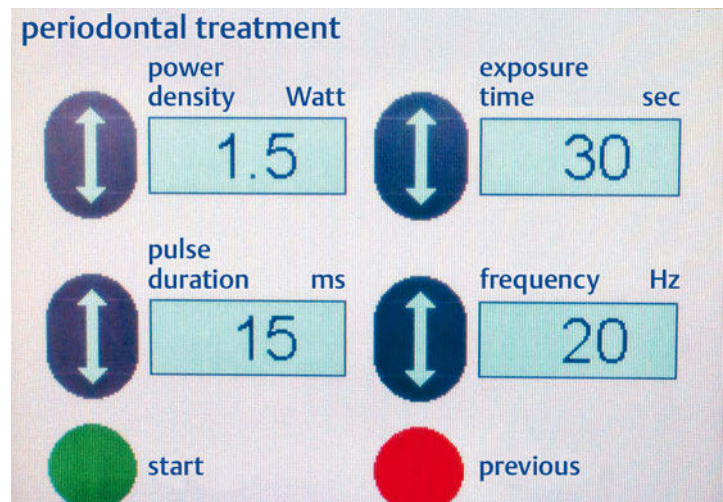
► **Fig. 17.140 Laser handpiece.** The diode laser's very thin working tip lets it access nearly all parts of the oral cavity.



► **Fig. 17.142 Laser software programs for the oral cavity.** Settings come pre-set but can be adjusted for the individual areas of use.



► **Fig. 17.141 Laser in the focusing handpiece.** The strong beam focusing of the focusing handpiece allows very precise incisions and disinfection, depending on the power used. The laser's working temperature reduces the bacteria in the treatment area similar to nonspecific antibiotic treatment, while the resection procedure also achieves hemostasis.



► **Fig. 17.143 Calibrating the laser for pocket disinfection.** As an example, the parameters for treating periodontal pockets are shown here. The wattage and exposure time can be adjusted separately. In addition to a steady beam, the laser can also be used in pulse mode, which prevents tissue from overheating.

### 17.2.14 Laser Applications in Periodontology

The thin working tip of a diode laser can easily be inserted into a periodontal pocket to reduce the bacterial load and remove inflamed mucosa (► Fig. 17.144, ► Fig. 17.145).



► **Fig. 17.144 Laser application in the sulcus.** The fragile light conductor is inserted into the sulcus and the laser is then activated to disinfect or remove granulation tissue from the periodontal pockets.



► **Fig. 17.145 Circular laser application.** It is important to work the laser around the tooth in a circular manner throughout the periodontium.

### 17.2.15 Laser Gingivectomy in Cats

Laser gingivectomy is particularly suitable for the very delicate feline gingiva. The laser enables highly targeted resection of the gingiva. It has hemostatic and tissue-sparing effects (► Fig. 17.146, ► Fig. 17.147, ► Fig. 17.148, ► Fig. 17.149, ► Fig. 17.150, ► Fig. 17.151, ► Fig. 17.152, ► Fig. 17.153, ► Fig. 17.154, ► Fig. 17.155, ► Fig. 17.156, ► Fig. 17.157, ► Fig. 17.158, ► Fig. 17.159).



► **Fig. 17.146 Gingival hyperplasia, right maxilla.** Diode lasers are especially effective for gingivectomy in cats. Juvenile periodontitis often involves gingival hyperplasia. The gingiva is thickened, bulging, and growing along the tooth crown and covering it; it is relatively soft. Due to the inflammation, the gingiva is bright red, which favors absorption of the light of the laser.



► **Fig. 17.147 Gingival hyperplasia, left maxilla.** The severe inflammation significantly impairs the animal's eating.





► **Fig. 17.148 Gingival hyperplasia, left mandible.** Hyperplasia is usually not as pronounced in the mandible as in the maxilla for functional reasons, but the teeth in the area of the attached gingiva are nevertheless all affected.



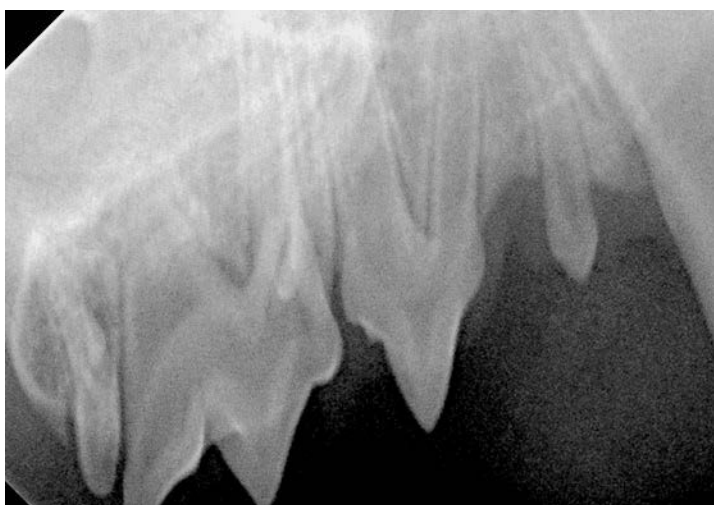
► **Fig. 17.151 Radiograph of the left maxilla.**



► **Fig. 17.149 Gingival hyperplasia, right mandible.** The integrity of the alveolar ridge must be confirmed with radiography. If the ridge is unremarkable, gingivectomy can be performed.



► **Fig. 17.152 Radiograph of the left mandible.** In the mandible, the actual height of the alveolar bone can be visualized very well radiographically using the right-angle technique.

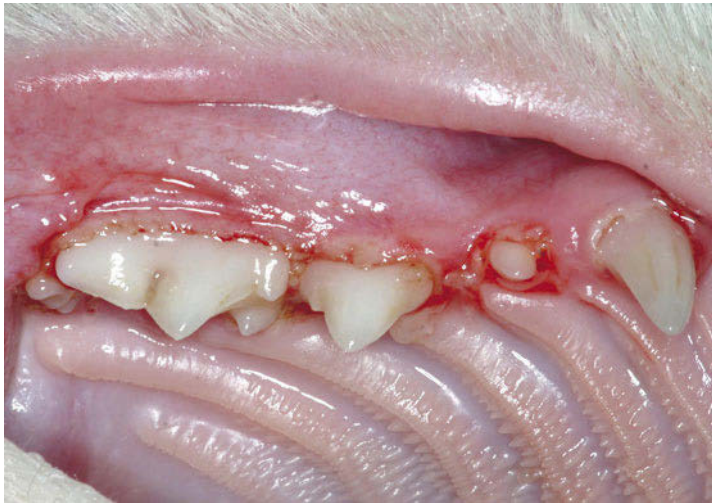


► **Fig. 17.150 Radiograph of the right maxilla.** If pronounced osteolysis with furcation is observed, the teeth should be extracted, even in a young animal.



► **Fig. 17.153 Radiograph of the right mandible.**





► **Fig. 17.154 Right maxilla after laser gingivectomy.** The laser allows hemostasis during resection of the excess gingiva, which maintains visualization.



► **Fig. 17.156 Left mandible after laser gingivectomy.**



► **Fig. 17.155 Left maxilla after laser gingivectomy.** All of the hyperplastic and reddened gingiva was removed.



► **Fig. 17.157 Right mandible after laser gingivectomy.** After the procedure, the owner should start home dental care promptly. Regular care will maintain healthy periodontium.



### 17.2.16 Dissecting Periodontal Mucosa

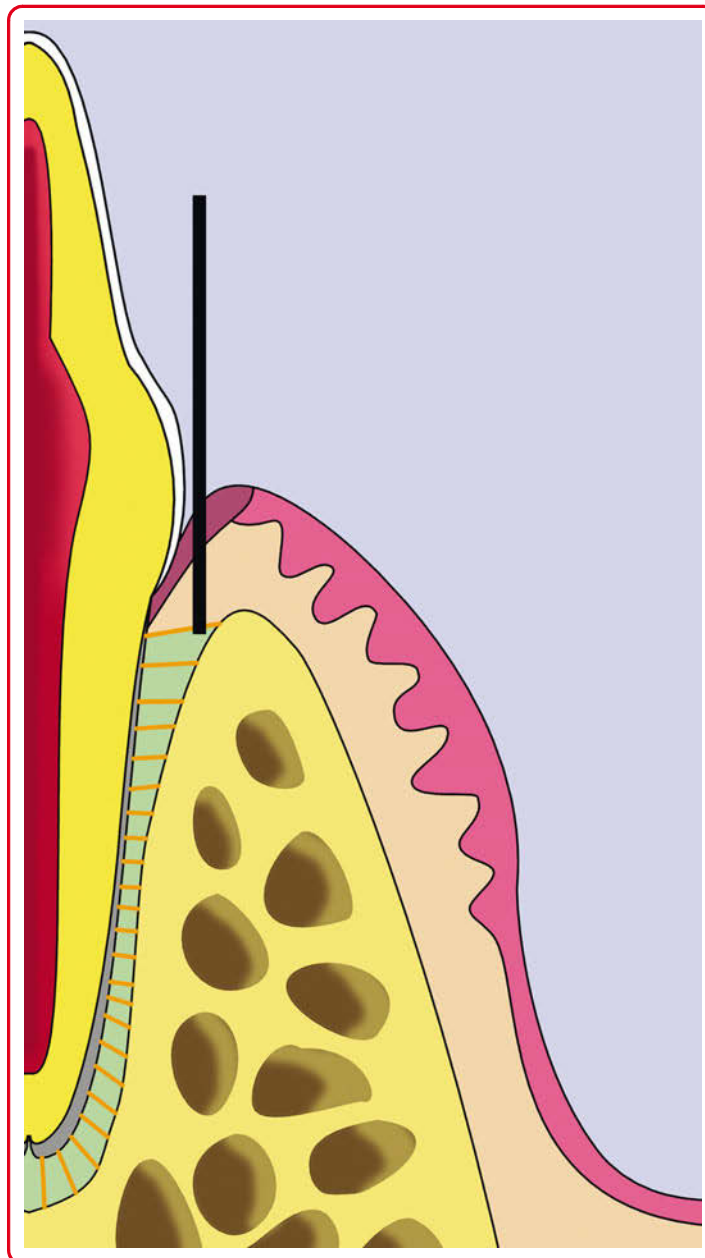
The diagrams below (► Fig. 17.160, ► Fig. 17.161, ► Fig. 17.162) show the fundamental principles and most common periodontal dissection techniques



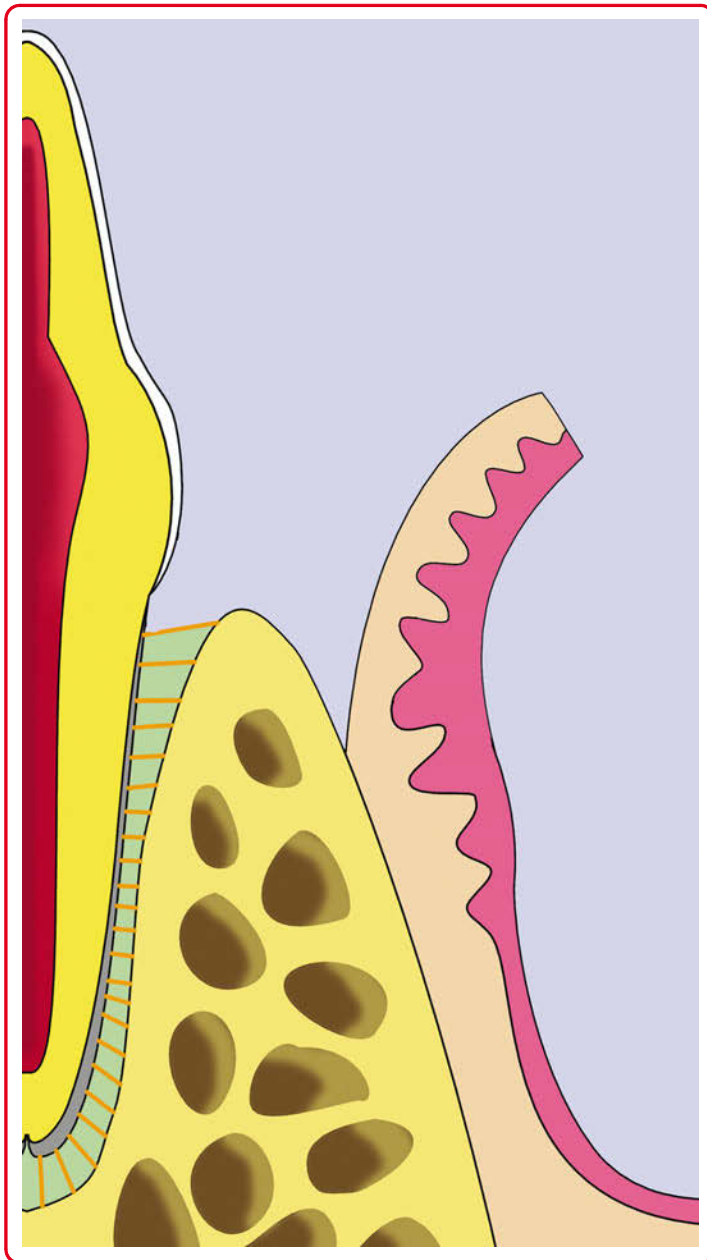
► **Fig. 17.158 Follow-up examination of the right oral cavity 2 weeks later.** The initial success of the gingivectomy with daily dental care is apparent only 2 weeks after the procedure. The free gingiva is slightly red because of a defective local immune response in the gingival sulcus.



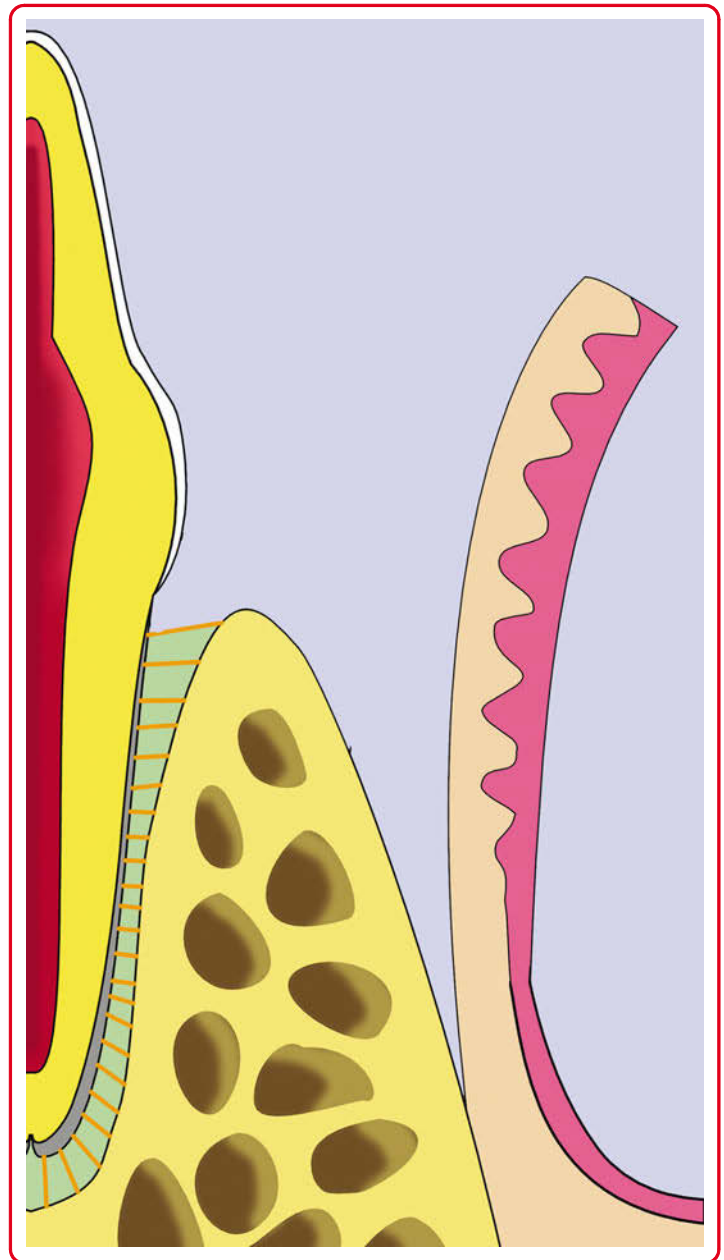
► **Fig. 17.159 Follow-up examination of the left oral cavity 2 weeks later.** If the cat's oral health is maintained into maturity, the need for treatment usually diminishes as the immune system matures, and periodontal disease can be prevented. Otherwise, periodontal damage often worsens rapidly, which necessitates extraction of the teeth.



► **Fig. 17.160 Incising the gingival margin.** The gingiva is detached from the tooth by incising the gingival margin. The scalpel is inserted at the tooth surface near the sulcus to the level of the alveolar ridge and guided along the contour of the tooth. The gingiva is then detached from the bone with a periosteal elevator. This incision is the first step of dissecting a buccal mucosal flap, e.g., for surgical extraction.



► **Fig. 17.161 A partially mobilized mucoperiosteal flap.** A partially mobilized mucoperiosteal flap is folded over before reaching the mucogingival junction. The flap remains firmly anchored to the bone near the mucogingival junction and cannot be advanced.



► **Fig. 17.162 A fully mobilized mucoperiosteal flap.** A fully mobilized mucoperiosteal flap is dissected beyond the mucogingival junction. This dissection starts at the gingiva attached to the alveolar bone and extends to the loose vestibular mucosa with underlying submucosa. This mucosa also cannot be stretched due to the collagenous periosteum. After the periosteum is dissected with a scalpel, the now elastic mucoperiosteal flap can be advanced palatally or lingually to close the alveolus without tension.

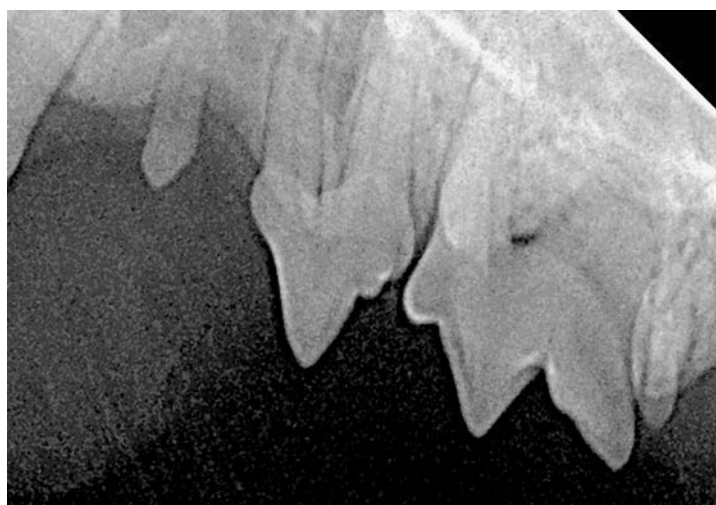


### 17.2.17 Covering Gingival Recession at the Maxillary Carnassial Tooth in a Cat

The following figures (► Fig. 17.163, ► Fig. 17.164, ► Fig. 17.165) show the findings and approach to cover gingival recession at the maxillary carnassial tooth of a cat.



► **Fig. 17.163 Distal recession at tooth 208.** This cat shows recession over the distal root with otherwise unremarkable gingiva.



► **Fig. 17.164 Radiograph of the region around tooth 208.** Radiographically, the defect that is located buccally is very difficult to visualize over the distal root. The slight inflammation at the furcation with early osteolysis is striking.



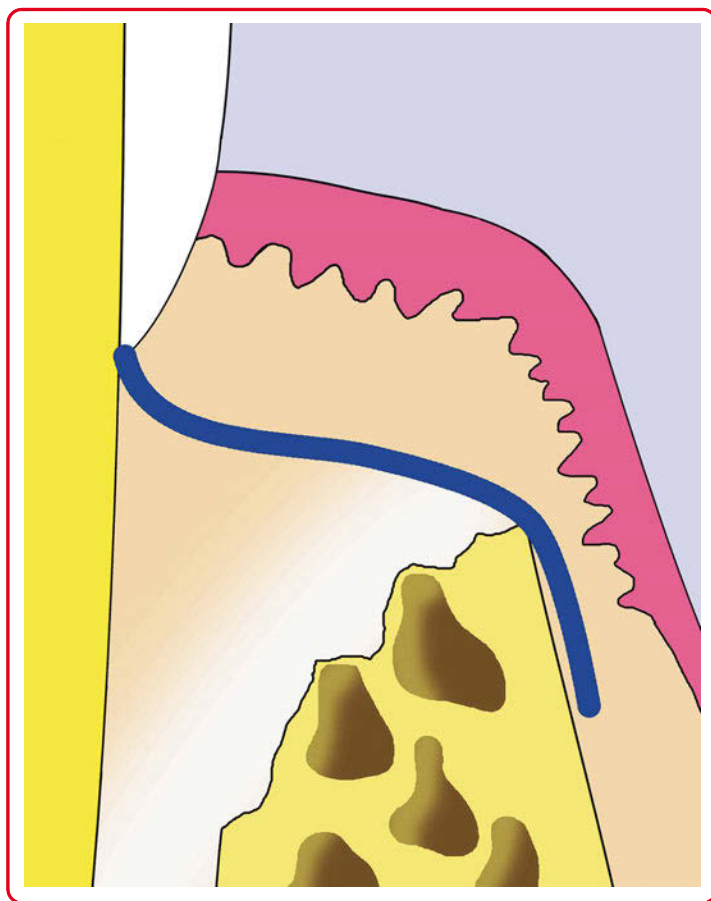
► **Fig. 17.165 Suture of the advancement flap.** After the tooth is cleaned, the flap is advanced distally, the gingiva is advanced mesially, and individual sutures are placed. The missing alveolar bone and lengthened epithelial attachment make the area more fragile than the physiological situation.

### 17.2.18 Guided Tissue Regeneration and Guided Bone Regeneration

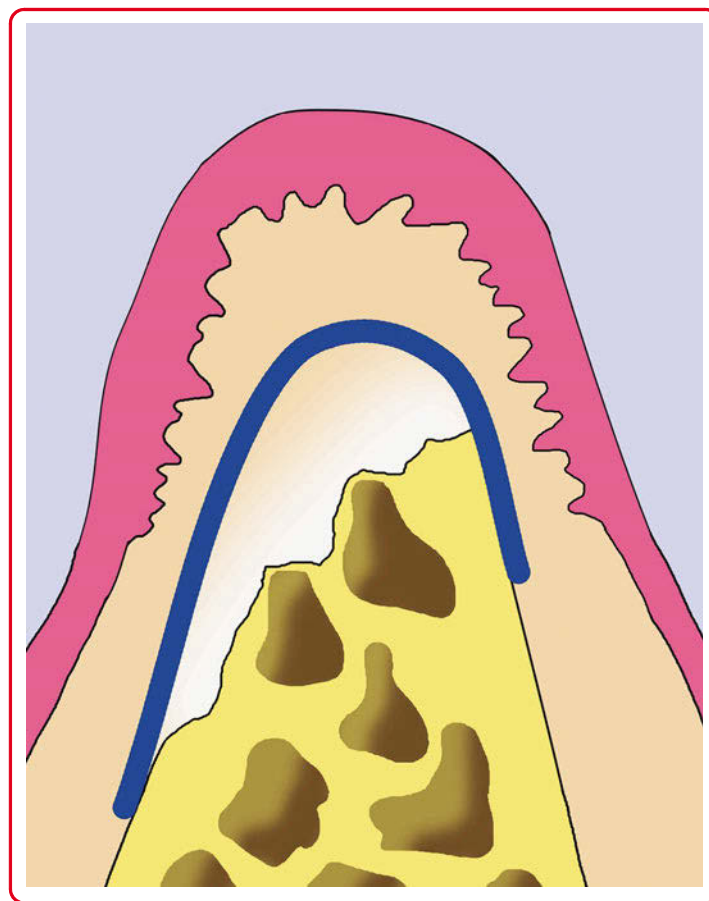
Periodontology distinguishes between guided tissue regeneration (GTR) on the tooth and guided bone regeneration (GBR).

The regeneration of bone on the tooth (GTR, ► Fig. 17.166) occurs in an open system: Since the sulcus allows access to the bone to be replaced, a tight seal is needed to prevent epithelial cells from growing from a coronal direction and to allow new desmodontal attachment between the alveolar bone and tooth. Bone (replacement) material is protected via a resorptive membrane that is attached to the tooth crown. In veterinary dentistry, this procedure is used in isolated cases only if the remaining periodontium may be maintained with proper oral hygiene and dental care.

Regeneration of the jawbone without tooth involvement (GBR, ► Fig. 17.167) provides coverage while maintaining closed mucosa. The new bone forms in a closed matrix of bone (replacement) material, which is separate from the tooth and thus offers a better prognosis. In veterinary dentistry, this procedure is used primarily after the extraction of larger teeth (e.g., canine teeth) or for reconstructing jawbones in the context of cyst formation (e.g., retained premolars).



► Fig. 17.166 Guided tissue regeneration (GTR).



► Fig. 17.167 Guided bone regeneration (GBR).



## 17.3

**Gingival Hyperplasia**

Gingival hyperplasia is general proliferation of the gingiva. The teeth may eventually be fully covered by overgrown tissue. The situation may be complicated by trauma of opposing teeth, which may result in severe inflammation. This is not typical tumor growth, but rather a reactive change of the gingiva. Recurrence is likely in dogs, even after elimination of most of the exogenous stimuli. Some breeds, such as Boxers, are predisposed to this condition, so a genetic component is likely. Microscopically, a thickened epithelial layer is generally seen, with strands invading the underlying connective tissue. While invasion of the bone is rare, the accompanying inflammation can encourage periodontal bone damage. Pseudopockets may form near the teeth, impacting plaque, food, hair, etc., and promoting gingival inflammation, which may in turn exacerbate the periodontitis. The treatment consists of resecting the superfluous tissue and creating a treatable, hygienic periodontium.

**17.3.1 Gingival Hyperplasia and Gingivectomy**

The findings and therapy for gingival hyperplasia are shown in the following figures from a Boxer (► Fig. 17.168, ► Fig. 17.169, ► Fig. 17.170, ► Fig. 17.171, ► Fig. 17.172, ► Fig. 17.173, ► Fig. 17.174, ► Fig. 17.175, ► Fig. 17.176, ► Fig. 17.177, ► Fig. 17.178, ► Fig. 17.179, ► Fig. 17.180, ► Fig. 17.181).



► **Fig. 17.168 Gingival hyperplasia, right maxilla.** The teeth appear short in this Boxer because of the gingival hyperplasia toward the crown. The gingiva is thickened and partially inflamed.



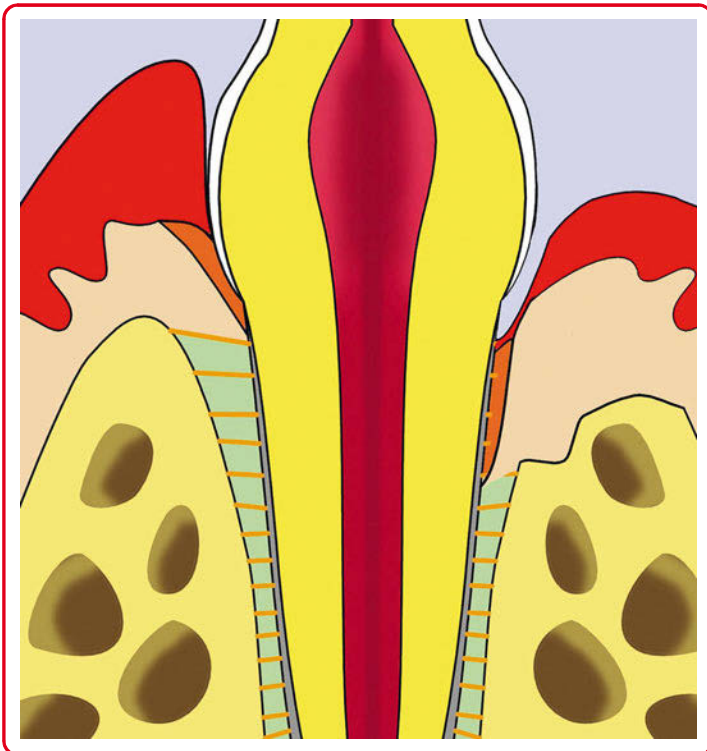
► **Fig. 17.169 Gingival hyperplasia, left maxilla.** The hyperplasia is not limited to the labial surfaces, but also occurs palatally.



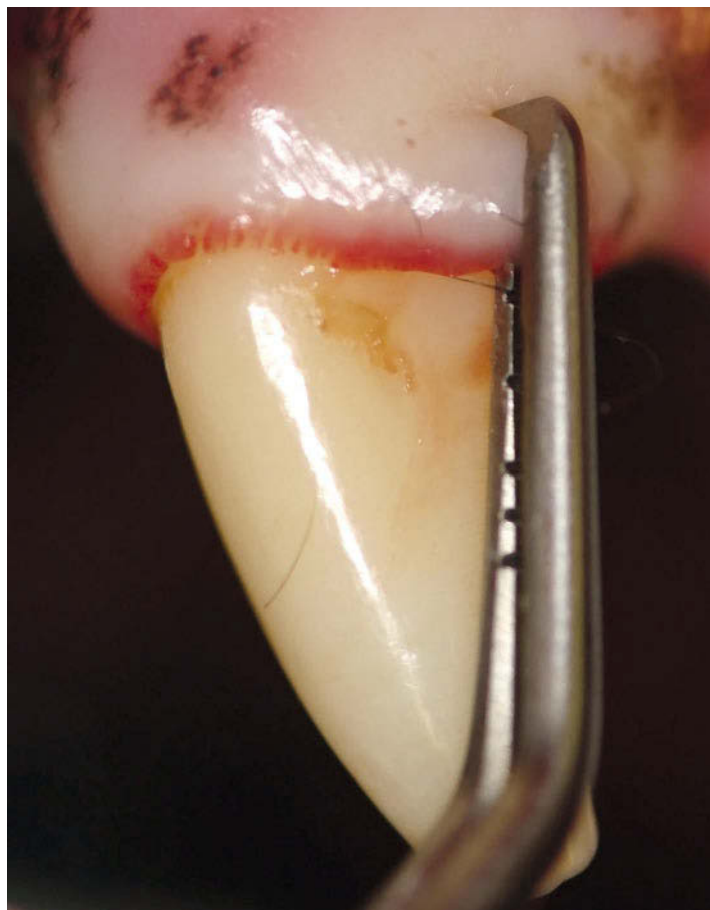
► **Fig. 17.170 Gingival hyperplasia, left mandible.** The mandibular cheek teeth are also surrounded by gingival cuffs.



► **Fig. 17.171 Gingival hyperplasia, right mandible.** The tissue is coarse and firm. In this case, pocketing is not accompanied by edema or consecutive loosening of the tissue.



► **Fig. 17.172 A pseudopocket and a true periodontal pocket.** This diagram illustrates the difference between a pseudopocket (left) and a true infrabony periodontal pocket (right). In a pseudopocket, the epithelial attachment remains intact and opens at the normal gumline. The periodontal bone is not affected. In a true periodontal pocket (right), the epithelial attachment is damaged, and located further apically and lengthened. The periodontal bone is destroyed crestally, periodontal fibers have degraded, and the desmodontal attachment has been affected. The left side shows a fully reversible, purely gingival process. Except in occasional cases, the periodontal process on the right is generally irreversible.



► **Fig. 17.173 Pocket marker in a pseudopocket.** Periodontal pocket markers facilitate gingivectomy. The blunt end is inserted into the periodontal pocket until it reaches the pocket floor. The ends of the marker are then pressed together, which presses an outer bevel into the gingiva and creates a bleeding point.



► **Fig. 17.174 Bleeding points after use of a pocket marker.** Multiple bleeding points indicate the depth of the pocket floor, which enables planning of the new gumline.





► **Fig. 17.175 Pocket marker in the premolar area.** A pocket marker can be used throughout the bite.



► **Fig. 17.176 Right maxilla after gingivectomy.** After the excessive gingiva is removed, the crown heights are fully visible. Since dissecting the gingiva at a 90° angle would create a “ledge”, the gingiva is angled toward the vestibule to give it a more normal appearance and to minimize the accumulation of plaque.



► **Fig. 17.178 Left mandible after gingivectomy.** Resection may be performed with a scalpel, electrosurgical loop, or laser.



► **Fig. 17.177 Left maxilla after gingivectomy.**



► **Fig. 17.179 Right mandible after gingivectomy.** While angulation enlarges the wound, care will be easier once it has healed. Dental care is required to remove debris and bacteria and thus prevent recurrence.



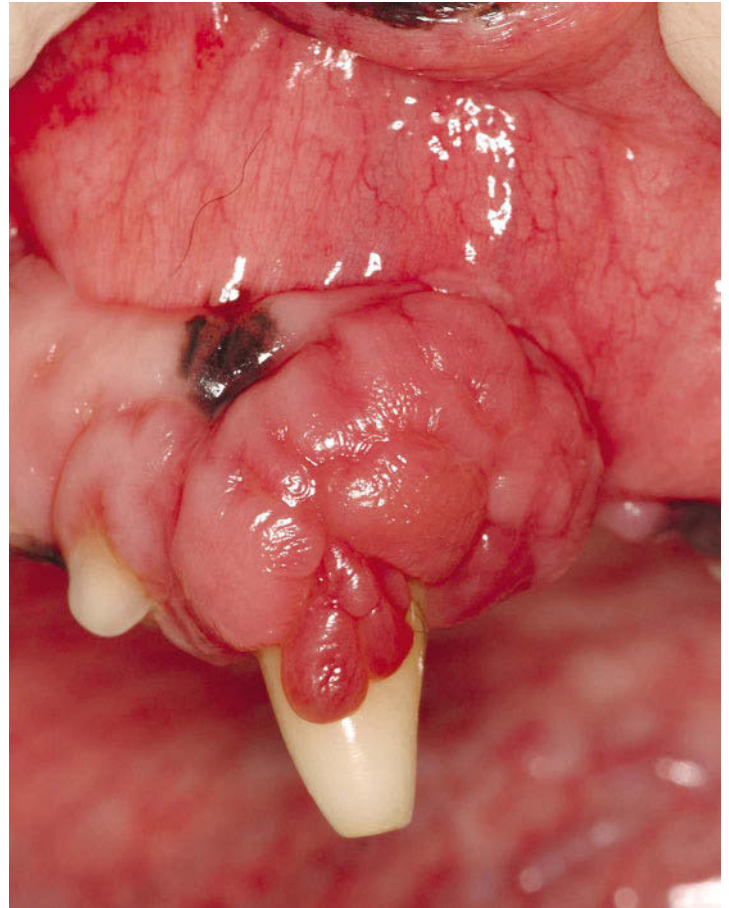
► **Fig. 17.180** Gingiva on the right side 6 months later. At the 6-month follow-up examination, with supportive dental care, the periodontium appears normal.



► **Fig. 17.181** Gingiva on the left side 6 months later.

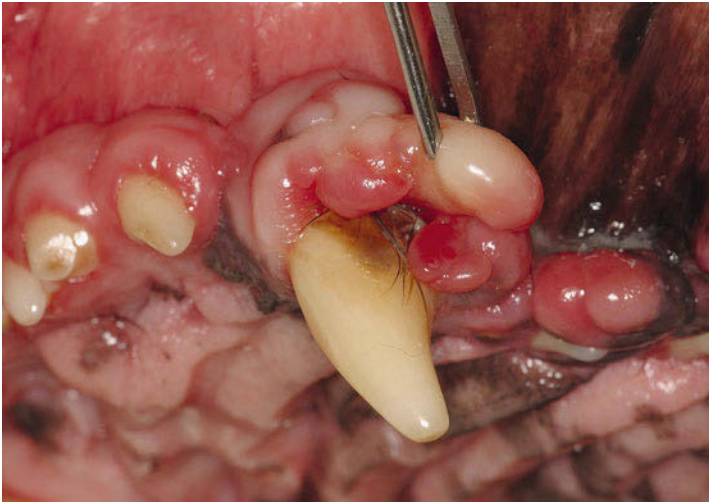
### 17.3.2 Gingival Hyperplasia and Pseudopockets

The following figures (► Fig. 17.182, ► Fig. 17.183, ► Fig. 17.184, ► Fig. 17.185, ► Fig. 17.186, ► Fig. 17.187 ► Fig. 17.188) illustrate the findings and treatment of gingival hyperplasia with pseudopockets.



► **Fig. 17.182** Gingival hyperplasia at the maxillary left canine tooth. While the gingival hyperplasia may seem extreme, if the process is generalized and symmetrical, it generally does not involve an underlying tumor.

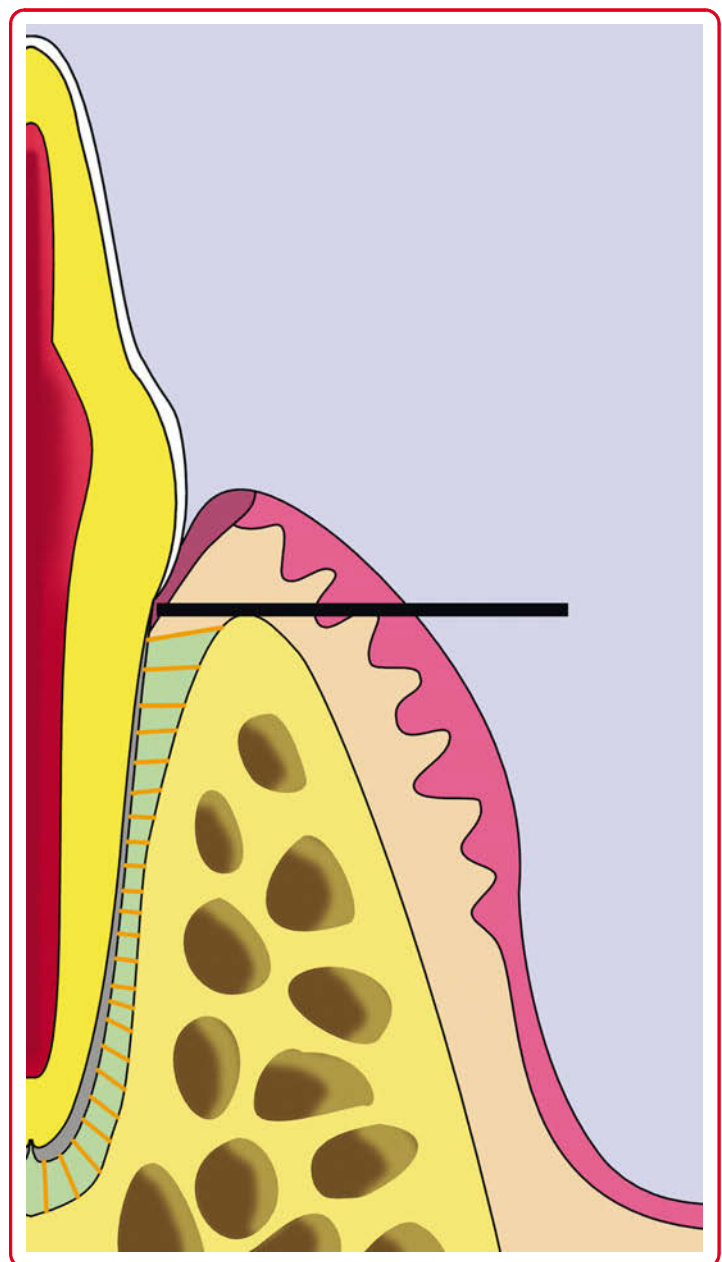




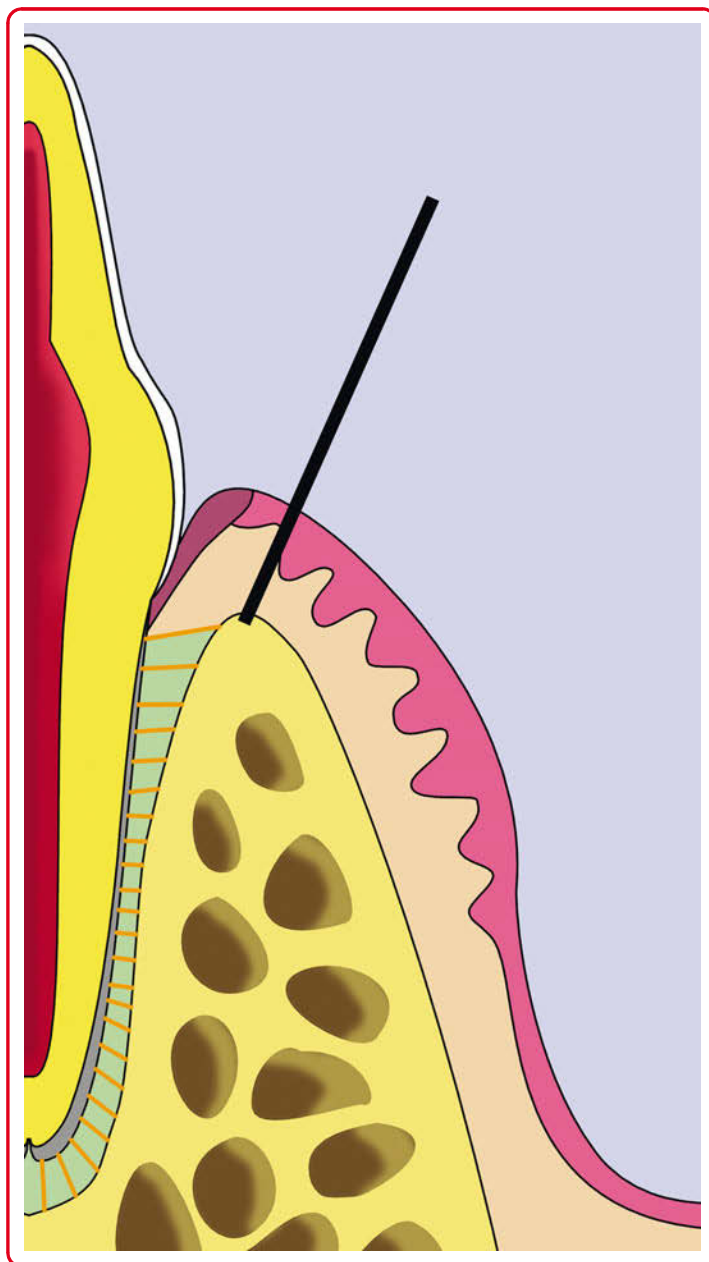
► **Fig. 17.183 Plaque accumulation in the pseudopocket.** The pocket is visible when the gingiva is everted. Below the mucosa, the collection of calculus, plaque and hair promotes development of a pathogenic biofilm.



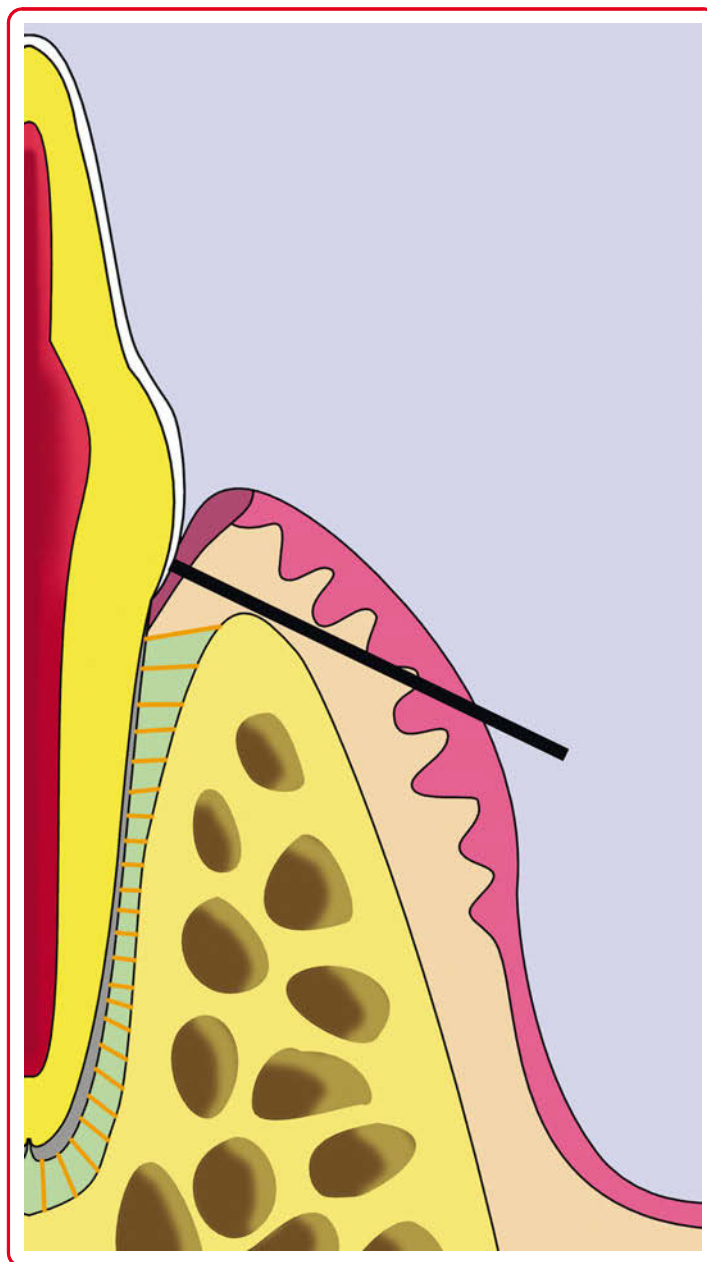
► **Fig. 17.184 Measuring the pocket depth with a pocket marker.** Here, too, a pocket marker can be used to evaluate the floor of the pockets.



► **Fig. 17.185 Apical horizontal incision.** While an apical horizontal incision would enable removal of all of the excess tissue, this would create a new "ledge".



► **Fig. 17.186 Internal gingivectomy.** While an internal gingivectomy with removal of the internal lining of the pockets is aesthetically pleasing, it is generally not appropriate for a dog. Gingival hyperplasia is less common in cats, and it occurs mainly in animals with juvenile periodontitis.



► **Fig. 17.187 External gingivectomy.** An external gingivectomy is recommended. It is used to remove superfluous tissue and facilitate future plaque removal. Gingiva should be removed only from pseudopockets, because it cannot be removed from true infrabony pockets.

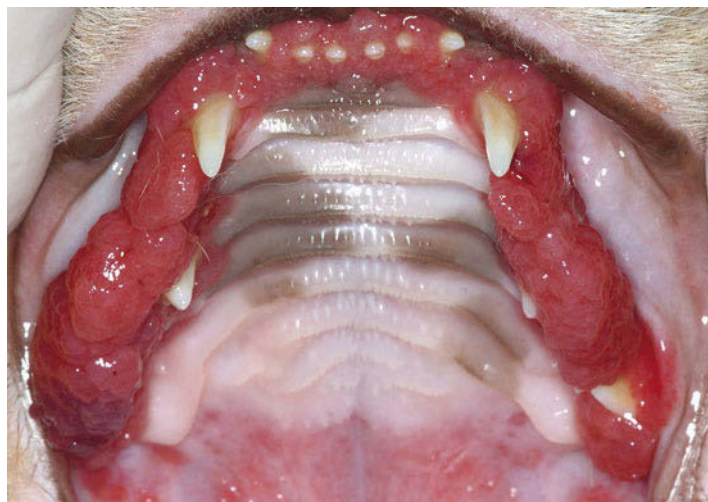


### 17.3.3 Gingival Hyperplasia in a Cat

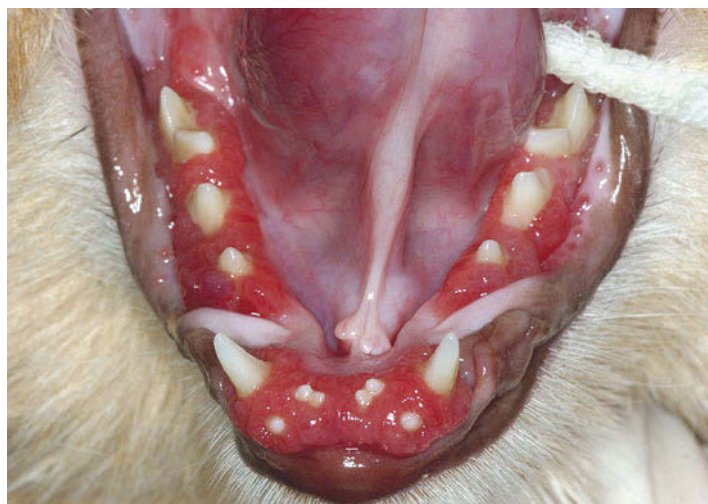
Due to their short crowns (aside from the canine teeth), feline teeth are quickly covered by the enlarged gingiva. The cause of the gingival hyperplasia must be identified to avoid recurrence and select the correct treatment (► Fig. 17.189, ► Fig. 17.190, ► Fig. 17.191, ► Fig. 17.192). Gingivectomy using a diode laser (p.370) is recommended for cats.



► **Fig. 17.188 Left side after gingivectomy.** An external gingivectomy involves a wide resection margin and requires more recovery time than the other variants. Wound healing should initially be supported with antibiotics, anti-inflammatory drugs, and analgesics. The owner should then start dental care after approximately 10 days.



► **Fig. 17.189 Generalized maxillary gingival hyperplasia.** Gingival hyperplasia in a cat is often notable due to both the proliferation of tissue and the severe inflammation. All teeth are covered by hyperplastic gingiva.



► **Fig. 17.190 Generalized mandibular gingival hyperplasia.** The gingiva is dark red, highly inflamed, and rough with a soft, disintegrating consistency.

### 17.3.4 Feline Gingival Hyperplasia and Extractions

If it is impossible to keep cat teeth free of plaque, which triggers gingivitis, then all surfaces on which plaque can deposit (namely the teeth) may require extraction (► Fig. 17.193, ► Fig. 17.194, ► Fig. 17.195, ► Fig. 17.196, ► Fig. 17.197, ► Fig. 17.198, ► Fig. 17.199, ► Fig. 17.200).



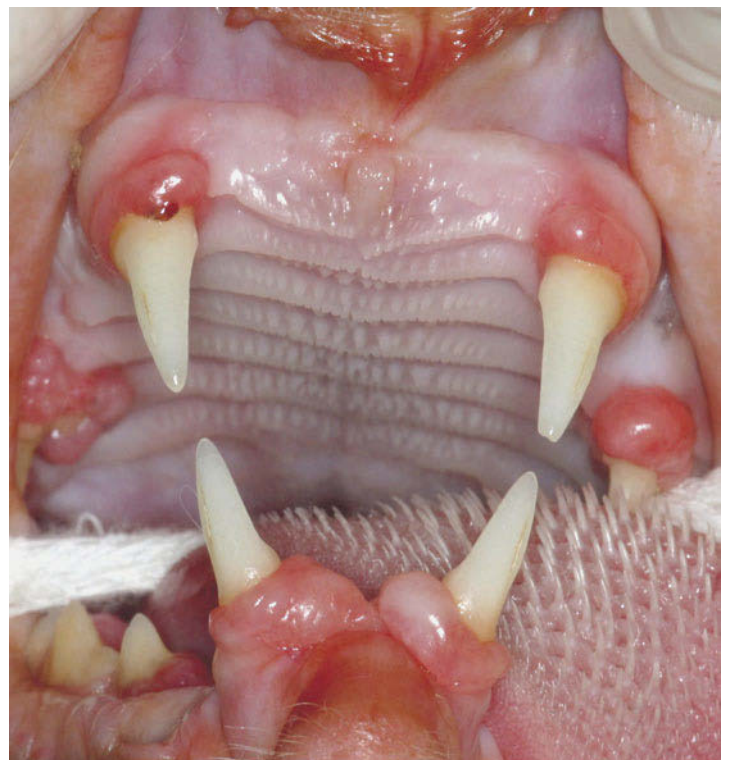
► **Fig. 17.191 Radiograph of the left mandible.** If a cat with gingival hyperplasia is not presented early in the disease process, the initially purely gingival process may develop into true periodontitis with loss of height on the alveolar ridge. This is most apparent at the mandibular cheek teeth.



► **Fig. 17.193 Gingival hyperplasia, right maxilla.** Despite an already reduced number of teeth in this cat, severe gingival hyperplasia has developed in tooth-bearing areas.



► **Fig. 17.192 Radiograph of the right mandible.** When alveolar ridge height is lost, the root furcations are exposed, which in turn generates new pockets that can collect debris. If the bone has already deteriorated significantly, with furcation involvement, preserving the teeth may not be possible. Dental care, already more difficult in cats than in dogs in the first place, is impossible in the current condition. If a gingivectomy can no longer create a maintainable periodontium the teeth should be extracted to remove this vulnerability and to prevent inflammation through closed mucosa without penetrating teeth.



► **Fig. 17.194 Gingival hyperplasia, canine teeth.** The tissue is rather hard and shows moderate gingivitis.





► Fig. 17.195 Gingival hyperplasia, left maxilla.



► Fig. 17.197 Gingival hyperplasia, right mandible. In addition to the clinical signs, early osteolysis is apparent in the radiograph. The owner is unable to regularly clean the teeth. For this reason, all of the cheek teeth and incisors are extracted.



► Fig. 17.196 Gingival hyperplasia, left mandible.



► Fig. 17.198 Recheck 2 weeks later. After 2 weeks, recovery is unremarkable.

## 17.4

**Oronasal Fistula**

An oronasal fistula may result from advanced periodontitis near the maxillary canine teeth. This does not necessarily involve the loss of a canine, which in fact often masks the process.

**17.4.1 Symmetrical Oronasal Fistulas of the Maxillary Canine Teeth**

While unilateral nasal discharge often indicates periodontal disease at the ipsilateral maxillary canine tooth and bilateral nasal discharge tends to indicate infection, infection should not prevent the veterinarian from performing a more detailed examination (► Fig. 17.201, ► Fig. 17.202, ► Fig. 17.203, ► Fig. 17.204, ► Fig. 17.205, ► Fig. 17.206, ► Fig. 17.207, ► Fig. 17.208, ► Fig. 17.209, ► Fig. 17.210, ► Fig. 17.211, ► Fig. 17.212, ► Fig. 17.213, ► Fig. 17.214, ► Fig. 17.215, ► Fig. 17.216).



► **Fig. 17.199 Follow-up examination 1 year later, left maxilla.** At the 1-year follow-up, gingival hyperplasia has not recurred. Extracting the teeth has removed the source of the disease. Closed mucosa offers better immunological protection than the open mucosa adjacent to a tooth.



► **Fig. 17.201 Maxillary right canine tooth, clinical findings.** This dog has bilateral nasal discharge, sneezing, and poor general health. The maxillary right canine tooth shows slight buccal recession but is otherwise clinically unremarkable.

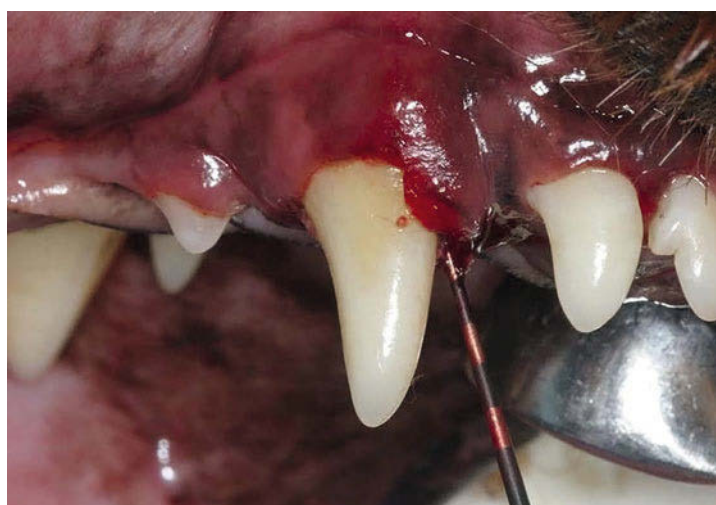


► **Fig. 17.200 Follow-up examination 1 year later, right mandible.**



► **Fig. 17.202 Maxillary left canine tooth, clinical findings.** While buccal recession is slightly more pronounced on the maxillary left canine tooth, this tooth is otherwise clinically unremarkable.





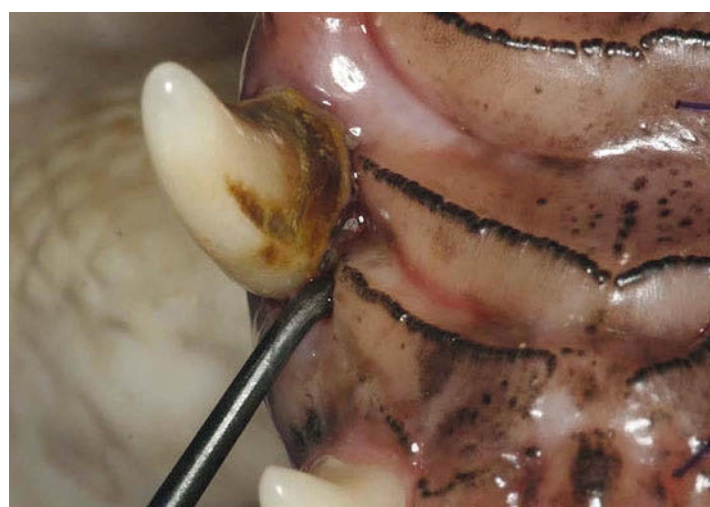
► **Fig. 17.203 Probing palatal to tooth 104.** Periodontal probing is intended to check for infrabony pockets on the palatal side because nasal signs generally indicate involvement of one or both canine teeth.



► **Fig. 17.205 Probing palatal to tooth 204.** The same procedure is used for the maxillary left canine.



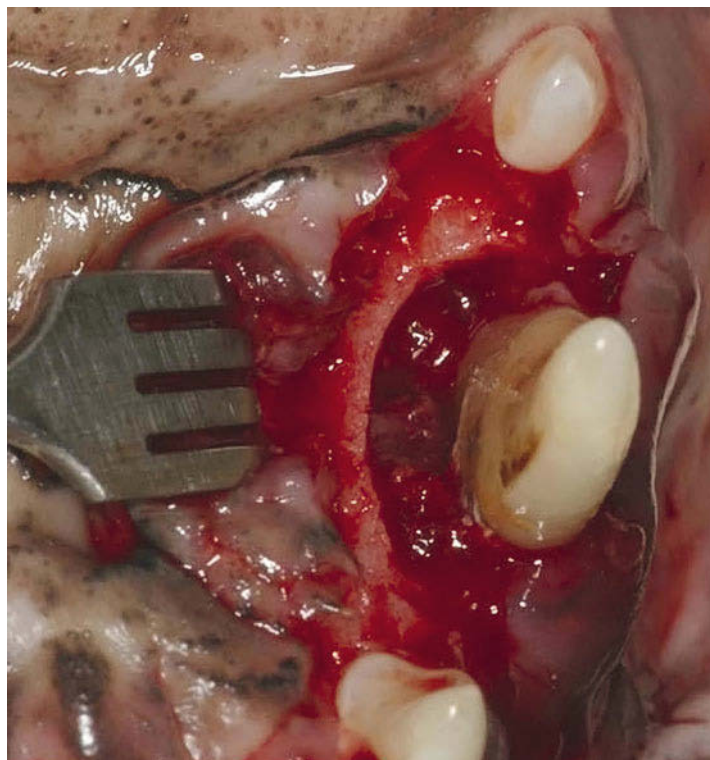
► **Fig. 17.204 Probing of palatal pocket at tooth 104.** The periodontal probe can be inserted to the point where the working tip begins to bend, distinctly indicating osteolysis.



► **Fig. 17.206 Probing of palatal pocket at tooth 204.** This site has the same findings.



► **Fig. 17.207 Radiograph of tooth 104.** In the radiograph, a mesiopalatal infrabony pocket is seen on the maxillary right canine tooth.



► **Fig. 17.209 Dissection palatal to tooth 104.** With the retraction of the gingival mucosa, the infrabony pocket on the maxillary right canine tooth is clinically apparent.



► **Fig. 17.208 Radiograph of tooth 204.** The same lesion can be visualized more clearly in the radiograph of the maxillary left canine tooth.

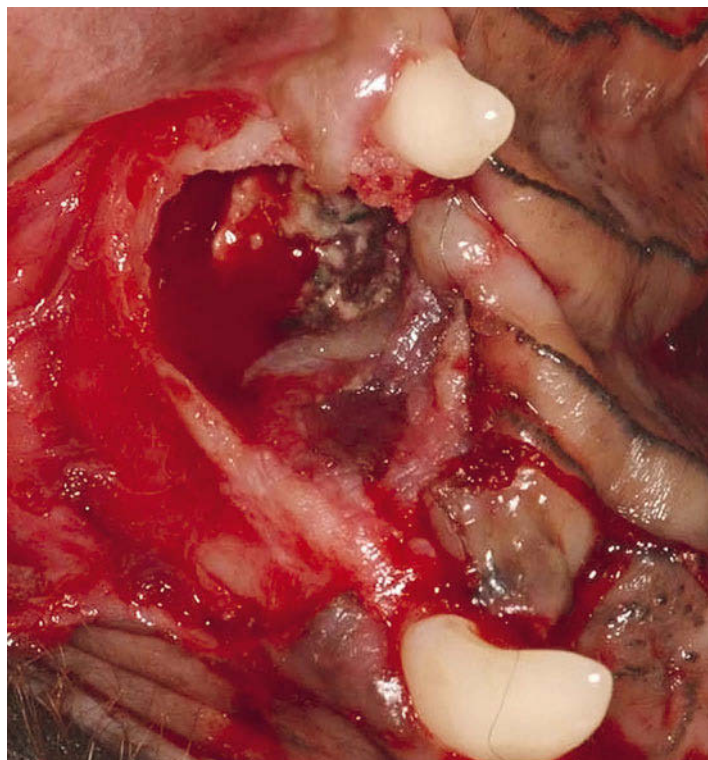


► **Fig. 17.210 Dissection palatal to tooth 204.** The conditions are similar on the maxillary left canine tooth.

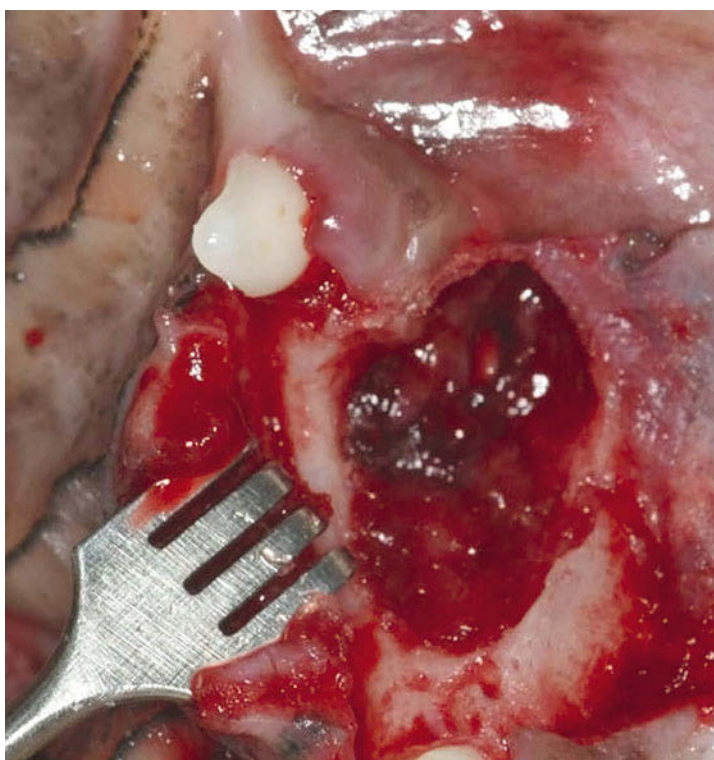




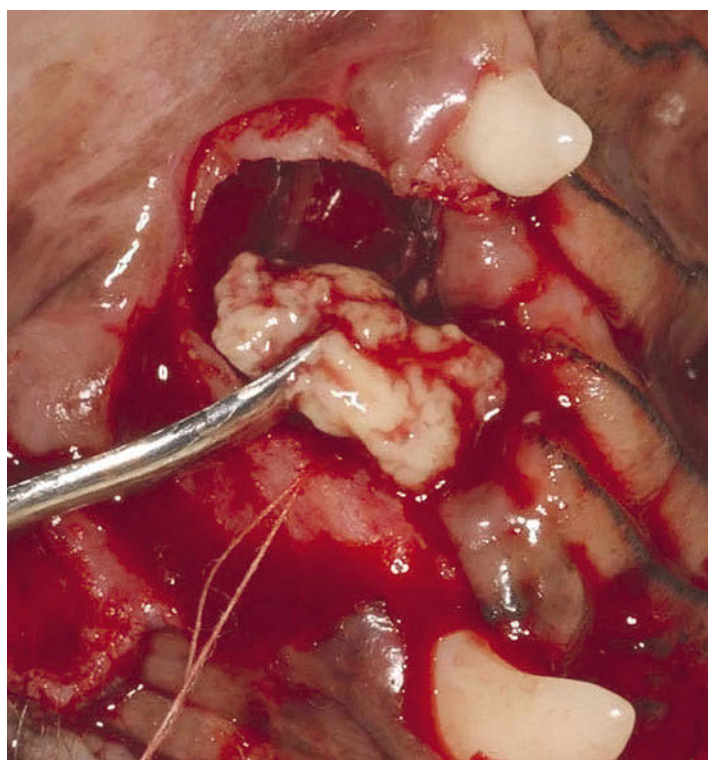
► **Fig. 17.211 Dissection buccal to tooth 104.** Dissection of a buccal mucosal flap at the maxillary right canine tooth reveals the advanced buccal bone loss.



► **Fig. 17.213 Oronasal fistula on the left side.** On the left side, purulent deposits are visible in the nasal cavity after the tooth is extracted.



► **Fig. 17.212 Oronasal fistula on the right side.** The extraction of the tooth reveals a wide opening into the right nasal passage. The advanced periodontitis has eliminated the normal separation between the oral and nasal cavity.



► **Fig. 17.214 Curettage of the left side of the nose.** All purulent deposits and granulation tissue should be removed by curettage.





► **Fig. 17.215** Radiograph after extraction of tooth 104. A postoperative radiograph is taken.



► **Fig. 17.216** Radiograph after extraction of tooth 204.

#### 17.4.2 Closing an Oronasal Fistula at the Maxillary Left Canine Tooth

The following figures show the procedure for closing an oronasal fistula at the maxillary canine tooth (► Fig. 17.217, ► Fig. 17.218, ► Fig. 17.219, ► Fig. 17.220, ► Fig. 17.221, ► Fig. 17.222, ► Fig. 17.223).



► **Fig. 17.217** Severe recession at tooth 204. Clinically, severe recession at the maxillary and mandibular left canine teeth indicates advanced bone lesions.

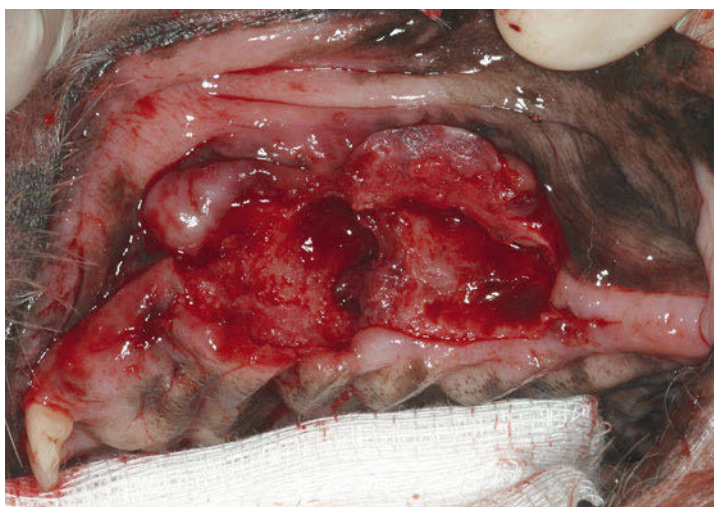




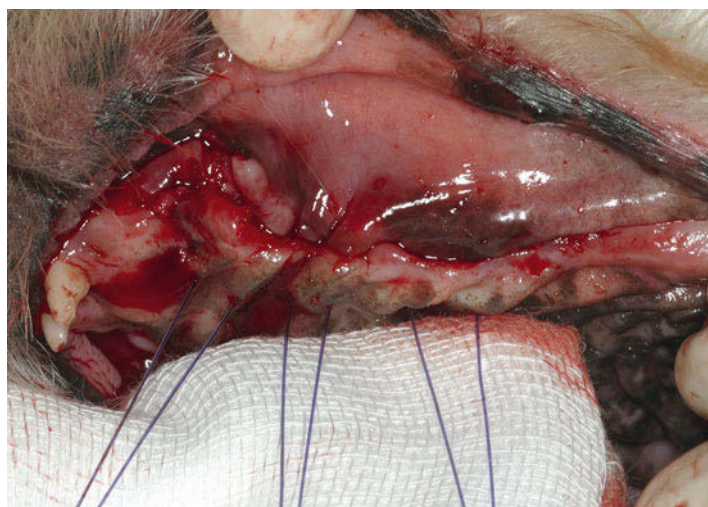
► **Fig. 17.218 Radiograph of tooth 204.** The radiograph shows osteolysis of the maxillary canine tooth covering more than half of the root length. A retained root fragment appears in the premolar area.



► **Fig. 17.220 Radiograph after extraction.** Before closing, the full extraction of the teeth is confirmed radiographically.

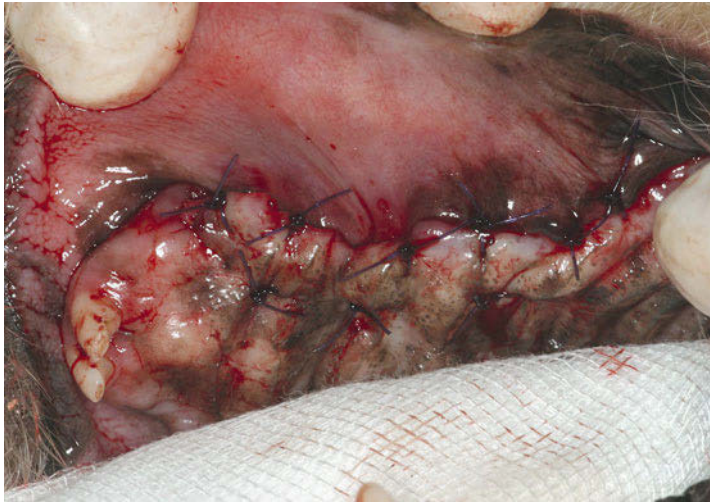


► **Fig. 17.219 Alveoli after extraction.** After the canine tooth and the root fragment are removed, the alveoli are curetted. A bony border can no longer be palpated nasally in the alveolus of the maxillary canine tooth. Thus, the wound was closed over the oronasal fistula.



► **Fig. 17.221 Suture material placed in front.** A vestibular mucosal flap is mobilized. An incision is made at the base of the periosteum to dissect the collagenous fibers. The suture material is first positioned in front and then the flap is pulled under the undermined gingival mucosa. The sutures are not closed until everything is in position.





► **Fig. 17.222 Wound closure.** The free margin of the gingival mucosa is sutured to the advanced vestibular mucosal flap.



► **Fig. 17.223 Follow-up examination of the wound closure 3 weeks later.** After closure of an oronasal fistula with a vestibular advancement flap, a tight mucosal cover remains in place 3 weeks after the operation. The loose oral mucosa extends to the palatal mucosa. The bone-supported suture at the palate has promoted healing.

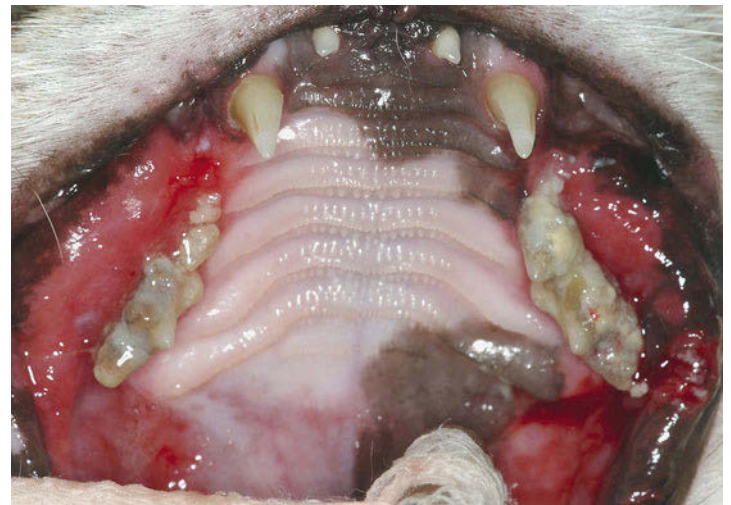
## 17.5

### Gingivostomatitis

Gingivostomatitis occurs mainly in cats. This disease is very frustrating for the owner, the veterinarian, and most importantly the cat. The initial goal is eliminating all potential causes or accompanying factors to assess the remaining inflammation and offer specific treatment.

#### 17.5.1 Gingivostomatitis with Extraction of All Cheek Teeth

A cat presented with significantly reduced eating, weight loss, and poor general health. The patient was conscious for the oral cavity examination, and the oral pain and clinical findings were severe. The following images (► Fig. 17.224, ► Fig. 17.225, ► Fig. 17.226, ► Fig. 17.227, ► Fig. 17.228, ► Fig. 17.229, ► Fig. 17.230, ► Fig. 17.231, ► Fig. 17.232, ► Fig. 17.233, ► Fig. 17.234, ► Fig. 17.235, ► Fig. 17.236) illustrate the clinical and radiographic findings as well as the treatment.



► **Fig. 17.224 Hyperplastic gingivostomatitis, maxilla.** The maxillary teeth are completely covered with calculus and soft plaque interspersed with pus. Both the gingiva and all of the surrounding mucosa are severely inflamed. They are red, edematous, and bleed upon contact. The corners of the mouth are also inflamed.



► **Fig. 17.225 Hyperplastic gingivostomatitis, mandible.** The mandibular cheek teeth are hidden by the surrounding enlarged mucosa.





► **Fig. 17.226 Radiograph of the right maxilla.** The radiographs show severe tooth resorption, in some cases leading to crown fracture and root fragments persisting in the jaw.



► **Fig. 17.228 Radiograph of the left mandible.**



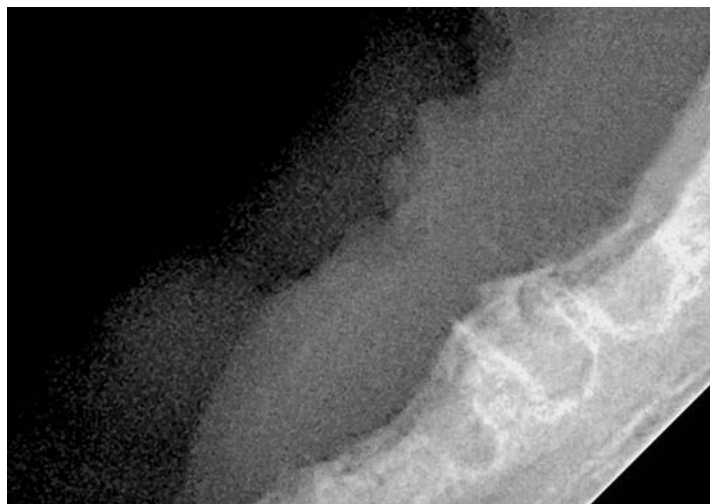
► **Fig. 17.227 Radiograph of the left maxilla.** Distinct cervical resorptive defects are seen that have in part resulted in severing of the associated roots.



► **Fig. 17.229 Radiograph of the right mandible.** The right mandible shows extensive resorption and decreased alveolar bone height due to horizontal bone loss.



► **Fig. 17.230 Radiograph of the right maxilla after extraction.** In order to treat the inflamed mucosa, all destroyed or fractured teeth and root fragments must first be removed. In this cat, full extraction is possible only after radiographic confirmation of the tooth condition.



► **Fig. 17.232 Radiograph of the left mandible after extraction.**

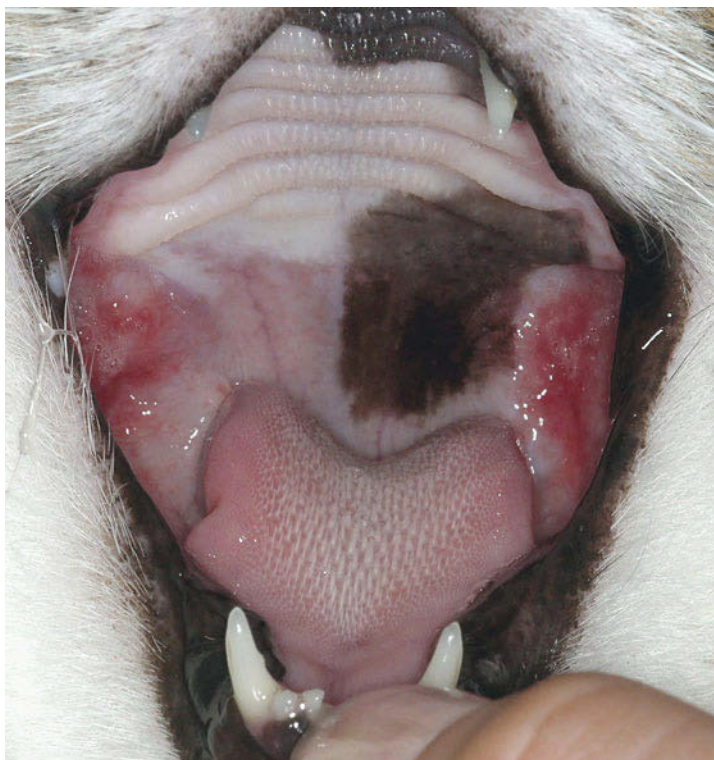


► **Fig. 17.231 Radiograph of the left maxilla after extraction.**

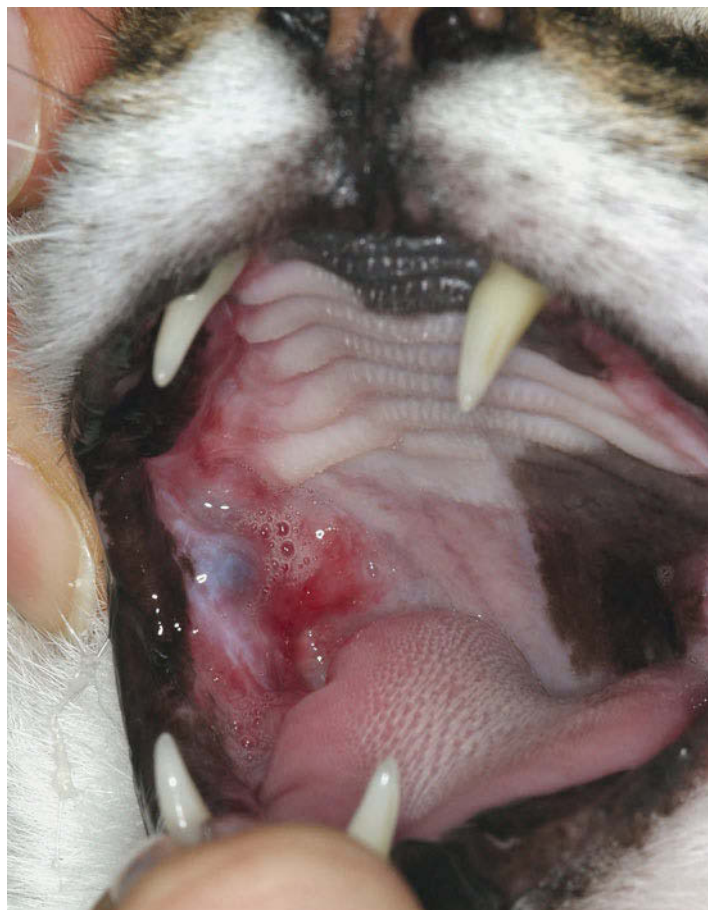


► **Fig. 17.233 Radiograph of the right mandible after extraction.**

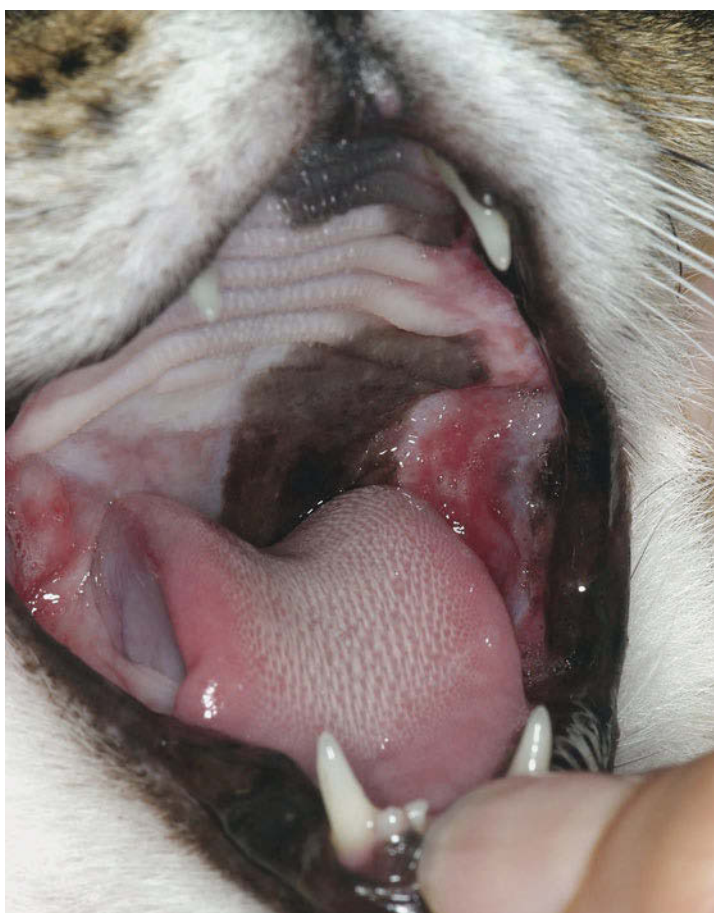




► **Fig. 17.234** Follow-up examination of the oral cavity 2 weeks later. After only 2 weeks, recovery is unremarkable and inflammation clearly reduced; the mucosa no longer appears enlarged, although no soft tissue was resected.



► **Fig. 17.236** Follow-up examination of the right oral cavity 2 weeks later. Because the animal is healthier and eating well, the anti-inflammatory medicine can quell the chronic disease process. While the original approach was to treat the gingivostomatitis as an independent process, the inflammation was clearly related to dental disease. By eliminating the teeth, the alveolar inflammatory stimulus was blocked and the inflammation curbed.

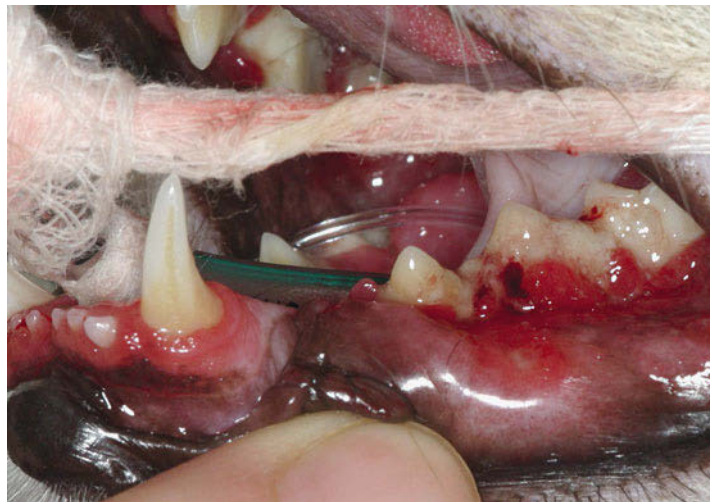


► **Fig. 17.235** Follow-up examination of the left side of the oral cavity 2 weeks later. The remaining redness, especially in the retromolar space, can now be treated medically because the teeth were removed as a source of persistent inflammation.



### 17.5.2 Gingivostomatitis in a Young Cat

Gingivostomatitis can also affect young cats (► Fig. 17.237, ► Fig. 17.238, ► Fig. 17.239, ► Fig. 17.240, ► Fig. 17.241, ► Fig. 17.242, ► Fig. 17.243, ► Fig. 17.244, ► Fig. 17.245, ► Fig. 17.246, ► Fig. 17.247, ► Fig. 17.248, ► Fig. 17.249, ► Fig. 17.250, ► Fig. 17.251).



► Fig. 17.239 Gingivostomatitis, left mandible.



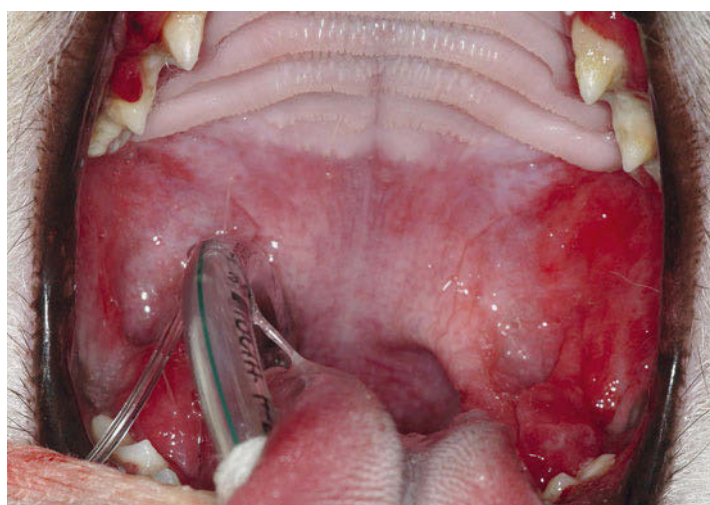
► Fig. 17.237 Gingivostomatitis, right maxilla. A nearly 1-year-old cat presents with severe inflammation of the oral cavity, decreased eating, and severe pain. The gingiva around the maxillary cheek teeth is highly inflamed and thickened, and the teeth are covered with a lot of soft plaque. The accumulation of soft plaque indicates that the cat does not use the teeth for chewing.



► Fig. 17.240 Gingivostomatitis, right mandible.

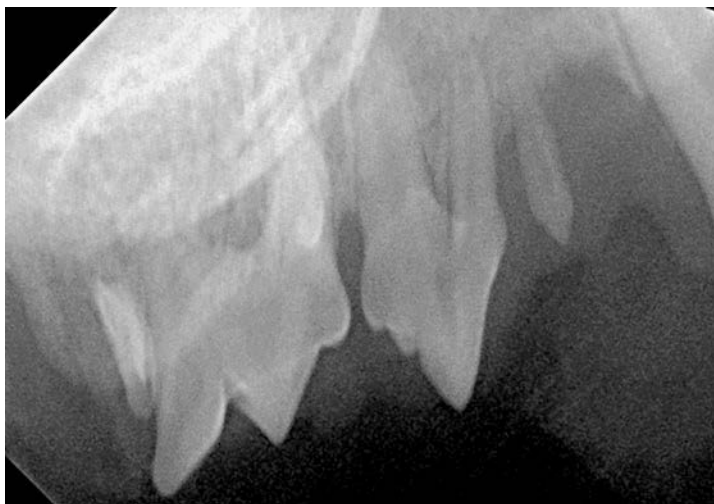


► Fig. 17.238 Gingivostomatitis, left maxilla. This condition is referred to as gingivostomatitis because it involves the gingiva and the surrounding mucosa.



► Fig. 17.241 Gingivostomatitis, retromolar. The pharynx is also inflamed.





► **Fig. 17.242 Radiograph of the right maxilla.** The radiograph shows cervical osteolysis. The bony periodontium appears unremarkable and not nearly as clinically inflamed as the oral mucosa.



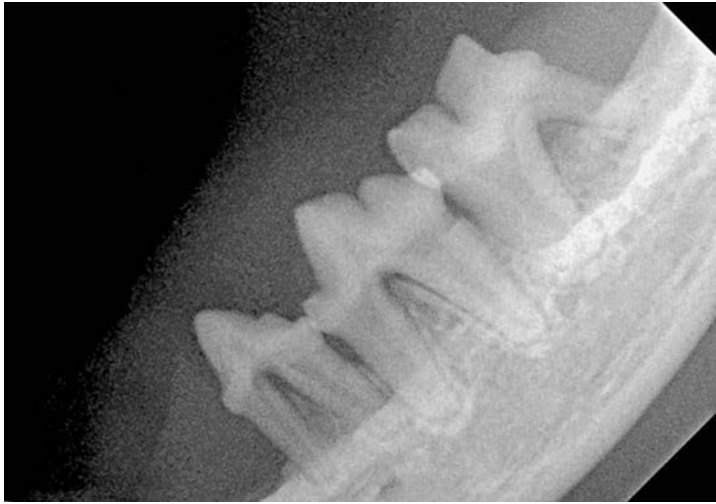
► **Fig. 17.244 Radiograph of the maxillary left canine tooth.**



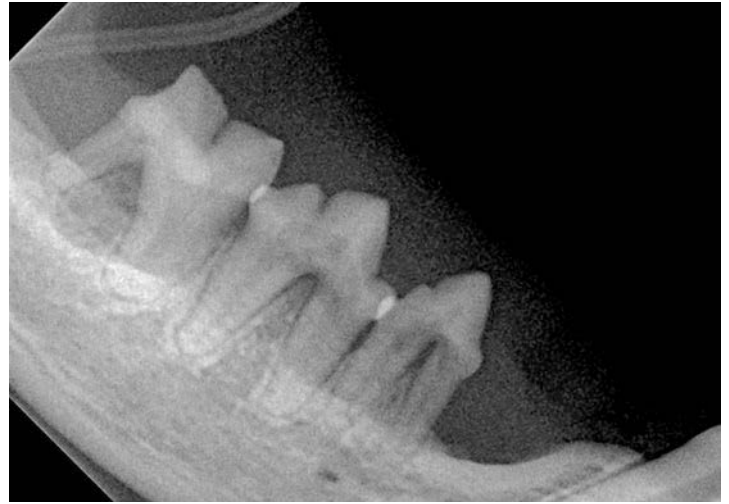
► **Fig. 17.243 Radiograph of the maxillary right canine tooth.** Aside from cervical osteolysis, the maxillary right canine tooth is largely unremarkable, while the bone loss at the incisors is already advanced.



► **Fig. 17.245 Radiograph of the left maxilla.** Osteolysis is seen around tooth 206, along with an infrabony pocket around teeth 207 and 208.



► **Fig. 17.246 Radiograph of the left mandible.** The alveolar crest is abnormally radiolucent. The bony furcation does not appear involved.



► **Fig. 17.248 Radiograph of the right mandible.** The horizontal bone loss is especially prominent on tooth 407 as well as in the radiolucency around tooth 409.

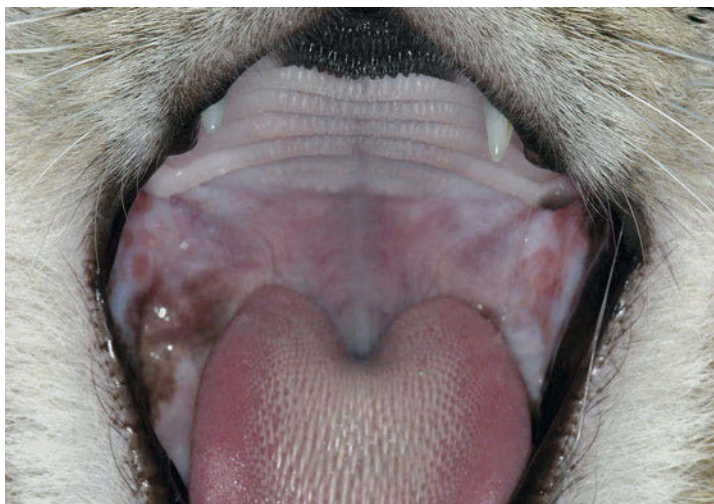


► **Fig. 17.247 Radiograph of the mandibular front teeth.** The incisors show severe horizontal bone loss, while the canine teeth are largely unremarkable.



► **Fig. 17.249 Follow-up examination of the oral cavity 3 weeks later.** Without cheek teeth or incisors, the oral inflammation is clearly reduced even though wound healing appears delayed.





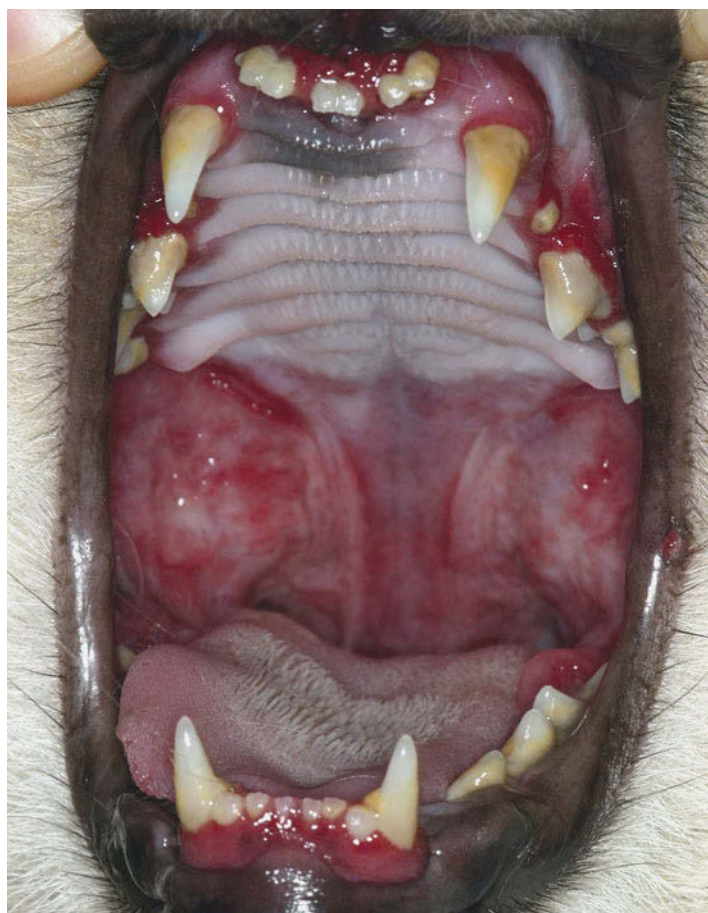
► **Fig. 17.250** Follow-up examination of the oral cavity 3 months later. Inflammation in the oral cavity has subsided after 3 months.



► **Fig. 17.251** Follow-up examination of the oral cavity 5 months later. A light pink, speckled retromolar space remains, and the alveolar ridges are not inflamed. The animal is not in pain and eats normally. It is generally healthy and functioning normally. The slight persistent redness in the pharynx requires no further treatment because this is not “autonomous” inflammation but rather the remnant of a periodontal process.

### 17.5.3 Delayed Recovery from Gingivostomatitis

Due to the massive inflammation, more time is required for recovery after surgery. Chronically inflamed tissue rarely heals as quickly as healthy mucosa (► Fig. 17.252, ► Fig. 17.253, ► Fig. 17.254, ► Fig. 17.255, ► Fig. 17.256, ► Fig. 17.257, ► Fig. 17.258, ► Fig. 17.259, ► Fig. 17.260).

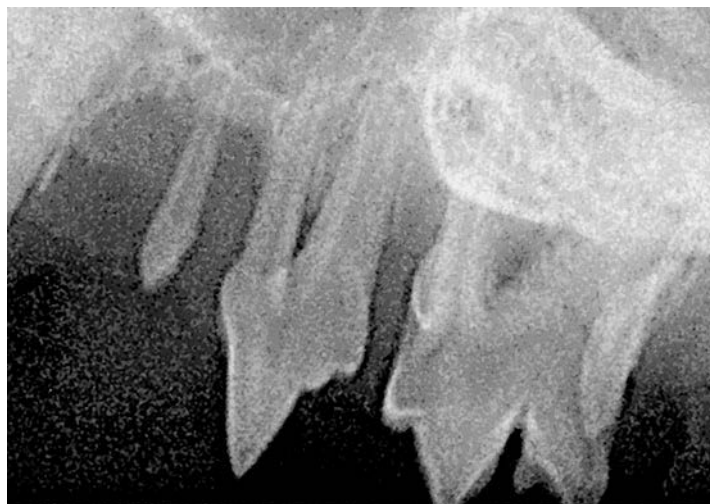


► **Fig. 17.252** Gingivostomatitis. Oral inflammation in a middle-aged cat induced weight loss, severe pain, and a depressed mood.





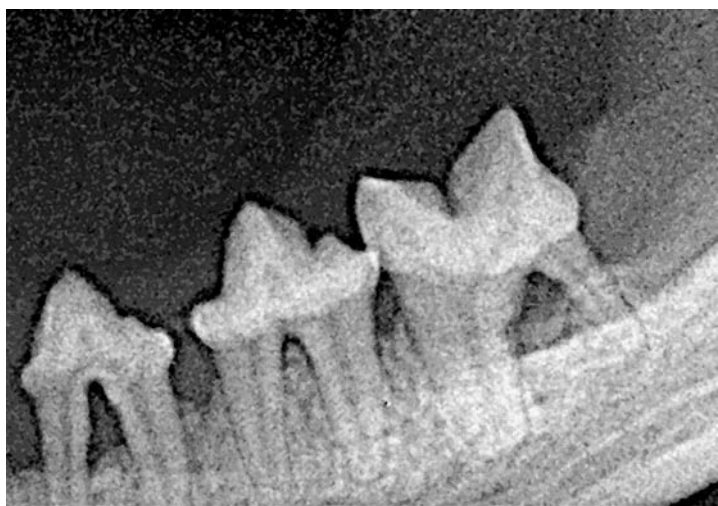
► **Fig. 17.253 Periodontitis, left maxilla.** The teeth are covered with abundant calculus and plaque, and the surrounding gingiva is highly inflamed. These signs appear in all jaw quadrants. Other parts of the oral mucosa are also inflamed.



► **Fig. 17.256 Radiograph of the left mandible.** The furcation areas of the teeth are affected by the osteolysis, creating new pockets of debris.



► **Fig. 17.254 Periodontitis, left mandible.** Lingually, the molar salivary gland is also involved. It is red and enlarged.

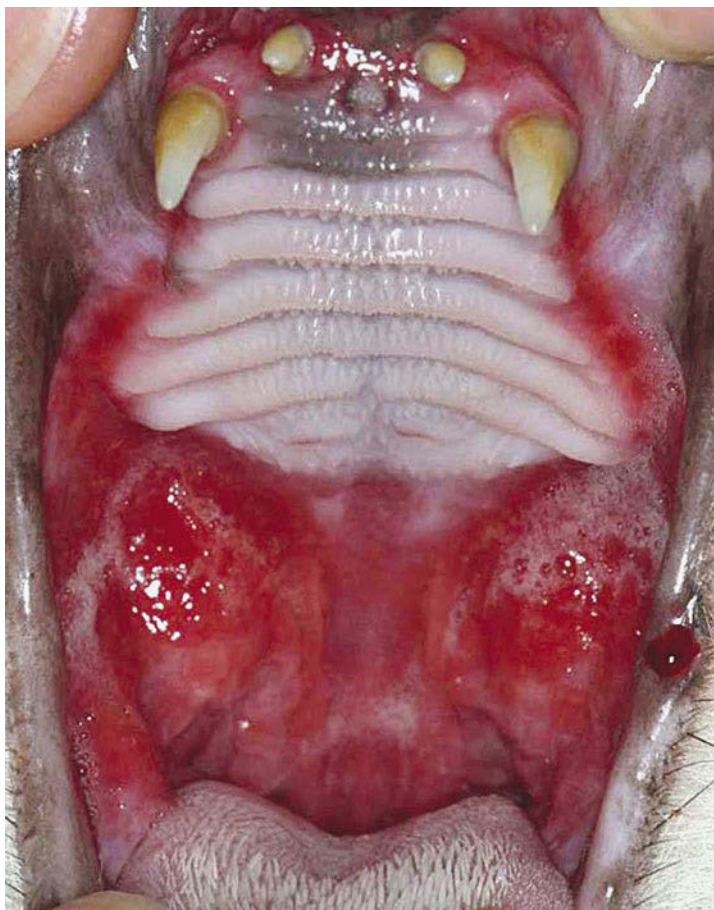


► **Fig. 17.255 Radiograph of the left maxilla.** In the radiograph, horizontal bone loss pervades the areas of mucosal inflammation.

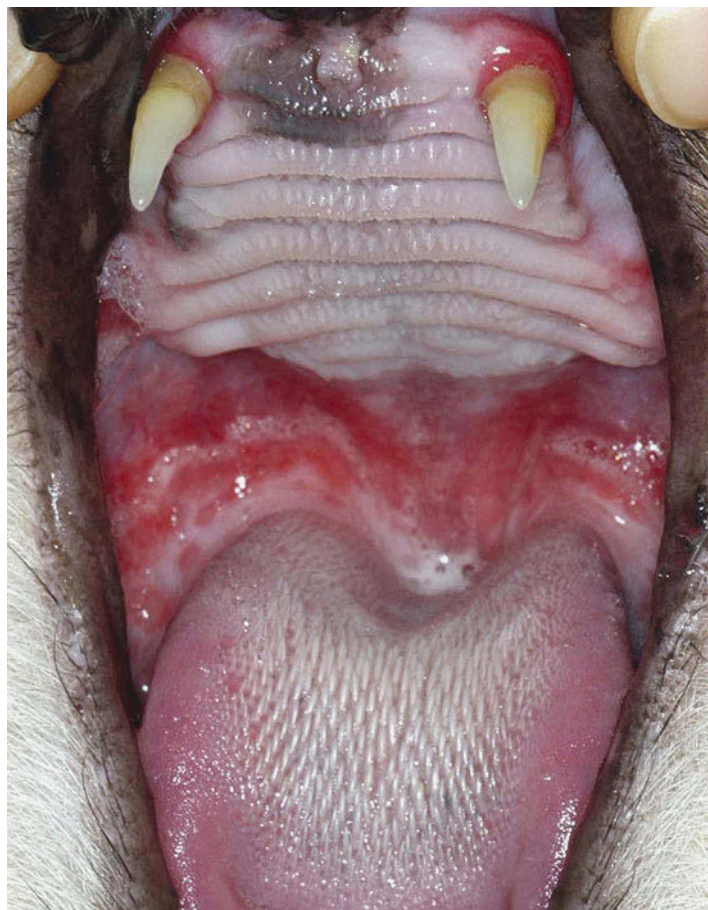


► **Fig. 17.257 Radiograph of the mandibular front teeth.** The mandibular incisors show dramatically decreased alveolar bone height from horizontal bone loss.





► **Fig. 17.258 Oral cavity 2 years later.** Despite the extraction of the cheek teeth, the condition persisted even 2 years later. Despite unsuccessful drug therapy with Interferon omega and later immunosuppressant therapy with prednisolone, severe inflammation of the oral cavity continued.



► **Fig. 17.259 Condition of the oral cavity 3 years later.** 3 years later after extraction of the remaining incisors, the inflammation slowly started to subside. The canine teeth show increasing gingival recession.

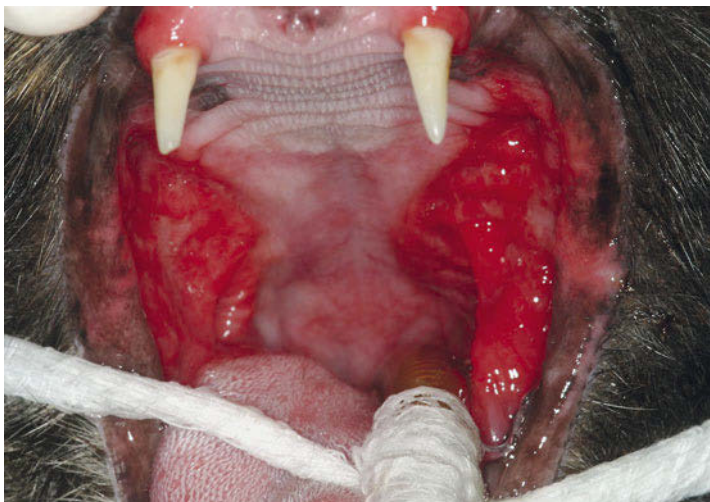




► **Fig. 17.260 Oral cavity 4 years later.** The condition was acceptable only after 4 years. The red mucosa is now pink and speckled, eating is improved, and the animal appears healthy with no indication of pain. In sum, despite a proper approach, the situation often requires time to improve. Depending on the animal's immune condition, long-term immune modulation with various drugs may be required to address changes. No further drug therapy was necessary in this case.

#### 17.5.4 Gingivostomatitis Before and After Extraction of All Teeth

Extraction of all (cheek) teeth to eliminate the source of bacteria and plaque accumulation often restores oral health to an acceptable level (► Fig. 17.261, ► Fig. 17.262).



► **Fig. 17.261 Gingivostomatitis.** Despite extraction of the cheek teeth and incisors, severe inflammation continues in this cat.



► **Fig. 17.262 Oral cavity after extraction of the remaining canine teeth.** Extraction of the canine teeth was required to minimize bacteria-induced plaque and relieve the inflammation.

### 17.6

#### Stomatitis in a Dog

In dogs, stomatitis unrelated to periodontal disease can have many causes and is just as enigmatic as it is in cats.

##### 17.6.1 Polypoid Stomatitis

► Fig. 17.263 is an example of polypoid stomatitis.



► **Fig. 17.263 Gingivitis around tooth 104.** Inflammation may present in different ways. This dog presents with deep-red, thickened, and papillomatous gingiva. Pseudopockets resulted from hyperplasia.



### 17.6.2 Mucositis

One clinical presentation of mucositis affecting many kinds of mucosa appears in ► Fig. 17.264 and ► Fig. 17.265.



► **Fig. 17.264 Mucositis of the palate.** Oral inflammation may affect many different types of mucosa. Even the less vulnerable gingival mucosa is ulcerated. There is no single dental cause of these abnormalities. They are in fact caused by an underlying immune disorder.



► **Fig. 17.265 Flattened palate related to mucositis.** In the advanced stage, the palatine folds have flattened, and the mucosa is pinkish-reddish and speckled. True ulcerations are not present. Identifying an organic cause is critical to knowing how the disease process will play out. Extraction of unsalvageable teeth and proper dental care can improve the condition. A microscopic histopathological examination of mucosal biopsies is advised to narrow down or exclude possible causes.

## 18 Oral Mucosa

In addition to the teeth and the directly adjacent periodontium, the oral cavity is the site of a number of specific mucosal disorders.

### 18.1

### Immunogenic Inflammation

Systemic autoimmune disorders are not the only type of immunogenic defects. A locally aberrant defense to microbes throughout the oral cavity can cause distinct clinical signs. Primary autoimmune disorders often induce changes in the oral cavity because the mucosa is a particularly sensitive early indicator.

#### 18.1.1 Contact Ulcer

Starting with the bacterial film on the teeth, an inflammatory process may spread uncontrollably simply through contact between the teeth and the surrounding mucosa; this may present as a contact or “kissing” ulcer (► Fig. 18.1, ► Fig. 18.2, ► Fig. 18.3, ► Fig. 18.4, ► Fig. 18.5).



► **Fig. 18.2 Kissing ulcer on the edge of the tongue.** Like the lip, the edge of the tongue may be affected due to its proximity to the lingual tooth surfaces. Animals with lesions of the movable mucosa are often in pain.



► **Fig. 18.1 Kissing ulcer on the right upper lip.** Cause and effect are sometimes directly interconnected due to anatomical proximity. A dog with dental calculus and a biofilm may develop ulcerative defects on the overlying lip mucosa. This is referred to as a kissing ulcer(). The large surface of the maxillary canine with its biofilm irritates the lip against it, so this is a common location for kissing ulcers. Contact mucosal inflammation generally occurs at the level of the occlusal plane.



► **Fig. 18.3 Examination of the kissing ulcer 3 weeks later.** After dental cleaning under anesthesia and then at home, the inflammation has decreased and the ulcers on the labial mucosa are healing 3 weeks later.





► **Fig. 18.4 Examination of the kissing ulcer 3 months later.** After 3 months, the lip mucosa is unremarkable except for slight redness. The gingivitis has also resolved.



► **Fig. 18.5 Examination of the kissing ulcer 6 months later.** In addition to toothbrushing, an antiseptic salve (e.g., preparations containing chlorhexidine) may decrease the local mucosal reactivity. However, the most important prophylaxis is active, ongoing oral hygiene at home, which should be performed daily if possible.

### 18.1.2 Eosinophilic Granuloma Complex

Eosinophilic granuloma complex describes three forms of skin lesions in cats, two of which affect the mouth: eosinophilic granuloma and eosinophilic ulcer. By definition, the complex is characterized by collagen degeneration and an inflammatory response with eosinophilia. However, electron microscopic studies have shown that the collagen fibrils themselves are intact and that between the fibrils degranulation of eosinophilic granulocytes occurs with granulomatous and ulcerative reactions. In general, this is a hyperplastic, superficial, and deep perivascular dermatitis or mucositis. The cause has not yet been identified, but an immunological process has been suggested.

Eosinophilic granuloma (► Fig. 18.6, ► Fig. 18.7) occurs primarily on the tongue and palate. The tissue mass is usually firm and has a papillomatous surface with white gingival stippling. Young animals are particularly affected.

Eosinophilic ulcers (► Fig. 18.8, ► Fig. 18.9) are found particularly on the upper lip and can occur unilaterally or bilaterally. The animals do not show signs of pain or itching.

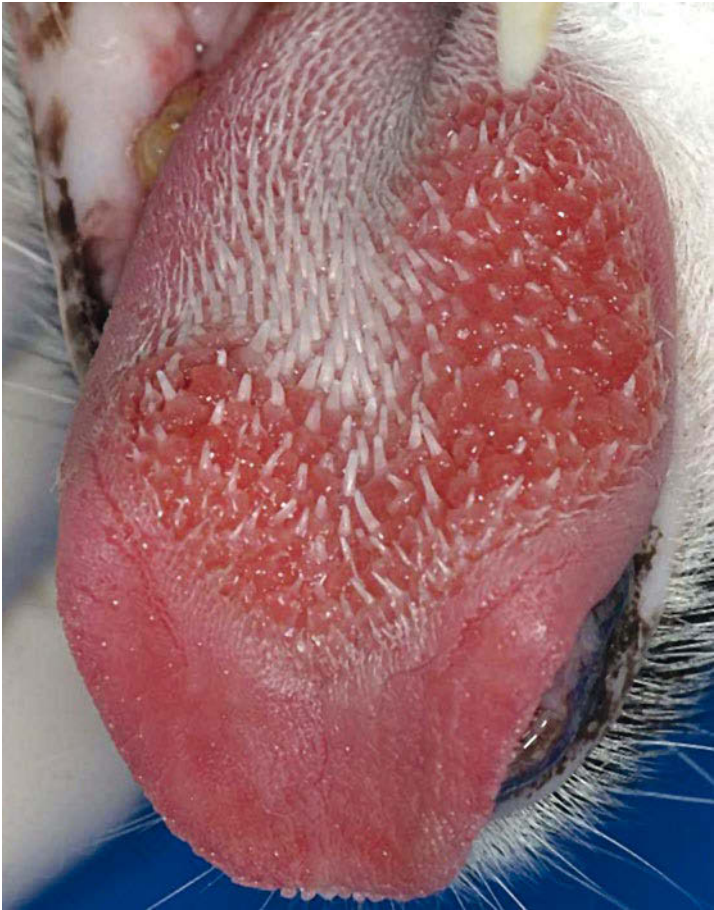
The condition is diagnosed based on the clinical examination, histopathological verification, and in some cases, a blood test.

Prednisolone is the primarily immunosuppressant treatment given at a dosage of 1 to 2 mg/kg body weight 1 to 2 times a day.



► **Fig. 18.6 Eosinophilic granuloma on the tongue.** Eosinophilic granuloma at the caudal part of the tongue can impair eating and swallowing. Surgical excision is indicated only with severe impairment. Otherwise, drug therapy usually offers sufficient remission.

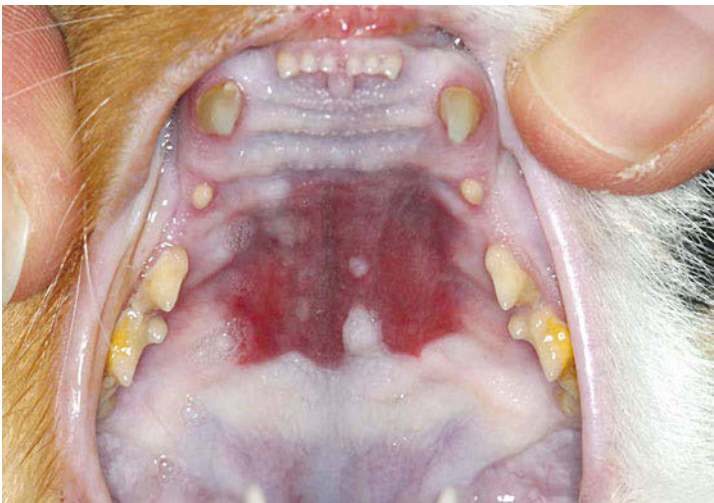




► **Fig. 18.7 Eosinophilic glossitis.** In addition to a genuine granuloma, the condition may also present as a diffuse mucositis.



► **Fig. 18.9 Eosinophilic ulcers on the lips.** Unilateral or bilateral tissue defects on the upper lip are a classic clinical sign of feline eosinophilic granuloma complex. These ulcers differ from mechanically-induced lesions from the cusps of the mandibular canine teeth because these mechanically induced lesions often occur after extraction of the maxillary canine teeth.



► **Fig. 18.8 Eosinophilic ulcer on the palate.** A palatal ulcer is susceptible to injury due to the cat's rough lingual papillae, which can cause bleeding that is difficult to stop. Drug therapy to reduce inflammation is crucial to avoiding mechanical injury.



### 18.1.3 Systemic Lupus Erythematosus (SLE)

Systemic lupus erythematosus (SLE) is an autoimmune disease in which autoantibodies referred to as antinuclear antibodies (ANA) target the body's own cellular nuclei, potentially affecting the skin and organs depending on severity. The main diagnostic methods are biopsy and laboratory testing. In the dog discussed below (► Fig. 18.10, ► Fig. 18.11, ► Fig. 18.12, ► Fig. 18.13, ► Fig. 18.14, ► Fig. 18.15), biopsies and ANA testing confirmed the diagnosis of SLE. This dog had oral abnormalities and poor health. No further damage to the organs was confirmed.



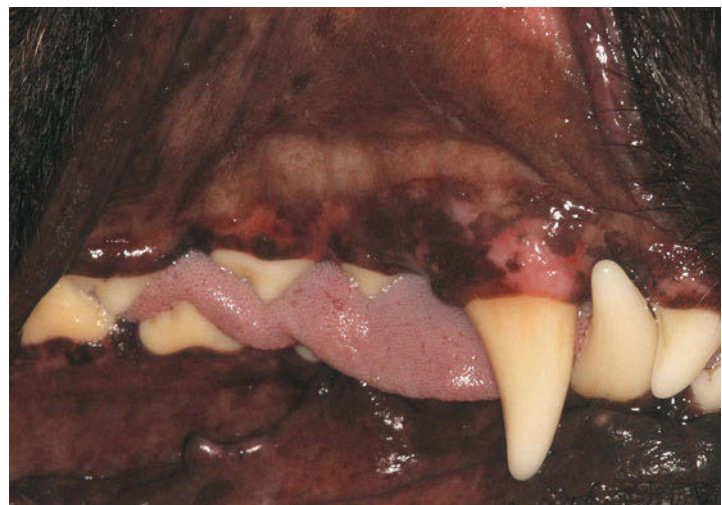
► Fig. 18.10 Systemic lupus in the right maxilla. The gingiva is bright red due to severe inflammation, and it bleeds, coloring the plaque red.



► Fig. 18.12 Systemic lupus, palate. The palatal mucosa is also involved, with red stippling interrupted by darker pigmented areas.



► Fig. 18.11 Systemic lupus in the left maxilla. The gingival area is especially red, while the loose oral mucosa appears normal.



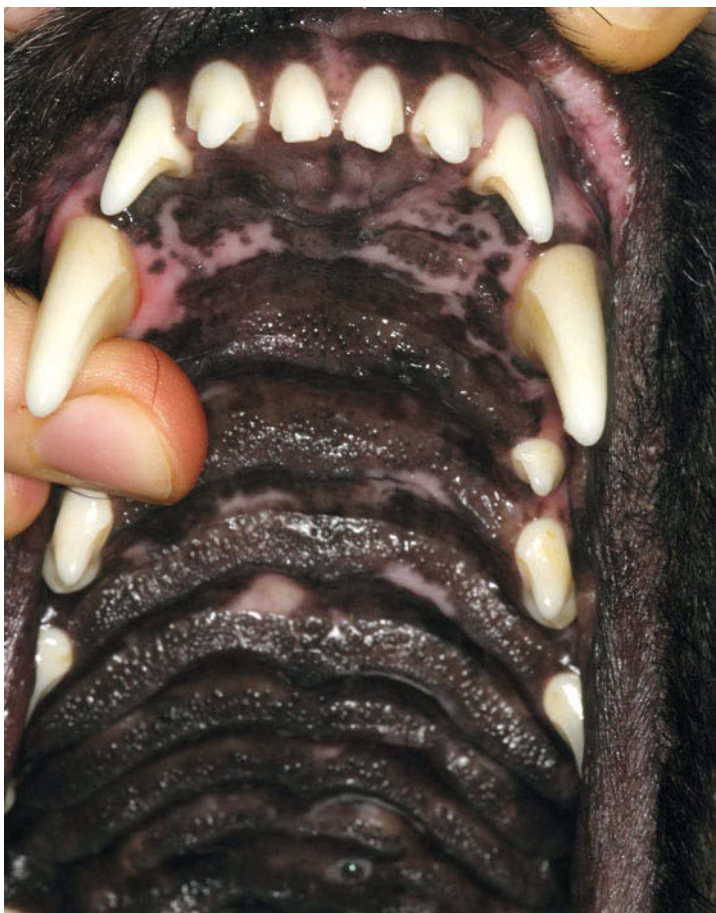
► Fig. 18.13 Follow-up examination of a dog with systemic lupus 8 weeks later, right maxilla. After 8 weeks of drug therapy (doxycycline, prednisolone and nicotinamide), only slight redness of the gingiva remains.

The treatment included prednisolone (1 mg/kg BW twice daily), nicotinamide (500 mg twice daily) and doxycycline (300 mg twice daily).





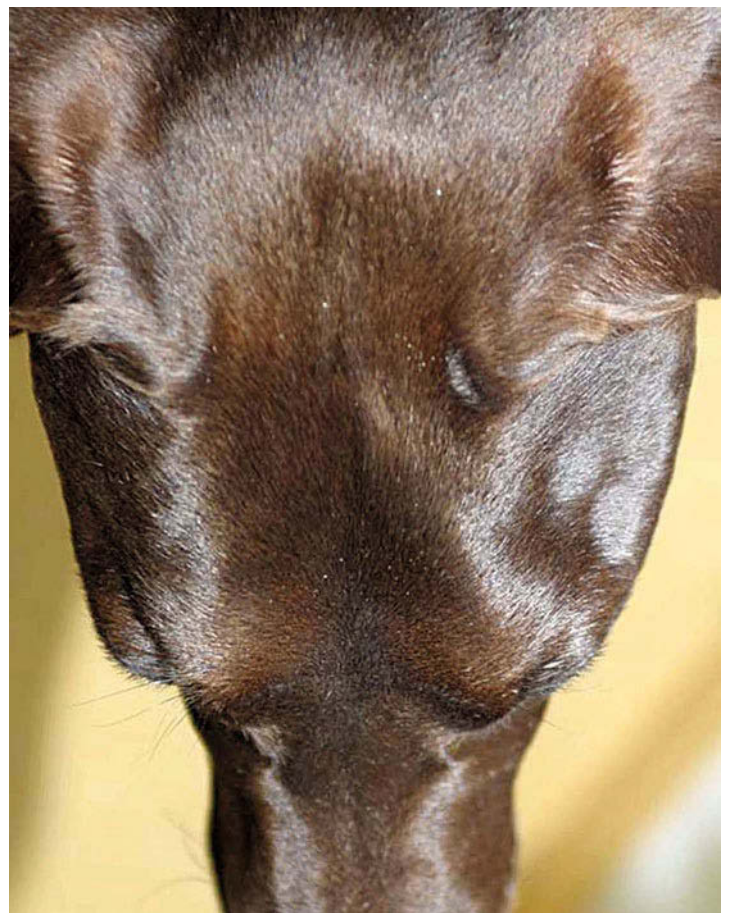
► Fig. 18.14 Follow-up examination of a dog with SLE 8 weeks later, left maxilla.



► Fig. 18.15 Follow-up examination of a dog with SLE after 8 weeks, palate. The palatal mucosa is nearly completely uninflamed. Doxycycline and prednisolone were discontinued, and nicotinamide was reduced to 100 mg twice daily. This medication sustained the normal oral condition.

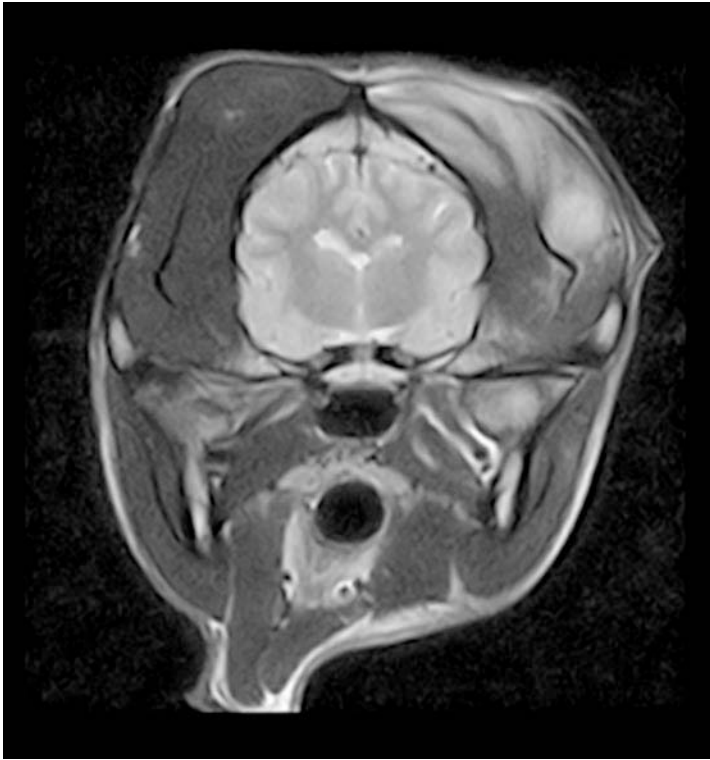
#### 18.1.4 Eosinophilic Myositis

Eosinophilic myositis, also known as masticatory myositis, is caused by antibodies to 2M muscle fibers, which are found exclusively in the masticatory muscles. The cause is still unknown. Both hereditary and exogenous causes have been suggested. The death of the muscle fibers initially causes swelling of the affected area. Muscle atrophy then occurs (► Fig. 18.16, ► Fig. 18.17, ► Fig. 18.18). The initially painful restriction of jaw opening in the acute phase increases as the muscle atrophies. The condition is diagnosed using computed tomography or magnetic resonance imaging to observe the remodeling processes in the muscle tissue and a histological examination of tissue samples from the affected muscles. In most cases (85%) the autoantibodies to 2M muscle fibers can be detected in the blood. Prednisolone is the standard treatment. After an initial dose of 2 mg/kg body weight twice daily, the dose is minimized.



► Fig. 18.16 Atrophy of the left masticatory muscles in a dog with eosinophilic myositis. After the acute symptoms subside, the affected masticatory muscles start to atrophy. This can occur unilaterally or bilaterally. In this dog, atrophy of the masticatory muscles is seen on the left side.





► **Fig. 18.17 Eosinophilic myositis in a sagittal MRI section.** Magnetic resonance imaging (MRI) shows the muscle remodeling process. The left temporal muscle is particularly affected. The muscles are atrophied, with flattening of the silhouette.



► **Fig. 18.18 Eosinophilic myositis in a coronal MRI section.** The coronal section illustrates how the temporal muscle swelling in the acute phase can cause exophthalmos.

### 18.1.5 Lip Fold Dermatitis

Breeds with pendulous lips and skin folds can develop inflammation of the lower lips. The lip fold is ideal for creating a new warm, protected microclimate with saliva, hair and food; longer hair contributes to it. The condition is more prevalent in some breeds, such as the Cocker Spaniel. The origin and progression of lip fold dermatitis appear to be determined more by anatomy than by an immunological aberration (► Fig. 18.19, ► Fig. 18.20, ► Fig. 18.21, ► Fig. 18.22, ► Fig. 18.23). If hygienic measures including thorough cleaning and oral hygiene fail to eliminate the inflammation, the situation can be remedied using cheiloplasty. The inflamed tissue in the fold is resection along the entire length of the lip and the defect sutured. Tightening the lip eliminates the pockets of contamination.



► **Fig. 18.19 Lip fold dermatitis on the right side.** After the right lower lip is shaved, the full extent of this Cocker Spaniel's dermatitis is visible. The fold of concern must be pulled apart to recognize the full extent. The skin is very red, inflamed, and swollen.



► **Fig. 18.20 Lip fold dermatitis on the left side.** The predisposing anatomical features and skin response are even more striking on the left side.





► **Fig. 18.21 Lip fold dermatitis on the left side.** The skin folds are in constant contact, causing inflammation. Cheiloplasty with resection of the inflamed skin and lip tightening is performed bilaterally, eliminating the folds.



► **Fig. 18.22 Examination of the lip fold dermatitis on the right side 6 months later.** The lips are healthy after 6 months. No signs of inflammation remain, and the formerly affected parts of the lips no longer show any adhesions or folds.



► **Fig. 18.23 Examination of lip fold dermatitis on the left side after 6 months.** Despite the new development of slight folds, the dermatitis did not recur.

## 18.2

### Trauma

Dogs playing with sticks are prone to oral trauma from stick injuries. In addition to stick injuries, trauma can include pieces of blunt wood caught between the teeth, cuts, and wood particles penetrating the oral mucosa as far back as the pharynx or below the tongue. Hunting dogs may injure the mouth in the heat of the chase.

#### 18.2.1 Stick Injury to the Palate

Normally, carrying a stick does not lead to injury. However, the illustrations below show the risks of a dog fetching a stick (► Fig. 18.24, ► Fig. 18.25, ► Fig. 18.26, ► Fig. 18.27, ► Fig. 18.28, ► Fig. 18.29).



► **Fig. 18.24 Defect of the palatal mucosa after a stick injury.** When a dog bites a stick, the cutting action of the carnassial teeth may cause the center of the stick to become wedged between the maxillary carnassial teeth. The dog may behave abnormally as it tries to expel the foreign body. In many cases, the dog cannot expel the stick and accepts the situation, with the stick remaining firmly wedged in the palatal mucosa between the maxillary carnassial teeth. In this dog, the injury was not immediately detected. The dog had increasingly bad breath, and the piece of wood was discovered during examination and removed. The palate shows a healing mucosal defect between the two carnassial teeth. The mucosa still shows signs of the removed foreign body.





► **Fig. 18.25 Palatal defect at the maxillary right carnassial tooth.** Impacted foreign material and a purulent exudate can still be observed near the gingival margin, palatal to the maxillary right carnassial tooth.



► **Fig. 18.27 Fractured cusp of tooth 208.** In addition to calculus, plaque and gingivitis, the maxillary left carnassial tooth has a fractured cusp. The plaque conceals the exposed pulp.



► **Fig. 18.28 Radiograph of the region around tooth 108.** The radiograph shows the impact of the long amount of time that the stick was lodged between the carnassial teeth. The furcation area exhibits significant bone loss. Clinically, a periodontal probe can fully penetrate the furcation.



► **Fig. 18.26 Palatal defect at the maxillary left carnassial tooth.** A similar mucosal defect appears palatally to the maxillary left carnassial tooth. This one contains wood fragments.

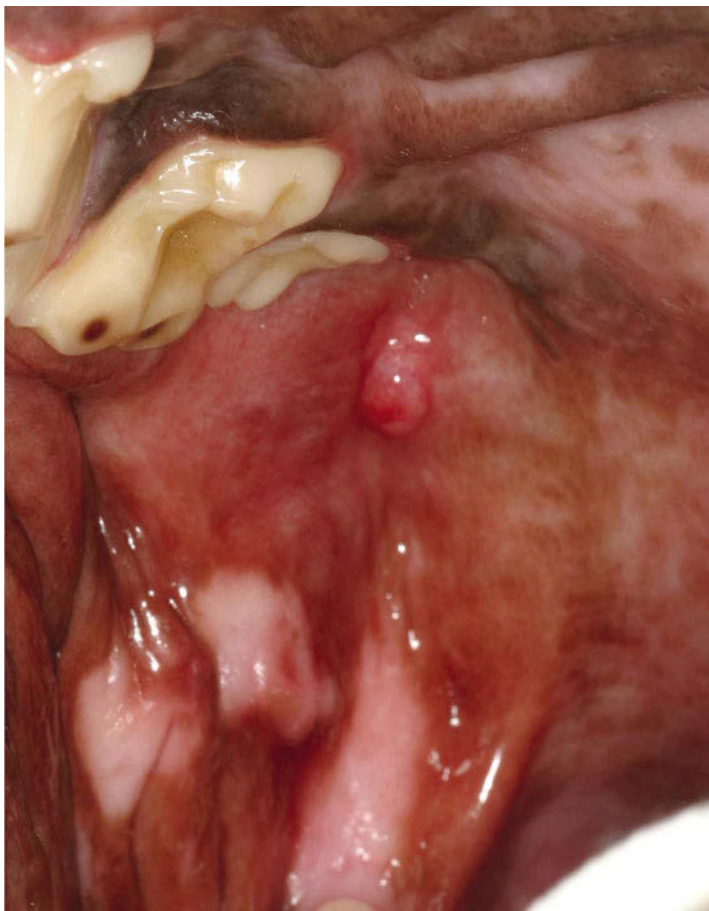


► **Fig. 18.29 Radiograph of the region around tooth 208.** In addition to damaging the furcation, the tooth fracture has led to involvement of the pulp. High-grade osteolysis has occurred periapically on the distal root, and root resorption is also observed on the distal surface. The maxillary left carnassial tooth is extracted. The maxillary right carnassial tooth is not treated but the owner is shown how to care for it.

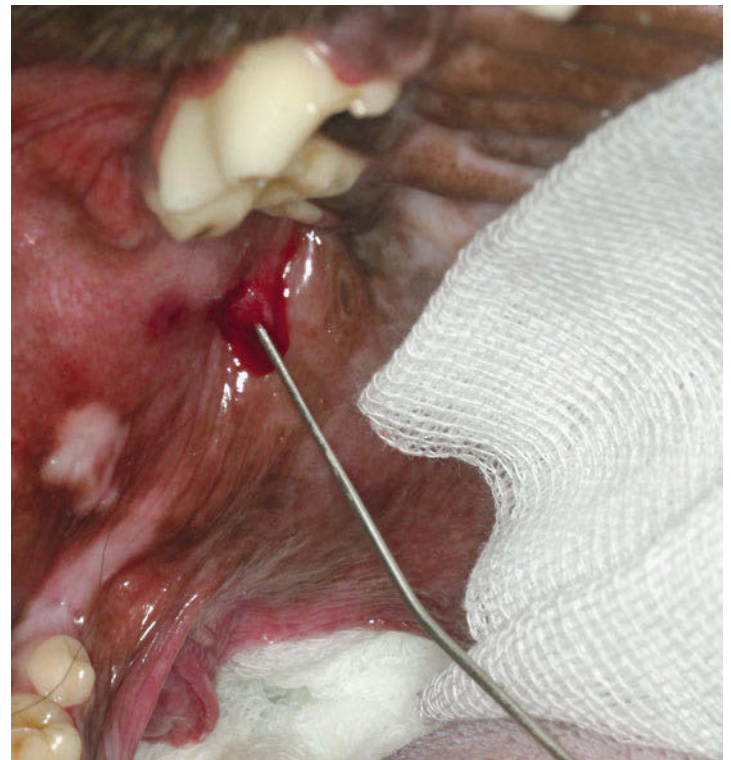


### 18.2.2 Fistula Formation after a Stick Injury to the Palate

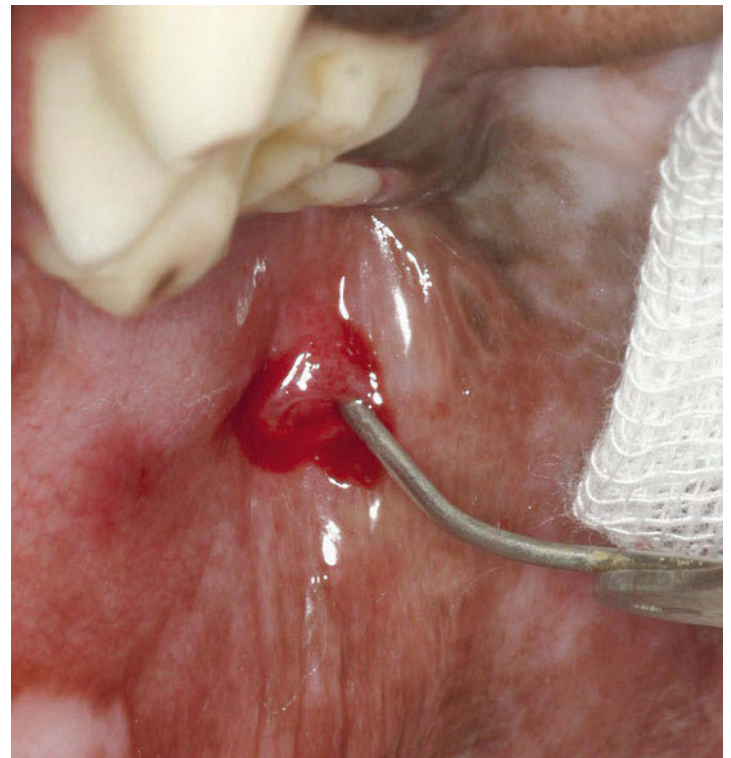
Diagnosing the condition is much more difficult if the trauma-induced inflammation occurs further caudally and abnormal behavior or signs of pain do not occur until much later. Poor appetite and painful chewing or yawning are often the only signs of trauma. Clinically, jaw opening may be painful. The orbital floor may be less resilient due to a foreign body penetrating the orbital area via the oral cavity. In many cases the injury to the oral cavity can be found by meticulously examining all the mucosa with the patient under general anesthesia (► Fig. 18.30, ► Fig. 18.31, ► Fig. 18.32, ► Fig. 18.33, ► Fig. 18.34).



► **Fig. 18.30** **Fistula opening in the right retromolar space.** In a dog with pain on opening the mouth, a radiograph of abraded molars did not show any conspicuous bony reactions. The right orbit is less resilient because the orbital floor has hardened due to a possible foreign body and inflammation. A fistula opens in the right retromolar space. In this area, the bony support is missing. The trauma to the mucosa causes a path to form toward the base of the skull and the orbit.

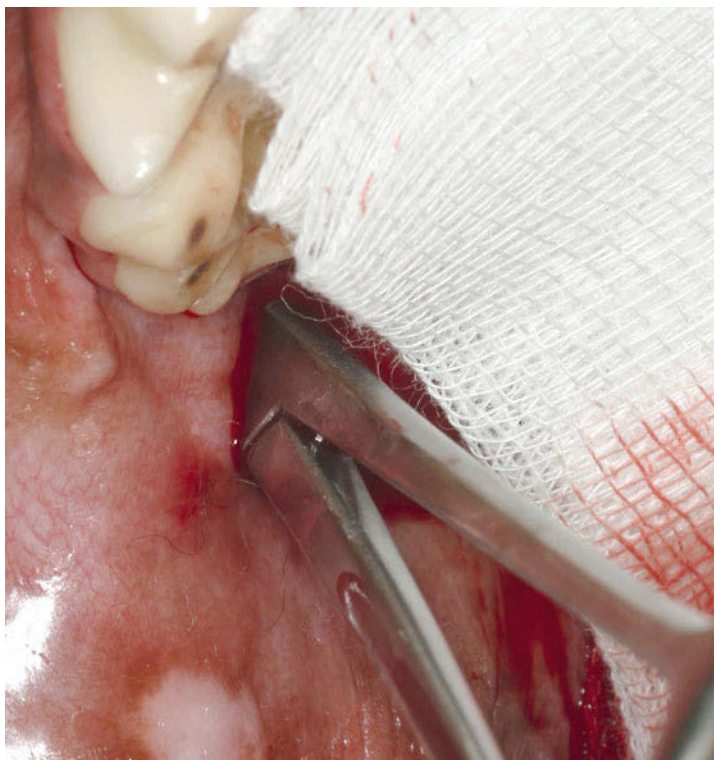


► **Fig. 18.31** **Probe at the fistula opening.** A Bowman probe is placed at the fistula opening.



► **Fig. 18.32** **Probe introduced in the fistulous tract.** The probe can be inserted several centimeters into a fistulous tract without applying any pressure.





► **Fig. 18.33 Dilating the wound cavity.** The fistula opening is excised and the fistulous tract is bluntly dilated.

### 18.2.3 Avulsion of the Skin over the Mandible after an Accident

Trauma from a car or a fight with another animal can be severe (► Fig. 18.35, ► Fig. 18.36, ► Fig. 18.37, ► Fig. 18.38, ► Fig. 18.39, ► Fig. 18.40).



► **Fig. 18.35 First aid attempted for avulsion of the skin over the mandible.**

This German Hunting Terrier injured its mandible when attempting to flush a badger from its burrow. The skin of the mandible was completely torn off. Repositioning of the detached skin was unsuccessful.



► **Fig. 18.34 Exploring the wound cavity with the fingers.** The wound cavity can be explored with the fingers to check for an embedded foreign body. In many cases, however, the stick that had penetrated the space is immediately pulled out, so the original cause of the lesion is no longer apparent. A wide drainage area and antibiotic and anti-inflammatory drug therapy can often heal the fistula.

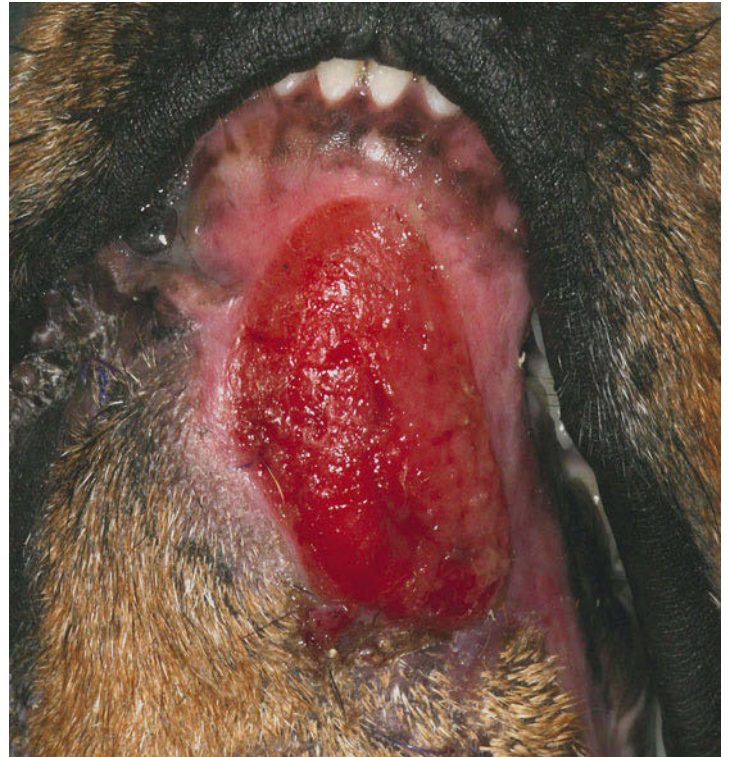


► **Fig. 18.36 Appearance of the avulsion after cleaning.** First, the necrotic areas of the skin were debrided and the wound was thoroughly cleaned. Removing the necrotic areas exposed a large wound area that was left to heal by open granulation.

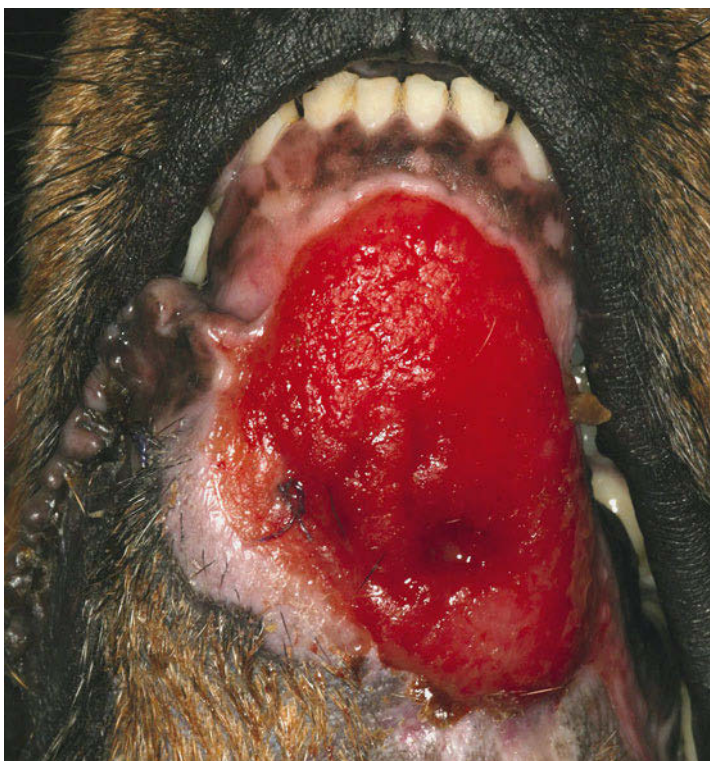




► **Fig. 18.37 Frontal view of the avulsion.** The raised edges are signs of the inflammatory response of the wound, which is no longer fresh. Sutures are placed on the side of the oral cavity to secure the free skin edges in the absence of soft tissue on the mandibular bone.



► **Fig. 18.39 Examination of the avulsion after 4 weeks.** The granulation area is continually becoming smaller and the former wound edges are receding.



► **Fig. 18.38 Examination of the avulsion 2 weeks later.** After 2 weeks, bright red fresh granulation tissue is observed. Epithelialization is beginning from the peripheral areas.



► **Fig. 18.40 Examination of the avulsion 7 weeks later.** After 7 weeks, the area is nearly completely free of inflammation. Salivation increases because part of the lip is missing. Otherwise, no functional impairment is observed.



## 19 Oral Masses

Increased tissue volume is suggestive of a mass. Half the masses in dogs and 90% in cats are caused by a neoplasm.

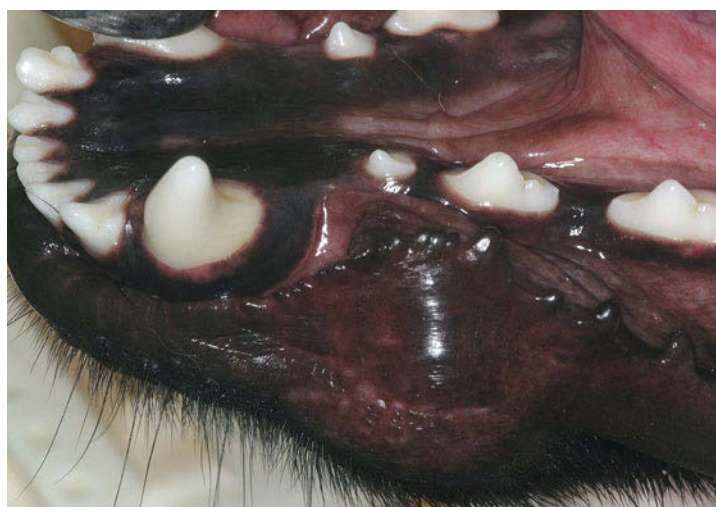
### 19.1

### Cysts

Dogs are often missing teeth. Clinical examination does not reveal whether the tooth has been retained in the jaw or has in fact never developed; this is a risky situation. Retained teeth may cause a cyst to develop. The tooth is located inside this cyst. The epithelium of a follicular cyst is formed from the enamel epithelium. This painless mass, which is filled with liquid, grows osmotically and may escape the dog and the owner's attention until the clinical signs of bone and root resorption become apparent. For example, the mandibular first premolar is often underdeveloped due to the phylogenetic tendency for the number of teeth to be reduced or because it is congenitally absent. If abnormal morphology, root growth or tooth inclination prevent the tooth from erupting, the owner may notice or the dog's bite may weaken. However, if the dog is not a guard dog, for example, or does not play with sticks or dog chews, the disease can go unnoticed until severe swelling occurs. For this reason, a missing tooth should always be radiographed to confirm its presence or absence in the jaw.

#### 19.1.1 Follicular Cyst in the Mandible Near a Partially Retained Premolar

The following figures (► Fig. 19.1, ► Fig. 19.2, ► Fig. 19.3, ► Fig. 19.4, ► Fig. 19.5, ► Fig. 19.6, ► Fig. 19.7, ► Fig. 19.8, ► Fig. 19.9, ► Fig. 19.10) present the findings and approach for a follicular cyst in the mandible near a partially retained premolar.



► **Fig. 19.1** Partially retained mandibular premolar in swollen gingiva. This dog shows increased swelling around the mandibular left first premolar. Compared to the mandibular right first premolar, the left one has not reached its full height and is therefore considered partially retained.



► **Fig. 19.2** Radiograph of the cyst around tooth 305, mesial. A large, round translucent area surrounds the first premolar. The second premolar is also fully involved. The lesion extends into the area of the canine root.

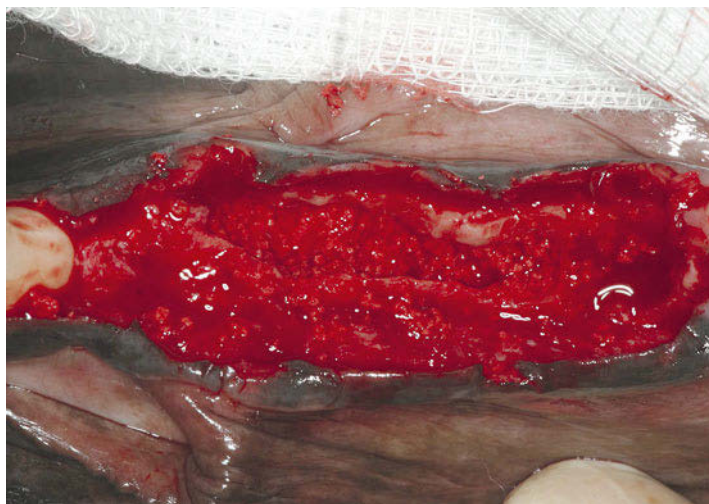


► **Fig. 19.3** Radiograph of the cyst around tooth 305, distal. The translucency of the primary cavity extends distally with somewhat greater radiopacity, into the area of the roots of the third premolar.

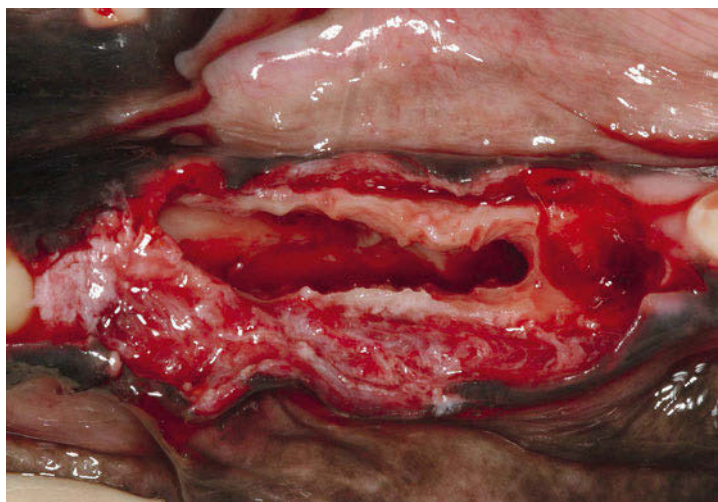




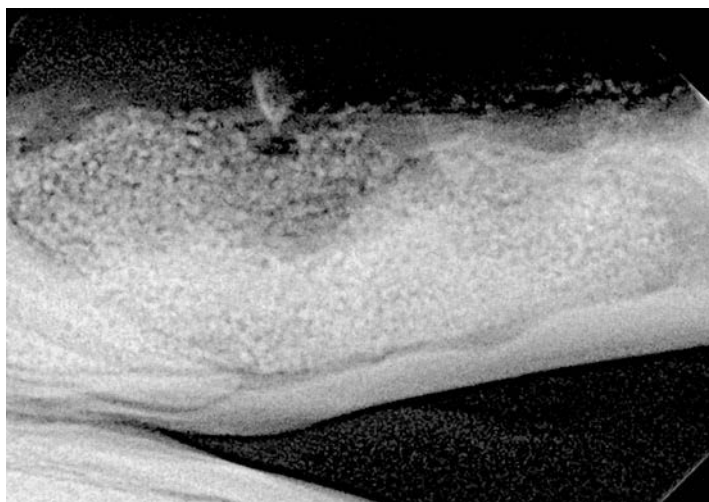
► **Fig. 19.4 Buccal mucoperiosteal flap.** A buccal mucoperiosteal flap is created to reveal the defect.



► **Fig. 19.7 Placed bone replacement material.** The entire cyst cavity is filled with bone replacement material.



► **Fig. 19.5 Visualization of cyst.** After extraction of the teeth, which are easy to luxate, the entire cyst cavity is visible. The epithelial lining of the cyst is removed with curettage.



► **Fig. 19.8 Radiograph of the bone replacement material.** The position of the bone replacement material is verified by radiography.

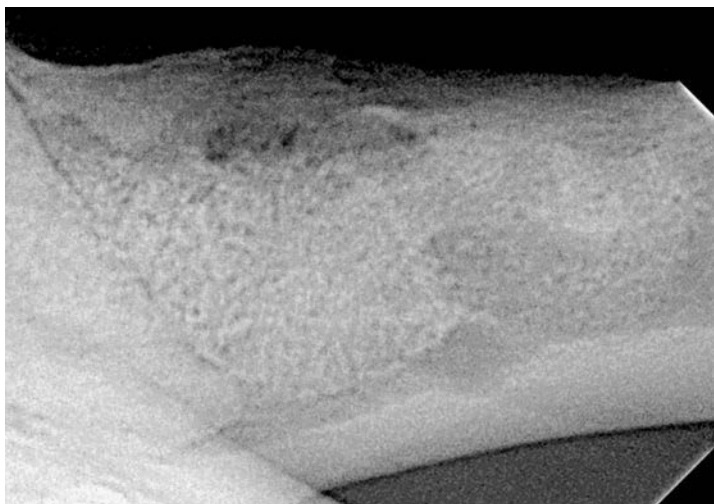


► **Fig. 19.6 Tricalcium phosphate in a dappen dish.** Tricalcium phosphate is used to fill the bony defect. The material becomes a gel-like, movable medium when mixed with blood, which eases handling and allows addition of bone growth factor. When inserted in the cyst cavity, the material's porous character serves as a matrix for new bone formation.



► **Fig. 19.9 Closure of the cyst cavity.** Lingual and buccal mucosa is sutured over the cyst cavity. The high retained alveolar walls allowed the replacement material to be securely packed into the bony defect. Retained walls improve the prognosis of the bone replacement material.





► **Fig. 19.10 Follow-up radiograph 10 weeks later.** A follow-up radiograph is taken after 10 weeks. The material is in place, and no new cystic changes are seen.



► **Fig. 19.12 Radiograph of retained tooth 405 with a follicular cyst.** The radiograph shows a fully developed and retained mandibular first premolar within a translucent cavity.

### 19.1.2 Symmetrical Follicular Cysts in the Mandible

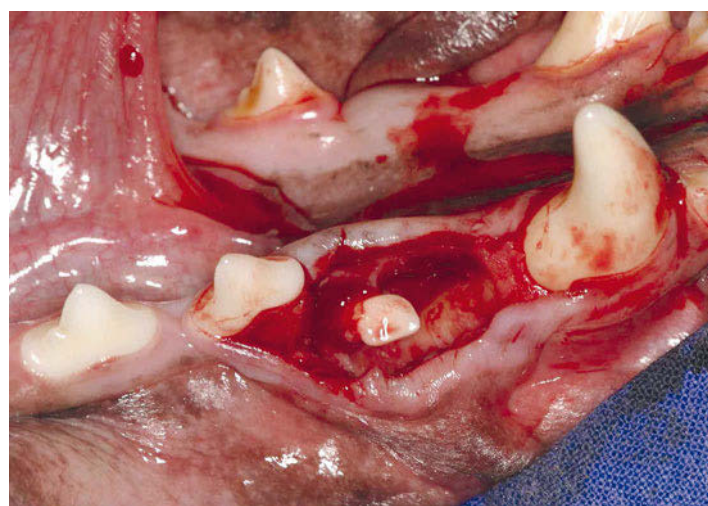
While cyst formation around a retained first premolar is common in brachycephalic breeds, dolichocephalic breeds may also be affected. A two-year-old Saluki was presented for symmetrical swelling of the mandible caudal to the mandibular canine teeth (► Fig. 19.11, ► Fig. 19.12, ► Fig. 19.13, ► Fig. 19.14, ► Fig. 19.15, ► Fig. 19.16, ► Fig. 19.17, ► Fig. 19.18, ► Fig. 19.19, ► Fig. 19.20, ► Fig. 19.21, ► Fig. 19.22, ► Fig. 19.23, ► Fig. 19.24, ► Fig. 19.25, ► Fig. 19.26, ► Fig. 19.27, ► Fig. 19.28).



► **Fig. 19.13 Incision in the cyst area.** Incision of the alveolar ridge causes immediate drainage of a clear cystic fluid.

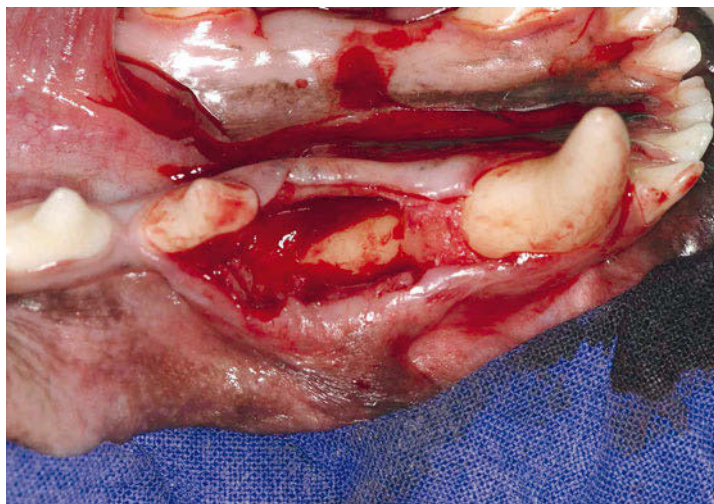


► **Fig. 19.11 Swelling at the site of missing tooth 405.** A round, taut, and fluctuant swelling has taken the place of the mandibular right first premolar.



► **Fig. 19.14 Exposing retained tooth 405.** The exposed retained premolar is "floating" in the cyst lumen and is not embedded in the periodontium.

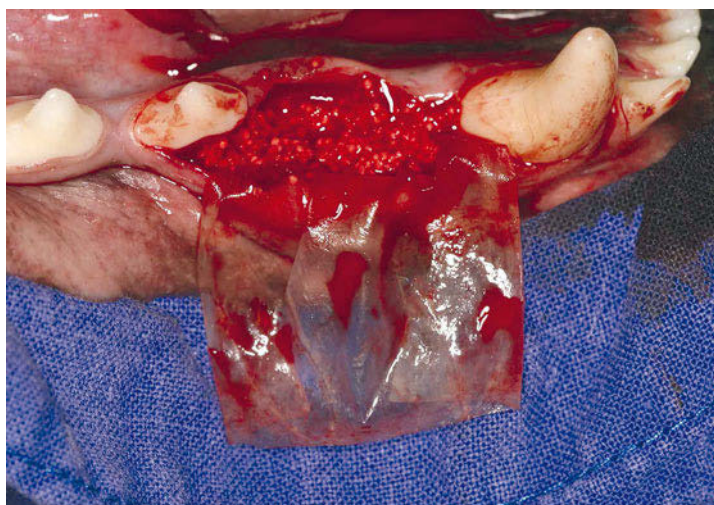




► **Fig. 19.15** Appearance of the cyst lumen after extraction of tooth 405. The cavity itself extends to the root of the carnassial tooth.



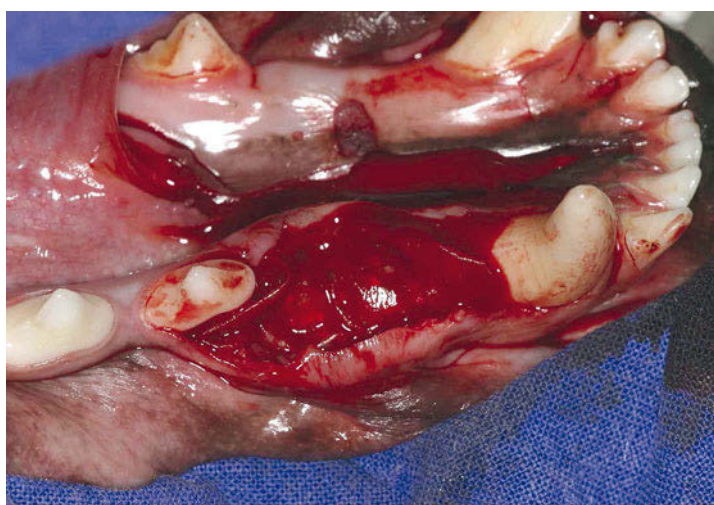
► **Fig. 19.18** Intraoperative radiograph after placement of the bone replacement material. The radiograph shows a completely filled bone cavity.



► **Fig. 19.16** Filling the cyst lumen with bone replacement material. After extraction of the retained tooth and curettage of the epithelial lining of the cyst, the defect is filled with bone replacement material (tricalcium phosphate). To ensure smooth integration of the bone replacement material, it is covered with resorbable membrane (BioSist), which provides an additional layer on the jawbone and below the gingiva.



► **Fig. 19.19** Closure of the incision around tooth 405.

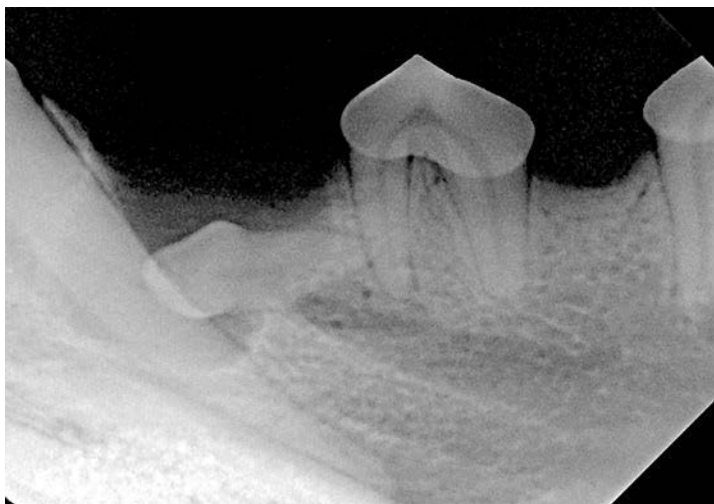


► **Fig. 19.17** Covering bone replacement material with a membrane. After the membrane is placed buccally, it is folded over the defect and anchored below the lingual gingiva.

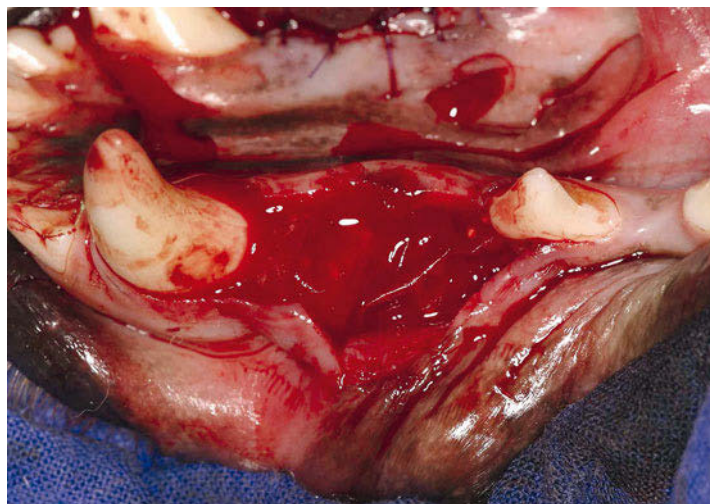


► **Fig. 19.20** Swelling around missing tooth 305. The left side appears similar, with a missing first premolar and a nodular, fluid-filled swelling.

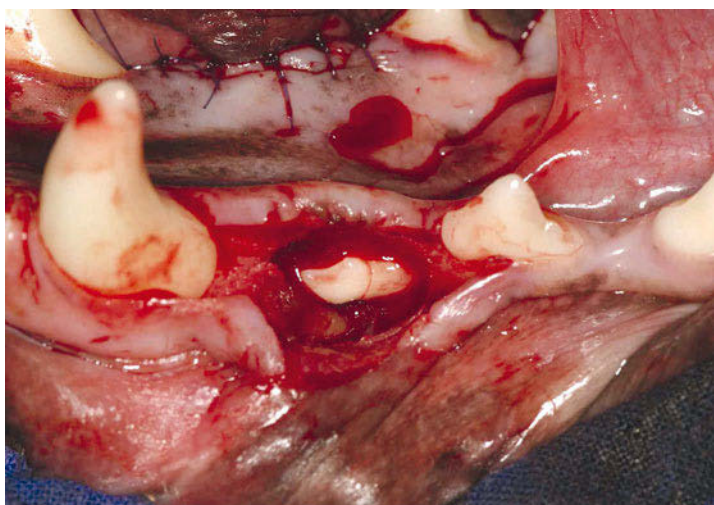




► **Fig. 19.21 Radiograph of retained tooth 305 with follicular cyst.** Retained tooth 305 in the cyst lumen is oriented mesiodistally and is unlikely to erupt into the oral cavity.



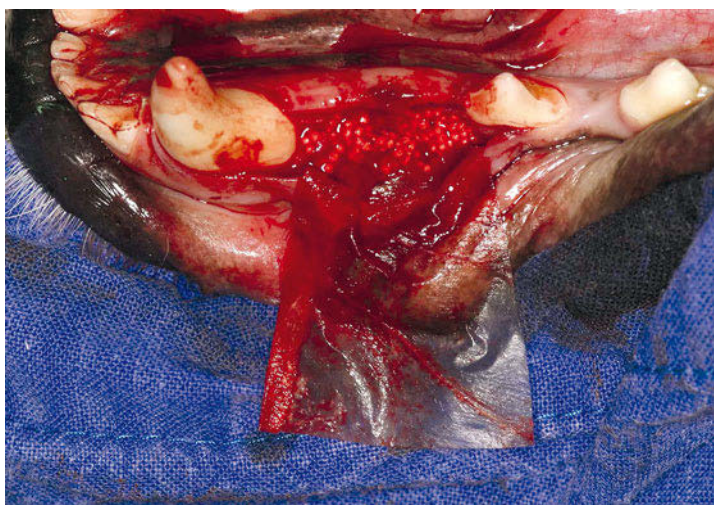
► **Fig. 19.24 Covering the bone replacement material with membrane.** The resorbable membrane provides an additional layer.



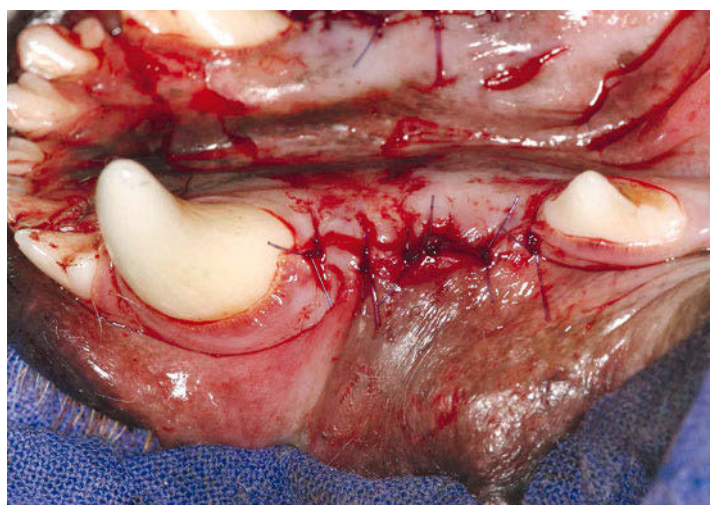
► **Fig. 19.22 Exposing retained tooth 305.** After buccal dissection, the retained tooth is visible in the cyst lumen.



► **Fig. 19.25 Intraoperative radiograph after placement of the bone replacement material.**



► **Fig. 19.23 Filling the cyst lumen with bone replacement material.** The tooth is extracted, the cyst epithelium is removed, and bone replacement material is inserted.



► **Fig. 19.26 Closure of the incision around tooth 305.**





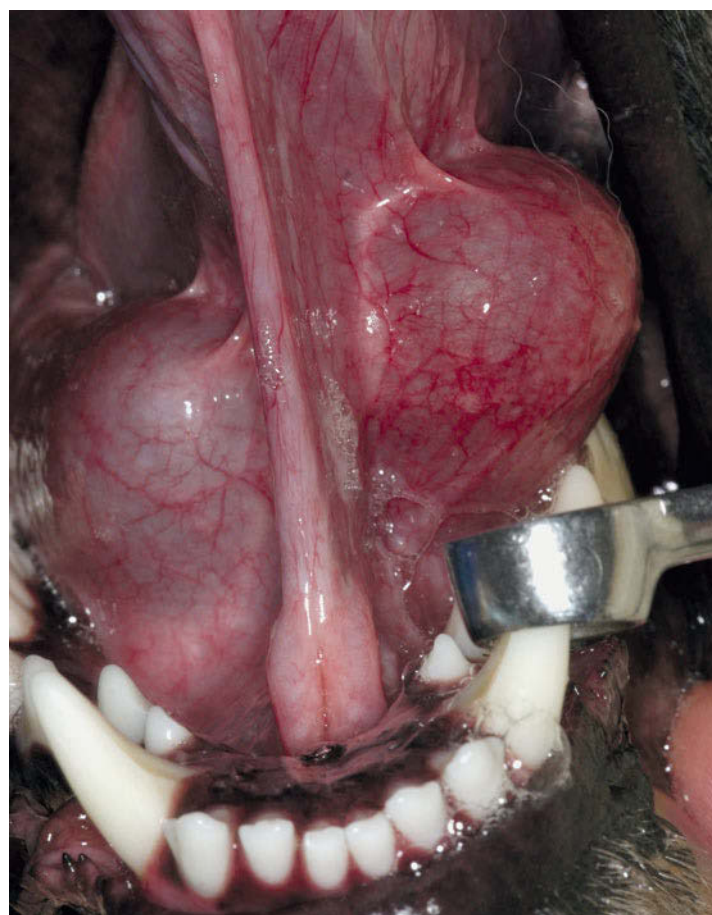
► **Fig. 19.27 Intraoperative radiograph of both premolar regions.** The radiograph of the jaw defects in both regions clearly shows the granular structure of the freshly placed bone replacement material.



► **Fig. 19.28 Follow-up radiograph of both premolar regions 2 years later.** After 2 years, the bone replacement material has been remodeled and is not reactive. The granular structure of the matrix tissue is being replaced by trabecular bone.

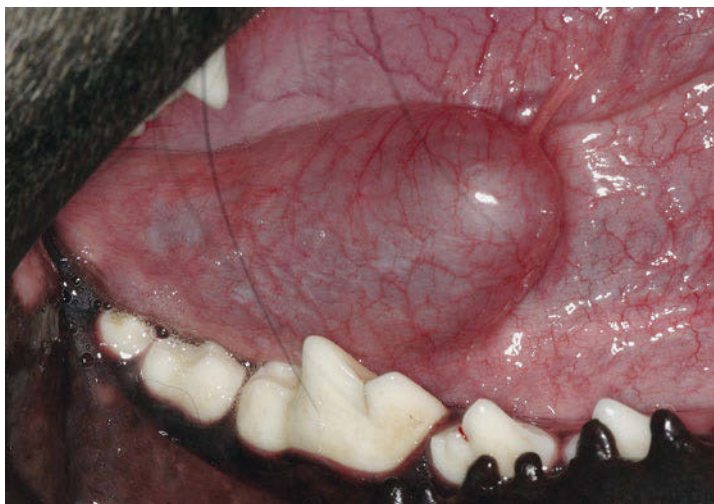
### 19.1.3 Symmetrical Ranula Formation

A symmetrical cyst may or may not be the result of a predisposition or an inflammatory process. However, symmetrical sublingual sialoceles, or ranula (► Fig. 19.29, ► Fig. 19.30, ► Fig. 19.31, ► Fig. 19.32, ► Fig. 19.33, ► Fig. 19.34, ► Fig. 19.35), is unlikely to be due to local unilateral trauma.



► **Fig. 19.29 Symmetrical ranula.** Symmetrical sublingual salivary cysts are less likely to be traumatic than idiopathic. In the sublingual space, symmetrical liquid-filled cysts can be seen on the left and right side.





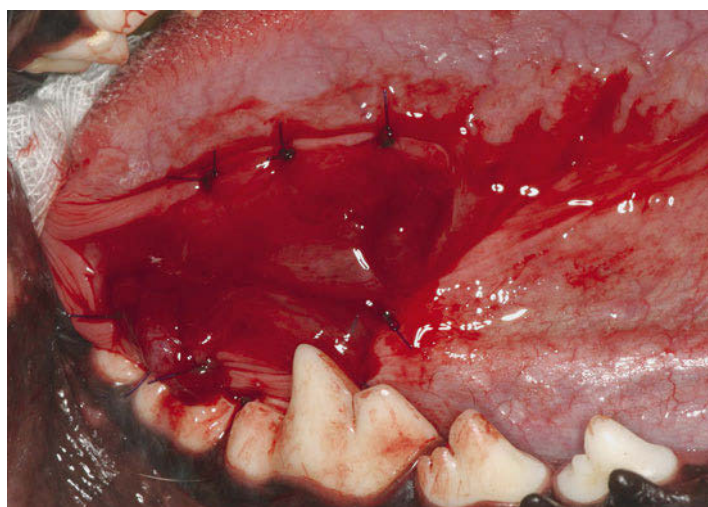
► **Fig. 19.30 Ranula on the right.** The cigar-shaped proliferation along the duct of the right mandibular gland suggests this gland's involvement in the ranula.



► **Fig. 19.32 Opened ranula on the right side.** A wide incision into the ranula allows the cyst to completely drain on the right side. If the ranula goes untreated, the wound edges would lie on top of each other, which might promote cyst recurrence.

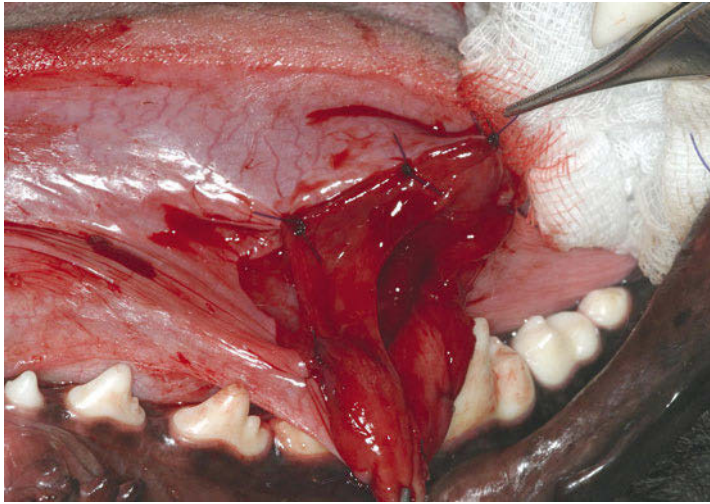


► **Fig. 19.31 Ranula on the left side.** The proliferation is similar on both sides. The entire tongue is lifted, making eating difficult. However, the animal shows no signs of pain.



► **Fig. 19.33 Marsupialization on the right side.** One treatment option is marsupialization. The cyst is sutured wide open to prevent closure and formation of a new cavity.





► **Fig. 19.34 Marsupialization on the left side.** The viscous fluid and the thickened wall of the normally very thin sublingual mucosa are apparent on the left side.

## 19.2

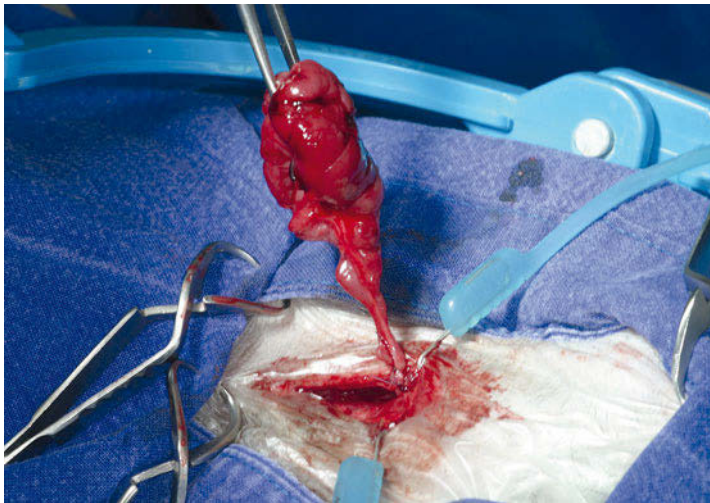
### Tumors

As animals age, they are increasingly prone to malignant oral tumors. Starting around 7 years of age, the incidence of squamous cell carcinoma and fibrosarcoma increases in dogs, and malignant melanoma is particularly prevalent in older dogs. In cats, squamous cell carcinoma is the most common type of tumor. Nine out of 10 oral masses in cats are malignant. In contrast, benign and malignant masses are nearly equal in dogs. For this reason, more in-depth diagnostics with radiography and biopsy may be required to inform treatment decisions.

The jaw may also show external swelling. Affected animals may show signs including hypersalivation, bleeding, difficulty eating, expressions of pain, or simply halitosis. However, the problems often go unnoticed for a long time. Many oral tumors are not discovered until they are too large to fully excise. The invasive tumor growth may require removal of large portions of the bone along with the tumor. The local process generally determines the disease course, with metastases playing a lesser role.

#### 19.2.1 Squamous Cell Carcinoma at the Mandibular Front Teeth of a Dog

Squamous cell carcinoma is the second most common oral tumor in dogs (► Fig. 19.36, ► Fig. 19.37, ► Fig. 19.38, ► Fig. 19.39, ► Fig. 19.40, ► Fig. 19.41, ► Fig. 19.42), with the average onset at 7 to 10 years of age.



► **Fig. 19.35 Excision of the right mandibular salivary gland.** If marsupialization alone does not prevent recurrence, the involved gland must be removed. The excision of the mandibular salivary gland, which is most often involved in a ranula, is made near the bifurcation of the external jugular vein. The gland is held in place with the fingers, and the overlying skin is resected with a rostrocaudal incision. The gland capsule is located and resected. The mandibular salivary gland is bluntly resected. The gland is mobilized caudally with an Allis clamp until the rostral part with the sublingual salivary gland is exposed. The afferent vessels are ligated and the gland is sectioned as rostrally as possible in the area of the duct after ligation. The wound is closed using capsulorrhaphy, a subcutaneous suture, and a cutaneous suture.

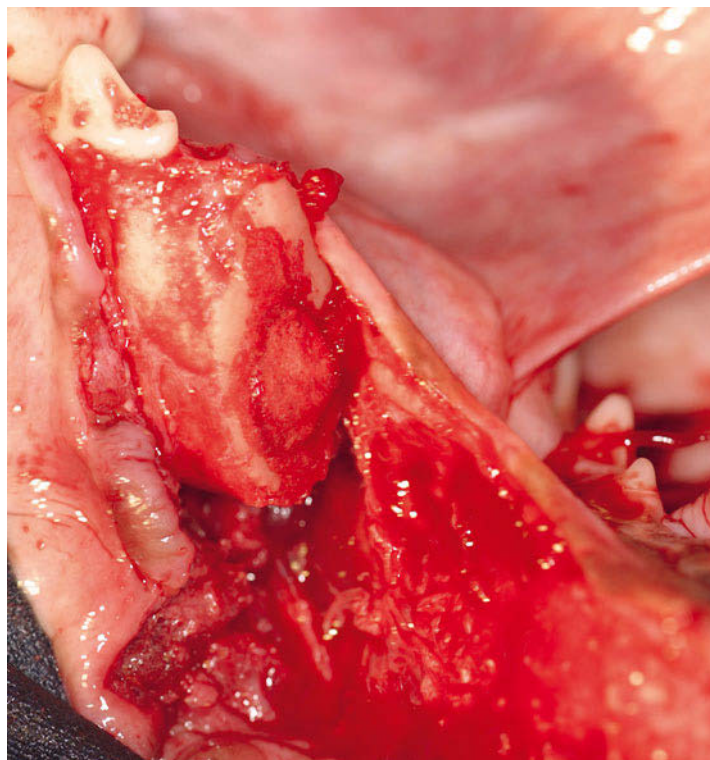


► **Fig. 19.36 Squamous cell carcinoma in a dog, mandibular right front teeth.** This is a classic presentation of squamous cell carcinoma in the mandibular front teeth of a dog: bumpy, bright red, brittle and prone to breakage. The mandibular right canine tooth is completely surrounded by the tumor.

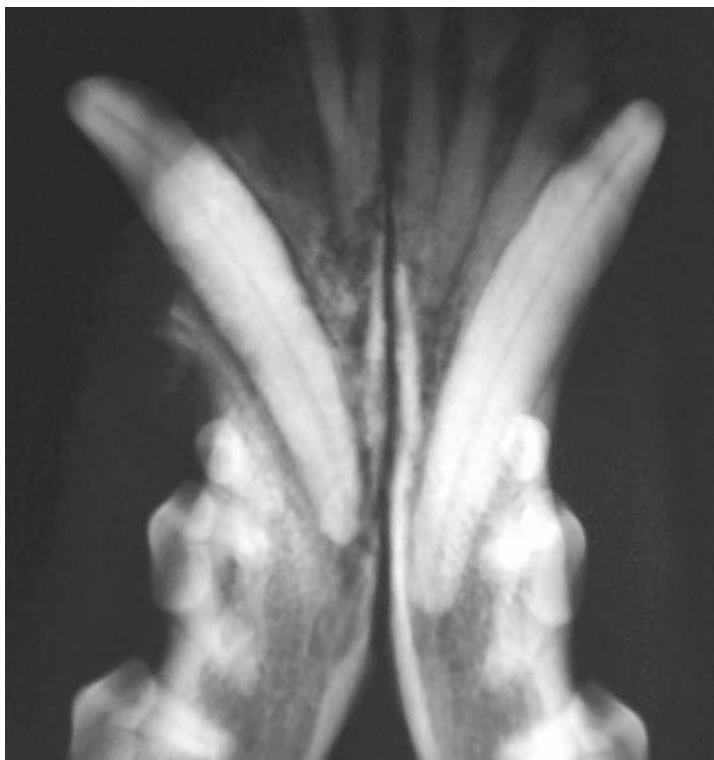




► **Fig. 19.37 Discolored mandibular right canine tooth.** The mandibular canine tooth surrounded by the tumor is discolored red because the pulp is involved.



► **Fig. 19.39 Rostral hemimandibulectomy on the right side.** A hemimandibulectomy is performed, which involves resection of the right mandible rostral in the symphysis and caudal near the second premolar. The inferior alveolar artery and vein are ligated. If ligation is not possible, the mandibular canal is closed by bone wax.



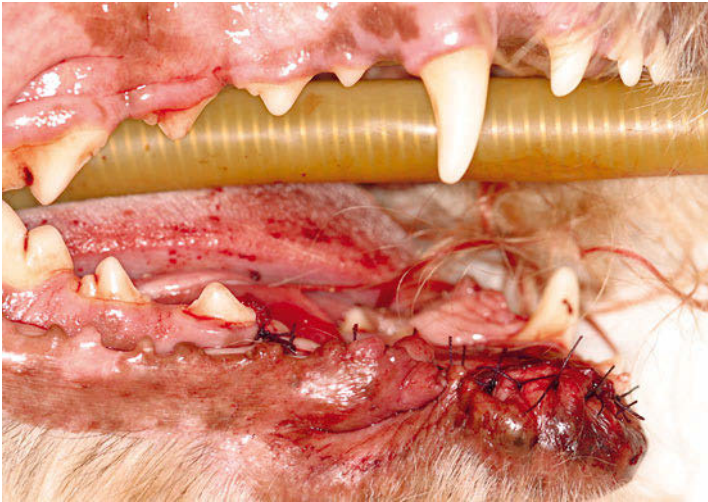
► **Fig. 19.38 Radiograph illustrating osteolysis of the mandibular front teeth.** Mandibular osteolysis surrounds the canine tooth. The resorption extends beyond the root tip, and the entire periodontal ligament space is widened.



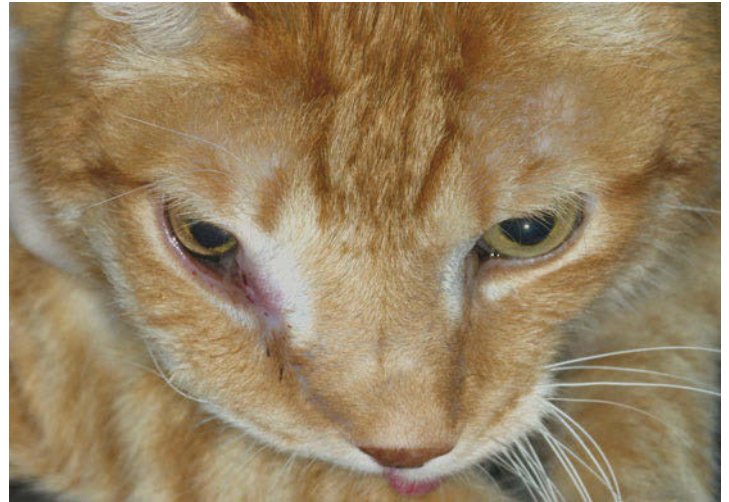
► **Fig. 19.40 Radiograph of the rostral hemimandibulectomy.** A radiograph verifies that the resection is sufficiently distant from the tumor. Resecting the mandible at the second premolar destabilizes the right and left mandible because the bodies no longer meet at the symphysis.

### 19.2.2 Squamous Cell Carcinoma in the Maxilla of a Cat

In cats, squamous cell carcinoma constitutes 70% of all tumors, making it the most prevalent feline tumor (► Fig. 19.43, ► Fig. 19.44, ► Fig. 19.45). The average age of onset in cats is approximately 10 years.



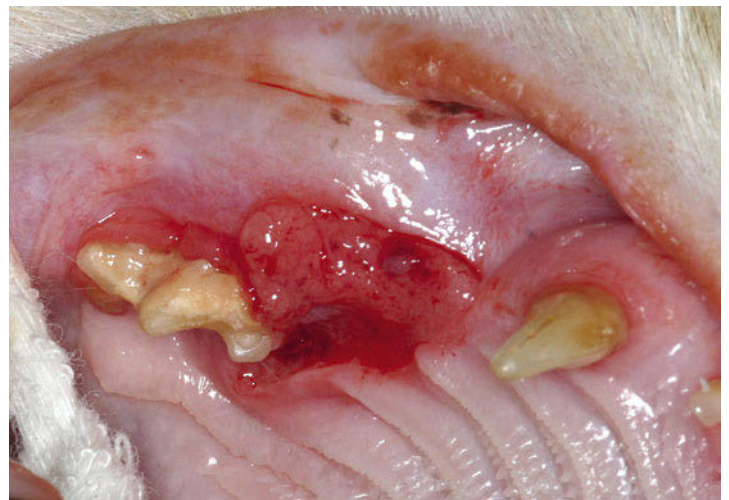
► **Fig. 19.41 Wound closure after hemimandibulectomy.** The wound edges are sutured securely, and excess soft tissue is removed. This promotes scarring, which compensates for the unbalanced dorsal tension of the right masticatory muscles and allows the mandible to close properly.



► **Fig. 19.43 Asymmetry of the maxilla in a cat.** The owner presented this cat due to the increasing asymmetry of the skull. The entire right maxilla is distended. The right orbit and eye are also involved.



► **Fig. 19.42 Follow-up 6 weeks later.** At the 6-week follow-up examination, wound healing is unremarkable, without any signs of recurrence. The dog is healthy and able to eat. Due to the lack of support from the mandibular right canine tooth, the tongue sticks out of the right side of the mouth.



► **Fig. 19.44 Squamous cell carcinoma in the right maxilla.** The part of the tumor in the oral cavity at the right maxilla does not account for the external swelling. Nevertheless, the mass is indeed squamous cell carcinoma that has already caused severe bony changes. Unfortunately, squamous cell carcinoma often develops very rapidly in cats, quickly becoming untreatable.





► **Fig. 19.45 Radiograph of the tumor region.** The radiograph shows the missing front premolars as well as extensive osteolysis. Because the tumor is advanced, definitive treatment is no longer possible. Treatment is restricted to palliative care until the local disease process requires euthanizing the animal.

### 19.2.3 Squamous Cell Carcinoma in the Mandible of a Cat

Cats are often able to conceal tumors until the disease is highly advanced. In many cases, the massive bone loss caused by the tumor is only seen on a radiograph (► Fig. 19.46, ► Fig. 19.47).



► **Fig. 19.46 Squamous cell carcinoma in the mandible of a cat.** The entire right body of the mandible is significantly distended. There are no superficial mucosal defects or typical signs of squamous cell carcinoma.



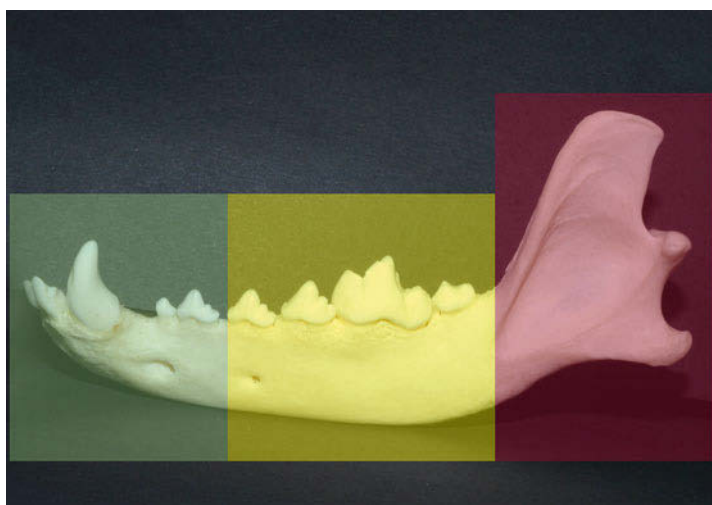
► **Fig. 19.47 Radiograph of the tumor region.** Complete osteolysis of the right body of the mandible is apparent in the radiograph. The clinical presentation fails to demonstrate the destruction of the mandible that the squamous cell carcinoma has already caused.

### 19.2.4 Diagram of Jaw Resection

When removing parts of one side of the jaw, rostral, central, and caudal hemimaxillectomy (► Fig. 19.48) and hemimandibulectomy (► Fig. 19.49) are the typical options. A complete mandibulectomy or complete hemimandibulectomy is less common.



► **Fig. 19.48 Maxillectomy.** The diagram shows the areas removed in various types of hemimaxillectomy: green (rostral hemimaxillectomy), yellow (central hemimaxillectomy), and red (caudal hemimaxillectomy).



► **Fig. 19.49 Mandibulectomy.** The areas removed in a hemimandibulectomy are shaded green (rostral mandibulectomy), yellow (central hemimandibulectomy), and red (caudal hemimandibulectomy).

### 19.2.5 Acanthomatous Ameloblastoma at the Caudal Body of the Mandible in a Dog

Acanthomatous ameloblastoma is a special type of oral mass. It is considered semimalignant because while it is locally invasive and destructive, it does not tend to metastasize. It is located at the gingiva directly connected to a tooth and its periodontium (► Fig. 19.50, ► Fig. 19.51, ► Fig. 19.52, ► Fig. 19.53, ► Fig. 19.54, ► Fig. 19.55, ► Fig. 19.56).

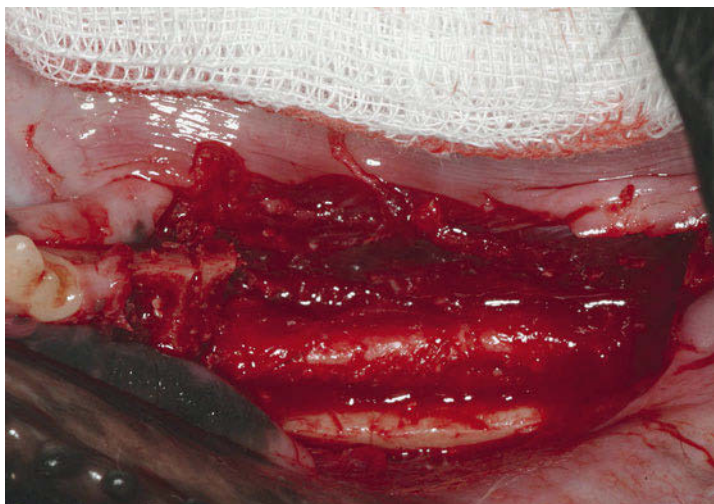


► **Fig. 19.50 Acanthomatous ameloblastoma in a dog, left body of the mandible.** It is named for the cells from which it originates, ameloblasts, which are flattened cells from the enamel epithelium that remain in the periodontium. This tumor shows the classic presentation of an acanthomatous ameloblastoma at the marginal periodontium of the left mandibular carnassial tooth.

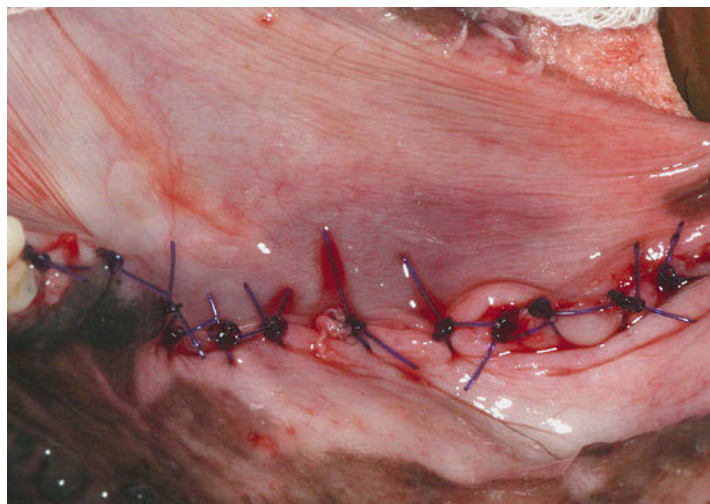


► **Fig. 19.51 Radiograph of the tumor region.** The invasiveness and destruction of the alveolar bone are apparent in the radiograph. The furcation area of the mandibular carnassial tooth shows osteolysis along the mesial root to its tip.





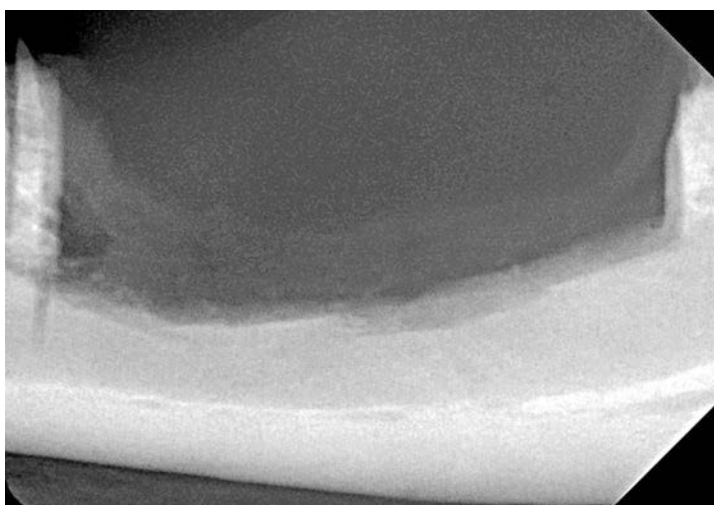
► **Fig. 19.52 Resection to the mandibular canal.** The standard treatment for this tumor is currently radical or wide resection. This approach is problematic for tumors in the caudal mandibular cheek tooth area because it would require a central resection or a complete hemimandibulectomy, which would result in a loss of stability and thus a loss of function. In contrast, in our experience, resection of only the involved tooth and surrounding bone are often enough to prevent recurrence. If the tumor recurs, a more radical approach is still possible because the tumor does not metastasize. The teeth in the tumor area were resected along with the surrounding bone at the level of the mandibular canal. This maintained the innervation and blood supply of the rostral jaw intact, while the grossly affected bone was completely resected. The course of the blood supply inside the mandibular canal is clear in this image.



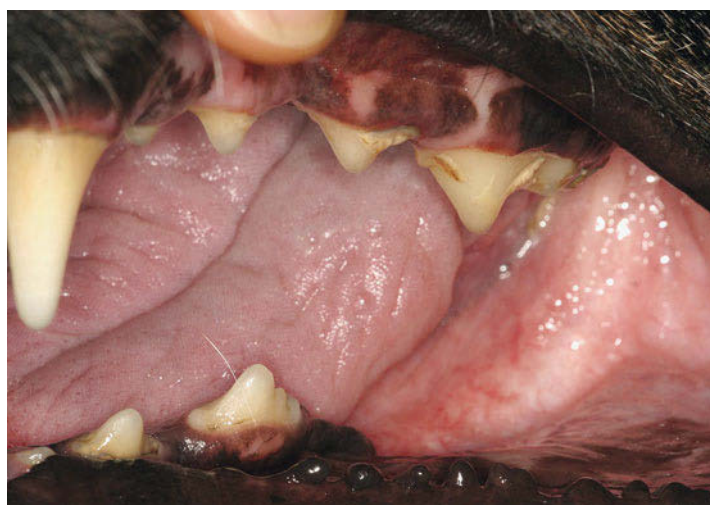
► **Fig. 19.54 Suture in the resected area.** The defect can be closed properly by mobilizing a labial mucosal flap.



► **Fig. 19.55 Follow-up 3 months later.** After 3 months, the surgical site is unremarkable. There are no signs of recurrence.



► **Fig. 19.53 Intraoperative radiograph after resection.** Complete resection is verified in the radiograph. The jaw was resected near the tumor area at the dorsal edge of the mandibular canal.

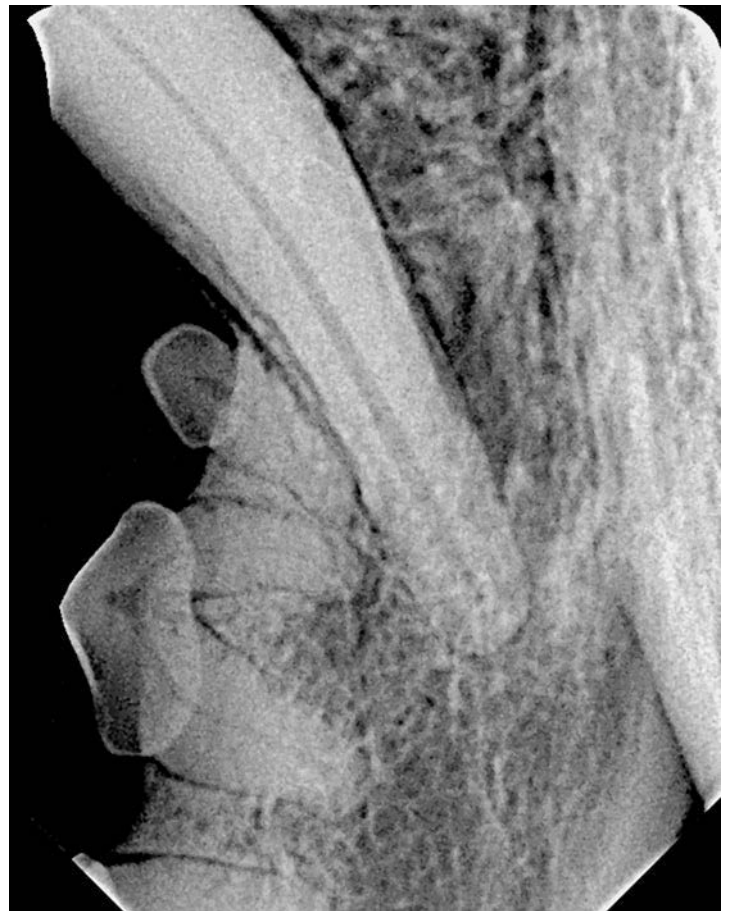


► **Fig. 19.56 Follow-up 9 months later.** The alveolar ridge still lacks signs of recurrence after 9 months. The disease did not recur in the following years.



### 19.2.6 Acanthomatous Ameloblastoma at the Mandibular Front Teeth of a Dog

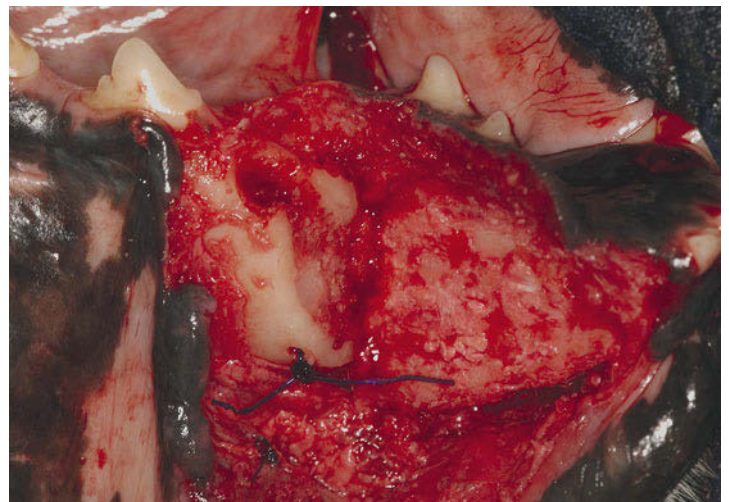
The following images (► Fig. 19.57, ► Fig. 19.58, ► Fig. 19.59, ► Fig. 19.60, ► Fig. 19.61, ► Fig. 19.62, ► Fig. 19.63, ► Fig. 19.64, ► Fig. 19.65) show the findings and treatment for an acanthomatous ameloblastoma at the mandibular front teeth of a dog.



► Fig. 19.58 Radiograph of the tumor region. The radiograph shows osteolysis extending up the apical third of the root of the canine tooth.



► Fig. 19.57 Acanthomatous ameloblastoma at the mandibular front teeth of a dog. An acanthomatous ameloblastoma near the mandibular right incisors and canine tooth has already grown beyond the mucogingival junction and spread into the vestibular mucosa.



► Fig. 19.59 Stabilization of the mandibular body with an intraosseous suture. To remove the entire tumor, the teeth near the mandibular symphysis and the second premolars must be excised. As a result, the mandibular bodies no longer support one another via apposition at the symphysis. To stabilize the right side of the mandible, the bone is drilled at its left and right ventral margins, and resorbable permanent suture material is looped through the holes. During recovery, the suture allows the connective tissue of the two mandibular bodies to fuse, ensuring proper function of the mandible.





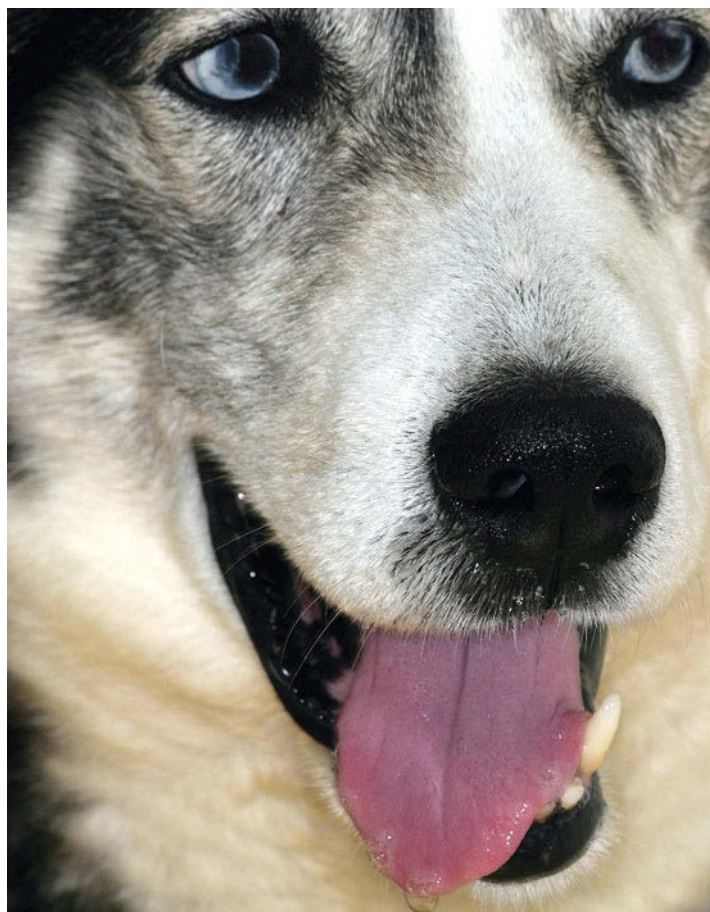
► **Fig. 19.60 Intraoperative radiograph after resection.** Due to the size of the resected area, the symphysis is no longer able to stabilize jaw movement.



► **Fig. 19.61 Suture in the resected area.** The side of the oral cavity is sutured closed. Excess tissue not required for the suture is removed.



► **Fig. 19.62 Follow-up 6 months later.** After 6 months, the jaw is unremarkable, with no signs of recurrence. The function of the jaw is unrestricted, and eating is not impaired.



► **Fig. 19.63 Status 6 months later.** Because the tongue is no longer kept in place due to the extraction of the mandibular right canine tooth, the tongue increasingly points to the right. The resected area is now covered by the tongue and less conspicuous.



► **Fig. 19.64 Follow-up radiograph 3 years later.** A follow-up radiograph taken 3 years later also shows no signs of tumor progression in the jawbone.



► **Fig. 19.65 Follow-up radiograph 5 years later.** After 5 years, the situation remains stable and unremarkable clinically and radiographically.

### 19.2.7 Papilloma in a Young Dog

Although most tumors develop in older dogs with a multicausal development, papillomas also occur in young dogs. These tumors are caused by canine papillomavirus (► Fig. 19.66, ► Fig. 19.67, ► Fig. 19.68, ► Fig. 19.69). The tumors are pedunculated and wart-like with a cauliflower-like surface; they are found on the labial mucosa, gingiva, or tongue. As the dog's immune system matures, the lesions are usually self-limiting and do not need to be surgically removed. However, if they are large enough to alter health or eating, they should be resected.

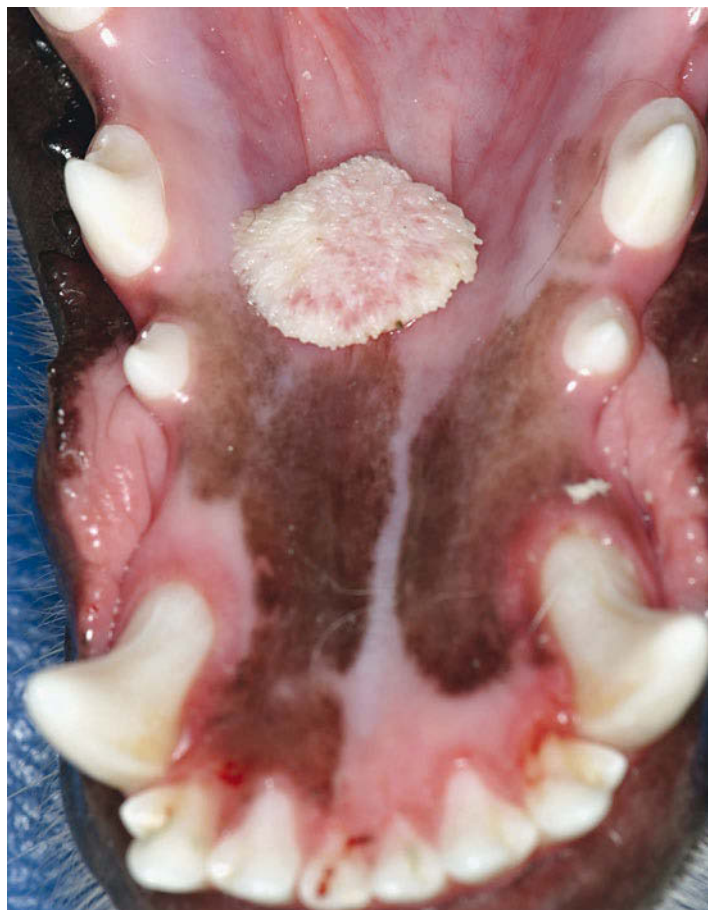


► **Fig. 19.66 Papilloma on the lip.** Small gray tumors with an anemone-like surface on the oral mucosa of a young dog generally turn out to be papillomas. They generally do not need to be removed.

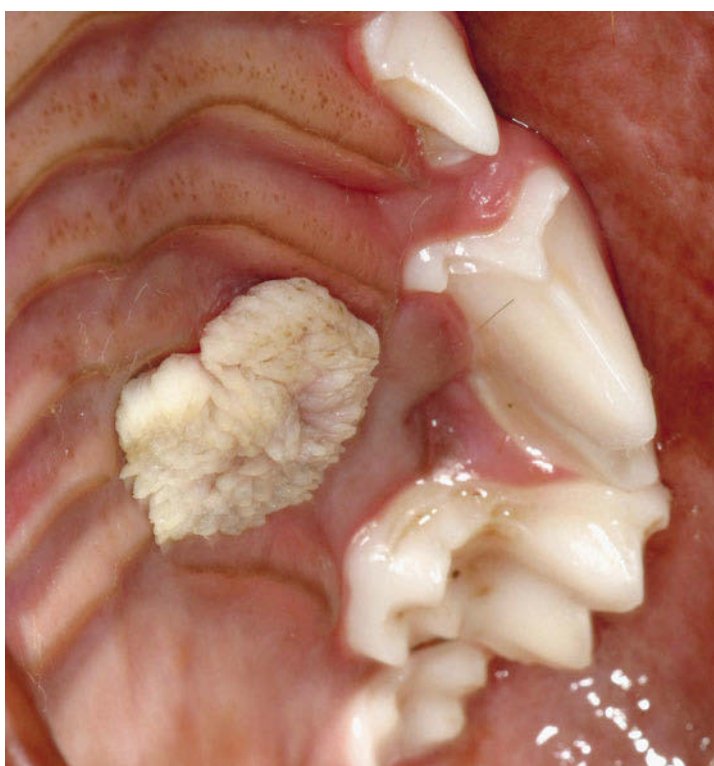




► **Fig. 19.67 Small papilloma on the palate.** In addition to the labial mucosa, the palatal mucosa can also be affected. In this case, the papilloma is pink with an anemone-like appearance.



► **Fig. 19.69 Papilloma in the sublingual space.** Tumors in the sublingual space are often much more annoying to the animal. Such papillomas should be removed if they bother the animal. If this tumor is not removed, the owner should be advised that the clinical findings and age of the dog suggest a tumor that is benign and self-limiting.



► **Fig. 19.68 Large papilloma on the palate.** Even a large papilloma such as that depicted here does not generally impair function.

### 19.2.8 Odontoma in a Dog

An odontoma is not a real neoplasm but rather a “hamartoma”. It is an atypical differentiation of germplasm that resembles a neoplasm due to its size. An odontoma is odontogenic and reciprocal induction processes between odontogenic cells occur with the production of odontogenic hard tissue, similar to the physiological development of a tooth. There are different types of odontomas. A compound odontoma has many different small “toothlets” (denticles). A complex odontoma has many small unorganized dental hard tissue particles. In a compound odontoma, simple resection of the denticles is sufficient. A complex odontoma must be completely removed because remaining surrounding tissue may continue to produce tooth substance. Complex odontomas have also been reported to become neoplasms.

Young, growing animals are predisposed to odontomas because they are an anomalous differentiation of developing dental tissue rather than a neoplasm (► Fig. 19.70, ► Fig. 19.71, ► Fig. 19.72, ► Fig. 19.73, ► Fig. 19.74, ► Fig. 19.75, ► Fig. 19.76, ► Fig. 19.77, ► Fig. 19.78).



► Fig. 19.71 Radiograph of the tumor region. The radiograph shows radiolucency of the body of the mandible around the developing carnassial tooth. The carnassial tooth is framed by multiple radiopaque particles.



► Fig. 19.70 Oral mass on the caudal body of the mandible. A 3-month-old Tibetan Spaniel was presented for swelling of the right mandible. In addition to a slight bulge on the right ventral margin of the mandible, the alveolar ridge was severely distended at the distal end of the deciduous dental arch.

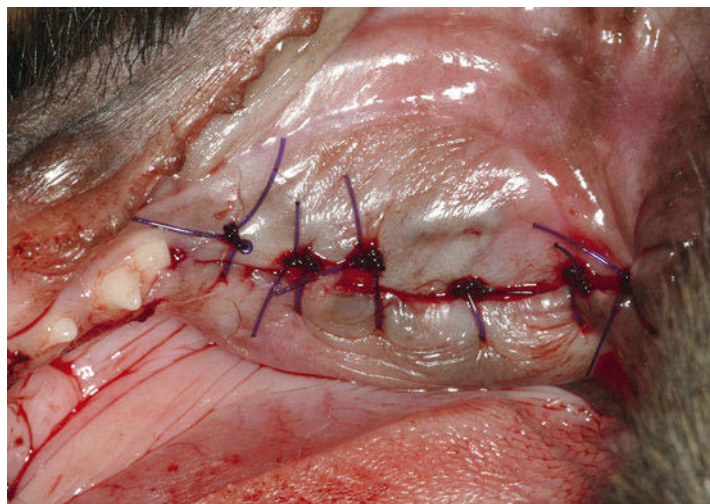


► Fig. 19.72 The resection area after extraction. All the teeth and dental particles in the osteolytic area and the soft tissue of the tumor were extracted. The oral cavity was curetted.





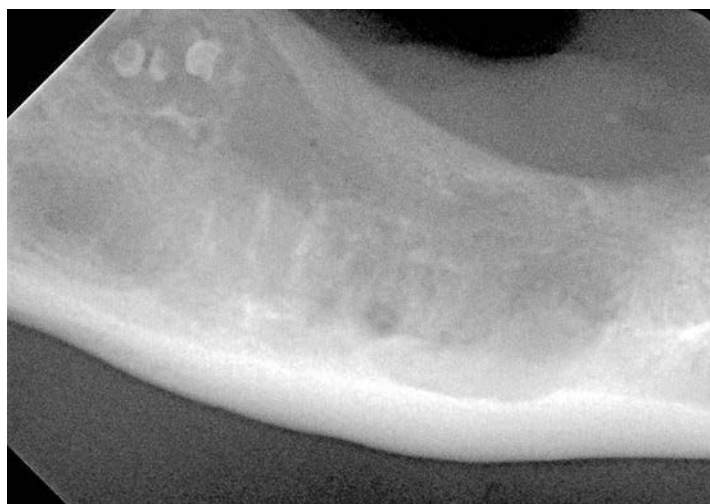
► **Fig. 19.73 Intraoperative radiograph of the resection area.** A radiograph was taken to verify complete extraction of all teeth and dental particles from the osteolytic area. The rounded, bubble-shaped, and clearly circumscribed extent of the mass is apparent because the odontoma did not invade any of the surrounding area.



► **Fig. 19.75 Suture in the resected area.**



► **Fig. 19.74 Extracted dental particles.** The unstructured dental hard tissue particles and the irregular shape of the mandibular carnassial tooth clinically support the diagnosis of complex odontoma, and this diagnosis was confirmed by histopathological examination.



► **Fig. 19.76 Regrowth of dental hard tissue 3 months later.** A follow-up radiograph taken 3 months later shows increased radiopacity in the tumor area consistent with healing. However, three new small hard tissue particles are also visible caudally.

### 19.2.9 Odontoma in a Cat

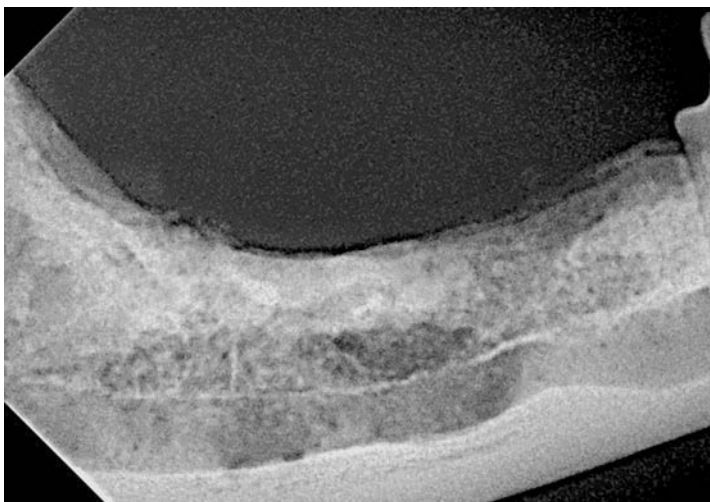
While odontoma is mainly reported in dogs, cats can also be affected (► Fig. 19.79, ► Fig. 19.80, ► Fig. 19.81, ► Fig. 19.82, ► Fig. 19.83, ► Fig. 19.84).



► **Fig. 19.77 Intraoperative radiograph after extraction of the new growths.** The extraction site of the new growths was radiographed. As in the development of a complex odontoma, the remaining active tissue can induce regrowth of dental hard tissue. Because there is no risk of metastasis, lesion growth can be restricted with ongoing radiographic monitoring and removal of any new growths, without performing a radical resection. This allows preservation of the jaw structures, which would not be possible after radical resection.



► **Fig. 19.79 Odontoma on the body of the mandible in a cat.** This 11-month-old cat had a fractured maxillary canine tooth and swelling in the mandibular right alveolar ridge. The jaw is widened over the entire premolar area. The teeth are tilted, there are three rather than two premolars, and the gingiva near the teeth is severely inflamed.

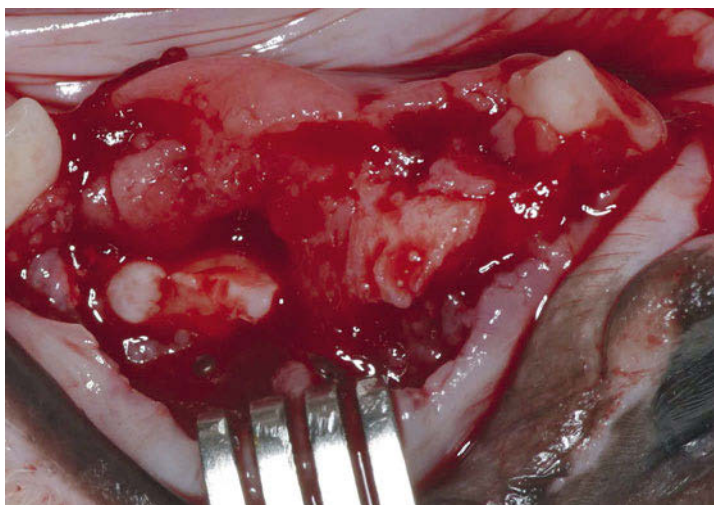


► **Fig. 19.78 Follow-up radiograph 12 months after the second operation.** One year later, a new radiograph shows an unremarkable lesion area without any signs of new dental hard tissue formation and with ongoing bone recovery. While the jaw remains somewhat distended in a buccolingual direction, the clinical findings are otherwise unremarkable.



► **Fig. 19.80 Radiograph of the tumor region.** The radiograph shows a total of five teeth in an area that is partly osteoproliferative but centrally osteolytic. The second visible cheek tooth is a deciduous tooth because it has a narrow pulp cavity and partially resorbed roots. Three premolars are observed, as well as the highly developed fourth premolar at the ventral edge of the mandible, deep within the bone. The apical part of the mandibular carnassial tooth is also affected by osteolysis.

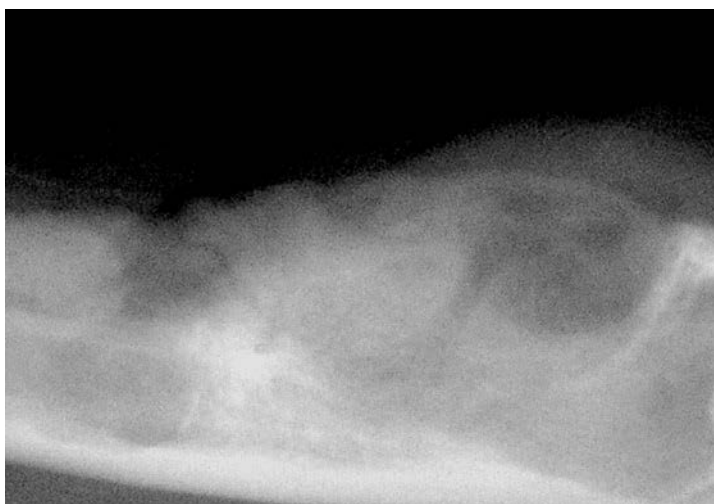




► **Fig. 19.81 View of the tumor region.** Dissection of a buccal mucoperiosteal flap reveals the irregular bony surface of the tumor region.



► **Fig. 19.83 Suture in the resected area.** The full surgical site is closed with simple interrupted sutures.



► **Fig. 19.82 Intraoperative radiograph of the resection area.** After extraction of all involved teeth, the soft tissue is removed and osteoplasty is performed. The radiograph does not show tooth remnants. Extracting the retained teeth usually cures compound odontomas because the teeth in the lesion are fully developed and differentiated, and no further induction processes between ameloblasts and odontoblasts should occur. Differential diagnoses include hyperdontia or feline inductive odontogenic tumor, but the clinical findings suggest a compound odontoma, which was confirmed histopathologically.



► **Fig. 19.84 Follow-up 4 months later.** The mandibular alveolar ridge is clinically nonreactive, flattened, and unremarkable after 4 months, and the cat is doing well.

### 19.2.10 Symmetrical Tissue Granulation in the Mandible of a Cat

In cats, not all tumor-like masses are malignant. Bilateral symmetrical growth in the oral cavity is very unlikely to be neoplastic (► Fig. 19.85, ► Fig. 19.86, ► Fig. 19.87, ► Fig. 19.88, ► Fig. 19.89, ► Fig. 19.90, ► Fig. 19.91, ► Fig. 19.92).



► **Fig. 19.85 Large oral mass in the caudal left mandible of a cat.** A cat was presented for a second opinion prior to euthanasia. A huge tumor in the left mandible was causing extreme hypersalivation, poor eating, and bleeding from the oral cavity. The examination revealed a large oral mass near the caudal left body of the mandible. The tissue was multilobulated and soft, with a fissured, inflamed surface and some bleeding defects. The teeth were all heavily covered with plaque.



► **Fig. 19.87 Radiograph of the left mandible.** The radiograph shows a retained mesial root fragment from the extracted fourth premolar. The mandibular carnassial tooth is missing, and the bone is otherwise unremarkable. In contrast to the typical invasive and destructive effects of a neoplasm, this mass does not appear to have affected the bone. The mass was completely resected, and the root fragment and maxillary carnassial tooth were extracted. The histopathological examination showed inflammatory granulation tissue without any signs of a neoplasm as a reaction to the trauma with high bacterial load of the maxillary carnassial tooth.



► **Fig. 19.86 Penetration of the swelling by tooth 208.** The maxillary carnassial tooth penetrated the mass when the mouth closed.



► **Fig. 19.88 Follow-up examination of the left mandible 2 months later.** After 2 months, the mandibular alveolar ridge is completely unremarkable, with no signs of inflammation or recurrence.





► **Fig. 19.89 Small oral mass on the caudal right mandible.** At the follow-up examination, a small, round oral mass was found on the right side in the area where the cusp of the maxillary carnassial tooth penetrated the mandibular mucosa. The teeth were again covered in plaque.



► **Fig. 19.91 Radiograph of the right mandible.** The radiograph shows a completely unremarkable alveolar ridge in the area of the tumor after mass was resected and the maxillary carnassial tooth penetrating the mucosa was extracted.



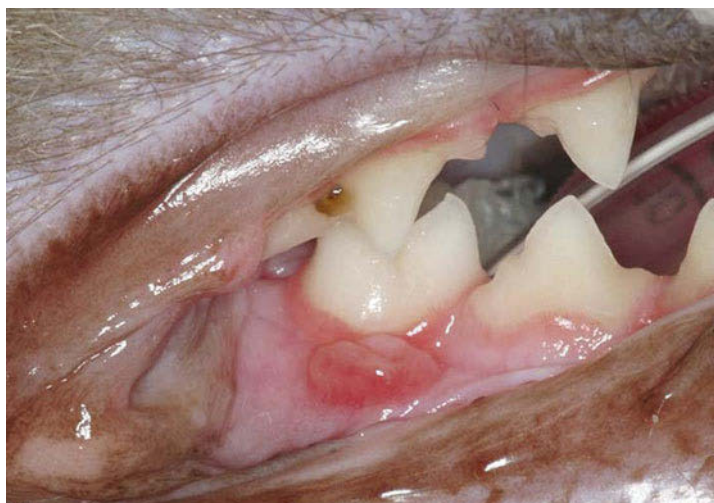
► **Fig. 19.90 Dramatic growth of the oral mass at the caudal right mandible.** When the cat presented for resection of the mass 1 month later, it had already grown dramatically. Clinically, this mucosal response resembled that on the left side, but to a lesser extent.



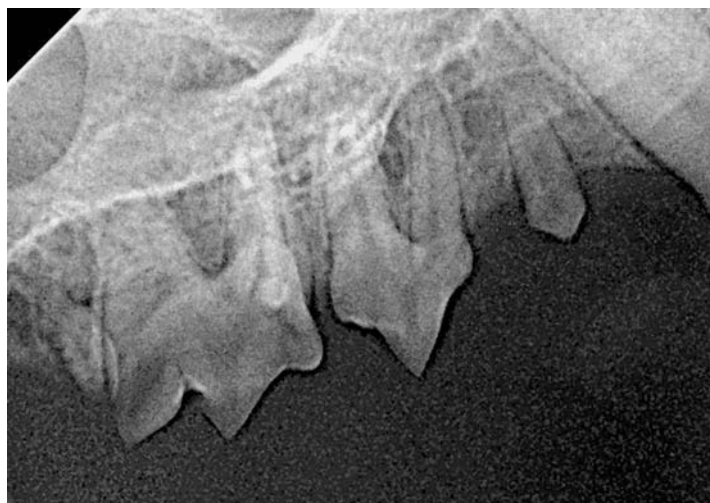
► **Fig. 19.92 Postoperative examination of the right mandible 1 month later.** The site is nonreactive one month later. Eliminating the maxillary carnassial tooth that is penetrating the mandibular mucosa prevents an inflammatory response. However, the mechanical contact of the maxillary carnassial tooth cusp was not the only reason for the dramatic response of the mandibular mucosa. The trauma to the mucosa caused by the maxillary carnassial tooth cusp allowed bacteria to invade the wound, which in turn led to a mucosal reaction. Regardless of the clinical presentation, the problem was tissue hyperplasia due to inflammation. Eliminating the inflammatory trigger restored oral health.

### 19.2.11 Treatment of Inflammatory Oral Masses through Crown Reduction of the Carnassial Teeth in a Cat

It is not absolutely necessary to extract the maxillary carnassial teeth in cases where they are penetrating the mandibular vestibular mucosa, despite deep interdigitation. In many cases, rounding and shortening the teeth can help preserve them and retain their function for eating (► Fig. 19.93, ► Fig. 19.94, ► Fig. 19.95, ► Fig. 19.96, ► Fig. 19.97, ► Fig. 19.98, ► Fig. 19.99, ► Fig. 19.100).



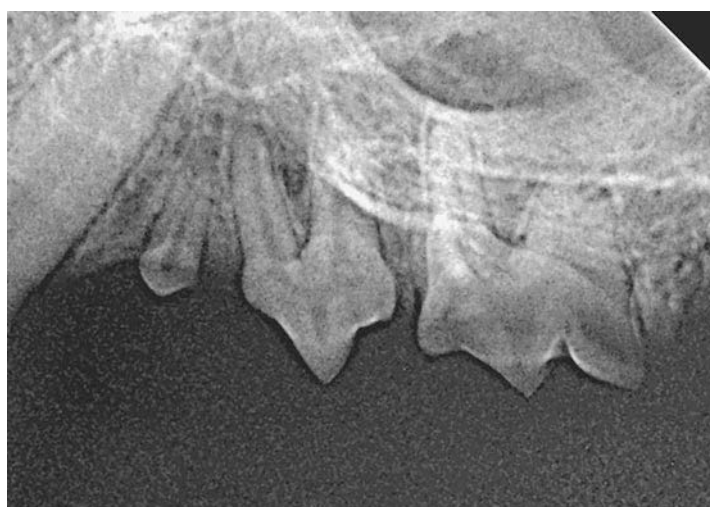
► **Fig. 19.93** Granuloma on the right mandible from penetration of tooth 108. A British Shorthair cat has a hyperplastic inflammatory response to the maxillary right carnassial tooth penetrating the mandibular mucosa.



► **Fig. 19.95** Radiograph of the region around tooth 108 following crown reduction. The maxillary carnassial teeth are shortened, rounded and sealed. As little tooth substance as possible is removed to prevent damage to the young cat's wide pulp canals. Sealing should decrease sensitivity of any opened dentinal tubules. The radiograph documents the current developmental stage of the tooth in order to monitor for any later pathological changes, because tooth death may not always be clinically apparent.



► **Fig. 19.94** Granuloma on the left mandible due to penetration by tooth 208. The left side of the jaw is similar.



► **Fig. 19.96** Radiograph of tooth 208 after crown reduction.

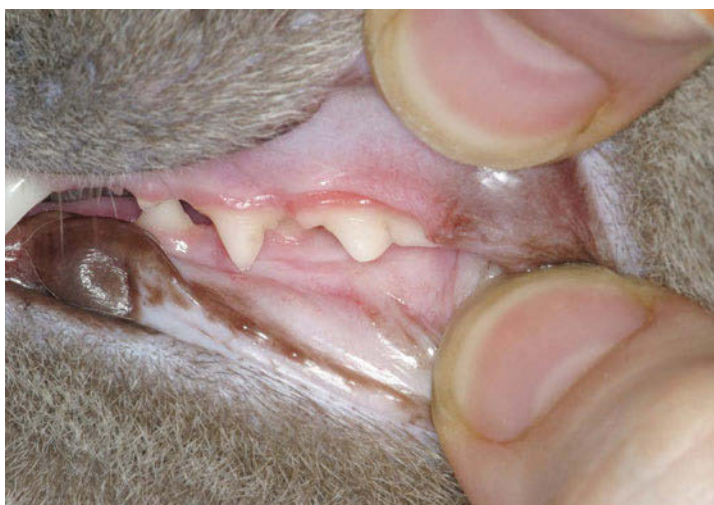




► **Fig. 19.97** Follow-up examination of the right side 3 months later. The clinical findings are normal after 3 months, and the teeth no longer penetrate the mandibular mucosa.



► **Fig. 19.99** Follow-up radiograph of the region around tooth 108 after 7 years. After 7 years, the maxillary right carnassial tooth is still healthy. The tooth walls are thick, the pulp canal is significantly narrowed, and the root tips and the periapical bone tissue appear normal.



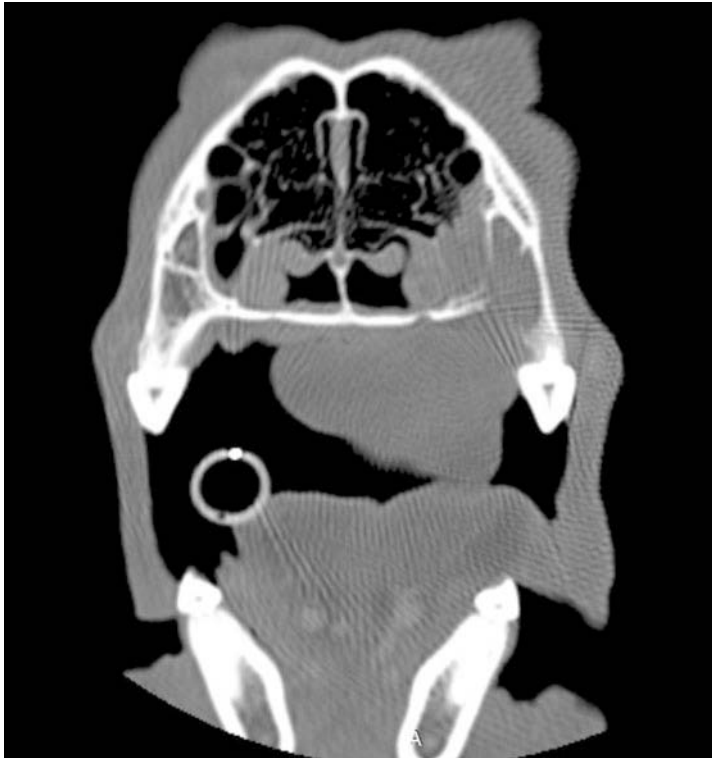
► **Fig. 19.98** Follow-up examination of the left side 3 months later. Shortening and rounding the crown of the maxillary carnassial tooth eliminated the cause of chronic trauma and, in turn, the mucosal inflammatory response. The crown reduction is visible in the radiograph. If the procedure is initially insufficient, reduction may be repeated gradually to avoid causing pulpitis.



► **Fig. 19.100** Follow-up radiograph of the region around tooth 208 after 7 years. The left side radiographically resembles the right.

### 19.2.12 Other Diagnostic Imaging

Tomographic images, whether obtained through computed tomography (CT) or magnetic resonance imaging (MRI), are sometimes the best option for assessing the full extent of oral masses (► Fig. 19.101, ► Fig. 19.102).



► **Fig. 19.101 CT scan of a maxillary tumor.** Radiologic imaging can often reveal the extent of tumors of the maxilla in particular. This imaging provides three-dimensional modeling of the disease and often assists in surgical planning, in terms of resection and other options.



► **Fig. 19.102 CT scan of a maxillary nasal tumor.** When the nasal cavity is involved, clinical examination alone cannot show the full extent of the tumor. This CT scan of the maxilla reveals displacement of the entire left nasal passage by the tumor.



## 20 Jawbone

The maxilla and mandible must function properly to ensure healthy teeth and mucosa. Even mild malocclusions can cause functional jaw impairment. The tight occlusion of the carnivore bite allows for only slight deviation of the mandible and maxilla. Otherwise, malocclusion can quickly impair mouth opening.

### 20.1

### Jaw Fractures

Jaw fractures, especially mandibular ones, may damage the teeth. The aim of treatment is to create a stable situation without damaging the teeth and undisturbed occlusion. Plate osteosynthesis is rarely performed. Cerclage wires and/or splints placed along the dental arch are more common.

#### 20.1.1 Noninvasive Repair of a Fractured Body of the Mandible in a Dog

A noninvasive fracture repair is preferable to prevent damage to the teeth (► Fig. 20.1, ► Fig. 20.2, ► Fig. 20.3, ► Fig. 20.4, ► Fig. 20.5).



► **Fig. 20.2 Radiograph of the mandibular fracture.** A continuous fracture line appears in the radiograph. The fracture line starts in the area of the split third premolar, runs ventrally to the apices distally, and continues ventrally through the edge of the mandible. The dislocation is minimal. The young dog's periodontium is healthy. The fractured tooth is removed from the fracture area, and the jaw is repositioned.



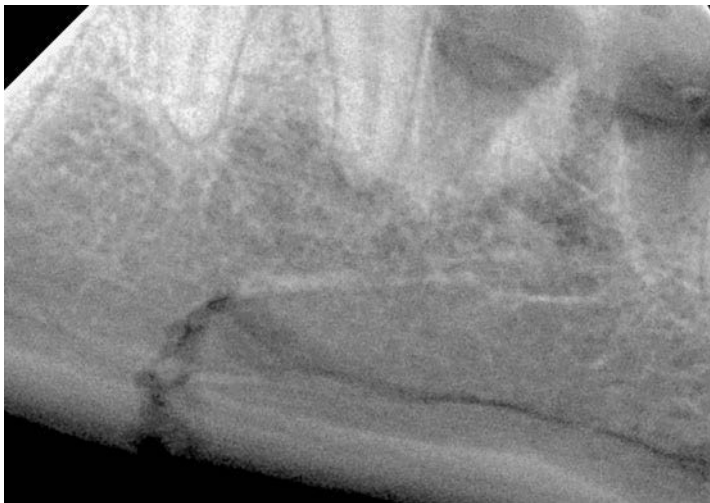
► **Fig. 20.1 Fractured right mandible.** A 15-month-old dog was kicked by a horse and fractured its right mandible. The mouth no longer closed completely, and moving the mandible was painful. The intraoral examination reveals a fracture of the third mandibular premolar. The tooth cusps are misaligned. More than 1 cm of the mandibular bone is visible near the mucogingival junction, under the roots of the fourth premolar.



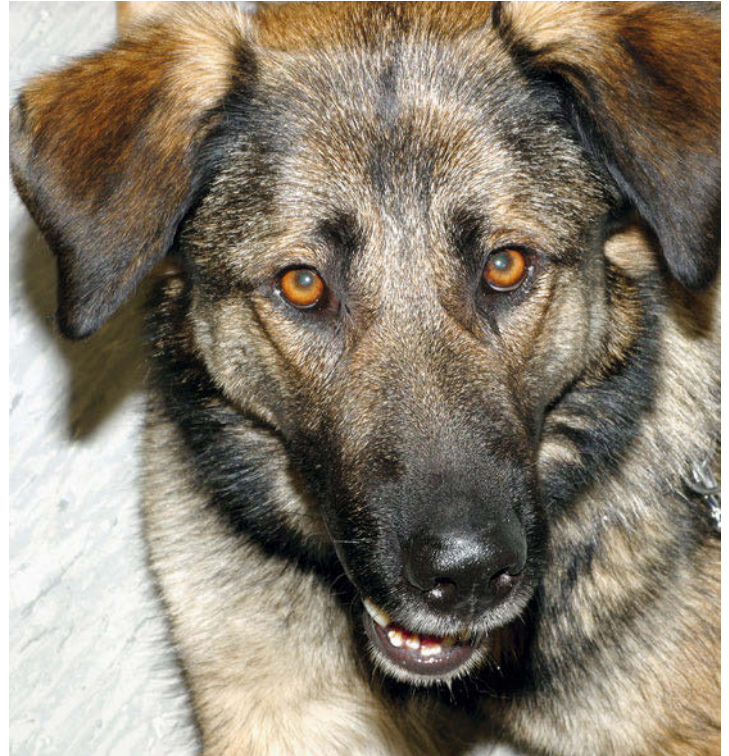
► **Fig. 20.3 Repositioning and fixation.** An intraoral acrylic splint over the dental arch is used to reposition and fix the body of the mandible in a way that does not affect occlusion.

### 20.1.2 Nasal Fracture

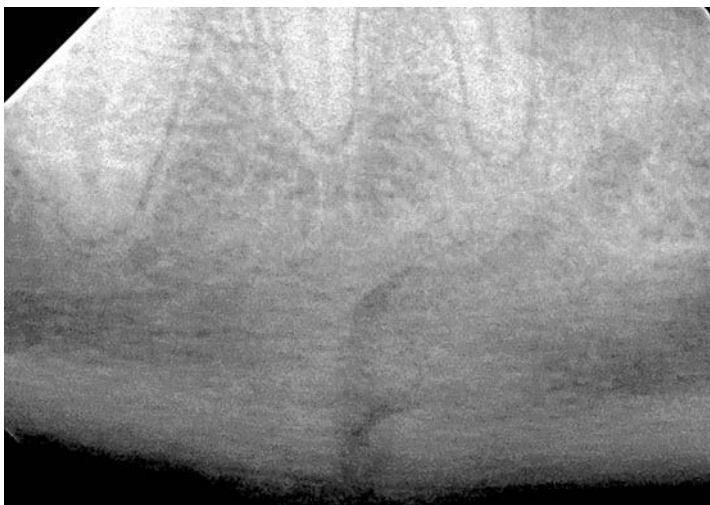
The maxilla comprises multiple bones that work together: the maxillary, premaxillary, and palatine bones. While fractures rarely cause pronounced displacement, the number of bones makes it harder to reposition the fracture areas (► Fig. 20.6, ► Fig. 20.7, ► Fig. 20.8, ► Fig. 20.9, ► Fig. 20.10, ► Fig. 20.11, ► Fig. 20.12, ► Fig. 20.13, ► Fig. 20.14, ► Fig. 20.15).



► **Fig. 20.4 Radiograph after repositioning.** The repositioning is verified radiographically. The goal of repositioning jaw fractures is not first and foremost the anatomically correct alignment of the fragments but rather unhindered occlusion of the opposing dental arches.



► **Fig. 20.6 Deviation of the nose.** A dog presented with a crooked nose after being hit by a car. While mouth opening is impaired, the mandible is freely movable.

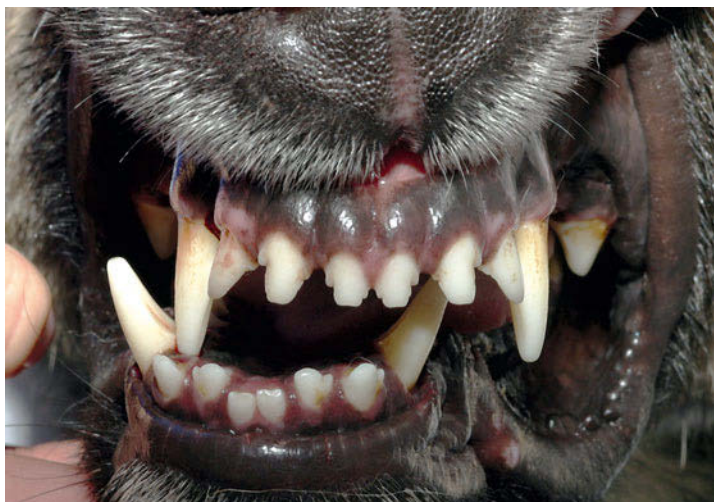


► **Fig. 20.5 Follow-up radiograph 4 weeks later.** In the follow-up radiograph, after removing the acrylic splint 4 weeks later, the fracture gap is undergoing bone remodeling. Clinically, the jaw is load-bearing. The advantage of stabilizing a mandibular fracture with acrylic splinting over the dental arch is that this approach is noninvasive. It avoids placing cerclage wires or bone screws near the delicate tooth roots. Furthermore, attaching the splint to the alveolar crest, the side under tension, is advantageous for treatment because the fracture gap must be minimized for load-bearing and to promote healing.



► **Fig. 20.7 Soft tissue trauma and malocclusion due to a maxillary fracture.** The nose is mobile, and the oral mucosa is torn at the level of the second and third premolars. The maxilla deviates to the left, which impairs occlusion, particularly of the canine teeth.





► **Fig. 20.8 Malocclusion of the front teeth due to deviation of the maxilla.** The leftward deviation of the maxilla is particularly evident in the rostral view.



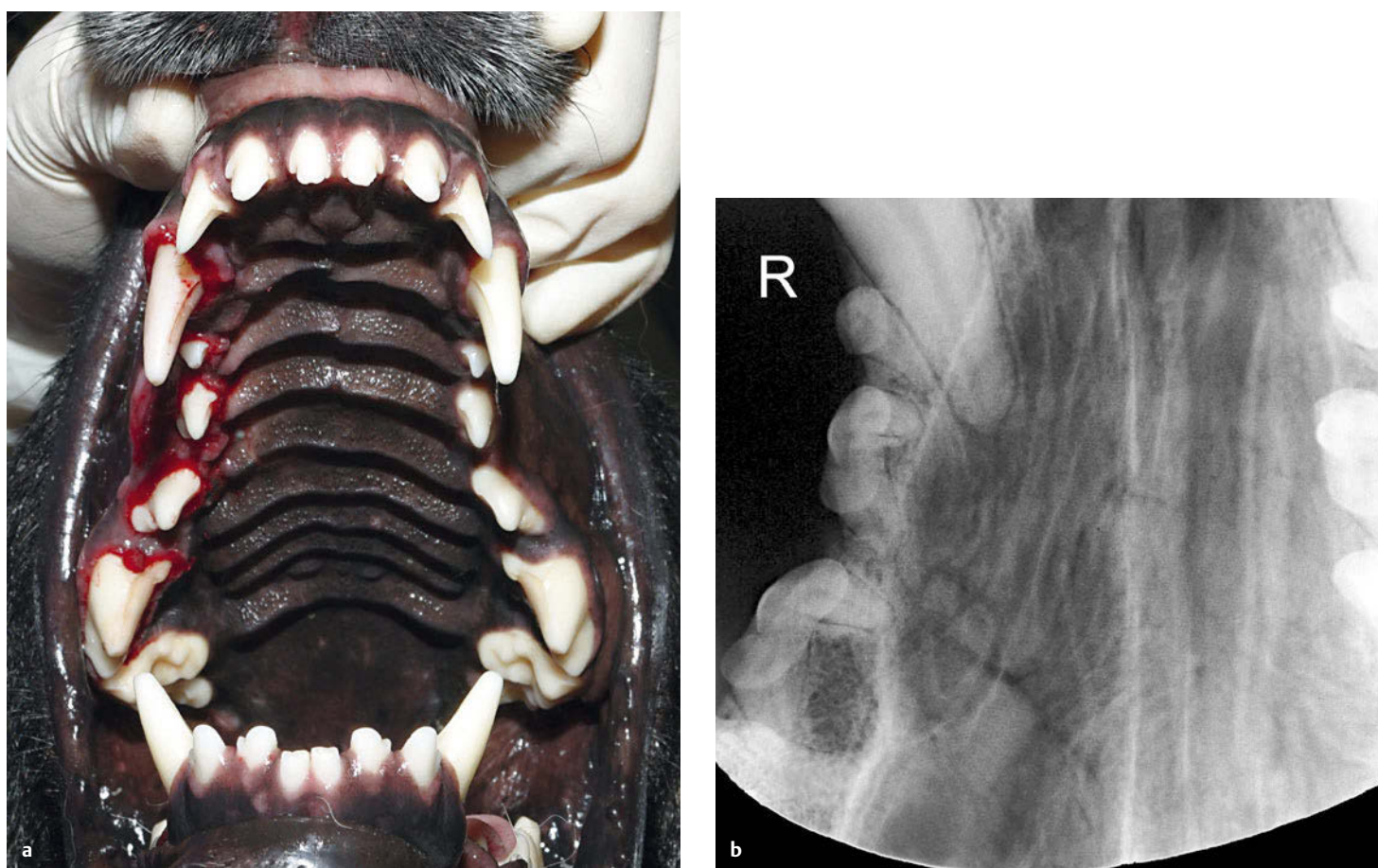
► **Fig. 20.10 Repositioning and splinting.** The nose is then repositioned and fixed in place with cerclage wire around the dental arch and an intraoral splint.



► **Fig. 20.9 Radiograph of the maxillary fracture.** The radiograph shows a large fracture gap between the second and third premolars, and the nose points to the left.



► **Fig. 20.11 Radiograph after repositioning.** The postoperative radiograph after repositioning shows the relative position of the fracture ends to one another.



► Fig. 20.12 Recheck.

**a Maxilla after removal of the splint.** After the splint is removed 6 weeks later, the bone is stable and occlusion is unimpaired. The gingiva covered by the intraoral splint during treatment is severely inflamed. This area heals within 1 week of the resumption of dental cleaning.

**b Follow-up radiograph of the nasal fracture after 6 weeks.** The fracture gap shows remodeling in a clinically stable jaw.

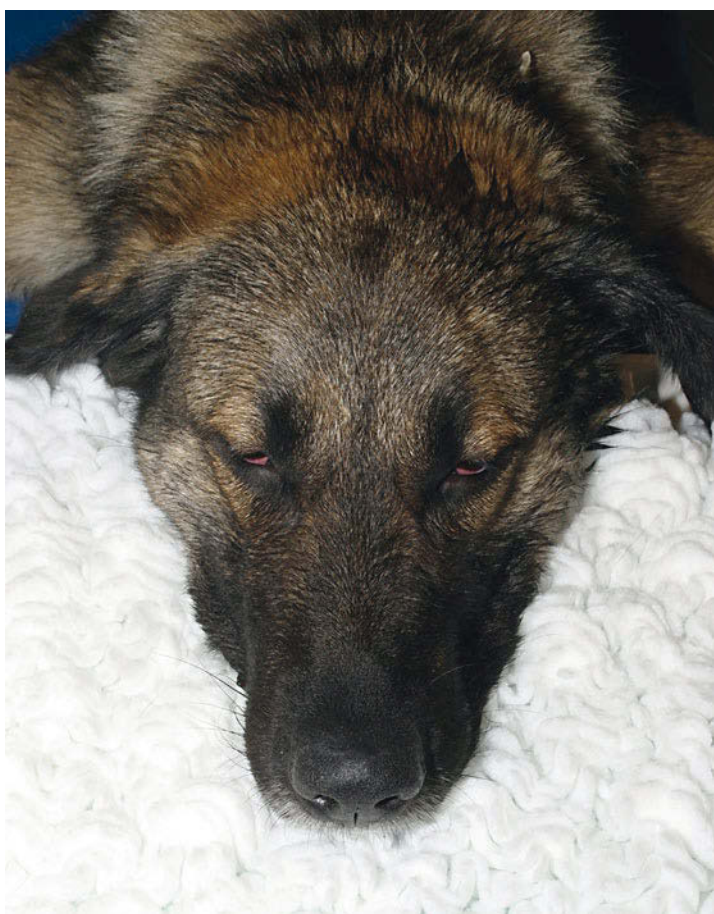




► **Fig. 20.13 Occlusion of the front teeth after removing the splint.** The upper and lower incisors malocclude slightly; however, it is unknown whether the patient's bite was correctly aligned before the trauma. Slight leftward deviation of the maxilla persists but does not alter function.



► **Fig. 20.15 Discoloration of the maxillary canine tooth.** The trauma caused pulpitis and hence discoloration of the maxillary canine tooth. The canine tooth can be preserved with root canal therapy.



► **Fig. 20.14 Nose after removing the splint.** The nose appears externally normal.



### 20.1.3 Nasal Avulsion

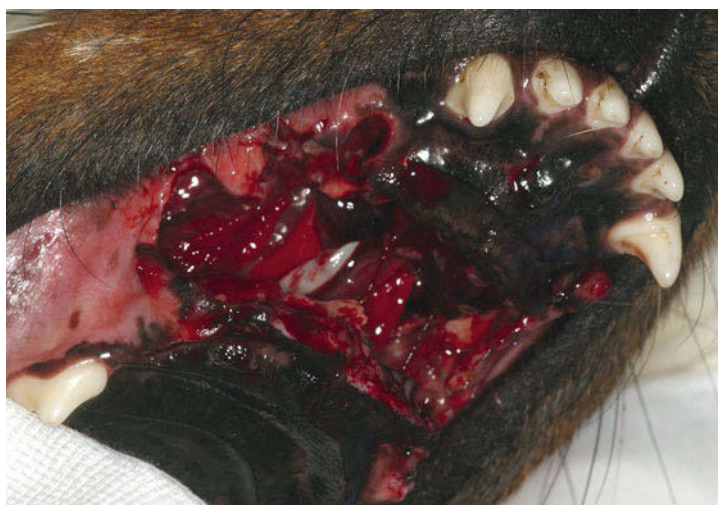
A massive skull trauma can lead to an avulsion fracture of the nose or front mandible (► Fig. 20.16, ► Fig. 20.17, ► Fig. 20.18, ► Fig. 20.19, ► Fig. 20.20, ► Fig. 20.21, ► Fig. 20.22, ► Fig. 20.23, ► Fig. 20.24).



► **Fig. 20.16 Nasal avulsion.** An unknown facial trauma in this 7-year-old Beauceron resulted in complete avulsion of the nose and loss of the maxillary canine teeth. The nose can be everted and the interior of the nasal passages exposed.



► **Fig. 20.18 Radiograph of the fracture line on the maxilla.** The intraoral radiograph shows the displacement of the maxilla to the left, both maxillary canines are completely missing.



► **Fig. 20.17 Lateral view of the nasal avulsion.** The large opening demonstrates the complete avulsion of the rostral part of the nose.



► **Fig. 20.19 Occlusion after repositioning.** The maxillary front teeth may be repositioned to allow undeviated, relatively normal occlusion.





► **Fig. 20.20** Radiograph after repositioning and fixation with cerclage wires. Reduced fracture gap of the maxilla with cerclage wire after repositioning.



► **Fig. 20.23** Postoperative radiograph of the maxilla after 10 weeks. In the radiograph, the fracture area and the bone remodeling processes in the area of the palatine fissures can be visualized. Bone remodeling is already further advanced near the thicker-walled alveolar process.



► **Fig. 20.21** Palatal suture. The soft tissue injuries are closed using sutures.



► **Fig. 20.22** Recheck of the maxilla 10 weeks later. After 10 weeks, the wound is healing, the mucosa shows no inflammation, and the bone appears stable.



► **Fig. 20.24** Follow-up radiograph after removing the cerclage wires after 10 weeks. After the cerclage wires are removed, the clinical situation remains stable and the follow-up radiograph is unremarkable.

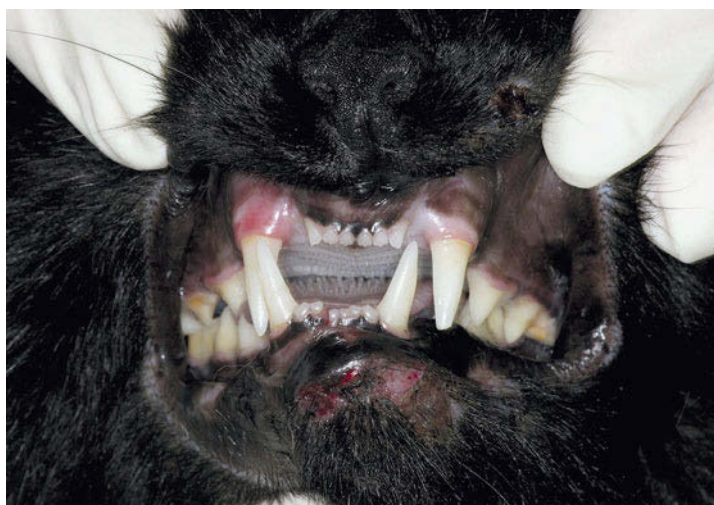
### 20.1.4 Symphyseal Separation in a Cat

The mandibular symphysis is a common fracture site in dogs and cats; however, it is not a true fracture but rather a separation. Even in a normal state, there is no bony fusion of the mandibular symphysis because the right and left mandible meet at a syndesmosis.

Cats are particularly prone to separation of the mandibular symphysis if the mandible hits the ground after a fall (high-rise syndrome) (► Fig. 20.25, ► Fig. 20.26, ► Fig. 20.27, ► Fig. 20.28, ► Fig. 20.29).



► **Fig. 20.26 Radiograph of the symphyseal separation.** The radiograph reveals the separation of the mandibular symphysis along with partial fracture of the right central incisor.



► **Fig. 20.25 Separation of the mandibular symphysis in a cat.** A 2-year-old indoor cat was presented for poor well-being and decreased eating after going outdoors. The rightward deviation of the mandible is the result of rostral luxation of the left temporomandibular joint (TMJ).



► **Fig. 20.27 Radiograph after repositioning.** After noninvasive repositioning of the left TMJ, extraction of the right central incisor, and circummandibular cerclage, a postoperative radiograph is taken. The cerclage should not be too taut; otherwise the mandibular canine teeth may tilt together, possibly resulting in jaw-closing problems.

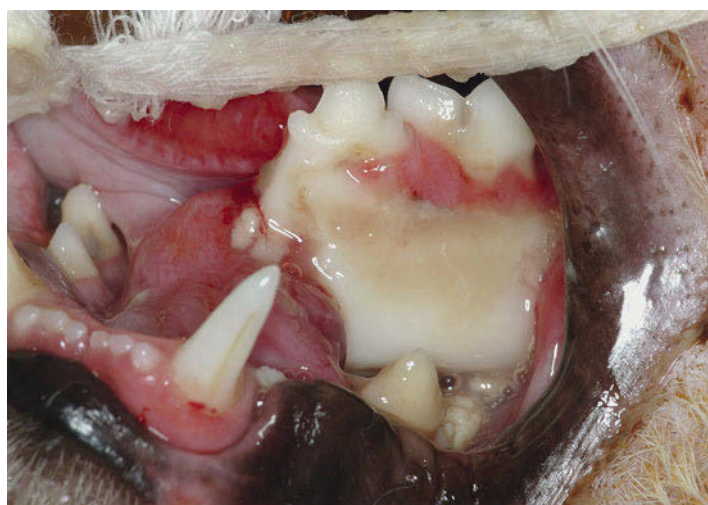


### 20.1.5 Fracture of the Caudal Body of the Mandible in a Cat

Stabilization of a fracture to allow load bearing may require both non-invasive and surgical treatments (► Fig. 20.30, ► Fig. 20.31, ► Fig. 20.32, ► Fig. 20.33).



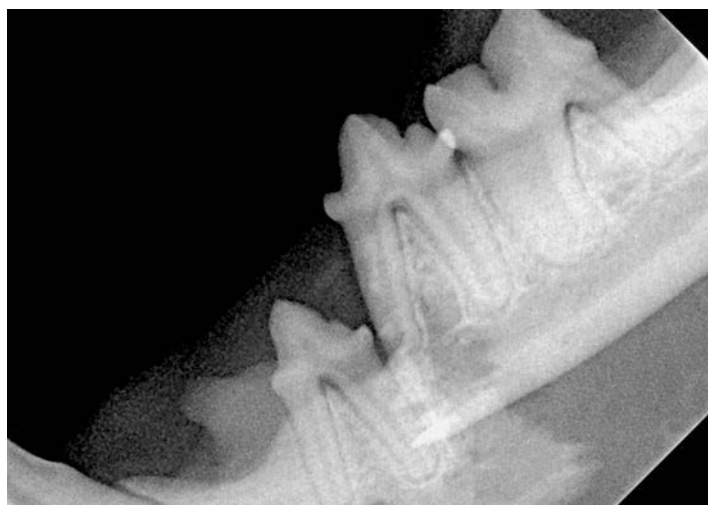
► **Fig. 20.28 Occlusion 3 months later.** A follow-up examination after 3 months shows normal occlusion and mouth closure. The cat's bite reveals very tight occlusion that does not allow even slight deviation, as a result of tipping for example.



► **Fig. 20.30 Fractured body of the mandible in a cat.** In this case, a true fracture of the jawbone has occurred near the cheek teeth. Depending on the course of the fracture line, the masticatory muscles may displace the caudal fracture fragment dorsally. In this cat, the soft tissue is torn and the jawbone is exposed on the dorsally displaced part.



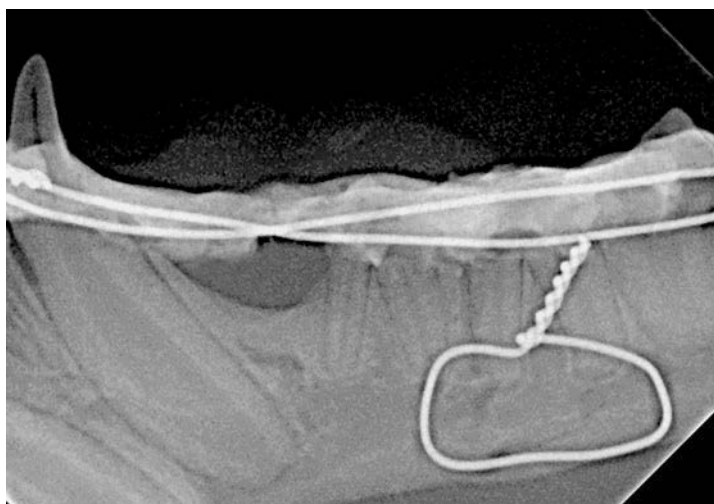
► **Fig. 20.29 Follow-up radiograph of the symphysis after removal of the cerclage 3 months later.** The right and left mandible meet symmetrically at the symphysis in the radiograph. The symphysis appears clinically stable, and syndesmotomic remodeling has occurred.



► **Fig. 20.31 Radiograph of the fractured left body of the mandible.** The fracture line runs between the third and fourth premolars, and the caudal part is dislocated dorsally in the radiograph.



► **Fig. 20.32 Intraoral splint, left mandible.** The broken mandible is set by stabilizing the dental arch with an intraoral splint that is reinforced with cerclage wire and attached to the teeth.



► **Fig. 20.33 Intraoperative radiograph of the cerclage wire.** In addition, the fracture gap can be reduced by guiding cerclage wire intraosseously at the ventral margin of the mandible. The knot of the wire loop is placed buccally and the intraosseous guide is apical to the tooth roots. In order to improve load bearing, the dental arch is immobilized on the pull side by the acrylic splint, and the fracture gap is reduced on the mandibular ventral margin with cerclage wire.

### 20.1.6 TMJ Fracture in a Cat

In a TMJ fracture in the cat, it is very difficult to directly access and adapt the fracture ends (► Fig. 20.34). First, the anatomy obscures the surgical site, and second, the bony structures are so fragile that both cerclage wires and osteosynthesis plates carry a poor prognoses. In case of unstable occlusion and impaired mouth closing a fracture near the TMJ at the ramus of the mandible can be diagnosed with a radiograph of the skull or, better yet, with a CT. The correction of the lower jaw position takes place at a distance, using the canine teeth to stabilize the maxilla against the mandible. The mandible can be immobilized with complete jaw closure, but the patient must then be tube fed since it cannot open its mouth to eat. The advantage is the maxillary teeth occlude properly with the mandibular teeth, which prevents impaired mouth opening after removing the fixation. Alternatively, the jaw can be immobilized in a semi-open position (► Fig. 20.35). This allows the animal to continue eating on its own. This also eliminates the risk of aspiration in the event of vomiting because the vomitus can be removed from the mouth. It is important to set the mandible against the maxilla in a manner that is as close as possible to the pre-trauma configuration during the jaw opening to avoid interference contacts during jaw opening and closing after the immobilization has been removed.



► **Fig. 20.34 TMJ fracture in a cat.** The mandibular condyle separated completely from the mandibular bone near the right TMJ. The fractured end of the body of the mandible is pulled medially, and the entire mandible shifts rostrally toward the fractured side. The mouth cannot be closed. Surgical access to the small structures on the mandibular condyle is difficult. An alternative is to reposition the jaw in normal occlusion and fix the mandible against the maxilla.





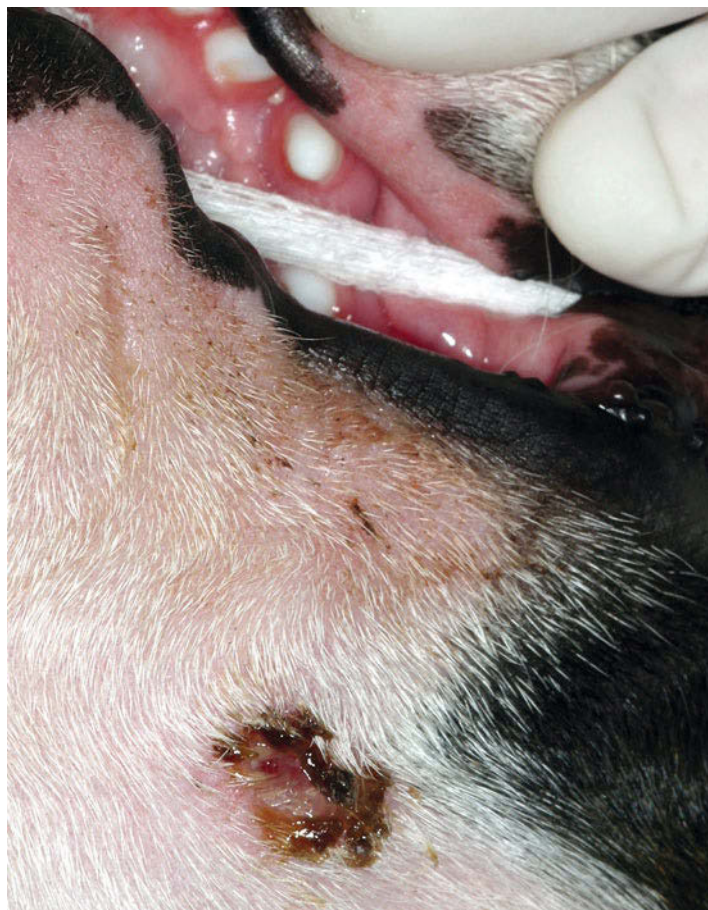
► **Fig. 20.35 Maxillomandibular fixation in a cat.** Maxillomandibular fixation in a semi-open position is performed with composite. The cat cannot open or close its jaw for approximately 2 weeks. However, this is not absolute immobilization, because some mobility remains in the fracture area due to the distance between the fixation and the fracture area. The maxillomandibular fixation is removed after 2 weeks in order to avoid joint changes in the TMJ, given that the fracture area is sufficiently stable.

#### 20.1.7 Carnassial Tooth in the Fracture Gap

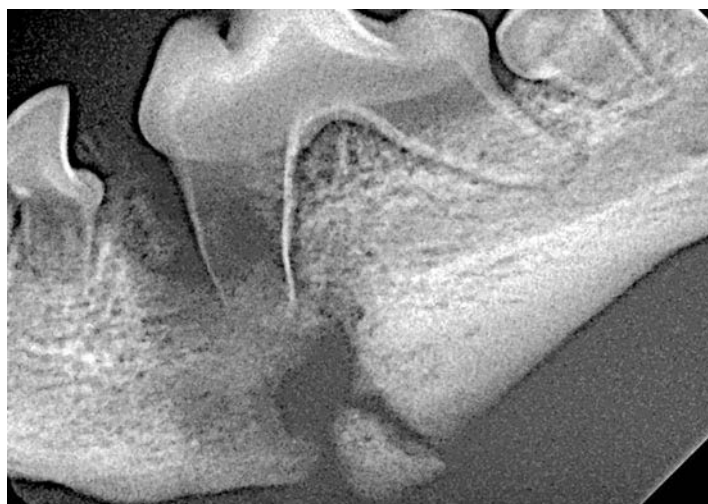
A tooth in the fracture gap of a mandibular fracture often poses a challenge for the veterinarian. On the one hand, the tooth may be useful for adaptation of the fracture ends, but on the other, the tooth allows open communication with the oral cavity, which is a potential source of infection. In case of doubt, the affected tooth should be extracted, with the fracture stabilized using an alternate method (► Fig. 20.36, ► Fig. 20.37, ► Fig. 20.38, ► Fig. 20.39, ► Fig. 20.40, ► Fig. 20.41, ► Fig. 20.42, ► Fig. 20.43, ► Fig. 20.44) rather than jeopardize healing of the fracture by leaving the tooth in place.



► **Fig. 20.36 Mandibular left carnassial tooth with mesial infrabony pocket.** After a fight with the neighbor's dog, a six-month-old Boston Terrier fractured the left body of the mandible. The jaw was immobilized with cerclage wire. After 1 month, a fistula formed at the ventral edge of the mandible. Removing the cerclage wire failed to improve the situation. A 2 mm gingival recession appears on the mesial root of the mandibular carnassial tooth, and the fourth premolar and mandibular carnassial tooth are tilted toward each other.

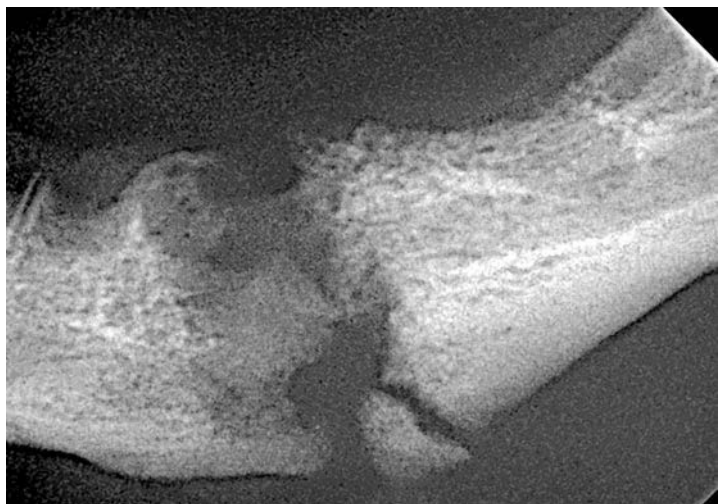


► **Fig. 20.37 Fistula formation near the left ventral body of the mandible.** At the level of the mandibular carnassial tooth, there is a fistula that opens at the ventral margin of the mandible and is draining purulent discharge.



► **Fig. 20.38 Radiograph of mandibular carnassial tooth in the fracture gap.** Radiographically, a wide osteolytic fracture gap appears between the fourth premolar and the mandibular carnassial tooth. The tooth roots have not yet fully developed, and the pulp canals are wide, consistent with the dog's age. The mesial root of the mandibular carnassial tooth is in the fracture gap and functions as a matrix for a bacterial infection of the fracture; an "open" mandibular fracture often encourages infection.

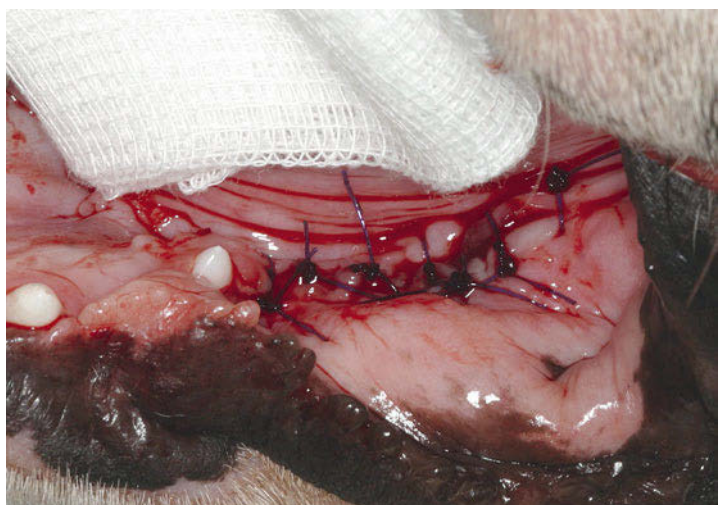




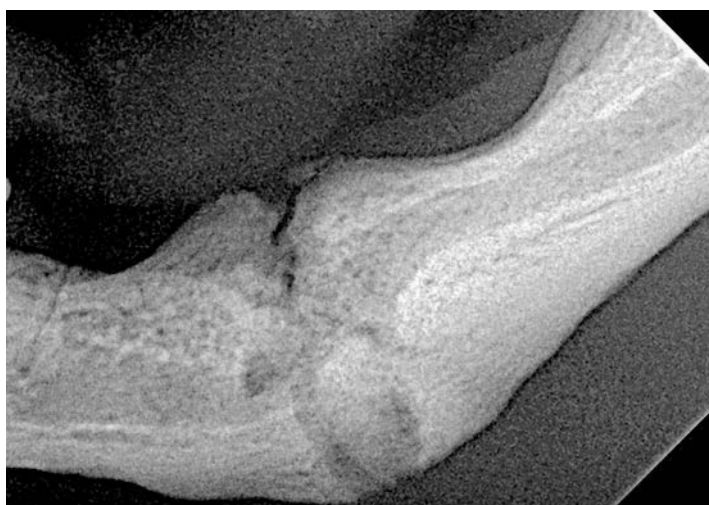
► **Fig. 20.39 Intraoperative radiograph after extraction.** The surrounding teeth are surgically removed to allow for healing and to eliminate a pathway for infection.



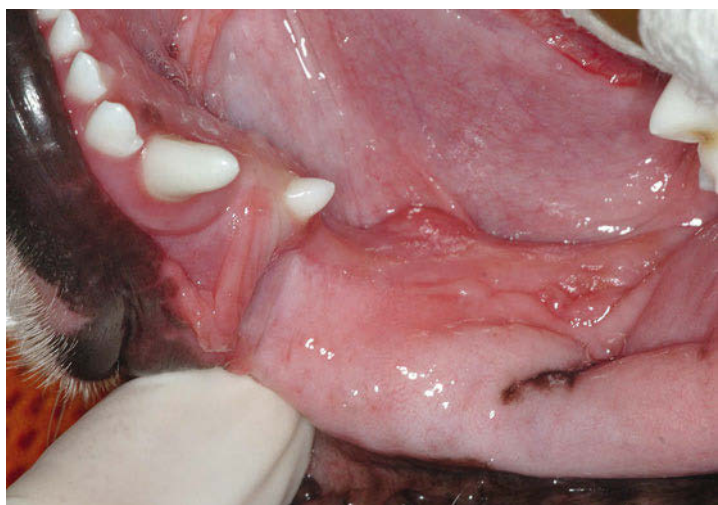
► **Fig. 20.42 Follow-up examination of the fistula after 2 months.** The fistula on the ventral margin of the mandible has healed.



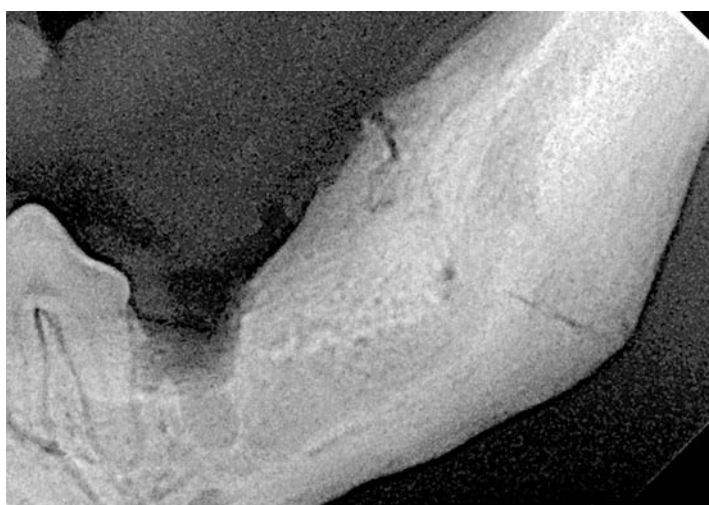
► **Fig. 20.40 Suture.** The alveolar ridge is closed with a vestibular advancement flap and suture, the fistula opening is excised, and the fistulous tract is curretted.



► **Fig. 20.43 Radiographic follow-up after 2 months.** The follow-up radiograph after 2 months shows increased opacity of the fracture area, and the osteolysis is resolving.



► **Fig. 20.41 Follow-up examination of the fracture area after 2 months.** Clinically, the alveolar ridge appears relatively normal after 2 months.



► **Fig. 20.44 Radiograph 5 months later.** In the final radiograph after 5 months, the fracture area is of nearly homogeneous opacity. The reactive distension of the jaw has receded, and the mandibular canal has recovered. As part of the follow-up, a root fragment of the third mandibular molar was removed.



## 20.2

**TMJ Luxation**

TMJ luxation in cats and dogs is usually rostradorsal; the mandibular condyle is luxated forward out of the joint socket. This generally prevents mouth closing. The mandible is deviated, with a midline shift toward the nonluxated side.

**20.2.1 TMJ Luxation in a Dog**

Similar to patellar luxation, TMJ luxation may be intermittent or continual. In the intermittent form, misalignment and wide spacing in the TMJ and loose jaw ligaments can cause the mandibular condyle to shift. The condyle may or may not spontaneously return to the TMJ socket (► Fig. 20.45, ► Fig. 20.46, ► Fig. 20.47, ► Fig. 20.48).



► **Fig. 20.45 TMJ luxation with deviation to the right.** This dog's mandible sometimes deviates to the right, which prevents full mouth closure. After a short time, the luxation resolves, and the dog can close its mouth and eat normally.



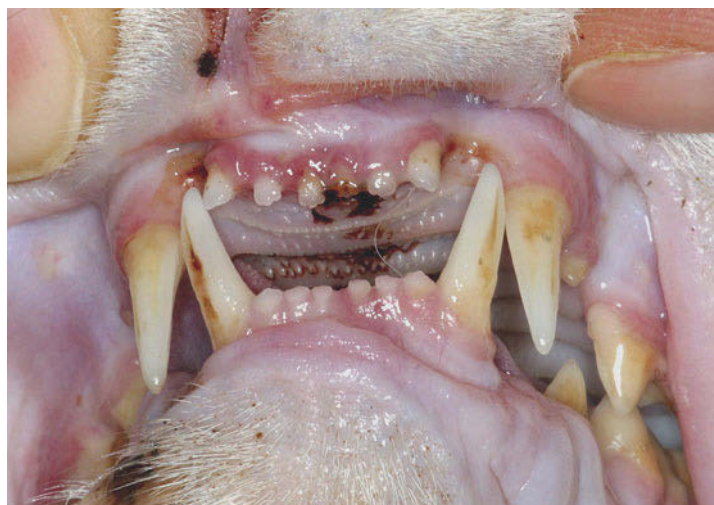
► **Fig. 20.46 Radiograph of the luxated left TMJ, ventrodorsal projection.** The ventrodorsal projection shows rostral displacement of the left mandible in front of the socket. Due to a lack of bony support, this side of the mandible also slides dorsally. The teeth are displaced toward each other, normal occlusion is no longer possible, and the jaw cannot close.



► **Fig. 20.47 Radiograph of left TMJ luxation, lateral projection.** The lateral projection also shows the TMJ luxation rostrally and dorsally.

### 20.2.2 TMJ Luxation in a Cat

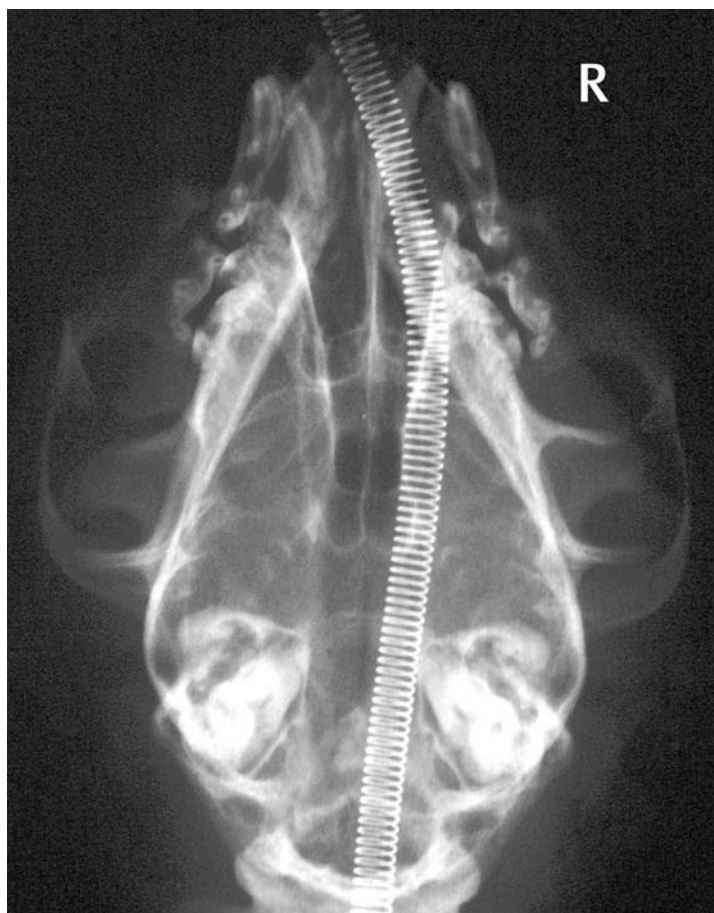
Traumatic TMJ luxation in cats is common. Noninvasive repositioning back to the normal position is often possible (► Fig. 20.49, ► Fig. 20.50, ► Fig. 20.51, ► Fig. 20.52, ► Fig. 20.53, ► Fig. 20.54, ► Fig. 20.55). Prompt action should be taken to replace the mandibular condyle to avoid bone remodeling that could lead to poorer prognosis.



► **Fig. 20.49 TMJ luxation with rostral leftward deviation in a cat.** This cat presented with bleeding from the nose and pharynx after being found in a depressed state. The cat had sustained trauma that impaired mouth closing.

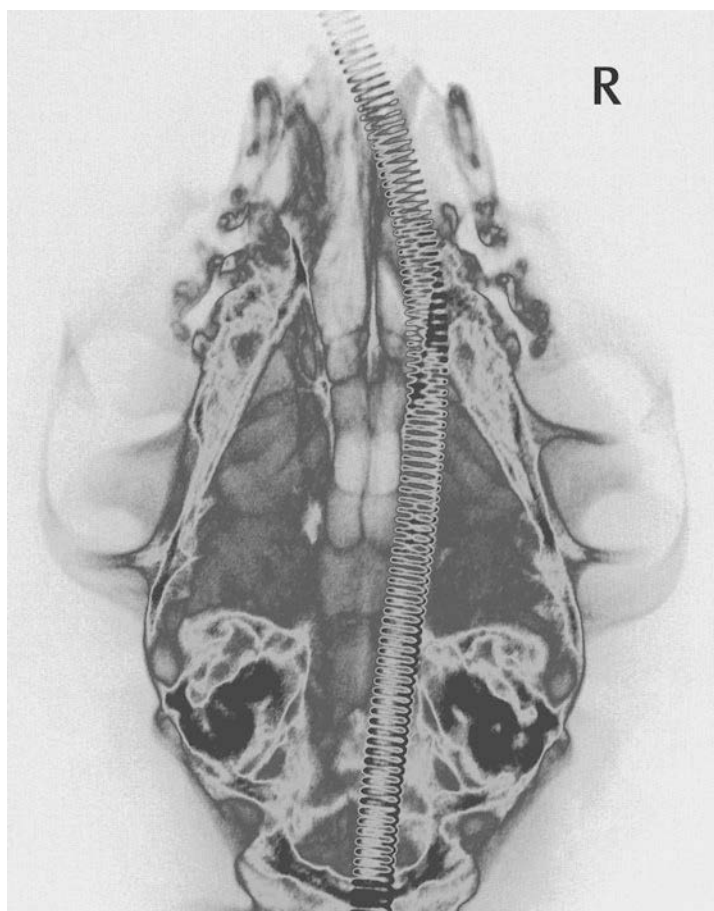


► **Fig. 20.48 3-Dimensional CT reconstruction of the jaw.** Because of its rostral displacement, the left mandibular condyle is visible in the 3D CT image of the bone structures. The intermittent nature of this TMJ luxation is notable. The left TMJ habitually luxates because of the extended opening movement with rostral gliding of the ramus of the mandibular condyle on the articular facet. Further movement of the jaw returns it to its normal position. Intermittent TMJ luxation can result from incongruity of the condyle and joint socket as well as loose ligaments in the TMJ area, which allows the mandibular condyle to move rostrally. The dog did not show signs of pain. No treatment was provided.

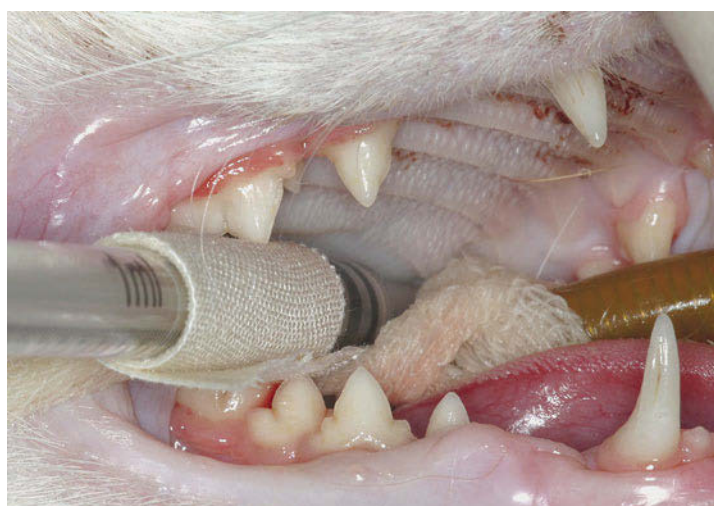


► **Fig. 20.50 Radiograph of the TMJ luxation, ventrodorsal projection.** In the ventrodorsal projection, rostral TMJ luxation is seen on the right side. The right mandibular condyle is located rostral to the TMJ socket, which has resulted in leftward deviation of the mandible.





► **Fig. 20.51 Inverse view of the TMJ luxation radiograph.** The displacement on the right side is clearer in the inverse view. Editing of radiographs often facilitates diagnosis. Digital radiographs are particularly suited to editing.



► **Fig. 20.52 Reduction of the TMJ luxation.** The remedy in this acute case is closed reduction of the mandibular condyle. The procedure involves first placing a pencil or a “non-slip” syringe transversely across the cheek teeth to function as a fulcrum. Upward pressure is applied to the rostral mandible in the area of the mandibular symphysis, which disengages the mandibular condyle from its dorsally luxated position to a more ventral position. At the same time, the rotation of the pencil or syringe shifts the mandible back into place. This may have to be repeated in the event that a blood clot in the TMJ cavity prevents permanent repositioning.



► **Fig. 20.53 Occlusion after repositioning.** After repositioning, occlusion (particularly of the canine teeth) when opening and closing the jaw should be examined. The midlines of the maxilla and mandible should now be vertically realigned.



► **Fig. 20.54 Radiograph after repositioning.** The follow-up radiograph confirms the clinical diagnosis. The mandibular condyle is in its normal position in the TMJ socket.

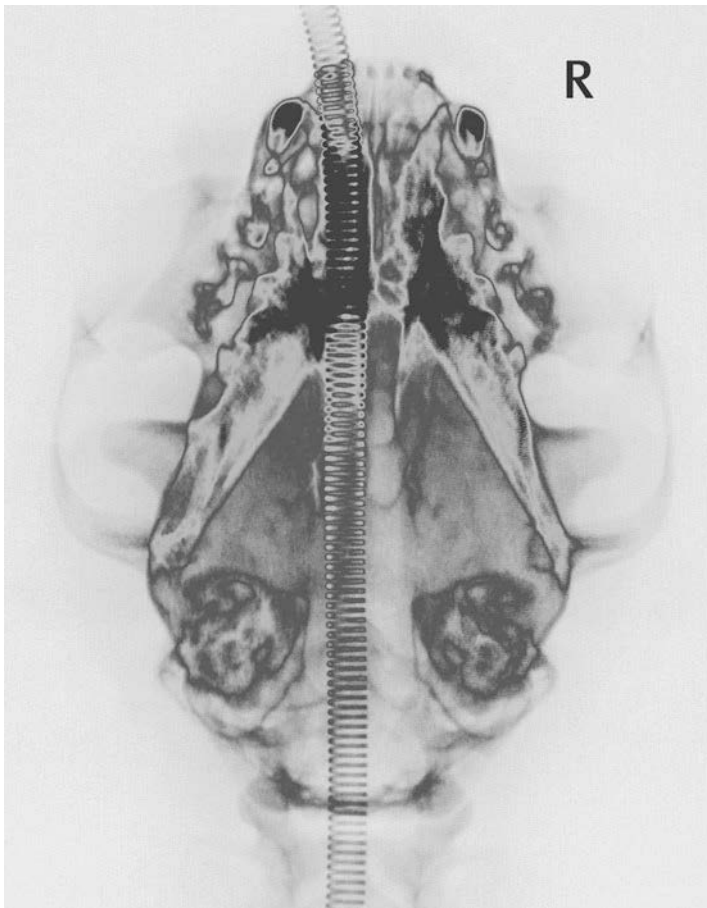
## 20.3

**TMJ Dysplasia**

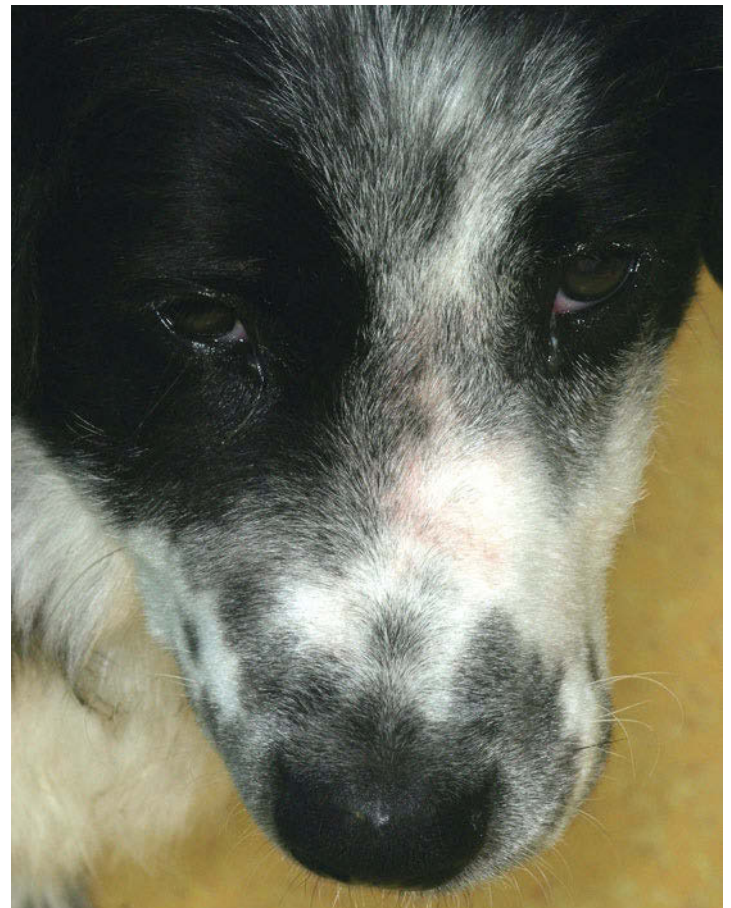
Jaw dysplasia in young animals can be congenital or acquired as the result of a disorder during development. The abnormal bone structures generally cannot be repaired. The focus is restoring jaw function and minimizing inflammation.

**20.3.1 TMJ Dysplasia in a Dog**

The six-month-old dog in the following figures (► Fig. 20.56, ► Fig. 20.57, ► Fig. 20.58, ► Fig. 20.59, ► Fig. 20.60, ► Fig. 20.61) had a crooked nose following trauma as a puppy. This deviation became increasingly apparent as the dog grew.



► **Fig. 20.55** Inverse view of the radiograph after repositioning. The inverse view makes the restored relationships even clearer.



► **Fig. 20.56** Asymmetrical TMJ dysplasia. The trauma to the right maxilla affected development here in particular. The maxilla is shortened on the right and curved to the right.





► **Fig. 20.57 Malocclusion due to TMJ dysplasia.** Intraorally, the underdeveloped maxilla shows a crossbite of the incisors. The maxilla is displaced to the right, but jaw opening is not itself impaired.



► **Fig. 20.59 Teeth 108 and 109 after cleaning.** Rough scaling of the calculus reveals a dark discoloration of the teeth.



► **Fig. 20.58 Severe plaque accumulation on the maxillary right cheek teeth.** The maxillary right cheek teeth, in contrast to the other teeth, show severe accumulation of plaque and calculus. The carnassial tooth is also rotated. The severe calculus on individual teeth usually results from the animal avoiding use of the problematic teeth. The patient chews on the healthy, pain-free side, while bacteria accumulate on the affected side and gingivitis develops.



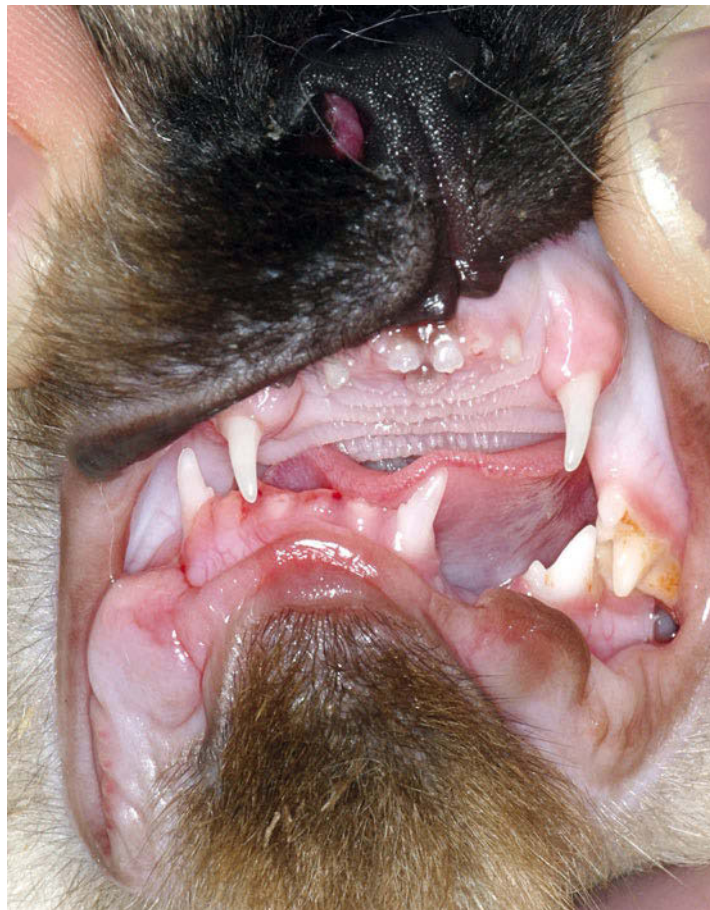
► **Fig. 20.60 Radiograph of the region around tooth 108.** The radiograph shows suspended development of the immature teeth. Root formation is suspended, and the distal root of the carnassial tooth and the roots of the maxillary first molar cannot be seen. Instead, extensive osteolysis is present.



► **Fig. 20.61 Intraoperative radiograph after extraction.** The radiograph verifies complete removal of the maxillary carnassial tooth and the molars. The full extraction of the teeth favors uncomplicated healing of the surgical area. This should eliminate any potential inflammation in the future. Correcting the crooked nose is neither possible nor necessary.

### 20.3.2 TMJ Dysplasia in a Cat

This four-month-old cat has not been able to open its jaw since birth (► Fig. 20.62, ► Fig. 20.63, ► Fig. 20.64, ► Fig. 20.65). The jaw cannot be actively or passively opened any further, nor can it close. The overall opening is restricted to 1 cm. Since the mandible is fixated to the skull in a semiopen position, the cat is able to eat and develop.

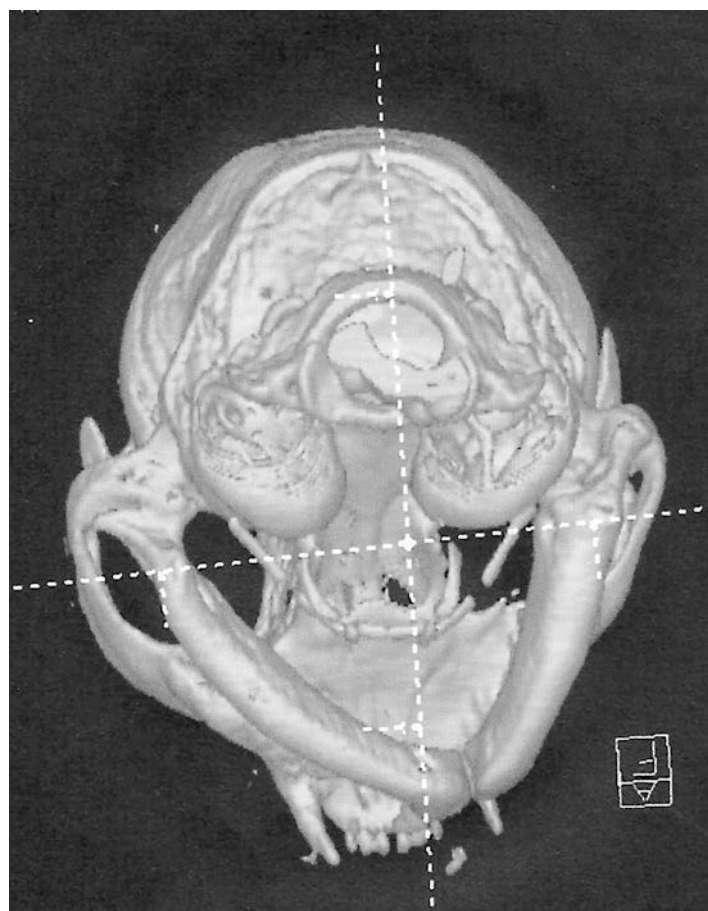


► **Fig. 20.62 Restricted mouth opening due to TMJ dysplasia.** The mandible deviates dramatically to the right, and at this point, the occlusion of the deciduous teeth is essentially irrelevant because the mandible is completely immobilized.





► **Fig. 20.63 Ventrodorsal radiograph of the skull.** This radiograph of the skull shows increased radiopacity near the right TMJ. The mandible is clearly deviated to the right.



► **Fig. 20.64 Radiograph of the TMJ using shaded surface display (SSD).** In the CT reconstruction of the bone structures, the right TMJ is dysplastic. Instead of the normal hinge movement of the cat's horizontally located mandibular condyle, the movement is restricted by caudodorsal extension on the mandibular condyle. In addition, some areas of the TMJ may have fused but cannot be seen in this imaging mode.



► **Fig. 20.65 Improved jaw opening after severing the ramus of the mandible.** Since full removal of the right mandibular condyle is not feasible due to possible fusion in the articular space, the ascending ramus of the mandible is instead severed. This releases the lock and allows the mandible to open and close. A continuous movement of the operated jaw creates a "pseudojoint" so that the cat's jaw moves unhindered even years later. Cheek teeth were extracted because of their abnormal, nonfunctional position to prevent the development of periodontitis.







## Part 4 Appendix

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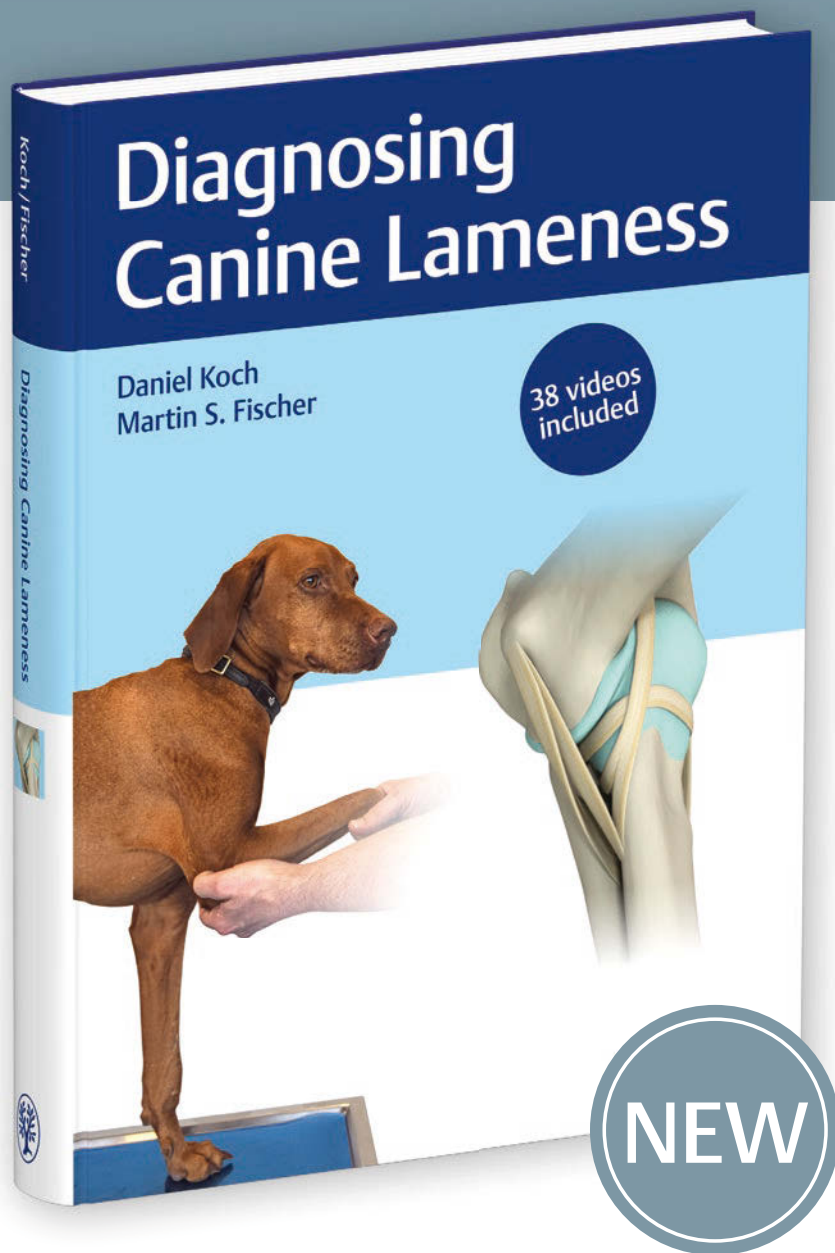
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