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Every effort has been made to ensure that the drug dosage schedules within this text are accurate and conform to standards accepted at time of publication. However, as treatment recommendations vary in the light of continuing research and clinical experience, the reader is advised to verify drug dosage schedules herein with information found on product information sheets. This is especially true in cases of new or infrequently used drugs.

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Dedicated to Marion and to all those who dug in the dirt with me when I was young

Series Preface

The Practical Veterinarian series was developed to help veterinary students, veterinarians, and veterinary technicians quickly find answers to common questions. Unlike larger textbooks, which are filled with detailed information and meant to serve as reference books, all the books in The Practical Veterinarian series are designed to cut to the heart of the subject matter. Not meant to replace the reference texts, the guides in this series complement the larger books by serving as an introduction to each topic for those learning the subject matter for the first time or as a quick review for those who have already mastered the basics of each subject.

The titles for the books in our series are selected to provide information for the most common subjects one would encounter in veterinary school and veterinary practice. The authors are experienced and established clinicians who can present the subject matter in an easy-to-understand format. This helps both the first-time student of the subject and the seasoned practitioner to assess information often difficult to comprehend.

The editor and authors hope that the books in The Practical Veterinarian series will meet the needs of readers and serve as a constant source of practical and important information. We welcome comments and suggestions that will help us improve future editions of the books in this series.

Shawn P. Messonnier, D.V.M.

Preface

Dentistry is a discipline that has long been ignored as an important part of veterinary medicine, but a few brave pioneers recognized its necessity in the lives of pets more than 25 years ago. Borrowing knowledge and experience from human dentists, these veterinarians forged a new field by building on the similarities and differences between the teeth of people and the teeth of animals. We may all thank this handful of veterinary dentists for persevering in the idea that an intimate relationship exists between the health of an animal's mouth and the systemic health of that animal.

Modern veterinary dentistry is an exciting and rapidly evolving field, rivaling human dentistry in its sophistication and scientific advancement. The same preventative oral care and advanced procedures that have made the lives of so many people better are now available for animals. It is possible to give our veterinary patients the pain-free functional mouths they deserve, instead of letting them suffer silently. Today's veterinary dental care is aimed at increasing both the quality and quantity of animals' lives by making sure that their oral cavities are as healthy as possible.

In our continuing efforts to expand and improve the scope and quality of medical services offered, we must take full advantage of the benefits that complete oral care provides. Dentistry, in its many forms, from annual preventative cleanings to daily brushing to advanced pain-relieving procedures such as root canal therapy, is a natural extension of our commitment to patient wellness and aggressive pain management. We should not wait until the animal shows us the sign we are looking for to tell us that its mouth hurts but rather anticipate the discomfort that similar dental problems would cause in our own mouths.

It is my sincere hope that the following material will reveal the necessity of dental care in every animal's life. One day, I am sure, the "benign neglect" that many veterinarians have shown to the oral cavity will be regarded as below the standard of care by all conscientious practitioners. As the advocates for the pet, we have the duty to find all diseases threatening health and treat them appropriately and timely. With the essential discipline of dentistry, it simply starts with lifting the lip.

P.Q.M.

Acknowledgments

I am grateful to so many people for the support, encouragement, and knowledge they have imparted to me. Many of these generous people have done so without knowing fully how much of a difference they have made in my career and my life. I am entirely convinced that something valuable may be learned from everyone associated with the field of veterinary dentistry, no matter what their skill level or knowledge base, if only we are open and observant. I can only hope that this book accurately reflects some of the ideas of the practitioners of this fine craft I have been privileged to observe.

Above everyone else, I owe my greatest debt of gratitude to my mentor, inspiration, and friend, Dr. Robert Wiggs. There is no finer teacher and no greater proponent for the advancement of what has truly grown into a science and an art. He is the expert's expert, and I count myself exceptionally fortunate to have been one of his residents. My fondest hopes throughout my career in veterinary dentistry continue to be to live up to his high standard of excellence, to teach others through his tireless and selfless example, and to add my own contribution to the field on which Dr. Wiggs has left his unmistakable imprint.

1

Introduction

This book is meant to be your introduction to the vibrant and satisfying field of veterinary dentistry. It is both a quick reference and a tutorial in the basics, to help the reader gain proficiency in the recognition of common dental problems and to build confidence in the recommendation of proper treatment options. This book is not an exhaustive treatment of all of the subdisciplines of dentistry, but is designed to spur the interested reader on to more involved texts, such as the following:

Harvey CE, Emily PP. *Small Animal Dentistry*. Philadelphia: Mosby, 1993.

Holmstrom SE, ed. Canine dentistry. *Vet Clin North Amer Sm Anim Pract.* 1998;28(5):1049–1324.

Holmstrom SE, Frost P, Eisner ER. *Veterinary Dental Techniques*, 2nd ed. Philadelphia: Saunders, 1998.

The Journal of Veterinary Dentistry.

Kertesz P. *A Colour Atlas of Veterinary Dentistry and Oral Surgery*. Aylesbury, England: Wolfe, 1993.

Mulligan TW, et al. *Atlas of Canine and Feline Dental Radiography*. Trenton, NJ: Veterinary Learning Systems, 1998.

Verstraete FJ. *Self-Assessment Color Review of Veterinary Dentistry*. Ames: Iowa State University Press, 1999.

Wiggs RB, Lobprise HB. *Veterinary Dentistry: Principles and Practice*. Philadelphia: Lippincott-Raven, 1997.

Dentistry is a field that has long been overlooked in the care of veterinary patients. There has been a glaring lack of emphasis on both the routine preventative oral care for animals and the advanced tooth-saving procedures that are commonplace in modern human dentistry. Although there are differences in tooth size, shape, and number, the teeth of our domestic pets are very similar to our own. Our patients are subject to dental problems much like those that plague human mouths. Because our patients cannot speak and rarely show obvious signs of oral pain, it is up to the veterinarian, as the advocate for the animal, to aggressively identify and treat dental disease.

The veterinary dental newcomer must first strive to understand what is normal for our patients' mouths by becoming reacquainted with oral anatomy. The anatomy chapter is designed not only to provide a tutorial on anatomical normalcy, but also to go further, into the logical progression of the complete oral exam. Because a veterinarian may only get a few seconds to look into the mouth of a dog or a cat, it is critical that that time is well spent actively looking for aberrations of normalcy. Also included in this chapter is a list of twenty oral disease processes that are considered to be the minimum acceptable level of diagnostic proficiency.

Beyond the visual inspection of the teeth and other oral structures, the student of veterinary dentistry must also master intraoral radiography. The information gleaned from these detail films cannot be gained from any other source. The teeth simply cannot be fully evaluated without knowing about the health status of the roots and their supporting bone. The beginner can use the technique provided in the radiology chapter to ease into the world of intraoral radiographs. Such a vital tool is close at hand to most, if not all, veterinary hospitals.

Above all else the goal of modern comprehensive veterinary dentistry should be the prevention of oral disease and the preservation of healthy teeth. The periodontics chapter provides solid prevention and treatment recommendations as well as providing a detailed description of the routine dental cleaning. The endodontics chapter discusses the saving of teeth that might previously have been extracted and describes the steps involved with a root canal procedure. It is essential that everyone understand what root canal therapy is and how it can be so helpful at saving diseased teeth and rendering them painfree.

Tooth extraction is a large part of veterinary dentistry and its proper execution requires continual improvement of technique so that the patient can be spared as much trauma and pain as possible. The oral surgery chapter explains the deliberate steps needed to extract teeth with confidence and success. Great attention must be paid to how the oral surgeon leaves the mouth following surgery. The goal of a tooth extraction is not simply to remove the tooth from the mouth, but also to carefully respect the soft tissues of the oral cavity and to close the defect appropriately. To aid the newcomer to surgical extractions and oral surgery as a whole, a separate chapter on specialized instruments provides a look at some of the most useful tools for work in the oral cavity.

The relationship of the teeth to one another and the pain that is caused by abnormalities in the bite of a dog or cat is discussed in the orthodontics chapter. The pain that malocclusions can cause is emphasized in this chapter. A dental malocclusion can be much more than a cosmetic problem and one that can have far reaching consequences if not recognized and addressed. This chapter also discusses the ethical concern involved with orthodontic treatment.

Too many veterinary students and graduate veterinarians have accepted a sustained level of ignorance for all things dentally related to their patients and it is this book that seeks to begin the undoing of such ignorance. A quick reference and glossary are available in the back of the book to gain fast answers. We know too much to allow such oral disease to continue unchecked and untreated. As the reader moves through the following pages, may they gain a sense of the magnitude of the pain and suffering pets have endured unnecessarily. And further may they develop a keen desire to find and right the dental and oral maladies they shall see every day in practice.

2

Anatomy and the Oral Exam

Anatomy

Dentistry has its own language, and the newcomer must learn the terminology. Knowledge of the proper terms will greatly enhance both your appreciation of dentistry and your ability to share your findings with others. It is important to be precise to avoid causing confusion or spreading misinformation, especially when consulting with or referring to a specialist.

Directional Terms

The oral cavity has a few directional terms that are very important to understand so that structures or lesions can be properly oriented in the mouth. Because the teeth are arranged in arches or arcades, the terms *rostral* and *caudal* are not used to describe the teeth. Instead, the term *mesial* is used to describe a tooth or tooth surface that is toward the imaginary centerline of the dental arcade. Likewise, the term *distal* is used to describe a tooth or tooth surface that is away from the imaginary centerline of the dental arcade. The maxillary right canine tooth, for example, is said to be distal to the maxillary right third incisor tooth.

Another important set of directional terms relates to adjacent oral structures, such as the palate, tongue, cheek, or lip, giving the following terminology:

Palatal: Toward or adjacent to the palate.

Lingual: Toward or adjacent to the tongue.

Buccal: Toward or adjacent to the cheek (primarily used for premolar and molar teeth and their associated structures).

Labial: Toward or adjacent to the lip (primarily used for the incisor and canine teeth and their associated structures).

Facial: Toward or adjacent to the face (a combination of buccal and labial to be used for all teeth).

When describing an individual tooth, the terms *coronal* and *apical* denote directions toward the crown and toward the apex of the root, respectively. Other terms, such as *occlusal*, the chewing or grinding surface of a tooth, and *proximal*, the touching surfaces of two adjacent teeth, can be used to further define a dental lesion.

Types of Teeth

There are four major types of teeth: incisors, canines, premolars, and molars. Each tooth type is designed for specific purposes:

Incisors: For gnawing and grooming.

Canines: For grasping and tearing.

Premolars and *molars:* For shearing and grinding.

The maxillary fourth premolar teeth and the mandibular first molar teeth are also known as *carnassial*, or "flesh-shearing," *teeth*.

Tooth Numbering Systems

Dental notation systems were created to help in the written communication of dental problems. These systems are meant to simplify medical record keeping, and the two most used in veterinary dentistry are the anatomic system and the modified triadan system.

The *anatomic system* uses a letter to designate the tooth type (lower case for deciduous or primary teeth and upper case for permanent or adult teeth) as well as an appropriately positioned subscript or superscript to designate both the tooth's location and quadrant:

C^1: Maxillary right permanent canine tooth.

$_3I$: Mandibular left permanent third incisor tooth.

^2p: Maxillary left primary second premolar tooth.

i_2: Mandibular right primary second incisor tooth.

The *modified triadan system* uses a three-digit code to identify each tooth in a patient's mouth. The first digit designates the quadrant in which the tooth is located and the last two digits designate the tooth's location within that quadrant, always starting with the central incisor and moving distally.

Quadrant designations for the first digit are as follows:

1: Right maxillary (permanent).

2: Left maxillary (permanent).

3: Left mandibular (permanent).

4: Right mandibular (permanent).

The primary dentition can also be designated with the following quadrant digits:

5: Right maxillary (primary/deciduous).

6: Left maxillary (primary/deciduous).

7: Left mandibular (primary/deciduous).

8: Right mandibular (primary/deciduous).

When the last two digits are added to the quadrant digit, a unique code is created for each tooth:

104: Right maxillary permanent canine tooth.

201: Left maxillary permanent first incisor tooth.

308: Left mandibular permanent fourth premolar tooth.

411: Right mandibular permanent third molar tooth.

502: Right maxillary primary second incisor tooth.

704: Left mandibular primary canine tooth.

Tooth Anatomy

The tooth is externally divided into three main sections (Figure 2-1):

Crown: The crown is the enamel-covered portion of a tooth and normally the only part of the tooth to stick up above the gingival margin. The tip of the crown is known as the *cusp* of the tooth.

Root: The root is the portion of a tooth normally below the gingival margin. A hard, thin layer, called

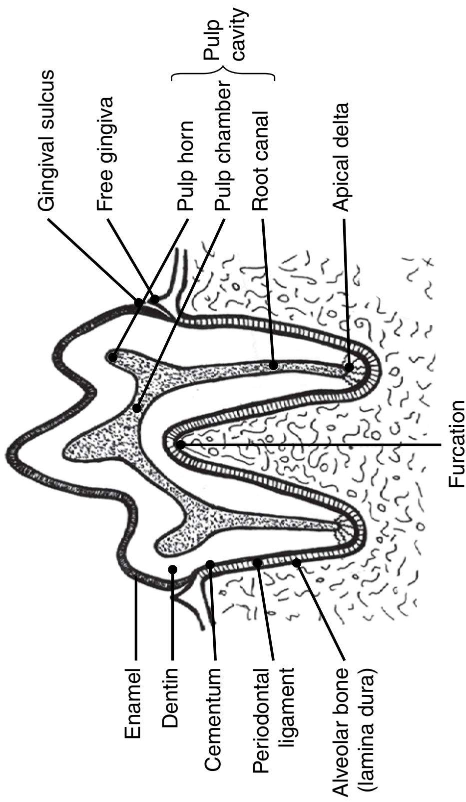


Figure 2-1 Diagram of pertinent cross-sectional tooth anatomy.

cementum, covers it. The tip of the root is known as the *apex*. The furcation is the area where the roots begin to divide in multiple-rooted teeth.

Neck: The junction of the crown and root is the neck of the tooth, and the normal gingiva attaches here.

Dentin

Dentin is the main bulk of tooth substance beneath enamel or cementum. Different types of dentin can be produced:

Primary dentin: This is the dentin that is present at the time of tooth eruption.

Secondary dentin: This is the dentin normally added to the inside walls as a tooth matures. It is produced by healthy odontoblasts and forms in tubules. These tubules make dentin somewhat porous, looking like Swiss cheese on cross section when magnified.

Tertiary or reparative dentin: Tertiary dentin is laid down within a tooth in response to gradual wear or minor pulpal trauma.

Pulp Cavity

The pulp cavity is the internal hollow portion of a tooth:

Pulp chamber: The pulp chamber is the portion of pulp cavity within the crown of a tooth.

Root canal: The root canal is the portion of pulp cavity within the root of a tooth.

Dental pulp: The pulp is a collection of blood vessels, nerves, lymphatics, and connective tissue contained within the pulp cavity.

Apical Delta

The apical delta is the area of the root apex through which vessels and nerves pass. This is both a portal area of entrance to and exit from the pulp cavity. Primates have a single portal known as an apical foramen, but dogs and cats have many tiny portals.

Periodontium

The periodontium is the collection of hard and soft tissues that supports the roots and allows for the retention of the teeth within the mouth. There are four major components of the periodontium:

Gingiva: The gingiva is the soft tissue that protects the roots of teeth from the oral cavity proper. The free gingival margin is the edge of the gingiva normally overlying the base of the crown of a tooth. A valley is created between the free gingiva and the tooth, known as the *gingival sulcus.* The gingival sulcus normally is 1–3 mm deep in the dog and 0.5–1 mm deep in the cat. The attached gingiva is the portion firmly adherent to underlying bone, extending to the mucogingival junction.

Cementum: The cementum is the hard covering of the tooth root and attaches to the periodontal ligament.

Periodontal ligament: The periodontal ligament is a network of fibers that attach the cementum of the tooth root to the alveolar bone. It acts as a shock absorber for the tooth within the bony socket as an animal uses its teeth and also resists the tooth from pulling out of the alveolus.

Alveolus: The alveolus is the bony socket that holds and supports the tooth root through its connection to the periodontal ligament.

Occlusion

The normal occlusion of the teeth allows for both full function of the teeth and oral comfort. The teeth have important relationships to one another to make proper occlusion possible:

Incisor relationship: The maxillary incisor teeth should be positioned slightly labial to the mandibular incisors and they should overlap in a "scissors" bite.

Canine relationship: The mandibular canine tooth should flair labially, so that its cusp can fit in the space or diastema between the maxillary third incisor and the maxillary canine tooth without touching either tooth (Figure 2-2).

Premolar relationship: Each of the cusps of the maxillary premolar teeth should be directed toward the diastemae (the spaces between the teeth) of the opposing mandibular premolar teeth and vice versa, creating a "pinking shears" effect within the *premolar free space.*

Carnassial relationship: The maxillary fourth premolar tooth should occlude buccal to the mandibular first molar tooth.

Molar relationship: The occlusal surface of the maxillary molars should occlude with the occlusal surface of the mandibular molars to allow for effective grinding.

The Complete Oral Exam

Preoperative Exam

The preoperative oral exam can be done in the exam room in front of the client. It is important to be as thorough as possible so that an accurate treatment plan and financial estimate can be developed for the client. It is often helpful and rewarding to involve the client in this initial oral exam. The term *codiagnosis* is used to describe this activity in human dentistry, and it has been shown to

Figure 2-2 A model of a dog's mouth showing the proper canine occlusal relationship. The mandibular canine tooth should flair facially and fit between the maxillary third incisor and maxillary canine teeth without touching either.

be a much more rewarding experience for both the doctor and the patient. The more the client understands the problem the more he or she is willing to work at treating it appropriately.

To completely evaluate the oral cavity it is important to begin by fully assessing these extraoral parameters and structures:

Facial symmetry: Use your fingers to palpate the nasal bones and maxilla as well as the zygomatic arches. A difference seen or felt between the two halves of a face often signifies a problem.

Facial swelling: Frequently, facial swelling is due to dental problems, especially suborbital swelling. Although abscess of the maxillary fourth premolar tooth root(s) is commonly associated with suborbital swelling, facial swelling may be due to problems with the maxillary molar teeth, maxillary canine teeth, tumors and nondental causes.

Draining tracts: Draining tracts may be a good indication of severe endodontic disease or buried foreign bodies. These should be carefully inspected and probed as the patient permits.

Ophthalmic Exam

Due to the significant link between oral disease and ophthalmic disease, it is essential to closely examine the eyes in search of extension of dental problems. Retropulsion of the globes can be of use when looking for retrobulbar disorders.

Otic Exam

No body part on the head should be overlooked, especially with regard to malodor and sources of infection that can be confused with oral disease.

Lymph Node Palpation

It is very helpful to become reacquainted with the anatomy of the head and neck to differentiate between what is normal and abnormal for that animal and also between the lymph nodes and the salivary glands.

Salivary Gland Palpation

Salivary gland size and consistency are important to discern as well as any tenderness.

Nasal Discharge

The examiner should seek to clarify as much as possible any abnormal nasal discharge. Color, amount, viscosity, unilateral vs. bilateral, and chronicity all are very important considerations. A small mirror can be used to look for condensation from the warm air from the nostrils to determine any decreased airflow and, hence, obstruction.

Lip Fold and Lip Margins

This area is especially important to examine in such breeds as spaniels and golden retrievers, as they are particularly prone to lip fold pyoderma. It is essential to differentiate intraoral halitosis from the foul, fetid odor of infected lip folds, to make sure that a vital part of the presenting complaint is not overlooked and consequently not treated. Mucocutaneous zones are also prime spots for the detection of a number of autoimmune diseases.

General Physical Exam

Since oral disease is a systemic disease and the proper treatment invariably involves general anesthesia, it is imperative to consider the entire animal.

The preoperative oral exam also involves intraoral structures and parameters.

Occlusion

The most important question to ask is, Does this animal have a comfortable bite? Abnormal tooth-on-tooth contact or abnormal tooth-on-soft-tissue contact must be considered a painful situation. Consider each of the types of teeth and their relationships to one another:

Incisors: Look for a proper scissors bite, except in brachycephalic breeds, which may have pronounced alterations from mesatocephalic “normals.” In these breeds, it is important to look for tooth-on-tooth or tooth-on-soft-tissue contact to determine the relative comfort of the occlusion.

Canines: Examine the soft tissue of the palate to look for palatal ulcerations from displaced mandibular canine teeth (Figure 2-3). Hold the mouth closed, just lifting the lips, to look at the canine occlusal relationship. Check to see if the mandibular canine teeth touch the maxillary canine teeth or maxillary third incisor teeth.

Premolar free space: Look for the proper pinking shears relationship. If the cusps of the opposing premolars point to each other, it suggests a problem with relative length of the maxilla or mandible.

Carnassial teeth and molars: Look for the maxillary fourth premolar tooth to overlap the mandibular first molar tooth on the buccal side and examine the occlusal surfaces of the molars for signs of abnormal wear.

Gingiva

The gingiva should be examined for redness, swelling, or discharge, especially at the gumline of maxillary premolar and molar teeth. Fistulation apical to the mucogingival junction (MGJ) suggests periodontal abscess, whereas fistulation coronal to the MGJ suggests endodontic abscess (Figure 2-4).

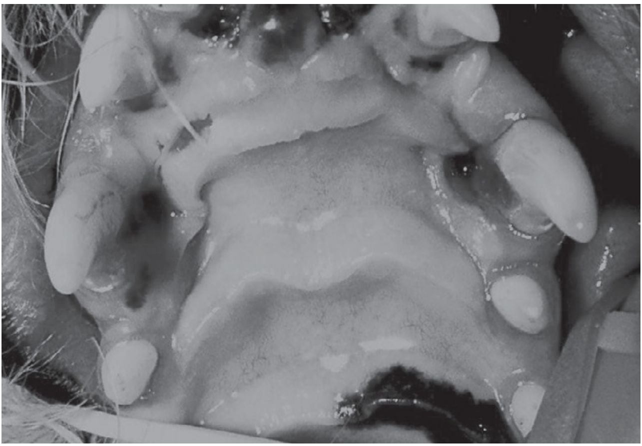


Figure 2-3 The palate of a dog with a mandibular canine malocclusion (linguoversion). The chronic contact of the cusps of the mandibular canine teeth caused ulcerations, periodontal defects, and attrition of the maxillary canine teeth.

Figure 2-4 A cat's mouth with severe periodontic and endodontic disease. The fractured left maxillary canine tooth lead to an endodontic abscess and a draining tract at the mucogingival junction. There is also purulent material at the gingival margin of this canine tooth.

Supragingival Tartar and Plaque

Ultraviolet light shown on the teeth in a darkened exam room may clearly reveal deposits of tartar and plaque through fluorescence of the porphyrins of the oral bacteria.

Mucosa

The mucosa should be examined for redness, swelling, or discharge. The buccal mucosa that contacts the maxillary teeth should be examined closely for ulcerations, known as *kissing lesions.*

Missing Teeth

The teeth should be counted, and all missing teeth should be accounted for through previous extraction or previous radiographic survey. The distinct possibilities of unerupted teeth, dentigerous cysts, or neoplasia should be considered for any “missing” teeth (Figure 2-5).

Fractured Teeth

Look closely to determine if the pulp cavity has been exposed.

Breath Odor

Take care not to confuse intraoral halitosis from odor caused by lip fold pyoderma or severe otitis.

Figure 2-5 The right rostral maxilla of a dog with a "missing" right maxillary canine tooth. There is a slight gingival swelling at the site where the tooth should be. It is safest to assume the tooth is present in an unerupted state until proven otherwise. An impacted tooth left untreated can cause a myriad of problems, including dentigerous cyst, odontoma, and other destructive processes.

Tongue and Sublingual Area

Use a thumb to pry open a cat's mouth and the middle finger to elevate the floor of the mouth, looking for linear foreign bodies wrapped around the base of the tongue. Also look for masses under the tongue.

Palate

Look for ulceration or erosion as well as foreign bodies, such as sticks.

Jaw Range of Motion, Awake

The range of motion should be smooth and not painful, but some normal animals may greatly resist manipulation and not permit proper evaluation.

Intraoperative Exam

The complete evaluation of oral health requires anesthesia for safety, immobilization, and proper visualization. Once anesthetized a patient's mouth can be evaluated by focusing on all the following important orodental structures and parameters.

Jaw Range of Motion, Anesthetized

The range of movement should be smooth, full, and uninhibited. It is sometimes helpful to auscult the joint with a stethoscope placed over the side of the head while the joint is manipulated. Listen for abnormal clicking and popping.

Gingiva

The gingiva should be carefully examined for redness, swelling, or discharge as well as any mass or abscess.

A periodontal probe should be used that is accurate and easy to read. Several spots around each tooth should be measured gently. The operator must take care not to damage the delicate gingival attachment with rough use of the probe.

The bleeding index is a subjective measure of periodontal disease. The examiner should note how easily the gingiva bleeds when touched or probed.

The entire mucosal lining of the oral cavity should be carefully examined for swelling, redness, or discharge. The mucosa should be examined for masses, draining tracts, ulceration, and foreign bodies.

Tonsils

The tonsils should be examined for redness and swelling, noting the surface texture as well as any masses.

Palate

The palate should be examined for ulceration, erosion or burns from chemicals or electrical cords, and trauma from mandibular canine malocclusion. The palate should also be examined for clefts, either congenital or traumatic, foreign bodies, such as sticks that tend to lodge between the maxillary fourth premolar teeth, and masses. It is very important to become well acquainted with the incisive papilla. The incisive papilla is a normal anatomic structure centrally located on the rostral palate, just caudal to the maxillary incisors. This raised lump of tissue continues to be confused for neoplasia and biopsied unnecessarily, sometimes with disastrous results.

Tongue and Sublingual Space

The surface of the tongue and its margins should be examined for swelling, redness, and ulceration. The tongue should be palpated to discern consistency and pliability of the tongue musculature, searching for neoplasia (Figure 2-6) and buried foreign bodies. The undersurface of the tongue should be examined for swelling from mucocele or ranula and tumor as well as any linear foreign body wrapped around the base of the tongue that may cut through the lingual frenulum.

Crowns

SUPRAGINGIVAL TARTAR AND PLAQUE The air from an air/water syringe can be used to dry the surface of the tooth in search of calculus deposits, which show up as

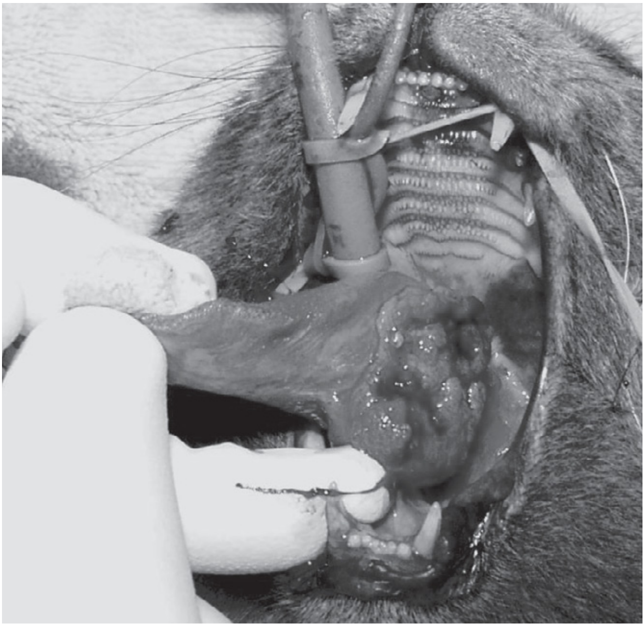


Figure 2-6 A cat's tongue with an ulcerated sublingual mass. Although linear foreign bodies should always be considered with sublingual lesions in cats, the degree of proliferation and its location are highly suggestive of feline oral squamous cell carcinoma.

chalky residue. This air can also be used to gently move the free gingival margin from the tooth to get a clearer view of the subgingival area.

FRACTURE EXPLORATION A fine instrument, such as an explorer (Figure 2-7) or a small diameter endodontic file, known as a *pathfinder*, is used to determine pulpal exposure on teeth that have been worn or fractured. It may sometimes be difficult to differentiate between a worn tooth sealed with tertiary or reparative dentin and a chronic pulpal exposure blocked with debris. Tertiary dentin tends to be golden brown in color and is hard and smooth. A tooth that cannot be penetrated with an explorer tip cannot be ruled out entirely for pulpal exposure. The examiner should always consider intra-oral radiography for any tooth with questionable pulpal exposure.

CARIES, PROBING WITH A FINE EXPLORER Any focal area of enamel discoloration should be explored with the sharp end of the explorer probe, especially the occlusal surfaces of the molar teeth. Normal enamel resists the sharp explorer, but the softer carious enamel and dentin allow the explorer to "stick." The removal of the explorer from a cavity feels like it is being pulled free from taffy.

RESORPTIVE LESIONS When examining the crowns of cats in particular it is necessary to look for gingiva that

Figure 2-7 A fractured right maxillary fourth premolar tooth with pulpal exposure in a dog. The explorer is used to see if the sharp tip can gain entry into the tooth to confirm pulpal exposure.

appears to be migrating coronally from the free gingival margin. This is very suggestive of feline resorptive lesions and may be confirmed with careful exploration and intraoral radiography.

DISCOLORATION The crowns should be closely examined for any alteration in color, such as pink, purple, beige, or gray. Tooth discoloration may be suggestive of endodontic disease, and such a tooth should be radiographed.

WEAR, ATTRITION AND ABRASION Wear on any of the teeth may be due to rock chewing, toy play, or malocclusion.

MOBILITY A finger can be used to palpate teeth to look for excessive mobility, in some cases this can be done in the exam room with cooperative patients as part of the preoperative oral exam.

Roots

SUBGINGIVAL TARTAR AND PLAQUE The air from the air/water syringe may be used to gently blow away the free gingival margin to examine the subgingival regions, as described previously. An explorer may be used cautiously to feel for the roughness of subgingival calculus deposits.

ROOT EXPOSURE A periodontal probe should be to measure any root exposure from the gingival margin to the cementoenamel junction of the tooth.

FURCATION EXPOSURE The periodontal probe may also be used on multirooted teeth to examine for bone loss in the furcation area (Figure 2-8). Furcation exposure, when present, can be categorized, based on severity. In Stage I furcation involvement, the probe tip can locate the furcation but cannot be inserted further. With Stage II, the probe is able to penetrate between the roots at the furcation but does not go all the way through to the other side of the tooth. In Stage III, the probe can be gently inserted all the way through a furcation area, showing a complete loss of bone in this region.

ROOT FRACTURE Crown fractures that extend subgingivally and teeth that are unstable from trauma suggest root fracture and should be radiographed.

Intraoral Radiography

Intraoral radiographs are indicated for accurate and complete evaluation of any of these possible orodental problems:

- Fractured or discolored teeth.
- Persistent primary or retained deciduous teeth.

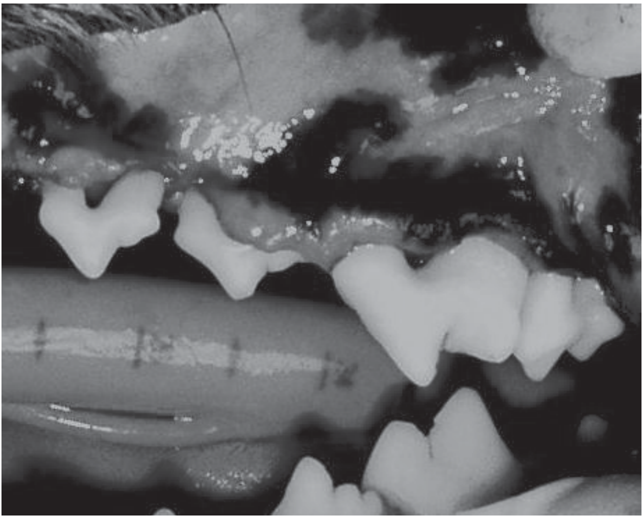


Figure 2-8 The left maxillary cheek teeth in a dog with marked periodontal disease. All these maxillary teeth show exposure of their furcations. The gingival recession and subsequent root exposure make the furcations even more exposed.

- Unexplained edentulous areas.
- Oral masses.
- Deep periodontal pockets.
- Resorptive lesions.
- Oral fracture.
- Furcation or root exposure.
- Draining tracts.
- Penetrating foreign body.
- Nonhealing extraction site.
- Temporomandibular joint dysfunction.

Twenty Things You Must Be Able to Recognize

1. Fractured tooth and treatment options: endodontics or extraction.
2. Periodontal disease: signs, prevention, and treatment.
3. Retained deciduous teeth.
4. Malocclusion.
5. Feline resorptive lesions.
6. Carious lesions.
7. Discolored tooth and treatment options: endodontics or extraction.

8. Oral foreign body (Figure 2-9).
9. Oral neoplasia and gingival hyperplasia.
10. Oral fracture and trauma.
11. Oronasal and oroantral fistulae.
12. Deep palatal pockets associated with maxillary canine teeth.
13. Carnassial tooth root abscess and associated suborbital swelling.
14. Endodontic vs. periodontal abscesses with mucosal or gingival fistulation.
15. Lip fold dermatitis.
16. Enamel hypoplasia or hypocalcification.
17. Attrition and reparative (tertiary) dentin.
18. Salivary mucocele or ranula.
19. Lymphocytic plasmacytic stomatitis (LPS).
20. Temporomandibular joint dysfunction.

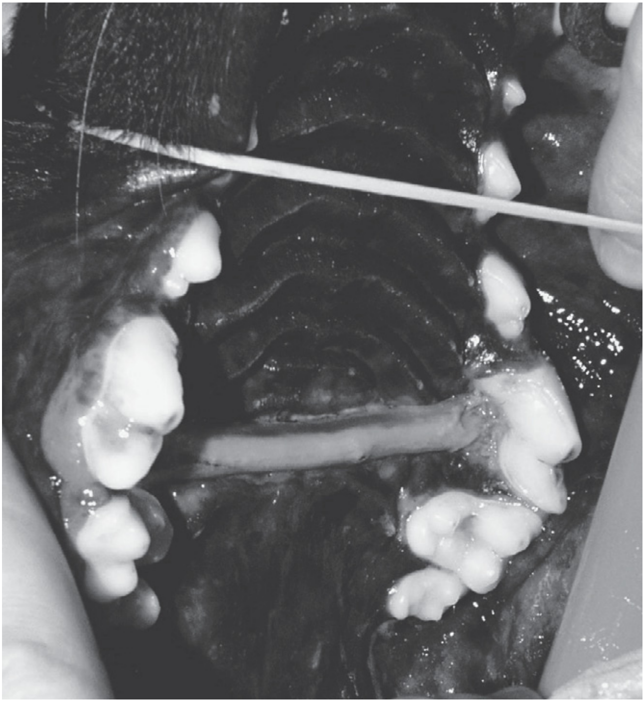


Figure 2-9 The palate of a dog with a stick (foreign body) stuck between its maxillary fourth premolar teeth. The stick is digging into the palate and the palatal aspects of the furcations are severely traumatized with purulent periodontal lesions.

3

Intraoral Radiology

Intraoral radiology is an essential tool in the diagnosis and treatment of dental problems. It is perhaps the tool that separates mere cleaning and pulling from more comprehensive veterinary dentistry. There is no better way of visualizing the usually hidden roots of teeth and the intricate bones of the mandible and maxilla. Only through the proper visualization of these orodental structures can an accurate diagnosis, treatment plan, and prognosis be determined.

Film

Although a dental radiographic unit is easier to use for intraoral radiography, a standard medical radiographic unit may be used with great effect. The main requirement for intraoral radiography is the use of dental film. Dental film comes in two main speeds, D speed and the faster E speed. E speed or Ektaspeed film is more sensitive than D speed or Ultraspeed film and, therefore, requires less energy for proper exposure. There are five sizes of dental film: 0, 1, 2, 3, and 4, with size 4 being the largest.

X-Ray Unit

When using dental film with a standard medical radiographic unit (Figure 3-1), a simple technique chart can be easily determined. The beginning technique should be 12 inch film to focal distance, 100 mA, 1/10 sec, and 65 kVp. The kVp can be altered from that point depending on the exposure created. The major difficulty with a standard medical radiographic head is the problem of proper positioning. While a dental radiographic head can be maneuvered easily around a patient's head, it is often easier to think about changing the patient's position when using a standard radiographic machine.

Positioning

Most dental film is clearly marked as to which surface should face the X-ray tube. This is important because a lead foil backing is inside each film packet to block backscatter radiation. Should the film be exposed

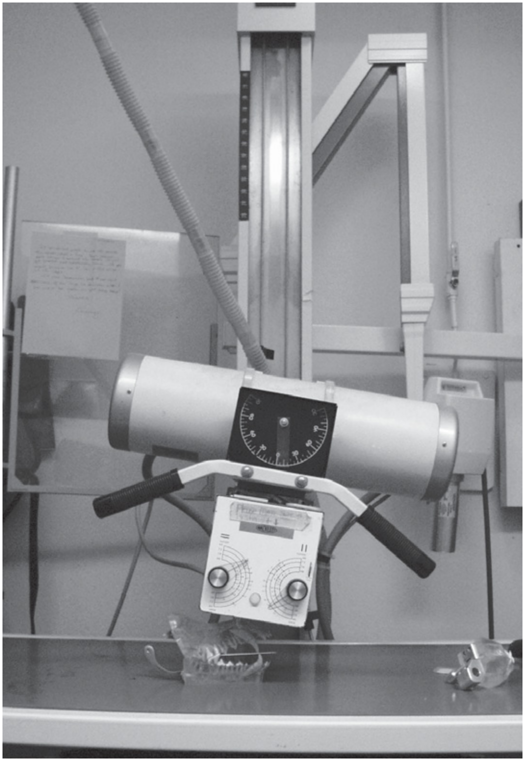


Figure 3-1 A standard medical radiography machine used with dental film to take intraoral radiographs. The head of this X-ray machine is mounted on a moveable mast, which allows the proper film-focal distance of about 12 inches. The X-ray tube also tilts, which further aids in positioning.

through this lead foil, a classic stippling pattern will partially obscure the intended image. Each film and film packet has a dimple or dot embossed into it to further aid orientation for interpretation (see later).

Parallel Technique

Two main positioning techniques are used for intraoral radiography. The first, the parallel technique, is the easier one. It can be employed only when the long axis of the object to be radiographed and the film are parallel to one another. This occurs primarily with mandibular premolar and molar teeth. The film is placed as close to the object as possible and the X-ray beam is directed perpendicular to the dental film. With minimal practice, this technique can be mastered.

Bisecting Angle Technique

The second technique, the bisecting angle technique, requires more practice to become proficient. This technique is employed when the object to be radiographed and the film are not parallel to one another, such as maxillary teeth and mandibular canine and incisor teeth (Figure 3-2). The dental film is placed as close to the object as possible; however, because the film and the long axis of the object are not parallel, an angle exists between film and object. This angle is bisected with an imaginary line and the X-ray beam is directed perpendicular to this line

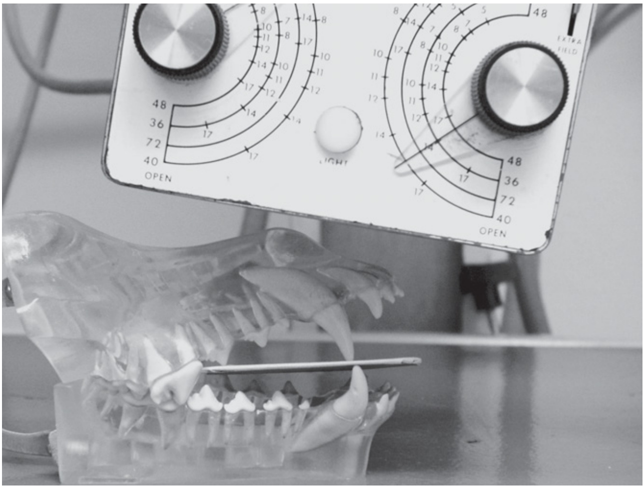


Figure 3-2 An intraoral radiograph of the maxillary canine tooth being taken with a standard X-ray machine and dental film. The plane of the film and the long axis of the maxillary canine tooth are not parallel but form an angle. The operator must imagine a line that bisects that angle formed between the film and tooth axis. The X-ray beam is positioned perpendicular to this imaginary line for proper size of the tooth.

of bisection. With practice and a proper understanding of the underlying anatomy, this technique becomes much easier.

Tube Head Shift Technique

A helpful auxiliary positioning technique, the tube head shift technique, is employed in conjunction with the bisecting angle technique in multirooted teeth, such as the maxillary fourth premolar tooth. Because the maxillary fourth premolar tooth has three roots, it is common for the mesiobuccal and palatal roots to be superimposed on one another. The purpose of the tube head shift technique is to separate these superimposed roots to allow for individual assessment. When using a dental radiographic unit, the tube head is merely angled in a more mesial or more distal position, with all other settings the same. This technique can also be accomplished with a standard radiographic machine, but it may be easier to move the patient instead of the tube head.

By making this slight shift in angle, the previously superimposed roots are separated. To determine which root has moved into which new orientation, the SLOB (same lingual–opposite buccal) rule is employed. The SLOB rule helps to remind the dental operator that, when the tube head is shifted mesially, the lingual or palatal root also shifts mesially on the developed film and the buccal or mesiobuccal root shifts distally. Should the tube be shifted distally, the converse is true. A useful demonstration is to imagine this technique on the legs of a table. Position yourself with the table legs at eye level and the front and rear legs in line, or superimposed. Move slightly to the right and observe the relative change in the position of the legs. The rear legs should appear to have moved to the right, compared with the front legs, just like your line of vision.

Developing

Once the dental films have been exposed, the next step is to develop the latent image. Many practices have tried to use their full-size automatic processor with limited success by taping the dental films onto a blank full-size film. While this can work well, incomplete developing, lost film, and processor jams are possible. A better option is to use small, hand dip tanks. These can be used in the darkroom or in a small self-contained tabletop box, called a *chairside developer*. The chairside developer is an economical way to develop dental film, using the same developer and fixer solutions that resupply the automatic processor.

The chairside developer has an amber or ruby red plastic lid to enable the dental operator to safely view inside the box while manipulating the film in the solutions (Figure 3-3). The operator inserts the exposed film packet and film hanger into the incubator-style hand holes. Once in this light-safe environment, the film

Figure 3-3 The exterior of a chairside developer. This plastic box provides a portable darkroom and can be set up on a counter in the same room that dental procedures are performed. It is especially useful when combined with a dental X-ray unit, making a convenient combined package for taking and developing intraoral radiographs without moving the patient.

packet is torn open to reveal the lead foil, cardboard film protector, and the film itself (Figure 3-4). The film is extracted from the packet with the film hanger and plunged into the developer tank. Slight agitation of the film enhances the action of the developer chemicals, which normally take 15–30 seconds to develop the film. Freshness and temperature of the developer solution affect the developing time.

The film is observed through the plastic lid, and when an image appears, the film is removed from the developer, passed briefly through a water tank, and plunged into the fixer. The film typically remains in the fixer twice as long as it stayed in the developer; however, 5–10 minutes helps ensure proper fixing. Once the film has been properly fixed, with no spots of green or residual developer, it can be removed from the fixer and thoroughly washed under room temperature tap water to rinse off any chemical residue.

Interpretation

Now that the film has been developed properly, it can be interpreted. The first step of intraoral radiographic interpretation is to determine if the film has been properly exposed, developed, fixed, and rinsed. There should be adequate film density and contrast to assess all orodental structures present. If you cannot fully assess the film or if a critical portion of a structure is cut off with

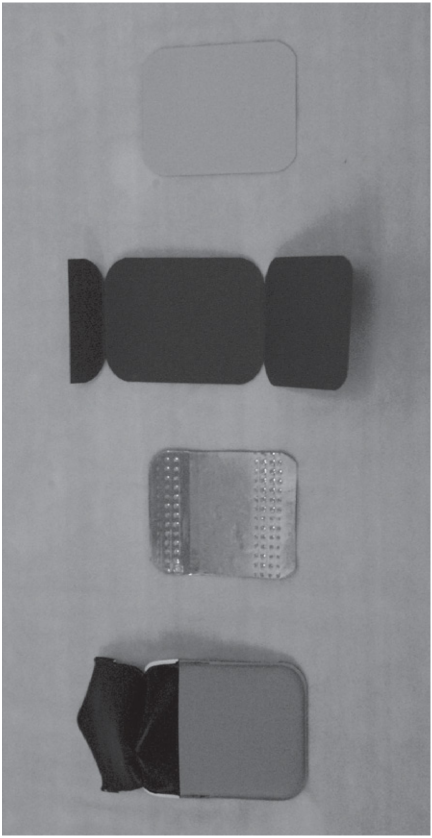


Figure 3-4 A dental film packet that has been opened and broken down. From left to right, the components are the outer film wrapper, lead foil backing (it prevents backscatter radiation from reexposing the film), inner paper wrapper, and the film itself.

this view, another intraoral radiograph should be taken to improve readability. A radiograph taken to assess the endodontic health of a tooth that does not include all of that tooth's roots and their apices is not a complete radiograph and should be retaken. Likewise, a radiograph of a multirooted tooth with superimposed roots needs to be retaken with the tube head shift technique.

Orientation

The next step of intraoral film interpretation is accurate orientation of the film and imaged structures. The embossed dot or dimple is the key to that orientation. Assuming the film was taken intraorally (i.e., with the film inside the mouth), looking through the concave surface of the dimple puts you in the perspective of being inside the mouth looking out. In this perspective, you must imagine that you are in the mouth and are looking at the teeth through the film. The alternative perspective, looking from the outside of the mouth inward, is gained by flipping the film over and looking through the convex surface of the dimple.

Radiographic Anatomy

It is helpful to understand the normal radiographic appearance of the oral cavity so that pathology can be readily appreciated when it exists. The enamel of the tooth crown is usually the greatest radiographic density, except when metallic restorations or orthodontic appliances are present. The dentin is also fairly dense and makes up the majority of the tooth's crown and root. The pulp cavity is the radiolucency inside of each tooth and decreases in diameter as the tooth matures, making the root walls thicker.

The bony walls of the alveoli are normally represented radiographically by a dense line of bone known as the lamina dura. The alveolar crestal bone normally is at the level of the neck of the tooth, the junction of the crown and root. The periodontal ligament joins the root of a tooth to its alveolus, and this appears as a radiolucent line sandwiched between the lamina dura of the alveolus and the radiodense root structure.

Pathology

PERIODONTAL DISEASE One of the most important radiographic signs of advancing periodontal disease is bone loss (Figure 3-5). Crestal bone may be lost between two teeth or bone may be lost from the furcation of a multirooted tooth. Bone loss around a particular root is either horizontal or vertical. Horizontal bone loss is associated with suprabony periodontal pocketing and appears as an even drop in the height of alveolar crestal bone. Vertical bone loss, associated with infrabony periodontal pocketing, appears as an uneven drop in the level of alveolar crestal bone, resulting in a walled bony defect. Radiographic signs of bone loss should be correlated with clinical probing depth findings.

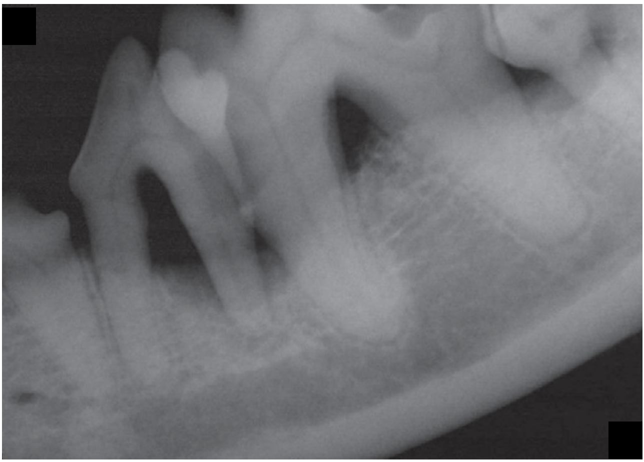


Figure 3-5 An intraoral radiograph of the left mandibular quadrant of a dog. This dog has severe periodontal disease, which is evident by the severe bony destruction and loss around the fourth premolar and first molar teeth. Although the mandibular fourth premolar tooth may still feel solid and firmly rooted, the radiograph shows that the bony destruction has severely compromised the distal root and perhaps the entire mandibular fourth premolar tooth.

ENDODONTIC DISEASE Intraoral radiography is commonly used to assess teeth for endodontic compromise. The diameter of the pulp cavity of a suspect tooth should be compared to the same tooth type on the opposite side of the mouth. If, for example, a radiograph of a discolored maxillary right canine tooth in a 5-year-old dog reveals a large-diameter pulp cavity as compared with the maxillary left canine tooth, this would indicate pulpal death of the maxillary right canine tooth. Other radiographic signs of endodontic compromise include widening of the apical periodontal ligament space, periapical lucency (Figure 3-6), and internal or external root resorption (Figure 3-7). Intraoral radiography is an essential tool in endodontic treatment as well.

FELINE RESORPTIVE LESIONS It is also extremely important to radiograph all teeth to be extracted, especially feline teeth with resorptive lesions (Figure 3-8). Radiography can provide valuable information about the root or roots of a tooth, such as root fracture, ankylosis, or external resorption. Root ankylosis appears radiographically as a loss of the periodontal ligament space and a loss of distinction between the root and the surrounding alveolar bone (Figure 3-9). External root resorption takes on a moth-eaten appearance radiographically.

EXTRACTIONS Intraoral radiography can be a very useful tool in association with tooth extraction. The operator should know as much information about the roots as

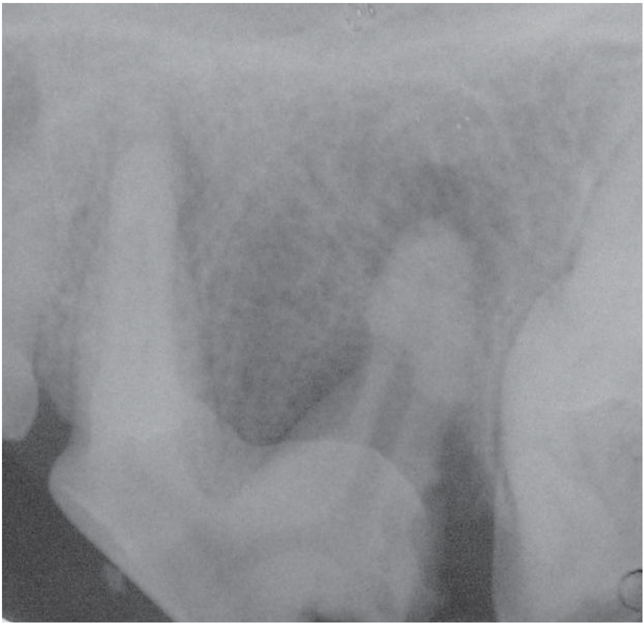


Figure 3-6 An intraoral radiograph of the left maxillary fourth premolar tooth of a dog with an endodontic abscess. The distal root has a marked amount of bony destruction around its apex. There is also a bony periodontal defect extending apically from the alveolar crest.

Figure 3-7 An intraoral radiograph of the right maxillary canine tooth of a cat with a mucosal draining tract. A radiodense gutta percha point was inserted into the draining tract to follow it, as a form of fistulogram. The source of the infected drainage is the resorbing root apex. Approximately 50–60% of the root apex has already been eaten away, suggesting a chronic dental problem.

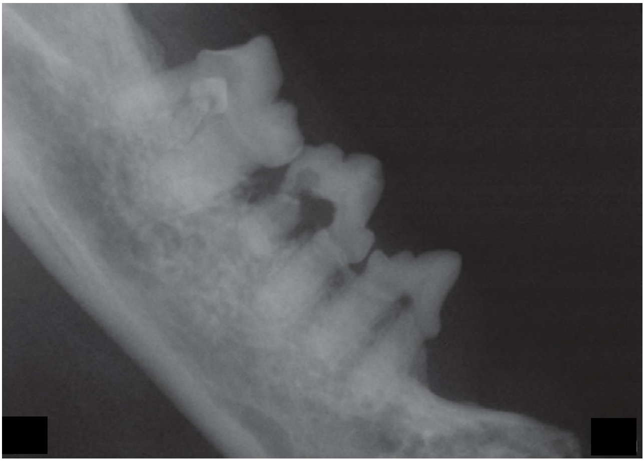


Figure 3-8 An intraoral radiograph of the right mandibular check teeth of a cat. The mandibular fourth premolar tooth has bone loss at the furcation as well as a resorptive lesion that drastically affects the distal crown (lucency just distal to furcation) and the distal root (40%) of the apical root has been resorbed. Note the small supernumerary mandibular molar, which is superimposed over the furcation of the mandibular first molar tooth.

Figure 3-9 An intraoral radiograph of the rostral mandible of a cat. The left mandibular canine tooth is moth eaten, with fuzzy, ill-defined margins and an overall decreased density as compared with the right mandibular canine tooth. This is a tooth affected by a massive resorptive lesion and is undergoing root resorption and ankylosis.

possible before making any incisions or doing any elevation. Potential pitfalls can be identified and prevented. If complications do arise during the procedure, such as fracture of a root, a radiograph can help to locate the root tip (Figure 3-10). The complete root removal is then confirmed with an intraoral radiograph.

Additional Uses

Another great use of intraoral radiography is in the assessment of oral masses. Bony proliferation or destruction can be helpful in determining staging, the treatment plan, and a prognosis of oral neoplasia. Intraoral radiography may also be used to get a highly detailed image of the nasal passages in the workup of chronic rhinitis or sinusitis. Many practitioners find these dental films useful for imaging puppy and kitten paws, animal tails, and exotic animals as well.

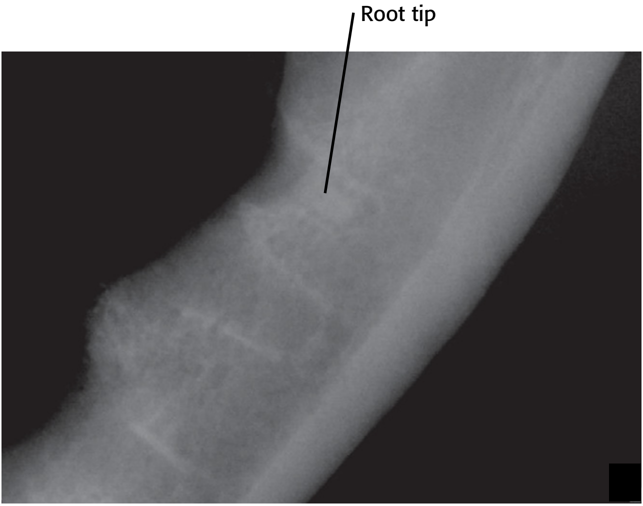


Figure 3-10 An intraoral radiograph of the left mandible of a dog. This dog had severe periodontal disease and had multiple extractions. The mesial root of the left mandibular second molar tooth fractured during extraction and this is the intraoperative view. The radiograph shows a very distinct root tip and can outline a path to its removal.

4

Periodontics

Periodontal Disease

Periodontal disease, the most prevalent disease threatening our patients, is an infectious disease caused by the bacteria of dental plaque, their toxic by-products, and the host's immune response to that infection. If the bacterial plaque is unchecked by daily oral hygiene and annual dental cleanings, the bacteria build in number and begin to cause destruction of the tooth's attachment to the mouth. This tooth attachment, know as the periodontium, can resist the onslaught of the bacterial infection for a limited time.

The success of the periodontium's natural defenses depends on many things, including the amount of bacterial buildup, the relative proportion of aerobic and anaerobic bacterial subpopulations, the bacterial toxins produced, and the nature of the host immune response. Periodontal tissue destruction occurs in a cyclic manner when the natural oral defenses no longer can withstand the insult. Histologically, periodontal disease is characterized by periods of active destruction (periodontitis) and periods of relative quiescence.

The single best treatment of periodontal disease is prevention. Starting at 1 year of age, every animal should have its teeth scaled, polished, and treated with fluoride once a year to prevent irreversible damage and loss of attachment of periodontal tissues. Every animal should also have regular home care, preferably daily brushing with an enzymatic toothpaste. With aggressive preventative measures the need for more advanced treatment is greatly reduced.

It is the goal of preventative oral care, through both annual professional dental cleanings and active daily home care, to maintain the health of a pet at the highest possible level. Not only is it possible to keep the teeth "clean" and the breath fresh, it is also possible to spare the animal a lifetime of oral pain, chewing discomfort, and systemic bacterial pollution. There are many known systemic ramifications of the spreading bacterial pollution, such as heart, liver, kidney, and lung insult, but perhaps even more ramifications are unknown as yet. One thing is sure: The bacteria and bacterial toxins that get absorbed into the circulation and traverse the body cannot possibly be completely benign.

When periodontal therapy beyond the routine cleaning (scale/polish/fluoride) is needed, there has usually been some degree of irreversible damage to the periodontium and its natural defenses. The goals of more advanced periodontal therapy are to remove the gross contaminants, improve the state of the infected and debilitated periodontium, and make future cleaning efforts easier. This can be accomplished in many ways; however, it must be recognized that periodontal surgery can rarely return destroyed attachment to its original level.

When periodontal disease has ravaged the supporting structures of the teeth (Figure 4-1), the frequency of professional cleaning and the aggressiveness of home care efforts must be increased. Depending on the degree of attachment loss and bony destruction, the teeth may need to be cleaned every 9 months, every 6 months, or even every 1–3 months. The use of oral antimicrobial agents in daily home care regimens is also helpful in patients with periodontal disease. Although these enhanced efforts, including periodontal surgery and guided tissue regeneration, can help slow the progression of the loss of supporting periodontal structures, they cannot compare to the overwhelming benefit of preventing periodontal disease by controlling plaque with annual cleanings and daily brushing.

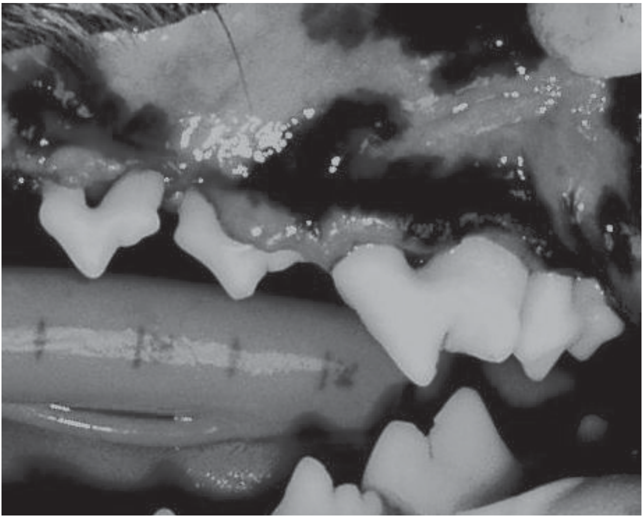


Figure 4-1 Left maxillary quadrant of a dog with significant periodontal attachment loss. All the maxillary teeth have some degree of root exposure and furcation exposure. The gingiva has receded, and the alveolar bone also has been partially destroyed to allow the gums to recede. The natural defenses of this animal's mouth have been dramatically and permanently altered. This dog will need aggressive periodontal care to prevent further attachment loss.

Scale/Polish/Fluoride

Many terms are used to describe dental cleaning and dental procedures. The terms *dental* and *dentistry* are quite common in most veterinary hospitals. The problem with these terms is that they are used to represent all dental procedures, from routine cleaning to multiple extractions to major oral surgery. As the level of sophistication in the field of dentistry rises to approaching other established fields within a hospital, it becomes necessary to more closely define the dental services we are capable of offering. Referring to the myriad of dental services we can offer by just one catch-all name misinforms our clients and shows a significant lack of respect to our medical expertise and surgical skills.

The term *scale/polish/fluoride* (SPF) is much more appropriate for routine dental cleaning, as it says exactly what is being done. If other dental procedures are indicated, as they often are, then they should be added onto the title of the procedure and performed appropriately. For example, if an older dog with severe periodontal disease is presented for dental treatment, it does not receive a “dental” or a “dentistry.” This dog, appropriately treated, would begin by receiving an SPF and then may have root planing, periodontal flap surgery, doxycycline gel insertion, guided tissue regeneration, or extractions, as necessary.

If we are to communicate the importance of total dental care and the full scope of dental treatment options now available to our clients, we must force ourselves to change some of our terminology to better reflect our commitment to the best medical care possible. A simple alteration in words can mean a huge alteration in the way our clients view our expanding dental services and in the way the entire veterinary team views its role in the commitment to maintaining the oral cavity of every patient in peak health.

The Use of Antibiotics

The role of antibiotic therapy in veterinary dentistry is currently being reshaped due to a greater understanding of periodontal disease, the bacteria that play a major role in that disease, and proper treatment protocols. The main goal of treatment of periodontal disease remains the removal and control of bacterial plaque. Antibiotics alone cannot effectively accomplish this goal, although they can play an integral part of the overall treatment of periodontal disease. Antibiotic therapy can also aid in the protection of immunocompromised, cardiac, and renal insufficiency or renal failure patients from bacteremia generated with routine dental cleaning.

A bacteremia is stimulated with any dental cleaning as well as chewing with periodontally diseased teeth. This bacteremia is usually a transient event in most healthy patients, with the body clearing bacteria from the bloodstream in 30–60 minutes. The concern over this bacteremia lies in the potential damage to patients with concurrent debilitating illness, such as immunocompromise, cardiac valvular insufficiency, or renal insufficiency or failure. These patients are at particular risk for exacerbation of their disease through the spread of bacteria and bacterial toxins. A major component of the treatment of these debilitated patients is the control of chronic systemic bacterial pollution through regular professional dental cleaning. The use of perioperative antibiotics provides an added level of safety for important dental maintenance procedures in these special patients.

For an antibiotic to be effective perioperatively, it needs to reach an adequate blood level by the time of the dental procedure and be capable of destroying oral pathogens. Debilitated patients undergoing routine dental cleaning should have an appropriate antibiotic administered before the procedure in time to have an effective blood level at the time bacteria are being introduced into the bloodstream. The value of administration of an extended course of preoperative antibiotics, for 1–2 weeks, has been questioned in recent years and may indeed be counterproductive. The fear is sensitizing the bacteria to the intended antimicrobial and creating resistance problems. This theory is similar to the recommendation of starting antibiotic therapy in urethral obstruction after the urinary catheter is removed.

An antibiotic used in the perioperative role can be administered orally as well as through parenteral routes. The antibiotic should be given before the procedure to reach optimum blood level by surgery time and should be repeated 1–2 hours after the procedure to ensure proper bacterial clearance. Clindamycin is an excellent choice for this role, as it sustains predictable blood concentrations and is highly effective against most of the oral pathogens. Other good antibiotic choices include amoxicillin–clavulanic acid, cephalexin, ampicillin, tetracycline, and doxycycline.

Antibiotics also play an important role in the treatment of established periodontal disease. Their role in the treatment of this chronic disease must be understood if they are to remain a useful tool. An analogy can be drawn between the use of antibiotics in the treatment of a catfight abscess and their use in the treatment of periodontal disease. Without the removal of gross contamination, antibiotic therapy alone is ineffective. Periodontal therapy still requires thorough cleaning of all tooth surfaces including periodontal pockets and contaminated roots, just as catfight abscess treatment still requires the establishment of adequate drainage. Antibiotic therapy may be extended beyond the perioperative role after dental cleaning or periodontal therapy for 1–2 weeks to aid in healing soft tissues.

Antibiotic treatment after dental cleaning in patients with established periodontal disease can help improve the health of soft tissues such as irritated gingiva and ulcerated oral mucosa caused by bacterial plaque. This can be particularly useful when further periodontal surgery is planned, as oral surgery is made more effective when working on healthy tissue. Another indication for antibiotics in veterinary dentistry is osteomyelitis within either the mandible or maxilla. Antibiotic therapy should be considered in association with endodontic treatment and oral fracture or trauma to aid in the control of oral bacteria and improve healing. By getting away from the indiscriminant use of antibiotics and utilizing them for specific roles, the veterinarian can preserve their potency for destroying bacteria with predictable results.

Professional Care Recommendations

Six Weeks of Age

A complete oral exam should be performed, looking for cleft palate, malocclusion, microglossia, impaction, or other oral abnormalities. This is a great time to talk about initial home care training, such as getting the owner to begin touching the mouth and gently rubbing the gums to get the young animal used to having its mouth worked on. This is also the time to talk about the benefits of regular home care, especially with owners of breeds prone to dental problems later in life.

Sixteen Weeks of Age

A complete oral exam should be performed, looking for malocclusion, impaction, retained deciduous teeth, or any other oral abnormalities. The owner should be talked to about starting brushing if it has not yet been started. A brushing demonstration is more helpful than any speech or pep talk. The pet should be set up for the removal of any retained deciduous teeth as soon as possible. It may aid compliance if the pet is spayed or neutered along with the extraction procedure.

Six Months of Age

A complete oral exam should be performed, looking for malocclusion, retained deciduous teeth, missing teeth, or any other oral abnormality. Any retained deciduous teeth present at this time should be removed as soon as possible with concurrent spay or neuter. There should also be a follow-up with the owner's home care efforts and necessary revisions made in the treatment regime.

One Year of Age

The first scale/polish/fluoride procedure should be performed, along with a complete oral exam and intraoral radiographs, if needed. The veterinary team should also follow up with owner's home care efforts and make necessary recommendations on improvement.

Annually

A scale/polish/fluoride should be performed along with a complete oral exam and intraoral radiographs, if needed. The veterinary team should also follow up with owner's home care efforts and make necessary recommendations on improvement.

Home Care Recommendations

Six Weeks of Age

- Begin training the puppy or kitten to accept and tolerate the lifting of its lips.
- Work at gently touching and rubbing the gums.
- Work for only short periods of time.
- Introduce pet toothpaste with a finger.

Twelve Weeks of Age

- Begin gently brushing with a soft toothbrush and pet toothpaste.
- Work for short periods of time to begin.
- Use circular motions directed at the gumline.
- Concentrate on facial surfaces, lifting only the lip.
- Start with twice weekly frequency for brushing.

Sixteen Weeks of Age

- Get an evaluation of the home technique by the veterinarian.
- Increase frequency to every other day brushing.
- Increase time spent brushing.

Six Months of Age

- Follow any new recommendations by the veterinarian.
- Increase frequency to every day brushing.
- Increase time spent brushing.
- May consider T/D food as a treat.

Maintenance

- Continue daily brushing for the life of the pet.
- Use T/D food daily.
- Monitor for signs of oral disease—bad breath, pain with brushing, gums that bleed easily, loose teeth, gum recession, broken teeth, oral growths, or swellings in or around the mouth. See your veterinarian if you notice any of these dental problems.

Every Pet Deserves

1. An oral exam as part of every physical exam.
2. To be offered a complete SPF at least once a year.
3. A complete oral exam by a veterinarian with every SPF.
4. To have all teeth probed and explored with every SPF.

5. A completed dental chart with every dental cleaning.
6. To have all fractured teeth with pulpal exposure treated with endodontics or extraction.
7. To have as comprehensive a home care program as possible.
8. To have intraoral radiographs taken of all oral abnormalities (periodontal pockets, fractured teeth, missing teeth, oral masses, discolored teeth, loose teeth, etc.).
9. To have periodontal disease treated appropriately and completely (annual SPF or more often if indicated, closed root planing, doxycycline gel insertion, open root planing, extraction, guided tissue regeneration, etc.).
10. To have oral fractures treated with minimal trauma to essential oral structures (i.e., with noninvasive or minimally invasive techniques wherever possible).
11. To have dental decisions made exclusively by a veterinarian who may then direct technicians to carry out nonsurgical treatments.
12. To be offered a plaque-controlling diet when it is not contraindicated.
13. Pain management with *all* extractions and other invasive dental procedures—possibly including, but not limited to, fentanyl patch, intraoral nerve blocks, preoperative and postoperative analgesia.

14. An orthodontic evaluation with all puppy vaccination visits (Figure 4-2).
15. To have *all* retained deciduous teeth extracted in a timely and minimally traumatic manner as well as having the bite evaluated once the teeth are removed.

The Complete Scale/Polish/ Fluoride Procedure

Safety for Patient

The primary concern of most owners is the necessity for general anesthesia when performing a complete SPF. Fear of anesthesia is the main reason for noncompliance with recommended professional dental care. It is essential that clients understand the high level of concern and safety that the veterinary team employs for all its anesthetic procedures, including dental procedures such as the SPF. Preanesthetic laboratory testing and use of safe modern anesthetic agents are the necessary starting points for patient safety.

All patients receiving an SPF or any other dental procedure must have an endotracheal tube properly placed and properly inflated. It is important that the cuff not be overinflated, as that is the leading cause of tracheal rupture, but the trachea must be protected from the inhalation of the infected debris cleaned from the teeth.

Figure 4-2 Anterior cross-bite malocclusion in a young dog. The maxillary incisors are positioned lingual to the mandibular incisors. The main problem, however, is the tooth-on-tooth interference of the maxillary third incisors on the mandibular canine teeth, causing oral pain and decreased grasping ability.

Another critical requirement is proper anesthetic monitoring, such as pulse oximetry, electrocardiography, respiratory monitor, and capnograph. Patients that are anesthetized for an SPF receive the same anesthetic as patients that go into the surgical suite and therefore demand the same diligence to monitoring throughout the procedure.

One other vital sign to closely monitor is the patient's temperature. Animals undergoing SPF procedures can lose a significant amount of body heat, especially when lying on a wet tub or table and, therefore, need to be kept warm and dry as much as possible. The use of a warm water circulating heating blanket is recommended along with blanket(s) to cover the patient. Electric heating with heating coils should never be used, as they can cause severe skin burns.

A dental speculum, or mouth gag, should be used only if absolutely necessary. If such a device is used, it should be used with caution, considering the potential damage it can cause to the patient's temporomandibular joints. The speculum should open the jaws only as much as is needed to work properly, never fully opening the jaws. This device should also be used like a tourniquet, removed after 15 minutes and allowing the jaws to relax.

Safety for Operator

Safety for the operator starts with gloves, mask, and eye protection, but there are many other concerns to make the procedure as safe and as satisfying as possible. A good quality light source is necessary to properly visualize the teeth and attached contaminants. Overhead fluorescent lighting alone is insufficient, an auxiliary surgical light is necessary to do the job right.

Perhaps the biggest consideration beyond the obvious basic safety equipment is that of ergonomics. Too many dental cleaning procedures are performed on tables that are entirely inadequate for the operator's long-term safety, comfort, and enjoyment. Most tables are too low for the operators to stand without bending their backs, which leads to lumbar pain and strain over time. Some tables lack knee space and therefore make it very difficult for operators to sit at properly. The operators should strive to find a table that allows them to maintain their backs in a vertical position, either standing or sitting.

Aerosolization of bacteria and bacterial toxins during the procedure is another safety concern, if not for the masked operator, then at least for the personnel and hospital patients nearby the procedure table (Figure 4-3). Some veterinary hospitals have drastically minimized this risk of contamination by creating a separate dental suite, away from the surgical prep room and the surgical suite. For those hospitals whose designs that do not allow for a separate suite, detoxification of the mouth before scaling commences may be a practical alternative. Many preparations of oral chlorhexidine rinses are made for just such a purpose.

Figure 4-3 Severe periodontal disease of the maxillary incisor teeth in a dog. The incisor teeth are heavily laden with bacteria and toxic by-products, all of which may be aerosolized with dental scaling.

Gross Removal of Heavy Calculus

The first step to cleaning the teeth is to remove the majority of the heavy calculus adherent to the crowns of the teeth. The best tool for this job is the tartar-cracking forceps (Figure 4-4). These differ from the instrument usually used for this job, extraction forceps, in the shape of their jaws. Extraction forceps are meant to grasp loose teeth and remove them from the mouth. To facilitate their purchase on a tooth, these forceps have two equal jaws with tips that meet. Tartar-cracking forceps have two jaws of differing shapes, one long straight jaw and one hooked jaw.

The straight jaw of the tartar-cracking forceps is placed on the cusp of the tooth, while the hooked jaw is carefully located at the edge of the calculus deposit next to the free gingival margin (Figure 4-5). The handles are simply squeezed together and the tartar is removed. This is a much more effective and a safer way of removing tartar than the extraction forceps, which require a pulling and twisting motion. The more tartar removed with the tartar-cracking forceps, the less remains to be removed by the power scaler, thus drastically increasing the efficiency of the entire procedure.

Power Scaling of Supragingival Crowns

Once the bulk of the calculus has been removed with the tartar-cracking forceps, a power scaler can be employed

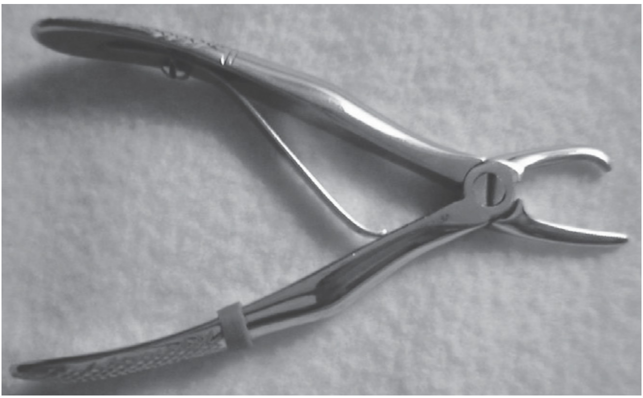


Figure 4-4 A tartar-cracking forceps. This is one of the first instruments to be used in the SPF procedure. Proper use of tartar-cracking forceps reduces the time needed for power scaling. This can increase the overall efficiency of the SPF.

Figure 4-5 A tartar-cracking forceps in use on a model of a dog's mouth. The straight jaw is placed on the cusp of the tooth and the hooked jaw is placed between the edge of the tartar and the edge of the gingiva. The tartar is easily chipped off the tooth surface by just squeezing the handles together. This instrument can remove a lot of tartar in a short period of time.

to continue the supragingival calculus removal. There are three major forms of power scaling. The first, rotary scaling, uses a six-sided metal bur placed in a high-speed handpiece. The metal bur rotates at a very high rate of speed to scale the tartar off of the tooth surface. Rotary scaling is not recommended, as it is potentially damaging to the tooth and is not as efficient as the other two scalers. The other two types of scaler, sonic and ultrasonic, are similar and are used effectively in much the same manner.

The sonic scaler uses compressed air from a dental unit to spin a rotor around a shaft within the handpiece. This spinning produces vibration within the shaft, which is transferred to the tip. The side of the sonic scaling tip is used to remove remaining calculus deposits. Care is taken not to use the end of the tip of the scaler, so that the enamel is not harmed, and to keep the scaler tip on any particular tooth for only 15 seconds or less. Since the vibrating tip produces heat, the operator must make sure that the coolant water is flowing sufficiently to keep the tip cool. The heat from a sonic scaler can harm the dental pulp if it is left on the tooth for an extended period of time. One big disadvantage of the sonic scaler is that it requires a lot of compressed airflow to operate properly and this demand may overwork a smaller dental compressor, leading to premature failure.

The ultrasonic scaler uses electricity to create higher-frequency vibrations than the sonic scaler. This means that the two big advantages it has over sonic scaling are increased power, and thus efficiency, and independence from the compressed air reserves of the dental unit. The ultrasonic scaler has proven itself to be a great general-purpose item in the veterinary practice. It is also necessary to limit the time spent scaling any particular tooth to 15 seconds to avoid excess heat buildup. If more time is needed to completely scale that tooth, it is advisable to move to another tooth and come back later to finish the job. The side of the scaling tip is also preferred so as to be the most efficient and to avoid damage to the enamel.

Subgingival Tartar and Plaque Removal

Although scaling of the supragingival calculus is perhaps the more obvious task, the subgingival plaque and tartar deposits are of critical importance. Without removing contaminants from below the gumline, the job of SPF becomes only a superficial exercise in making the teeth "look good." To truly improve the health of the mouth and, hence, the whole animal, the operator must make sure that all the irritating biofilm of bacteria and their toxic by-products are removed from all the teeth. The subgingival region of the teeth is the battleground for periodontal disease and must be treated with utmost concern and care.

In animals with relatively healthy periodontium and normal gingival sulcus depths (0.5–1 mm for cats and 1–3 mm for dogs), the sonic or ultrasonic scaler can be used to gently sweep the subgingival surface of the tooth (Figure 4-6). It is important to use a scaler tip that is slender enough to easily fit under the gumline and not harm the delicate gingival attachment apparatus. The scaler tip should not be used with force, and it should not remain under the gumline for more than a few seconds. This movement can be incorporated into the total scaling of a tooth with a gentle sweep under the gumline after scaling the supragingival crown.

For those subgingival areas that have larger, more stubborn tartar deposits or have deeper pockets, hand curettes should be used. A hand curette differs from a hand scaler in the tip design. The hand scaler has a sharp, pointed tip and is meant to be used only supragingivally. The hand curette, however, has a blunt, rounded tip so that it may be used subgingivally without lacerating the delicate gingiva on either its insertion or withdrawal. The side of the curette working head contains the cutting blade. If kept sharp, this blade can easily remove subgingival tartar deposits, without the risk of the heat buildup of power scalers.

Disclosing Any Remaining Calculus Deposits

The teeth must be closely inspected as a quality control measure on the effectiveness of complete plaque and calculus removal. Known as *disclosing*, this has classically been carried out using a red dye solution. The red disclosing solution can be messy, and a better method is

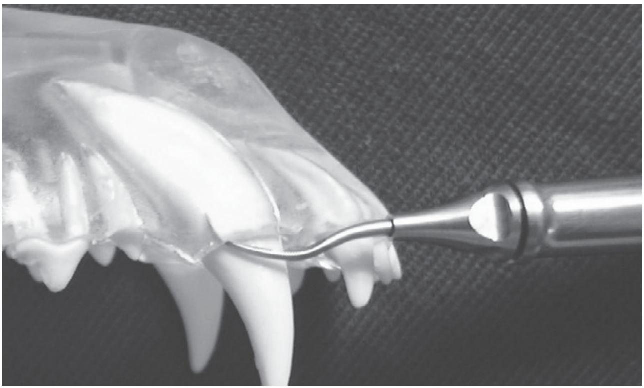


Figure 4-6 A sonic power scaler tip being used on a model of a dog's mouth. The tip of the scaler is gently inserted underneath the gumline and used to sweep the subgingival surface of the crown. Great care is taken to not harm the delicate gingival attachments and to not keep the tip of the scaler under the gumline for a long period of time. The subgingival region of the crown is the most important area of the mouth to scale and periodontally debride completely.

at hand and more convenient to most veterinary practices. The air/water syringe present on most dental units provides a much neater way of checking for remaining contaminants. Once the teeth have been thoroughly scaled and the debris flushed away, the teeth are dried with the compressed air.

The remaining bits of calculus show up as chalky deposits on the shiny enamel surface. This type of detection requires bright, surgical-quality light and is enhanced by magnification. The remaining calculus can be removed easily with a sharp hand scaler. The air also may be very helpful in gently blowing the free gingival margin away from the tooth surface so that the subgingival areas may be more closely inspected.

Irrigation of the Gingival Sulcus

It is important not only to scale the infected debris from the tooth surface but to make sure that no loose bits of tartar are left within the sulcus to continue the irritation. Another important consideration is to make sure that no chunks of tartar remain in the mouth, such as between the cheek and gums. It is the job of the operator to remove all contaminants not only from the teeth but the mouth and patient as a whole. Any stray chunks of bacteria-laden tartar that may remain to be ingested or inhaled as the patient recovers can lead to dire problems. Sterile saline or dilute chlorhexidine in a syringe with a blunt-tip needle works well as an irrigating solution.

Periodontal Probing of All Teeth

While the power scaling tip may be an indicator of the gingival sulcus or periodontal pocket depth, as it is used to gently sweep under the gumline, the periodontal probe is the proper instrument to accurately measure this depth (Figure 4-7). This instrument must be used with caution to avoid damaging the delicate attachment apparatus and return an exaggerated measurement. The tip of the instrument is gently inserted between the free gingival margin and the tooth, almost passively allowing it to reach the bottom. It is advisable to make at least three measurements on the facial surface of each tooth and at least three measurements on the palatal or lingual surface of each tooth. These should be separate measurements, instead of dragging the probe tip along and thus raking the attachment apparatus.

Exploring Any Discolored Areas

The explorer is the instrument with the sharp tip, usually located on the opposite end of the periodontal probe. This sharp tip is used quite commonly in human dentistry to detect dental caries or cavities. While true caries are relatively rare in dogs and almost unheard of in cats, it is still important to explore the occlusal surfaces of the molar teeth in dogs. Normal enamel is very hard and resists the sharp explorer tip. However, carious enamel is soft and will allow the explorer tip to penetrate its

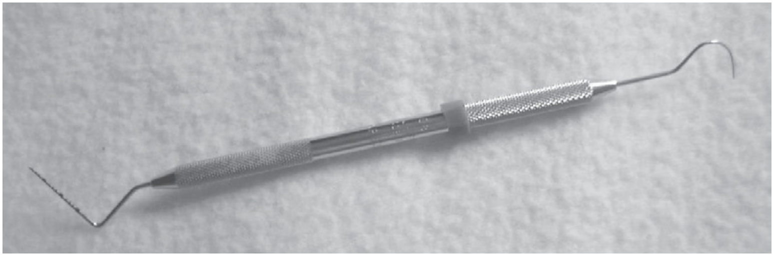


Figure 4-7 An explorer/probe instrument. The sharp, curved end is the explorer and may be used to detect cavities and assess tooth fractures for pulpal exposure. The other end is the periodontal probe with millimeter markings. Periodontal probes come in many varieties; however, it is important to find a version that is marked clearly and easily read. The probe is used to measure gingival sulcus or periodontal pocket depth by gently inserting it between the gingival margin and the tooth surface.

surface. There is a distinct "tacky" feel when the explorer is withdrawn, as if it were in taffy.

The sharp explorer may also be used on worn or fractured teeth to discern pulpal exposure from tertiary dentin. Tertiary or reparative dentin is formed by the dental pulp in response to the irritation caused by gradual wear on that tooth. Thus a vital tooth maintains itself as a sealed pulp cavity, even though the tooth material is being worn away. This tertiary dentin appears as a golden brown dot in the center of worn teeth. It is hard and smooth so that it will resist the tip of the explorer and feel like glass when that tip is drawn across its surface.

A pulpal exposure, on the other hand, will look red or pink in the early stages and dark brown or black as the pulp goes on to die. The tip of the explorer usually can be inserted to some depth within the tooth. However, debris may block the exposure site and prevent the explorer's entry or the exposure site may be of a smaller diameter than that of the tip. A suspected pulpal exposure should always be further investigated with intraoral radiography.

Charting All Abnormal Dental Findings

It is essential that the complete results ascertained in the SPF procedure and subsequent oral exam be thoroughly charted. This is a legal document and a permanent part of the medical record. It is advisable to have a full-page chart so that all the teeth can be represented with ample room for notation. A key to common dental abbreviations can be included so that dental problems can be recorded in shorthand with no loss of understanding. A carbonless duplicate chart is helpful as a copy for owners to take home to enhance their appreciation of the oral condition of their pet. The dental chart can also be used for future reference in the examination and the treatment of the oral cavity (Figures 4-8 and 4-9).

Intraoral Radiographs of All Potential Dental Problems

Intraoral radiography is a diagnostic tool indispensable for further evaluating dental problems. Without the ability to take high-quality radiographs of the teeth and surrounding bone, the clinician is blind to anything below the gumline, which includes the majority of the total tooth mass and all the supporting bone. A clinician who relies entirely on what is visually apparent is making decisions without knowing all the facts. How can such decisions be in the best interest of the patient's health? Consider intraoral radiographs for any fractured tooth, periodontal pocket, furcation exposure, root exposure, loose tooth, mucosal fistula, discolored tooth, cavity, or any other suspicious dental abnormality.

Polishing the Tooth Surfaces

The second most important part of the SPF, after removing the subgingival plaque and tartar, is polishing all

FELINE DENTAL CHART

VCA SOUTH SHORE VETERINARY HOSPITAL

595 Columbian Street, South Weymouth, MA 02190

Tel: 781-337-6622 Fax: 781-340-6629

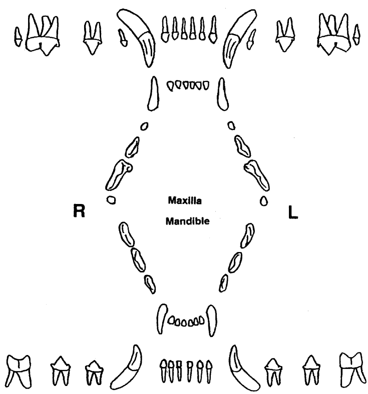
Owner:______________________ Patient:______________ Date:__________

Breed:__________ Sex:_____ Age:_____ RDVM/VMD:______________Fax:__________

History:____

Diagnostic Notes:______________________________________

____



☐ Scale/Polish/Fluoride ☐ Intraoral X-rays:_____views ☐ Local Anesthesia:______________

Treatment Notes:______________________________________

____

____

AT = Attrition
© = Consil Use
⊖ = Heska Use
CA = Caries
CR = Crown
CU = Contact Ulcer
CWD = Crowding
DB = Dentinal Bonding
DT = Discolored Tooth
ED = Enamel Defect

FE (Stage) or ∇ = Furcation Exposure
FX or / = Fracture
GH = Gingival Hyperplasia
GP = Gutta Percha
GVP = Gingivoplasty
LPS = Lymphocytic/Plasmacytic Stomatitis
M (Stage) = Mobile Tooth
O = Missing Tooth (circle)

OAF = Oroantral Fistula
OM = Oral Mass
ONF = Oronasal Fistula
OP = Odontoplasty
P (mm) / V = Periodontal Pocket
PC = Pulp Capping
PD (Stage) = Periodontal Disease
PE = Pulp Exposure
R/C = Restorative/Composite
R/I = Restorative/Ionomer

RC = Root Canal
RD = Retained Deciduous
RE (mm) = Root Exposure
RL (Stage) = Resorptive Lesion
RPC = Root Planing - Closed
RPO = Root Planing - Open
SPF = Scale/Polish/Fluoride
VP = Vital Pulpotomy
X = Extraction
ZOE = Zinc Oxide - Eugenol

Figure 4-8 A feline dental chart. It is necessary to accurately chart all dental problems, and this type of chart provides a large area for recording the abnormal findings.

CANINE DENTAL CHART

VCA SOUTH SHORE VETERINARY HOSPITAL

595 Columbian Street, South Weymouth, MA 02190

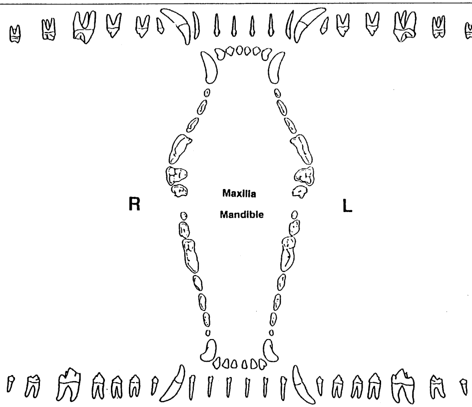
Tel: 781-337-6622 Fax: 781-340-6629

Owner:__________ Patient:__________ Date:__________

Breed:__________ Sex:_____ Age:_____ RDVM/VMD:__________ Fax:__________

History:__________

Diagnostic Notes:__________



☐ Scale/Polish/Fluoride ☐ Intraoral X-rays:_____views ☐ Local Anesthesia:__________

Treatment Notes:__________

AT = Attrition
© = Consil Use
Θ = Heska Use
CA = Caries
CR = Crown
CU = Contact Ulcer
CWD = Crowding
DB = Dentinal Bonding
DT = Discolored Tooth
ED = Enamel Defect

FE (Stage) or V = Furcation Exposure
FX or / = Fracture
GH = Gingival Hyperplasia
GP = Gutta Percha
GTR = Guided Tissue Regen.
GVP = Gingivoplasty
M (Stage) = Mobile Tooth
O = Missing Tooth (circle)
OAF = Oroantral Fistula

OM = Oral Mass
ONF = Oronasal Fistula
OP = Odontoplasty
P (mm) or V = Periodontal Pocket
PC = Pulp Capping
PD (Stage) = Periodontal Disease
PE = Pulp Exposure
R/C = Restorative/Composite
R/I = Restorative/Ionomer

RC = Root Canal
RD = Retained Deciduous
RE (mm) = Root Exposure
RL (Stage) = Resorptive Lesion
RPC = Root Planing - Closed
RPO = Root Planing - Open
SPF = Scale/Polish/Fluoride
VP = Vital Pulpotomy
X = Extraction
ZOE = Zinc Oxide - Eugenol

Figure 4-9 A canine dental chart. A key to commonly used abbreviations is included at the bottom of the chart to aid clarity for everyone.

tooth surfaces. Scaling the teeth microetches the enamel, leaving the freshly scaled surface slightly roughened. These tiny scratches on the enamel surface make it plaque retentive. The purpose of polishing is to create a smooth enamel surface to inhibit plaque reattachment as much as possible.

Polishing should be done with a fine paste, a soft prophy cup, and at a low speed with the polishing handpiece. The fine paste not only makes the tooth surface smoother than coarser grits but also removes a minimum of enamel. Because enamel is so resistant and does not grow back once it is lost, it is very precious. It is preferable in many cases to leave stains on teeth rather than removing them by removing the stained enamel. The soft prophy cup is helpful to be able to get the polishing surface to splay out easily, with little pressure, so that the lip of the cup can sneak under the gumline and polish the subgingival surface of the tooth.

The polishing handpiece should be run at a low speed to minimize the friction produced. Great care must be exercised with the polisher, because it produces heat from the friction of the prophy cup. The polisher is potentially more dangerous to the pulp tissue than the power scaler in terms of heat buildup; therefore, it is recommended to not polish any particular tooth for more than 5–10 seconds at a time. Finally, all the prophy paste should be thoroughly rinsed from the mouth, especially from the subgingival regions.

Application of Fluoride to All Teeth

Fluoride use has always been controversial, with some believing it to have minimal benefit. However, if its use does not cause harm and there are potential benefits, then the author believes it should be used. There are many types of fluoride, but a good acidulated phosphate fluoride is a fine general-use product. It should be applied as a last step to dry teeth, allowed to sit for 3–5 minutes, then wiped from the teeth. Fluoride should not be rinsed from the teeth because water can deactivate some fluorides. The potential benefits to in-office fluoride treatment are remineralization of partially demineralized enamel, desensitization of exposed roots, and an antimicrobial effect.

Specific Home Care Recommendations to the Owner

An annual SPF alone is not enough to keep an animal's oral cavity in peak health; the owner must supply some form of home care. Home care may take on several different forms, but all of them should be directed at addressing daily plaque removal and control. Brushing the teeth is still the best means of plaque control, just like with human mouths. An enzymatic toothpaste should be used along with a soft bristled toothbrush. It is very helpful and encouraging to give clients a visual demonstration of tooth brushing to show them that it is possible.

Teeth should be brushed at least once a day in a circular motion directed chiefly at the gum-tooth interface, so that the soft bristles can sweep food and debris away from under the gums.

Other forms of home care may include Hills t/d food fed as a treat or a maintenance diet, specifically made edible dental chews, and even oral gels. The owner needs encouragement and positive reinforcement just as much as the pet. It is always best to start as early as possible in an animal's life, getting it used to the routine daily home care that will enable it to live a better, longer life. A printed sheet should go home with the owner to remind them of the veterinarian's recommendations for their pet's home care regimen.

Next SPF Scheduled with Owner and Reminder Set Up

Part of the complete dental cleaning is making the best recommendations for maintaining an animal's optimal oral health, including the next time for professional intervention. If the teeth and oral tissues are in great condition, then the next scheduled SPF should be in 1 year. However, if the oral tissues are in poor condition or at risk for further destruction or if some of the natural oral defenses have been altered, the next scheduled periodontal treatment should be sooner, depending on the severity of pathology. A helpful reminder should be set up to facilitate both owner and veterinary practice.

Periodontal Therapy Armamentarium

Professional Dental Cleaning (Scale/Polish/Fluoride)

The SPF is the cornerstone of periodontal therapy and care. As the level of disease increases, so should the frequency of the SPF. It is hoped that further periodontal destruction can be prevented as much as possible through frequent SPF procedures.

Closed Root Planing

Closed root planing is the cleaning of contaminated root surfaces within periodontal pockets without the use of a periodontal flap for direct visualization (Figure 4-10). The purpose of closed root planing is to establish a clean root surface in periodontal pockets of 4–6 mm depth. Care must be taken not to harm the root by removing excess cementum. Performing closed root planing properly requires a sharp hand curette and practice. It is necessary to develop the proper feel and sound of effective root care.

Doxycycline Gel Insertion

Doxycycline has many benefits for the diseased periodontium, particularly when it is locally delivered. Doxycycline is an antibiotic that is effective against most of the pathogens present in periodontal disease. It also has an

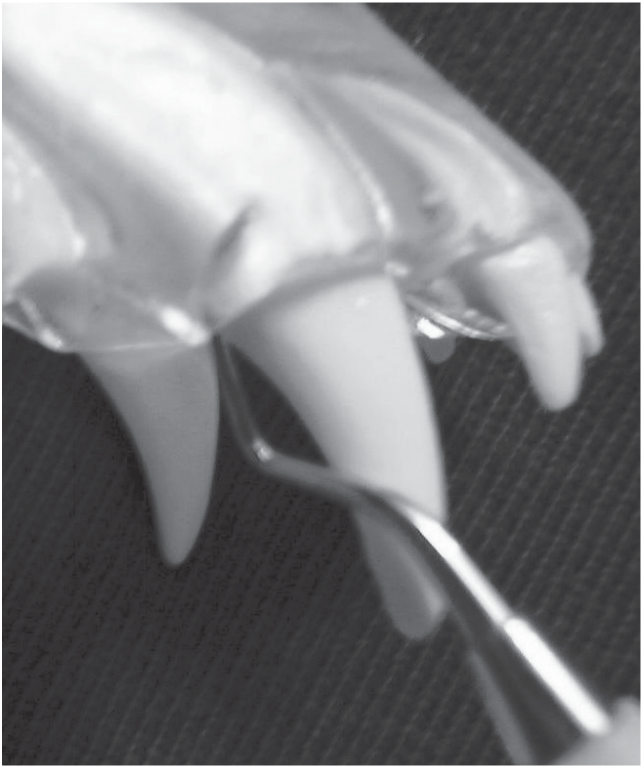


Figure 4-10 A dental hand curette inserted subgingivally. The dental hand curette has a blunt tip and can be used underneath the gumline to debride the root of contaminants.

anticollagenase property to prevent the periodontal ligament from being further destroyed. It has also been shown that doxycycline can bind to the root surface to provide an extended release of the drug for longer lasting benefits and the root may become conditioned to facilitate future reattachment of the periodontium. In brief the periodontal treatment gel provides a convenient form of doxycycline, which improves the health of the remaining periodontal tissues.

Open Root Planing

Open root planing involves the creation of a gingival flap to gain direct access to and visualization of the roots for periodontal debridement. Periodontal pockets of 7 mm or greater depth typically require a gingival flap to completely remove contaminants from the root surfaces. The further goal of open root planing is the reduction of pocket depth through careful suturing of the flap when the periodontal debridement of the root(s) is complete.

Guided Tissue Regeneration

Guided tissue regeneration is the regrowth of lost supporting periodontal tissues. It is aimed at improving the level of bone and periodontal ligament through diligent periodontal debridement with open root planing, as well as the use of osseopromotive implant materials. This is an advanced surgical procedure and not appropriate for all periodontally diseased teeth or all patients.

Home Care

The importance of daily plaque control through home periodontal care cannot be stressed enough. There is simply no better way of caring for the oral cavity. Although brushing the teeth once or twice a day remains the best form of plaque control, supplemental products are available. Chlorhexidine, a potent oral antimicrobial agent, can be used on a daily basis without known resistance development. It should be reserved for patients with existing attachment loss, however, and should be used with a toothbrush as the toothpaste.

Plaque control diets are a simple method of home care and work by rubbing away some of the supragingival plaque. They work most effectively after a professional cleaning, as a preventative measure. Although they are no replacement for daily brushing, they are a useful adjunct to periodontal care with which owners have good compliance. It must be noted that, although they are more effective when fed as the entire diet, they can be fed as a treat with plaque controlling benefits. However, the owner must be made aware that these foods have a high degree of fat to assure palatability, so total caloric intake must be adjusted accordingly.

Stages of Periodontal Disease and Treatment Recommendations

Periodontal disease can be staged, based on clinical appearance of the gingiva and attachment loss of the periodontium. Attachment loss may differ somewhat from probing depth because it also takes root exposure into account. Attachment loss is the measurement from the bottom of the pocket (the present attachment level) to the cementoenamel junction (the normal attachment level). Attachment loss is typically expressed as a percentage of loss versus the total normal attachment. The purpose for staging periodontal disease is to make appropriate treatment recommendations based on the severity of the disease and the alteration in the natural oral defenses. Table 4-1 summarizes treatment recommendations for the stages of periodontal disease.

Feline Stomatitis Complex

One of the most frustrating oral diseases of cats is feline stomatitis complex. It is known by many names, including *lymphocytic plasmacytic stomatitis* (LPS). Its etiology is still unknown and it yet defies a universally effective treatment, let alone a cure. It appears to be an immunologically related disease and so may be thought of as a special form of periodontal disease, since periodontal disease involves not only bacterial plaque but also the host's immune response. The response to the plaque

Table 4-1 Stages of Periodontal Disease

Stage	0	1	2	3	4
Appearance	Healthy	Mild gingivitis	Moderate gingivitis	Marked gingivitis	Marked gingivitis
Attachment loss	0%	0%	<25%	25–50%	>50%
SPF frequency	12 months	9–12 months	9 months	6 months	1–3 months
Plaque control diet	Yes	Yes	Yes	Yes	Yes
Toothpaste	Enzymatic	Enzymatic	Enzymatic	CHX	CHX
Brushing frequency	sid	sid	bid	bid	bid
Root planing	No	No	Possibly	Yes	Yes

Note: Some Stage III and most Stage IV periodontal disease will require some form of surgical intervention, either in the form of periodontal surgery or extraction.
CHX = chlorhexidine.

biofilm appears to be inappropriate and exaggerated. Many have called feline stomatitis a disease of plaque intolerance, but why that should exist in some cats remains a mystery.

Cats with feline stomatitis have a variable degree of inflammation to the lining of the oral cavity. The inflammation may take the form of severe gingivitis, mucositis, faucitis, palatitis, glositis, or pharygitis. Cats can experience a lot of pain and may have decreased appetite or excessive salivation. One of the first steps to managing cats with severe oral inflammation is to obtain an oral biopsy. Lymphocytic/plasmacytic stomatitis is a histological diagnosis and does not indicate an etiology, but it is important to rule out other known causes of oral inflammation.

Medical Treatment

A good first step in the medical treatment of feline stomatitis is a complete physical exam with thorough lab work, including a retrovirus scan. It is important to rule out any systemic causes of oral inflammation and determine the cat's FIV/FeLV status. Feline immunodeficiency virus and feline leukemia virus, although not proven to cause stomatitis, can exacerbate stomatitis and decrease the overall prognosis for control of the disease. The physical exam and lab work also clear the way for the next step in treatment, which is obtaining the oral biopsy.

The cornerstone of medical treatment is plaque control, as the biofilm of plaque is known to aggravate the inflammation. Plaque control starts with a complete SPF and any other necessary dental procedures, such as root planing or extractions. The initial SPF can be performed at the same time the oral biopsy is harvested. The most important form of plaque control, though, is daily home care. The SPF is intended to make that home care easier to perform; however, in many cases, home care is not well tolerated. In those cases, the SPF will need to shoulder more of the responsibility for plaque control and will need to be performed at frequent intervals to keep the irritant plaque at bay.

Although many cats have been treated with corticosteroids or antibiotics with varied response, these medications are in no way a long-term solution to this frustrating disease. If long-lasting relief and oral comfort are to be achieved through nonsurgical means, then plaque control must play the major role, with medication aiding mainly in acute flare-ups. Plaque-controlling diets, oral gels and rinses, and the mechanical action of brushing are needed on a daily basis to prevent the plaque from overwhelming the mouth.

Surgical Therapy

When medical therapy is exhausted or when the inflammation is exceptionally severe, surgical therapy is indicated. Surgical therapy typically means multiple extractions, sometimes of all the teeth (Figure 4-11). It is hoped that by such drastic means that all problems may be cured, but there are cases that do not show a complete response to full-mouth extractions. In general, if the inflammation is mainly around the teeth, then extractions are likely to provide a dramatic improvement. However, the prognosis for complete resolution of inflammation decreases the further caudally the inflammation is present in the mouth. Although full-mouth extractions may be part of the therapy for a pharyngitis, some form of auxiliary therapy will likely be needed to keep the inflammation under control.

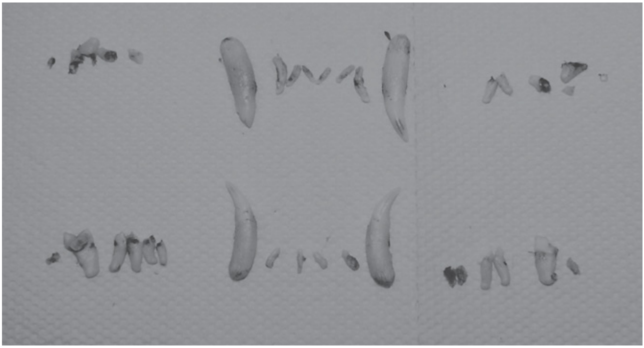


Figure 4-11 The teeth and teeth remnants removed in a full-mouth extraction. This drastic procedure should not be undertaken until medical therapy has been entirely ruled out.

5

Endodontics

The field of endodontics deals with the health and the disease processes of the inside of teeth. A tooth is hollow and dental pulp occupies that confined space (pulp cavity.) The dental pulp is composed of blood vessels, lymphatics, nerve fibers, connective tissue, and mesenchymal cells. As a healthy tooth matures, the pulp cavity becomes narrower. Dentin, which is produced by the odontoblasts of the pulp, is laid down as secondary dentin throughout the life of a healthy tooth, gradually decreasing the diameter of the pulp cavity, or root canal, and increasing the thickness of the walls of the root.

The pulp can be insulted in many ways, such as fracture of the crown of a tooth, which exposes the pulp cavity; blunt force trauma (i.e., tug-of-war, car accident);

advanced caries; or infection from hematogenous spread. However, the pulp has very few ways of responding to these insults. Due to the unyielding walls of the root canal and the poor collateral microcirculation of the pulp, pulpal death and chronic infection of the necrotic remnants are very common sequelae to endodontic insult.

When a tooth has been fractured and the pulp cavity exposed, it must be treated endodontically or extracted (Figure 5-1). If left untreated the tooth will likely be a chronic source of both pain and infection, leading to long-term bacterial infection, abscessation, or secondary periodontal disease. In most cases, endodontic treatment is preferred if it will save the function of the tooth and maintain the integrity of the surrounding alveolar bone. Although extraction is usually considered a lesser option, it is sometimes necessary, due to the extent of crown or root damage or the owner's refusal to save the tooth with endodontics.

Intraoral radiography is essential for accurate assessment and successful treatment of an endodontically compromised tooth. Proper diagnosis and endodontic treatment simply cannot be performed without high-quality intraoral films. Radiographic signs of pulpal death may include a wider than expected pulp cavity, when compared to the same tooth type on the opposite side of the mouth, or radiolucency around the apex of a root (Figure 5-2). Radiographs are taken throughout an endodontic procedure to monitor progress and may also

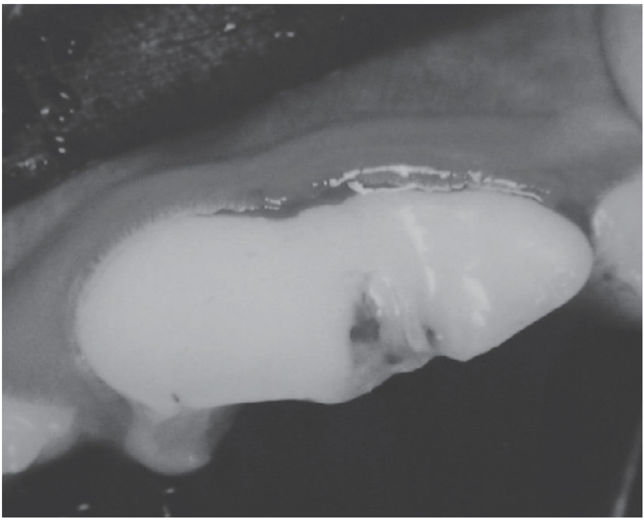


Figure 5-1 A fractured left maxillary fourth premolar tooth with pulpal exposure. The cusp of the tooth is fractured off, and the pulp is bleeding slightly at the center of that fracture site. This tooth needs to be treated either endodontically or with extraction.

Figure 5-2 An intraoral radiograph of a cat with a fractured right mandibular canine tooth. The diameter of the pulp cavity in the canine tooth on the right is much greater than the canine tooth on the left. This indicates that the right mandibular canine tooth died and did not continue maturation and further secondary dentin deposition. Note also the lucency and root end resorption of the right mandibular canine tooth.

be taken at 6- to 12-month intervals to check on the long-term success of treatment.

A root canal is the most common endodontic procedure and caries the most predictable chance for success. The goals of root canal therapy are to remove infected and necrotic pulpal remnants, clean and flush the walls of the pulp cavity, shape the pulp cavity in preparation for a filling, seal the pulp cavity and fill it three-dimensionally with an inert material, and restore the pulp cavity exposure to the oral cavity. When a tooth has been successfully treated endodontically, it is impervious to infection and should serve the animal for many, many years with proper care.

Many of the teeth previously thought unsalvageable, such as maxillary carnasial teeth with root abscessation and suborbital drainage, can be saved with root canal therapy. A root canal procedure is less painful and less traumatic than extraction and preserves the function of the tooth. Those teeth previously thought not to be problematic, because the animal continued to eat despite an obviously exposed pulp, can also greatly benefit from root canal therapy, ending chronic infection and silent discomfort for the pet.

In special instances, more involved endodontic therapy is needed to save a tooth, but that evaluation is made only with the benefit of intraoral radiography and careful probing with magnification. It is important to radiograph and consider endodontic treatment of all teeth with fractured crowns or roots, crown discoloration, associated mucosal fistula formation, root abscess, or any teeth of questionable vitality. Many of these teeth are good candidates for the beneficial effects of endodontic therapy.

Clinical Signs of Endodontic Disease

Silent Suffering

The vast majority of animals with endodontic disease show no outward signs of the pain and discomfort they must feel. Since dog and cat teeth are very similar to human teeth, whatever dental problems are painful to people are most likely painful to veterinary patients. It can be very difficult to explain to owners that, even though their pet is still eating, it has a painful mouth. It is wise to understand that the power of hunger is immense, controlled by the stomach and the brain. Animals will suffer through tremendous pain and discomfort to satisfy that hunger which keeps them alive. Since the clinical signs of endodontic disease, like other forms of dental problems, are often subtle and insidious, it may only be after the disease is properly addressed and treated that a change is appreciated. Owners are routinely amazed at the improvement in their pets, claiming that they seem rejuvenated and much happier.

Facial Swelling

Careful inspection and palpation of the head and face should be part of any thorough physical examination.

The veterinarian should look for asymmetry, abnormal swelling, and areas painful or warm to the touch. Facial swelling may represent endodontic, or tooth root, abscessation and should be considered in association with the anatomy of the roots of the teeth within the maxilla and mandible.

Suborbital Purulent Drainage

An endodontic abscess of the maxillary fourth premolar tooth is well known to cause suborbital swelling and eventual purulent drainage, but the maxillary first molar and the maxillary canine teeth may cause similar swellings or cutaneous draining tracts. The mandibular teeth, when grossly abscessed, can also cause purulent cutaneous discharge. This is especially true of the mandibular canine teeth. The shrewd veterinarian should always include intraoral radiography in the workup of these draining tracts, not only to discern dental causes from nondental causes, but also to determine which tooth or teeth are endodontically diseased.

Mucosal Fistulation

A good portion of the oral exam should be directed at inspecting the soft tissues. The mucosa should be examined just as closely as the gingiva, looking for redness, swelling, and discharge. The examiner should always carefully bear in mind the anatomy of the roots, especially their curvature and location of apices. Mucosal fistulas caused by endodontic abscess typically are located at or slightly apical to the mucogingival junction. This fistula is the drainage of the periapical abscess of an endodontically diseased tooth (Figure 5-3).

Fractured Crown

Fractured crowns observed through oral examination should always be considered for potential pulpal exposure. The presence of heavy tartar sometimes obscures the fracture site and makes assessment of pulpal exposure challenging, if not impossible. It is often necessary to scale suspected teeth before completely examining and exploring them. A tooth that is excessively worn may also present a diagnostic challenge. If a tooth has been worn gradually through chronic chewing on items such as tennis balls, the healthy tooth may be able to keep up with the wear and maintain a sealed pulp cavity by laying down tertiary, or reparative, dentin. The worn surface of such a tooth will be smooth and have a golden brown center. A sharp explorer will not be able to penetrate into the pulp cavity, unlike a tooth with true pulpal exposure.

Discolored Crown

Teeth with pulpal irritation and pulpal bleeding often discolor the crown from the inside. The crown takes on a pink, purple, beige, or even gray tint. Most of these teeth, even though the crown may be fully intact, are not vital and need to be treated with root canal therapy or

Figure 5-3 The fractured right maxillary canine tooth and endodontic abscess of a cat. The draining tract is being explored with a gutta percha point, which will be radiographed in situ as an intraoral fistulogram. This draining tract is at the mucogingival junction, which typically suggests endodontic abscess.

extraction. The nonvital pulp makes an excellent medium for hematogenously spread bacteria, and these teeth can become just as troublesome as those endodontically infected through a fracture site communicating with the oral cavity.

Radiographic Signs of Endodontic Disease

Widening of the Periodontal Ligament Space

One of the first radiographic signs of endodontic disease is the widening of the periodontal ligament (PDL) space around the apex of the root. The periodontal ligament normally appears as a radiolucent line around the entire root, contrasted nicely by being sandwiched between the radiodense lamina dura of the bony socket and the radiodense root. When endodontic disease and infection extend outside the tooth, the area adjacent to the root apex, the portal of exit, is the first area to show radiographic destruction of the bone.

Periapical Lucency

As endodontic infection becomes more established and more bone destruction is brought about, the radiolucency around the root apex enlarges from a mere widening of the periodontal ligament space to a round halo of periapical lucency (Figure 5-4). This lucency represents

Figure 5-4 An intraoral radiograph of an endodontically diseased left maxillary fourth premolar tooth of a dog. There is a significant halo of lucency around the apex of the distal root. The pulp cavity of the distal root is also larger than the maxillary first molar tooth, suggesting pulpal death and infection.

bone destruction and requires time to develop, so its absence does not rule out endodontic disease. For a recent endodontic insult, the clinician must rely on clinical appearance and careful probing with a fine explorer.

Wide Pulp Cavity (Compared with the Opposite Tooth)

An endodontically disease tooth that has become nonvital will not continue to lay down secondary dentin on the walls within the pulp cavity. Over time, a discrepancy may be noted in the diameter of the pulp cavities of a nonvital tooth and its vital counterpart on the opposite side of the arcade. This discrepancy is especially noticeable when the pulpal death has occurred early in the patient's life, with the nonvital tooth having a much broader pulp cavity diameter. Such a discrepancy also requires time for the vital tooth to continue its deposition of secondary dentin, so that a recent endodontic insult may not show a noticeable difference.

Lucency Within the Pulp Cavity

Certain endodontic conditions, such as internal root resorption, can be evident radiographically as discrete enlarged lucencies within the pulp cavity (Figure 5-5). Many of these abnormalities are found incidentally but demand proper endodontic treatment or extraction of the affected tooth.

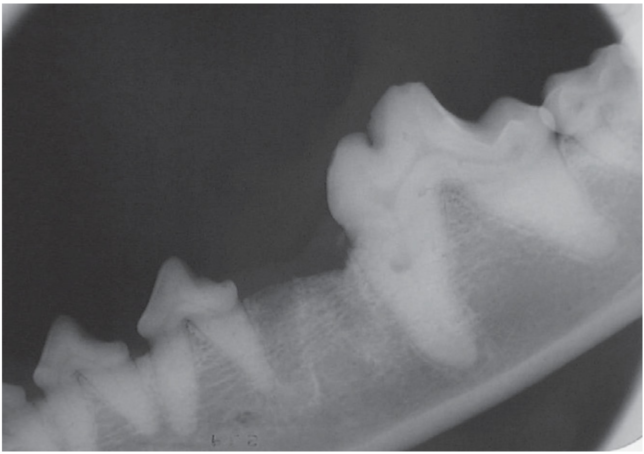


Figure 5-5 An intraoral radiograph of the internal resorption of the mesial root of the left mandibular first molar tooth of a dog. The round lucency represents an area of the pulp cavity where inflamed or traumatized pulp tissue has led to resorption of the internal root walls.

Endodontic Instruments

Round Ball Bur on High-Speed Handpiece

The round ball bur, either the smaller #2 or the larger #4, inserted into a high-speed handpiece is the ideal instrument for creating additional endodontic access sites into the fractured tooth. This instrument is quite effective at creating holes into teeth and, therefore, must be used with great care. It is important to remove the least amount of natural tooth necessary, so that structural integrity of the tooth can be maintained. Always remember that there is no more desirable restorative material than the patient's own natural tooth material.

Endodontic Files

Endodontic files are usually made of either stainless steel or nickel-titanium alloy. They are available in several styles and lengths, sized by their tip diameter (Figure 5-6). The instrumentation of the root canal procedure is accomplished with these files. By using ever increasingly sized files, the operator can enlarge, debride, and shape the pulp cavity. Files may be prebent to better follow the internal curvature of a canal and can be used in several different techniques to achieve a properly cleaned and shaped canal.

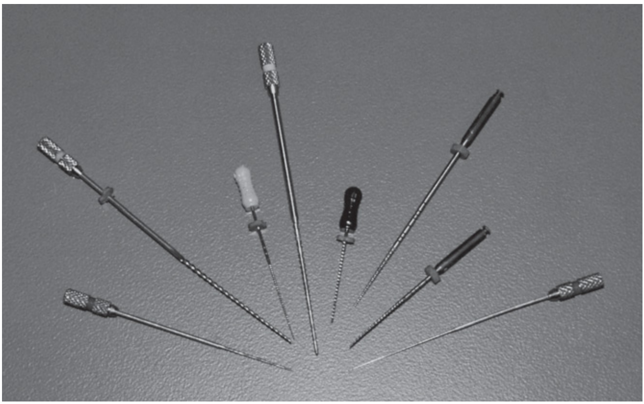


Figure 5-6 A variety of endodontic files. Endodontic files differ in many ways, such as diameter, length, cutting flute design, and production for hand versus engine driving. Many types of files are necessary to treat the varied endodontic conditions and species involved in veterinary dentistry.

Irrigation Needles

Copious lavage is a necessary part of any root canal procedure. Although standard hypodermic needles may be used at the end of the irrigating syringe, there are specialized needles for endodontic lavage. The needles are blunt at the tip and have a side discharge instead of an end discharge. One very important consideration in endodontic lavage is to prevent lodging the needle in the canal and applying excessive pressure. This excessive lavage pressure can force infected debris and irrigants through the apex and into the periradicular tissue, causing a severe inflammation. Using smaller-diameter needles and specific endodontic irrigating needles helps prevent such occurrences.

Bleach and Saline

Sterile saline and bleach, used alternatively, are a popular combination for irrigation of the root canal. The canal is irrigated frequently throughout a root canal procedure to remove infected debris and not allow it to block the canal. Bleach is very good at the disinfection and dissolution of organic debris. However, it should never be used under pressure, especially in a canal in which the apex is suspected of being open. Bleach in the periradicular tissues is exceptionally irritating and causes a tremendously nasty inflammatory response.

Paper Points

Paper points are sterile tapered pieces of rolled-up paper. These are available in specific lengths and diameters, which correspond to the endodontic files. The points are used to dry the canal after it has been completely cleaned and shaped. They are very absorbent and may also be used to locate the source of bleeding in a canal with persistent hemorrhage.

Endodontic Sealant

The endodontic sealant is a cement designed to line the walls of the instrumented canal to seal the canal from the periapical or periradicular tissue and prevent ingress or egress of fluids and bacteria. Most endodontic sealants currently used are subject to some degree of resorption by the body. Therefore, it is important to apply only a thin layer of sealer cement to the walls of the root canal to avoid future voids from excess resorption.

Gutta Percha Points and Warm Gutta Percha

Gutta percha is a rubbery material meant to fill the root canal three-dimensionally and force the sealer cement into an intimate contact with the dentinal walls. It is available in slender tapered points similar to paper points, sized in varying diameters to correspond to the endodontic file sizes. The points are used by packing them into place and wedging additional points into the canal to fill it completely. Heated instruments may be used to mold the material while packing it more completely. The material itself is sometimes warmed before insertion so that it is soft when put into the canal, easily conforms to the intricate canal anatomy, and solidifies as it is tightly packed into the canal.

Acid Etch

Acid etch is a concentrated phosphoric acid applied to the tooth surface to remove the "smear layer" and allow the bonding and restorative materials to attach to the tooth. The acid etch is applied to the tooth for a short period of time, usually 15–60 seconds is all that is needed to create a surface that will accept the actual restorative material.

Dentinal-Enamel Bonding Agent

The bonding agent is a low viscosity adhesive able to penetrate into the tooth surface. With the use of more modern bonding materials, composite restoratives are better able to bond to the tooth. The bonding agent bonds firmly to the tooth and the composite restorative bonds firmly to the bonding agent.

Composite Restorative

The composite restorative, in many cases, is the final restorative. Newer-generation composites allow for a tougher, longer-lasting, and wear-resistant restoration. The composite comes in a variety of shades to approximate the color and shade of the natural tooth. Most of the modern composites are soft and pliable until cured with a special visible light cure gun. This allows an increased working time to the material as well as a more predictable cure. The goal of the final restoration is to blend with the natural tooth structure, smoothing rough edges and sealing the inside of the tooth from the bacteria of the oral cavity. It is crucial to long-term success that the gingival margins of the restoration maintain periodontal health, in that they are as minimally plaque retentive as possible.

Standard Root Canal Therapy

Root canal therapy is the most common form of endodontic treatment and carries a high degree of success when performed appropriately. Many specialized instrument and supplies are needed to effectively complete a root canal procedure, but none is more important than intraoral radiography. Performing a successful root canal procedure also demands the operator to be experienced in the subtleties of cleaning and shaping the canal. Only with considerable practice can one become proficient at achieving a "good fill." The following steps are involved in root canal therapy.

Preoperative Radiograph

The preoperative radiograph must be the first step in performing a root canal procedure because it enables the operator to assess the root anatomy. The integrity of the root or roots and the surrounding bone must be fully evaluated before the procedure is started. If the root(s) is incapable of holding the filling material, due to an open, immature apex or unstable root fracture, then the prognosis for success is drastically reduced without other, more highly advanced endodontic treatments. The preoperative radiograph can also help the operator with visualization for proper access site preparation.

Creating an Endodontic Access Site

Due to the curved canals of dog canine teeth and the complexity of the pulp cavities of multiple-rooted teeth, it is often difficult, if not impossible, to perform the necessary endodontic file instrumentation through the original fracture site or pulpal exposure. To make the complete cleaning, shaping, and filling of the canal(s) easier, it is usually necessary to create one or more separate access sites in the tooth to be treated. This is accomplished with a round ball bur on a high-speed handpiece. Either a #2 or #4 round ball bur will work, but it is always best to remove as little of the natural tooth structure as possible, to maintain the strength of the tooth.

Determining the Working Length of the File

The first major goal of endodontic file instrumentation is to determine the accurate length of the canal(s) (Figure 5-7). This distance, known as the *working length*, is used throughout the procedure. Although the length can be estimated roughly from the preoperative radiograph, a small-diameter file is needed to traverse the canal to the apical extent of the canal. This is confirmed radiographically, and the measurement is recorded in millimeters. Although healthy, mature dog and cat teeth have an apical delta, which usually provides a comforting and definitive stop to the tip of the file, endodontically diseased teeth should be treated gently. It is much better to advance the first file cautiously, taking serial radiographs than force the file and risk damaging an already compromised apex.

Canal Debridement and Canal Shaping

Endodontic files are used to remove all pulpal remnants and infected debris from the canal. Care is taken throughout instrumentation to not exceed the working length of the canal. Filing is continued until the canal has been thoroughly cleansed and properly shaped to accept the filling material. The ideal shape for a fully instrumented canal is that of a gently tapered funnel, with the narrowest point at the apex and the broadest point at the coronal access site. A funnel-shaped canal

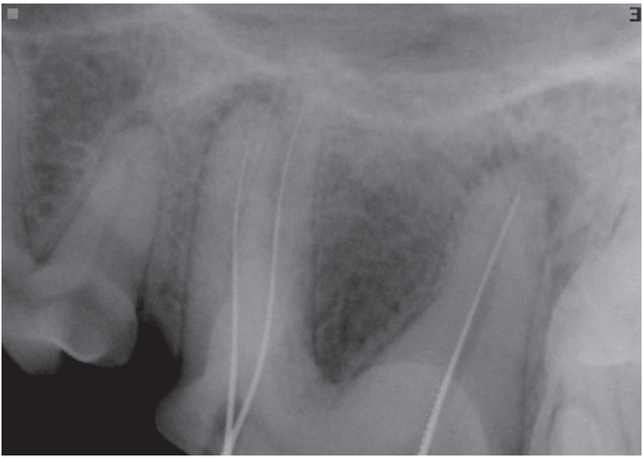


Figure 5-7 An intraoral radiograph of the left maxillary fourth premolar tooth of a dog undergoing a root canal procedure. Three fine-diameter endodontic files are placed into the three canals of this tooth. All three files reach the apex of the pulp cavity and are measured for depth. This depth of each file is known as the *working length* of that canal. This measurement is used for reference during the entire procedure.

allows easier and more complete obturation with the filling material.

Irrigation

Copious flushing is used throughout the canal debridement and shaping. Sterile saline and bleach, used alternatively, is the most common combination, but hydrogen peroxide is also used. Irrigation helps disinfect the canal and removes contaminated debris. Bleach is very useful in this chemomechanical debridement, as it can dissolve organic debris and is a potent antimicrobial agent.

Intraoperative Radiographs

Radiographs are taken throughout the procedure to monitor progress of the debridement and shaping. There is no other reliable way of assuring the proper placement of the endodontic files. It has been said that the intraoral radiograph is the best friend of the endodontic operator. The master file is the largest size file (measured by diameter at the tip) that reaches to the apical extent of the canal. The master file placement is confirmed radiographically.

Canal Drying

After the final irrigation, the canal is thoroughly dried with sterile paper points.

Endodontic Sealant

The walls of the cleansed, shaped, and dried canal are then sealed. The sealant is meant to prevent bacteria from regaining entry into the prepared tooth from the periradicular tissues. Only a thin layer is required to achieve the necessary protection.

Obturation of Canal

An inert filling material, known as *gutta percha*, is then packed into the canal. This hard, rubbery material should fill up the canal space completely in three dimensions. This obturation assures that the sealant is intimately associated with the canal walls. The prime goal of obturation is to completely fill the apical one third of the root canal with no voids. The obturation material is radiopaque to make radiographic assessment possible.

Postoperative Radiograph

A radiograph must be taken to assure a complete fill of the canal or canals (Figure 5-8). If any radiolucent voids are evident in the apical one third of the canal, the obturation must be redone to remove the voids and assure a complete fill. The postoperative radiograph is used to compare subsequent follow-up radiographs to ascertain long-term success or failure of the root canal therapy.

Figure 5-8 An intraoral radiograph of the left maxillary fourth premolar tooth of a dog that has been treated with root canal therapy. This is a film of the final fill and shows a good obturation. A small "puff" of extruded endodontic sealant is close to the apex of the mesiobuccal root (the middle root). This radiograph is used as a reference for regular follow-up radiographs in 6–12 months.

Restoration of Access Site

The tooth fracture and endodontic access site(s) are typically restored with a durable composite filling to seal the canal to the oral cavity (Figure 5-9). It is essential that the final filling is waterproof, so that bacteria from the oral cavity cannot gain access into the treated tooth and reinfect the pulp cavity. The restoration can also enhance the cosmetic appearance of the treated tooth. Although the composite restorative should not be excessively built up to minimize its chances of breaking, a properly restored tooth can be made to look fairly aesthetically pleasing as well as made functional, smooth, and as minimally plaque retentive as possible.

Given proper care, a composite restoration works well for most animals with endodontically treated teeth; however, it must be made clear to the owner that this nonvital tooth is not as strong as a vital tooth. If the natural tooth could break, then this restoration can also be broken. Therefore, it is imperative that owners eliminate all hard chew toys, such as cow hooves, animal bones, nylon bones, and rocks. This is meant to protect not only the composite restoration but also the other teeth. For those teeth in which continued trauma or abuse is expected, such as in police and military working dogs, metal crowns can help to protect the endodontically treated tooth from additional fracture (Figure 5-10).

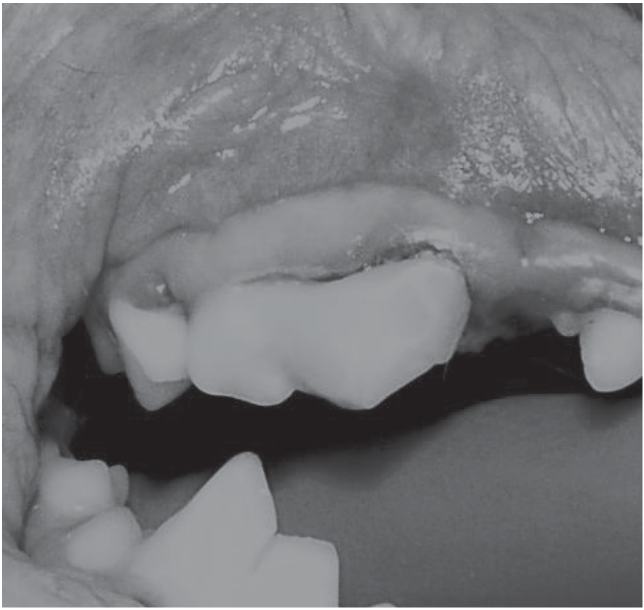


Figure 5-9 The right maxillary fourth premolar tooth in a dog that has been restored after root canal therapy. The composite is close in shade to that of the tooth. The restoration is also smooth, with a minimally plaque-retentive surface. The marginal gingiva has been trimmed slightly to create a better tooth-gingival interface.

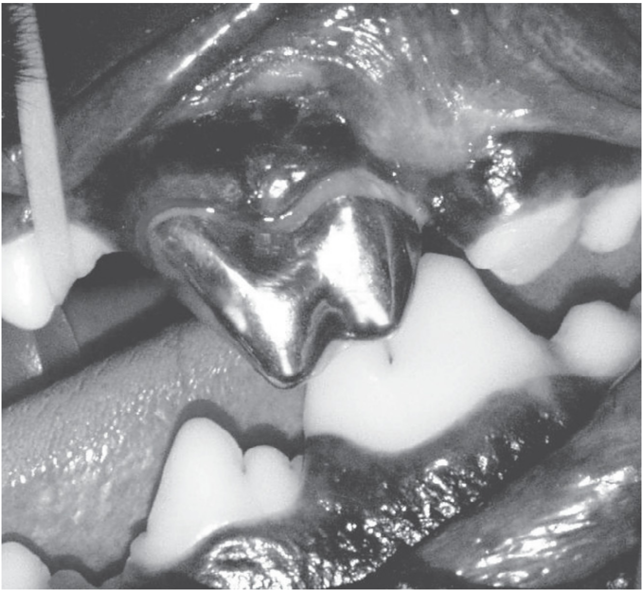


Figure 5-10 The left maxillary fourth premolar tooth of a dog with a white-gold cast crown in place. This crown is meant to protect the tooth from additional fracture. Crowns are a viable choice for restoration, especially in those animals expected to continue to abuse and traumatize their teeth.

Special Endodontic Procedures

Vital Pulpotomy and Pulp Capping

A vital pulpotomy with a pulp capping is an endodontic procedure performed on a tooth with vital pulp. The purpose of the procedure is to keep the majority of the remaining pulp vital and healthy and to stimulate it to form its own seal of reparative dentin over this remaining pulp tissue. This is done by first removing 5–7 mm of coronal pulp tissue with a bur on a high-speed handpiece. Once the bleeding is controlled, calcium hydroxide is gently placed over the remaining pulp tissue to irritate it and stimulate it to form a dentinal bridge within the pulp cavity, coronal to the remaining pulp tissue. A final restorative is placed over the pulp capping to seal the tooth from the oral cavity.

It is absolutely essential to follow up these cases with intraoral radiography to monitor for failure and endodontic disease. Many of these procedures end in failure within 6 months or perhaps after 6 years. Without routine intraoral radiographic monitoring, the condition of the pulp on an ongoing basis can only be guessed at and never fully known.

The procedure usually takes less time to perform than a root canal and has the potential to retain the treated tooth's vitality if it is successful. One very big problem is that pulp capping is a much less successful procedure than a root canal, especially on teeth with a pulpal exposure caused by trauma. The success of the pulp capping procedure relies on the pulp tissues' ability to fend off the insult to it through exposure and maintain its vitality. When a tooth has sustained pulpal exposure traumatically, root canal therapy is the treatment of choice, if it can be done, as it is the most predictably successful procedure.

In certain instances, a root canal cannot be performed directly, such as tooth fracture with pulpal exposure to an immature tooth. If this tooth does not yet have a closed end to the apex, a root canal must be delayed until either apexogenesis or apexification is performed to gain closure to the apical area so that the root canal filling material can be contained within the pulp cavity.

One situation that may be well suited for a vital pulpotomy with pulp capping is the treatment of the malocclusion, linguoversion, or base-narrow canines in young animals. In this malocclusion, the mandibular canine teeth do not flair properly in a buccal direction and are oriented in an upright fashion. This can cause the tips of these teeth to hit the palate and cause ulcerations at those sites. Although orthodontic treatment is the preferred treatment in most cases, another option is the alteration in height of the crowns of these mandibular canine teeth. The crowns are amputated with a cross-cut bur on a high-speed handpiece to the level of the adjacent incisors and the resultant pulpal exposures are treated with vital pulpotomies with pulp cappings.

Apexogenesis

Apexogenesis is a vital pulpotomy with pulp capping performed on an immature tooth with vital pulp. The purpose of the procedure is to maintain the vitality of the pulp long enough to allow it to complete the closure of the apex. It is accepted that the pulp probably will not remain vital indefinitely, and this will not be the only endodontic procedure necessary. An apexogenesis is performed to make an immature tooth ready for the final treatment of a root canal procedure.

Apexification

Apexification is also an intermediate endodontic procedure performed on an immature tooth, but it differs from an apexogenesis in that the pulp is not vital. The canal is carefully debrided of necrotic pulpal tissue and copiously lavaged with sterile saline only. Great care is taken to avoid damaging the delicate periradicular tissue with endodontic files pushed beyond the open apex. Once cleaned of gross debris, the canal is filled with a slurry of calcium hydroxide in sterile saline. The canal is temporarily sealed and rechecked every 3–6 months with intraoral radiographs. The procedure is repeated until there is closure of the root apex. When the apex has closed a root canal is performed.

Surgical Endodontics

A surgical root canal requires the operator to approach the pulp cavity from the apical end. It involves incising the mucosa to expose the buccal alveolar bone overlying the root end. The bone is burred away to expose the root apex. Once the apex is exposed, the root tip may be amputated and the infected periapical soft tissues curetted. The root is then instrumented and filled in a retrograde fashion. A surgical root canal is indicated for continued periapical infection after multiple attempts at standard, orthograde endodontics have been unsuccessful. A surgical root canal may also be necessary if chronic periapical infection has caused root-end resorption or for the treatment of endodontic file disarticulation.

Endodontic Complications

File Disarticulation

One of the most frustrating endodontic complications is file disarticulation or file separation or breakage. A file can break when weakened or stuck in a tight canal. To avoid breakage, files should always be carefully inspected before insertion into the canal. Any files with defects should be discarded, and apparently normal files should not be used indefinitely, especially small-diameter files. Care should be taken when navigating narrow and tortuous canals. Creating a secondary access site to establish straight-line access to the apex, prebending files to approximate canal curvature, and the liberal use of lubrication within a canal all help in the instrumentation of difficult canals without file separation.

Incomplete Obturation

The primary objective of a successful root canal procedure is complete obturation of the canal, especially the apical one third. Voids in the apical one third of the canal indicate a good likelihood that the procedure will not work. The canal should immediately be reinstrumented and reobturated to correct the voids.

Lateral or Accessory Canal

Some pulp cavities have complicated anatomical variations, known as *lateral* or *accessory canals.* These are smaller branches of the main canal and may be missed by routine instrumentation and obturation, harboring infected necrotic pulpal tissue. The only evidence of this complication may be lucency on follow-up intraoral radiographs located on the side of the root, away from the apex. This is one more criterion to examine on follow-up radiographs of endodontically treated teeth. If such a lucency becomes evident, the tooth must be retreated.

Uncontrollable Bleeding

Bleeding is often present in the initial stages of root canal instrumentation, especially with partially vital pulp tissue. With complete instrumentation most hemorrhage is eliminated. If hemorrhage continues beyond what is expected, the operator must first check for file perforation of the canal with an intraoral radiograph. Then, the operator can check for incomplete apical pulp removal or lateral canal presence with a paper point. Paper points are used to first absorb the excess blood in the canal. After that, a paper point is inserted into the dried canal. If there is hemorrhage from a lateral canal, the blood will not be at the tip of the point, but slightly away from the tip.

Perforation

One of the most devastating endodontic complications is perforation of a file through the canal. This may occur at the apex, along the root, or at the furcation. Perforation can be very difficult to treat and should be referred to a veterinary dentist as soon as possible.

6

Oral Surgery

Oral surgery in many ways is plastic and reconstructive surgery for the mouth. All aspects of fine general surgery apply to success in the oral cavity, such as delicate tissue handling, hemostasis, minimizing hard tissue trauma, adequate exposure, and proper closure of surgical defects. Although the mouth has a tremendous ability to heal, the pain and trauma the veterinarian inflicts must be kept to a minimum. Both postoperative healing time and pain can be improved with careful adherence to precision in surgical technique.

The proper instruments greatly enhance the precision and delicacy with which oral surgical procedures can be performed. In general, instruments that are smaller and finer afford more precise surgery. However, it must be stressed that even the best instruments will be rendered inadequate if they are not kept as sharp as possible. Regular attention to the maintenance of oral surgical instruments, such as root elevators and periosteal elevators, dramatically improves the results and satisfaction that can be achieved.

Magnification is another instrument with a great impact on the ability to accurately identify oral lesions and the quality of work performed. Vision enhancement comes in many forms, from drug store "reading" glasses to visor magnifiers to surgical loupes. Having the proper magnification also reduces eyestrain and improves posture. A good-quality surgical light is essential to maximize visualization.

Intraoral Analgesia

One of the biggest concerns in modern veterinary medicine is pain management. We have become much more aware of the silent suffering our patients endure, and as a profession, we now take a much more aggressive stance in its alleviation. The use of local anesthetics in intraoral nerve blocks can greatly reduce postoperative discomfort. Also, when used preemptively, the nerve block can reduce the level of general anesthesia needed. Local anesthetics for intraoral analgesia should be administered after induction but before commencing surgery.

The veterinarian should wait until the local anesthetic has taken effect to get full benefit of the preemptive analgesia. It must be noted that pain, like most other disease processes, is better and easier to prevent than treat. When epinephrine is not contraindicated, commercially available preparations of local anesthetics with epinephrine can provide the added benefits of prolonged analgesic action and improved hemostasis. The long-acting bupivacaine and the shorter-acting lidocaine are two of the more common anesthetics used for intraoral analgesia. Bupivacaine with epinephrine has an onset of action of 10–15 minutes and a duration of action of 6–8 hours, while lidocaine with epinephrine begins working in 3–5 minutes and lasts for $1\frac{1}{2}$–2 hours. Both anesthetics can be obtained in preparations without epinephrine, but they have correspondingly shortened durations of action.

The Dental Aspirating Syringe

Although a standard plastic syringe with attached small gauge hypodermic needle can be used to instill the local anesthetic, the dental aspirating syringe offers a more ergonomic and convenient means of administration. The syringe holds premeasured 1.8 ml carpules of local anesthetic in its barrel and has a thumb ring on the end of its plunger (Figure 6-1). With practice and experience, it is possible to accurately estimate the volume administered, even though the 1.8 ml carpule has no volume gradations. However, the beginner may find it best to start with a standard graduated syringe to become

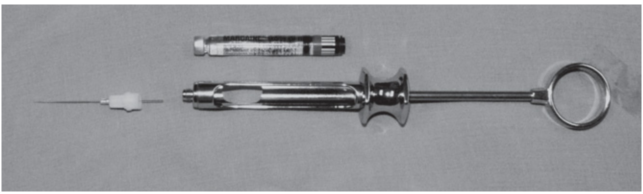


Figure 6-1 A dental anesthetic aspirating syringe and its components. The metal syringe has a barrel that holds the glass 1.8 ml carpule of local anesthesia. When properly inserted into the syringe, the carpule's rubber stopper is engaged by the plunger end, and the carpule's injection port is pierced by a double-ended needle. A great advantage of this syringe system, in addition to the premeasured single-use anesthetic carpules, is the thumb ring on the plunger. This thumb ring allows the operator to aspirate and inject in a smooth motion, instead of having to switch hand positions, as needed with a standard needle and syringe. The tip of the needle needs to be kept as still as possible after being inserted submucosally to avoid damage to vital structures.

familiar with volume quantities and the size of their corresponding submucosal "blebs." The thumb ring offers the distinct advantage of allowing the operator to aspirate and inject without changing hand positions on the syringe. This avoids excess motion of the needle tip, thus avoiding damage to adjacent nerves and vessels.

Volume to Infuse

When using bupivacaine with epinephrine, the recommended volume for intraoral nerve blocks in the dogs is *0.25–0.7 ml* per site. In cats, the recommended volume is *0.1–0.3 ml* per site. The maximum recommended total dose of bupivacaine with epinephrine in dogs and cats is *2 mg/kg*. This drug is quite basic and causes a stinging sensation when infused submucosally. It is necessary to closely monitor the patient during infusion, watching for a change in the plane of general anesthesia and compensating for the increased stimuli.

Needle Insertion

The needle size may vary somewhat, but it is best to use a fine gauge, such as 27 or 30, to minimize trauma and allow for flexibility. The needle is typically inserted with the bevel facing the bone in an effort to avoid getting caught on the periosteum and giving a subperiosteal injection. Before injecting any of the local anesthetics, it is essential to aspirate after submucosal needle insertion.

It is necessary to make sure that the needle has not been introduced into a blood vessel, to avoid intravenous injection. If blood is aspirated, the needle is withdrawn and reinserted at a slightly different site. It is sometimes possible to inadvertently insert the needle into a vessel and not get blood back into the syringe on the first aspiration. Presumably, the vessel wall may be sucked up into the needle bevel and occlude the needle lumen. Therefore, we recommend aspirating initially after needle insertion and, if no blood is noticed within the syringe, injecting a small amount of the local anesthetic. Then, a second aspiration is made and, if there is still no blood present in the syringe, the full amount of the block is delivered to the site.

Simple Infiltration

One of the easiest methods of intraoral analgesia is simple infiltration. Local anesthesia may be injected submucosally in much the same manner as it is injected within the skin. Simple infiltration is chiefly aimed at desensitizing the soft tissues for flap procedures; however, with the use of epinephrine-containing preparations, hemostasis may also be aided through vasoconstriction. Small volumes (0.1–0.2 ml) are injected submucosally peripherally around the site to be operated on, both on the facial and the palatal-lingual aspects. When epinephrine-containing preparations are used, the tissue may take on a blanched appearance. Although some of the local anesthetic agent may diffuse through thinner regions of bone, such as is found in the facial surfaces of the maxilla, simple infiltration should not be relied on as the main means of desensitizing the bone and teeth.

Mental Nerve Block

The mental nerve block is the primary means of providing analgesia to the mandibular canine tooth and mandibular incisor teeth as well as the associated labial soft tissue. The mental nerve is blocked by placing a submucosal bleb (0.25–0.5 ml for dogs and 0.1–0.2 for cats) of local anesthetic over the middle mental foramen. The middle mental foramen, the largest of the three foramina, is located on the facial aspect of the rostral mandible. In the cat, the middle mental foramen is located midway between the mandibular canine tooth and the mandibular third premolar tooth at the dorsoventral midpoint of the mandible. This places it under the cover of the labial frenulum, which is a great landmark to use in this block. The feline middle mental foramen is usually too small to be palpated.

A mental nerve block in the cat is performed by inserting the needle submucosally into the labial frenulum with the bevel facing the bone. The needle should not be inserted at a sharp angle but almost parallel to the mandible, so that the needle does not penetrate into the foramen, possibly lacerating the nerve or vessels. The 0.1–0.2 ml submucosal bleb of local anesthetic diffuses into the foramen, aided by digital pressure after the needle is withdrawn to block the nerve.

Since the middle mental foramen in the dog is larger, it usually can be palpated through the buccal mucosa caudal to the labial frenulum. The foramen is located apical to the first and second mandibular premolar teeth, approximately two thirds the distance ventrally from the dorsal mandibular border. The bevel of the needle is inserted submucosally, facing the bone, and advanced to the opening of the middle mental foramen without penetrating it (Figure 6-2). The syringe is aspirated and a 0.25–0.5 ml submucosal bleb is created over the foramen. The needle is withdrawn and digital pressure is applied for 15–30 seconds to aid in diffusion of the local anesthetic into the foramen.

Infraorbital Nerve Block

The infraorbital nerve block is very useful for oral surgery, as it can effectively desensitize all the dentition, facial bone, and soft tissue in a maxillary quadrant. This would be the block of choice for providing analgesia for extraction of a maxillary canine tooth or a maxillary carnassial tooth. The infraorbital foramen is located dorsal to the maxillary third premolar tooth in the dog and cat (Figure 6-3). Many nerves and vessels exit this foramen and are palpable through the mucosa. It is important not to spear or lacerate these nerves and vessels, as permanent damage may occur. A very helpful guide is created by retracting the upper lip and observing the reflection of buccal mucosa on the maxilla.

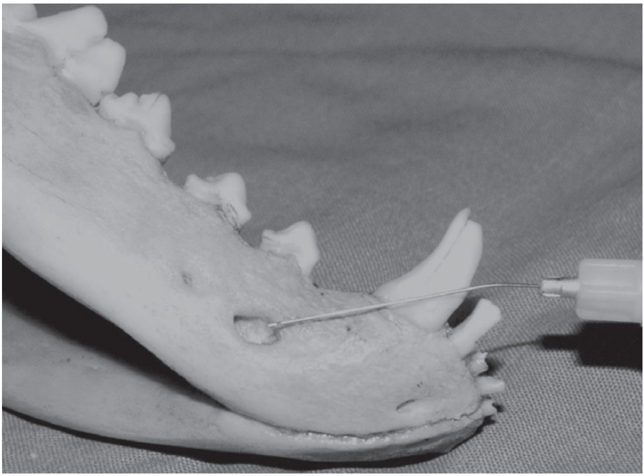


Figure 6-2 The mandible of a dog skull with a needle over the middle mental foramen. This is the site for injection in the mental nerve block. The goal is to deliver a submucosal bleb over the middle mental foramen and not in it. The bleb is forced to diffuse into the foramen with subsequent digital pressure. The needle need not and should not be forced into the foramen, where it can seriously traumatize vessels and nerves.

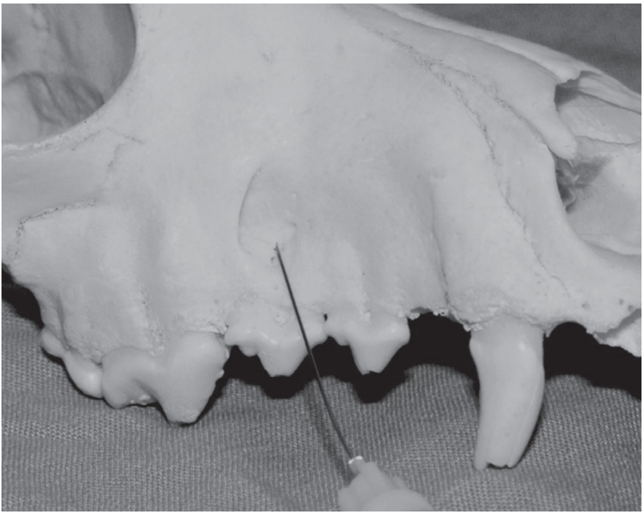


Figure 6-3 The maxilla of a dog skull with a needle over the opening of the infraorbital foramen and canal. This is the injection site for the infraorbital nerve block. It is located dorsal to the maxillary third premolar tooth.

With the upper lip retracted, the buccal mucosa forms a crease, showing the proper insertion site for the needle (Figure 6-4). By inserting the needle here submucosally with the bevel facing the bone and advancing it only as far as the opening of the infraorbital foramen, damage to the exiting nerves and vessels can be avoided. A bleb of 0.5–0.7 ml for the dog and 0.2–0.3 ml for the cat is injected at this site after careful aspiration to assure that the injection will not go intravascular. Digital pressure is applied to the submucosal bleb for 30–60 seconds to aid in the caudal diffusion of the local anesthetic into the infraorbital canal. Caudal diffusion of the anesthetic agent facilitates more complete analgesia of caudal maxillary structures and may be further aided by inclination of the nose and muzzle.

Inferior Alveolar Nerve Block

The inferior alveolar nerve block is used to desensitize the teeth and bone of one mandibular quadrant. It is a potent, useful means of analgesia for extractions, periodontal surgery, and mandibular tumor resection; however, significant potential complications may occur if it is not performed appropriately. If the local anesthetic is improperly placed, the innervation to the tongue may be affected and the animal may recover chewing its tongue and causing severe hemorrhage. More than any of the other blocks, this is one to practice on a cadaver, with a full understanding of the relevant anatomy.

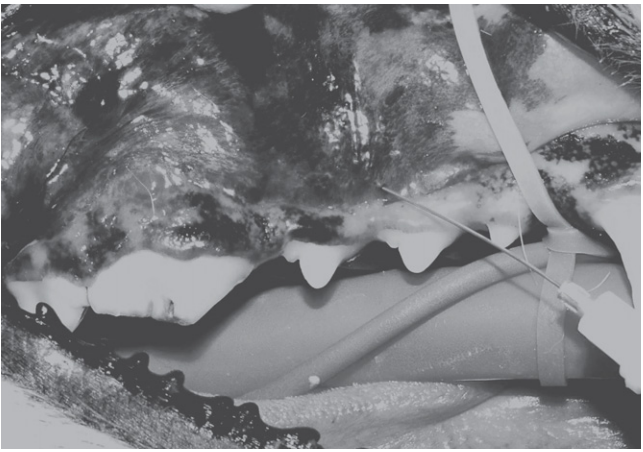


Figure 6-4 The maxillary quadrant in a dog, showing an infraorbital nerve block being performed. The needle is inserted submucosally and directed deep to the large bundle of nerves and vessels that exit the infraorbital canal. The tip of the needle is advanced to the foramen and a submucosal bleb is created after careful aspiration.

This block may be performed through either an extraoral or an intraoral approach. With both approaches, the idea is to deliver a bleb of local anesthesia to the opening of the inferior alveolar foramen, which is located on the medial surface of the caudal hemimandible. This foramen can often be palpated intraorally in larger dogs, lying under the oral mucosa caudally in the mouth. Due to the caudal location of the foramen, it is sometimes awkward to insert the needle and inject through this intraoral approach. For this reason, many have favored the extraoral approach.

With the extraoral approach the needle is inserted percutaneously, perpendicular to the ventral border of the mandible at the rostrocaudal midpoint of the zygomatic arch. In the dog, there is a notch in the mandible at this point. The tip of the needle is walked off the ventral border of the mandible toward the medial surface. The needle is advanced along the medial surface of the mandible, with the bevel facing the medial cortex, to a distance half of the ventrodorsal dimension of the body of the mandible. This should place the tip of the needle at the opening of the foramen (Figure 6-5). As with all of the other blocks, careful aspiration is done before administration of the anesthetic agent.

Extractions

Although one of the main goals of comprehensive veterinary dental care is to save teeth, extractions are sometimes

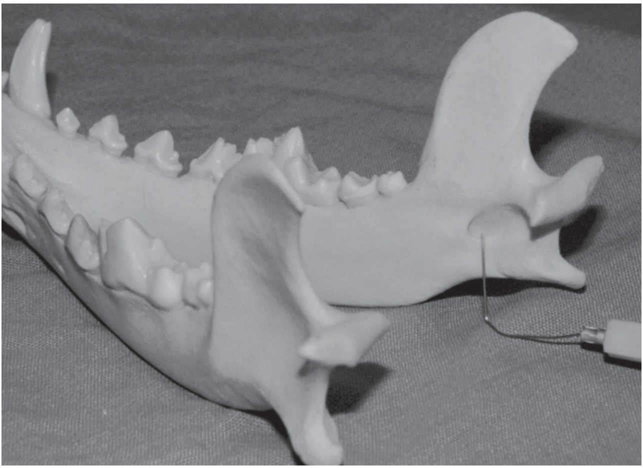


Figure 6-5 The mandible of a dog skull with a needle over the inferior alveolar foramen, the opening to the mandibular canal. This is the injection site for the inferior alveolar nerve block. This site can be approached either intraorally or extraorally. This block should be carefully practiced and executed, as it carries the potential complication of blocking the tongue, causing animals to awaken and chew their tongues.

necessary to treat dental problems. Loose teeth, teeth with advancing periodontal disease, fractured teeth, teeth associated with a malocclusion, teeth associated with oral tumors, teeth with extensive cavities, and feline resorptive lesions—all these may be candidates for extraction. Even though more advanced dental procedures can save the majority of fractured teeth, teeth associated with malocclusion, and even many teeth affected by periodontal disease, the owners' wishes may dictate extraction in some cases.

With the possible exception of manual removal of very loose incisor teeth and some weakly retained deciduous incisor and premolar teeth, tooth extraction is a surgical procedure. Although the difficulty and the time may vary, when gingiva is incised, periodontal ligament fibers are severed, a bony socket is invaded, a multirooted tooth is sectioned, alveolar bone is removed, or gingiva is sutured, oral surgery is being performed. Indeed, extractions are likely the most common oral surgeries performed on animals.

It is important to think of an extraction as the surgical procedure it is and to appropriately manage the pain associated with it. In keeping with the expected oral discomfort, the use of opioid premedications, fentanyl patches, intraoral analgesia with regional nerve blocks, acupuncture, postoperative opioids, and postoperative NSAIDs may be considered. The aggressive use of preemptive analgesia decreases not only patient suffering but the total need for general anesthesia and improves surgical wound healing.

The forces holding the teeth in the mouth must be identified and overcome. The major supporting structures of a tooth, the periodontium, can be quite a challenge to overpower if the tooth has not already been ravaged by periodontal disease. The fractured canine tooth of a dog with healthy periodontal tissues represents a very formidable extraction challenge. Its removal constitutes a major surgical extraction and involves mucoperiosteal flap creation, partial alveolar bone removal, marked root elevation, possible bone grafting, and flap suturing. If the root of such a tooth is normal, root canal therapy is more desirable, as it is less traumatic, less painful, and retains the tooth and its function.

Although extractions of teeth with moderate to severe attachment loss from advanced periodontal disease are generally easier to perform than extractions of teeth with full attachment, similar surgical principles and methods apply to all surgical extractions. A loose maxillary canine tooth associated with an oronasal fistula would be much easier to remove than a fractured maxillary canine tooth with full healthy periodontal attachment; however, both require a mucoperiosteal flap for closure. In fact, the oronasal fistula repair may take more time and effort than the closure of the fractured tooth's extraction site.

All the steps of a surgical extraction are aimed at facilitating a less traumatic procedure for both the patient and the dental operator. By utilizing these surgical techniques, the veterinarian can improve patient care by minimizing pain and maximizing the potential for quick healing and lasting benefit. It is not enough to simply pull loose teeth. The conscientious veterinarian must be able to completely extract firmly rooted teeth as well as loose teeth. In the extraction of teeth, the goals are to cause the least amount of trauma necessary and provide the best possible conditions for healing. Although the ideal of saving all teeth as perfectly healthy and functional is not readily possible, if teeth must be extracted, then the resultant oral cavity should be made as healthy and as pain free as possible.

Deciduous Tooth Extraction

Many deciduous teeth have long, delicate roots, which make them very fragile. It is essential that the removal of these teeth, when indicated, be done with extreme care and gentle technique. Some elevators have various curvatures to more closely follow the roots of these teeth. These root elevators are also made with smaller handles to force the operator to use less force. Every effort should be made to get the roots out intact, but this requires time, patience, and delicacy.

Once retained deciduous teeth are removed, the resultant occlusion of the adult teeth present must be properly assessed. This is perhaps the greater consideration of deciduous tooth extraction beyond merely removing unwanted baby teeth. Many adult tooth malocclusions are caused by these retained deciduous teeth and need to be adequately addressed for the future comfort of the mouth.

Mucoperiosteal Flaps

Mucoperiosteal flaps facilitate the exposure and visualization for open root planing and surgical extraction as well as the closure of oronasal fistulae and extraction sites. Prior planning and gentle tissue handling are essential in preservation of blood supply and flap vitality. In general, the base of the flap should be broader than its tip. Ideally, the width of the base is at least 1.5–2 times the width of the tip of the flap. Releasing incisions, when necessary, should be divergent away from the coronal margin of the flap.

FLAP ELEVATION Elevation of the flap requires time, patience, and delicacy above all else. A properly shaped and sharpened instrument can make a world of difference in periosteal elevation. The flap is best elevated from the tooth and bone in a full thickness by peeling the periosteum from the bone. This will leave denuded bone and a two-ply flap of mucogingiva and periosteum (Figure 6-6). While performing the necessary operations to the exposed hard tissues, it is advisable to protect the flap from desiccation and trauma.

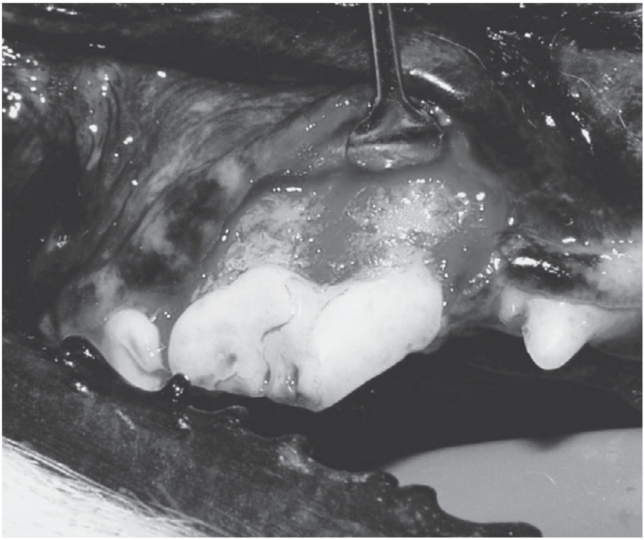


Figure 6-6 A full-thickness mucoperiosteal flap that has been elevated and retracted to expose the right maxillary fourth premolar tooth. The #4 Molt surgical curette is used here as the flap retractor but was used prior to this photo as a periosteal elevator. The buccal alveolar bone is now denuded and ready to be partially removed. The #4 Molt then is used as both a flap retractor and a tissue protector.

FLAP MOBILIZATION To gain flap mobility for closure, the unyielding periosteum of the underside of the flap must be severed. However, it is also important to avoid perforating the mucosa, to preserve its blood supply and vitality. The periosteum can be severed with a scalpel blade or a pair of blunt-tipped dissecting scissors. Gentle traction on the flap is sometimes useful to gain a tactile sense of the tension release afforded by the periosteal severing.

SUTURING The flap is sufficiently mobile if it can completely cover the defect and stay in place by itself, without instruments or suture. When the flap has been properly freed, the tip of the flap and the lingual or palatal margins should be trimmed slightly, so that incised epithelium will be sutured to incised epithelium. The flap should be sutured with an absorbable suture material, such as Monocryl or Vicryl, in a simple interrupted pattern. It is important to suture the tip of the flap first, then suture from the tip to the base. Placing sutures in this order prevents premature anchoring of the base of the flap, so as to not add tension to the tip of the flap.

Surgical Tooth Extraction

PREOPERATIVE INTRAORAL RADIOGRAPH A preoperative radiograph is necessary to assess the condition of the root(s) prior to extraction. The roots need to be examined for fracture, resorption, ankylosis, and anatomical variation, such as a supernumerary root. The operator needs to know as much as possible about the root(s) to be extracted to know what complications are likely to arise and what may need to be done to prevent or manage such complications. The preoperative radiograph then becomes a baseline image with which to compare intraoperative or postoperative films.

INTRAORAL ANALGESIA As described already, intraoral analgesia is indicated for all extractions, especially surgical extractions. The need for pain management cannot be overstressed, and intraoral analgesia is just one part of an oral surgical pain control protocol. The use of opioids, NSAIDs, and acupuncture should be considered as well as local anesthesia for proper and complete analgesia.

FLAP CREATION AND ELEVATION Many different flap designs may be employed for each of the teeth, and careful thought needs to go into flap creation before any incisions are made. It is wise to consider the amount of surgical exposure required as well as the best way to assure proper closure of the defect. The blood supply to the flap must be preserved, and the periodontal health of the adjacent teeth must not be compromised unnecessarily. Extractions of multiple, adjacent teeth can often be achieved best with a large single flap, instead of multiple smaller flaps, which intersect and compromise blood supply. Proper flap design addresses both the need for adequate exposure to facilitate root removal and the need for tension-free closure to allow proper surgical healing.

When a flap must be advanced any great distance to close a defect, such as in the extraction of a maxillary canine tooth, one or more releasing incisions may be required. These incisions should be divergent from the coronal tip of the mucoperiosteal flap and made with a sharp scalpel blade in one motion. Making several slices with the scalpel blade on the same incision is likely to cause a jagged incision with strips of wasted gingival and mucosal tissue. The scalpel blade can also be used to incise the gingival attachments around the circumference of the tooth with a sulcular incision.

When the necessary incisions have been made, the flap is elevated in a full thickness from the bone. A sharp periosteal elevator is necessary to peel the periosteum from the buccal alveolar bone. Great care is taken to avoid perforation of the flap as well as desiccation of the soft tissues. The flap is elevated at least to the level of the mucogingival junction. The palatal or lingual soft tissues may also be elevated slightly at this time. Elevating these palatal or lingual tissues helps keep them from being damaged with root elevation and aids in the final closure; however, it is unnecessary to elevate these tissues beyond 3 mm of the tooth margin at this point.

PARTIAL BUCCAL BONE REMOVAL By removing a portion of the buccal cortical plate, the underlying root is freed somewhat from its bony encasement. Since the alveolar bone is the strongest supporting structure of the periodontium, its partial removal is a significant means to weakening the body's attachment to the root. Although alternative extraction techniques specifically employ a lingual approach, only the buccal cortical plate is usually removed to maintain the structural integrity of the lingual or palatal alveolar bone.

The bone removal is best performed with a round ball bur on a high-speed handpiece. This bone removal requires the precision of this instrument as well as its built-in water coolant spray to avoid burning and damaging the bone. Care should be taken to remove the buccal bone the entire width of the root without causing collateral damage to adjacent roots. The bone is typically removed from the coronal half of the root (Figure 6-7); however, more buccal bone may be removed if more root exposure is desired. Additional root exposure is particularly helpful to isolate fractured root tip fragments for easier removal.

The soft tissue flap must be protected from the spinning bur to avoid damage. The Molt surgical curette makes an ideal tissue retractor and protector. Care should also be taken to avoid excessive gouging of the root itself. The bur can easily remove a significant amount of root along with the bone if the operator is not careful, especially in the maxilla, where the buccal cortical plate is quite thin. Gouging the root weakens it and may lead to its fracture with normal elevation force.

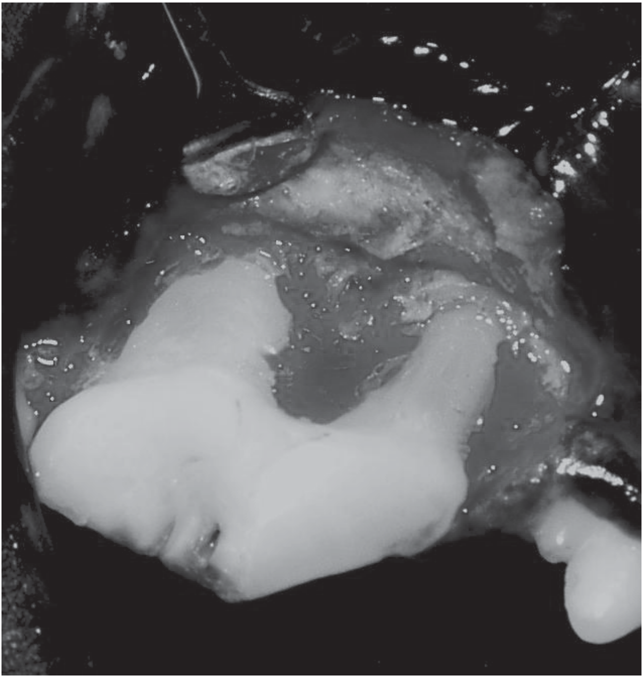


Figure 6-7 A right maxillary fourth premolar tooth extraction site after a portion of the buccal cortical plate was removed with a round ball bur on a high-speed handpiece. About 50% of the root's length was removed over the coronal aspect of the roots. The furcation is clearly evident between the two roots.

SECTIONING MULTIROOTED TEETH All multirooted teeth should be sectioned into single-root segments for easier extraction. This means that a double-rooted tooth, such as a mandibular premolar tooth, should be sectioned at the furcation into two separate root segments; and a triple-rooted tooth, such as a maxillary fourth premolar tooth, should be sectioned at the furcations into three separate root segments. Tooth sectioning counteracts the divergent roots' mechanical advantage and enables access to the interradicular area of the roots for elevation.

A crosscut bur on a high-speed handpiece makes the most effective sectioning tool (Figure 6-8); however, Gigli wire has also been used. The furcation needs to be clearly identified, and the cut through the crown must be complete. If the root segments do not move independent of one another and are still joined, the extraction will be very difficult, with the roots likely to break. The crown may be shaped with the crosscut bur after the sectioning in any way that allows for easier removal of the root(s). Many operators find it helpful to remove part of the remaining crown to facilitate elevator maneuvering.

ROOT ELEVATION AND LUXATION After the preceding steps have been performed in a surgical tooth extraction, the major remaining force to overcome is the root retention supplied by the periodontal ligament. Many instruments and techniques have been developed to weaken the periodontal ligament's powerful grip. One

Figure 6-8 A right maxillary fourth premolar tooth being sectioned with a crosscut fissure bur on a high-speed handpiece. This type of bur has side-cutting action and is well suited to sectioning large teeth. This tooth is being sectioned from the furcation to the incisal edge.

of the most consistently successful methods of loosening a root is luxation, the severing of periodontal ligament fibers with a sharp elevator.

The elevator is inserted between the alveolar bone and the root, into the periodontal ligament space, and directed parallel to the long axis of the tooth root (Figure 6-9). Apical pressure and a small rocking motion are used to sever the periodontal ligament fibers and gain further apical purchase. The periodontal ligament is attacked around the circumference of the root in a stepwise fashion, going further and further in an apical direction. Care is taken to avoid the gross levering of the root out of the alveolus, guarding against likely root fracture or unnecessary iatrogenic trauma to the alveolus.

Luxation is continued until the root is sufficiently loose. Applying a sustained rotational force to the elevator within the periodontal ligament space may additionally weaken the periodontal ligament. Once purchase has been gained between the root and the bone, the elevator is rotated 60–90° and held for 30–60 seconds. This force is meant to fatigue the periodontal ligament fibers and aid in loosening the root within the alveolus.

ROOT REMOVAL When the root has been loosened through luxation with a root elevator, it should be easily removed with extraction forceps. Extraction forceps are one of the most frequently abused oral surgical instruments. The only purpose for the extraction forceps is to grasp a loose tooth and remove it with a light twist and

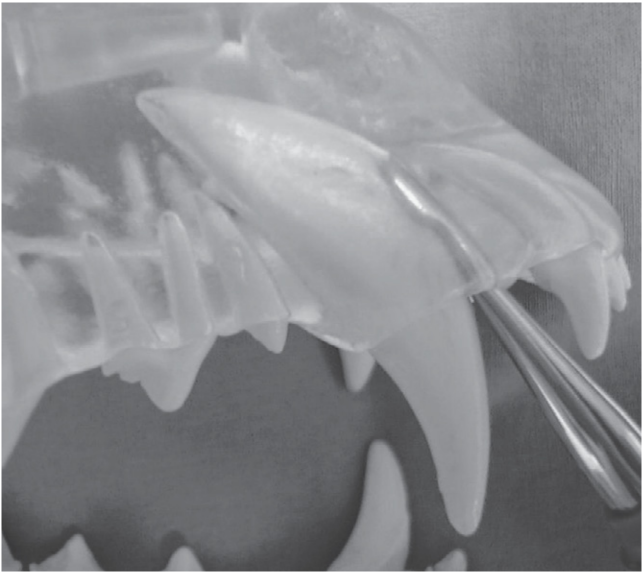


Figure 6-9 A model of a dog mouth showing the technique of luxation. A Wiggs elevator of a size that best approximates the diameter of the root is inserted between the root and the alveolar bone, into the periodontal ligament space. The instrument is inserted parallel to the long axis of the tooth, and apical pressure is applied to sever the periodontal ligament fibers with the sharp cutting edge. The thin neck and thin cross section of the cutting head allow the instrument to penetrate further apically along the root.

pluck action. If more force is needed to remove a tooth root, then the root requires more luxation with a root elevator. Extraction forceps can easily fracture a root that is not sufficiently loose, especially a large pair of extraction forceps. Once the loose root is removed from the mouth, the apex should be closely inspected to assure complete removal. The root end should be smooth and rounded with no pulpal exposure evident.

POSTOPERATIVE INTRAORAL RADIOGRAPH Before the surgical defect can be closed, an intraoral radiograph should be taken to confirm the complete removal of all roots and root fragments. This radiograph can be compared to the preoperative radiograph. If any fragments of root are evident, they must be removed.

ALVEOLOPLASTY Alveoloplasty is the shaping and smoothing of the alveolar bone. Once root removal is confirmed, the alveolar bone should be examined. The operator should look and feel for any sharp or loose areas of the bone. A gloved finger works well to feel for bone that could perforate the flap. The round ball bur on a high-speed handpiece is used to carefully smooth the bone without removing excessive amounts.

FLAP MOBILIZATION AND TRIMMING To be able to close the extraction site defect properly, the flap must be mobilized. Most mucoperiosteal flaps lack sufficient laxity to provide tension-free closure without additional surgical intervention. Tension is the biggest enemy to successful closure of the surgical defect. The base of a buccal mucoperiosteal flap is made of buccal mucosa bonded to the periosteum elevated from the alveolar bone. The mucosal portion of the flap base is very pliable and flexible, while the periosteum is tough, fibrous, and unyielding. The secret to flap mobilization and advancement is the selective severing of the periosteum at the base of the flap, while preserving the mucosa.

The periosteum can be severed with a scalpel blade, but this can easily cause a perforation of the base of the flap. A good pair of delicate flap scissors is a safer alternative for periosteal severing. Starting at the mesial or distal aspect of the flap base, the flap scissors are inserted, with the tips together, between the periosteum and the buccal mucosa. The scissor tips are then separated to gently separate the two planes of tissue: periosteum (the deep layer) and mucosa (the superficial layer) (Figure 6-10). Once the two layers have been separated, the free portion of the periosteum is cut with the scissors. Blunt and sharp dissection is continued alternatively along the entire base of flap. Flap scissors with flat dissecting blades move easily into these tight spaces to make dissection easier.

The flap, when sufficiently mobile, should cover the extraction site defect with slight overlapping and remain there without instruments or suture. When this level of mobility is achieved, the edges of the flap can be trimmed slightly to debride unhealthy tissue and assure

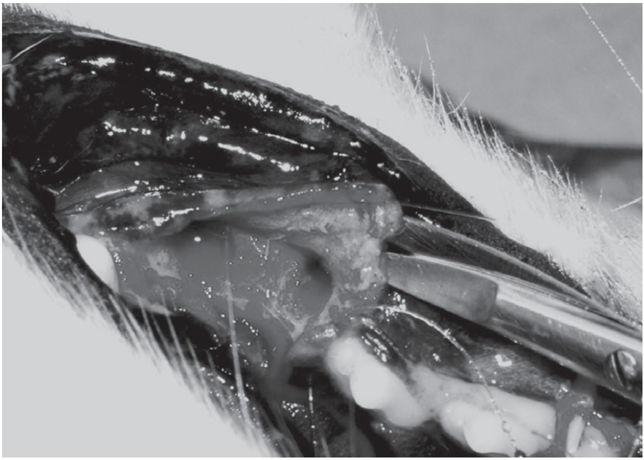


Figure 6-10 A right maxillary fourth premolar tooth extraction site with flap scissors performing blunt dissection. The tips of the closed scissors are inserted between the mucosa and the periosteum. The tips are then opened to separate the two planes of tissue. This allows for the selective cutting of the periosteum. A combination of blunt then sharp dissection is continued along the base of the flap until the periosteum is completely severed. Once the periosteum has been severed and the base of the flap is just a layer of mucosa, the flap should be highly mobile and permit marginal trimming and secure, tension-free closure.

proper healing. The recipient site of palatal or lingual mucogingiva should also be trimmed and debrided.

ALVEOLAR CURETTAGE AND LAVAGE When severe periodontal disease or oronasal fistulation is present and epithelial tissue invasion into the alveolus has occurred, this infected friable tissue must be removed. Mechanical debridement is important to the removal of infection and the proper, speedy healing of extraction sites ravaged by the destruction of severe periodontal infection. This epithelial tissue needs to be curetted from the alveolus to get down to healthy, bleeding bone. The alveolus is then lavaged with sterile saline in preparation for final closure.

ALVEOLAR IMPLANT PLACEMENT In some situations, it is advantageous to augment the mouth's own ability to heal through the use of osseopromotive materials. This is especially true in the mandible when a canine tooth or first molar tooth is extracted. Autogenous cancellous bone grafting or synthetic bone materials can be implanted into a properly clean and empty alveolus to enhance the growth of bone. Although a well-organized blood clot will lead to the growth of bone in an alveolus where the root was, osseopromotive implant material can provide a greater response.

FLAP CLOSURE If the flap has been properly mobilized and debrided so that no tension exists, flap closure is fairly straightforward. It is important to choose a suture material that is absorbable but does not persist in the mouth for a long time. Monocryl is one of the best suture materials for the oral cavity, due to its monofilament nature, low tissue drag, good knot security, low tissue reactivity, and predictable dissolution within 3–4 weeks. Vicryl makes a good second choice, but many oral surgeons still use chromic gut for routine extractions with good success.

It is necessary to accurately appose gingival margins solidly, with no gaps or constriction. It is also important to use at least four to five throws on knots to prevent suture material untying. Suture tags are left long, at least 3 mm, to resist untying and provide more comfort when using a monofilament suture like Monocryl (Figure 6-11).

Oronasal Fistula Repair

Oronasal fistula repair employs many of the same techniques used in a good surgical tooth extraction. The dental operator should strive to exert diligence in the appropriate closure of all oral surgical defects. In fact, many chronic oronasal fistulae can be prevented by primarily closing maxillary canine tooth extraction sites. When a chronic oronasal fistula does develop, its repair typically involves a tension-free mucoperiosteal flap closure. The epithelium of the stoma should be incised and debrided and the final suture line should lie over bone for support if possible (Figure 6-12).

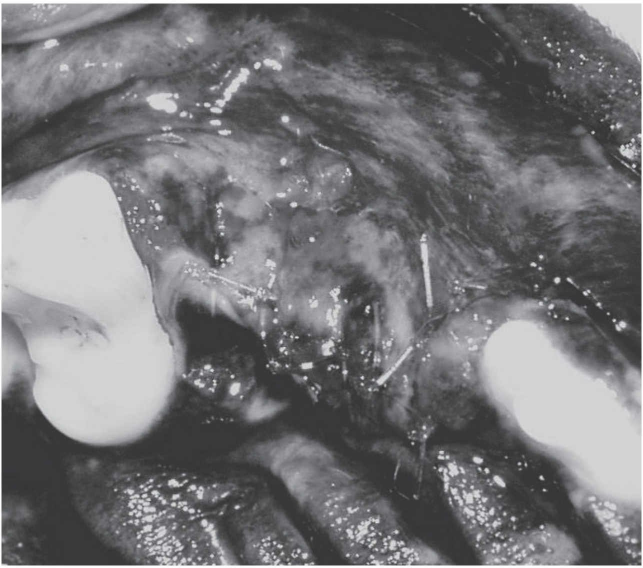


Figure 6-11 The closure of an extraction site of the right maxillary fourth premolar tooth. The flap is apposed solidly with Monocryl suture material. There are no gaps or "beef rolls." The suture tags are left 3 mm long to prevent untying and make the suture tags less irritating to the pet.

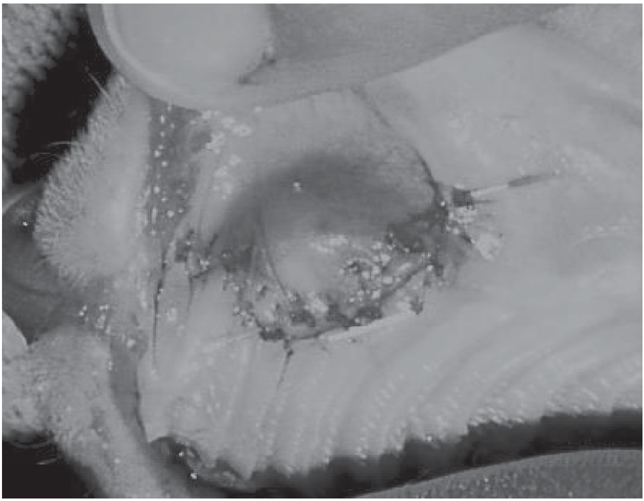


Figure 6-12 An oronasal fistula repair in a cat. The defect has been debrided and the flap has been sufficiently freed to allow proper closure. The flap is sutured neatly without tension using 5-0 Monocryl.

Special Concerns of Feline Extractions

Feline dentistry is a field with many frustrations and many unanswered questions. Mystery still surrounds the major feline oral diseases such as feline odontoclastic resorptive lesions and lymphocytic plasmacytic stomatitis. Although the etiologies and, hence, the definitive treatments for these perplexing conditions elude us at this point, one thing is certain: these are painful conditions. At the present time, extractions may offer the best chance of attaining pain-free mouths for these feline patients.

To perform feline dentistry well, it is necessary to extract cat teeth with precision and delicacy. Even the healthiest cat teeth are fragile and easily broken, not to mention those teeth weakened by resorption. To provide feline patients with the best possible oral surgical care, it is necessary for the veterinarian to constantly improve on delicacy, precision, finesse, and patience. Even though finer instruments, intraoral radiography, and magnification are available, surgical technique still plays the most important part in success.

Feline extractions should not be performed without intraoral radiography (Figure 6-13). Only with accurate visualization of the root structure and surrounding bone integrity can proper treatment decisions be made. Much of the success of an extraction depends on the condition of the root, the bone, and the periodontal ligament that constrains the diseased or fractured tooth. Without this

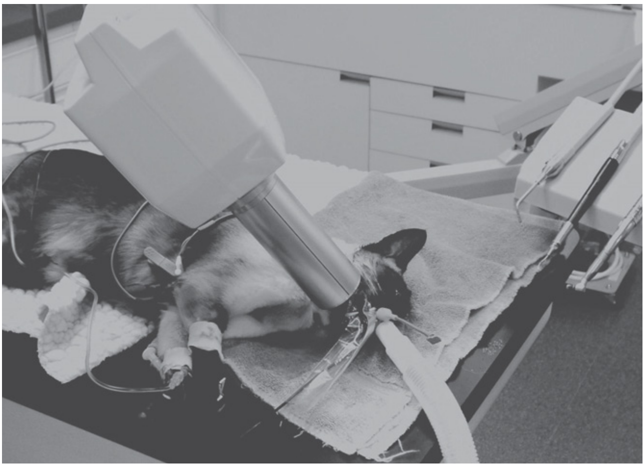


Figure 6-13 Intraoral radiography being performed on a cat, using a dental radiographic unit. The dental radiographic unit offers much more convenience than standard medical units, because it can be mounted where the patient receives the dental procedure. When the radiographs are more convenient to take, more radiographs end up being taken.

information, the dental operator is only guessing at the best course of action and, in some cases, may be headed down a very unrewarding path. If a tooth with a feline odontoclastic resorptive lesion has a root that is ankylosed and resorbing, it may actually be better off treated by amputation of the crown with intentional retention of the resorbing root(s). In these situations, it is necessary to remove all the enamel and smooth the alveolar crestal bone with a round ball bur on a high-speed handpiece as well as to properly suture the gingiva with an appropriate flap.

Another great aid to feline extraction is the use of magnification. Feline teeth can be quite small and difficult to see. Enlarging the teeth and illuminating them properly greatly enhances any oral surgery to be performed. Magnification comes in many types of eyewear at varying costs. It is not necessary to spend $1,000 to improve the work that was previously done with the unaided eye, but the quality of optics, clarity of the image, and depth of field are better with higher-end magnification and surgical loupes. A range of magnification powers is available, but it is generally recommended to stay within 2× to 3.5× for veterinary dentistry.

Finer, smaller instruments are necessary to perform high-quality feline dental extractions. Many instrument manufacturers now carry these root elevators, periosteal elevators, root tip picks, and dissecting scissors that were previously not available to the veterinary market. It is important to have instruments that are not mere adaptations from human dentistry but purposely built for the smaller, more delicate teeth of cats. Most practitioners should reconsider the crude tools that have been inherited and passed down within their practice.

Cat teeth, in most cases, demand more deliberate attention to surgical extraction technique than dog teeth. Mucoperiosteal flap creation, buccal alveolar bone removal, multirooted tooth sectioning, root elevation, and flap closure all require a more exacting touch to perform successfully. More precise instruments help, but throughout the extraction process the operator must treat the fragile root or roots with care to prevent further complications, such as root fractures.

Perhaps the biggest reason why feline tooth roots break is that too much force is applied too far coronally. To alleviate this problem, no instrument is more helpful than the high-speed handpiece. Feline extractions should not be attempted without a high-speed handpiece and a round ball bur. This instrument is indispensable to the precision removal of bone, sectioning of multirooted teeth, and shaping of the coronal tooth. While alveolar bone removal and tooth sectioning are similar in cats and dogs, the deliberate shaping of the crown is something optional in dogs but nearly essential in cats.

Always remember that the judge of success of the tooth extraction process is not the condition of what is removed but the condition of what remains within the mouth. To spare the oral cavity and the dental operator as much trauma as possible, the teeth may be altered in almost any way that facilitates their removal. By reducing the crown height of cat teeth as well as removing the cervical bulge of the crown, it is possible to create a tooth shape that is easier to extract. The resultant tooth permits easier direct access to the periodontal ligament space with the root elevator, while preventing leverage force on the crown.

If roots break, as they often do, the urge to use the high-speed handpiece to drill out or atomize the root(s) must be subdued. Atomization typically does one of two things: It removes either too little of the retained root, leaving root shards to potentially cause future problems, or too much material, including the surrounding bone. If the periapical bone is removed in the mandible, there is a great risk of damaging the neurovascular bundle running within the mandibular canal. If the periapical bone is removed in the maxilla, there is a great risk of entering the nasal cavity and creating an oronasal fistula.

When a root fractures, the immediate reflex of the operator should be to take a mental step back and obtain an intraoral radiograph to assess the amount and location of the remaining root material. The high-speed handpiece should be used for removal of more buccal bone in an apical direction. The flap can be retracted further apically while the additional buccal bone is removed to gain better visualization and isolation of the retained root tip.

Once the root tip has been carefully exposed, a fine-tipped instrument, known as a *root tip pick*, may be used to carefully tease the root tip away from the alveolar walls. The root tip pick is much more delicate than a root elevator, and it forces the operator to use more finesse. It should be used like the nut picks used to retrieve broken bits of nut from inside walnut shells. The force of the pick should be up and out of the alveolus, instead of the apical pressure a root elevator requires. The operator must guard against forcing a retained root tip further apically into the mandibular canal or nasal cavity. Patience is often rewarded with a whole root tip delivery from the alveolus, assuring the operator that the root removal is complete.

Oral Fracture Repair

The main objective in the repair of oral fractures is the maintenance of proper occlusion and function of the jaws. For this reason and because so many sensitive and vital structures are in and around the mouth, minimally invasive repair techniques are preferred whenever possible. Bone plating and intramedullary pinning have little place in the repair of oral fractures, due to the risk of injury to the neurovascular bundle that runs through the mandibular canal and to the roots of the teeth. While external fixators can sometimes be used effectively, the risk of injury to vital orodental structures and the delicacy of available bone present major drawbacks to their use.

Interdental wiring techniques in combination with acrylic or composite splinting represent an economical and effective means of maintaining occlusion and returning oral trauma patients to full function as soon as possible. These techniques have become much more popular in recent years, as the understanding of the unique challenges of oral fractures has increased. Provided proper imaging is available, most general practitioners can employ these techniques.

Pharyngostomy Tube Placement

The proper occlusion of the teeth must be maintained for the success of oral fracture repair. It is necessary to be able to check occlusion throughout the repair procedure, and an endotracheal tube can interfere with the complete closure of the jaws. To be able to maintain a patent airway and allow the jaws to close completely whenever required, it is necessary to have an alternate path for the endotracheal tube. Although a tracheostomy can be performed for tube insertion, pharyngostomy tube placement has fewer postoperative complications and can also provide an entry for a feeding tube, should one be indicated at the end of the repair procedure.

Interdental Wiring

The mandible, like most long bones, has a tension surface and a compression surface. The dorsal border of the mandible is the tension surface and the ventral border is the compression surface. This is based on the muscle pull, which tends to open the dorsal cortex of a mandibular body fracture while compressing the ventral cortex. The implication of this fact is that, if the dorsal border of a fractured mandibular body, the tension surface, is reduced and stabilized, then the ventral border will be compressed by the musculature and need not be additionally stabilized.

This leads to the minimally invasive technique of interdental wiring. The teeth represent "pins" physiologically attached to the mandible. If a strand of orthopedic wire is woven around and between the teeth, the mandibular fragments can be reduced and stabilized as the wire is tightened (Figure 6-14). Although there are many techniques of interdental wiring, the basic premise is similar: to use the teeth as anchors for the wire. A smaller gauge wire (24 gauge) can be used quite effectively, especially if the wire is not the only means of support and stabilization. An appropriately sized hypodermic needle makes a great wire passer to weave the wire through the gingiva and around the teeth.

Acrylic and Composite Intraoral Splints

With the interdental wire in place and the bone segments in reduction, either acrylic or composite can be bonded to the teeth and wire to provide additional stabilization. The wire acts very much like rebar within

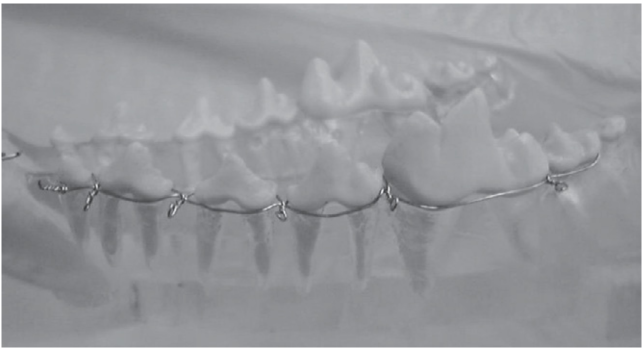


Figure 6-14 A model of a dog mouth with interdental wiring applied. This is Stout's multiple loop technique, used to stabilize oral fractures using the teeth as anchoring points for the wire to weave around. The smaller gauge wire is not strong enough to act as the entire stabilization. The loops allow the strand to be evenly tightened and allow additional anchorage for the subsequent acrylic or composite splint.

concrete to strengthen and support. Although acrylic is inexpensive and readily available, it has significant drawbacks with exothermia during setup and curing, objectionable smell, and toxic fumes. Self-cure dental composite is a much better alternative to acrylic.

The composite is extruded from a special gun and injected right onto the teeth (Figure 6-15), which have been acid etched to provide a stronger adhesion. The composite should be kept on the teeth as much as possible and not be applied to areas that would interfere with proper occlusion. With a pharyngostomy tube in place, the opposing arcade can be brought into occlusion while the material cures, provided that a nonstick separator is inserted. After 5–10 minutes, the composite hardens and can be trimmed and smoothed.

With such a repair it is usual for most patients to be eating a soft diet within 12–24 hours. The splint and wire remain on the teeth for 4–6 weeks. After radiographic confirmation of bony union, the composite is carefully removed with tartar-cracking forceps and the wire is snipped free. The teeth also need to be thoroughly scaled and polished, due to the gingivitis induced from such an appliance.

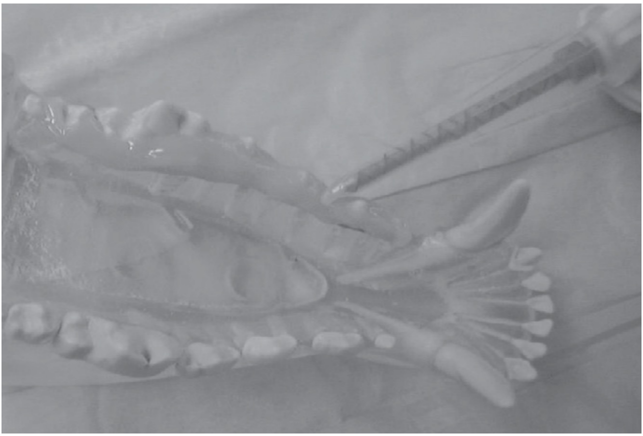


Figure 6-15 A model of a dog mouth with composite being applied to create an intraoral splint. The composite is bonded to the teeth directly and to the interdental wiring already applied. The composite is injected in a gel and hardens in about 5–7 minutes to a hard consistency. The wire underneath the composite acts like rebar, reinforcing the repair as well as providing reduction of the fracture fragments.

7

Specialized Instruments and Supplies for Oral Surgery

Every job is made easier by using the right tools, and oral surgery is no different. This chapter looks at some of the instruments found to be most useful (Figure 7-1). The guiding principle behind a very useful instrument is the idea that more precise surgery can be performed with finer and more delicate instruments. Superior technique should always be preferred to brute force, and the proper instruments can definitely enhance technique.

The choice of instruments is in many ways a matter of personal preference; however, it is wise to be aware of the vast array of new and improved instruments available for oral surgery. Whatever the instrument chosen, though, it is imperative to remember that it cannot

Figure 7-1 A canine oral surgery pack arranged in a plastic setup tray. The setup tray allows the instruments to be neatly organized, with separate compartments for commonly used supplies.

perform to its full potential if it is not properly maintained and kept sharp.

Magnification

Magnification eyewear serves many functions, such as protection from flying debris and enhanced visualization. Improved visualization, along with a high-quality light source, dramatically augments diagnostic ability. If the teeth appear larger, tiny lesions that might have been missed or misinterpreted are detected. Better visualization also means that treatment can be performed to more exacting standards. The difference between root and bone is enhanced as well as the ability to visualize broken root tips.

Many types of magnification are available, from drug store "reading glasses" to more expensive surgical loupes. While inexpensive magnified reading glasses improve on the visualization of the unaided eye, surgical loupes offer important advantages (Figure 7-2). Not only do surgical loupes provide higher-quality optics, they also provide a much better depth of field and focal length. If the focal length is properly set, it can dramatically improve posture and, hence, comfort by forcing the operator to sit up straight to focus effectively. Surgical loupes can be custom made with an individual's own corrective prescription as well. A magnification power of somewhere between 2× and 3.5× is typically recommended for most oral surgery.

Figure 7-2 Surgical magnifying loupes. These loupes offer 2.5× magnification and an excellent, clear field of view. Amber safety inserts are included specifically for dentistry, to protect the dental operator from the high-intensity curing light used in restorative dentistry. The focal length is fixed for these loupes and individualized for the wearer to provide the optimal focus with the proper posture.

Scalpel

#7 Scalpel Handle

The #7 scalpel blade handle accepts the same blades as a #3 handle, such as #10, #11, #15, and #15c blades, but it is thinner and longer. The handle resembles a delicate paintbrush and allows for more precise cutting through easier curves and spins.

#15c Blades

The #15c scalpel blade makes a great compliment to the precision afforded by the thin-shafted #7 handle. The #15c is a cross between the #11 and the #15 blades. It can get into tight spaces and makes it easier to control damage to collateral structures when making incisions for flaps or mass removal.

Periosteal Elevators

Molt Surgical Curette

The Molt surgical curette is perhaps the most useful and versatile oral surgical instrument. It is available in two main sizes, the smaller #2 and the larger #4 (Figure 7-3). Although it is called a surgical curette and can function admirably in this role, it is much more than a tool for scraping bone and curetting infected debris from alveoli. The #2 Molt has a small, thin cutting head and thin neck, which improves access and maneuverability. The #2 Molt

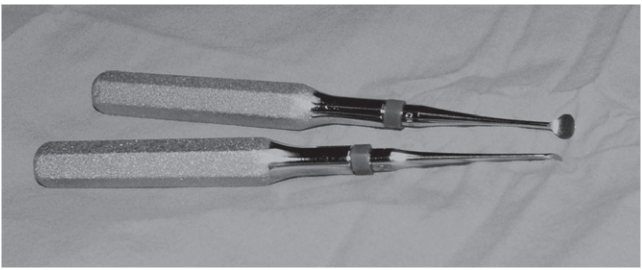


Figure 7-3 The #4 (top) and #2 (bottom) Molt surgical curettes. These instruments are among the most useful for oral surgery. They serve many functions as periosteal elevator, flap retractor, tissue protector, surgical curette, and scoop for implant material. Their sharpness and delicate features enable more precise surgical technique within the oral cavity.

makes a great cat and small dog periosteal elevator (Figure 7-4), while the #4 serves this function in larger dogs. A rounded cutting head decreases the chance of flap perforation, and the curvature of the head helps to conform to the alveolar bone.

Although perhaps more commonly used as a periosteal elevator to greatly facilitate the elevation of mucoperiosteal flaps, the Molt is also a very handy tissue retractor and tissue protector. After the flap has been elevated, the Molt can be used to retract the flap to provide visualization for use of a round ball bur on a high-speed handpiece. The Molt also helps protect the soft tissue of the flap from becoming damaged by the spinning bur. Of course, this instrument may be used as a surgical curette for the mechanical debridement of a severely infected alveolus.

Periosteotome

The periosteotome is a small, delicate, double-ended instrument designed to elevate mucoperiosteal flaps. Many dental operators find its delicacy extremely helpful for work in cat mouths. It is an advantage to have two different sizes of cutting head on opposite ends of the same instrument.

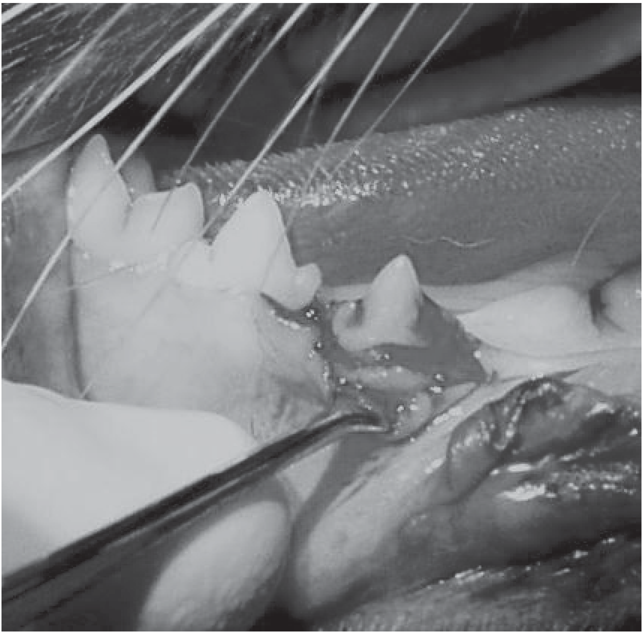


Figure 7-4 The #2 Molt surgical curette used as a periosteal elevator in a cat's mouth. The instrument is being used to carefully peel the gingiva and periosteum from the alveolar bone. For this instrument to work optimally, it must be kept sharp.

High-Speed Handpiece

Oral surgery simply should not be performed without a high-speed handpiece. There is no substitute for the precise bone and tooth cutting that it can perform. Along with the dental unit, which provides its power and water coolant source, it should be considered basic equipment and part of the minimally required instrumentation to provide dental and oral surgical services.

Burs

Although a myriad of burs are available that can be used with the high-speed handpiece, a few burs are extremely useful and versatile to begin with.

#2 Round Ball

The small cutting head on the #2 round ball bur makes it ideal for precise buccal bone removal in feline extractions. This same bur can be used to section and shape the crown of feline teeth to be extracted (Figure 7-5). After the roots are removed, alveoloplasty can be performed easily with the #2 round ball bur. Another use for this bur is the creation of small endodontic access sites for root canal treatment.

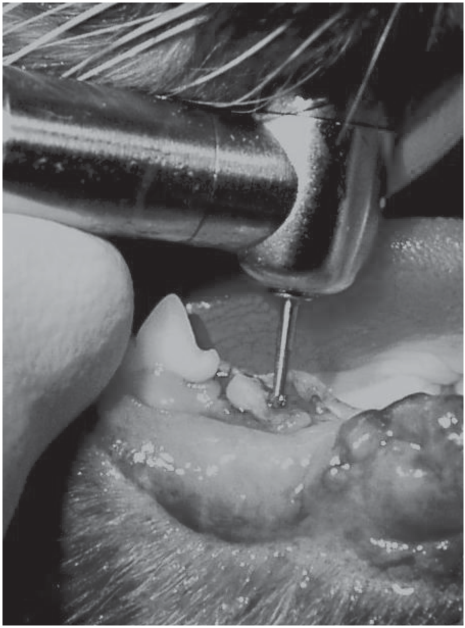


Figure 7-5 A #2 round ball bur attached to a high-speed handpiece used within a cat's mouth. The small bur is being used to section and shape the crown of this right mandibular third premolar tooth to facilitate extraction. The crown associated with the distal root of this tooth has been dramatically shortened to prevent applying stress to the crown with the root elevator. This is a good technique to avoid root fracture of fragile cat teeth. The same bur can be used to remove part of the buccal alveolar bone overlying the root(s) to further aid in extracting feline teeth without fracture.

#4 Round Ball

The cutting head of the #4 round ball bur is somewhat larger than the #2, but it can be used for similar purposes in dogs.

#701L Crosscut Bur

The #701L bur is a side-cutting bur most useful in sectioning the crowns of multirooted dog teeth, such as the maxillary fourth premolar tooth. This bur is also very useful for crown amputation in the treatment of malocclusion.

Root Elevators

Wiggs' Winged Elevators

The winged root elevators created by Dr. Robert Wiggs are some of the best instruments for loosening the roots of teeth. They are available in a range of sizes to conform to differently sized roots. Their thin neck aids in maneuverability and the thin cross section of their cutting head creates a long, thin wedge effect (Figure 7-6). They are specifically designed for luxation of teeth, which is the use of the sharp cutting tip to sever periodontal ligament fibers. The wings of the cutting head cup the root, and the shaft of the elevator is directed parallel to the long axis of the tooth. Primary force is directed apically, with force placed on the bulb handle seated in the palm of

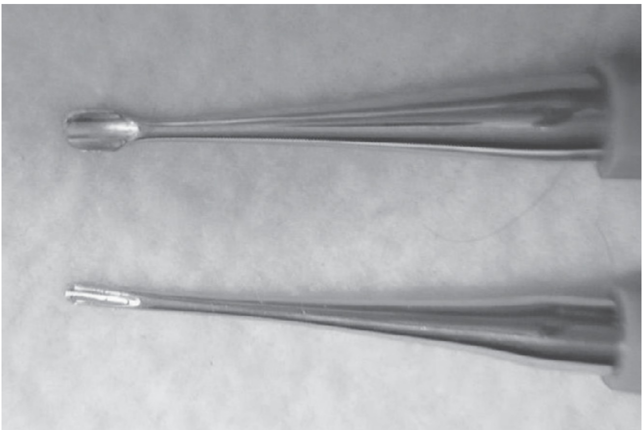


Figure 7-6 A Wiggs' root elevator (top) and a 301F root elevator (bottom). Both instruments provide a thin wedge effect with delicate features, such as a thin neck and a thin cross-sectional cutting head. These instruments are chosen to closely approximate the diameter of the root to be extracted and are used to sever the periodontal ligament fibers. The cutting edge of these elevators should be kept very sharp so they may perform optimally.

the hand. Small rotary and rocking motion allows the cutting head to gain more apical purchase and sever more of the periodontal ligament fibers.

301F Elevator

The 301F or 301 feline elevator has a smaller and more delicate cutting head, which is especially useful to approximate the root curvature of cat premolar tooth. By matching the size of the cutting head to the size of the tooth, undue force on the fragile roots can be minimized.

Root Tip Pick

The root tip pick has a very small, delicate, sharp tip on a thin handle. It is designed for the removal of fractured tooth roots. The smaller handle forces a mental step back and allows the operator to use more finesse. The root tip pick is used to tease the root circumferentially, loosening it and defining its outline. The sharp tip can then bite into the root fragment and pry it up and out of the alveolus (Figure 7-7).

Extraction Forceps

Small Breed Forceps

Small breed extraction forceps serve almost all of the needs for tooth removal. They are used with gentle force

Figure 7-7 A fine root tip pick used to gently pry a fractured feline root out of the alveolus. The root tip pick is much more delicate than the root elevator and requires the operator to use more finesse. The instrument is used to pry the root out of the socket to avoid further apical pressure, which might force the root into the mandibular canal or the nasal cavity.

to remove loose teeth and root segments. If more force is needed to remove a tooth, do not use a larger pair of extraction forceps, perform a more diligent breakdown of the periodontal ligament with the root elevator.

Stieglitz Splinter Forceps

Splinter forceps are great for loose root tips. They have very fine tips and jaws and are available in straight, 45°, and 90° angulation models.

Scissors

Mitchell Flap Scissors or Delicate Facelift Scissors

No instrument is as useful in adequate flap mobilization as a good pair of flap scissors (Figure 7-8). A good pair of flap scissors should have flat dissecting blades to move easily within tight spaces between tissue planes, such as the periosteum and the buccal mucosa. The tips should be rounded and curved to enable "nibbling" away at the periosteum of the underside of the flap without perforating the mucosa. A serrated edge on one or both blades grabs onto the tissue to be cut and keeps it from "running away" from the scissors. The Mitchell flap scissors works well in the dog but may be too large to be ideal in the cat.

Figure 7-8 The delicate facelift scissors (left) and Kaye dissecting scissors (right). The facelift scissors and Mitchell flap scissors have flat blades that curve and have rounded tips. These delicate blades enable the operator to carefully dissect the tissue planes present in a mucoperiosteal flap; namely, the mucosa and the periosteum. The flap can be delicately dissected and the periosteum precisely severed. The blades are serrated to aid in tissue cutting. The larger facelift and Mitchell flap scissors are well suited for dog flap surgery, but the finer Kaye dissecting scissors work better for the cat.

Kaye Dissecting Scissors

The Kaye dissecting scissors is very delicate, with fine curved dissecting blades. The edges of both blades are serrated, and the tips are blunt (Figure 7-9). Ribbon handles make them light and reduce fatigue when using this short pair of scissors for mobilizing feline mucoperiosteal flaps.

Needle Holders

There are just as many preferences in needle holder design as there are hands that hold onto them. However, the dental operator should always look for instruments that can make the job of suturing more precise and more comfortable. Suturing within the mouth can be quite a challenge, due to the confined space and close proximity of sensitive, vulnerable soft tissue structures. Needle holders with built-in scissors, such as Olsen-Hagar needle holders, can cause inadvertent damage, either while regrasping the needle or while trying to cut suture material.

Castroviejo

Castroviejo needle holders are not just for ophthalmic surgery. They can allow easier manipulation within smaller mouths due to their size. The locking mechanism permits operation without a lot of hand motion. The longer 7-in. versions also provide further reach into

Figure 7-9 The Kaye dissecting scissors. These scissors are ideal for mucoperiosteal flap surgery in cats. The fine dissecting blades with rounded tips allow for easier separation of the mucosa and periosteum, even within the confines of the feline mouth. Both blades are finely serrated to grab onto tissue and cut it more efficiently. These scissors can be used to carefully trim some gingival margins, but that job may require other scissors with stouter jaws.

the oral cavity and work well for cats and small breed dogs, especially when held in a modified pen grasp or "chopstick grip."

Dental Equipment and Supply Source List

ACE Surgical Supply

1034 Pearl Street

P.O. Box 1710

Brockton, MA 02403

(800) 441-3100

The company has a vast selection of dental and oral surgical instruments. It even carries delicate face lift scissors (40-030-04) for flap surgery.

Cislak

1866 Johns Drive

Glenview, IL 60025

(800) 239-2904

The company manufactures a nice line of high-quality hand instruments.

CK Dental Specialties
1407 N. Batavia, Suite 110
Orange, CA 92867
(800) 675-2537
The company has some hard-to-find equipment.

Dentalaire
17165 Newhope Street
Fountain Valley, CA 92708
(800) 844-7377
This is the source for "winged" elevators and tartar-cracking forceps. The company also has nice cat and dog models.

Dr. Shipp's Laboratories
351 N. Foothill Road
Beverly Hills, CA 90210
(800) 442-0107
The company has some veterinary-specific dental materials and instruments. Dr. Shipp is a board-certified veterinary dentist.

G. Hartzell & Son
2372 Stanwell Circle
P.O. Box 5988
Concord, CA 94520
(800) 950-2206

The company manufactures high-quality and exotic dental and surgical instruments.

Henry Schein, Inc.
135 Duryea Road
Melville, NY 11747
(800) 872-4346

The veterinary catalog has a nice section on dentistry, but their human dental catalog can be easily obtained and has a huge selection of dental equipment and supplies.

Spectrum Surgical
4575 Hudson Drive
Stow, OH 44224
(800) 444-5644

The company carries a nice quality and selection of instruments. It also offers a repair service for instruments.

Ultradent Products, Inc.

505 W. 10200 South

Salt Lake City, UT 84065

(800) 552-5512

The company carries great dental products. Its catalog describes techniques in detail.

8

Orthodontics

Orthodontics is the study of the spatial relationships of the teeth to one another and the potential therapy for abnormalities in that occlusion. Much more than merely "braces for dogs," modern veterinary orthodontics is about true and profound pain management. It is the duty of every conscientious veterinarian to carefully observe the form and function of the oral cavity, particularly how it pertains to the patient's comfort level. When assessing an animal's occlusion two important questions should be considered: Is this a comfortable bite? and Is this a functional bite? (Figure 8-1).

Painful mouths result from occlusions in which there is either abnormal tooth-on-tooth contact or tooth-on-soft-tissue contact. A complete orthodontic evalua-

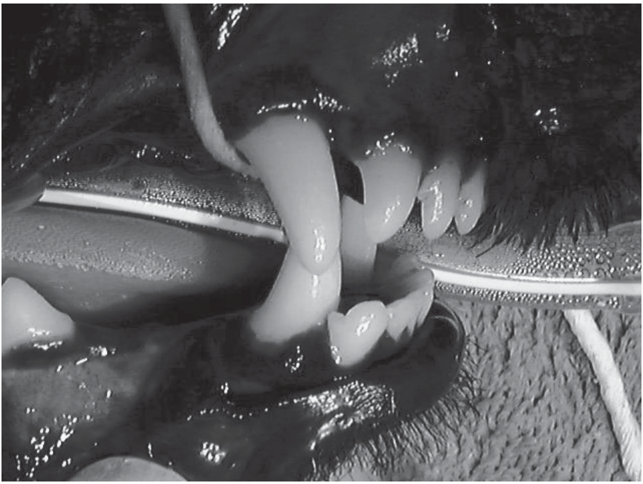


Figure 8-1 A dog with a malocclusion. This dog has linguoversion of the mandibular canine teeth compounded by mesioversion (rostroversion) of the maxillary canine teeth. This malocclusion of the adult dentition is likely the result of retained deciduous teeth that have since been extracted. The mandibular canine teeth impact the palate, causing palatal ulceration.

tion should look for these types of painful situations, comparing to "ideal" occlusion whenever possible. Some breeds typically deviate from the ideal occlusion, as outlined in Chapter 2, "Anatomy and the Oral Exam," such as the boxer and the bulldog. In these brachycephalic patients, it is necessary to look beyond the gross alterations from a "normal" occlusion and look for any painful contact areas.

Functionality is also of concern when examining occlusion, and it often goes hand in hand with comfort assessment. Teeth that are improperly occluding within a mouth cannot serve their intended function effectively, if at all. The teeth typically work best in the ideal relationship of normal occlusion, such as incisors that meet in a true scissor bite to allow for gnawing and grooming.

Classification of Malocclusions

Class 0: Normal/Orthoclusion

This class includes the ideal or true normal occlusion, Type 1, as well as normal, breed standard acceptable occlusions for brachycephalic dogs, such as boxers and bulldogs. An occlusion that is considered normal for a boxer would be known as Class 0—Type 3.

Class I: Neutroclusion

In this class both the maxilla and the mandible are of proper length; however, teeth within those jaws are malpositioned. Examples of a Class I malocclusion would include

Anterior crossbite. An abnormal incisor relationship in which the incisor teeth do not form a scissors bite, the cusps of the mandibular incisors occlude facially to the cusps of the maxillary incisors. This results in pain from tooth-on-tooth contact and decreased functionality for incising and grooming.

Posterior crossbite. An abnormal carnassial relationship in which the mandibular first molar teeth occlude buccally to the maxillary fourth premolar teeth. This can result in decreased functionality for shearing and grinding as well as painful tooth-on-tooth contact.

Linguoversion of the canine teeth (base narrow canines). An abnormal canine relationship in which the mandibular canine teeth do not flair out enough facially but are directed in a more upright manner. This results in pain from the canine teeth striking the soft tissue of the palate, causing palatal ulceration. If left untreated this tooth on palatal soft tissue contact can progress to the formation of oronasal fistulae.

Mesioversion of the canine teeth (lance canines). An abnormal canine relationship in which the maxillary canine teeth are directed mesially, decreasing the diastema between the maxillary canine tooth and the maxillary third incisor tooth. This can result in pain from tooth-on-soft-tissue contact, such as the mucosal lining of the upper lip, as well as a decrease in the grasping functionality of the mouth. A further result is the pain from tooth-on-tooth contact caused by these maxillary canine teeth occupying the space normally reserved for the mandibular canine teeth.

Rotated or crowded teeth. The condition may involve a single tooth or a combination of incisor, canine, premolar, or molar teeth. This can result in pain from tooth-on-tooth or tooth-on-soft-tissue contact or decreased functionality; it can also result in secondary periodontal disease. Rotated or crowded teeth alter the natural defenses of the mouth from periodontal insult and infection by trapping food particles and retaining plaque.

Class II: Distoclusion

In this class, the mandible is relatively shorter than the maxilla. This may be due to a mandibular brachygnathism (short mandible) or a maxillary prognathism (long maxilla), which results in decreased functionality of the incisor teeth for incising and grooming, the canine teeth for grasping, and potentially the carnassial teeth for shearing and grinding. This class of malocclusion also causes pain from the tooth-on-soft-tissue contact of the mandibular canine teeth on the palate.

Class III: Mesioclusion

In this class the mandible is relatively longer than the maxilla. This may be due to a mandibular prognathism (long mandible) or a maxillary brachygnathism (short maxilla), which can result in decreased functionality in a manner similar to a Class II malocclusion. This class of malocclusion can result in pain from tooth-on-soft-tissue contact if the maxillary incisor teeth strike the soft tissue caudal to the mandibular incisor teeth.

Class IV: Mesiodistoclusion

This is a special classification of wry bite malocclusion, in which one jaw is in mesioclusion and the other jaw is in distoclusion. Both comfort and function can be greatly affected.

Pedodontic Concerns

Orthodontic evaluation should begin as early as possible in the life of a puppy or kitten and should be continuous until it has stopped growing and the permanent teeth have fully erupted. By closely observing the dentition and developing occlusion, the veterinarian can catch orthodontic problems as soon as possible. This spares the animal undue pain and also means a better chance to correct the malocclusion. Younger animals are usually better orthodontic patients due to their active growth phases.

Relative jaw length is in a dynamic state in growing animals and can sometimes be difficult to judge for abnormalities. However, it is easy to recognize obviously painful conditions, such as linguoversion of the canine teeth or a Class II malocclusion, in which the palate is traumatized even at an early age. A close eye should be kept on the primary dentition; and if palatal trauma results from abnormally occluding mandibular canine teeth, they should be extracted as soon as possible. Primary teeth should also be observed closely for any signs of persistence when their permanent counterparts begin to erupt.

There should never be a primary and permanent tooth of the same type in the same location at the same time. These persistent primary teeth or retained deciduous teeth should be extracted as soon as the adult tooth begins to erupt. A persistent primary tooth can cause the permanent tooth to erupt into an abnormal location. Therefore, when extracting retained deciduous teeth it is crucial that the veterinarian evaluate the resultant occlusion.

Treatment of Malocclusion

Ethical Concerns

Although modern veterinary orthodontics provides the means to correct most malocclusions, it is necessary to ask if a malocclusion should be corrected. Each of our patients deserves to have a healthy, functional, pain-free mouth. However, many orthodontic problems are hereditary and pose a contraindication to breeding. Many of the bite problems that plague breeding and show dogs can be corrected, but the veterinarian must always consider the ethical issues of potential deception. Genetic counseling should be a part of the discussion in deciding to treat a malocclusion.

One must consider the control of pain first and cosmesis only secondarily. Every veterinarian must make his or her own ethical decisions, but many have adopted the policy to perform orthodontic treatment only on animals that are either spayed or neutered. This helps to avoid participation in deceptive orthodontic treatment and the perpetuation of a potential genetic defect.

Proper Case Selection

Although ethical considerations are a big part of case selection, other issues should be considered in selecting orthodontic cases. Orthodontic treatment is both an art and a science and its success requires skill and experience of the veterinarian, but it also requires patience and compliance of the client. It is absolutely essential that the client understand both the initial problem and the planned treatment completely. A lot of frustration and dissatisfaction can be avoided later on in the treatment phase if more time is spent explaining all phases of treatment to the owner, including potential complications.

Owners must understand that it is a huge commitment, involving multiple weekly rechecks and multiple anesthetic episodes.

Orthodontic Movement

Several different types of tooth movement can be employed in orthodontic treatment based on the malocclusion and the desired repositioning of those teeth. All these tooth movements rely on the same physiological activity for success. When an orthodontic force is applied to a tooth, the periodontal ligament is compressed in one region and stretched in another. Provided the force is not excessive, the area of periodontal ligament compression will lead to bone resorption and the area of periodontal ligament tension will lead to bone deposition. Through this physiological event, a tooth may be guided into a new location with appropriate force and remain in that location provided that necessary retention is provided.

It must be stressed that, although the physiology of orthodontics seems quite simple, the execution of successful tooth movement and retention requires considerable diligence, expertise, and experience.

INCLINE PLANE One of the most commonly used devices for correction of mandibular canine linguoversion (Figure 8-2) is the incline plane (Figure 8-3). This device is temporarily attached to the rostral maxilla and

Figure 8-2 A model of a dog's mouth with a simulated bilateral linguoversion malocclusion of the mandibular canine teeth. The mandibular canine teeth do not flair enough facially and the cusps strike the palate.

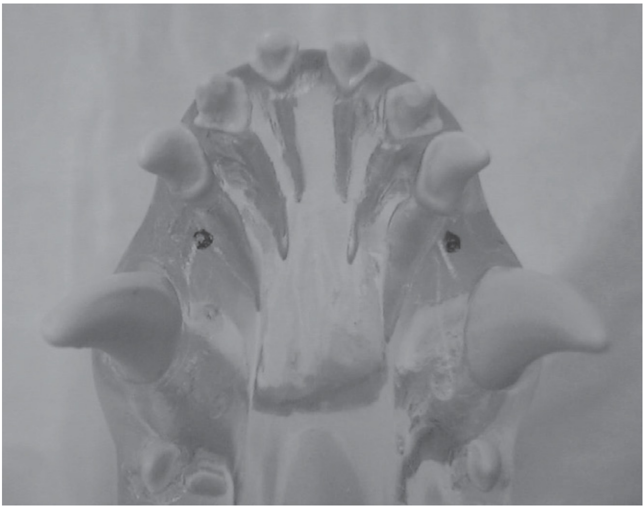


Figure 8-3 A model of a dog's mouth with simulated malocclusion from Figure 8-2. The dots on the palate simulate the palatal ulcerations caused by the trauma of the cusps of the mandibular canine teeth.

can even be fabricated entirely within the mouth. It is usually made with acrylic or composite and bonded directly to the maxillary teeth (Figure 8-4). The purpose of the device is to deflect the cusps of the mandibular canine teeth into a more comfortable position. The cusps contact a slope on the device and the pressure of closing of the animal's mouth provides the necessary force (Figure 8-5).

Simple buccal tipping of the mandibular canine teeth usually takes 4–8 weeks, and once the teeth are in the desired position, the maxilla and maxillary teeth act as a natural retainer to prevent rebound. The appliance is removed after the orthodontic treatment is complete.

BUTTONS AND POWER CHAIN Another common orthodontic appliance is created using small metal buttons temporarily cemented onto the teeth and attached to each other with elastic bands. The buttons are bonded to the teeth with careful respect for necessary root anchorage (Figure 8-6). The root support of the anchorage teeth must be greater than that of the tooth or teeth that are desired to move. The power for movement is provided by the elastic band and can be controlled somewhat to achieve proper movement (Figure 8-7).

Other Treatment Options

Due to the time and financial commitment, orthodontic treatment is not for every patient or every owner. There

Figure 8-4 A composite being applied to the model from Figure 8-3 to fabricate an incline plane. This material is used in human dentistry to fabricate temporary crowns. The composite consists of two parts mixed together in the applicator tip as the material is extruded from the gun.

Figure 8-5 A composite incline plane fabricated directly onto the maxilla of the model of a dog's mouth with the simulated malocclusion. The cusps of the mandibular canine teeth now strike the slope of the incline plane on each side. The cusps are gradually directed further along those slopes through the force provided by the closing of the jaws. Note that the appliance has been constructed in two halves without crossing the midline. This is done to young patients to allow for lateral maxillary expansion growth and to keep the composite from irritating the incisive papilla.

Figure 8-6 A dog with mesioversion (lance tooth) malocclusion of the left maxillary canine tooth. Metal orthodontic buttons have been strategically bonded onto the left maxillary canine tooth (the movement tooth) and the left maxillary fourth premolar and molar teeth (the anchorage teeth). The movement tooth has a button bonded close to the cusp of the tooth, while the anchorage teeth have buttons bonded close to the gingival margin. This configuration is meant to enhance leverage and encourage the canine tooth to be pulled distally into a proper location.

Figure 8-7 The dog with mesioversion from Figure 8-6. The bonded metal orthodontic buttons have been linked with an elastic band. There is no tension between the two anchorage teeth and moderate tension between the canine tooth and fourth premolar tooth. The plastic band, or power chain, provides the power to gently and gradually pull the canine tooth distally into the desired position.

are other ways of relieving the pain of a malocclusion, although they usually come with the sacrifice of natural tooth substance and ultimate functionality. Crown amputation with a requisite pulp capping procedure can treat a malpositioned tooth by reducing its height and eliminating the nasty tooth-on-tooth or tooth-on-soft-tissue contact. The advantage of crown amputation and pulp capping over judicious extraction(s), which is another option to treatment of malocclusion, is the retention of root structure as well as some small coronal tissue. With strategic teeth such as the canines, the root is typically twice the size of the crown and contributes considerable structural integrity to the rostral mandible. Bilateral extractions of the mandibular canine teeth can also inflict considerable trauma on both the patient and the operator.

Appendix: Quick Reference

Eruption Times of Dog and Cat Teeth[1]

Dog Deciduous Teeth

Incisors	3–5 weeks
Canines	3–6 weeks
Premolars	4–10 weeks

Dog Permanent Teeth

Incisors	3–5 months
Canines	3.5–6 months
Premolars	3.5–6 months
Molars	3.5–7 months

Cat Deciduous Teeth

Incisors	2–3 weeks
Canines	3–4 weeks
Premolars	3–6 weeks

Cat Permanent Teeth

Incisors	3–4 months
Canines	4–5 months
Premolars	4–6 months
Molars	4–6 months

Dental Formulae

Dental Formulae for the Dog

Deciduous: 2 × (i 3/3, c 1/1, p 3/3) = 28

Permanent: 2 × (I 3/3, C 1/1, P 4/4, M 2/3) = 42

Dental Formulae for the Cat

Deciduous: 2 × (i 3/3, c 1/1, p 3/2) = 26

Permanent: 2 × (I 3/3, C 1/1, P 3/2, M 1/1) = 30

Staging of Feline Odontoclastic Resorptive Lesions (FORLs)[1]

Stage 1	Into enamel only
Stage 2	Into dentin
Stage 3	Into pulp cavity
Stage 4	Extensive structural damage
Stage 5	Crown gone, only roots remain

Staging of Tooth Injuries[1]

1	Simple fracture of the enamel

2	Fracture extends into the dentin
3	Fracture extends into the pulp cavity, pulp vital
4	Fracture extends into the pulp cavity, pulp not vital
5	Tooth displaced
6	Tooth avulsion
7	Root fracture, no coronal involvement, tooth stable
8	Root fracture, combined with Stage 1 or 2 coronal fracture, tooth stable
9	Root fracture, combined with Stage 3 coronal fracture, tooth stable
10	Root fracture in combination with Stage 1–4, unstable tooth

Common Dental Abbreviations[1]

AB	Abrasion
AL	Attachment loss
AT	Attrition
AXB	Anterior crossbite
CAM	Crown amputation
CU	Contact ulcer (“kissing” lesion)
CWD	Crowding

ED	Enamel defect
EG	Eosinophilic granuloma
EH	Enamel hypoplasia or hypocalcification
EP	Epulis
FB	Foreign body
FE	Furcation exposure
FX	Fracture of tooth or bone
GH	Gingival hyperplasia
GP	Gutta percha
GTR	Guided tissue regeneration
LPS	Lymphocytic plasmacytic stomatitis
M	Mobility
O	Missing tooth (a circle is put around tooth on dental chart)
OAF	Oroantral fistula
OM	Oral mass
ONF	Oronasal fistula
ONF/R	Oronasal fistula repair
PC	Pulp capping
PDL	Periodontal ligament
PE	Pulpal exposure
PP	Periodontal pocket
PXB	Posterior crossbite
R/C	Composite restoration
RCS	Surgical root canal

R/I	Glass ionomer restoration
RC	Root canal therapy
RE	Root exposure
RD	Retained deciduous tooth
RL	Resorptive lesion
ROT	Rotation
RPC	Closed root planing
RPO	Open root planing
RR	Retained root
SN	Supernumerary tooth or root
TMJ	Temporomandibular joint
VP	Vital pulpotomy
X	Extraction (an X is put over the tooth on the dental chart)
XSS	Surgical extraction

Reference

1. Wiggs RB, Lobprise HB. *Veterinary Dentistry: Principles and Practice*. Philadelphia: Lippincott-Raven, 1997: 97–101, 677–687.

Glossary

Abrasion: Tooth wear caused by external force, such as excessive tooth brushing.

Access Site: The area of entry into the tooth for a root canal procedure.

Acrylic: A methyl methacrylate compound used to make appliances within the mouth.

Alveolar Crest: The most coronal extent of the alveolar bone.

Alveolar Juga: The bony prominence overlying and outlining the facial aspect of a tooth root.

Alveoloplasty: Shaping and smoothing of the alveolar bone.

Alveolus: The bony socket that holds the root of a tooth.

Ankylosis: Fusion of root cementum to alveolar bone.

Anterior Crossbite: A type of Class I malocclusion in which one or more of the maxillary incisor cusps is positioned lingual to the opposing mandibular incisor teeth.

Anterior Teeth: The incisor and canine teeth.

Apex: The end of a root.

Apexification: The stimulation of apical closure in an immature tooth with nonvital pulp, usually in preparation for a root canal procedure.

Apexogenesis: The guidance of apical closure in an immature tooth with vital pulp, usually in preparation for a root canal procedure.

Apical: In the direction of the tip of the root.

Apical Delta: Multiple points of entry and exit for the dental pulp at the apex of a tooth.

Apical Foramen: Single point of entry and exit for the dental pulp at the apex of a tooth, usually seen in humans and nonhuman primates.

Attrition: Tooth wear caused by masticatory forces.

Avulsion: The traumatic displacement of a tooth outside of the mouth.

Backscatter: Scatter radiation that may expose the back side of the film secondarily.

Barbed Broach: Endodontic instrument with small sharp teeth for the removal of pulpal remnants.

Base Narrow Canines: Orthodontic malocclusion of the mandibular canine teeth in which the cusps do not flair enough facially and impact the palate.

Bisecting Angle Technique: Radiographic technique accomplished by firing an X-ray beam perpendicular to the imaginary line that bisects the angle formed by the film and the long axis of the tooth.

Brachycephalic: Facial profile that is short and blocky, such as in a pug or boxer.

Buccal: In the direction of or associated with the cheek.

Burs: Small metal rotary cutting instruments that fit into a high-speed handpiece.

Calculus: Mineralized plaque firmly attached to teeth.

Canines: Large pointed teeth used for grasping.

Caries: True cavities caused by decay from bacteria.

Carnassial Teeth: Flesh-shearing teeth, the maxillary fourth premolar tooth and the mandibular first molar tooth in dogs and cats.

Cementoenamel Junction (CEJ): The meeting point of the cementum covering the root and the enamel covering the crown.

Cementum: The thin, hard coating of the root.

Chlorhexidine: A potent oral antimicrobial agent used to inhibit plaque.

Chronic Ulcerative Paradental Stomatitis (CUPS): An immune-mediated inflammatory disease of the lining of the oral cavity.

Commissure: The junction of the upper and lower lips; the corner of the mouth.

Composite: Plastic material typically used for restorations and oral fracture repair.

Coronal: In the direction of the crown or relating to the crown of a tooth.

Crown: The enamel-covered part of a tooth normally visible above the gumline.

Curette: An instrument used to debride deposits from roots or debride soft tissue from alveoli.

Cusp: The tip of the crown of a tooth.

Deciduous Teeth (Primary or Baby Teeth): Teeth that will normally be shed in favor of permanent teeth.

Dentrifice: Any substrate used to clean teeth.

Dentin: Hard tissue that makes up the majority of the tooth structure.

Dentinal Tubules: Tubes formed within the dentin.

Diastema: A space between adjacent teeth.

Disarticulated File: An endodontic file that has broken within the pulp cavity.

Distal: Away from the center line of a dental arcade.

Dolicocephalic: Facial profile which is long and narrow, such as in greyhounds.

Elongation: Radiographic positioning error that results in an overexaggeration of tooth root length on the radiographic image.

Enamel: The hard covering tissue of the crown.

Enamel Hypocalcification: Poorly mineralized enamel leading to discoloration.

Enamel Hypoplasia: Thinner than normal layer of enamel.

Epulis: Generic term for gingival growth; typically used for benign masses.

Extirpation: The removal of dental pulp tissue.

Facial: Pertaining to the outer surface of the teeth, a combination of buccal and labial.

Feline Odontoclastic Resorptive Lesion (FORL): Idiopathic external resorption of tooth substance, usually beginning at the cervical region of a tooth.

Film-Focal Distance (FFD): Measurement from the film to the X-ray generator focal spot.

Foreshortening: Radiographic positioning error that results in an underexaggeration of tooth root length on the radiographic image.

Free Gingiva: Marginal gingiva not firmly attached to the underlying hard tissue.

Freeway Space: Space between opposing maxillary and mandibular premolar teeth when the jaw is closed.

Frenulum: A band of tissue that limits movement, such as under the tongue (lingual frenulum) or between the lips and alveolar mucosa (labial frenulum).

Furcation: Area where the roots diverge in multirooted teeth.

Furcation Exposure or Involvement: Disease state involving bone loss and possible gingival recession at the furcation.

Gingiva: The resilient soft tissue that surrounds teeth and covers alveolar crestal bone.

Gingival Sulcus: Valley between the free gingiva and the tooth surface.

Gingivectomy: The partial removal of gingival tissue.

Gingivitis: Inflammation of the gingiva.

Gingivoplasty: Shaping of the gingival tissue.

Glass Ionomer: A dental restorative that bonds to teeth.

Guided Tissue Regeneration (GTR): Advanced periodontal therapy aimed at getting lost periodontal supporting tissues to grow back.

Gutta Percha: A rubbery root canal filling material.

Halitosis: Bad-smelling breath.

High-Speed Handpiece: A rotary dental power instrument that accepts burs for precise removal or shaping of oral tissues.

Impaction: An unerupted tooth covered by soft tissue or bone.

Incisive papilla: Small round lump of palatal soft tissue located on the centerline just caudal to maxillary incisors; part of the vomeronasal apparatus.

Incisors: Small teeth in center of arcade for cutting and grooming.

Incline Plane: Orthodontic appliance that attaches to maxilla and forces displaced mandibular canine teeth to tip facially when the animal closes its jaws.

Interdental Wiring: A form of oral fracture fixation with wire placement between and around teeth.

Interproximal Space: The space between adjacent teeth.

Interradicular: The area between roots of adjacent teeth or between roots of the same multirooted tooth.

Juga: *See* Alveolar Juga.

Junctional Epithelium: Epithelium of the gingivomucosa that attaches to the tooth.

Kissing Lesion: An ulcerated area of buccal mucosa that is normally in contact with a tooth; often seen in CUPS.

Labial: In the direction of or pertaining to the lips.

Lamina Dura: A dense white line evident on radiographs that represents the thick alveolar bone surrounding a tooth root.

Lance Tooth: A maxillary canine tooth that is malpositioned in a mesiorostral direction.

Lateral Canal: An additional portal of entry and exit of a pulp cavity coronal to the apex.

Lingual: In the direction of or pertaining to the tongue.

Linguoversion: *See* Base Narrow Canines.

Luxation: The traumatic displacement of a tooth completely out of the alveolus but within the mouth; complete displacement of the temporomandibular joint.

Lymphocytic Plasmacytic Stomatitis (LPS): Idiopathic feline oral inflammatory disease.

Mandibular Symphysis: The fibrous joint between the two hemimandibles at the centerline of the mandibular arcade.

Mental Foramen: Opening in the rostrolateral surface of the mandible.

Mesatocephalic: Facial profile that is balanced between brachycephalic and dolichocephalic, such as in Labradors.

Mesial: Toward the centerline of the dental arcade.

Mixed Dentition: A combination of deciduous teeth and permanent teeth at the same time.

Molars: Teeth used for grinding.

Mucogingival Junction (MGJ): The intersection of attached gingiva and alveolar mucosa.

Obturation: Complete filling to the pulp cavity.

Occlusion: The relative contact and positioning of opposing teeth in the maxilla and mandible.

Odontoblast: The cell type that produces dentin.

Odontoplasty: The shaping of teeth, either for periodontal therapy of crowded teeth or to facilitate removal.

Oroantral Fistula: An abnormal communication between the oral cavity and the maxillary sinus.

Orofacial Fistula: An abnormal communication between the oral cavity and the skin of the face.

Oronasal Fistula: An abnormal communication between the oral cavity and the nasal cavity.

Osseopromotive: Stimulating the growth of new bone.

Palatal: In the direction of or pertaining to the palate.

Palatine Fissures: Large paired holes in the rostral maxillary bone.

Parallel Technique: Radiographic technique accomplished by firing an X-ray beam perpendicular to the parallel film and the long axis of the tooth.

Periapical: Around the end of a tooth root.

Periodontal: Around the tooth.

Periodontal Disease: Inflammation or destruction of the supporting structures of the teeth.

Periodontal Ligament: Network of fibers that attach to the root cementum and the alveolar bone.

Periodontal Pocket: An abnormal deepening of the gingival sulcus.

Periodontal Probe: Instrument for measuring the depth of the gingival sulcus or periodontal pocket.

Periodontitis: Active state of destruction of the supporting tissues of the tooth.

Periodontium: The supporting structures of the teeth, including gingiva, root cementum, periodontal ligament, and alveolar bone.

Periosteal Elevator: Instrument used to peel a full-thickness mucoperiosteal flap from underlying bone.

Periosteum: Tough thin fibrous tissue covering the bone.

Periradicular: Around the root.

Plaque: Combination of bacteria, bacterial toxins, and glycoproteins that adhere to the tooth surface in a biofilm.

Polishing: Smoothing microetching in enamel caused by dental scaling.

Posterior Crossbite: A type of Class I malocclusion in which the maxillary fourth premolar tooth cusp is positioned lingual to the opposing mandibular first molar tooth.

Posterior Teeth: The premolar and molar teeth.

Premolars: Teeth for grasping and shearing.

Primary Dentin: The dentin present at the time of tooth eruption.

Pseudopocket: An increased periodontal probing depth caused by gingival hyperplasia.

Pulp: Collection of nerves, blood vessels, lymphatics, connective tissue, and odontoblasts within the pulp cavity of the tooth.

Pulp Cavity: The hollow portion of the tooth, including the root canal of the root and the pulp chamber of the crown.

Pulpal Exposure: An abnormal opening to the pulp cavity.

Pulpitis: Inflammation of the pulp tissue.

Ranula: Sublingual salivary cyst.

Releasing Incisions: Incisions made through gingiva to provide additional exposure with a mucoperiosteal flap.

Reparative Dentin (Tertiary Dentin): Dentin produced by the dental pulp in response to chronic irritation, such as gradual attrition, in an effort to maintain a sealed pulp cavity.

Root: The cementum-covered part of a tooth normally held within the alveolar bone below the gumline.

Root Canal: The portion of the pulp cavity that lies within the root; the endodontic procedure that involves the removal of infected pulpal debris and the filling of the canal with an inert material.

Root Elevator: Instrument used to loosen root material from the alveolus.

Root Exposure: Loss of periodontal tissue that exposes a root to the oral cavity.

Root Planing: Mechanical debridement of adherent debris from root surfaces with a dental curette.

Rugae: Ridges of soft tissue oriented transversely across the palate.

Scissors Bite: Normal occlusion for the incisor teeth, with the maxillary incisors facially overlapping the mandibular incisors.

Secondary Dentin: Dentin normally produced by healthy vital pulp tissue after eruption.

SLOB (Same Lingual–Opposite Buccal) Rule: In the tube head shift radiographic technique, the lingual object moves in the same direction as the X-ray head, and the buccal object moves in the opposite direction to the X-ray head.

Sonic (Subsonic) Scalers: Power scalers that use compressed air to spin a rotor and cause vibrations at less than 20,000 cycles per second.

Splint: Intraoral appliance for stabilizing loose teeth or loose bone fragments.

Stomatitis: Inflammation of the soft tissue lining of the mouth.

Strategic Teeth: The teeth considered most important to oral function, typically canine and carnassial teeth.

Subluxation: The traumatic displacement of a tooth within the alveolus.

Supereruption: Eruption of the cementoenamel junction beyond its normal level, usually found in the canine teeth of older cats.

Supernumerary Roots: An extra root beyond what is normally present.

Supernumerary Teeth: An extra tooth beyond what is normally present.

Temporomandibular Joint (TMJ): The hinged junction of the mandible and the skull.

Tertiary Dentin: *See* Reparative Dentin.

Tube Head Shift Technique: Radiographic technique to eliminate superimposition of roots or other interfering radiodense structures.

Ultrasonic Scalers: Power scalers that convert electricity into high frequency vibrations from 20,000 to 45,000 cycles per second.

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