250 clinical commented cases

CARDIAC ARRHYTHMIAS IN DOGS AND CATS

Luiz Henrique Filippi
Maurício Gianfrancesco Filippi

Celso Salgado de Melo
Coordinator



Fontoura

Luiz Henrique Filippi
Maurício Gianfrancesco Filippi
Authors

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Fontoura Editora Ltda.
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atendimento@editorafontoura.com.br
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AUTHORS



Luiz Henrique Filippi

The author of the book "Electrocardiogram in veterinary medicine", he is a veterinary physician graduated in 1985 from the Faculdade de Medicina Veterinária e Zootecnia – Universidade Estadual Paulista (UNESP) in Botucatu. Autonomous clinician of small animals, he

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specialized in the cardiology field. Professor of the Course of Advanced Electrocardiography at the Instituto de Pós-Graduação Qualittas and Associate Professor of Electrocardiography in the Postgraduate Course on Cardiology at the Universidade Anhembi Morumbi of São Paulo. Founding Member of the Sociedade Brasileira de Cardiologia Veterinária and active member of the Sociedade Latino Americana de Cardiologia Veterinária. Currently in charge of the Telemedicine Sector of the Deltalife company. Creator and coordinator of the Theoretical-Practical Course on Electrocardiography in Dogs and Cats (basic and advanced modules).
Contact: lhfilippi@terra.com.br
(55 11) 97247-7220



Maurício Gianfrancesco Filippi

Veterinary physician graduated from the Faculdade de Medicina Veterinária e Zootecnia (FMVZ) – Univesidade Estadual Paulista (UNESP), Botucatu/SP. He obtained a Master's degree in veterinary medicine focused on veterinary cardiology in the same Institution. Associate Professor of the Annual Course on Electrocardiography of Small Animals with the veterinary physician Luiz Henrique Filippi as Full Professor. Specialized in Doppler Echocardiography (basic and advanced course) at the Faculdade de Ciências Agronômicas e Veterinárias (FCAV) – Universidade Estadual Paulista (UNESP) Jaboticabal/SP. Member of the Sociedade Brasileira de Cardiologia Veterinária (SBCV).
Contact: mauriciofilippi@terra.com.br
(55 11) 97259-4331

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DEDICATION

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This book is dedicated to my whole family and particularly my parents, Álvaro Filippi and Tereza das Neves Filippi.

PREFACE

In the description of this excellent new book the authors express a goal to assist the reader to diagnose cardiac arrhythmias and even train their ability to analyze the tracings that may appear in daily practice. The latter part of this sentence is so important to me.

At first glance, an ECG presents us with an unsolved mystery. Some are mysteries that are very easy to answer as they are things we have seen many times before. Others require us, like the diagnostic detectives that we are, to ask the right series of questions to generate the facts that will help us solve the puzzle. Once we understand this, and once we know the questions to ask and answer, a clinician can confidently approach any ECG that they are presented with, no matter how complex they may at first appear.

This is the genius of the approach in this new book.

By presenting us with a broad array of cases and by carefully constructing a logical, systematic series of questions for each, along with answers richly illustrated with clear examples, annotated figures and detailed explanations, this guide will train the reader to understand the questions to ask, the analysis that they need and the interpretation of the answers they generate. In using clinical cases the interpretations generated are then placed in clinical context allowing the reader to gain insights about the practical application of the ECG in their day to day practice.

I know that this book will become a key part of your veterinary library and one that lives up to the aspirations set out by its authors. It will definitely assist you, the reader in diagnosing cardiac arrhythmias, and because of the approach taken it will also train you to analyze the tracings that will appear in your daily practice.

Andrew W. Beardow
BVM&S, MRCVS, Dip ACVIM (Cardiology)

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PRESENTATION

The proposal of this book is to provide the reader with a self-evaluation on his/her capacity to make a diagnosis in cats and dogs by using the electrocardiogram, of both isolated and associated arrhythmias in a tracing. Besides this, arrhythmias may often be accompanied by other findings suggesting heart diseases (as chamber enlargement) or extra-cardiac causes. For this reason, the electrocardiogram is a test rich in information, which can be very useful for clinicians, interventionists, surgeons, anesthesiologists or cardiologists for a better evaluation of patients.

These are 250 selected cases, accompanied by a brief history of the patient, and even with data on clinical examination and additional tests, when available. The electrocardiogram, as any other test, should be evaluated jointly with a database, including: history, physical examination, age, breed, weight, associated diseases and supplementary tests; all with the aim of aiding its interpretation. In the page following each presented case, there are relevant commentaries on the findings in each tracing. We trust that this method will excite the intellect and provide the reader with the first steps of logical analysis of the electrocardiogram, and thus stimulates the ability to analyze the more complex tracings that may arise daily. The "Q&A" format has the goal of making the reader practice and reason. The interpretation of some tracings could be difficult; mainly when there are many artifacts (as muscle tremors or electrical interferences) that are commonplace in most tracings recorded in veterinary medicine, as animals are not perfectly isolated, and neither are still. To facilitate the identification of the electrocardiographic findings we use visual cues (arrows, asterisks, lines, and so on), to draw the attention of readers to the most significant aspects in each tracing.

In fact, this work could be considered a sequel to our first book, "Electrocardiogram in veterinary medicine" (Editora Roca, 2011), where all the concepts exposed in it, are now presented in the way of illustrated and commented clinical cases; besides keeping the same bibliography already used.

Also, after extended and thorough studying, it will not be rare for readers to disagree with the interpretation of an ECG. This is to be expected and it is fine. We consider and value this difference in opinions

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and we hope to receive communications about it, so that we may evaluate them and if pertinent, introduce modifications in future editions.

Before starting with the interpretation of the 250 clinical cases, there will be an introduction and review of some basic concepts, and also the measurements of normal ECGs for cats and dogs, with the aim of reminding the reader about normal parameters and most of all, have the reader ready, not requiring to check other literature, to fully seize all the commentaries made.

All men carry inside the child they once were.Antoine de Saint-Exupéry

NORMAL ELECTROCARDIOGRAPHIC TRACINGS

A properly interpreted tracing may reveal cardiac, and even extra-cardiac diseases. Still, we should be aware of its limitations (as any other diagnostic means), thus being imperative to interpret it jointly with the history of the patient, besides performing a thorough semiological examination and other additional tests, when available.

The electrocardiogram could be used to detect or accompany:

- Cardiac arrhythmias (efficient in 99% of cases).
- Overloads in cardiac chambers.
- Myocardial hypoxia and ischemia.
- Unspecific heart diseases such as myocarditis, endocarditis or neoplasia.
- Pericardial diseases.
- Systemic diseases that generate arrhythmias.
- To establish prognosis, for presurgical planning, and monitoring of therapeutic responses (e.g., using antiarrhythmic agents).
- Electrolyte imbalances.
- The evaluation of results of procedures, such as punctures.
- Healthy patients, with the aim of storing a record to compare subsequent evaluations.

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- The operation of electronic devices implanted in the heart, such as pacemakers.

We suggest veterinarians to always measure the following parameters, during the evaluation of a tracing:

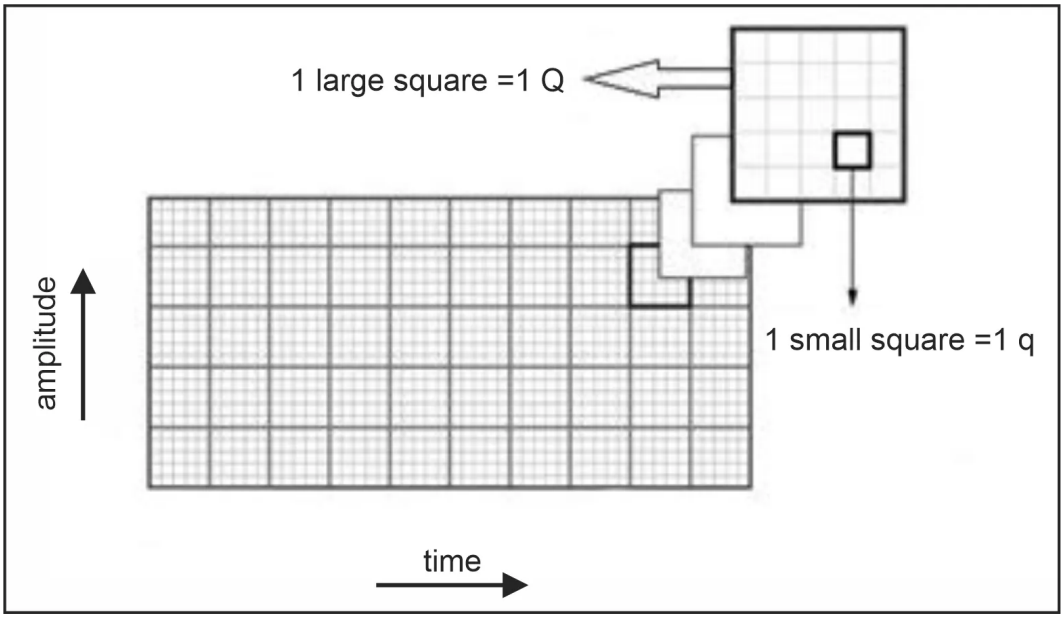
1. Estimation of heart rate.
2. Determination of the QRS mean electrical axis and the P wave.
3. To analyze the amplitude and duration of P, QRS and T waves.
4. To analyze the PR and QT intervals, and ST segment.
5. To observe the morphology of T wave.
6. To thoroughly evaluate heart rhythm and its possible alterations.

Electrocardiographic paper

Electrocardiographic paper is in fact, equivalent to a Cartesian coordinate system (voltage x time), subdivided into large squares (in this text called Q) and small squares (in this text called q), where the distances between q (horizontal or vertical) is 1 millimeter.

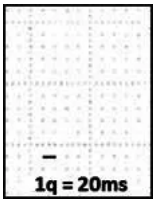
Every five small squares (5q) the line is thicker (both vertical and horizontal), thus delineating a Q (large square):

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Recommended velocity to record the tracing is 50 mm/second

To know the horizontal measure of each small square:



50 mm = distance travelled in one second.

1 mm = distance travelled in q seconds.

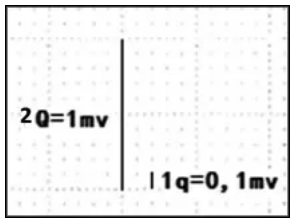
q = 1: 50 = 0.02 seconds (two hundredths of a second or 20 milliseconds).

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That is to say, the horizontal measure of q corresponds to 0.02 seconds (two hundredths of a second or 20 milliseconds) and every five q (one Q), correspond to 0.10 seconds (10 hundredths of a second or 100 milliseconds).

To know the vertical measure of every small square:

It is established by convention that in the N pattern of sensitivity, 10 small squares (10q) correspond to 1 mv. Proceeding in this manner, every small square (q) corresponds to a potential difference of 0.1 mv.



Analysis of the electrocardiogram

The success of a good interpretation of an electrocardiogram starts by the identification of the patient. It is the beginning of a successful electrocardiographic analysis. The essential data of a patient include:

- Name, date of the test, gender, age, breed, weight, height.

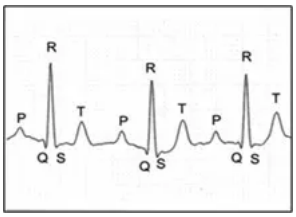
Other data that may help to make the diagnosis:

- Clinical condition, medications in use, previous electrocardiograms and other tests already made.

1. Rhythm

In a normal electrocardiogram, the P-QRS-T cycles succeed in a habitual sequence and frequency. Rhythms originating from the sinus node, are the most commonly found. Sinus complex is a term that describes a heartbeat with normal sequence; i.e. that originates in the sinus node, which depolarizes the atrial myocardium, to next be transmitted into the atrioventricular node and spread through the interventricular conduction system, to promote the contraction of the ventricles, and finally end the cycle with the process of ventricular repolarization.

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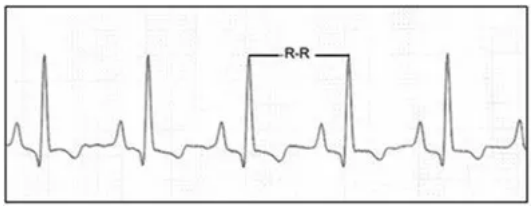
Any alteration in the normal pattern of relationship between P waves and QRS complexes is called arrhythmia

2. Heart rate

Heart rate is the number of beats per minute.

As rate is measured by minutes (60 seconds), and as every q corresponds to 0.02 seconds, we divide one value by the other = 60; 0.02 = 3,000.

Thus, if we divide the number of small squares (q) between the peaks of the two R waves (RR interval) by 3,000, we obtain the heart rate per minute.



In the example above, we divided 3,000 by 20q. Then, the rate is 150 beats per minute.

Normal heart rate in dogs

Because of the variability of heart rate in dogs, we should take into account the variations of the autonomic stimulus in the sinus node, particularly the adrenergic action at which the patient should undergo the evaluation. There is no consensus on the range of normality for the heart rate of dogs because of the great variation between the bibliographical references in veterinary medicine. We have observed rates from 70 to 160 beats per minute (bpm) in adult dogs, considering that in small breeds

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(toys), the rate could reach 180 bpm. In puppies, a rate of up to 220 bpm is considered normal.

Normal heart rate in cats

In cats, heart rate variability related to the variations in the autonomic nervous (sympathovagal) system are more accentuated than in dogs; mainly because of the stress this species suffers while evaluated. Just as with dogs, there is no consensus about the range of normality of heart rate in cats. A rate between 160 and 240 bpm is considered normal in healthy cats.

3. Mean electrical axis

We should always include the determination of the mean QRS axis in the frontal plane in the electrocardiogram analysis, because of its clinical significance. The correlation between cardiac axis shifts and cardiac diseases such as hypertrophies, overloads and conduction system disorders, is worthy of consideration. In the heart of a normal dog, the expectation is for the mean QRS axis in the frontal plane to be between 40° and 100°.

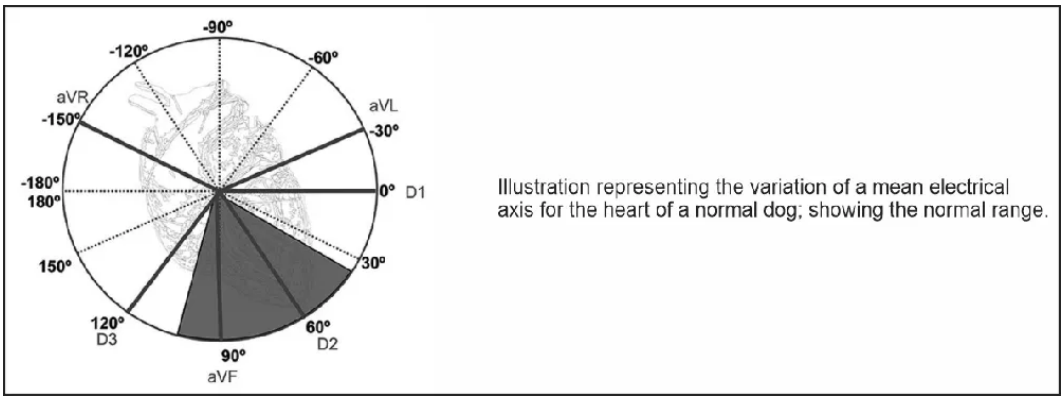


Illustration representing the variation of a mean electrical axis for the heart of a normal dog; showing the normal range.

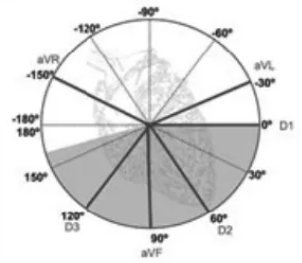
The chest shape of some breeds of dogs may influence the mean QRS electrical axis:

- Breeds that have a narrower chest (German shepherd, poodle, collie) tend to have a more vertical heart, with deviation of the cardiac axis to the right.

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- Breeds that have a wider chest (boxer, cocker spaniel) tend to have a more horizontal heart, with deviation of the cardiac axis to the left.
- The exceptions are the dachshund, which has a wide chest and may present axis deviation to the right; and the spitz, which has a narrow thorax and may present axis deviation to the left.

In the heart of a normal cat, the expectation is for the mean QRS axis in the frontal plane to be between 0° and 160°.



Variation of a mean electrical axis for the heart of a normal cat.

The chest shape of cats (the difference is too small) does not influence the mean QRS electrical axis.

4. P wave

It represents atrial depolarization. Its duration indicates the time it takes the impulse to get from the sinus node to the atrioventricular node.

Duration and amplitude of normal P wave in dogs:

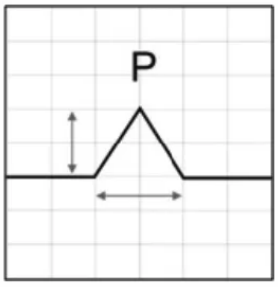


Maximum duration 40 ms (2q)

Maximum amplitude 0.4 mv (4q)

Duration and amplitude of normal P wave in cats:

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Maximum duration 40 ms (2q)

Maximum amplitude 0.2 mv (2q)

5. PR interval

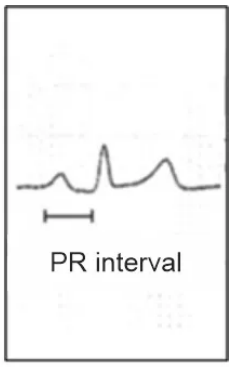
This interval represents the time it takes the impulse to spread from the sinus node to the first depolarized ventricular fiber. The PR interval is measured from the onset of P wave inscription until the onset of the first wave of the QRS complex (whether the Q or the R waves).

The normal PR interval in small animals varies:



60 ms to 130 ms (3 to 6.5q), for dogs

50 ms to 90 ms (2.5 to 4.5q), for cats



PR segment: It is a segment inscribed at the end of the P wave until the onset of the QRS complex and that should be leveled with the baseline of the tracing.



Although rare, depressions (PR segments inscribed below the baseline) or elevations (PR segments inscribed above the baseline) may occur.

6. QRS complex

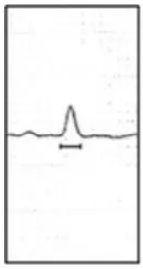
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The QRS complex represents the total period of time of ventricular depolarization, and it should be considered not just in terms of duration and morphology, but also the individual analysis of the waves that constitute it. Normal QRS complex duration for cats and dogs:



Dogs
Up to 10 kg = up to 55 ms (2.75 q)
More than 10kg = up to 70ms (3.5q)

Cats
Maximum of 40 ms



Amplitude: we should always take into account the cardiac and extra-cardiac condition (obesity, edema, effusions, among others) before analyzing the amplitude of QRS complex waves.

R wave = R wave amplitude in the QRS complex for dogs, measured in the frontal plane, should not go beyond:



2.5 mv (25q) in small breed dogs

0.9 mv (9q) in cats



S waves (in dogs) = the amplitude of S wave in the QRS complex for a normal dog varies in leads:



QRS complex in lead D2, showing S wave

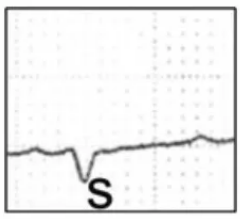
D1 = up to 0.05 mv (1/2q)
D2 = up to 0.35 mv (3.5q)
V2 = up to 0.8 mv (8q)
V4 = up to 0.7 mv (7q)

Q wave (in dogs) = the amplitude of Q waves in the QRS complex for a normal dog should not exceed 0.5 mv (5q) in leads D1, D2, D3 and aVF.



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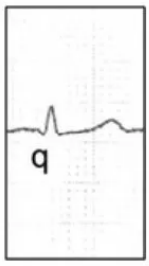
S waves (in cats) = the amplitude of S waves in the QRS complex for a normal cat should not exceed:



QRS complex in lead D1. S wave is shown in the box.

0.5 mv (5q) in D1, D2, D3 and aVF</p>
0.7 mv (7q) in V2 and V4to 130 ms (3 to 6.5q), for dogs

Q wave (in cats) = although the values of Q wave amplitude in the QRS complex for a normal cat have not been established yet, we believe they should not exceed 0.5 mv (5q) in leads D1 and aVL.



QRS complex in lead aVF. q wave shown in the box.

7. ST segment

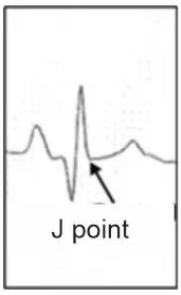
It represents the early phase of ventricular repolarization (considered a period of slow repolarization). The ST segment starts in the J point (or junctional point) that is at the end of the QRS complex inscription and ends with the first deflection of T wave (though the limits of the latter are not always well defined).

It is expected that in all leads (frontal and horizontal plane), this segment should be isoelectric or discretely concave or convex. The isolated duration of this segment is not determined. Although the isolated duration of ST segment is not determined, its measure should be inserted in the estimation of the Q-T interval.

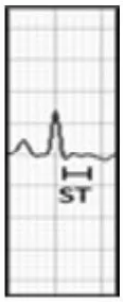
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Small ST segment shifts, called depressions (below the baseline) or elevations (above the baseline) are acceptable; but within certain limits. ST segment depression (or ST depression) should not exceed 0.2 mv (2q) in any lead; while ST segment elevation (or ST elevation) should not exceed:



0.15 mv (1.5q) in the frontal leads
0.2 mv (2q) in the precordial leads

In cats, both ST segment elevations and depressions should not exceed 0.1 mv (1q) in D2.

8. T wave

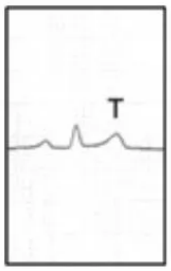
It represents ventricular repolarization proper. T wave inscription is more delayed than QRS because in physiological conditions of repolarization, it is a slower process than depolarization.

Duration: just as with ST segment, T wave duration is not determined in isolation, but linked to the estimation of the QT interval.

Amplitude: there are no defined criteria, but the standard for T wave in dogs is that it should be relatively less than the QRS complex.

Another valuable criterion is that T wave amplitude should not exceed 25% of the largest deflection of this complex. According to some authors, its amplitude should not reach 0.5 to 1 mv in any lead.

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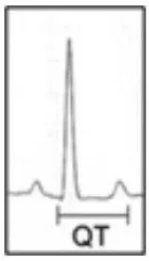
In cats, T wave rarely exceeds 0.3 mv (3q)

Morphology: T wave in small animals could be positive, negative or biphasic.



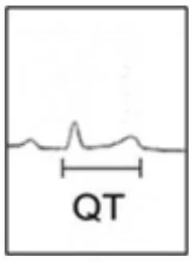
9. QT interval

The QT interval is measured from the onset of the QRS complex until the end of T wave, and it corresponds to ventricular depolarization plus repolarization.



In dogs, a normal QT interval is expected to be between 0.15 and 0.25 sec (7.5 to 12.5q)

In cats, a normal QT interval is expected to be between 0.12 and 0.18 sec (6 to 9q)



CASES

CASE 01: Tracing of a 6-year-old mongrel, weighing 25 kg. He has a history of normal body mass index and presents only clinical signs of chronic dermopathies and decrease in the red blood cell count in hemogram.



1) What is the main suspicion, considering that the dog is not dyspneic and has no heart disease?

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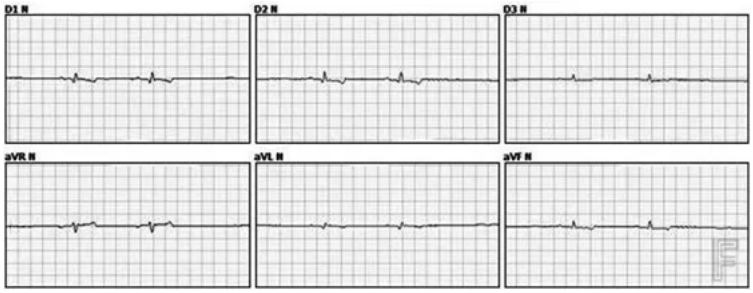
2) What additional test may help to make the diagnosis?

CASE 02: Tracing (in D2) of a 7-year-old Poodle, that presents hyperthermia and bronchopneumonia in chest X-rays.



1) What is the rhythm and heart rate in this tracing? How can we estimate it, knowing that the R-R distance (line) is 150 ms (15q)?
2) Are P waves within normality, taking into consideration that their duration is 40 ms (2q) and amplitude 0.5 mv (5q)?

CASE 01:



1) Asymptomatic dogs with this electrocardiographic pattern and that do not present signs of (pleural or pericardial) effusions should be suspected of being hypothyroid, a condition responsible for the symptom of myxedema. In these cases, QRS complexes appear with low voltage in all leads. Moreover, rhythm tends to bradycardia (in this tracing the heart rate is 90 bpm) that is also a strong indication of this endocrinopathy.
2) The most appropriate additional test is the measurement of thyroid hormones, that in this case were decreased.

CASE 02:



1) The tracing presents sinus tachycardia with heart rate of 200 bpm, a relatively common finding in dogs in a feverish state. Heart rate was

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estimated dividing 3,000 by 15 (q) = distances between R waves, thus reaching a value of 200 bpm.

2) P waves appear in spikes and with increased amplitude, a condition that, in addition to being observed in sinus tachycardia, is often found in pneumopathies.

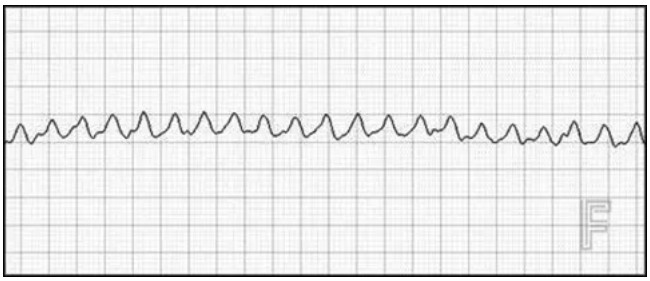
CASE 03: Tracings (in D2) of the same patient: an 8-year-old, female schnauzer that presents episodes of syncopes.



1) What is the base rhythm in this dog?

2) What is the usually related disease?

CASE 04: Tracing (in D2) of a 5-year-old Boxer with symptoms of pleural effusion, dyspnea and cyanosis.



1) What rhythm can we see in this tracing?

2) What would be the evolution of this arrhythmia, and what can we do to attempt reverting these symptoms?

CASE 03:

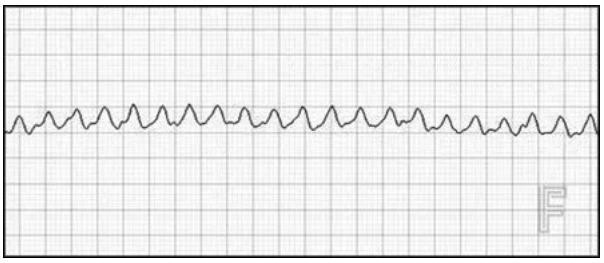


1) Brady-tachy syndrome. They are episodes of sinus bradycardia interspersed with sinus tachycardia or supraventricular tachycardia runs.

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2) Sinus node disease is the main cause. It is worth emphasizing that this arrhythmia is usually found in middle-aged female Schnauzer dogs.

CASE 04:



1) We observe ventricular flutter, characterized by morphological modification of QRS complexes, to the point that they fuse with T waves, showing a single, wide and bizarre wave, assuming an aspect of sine wave, similar to a bell. The rate is rapid and P waves are not visualized, as they are concealed in QRS complexes.
2) Ventricular flutter that evolved quickly into ventricular fibrillation. The indicated procedure is using a cardioverter defibrillator. IV lidocaine is also an option.

CASE 05: Tracing (in D2) of a 7-year-old Boxer and asymptomatic.



1) Is a PR interval of 160 ms (8q) within normality?
2) What conduction disorder is related to this finding and what drugs should be avoided to sedate (or as preanesthetic medication) this patient?

CASE 06: Tracing (in D2) of a preoperative test in a 7-year-old mongrel with no symptoms.



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1) Which is the rhythm in this tracing?
2) Analyzing and comparing the duration of the PR intervals in all QRS complexes in this tracing, what is the conclusion we may draw?

CASE 05:



1) The PR interval (line) is above normality.
2) 1st degree atrioventricular block is the electrocardiographic diagnosis. In this cases, it is contraindicated to use alpha-adrenergic agonists (such as xylazine, medetomidine and dexmedetomidine, among others), as they act directly on the atrioventricular junction, making the passage of stimulus difficult and thus exacerbating the block.

CASE 06:



1) It is a sinus arrhythmia, that is an irregular sinus rhythm, caused by an irregularity in the depolarization of the cells that generate sinus node impulse, characterized by an oscillation in the inscription of cycles, with a variation of more than 10% between R-R distances.
2) The PR intervals of the two first QRS complexes are within the pattern of normality. The PR interval of the third QRS complex (line) is increased (180 ms or 9q), indicating that in this impulse there is 1st degree atrioventricular block. However, the intervals of the two last QRS complexes return once again to their normal duration. The diagnosis of this tracing is intermittent 1st degree atrioventricular block.

CASE 07: Tracings (in D2) of a 10-year-old mongrel. Preoperative test.

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1) What do the P waves indicated by arrow represent?
2) Why the P wave in tracing No. 2 is not followed by a QRS complex? What is the differential diagnosis?

CASE 08: Tracing (in D2) of 8-year-old Boxer, that presented arrhythmia in cardiac auscultation.



1) What arrhythmias can we identify in this tracing?

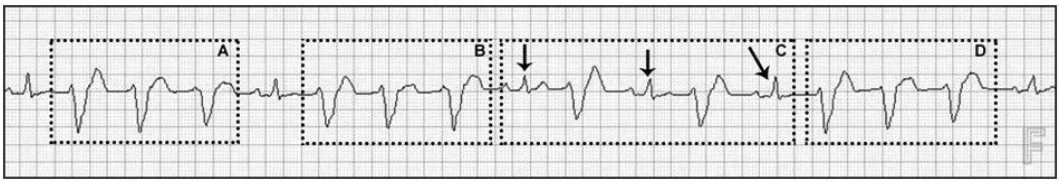
CASE 07:



1) Both are premature atrial contractions, distinguishable by P waves of early inscription and with morphology different from the other P waves observed in both tracings.
2) Because it is a non-conducted atrial extrasystole. In this case, there is no QRS complex inscription after the P wave (X), because of atrioventricular block, explained by His bundle branches still being in the refractory period. It could be confused with 2nd degree atrioventricular block, Mobitz type II, but this P wave is of a morphology different from the others in the tracing and is inscribed prematurely.

CASE 08:

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1) With rectangles A, B and D (indicated in the tracing), we observe premature ventricular contractions in runs. Within rectangle C, bigeminy is observed: sinus beats (arrows) interspersed with premature ventricular contractions. Because coupling intervals (*) are slightly different, the diagnosis of parasystole cannot be ruled out, which could be confirmed by a longer tracing or by 24 h Holter. (*) Coupling interval is defined as the time interval between the premature beat and the preceding beat.

CASE 09: Tracing (in D2) of a 6-year-old female Boxer, with clinical symptoms of dyspnea and apathy.



1) What arrhythmias are observed in this tracing?
2) Are the P waves (arrows) related to the QRS complexes that follow them?

CASE 10: Tracing (in D2) of a 10-year-old Yorkshire, with a weight of 2.5 kg, that presented clinical signs of nonproductive cough of the choking type, and murmur grade IV/VI in mitral focus during auscultation.



1) Knowing that the heart rate is 166 bpm, what is the rhythm of this tracing?
2) Is a P wave with 0.6 mv (6q) of amplitude within the boundaries of normality? What disease is most commonly associated to it, considering the breed and weight of this patient?

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3) Knowing that the amplitude of R wave is 2.5 mv, can we relate this finding to left ventricular enlargement?

CASE 09:



1) Due to the intermittent episodes (highlighted by the charts) and by presenting a heart rate of 136 bpm, it is compatible with an accelerated idioventricular rhythm.
2) P waves (arrows) that are inscribed before the ventricular ectopic complexes are not related to them; thus, the atria and ventricles are momentarily dissociated (even the P wave could be inscribed simultaneously as the ectopic complex, thus being concealed). We called this condition dissociation by usurpation.

CASE 10:



1) The rhythm is sinus, since in toy breeds the normal heart rate may reach 180 bpm.
2) The P wave is above its normal amplitude. This wave is called P pulmonale and a commonly associated condition in toy breeds is tracheal collapse. In this case, the patient presented in X-rays, intrathoracic tracheal collapse, at the level of the second intercostal space, confirming the suspicion.
3) In spite of the amplitude of the R wave being in the upper limit, this finding could be related to left ventricular enlargement, a comorbidity that was confirmed by echocardiogram.

CASE 11: Tracings (in D2) recorded in a 9-year-old pinscher.

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1) What arrhythmia is observed?

CASE 12: Tracing (in D2) recorded in a 12-year-old mongrel, evaluated before surgery.



1) What is the arrhythmia observed in this tracing?

CASE 11:



1) We are before atrial bigeminy; i.e., a rhythm where a premature atrial contraction is interspersed with QRS complex of sinus origin. The P waves (indicated) are of sinus origin; while the premature atrial contractions (P') –that are early p waves and with a morphology different from those of sinus origin- originate in an ectopic focus in the atrial myocardium.

CASE 12:



1) This is 2nd degree atrioventricular block, Mobitz type I. Also known as Wenckebach phenomenon, it is characterized by progressively

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longer PR intervals (lines) (in this case 152, 156 and 188 milliseconds), until a blocked P wave (arrow) appears. That is to say, not followed by a QRS complex. The next PR interval after the block (*) is once again shorter. This phenomenon is caused by decreasing conduction in the atrioventricular node region. This tracing even presents PR interval increase, already in the first beat of the Wenckebach cycle. Therefore, we can state that there is also 1st degree atrioventricular block associated.

CASE 13: Tracings (in D2) of a 10-year-old Fila, presenting clinical symptoms of gastric dilatation/volvulus.



1) What arrhythmias are present in this tracing, and how is it related to the clinical diagnosis presented?
2) How do we call the beat of sinus origin that is inscribed in the middle of such severe arrhythmia?

CASE 14: Tracing (in D2) of a 4-year-old Dalmatian, with no symptoms.



1) What rhythm is observed in this tracing?

2) Is there any arrhythmia in this particular tracing? If so, describe its clinical implication.

CASE 13:



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1) This is a rhythm of ventricular tachycardia with frequency of 180 bpm; an arrhythmia usually observed in dogs with gastric dilatation/volvulus and triggered by reduction in cardiac output and by hypoxia (shock). This alteration usually occurs between 12 and 36 hours after myocardial aggression caused by this condition.

2) We called it capture beat (arrows); i.e., it represents a stimulus of sinus origin (P wave with sufficient distance from the following QRS complex, to conduct the stimulus until the ventricles) that finds the ventricles outside their refractory period, depolarizing them normally. There is also a pseudo 1st degree atrioventricular block (line), that appears because of a retrograde concealed conduction in AV junction.

CASE 14:



1) This is a migrating pacemaker; a rhythm characterized by escape beats with many atrial foci, represented by positive, isoelectric and negative P waves (shown in the tracing) in every cardiac cycle, meaning that there is an inconstant site of impulse formation (sinoatrial node, regions of atrial myocardium and AV junction). The tracing also presents sinus arrhythmia, characterized by variation of more than 0% of PP distances.
2) A migrating pacemaker is a variation of sinus rhythm found in normal dogs. Sinus arrhythmia could also be found in healthy dogs and may even be related to the respiratory cycle proper.

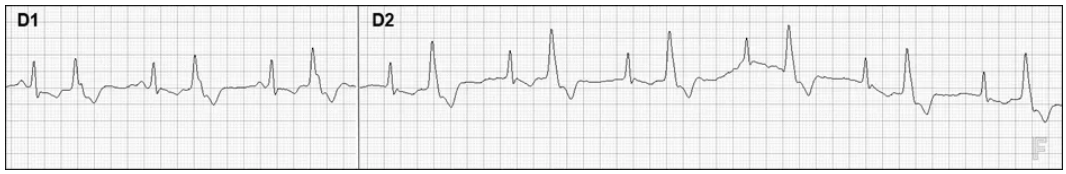
CASE 15: Tracing (in D2) of a 12-year-old Shih Tzu, that presented symptoms of dyspnea and intolerance to exercise. Cardiac imaging tests appeared normal.



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1) What arrhythmia is observed in this tracing?
2) What is the differential electrocardiographic diagnosis?

CASE 16: Tracings (leads D1 and D2 recorded simultaneously) of an 11-year-old female pinscher, weighing 1 kg and presenting ascites in the clinical examination.



1) What is the rhythm in the tracings, knowing that the electrical axis of the P wave is at -30 degrees and the electrical axis of QRS between 30 and 60 degrees?
2) A P wave with 60 ms (3q) of duration and only observed in D1, is usually related to what anomaly?

CASE 15:



1) Fascicular tachycardia is the rhythm in this tracing, that may occur in structurally normal hearts, using one of the left branch fascicles as an integrating part of the reentry circuit.
2) Supraventricular tachycardia is the differential diagnosis. This closeness to the normal conduction pathways of the heart provides the formation of a narrow QRS complex, leading to diagnostic confusion with supraventricular tachycardias, which do not present dissociated P waves (arrows), as in this tracing.

CASE 16:



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1) It is ventricular bigeminy, with the ectopic focus of origin in the right ventricle, due to the ectopic complexes (E) presenting positive polarity in lead D2. We do not observe P waves in D2, precisely because its electrical axis is shifted (to -30°); and therefore, this wave is isoelectric.
2) A P wave with its duration increased (observed in D1) is a strong indication of left atrial enlargement or interatrial conduction disorders.

CASE 17: Tracing (in D2) of a preoperative test in an 11-year-old Pit Bull and with no clinical symptoms.



1) What is the difference between P wave No. 1 and P wave No. 2?

CASE 18: Tracing (in D2) of a 7-year-old Persian cat and under general anesthesia with thiopental.



1) What arrhythmia appears in this tracing?
2) Does it present any relation to the drug used?

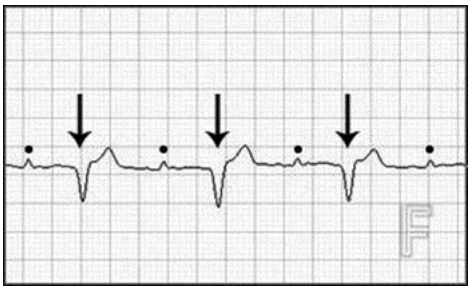
CASE 17:



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1) P wave No. 1 (immediately following premature ventricular contraction = arrow) is an atrial escape beat, since it is a delayed atrial beat and with a different morphology from other P waves in the tracing. P wave No. 2 is a beat of sinus origin, representing atrial contraction, but unrelated to the following premature ventricular contraction (point) meaning that temporarily there is no relation between the atrial contraction and the ventricular contraction.

CASE 18:



1) This is ventricular bigeminy, characterized by sinus beats (points), intercalated with premature ventricular contractions (arrows).
2) Yes. It is an arrhythmia that could be observed during anesthetic maintenance with thiopental.

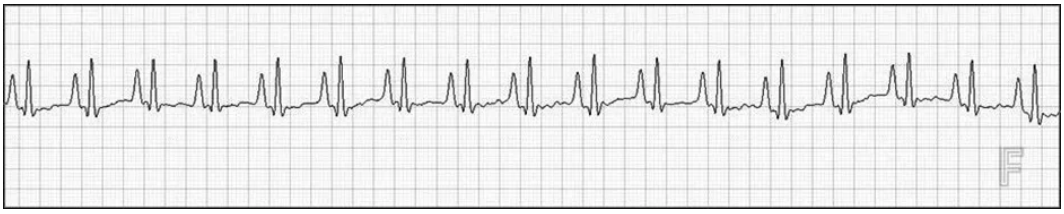
CASE 19: Tracing (in D2) of a 6-month-old female mixed-breed cat, with a weight of 2.5 kg. Preanesthetic evaluation. The animal appeared agitated during the test.



1) What is the rhythm in this tracing?
2) Imaging tests (chest X-rays and echocardiogram) showed that the heart was normal. Given this information, what is the cause for the presence of this rhythm?

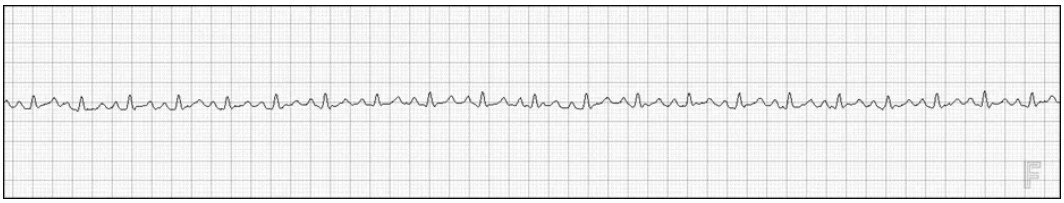
CASE 20: Tracing (in D2) of a 10-year-old Maltese and clinical symptoms of cough and dyspnea.

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1) What is the rhythm observed in this tracing?
2) Knowing that the duration of the P wave is 50 ms (2.5q) and its amplitude 0.70 mv (7q), can we state that they are within the boundaries of normality?
3) To what are these electrocardiographic findings related?

CASE 19:



1) This is a rhythm of sinus tachycardia with heart rate of 250 bpm.
2) Sinus tachycardia is the most frequent arrhythmia in cats, and it could be caused by the physiological response to fear, anxiety, excitement, manipulation, physical exercise or pain.

CASE 20:



1) It is a rhythm of sinus tachycardia with heart rate of 206 bpm.
2) The P waves of this tracing exceed the boundaries of normality, both in duration and amplitude (enhanced at the right).
3) The increase in its duration is related to left atrial enlargement, while the increase in its amplitude is related to right atrial enlargement. Therefore, in this case, we are before biatrial enlargement, confirmed by an echocardiogram.

CASE 21: Tracing (in D2) of a 13-year-old Cocker Spaniel. Presurgical evaluation.

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1) How many (and what) arrhythmias are observed in this tracing?

CASE 22: Tracing (in D2) of a 9-year-old Rottweiler and symptoms of dyspnea and pericardial effusion observed in echocardiogram.



1) What type of arrhythmia appears in this tracing?
2) Is there a relationship between the variation of amplitude of waves and the disease of the patient?

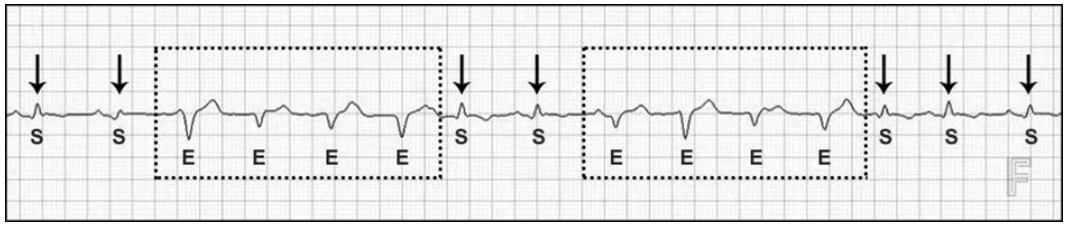
CASE 21:



1) R-R distance variation (of more than 10% = between R waves peaks) between the three first sinus complexes (and also between the 4th, 5th and 6th complexes) shows a base rhythm of sinus arrhythmia. However, between the 3rd and 4th QRS complexes there is a pause (twice the RR distance observed in the previous complexes), suggesting that there was sinoatrial block. Blocked P wave (arrow) represents 2nd degree atrioventricular block, Mobitz type II.

CASE 22:

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1) The tracing presents nonsustained ventricular tachycardia runs (indicated by the rectangles). The complexes of sinus origin are indicated by arrows.
2) Electrical alternation of waves (associated to a low amplitude), are findings highly suggestive of pericardial effusion. Nevertheless, in this patient in particular, electrical alternans is observed not just in the QRS complexes of sinus origin (S), but also in the beats of ectopic origin (E).

CASE 23: Tracing of a 6-month-old female Boxer. Preanesthetic test. Healthy animal.



1) What is the rhythm observed in this tracing?
2) Why are P waves difficult to be visualized?

CASE 24: Tracing (in D2) of a 15-year-old Dachshund with clinical signs of cough of the choking type and intolerance to exercise.



1) What can we state about a P wave and a PR interval with 60 ms (3q) and 140 ms (7q) duration respectively, observed in this tracing?
2) What is the relationship between these findings and the most common cardiac alterations in dogs of this breed?

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CASE 23:



1) It is a sinus arrhythmia with heart rate ranging from 103 and 130 bpm. This rhythm is frequently observed in brachycephalic dogs, secondary to the increase in vagal tone they present.
2) P waves of low voltage (arrows) and difficult to be visualized in the frontal plane leads, is a particularity that can occur in dogs of this breed. To see them better, a recording of at least one precordial lead is suggested in the left hemithorax or with 2N amplitude.

CASE 24:



1) P wave has increased duration, indicating left atrial enlargement. Equally increased is the PR interval duration, indicating 1st degree atrioventricular block (enhanced).
2) Dogs of the Dachshund breed presenting left atrial enlargement, usually are compromised by mitral valve endocardiosis. The dogs of this breed may also, as age advances, suffer a degeneration in atrioventricular node conduction, increasing PR interval duration.

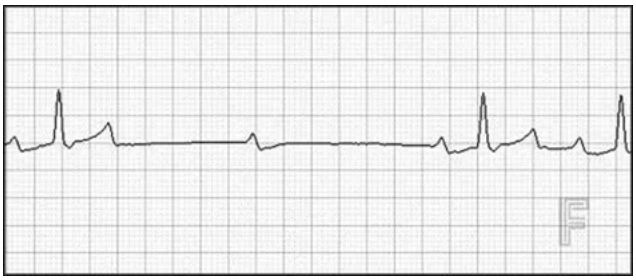
CASE 25: Tracing of a 10-year-old mongrel with no symptoms.



1) What alterations can we observe in this tracing?

CASE 26: Tracing of an 8-year-old Boxer.

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1) What are the electrocardiographic alterations observed in this tracing, knowing that the PR intervals present a 160 ms duration (8q)?

CASE 25:



1) Complete or 3rd degree atrioventricular block is observed. This condition occurs when all stimuli from the sinus node are blocked. There is atrioventricular dissociation, a situation where P waves are not related and there is no cause-effect relationship with ventricular beats, which by the way, are ventricular escape beats. These preserve the heart from asystole, as no stimulus of sinus origin is conducted by the atrioventricular node. The atria are activated by the sinus node and the ventricles by foci originating from its own muscles.

CASE 26:



1) This is a 1st degree atrioventricular block, represented by increase in PR interval (indicated by the line), associated to 2nd degree atrioventricular block (arrow). It is precipitated to classify as Mobitz type I or II, as in this tracing there is only one heartbeat that precedes it, thus requiring a longer tracing or a 24-hour Holter to evaluate it better.

CASE 27: Tracing (in D2) of a 7-year-old mongrel.

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1) What is the main suspicion based only on the duration of QRS complex that is 90 ms (4.5q)?
2) What arrhythmias can we also observe?

CASE 28: Tracing (in D2) that appears in the screen of a cardiac monitor, before the administration of preanesthetic medication in a 15-year-old, asymptomatic cat.



1) What is the main suspicion based only in the duration of the QRS complex, that is 80 ms (4q)?
2) Any restriction in the preanesthetic management?

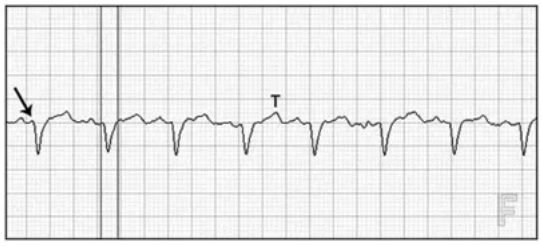
CASE 27:



1) In spite of presenting only the recording of D2 (and not all frontal plane leads, as it should be), this is a right bundle branch block. QRS complexes that exceed 80 ms (4q), mainly when their final portions are wider, associated to ventricular repolarization alterations (T waves polarity that are opposed to the two QRS complexes) and also with predominance of a negative area in D2, is a very common finding in this conduction disorder.
2) Additionally, there is also sinus arrhythmia (variation of more than 10% of the R-R distances) and even two sinus pauses (lines), indicating that the sinus node did not depolarize at the time.

CASE 28:

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1) Even observing just lead D2, we can verify QRS complexes exceeding 80 ms (4q) –mainly when its final portion is wider (check that there is a small initial r wave = arrow)- that associated to ventricular repolarization alteration (T waves polarity that opposes the two QRS complexes) and even with predominance of a negative area in D2, is a strong indication of right bundle branch block.
2) If this was an elective procedure, it would be ideal to rule out a heart disease (by performing an echocardiogram) before applying preanesthetic medication. It is important to take into consideration that right bundle branch block may also be found in healthy cats.

CASE 29: Tracing (in D2) of a 10-year-old Boxer.



1) What arrhythmias can we observe in this tracing? PR interval with 160 ms (8q) and QRS complex duration 90 ms (4.5q).

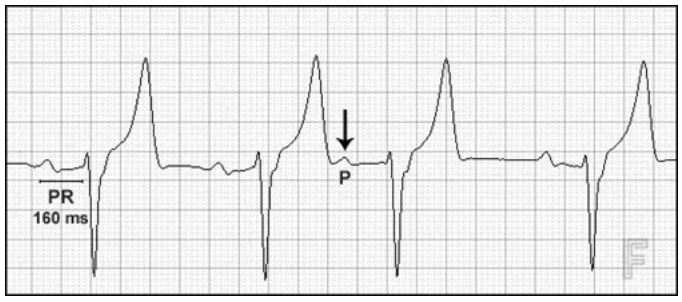
CASE 30: Tracing (in D2) of a 6-year-old Poodle.



1) What arrhythmias can we observe in this tracing, knowing that the PR intervals present with 160 ms (8q) of duration?
2) Could they be related to a disease? Which one?

CASE 29:

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1) 1) The increase in duration (line) of the PR interval shows that there is 1st degree atrioventricular block. The third P wave (arrow) is a premature atrial contraction (as it is of early inscription and with a morphology different from the previous ones in the tracing), and presents a slower conduction while it goes through the atrioventricular node, increasing the PR interval even more. Additionally, a QRS complex exceeding 80 ms (4q), mainly when it is wider in its final portion, associated to ventricular repolarization alteration (tall T waves and with polarity opposed to the QRS complex) is compatible with right bundle branch block.

CASE 30:



1) This is 2:1 sinoatrial block; i.e. there are 2 beats of sinus origin (arrows) for a sinoatrial block (pause indicated by the line). In this pause, there should be a complex of sinus origin; but the sinus node did not depolarize (dysfunction of its automatism) or if it did depolarize, the stimulus was not conducted by the atrial myocardium (conduction disorder).
2) In the case the sinus node did depolarize, we could be before sinus node dysfunction.

CASE 31: Tracing (in D2) of a 10-year-old Poodle.

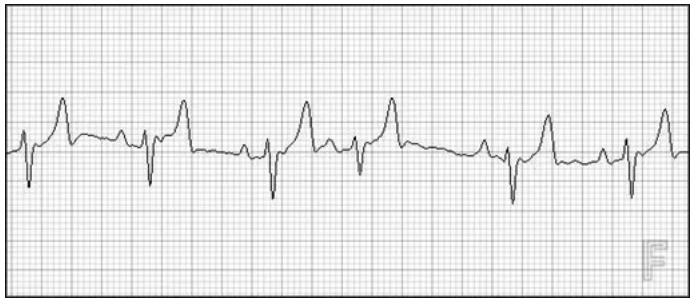


1) What is the base rhythm in this tracing?

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2) What arrhythmia can we see in the P wave indicated by the arrow?

CASE 32: Tracing (in D2) of an 11-year-old Lhasa Apso.



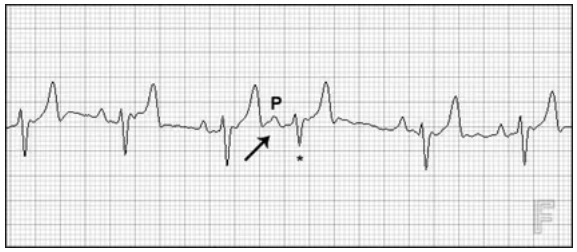
1) What is the base rhythm in this tracing?
2) The rhythm is interrupted momentarily by what arrhythmia?

CASE 31:



1) It is a sinus rhythm with mean heart rate of 150 bpm.
2) It is atrial escape beat, distinguished by P wave (arrow) of late inscription (check time indication) and morphology different from the others. Besides, the atrial ectopy was in the atrioventricular node (as it is not followed by a QRS complex), indicating that this escape beat is followed by 2nd degree atrioventricular block, Mobitz type II, since the PR intervals (lines) that precede it are constant in their duration.

CASE 32:



1) It is sinus rhythm with a rate of 150 bpm.
2) It is interrupted by premature atrial contraction conducted with aberrancy. The P wave (arrow) is of early inscription and morphology different from the others in the tracing; but the QRS complex after it presents a morphology (*) different from the others

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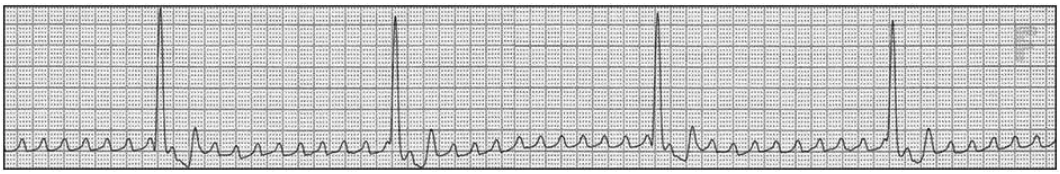
in the tracing, corresponding to the stimulus conducted with aberrancy through the His bundle, because their right and left branches will be in different refractory states.

CASE 33: Tracing (in D2) of a 7-year-old German Shepherd.



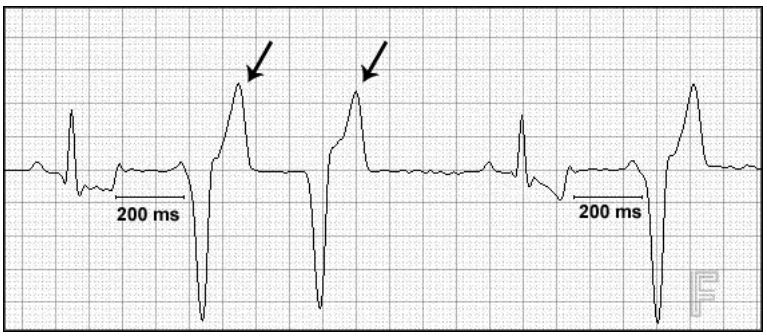
1) What are the three ectopic complexes and how can we classify them?

CASE 34: Tracing (in D2) of a 14-year-old Poodle, with diagnosis of chronic mitral valve disease and history of apathy and syncopes.



1) What is the rhythm of this tracing?
2) Is it a frequently observed rhythm in routine clinical practice?
3) What other arrhythmias are present in this tracing?

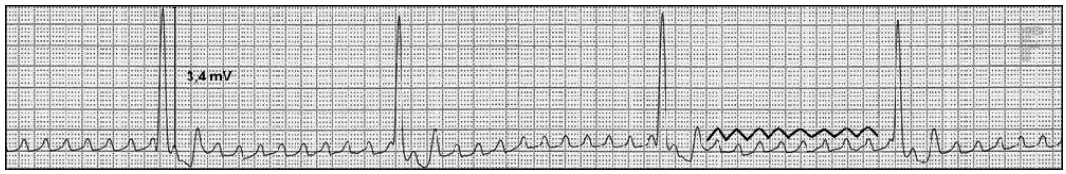
CASE 33:



1) All are monomorphic premature ventricular contractions (same morphology), originating a single ectopic focus (see lines with the same duration as the coupling interval) in the left ventricle, because its polarity is negative in D2. The two first ones are classified as coupled premature contractions (arrows) because they are inscribed successively (two consecutive premature ventricular contractions).

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CASE 34:



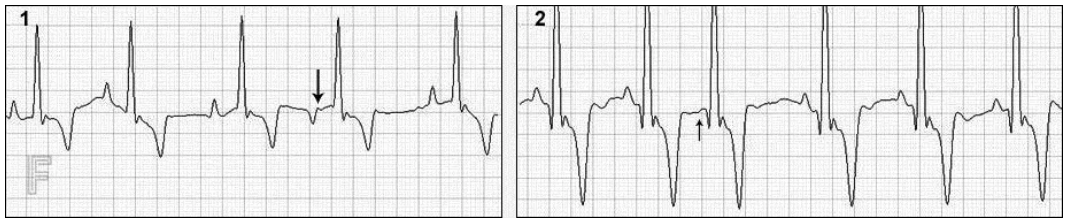
1) This is an atrial flutter, an arrhythmia presenting waves with appearance of "sawtooth" (indicated in the tracing) between the QRS complexes; preventing us from observing the baseline. These are typical waves (mixture of ectopic atrial waves and atrial repolarization waves) at a rate of 460 bpm and caused by the reentry phenomenon, that could be observed in atrial volume overloads.
2) On the contrary, it is rare in clinical practice because it is an arrhythmia that tends to evolve quickly into atrial fibrillation.
3) The tracing also shows complete atrioventricular block and idioventricular rhythm (rhythm of substitution); the latter characterized by slow and regular ventricular depolarizations.

CASE 35: Tracing in D2 of a 6-year-old Boxer with no symptoms.



1) How can we classify the arrhythmia in this tracing?
2) Based on this breed, is there a diagnostic hypothesis?
3) How can we reach a more accurate diagnosis and consequently evaluate the severity and the prognosis of this patient?

CASE 36: Tracings of two different patients, both recorded in D2.



1) What is the similarity of the two beats (identified by arrows) and what is the explanation about how they occur?

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CASE 35:



1) The ectopic complex (arrow) is an isolated premature ventricular contraction. As its polarity is positive in D2, the ectopic focus is located in the right atrium.
2) The diagnostic hypothesis is arrhythmogenic right ventricular dysplasia, a pathology where cardiomyocytes are substituted by fibrofatty tissue, generating arrhythmias.
3) Ambulatory electrocardiogram (Holter), echocardiogram and magnetic resonance are the most indicated additional tests for this patient.

CASE 36:



1) 1) Both are supraventricular extrasystoles. In tracing n° 1, there is a premature P wave and of negative polarity (indicating propagation of the wavefront from bottom to top), suggesting that it is a low atrial extrasystole, because the PR interval is the same as the rest of the same tracing. While in tracing n°2, it is a junctional extrasystole, because there is no visible P wave, as it is superimposed on the QRS complex (the speed of propagation of the anterograde impulse is equal to the retrograde one), and also observe the shortening of the R-R distance (marking) and the morphology of the QRS complex, which is not bizarre and is even identical to the others in the tracing (indicating that the ventricular myocardium is being depolarized by a stimulus of supraventricular origin).

CASE 37: Tracings of two different patients, both recorded in D2.

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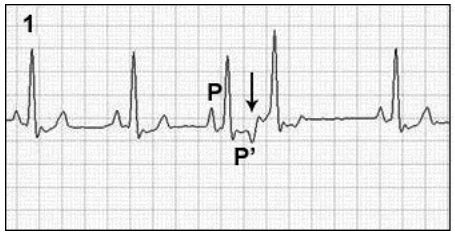
1) What is the similarity between the arrhythmias of the two tracings?

CASE 38: Tracing (in D2) of a 4-year-old basset hound.



1) What is the base rhythm of this tracing, knowing that the mean axis of the P wave is between 0 and -30 degrees and the QRS axis at 60 degrees?
2) There are two large pauses in this tracing. What happens during them?
3) Can we consider these notches in the QRS complexes as normal?

CASE 37:

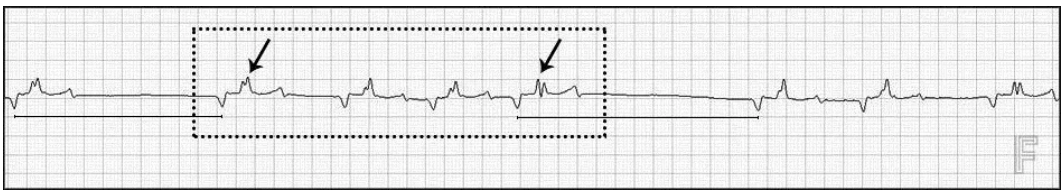




1) Both are supraventricular extrasystoles conducted with aberrancy. The impulse is conducted to the ventricles, but finds the branches (right and left) of the bundle of His in different refractory states, which causes these QRS complexes (of early inscription) to have a slightly different (but not bizarre) morphology of the other QRS complexes in the tracing. The difference between them is that in tracing n°1, there is a negative P' wave (arrow) that precedes it, of probable low atrial origin, and in tracing n°2 there is an extrasystole of junctional origin, where the P wave is invisible (*), superimposed on the QRS complex (reflex of the equality of the propagation speed of the impulse - anterograde and retrograde - in the AV junction).

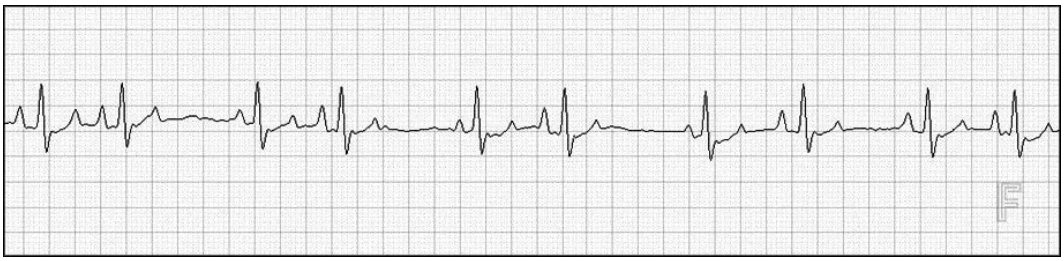
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CASE 38:



1) This is a sinus arrhythmia (observed in the rectangle). It could be very easily confused with a rhythm of junctional origin; however, as there is P wave axis shift, in this case a negative wave is expected in D2.
2) As the large pauses are followed by P waves of the same morphology as those in the base rhythm, there is sinus arrest on these occasions (lines).
3) Notches in the QRS complexes may not be a sign of a severe anomaly. Anyway, when we identify a QRS with RR' pattern (arrows), we could be before left bundle branch block.

CASE 39: Tracing (in D2) of a 9-year-old Poodle. Preoperative test.



1) What arrhythmia can we see in this tracing?
2) This arrhythmia could be confused with what other arrhythmia?

CASE 40: Tracing (in D2) of an 8-year-old Maltese, presenting left ventricular diameter increase in echocardiogram.



1) A q wave with 0.8 mv (8q) is within the limits of normality? What could this mean?
2) Is ST segment shifted? What disease could we be facing?

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3) Is there a relationship between the alterations found in echocardiogram and in the ST segment?

CASE 39:



1) The P waves (asterisk) are atrial escape beats = P waves inscribed after the sinus pauses and with a configuration different from the other P waves of the tracing (P). The portion indicated could be confused with atrial bigeminy (box), if we didn't see (and compare) the other P waves of the tracing (*). A tracing analyzed from left to right (as it should be done always) helps us understand the sequence of events. It is significant to observe that there is difference in the duration of PR intervals (markings).

CASE 40:



1) Q waves (arrows) greater than 0.5 mv (5q) in D2, indicate septal hypertrophy.
2) The ST segment of 0.5 mv (5q) is considered depressed (longer arrows) and above the limits of normality, indicating myocardial ischemia.
3) Always when there is left ventricular enlargement, there could also be myocardial infarction. This condition increases intramural tension, altering systolic pressure (by compression) of the coronary arteries, reducing its flow and rendering it incapable to satisfy the metabolic needs of the myocardium. A chronic coronary artery disease should be considered in this case.

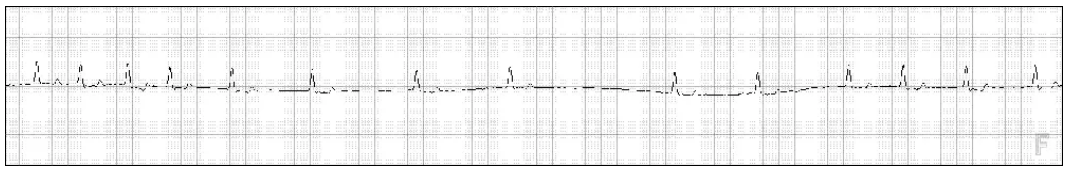
CASE 41: Tracing (in D2) of an 8-year-old Collie, presenting splenic neoplasm.

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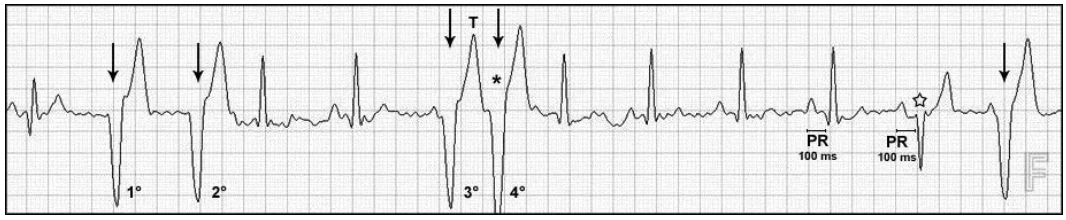
1) How can we classify the several premature ventricular contractions present in this tracing?
2) Is there a relationship with the existing disease in this patient?

CASE 42: Tracing (in D2) of a 6-year-old female Poodle, with 7 kg of weight, and no history. Test received by telemedicine.



1) What is the rhythm in this tracing?

CASE 41:



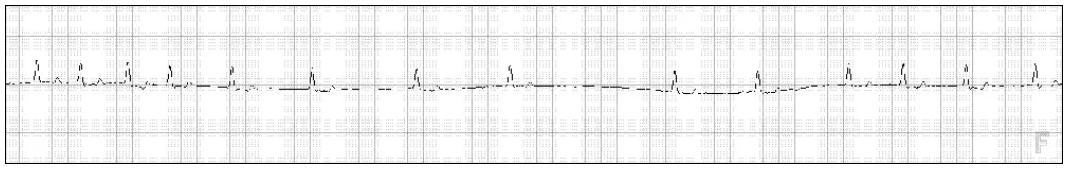
1) All of them are premature ventricular contractions (arrows), classified as unifocal, because the ectopic complexes have equal configurations, which means they originate in the same focus in the left ventricle (negative polarities in D2). The two first (1st and 2nd) are coupled. The third and the fourth ones are also coupled; however, the one identified with an asterisk (*) is too premature, thus overlapping onto the T wave of the previous ectopic complex, a potentially dangerous phenomenon as it may trigger more complex arrhythmias. The ectopic complex (indicated by a star), is in fact a fusion beat. This could be confused as coming from another focus (because of its different morphology), if the PR intervals (lines) were not equal to the sinus beats of the tracing. We should not rule out

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too, the possibility of parasystole, as there are variable couplings. Longer tracings could confirm the suspicion.

2) Yes, splenic neoplasms are significant sources for ventricular arrhythmias.

CASE 42:



1) Atrial fibrillation is the rhythm in the tracing, with its electrocardiographic characteristics; namely, the absence of P waves associated to rhythm irregularity. There is low ventricular response in the center of the tracing, subsequent to intrinsic atrioventricular conduction dysfunction.

CASE 43: Two tracings of the same patient and recorded simultaneously (number 1 in lead D3 and number 2 in lead aVL), in a 5-year-old mongrel. Presurgical evaluation.



1) How can we classify the morphology of the QRS complex (arrow) in these tracings? What is the hemodynamic implication?

2) What events occur during the pause observed?

CASE 44: Tracing (in D2) of a 12-year-old mongrel, with a weight of 11 kg.

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1) What is the rhythm of this tracing?
2) A P wave with 60 ms (3q) of duration and 0.5 mv (5q) of amplitude, is within the boundaries of normality?

CASE 43:



1) The notches in the QRS complexes (RR' pattern in D3 and W shape in aVL) indicate that the stimulus finds some difficulties to spread through the cardiac conduction system. We should suspect of first-degree bundle branch block (intermittent) when faced with this finding.
2) There is atrial escape beat (a delayed P wave inscribed and with an outline different from the rest, identified with an asterisk), that is not conducted to the ventricles due to 2nd degree atrioventricular block, Mobitz type II.

CASE 44:



1) We are before a 2nd degree atrioventricular block of the Wenckebach type. The irregularity of the R-R distances should indicate that there are some P waves that are being conducted, with AV intervals increasing progressively and other blocked P waves. It is possible to see P waves (enhanced) above the boundaries of normality (duration and amplitude), suggesting biatrial enlargement.

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CASE 45: Tracing (in D2) of an 8-year-old mixed Poodle, weighing 10 kg and evaluated before surgery. The patient was agitated during the test.



1) Knowing that the mean heart rate of this tracing is 170 bpm, what is the rhythm observed and with what it could be related?
2) In spite of the P wave being within the limits of normality, what can we say about its morphology?

CASE 46: Tracing (in D2) of a 10-year-old Poodle. The patient is a carrier of chronic mitral valve disease, and class C heart failure (ACVIM Classification, 2017).



1) The tracing is interrupted by a pause, because of what arrhythmia?
2) A PR interval with a duration of 160 ms (8q) and a P wave with duration of 60 ms (6q) could be related to what?

CASE 45:



1) This is a rhythm of sinus tachycardia, which could be related to a physiological response to fear, anxiety, excitement, manipulation, physical exercise or pain, or even be a sign of heart disease.

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2) A P wave shaped like a peak (but within normality in terms of amplitude) could be a normal finding in sinus tachycardias.

CASE 46:



1) A significant pause followed by inscription of P wave with morphology different from the others of the base rhythm, entails atrial escape beat (*). It occurs as a consequence of a failure in the generation or conduction of the sinus node impulse. Thus, momentarily, the cardiac activity is assumed by the atrial myocardium.
2) A PR interval of longer duration (line) is related to 1st degree atrioventricular block. The P wave presents an increased duration, suggesting left atrial enlargement.

CASE 47: Tracing (in D2) of an 8-year-old Belgian Shepherd. Presurgical evaluation.



1) What is the arrhythmia observed in this tracing?
2) Should we avoid using a particular drug in this case?

CASE 48: Tracing (in D2) of a 17-year-old mongrel.



1) What arrhythmias are observed in this tracing? The PR interval duration is 160 ms (8q).

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CASE 47:



1) There is quite pronounced 1st degree atrioventricular block (line), with PR interval of 200 ms (10q) of duration.
2) We should avoid using alpha-adrenergic agonists (such as xylazine, metedomidine and dexmedetomidine, among others) in this patient, as they act directly on the cardiac conduction pathway, making it difficult for the passage of the stimulus from the atria to the ventricles and thus exacerbating this block.

CASE 48:



1) Besides the 1st degree atrioventricular block (increase in PR interval duration = line), polymorphic premature contractions are observed in the left ventricle (arrows). Also, there is atrial escape beat (AEB) characterized by P wave with a morphology different from the others and with late inscription.

CASE 49: Tracing (in D2) of a 12-year-old Cocker Spaniel, presenting cardiomyopathy.



1) What arrhythmias do we observe in this tracing?

CASE 50: Three tracings (in D2) of the same patient: 6-year-old Boxer.

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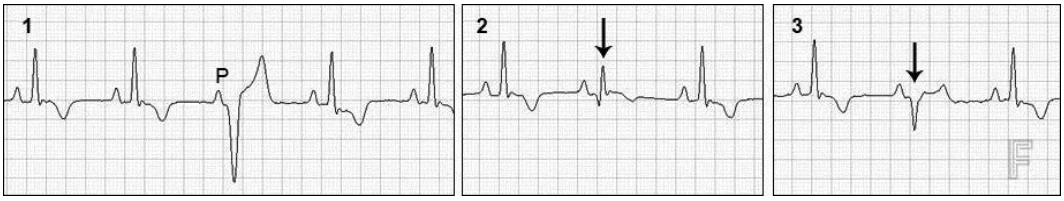
1) How can we identify the ectopic complex in tracing 1?
2) What do the ectopic complexes (arrows) in tracings 2 and 3 have in common? What is the reason they present different morphologies?

CASE 49:



1) There is a premature contraction originating in the left ventricle (arrow), another originating in the right ventricle (*), and also a fusion beat (first arrow); the latter indicating that the ventricles are being activated simultaneously by two stimuli = one originating in an ectopic focus, and another originating in the sinus node (for this reason this ectopic complex has a different –intermediate- morphology than the other ectopic complexes). Also, there is a junctional premature contraction (star), distinguished by presenting QRS complex with a configuration equal to the previous ones; however, of early inscription and not preceded by P wave.

CASE 50:

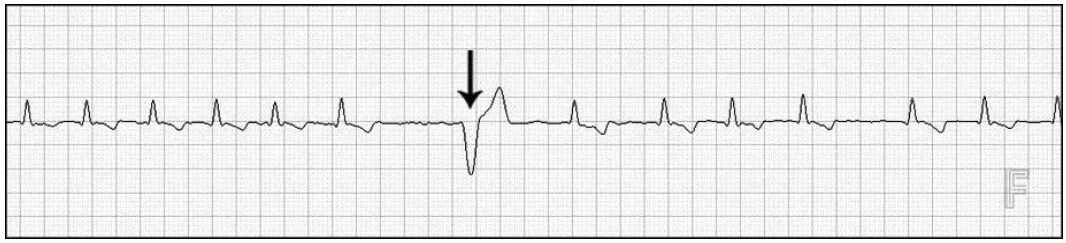


1) This is a premature ventricular contraction, since the beat is premature and bizarre. It originates in the left ventricular myocardium (negative polarity in D2). The preceding P wave (P) is not related to it; being, therefore, the atria and the ventricles are momentarily dissociated. We call this condition dissociation by usurpation.
2) Both are fusion beats, which occur due to the simultaneous trigger of two foci (one of sinus origin, another of ectopic origin), each of them

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activating a ventricular chamber region. Complexes with intermediate or mixed morphologies are inscribed, due to the collision of two wavefronts. Morphology variation is related to the myocardial area (mass) that each focus gets to activate at that moment.

CASE 51: Tracing (in D2) of a 12-year-old Poodle and diagnosis of chronic mitral valve disease.



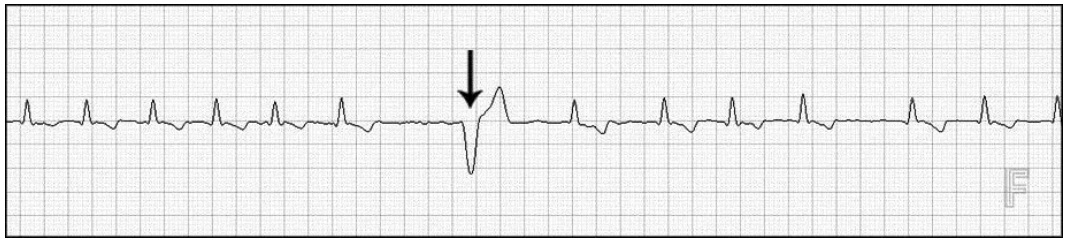
1) What is the rhythm of this tracing?
2) How can we classify the complex identified by an arrow?

CASE 52: Tracing (in D2) of a 3-year-old Cocker Spaniel, presenting clinical symptoms of apathy.



1) What arrhythmias are observed in this tracing?

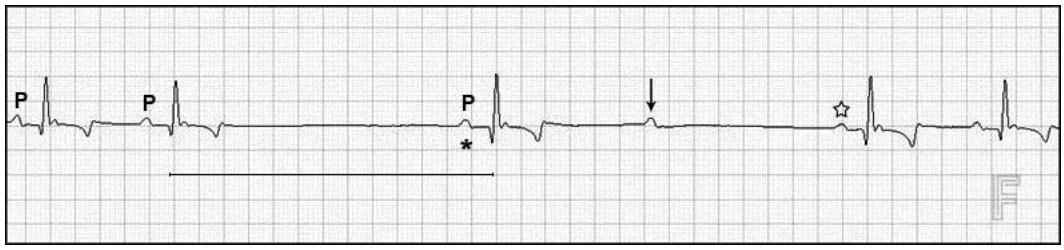
CASE 51:



1) We observe an irregular rhythm with variation in R-R distances, in association to absence of P waves, characteristic of atrial fibrillation.
2) It is a ventricular escape, that is an ectopic ventricular beat of late origin and presenting usually wider and bizarre.

CASE 52:

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1) In the indicated tracing there is sinus pause, characterized by presenting a long pause, followed by P wave inscription of the same morphology as the previous ones (*). The pause as a consequence of the impulse that is no longer generated by the sinus node, or if generated, is not conducted by the atrial myocardium. The pause observed is greater (or equal) to twice the R-R distance as the previous sinus beat. In the arrow, there is 2nd degree atrioventricular block, Mobitz type II, followed by another pause that ends with atrial escape (late P wave and with a morphology different from the others of the base rhythm), indicated by the star.

CASE 53: Tracing (in D2) of a 12-year-old Lhasa Apso. Presurgical evaluation.



1) The beats enumerated in 1, 2, 3 and 4, represent which arrhythmias?

CASE 54: Tracing of a 10-year-old Yorkshire Terrier, during routine evaluation.



1) What arrhythmias are observed in this tracing?
2) In what conditions could they be observed?

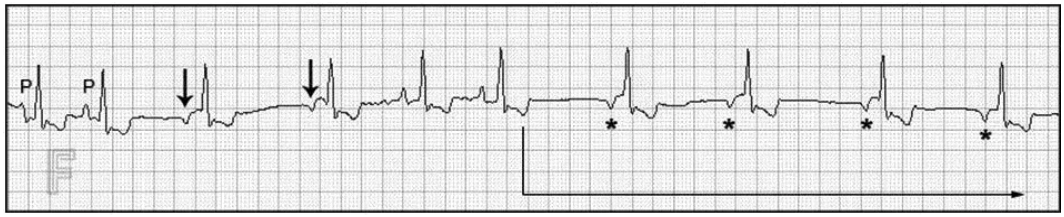
CASE 53:

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1) Number 1 and number 3 are atrial escape beats, characterized by P waves of late inscription and with morphology different from the previous ones. Check that the PR intervals durations are the same (100 ms = 5q) as the sinus complexes observed at the onset of the tracing. Number 2 is a premature atrial contraction; i.e. P wave of early inscription and of morphology different from the previous one. Number 4 is a junctional premature contraction, differentiated by QRS complex of configuration equal to the previous ones; however, of early inscription and not preceded by P wave.

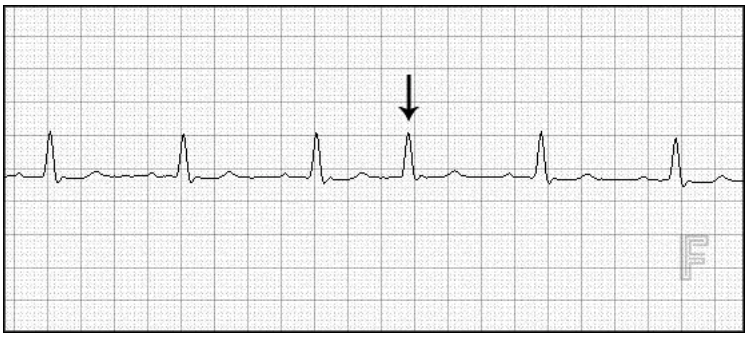
CASE 54:



1) The two first beats are complexes of sinus origin (P). The two following ones are escape beats of junctional origin (negative P waves (arrows) and presenting PR intervals of slightly shorter duration compared to the PR intervals of beats of sinus origin). Since the sixth complex (indicated in the tracing), junctional rhythm begins (junctional escape beats that repeat three or more times), identified by asterisks.
2) They can be observed in conditions that promote depression in sinus node automatism (because of senility or low right coronary artery irrigation) or conduction failures through the atrial myocardium, causing substitution or escape rhythms, making subsidiary pacemaker cells to trigger a spontaneous depolarization, substituting sinus node dominance.

CASE 55: Tracing (in D2) of a Birman cat. Presurgical evaluation.

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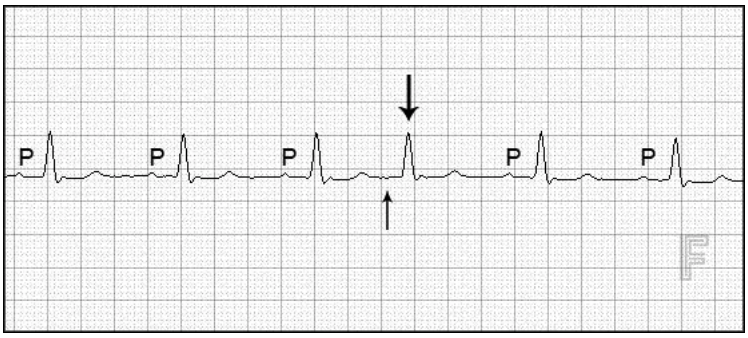
1) What is the rhythm of the tracing and what arrhythmia is identified by the arrow?

CASE 56: Tracing (in D2) of 15-year-old Poodle, with no symptoms.



1) The rhythm is interrupted by two pauses. What is the difference between what happens in each pause?

CASE 55:



1) The rhythm is sinus bradycardia, with heart rate of 150 bpm. The identified beat by the bigger arrow is a supraventricular extrasystole, characterized by being premature and configuration equal to the previous ones. The smaller arrow indicates the place where there could be a P wave, but due to the waves of cats presenting small amplitudes, it is difficult to confirm its inscription. Anyway, the premature ectopic activity originating in any cardiac region before the His bundle bivfurcation is called supraventricular extrasystole, a very appropriate term, as it covers the two types of presentation of supraventricular extrasystoles: atrial and junctional.

CASE 56:

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1) During the first pause, there is supraventricular escape (probably from the lower atrial region), identified by QRS complex with a configuration equal to the previous ones; however, of late inscription and preceded by negative P wave (arrow). In the second pause, the escape is atrial, identified also by QRS complex equal to the previous ones, and of late inscription (*); but in this case preceded by positive P wave and with morphology different from the previous ones.

CASE 57: Tracing (in D2) of a 7-year-old Boxer.



1) The rhythm is interrupted by two contiguous pauses; are they caused by the same phenomenon?
2) What is the state of atrioventricular conduction, knowing that the PR interval is 180 ms (9q)?

CASE 58: Tracing (in D2) of a 9-year-old Airedale Terrier.



1) What arrhythmia appears in the central part of this tracing?
2) Is a complex presenting R wave with more than 2.5 mv (25q) of amplitude in D2 a normal finding in dogs? What could it possibly be related to? Is it related to the arrhythmia?

CASE 57:

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1) No. The first pause of 1800 ms (90q) (that is to say, almost 2 seconds) caused an escape beat of junctional origin (QRS complex of configuration equal to the previous ones (arrow); however, of late inscription and with no presence of P wave). The second pause (of 1480 ms (74q); i.e. almost 1.5 seconds) triggered another escape beat; only this time of atrial origin (*) with P wave inscription of morphology different than the rest and late, also followed by QRS complex with a configuration equal to the previous ones.

1) Conduction presents a time greater than normal, indicating that there is concomitant 1st degree atrioventricular block (line).

CASE 58:



1) After the beat of sinus origin (P-QRS-T), there is an escape beat of ventricular origin inscribed (arrow). When these ectopic beats are repeated three or more times, we are before ventricular escape rhythm (in this case intermittent, highlighted in the box). This rhythm presents low depolarization rate, as it originates from the ventricular myocardium proper.

2) It is above the standards of normality, and it is usually accompanied by left ventricular enlargement. The arrhythmia observed may occur as a consequence of the aggression suffered by the cardiac muscle, because of the changes in the electrophysiological properties of its fibers, caused by volume increase and hypertrophy.

CASE 59: Tracing (in D2) of a 6-year-old Rottweiler in a state of toxemia.

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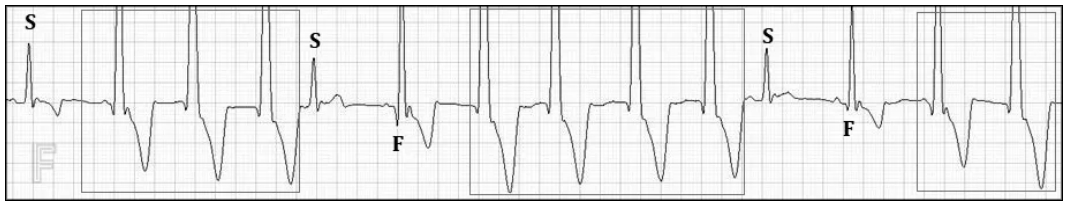
1) What arrhythmias can we identify in this tracing?
2) Do they present any relation to the symptoms of toxemia?

CASE 60: Tracing (in D2) of a 15-year-old mongrel. Presurgical evaluation.



1) Why is this rhythm irregular, even presenting two major pauses?
2) How can we call the beats inscribed after these pauses?

CASE 59:



1) Due to the non-sustained nature of the arrhythmia (shown by the markings), and also to the frequency of this ectopic rhythm being similar to that of sinus rhythm, it is an accelerated idioventricular rhythm. Also due to the fact that the coupling intervals are longer and that there are fusion beats (F), when this rhythm of substitution begins. Complexes identified with the letter S are of sinus origin.
2) Yes, systemic infections have repercussions on the myocardium and affect it, and they could trigger these arrhythmias.

CASE 60:



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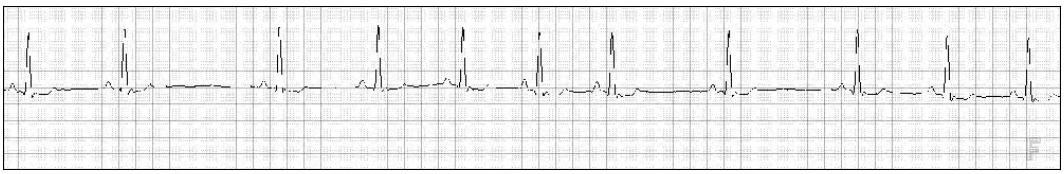
1) The rhythm is irregular, caused by sinus node dysfunction, characterized by electrophysiological disorders affecting the sinus node and its connections.
2) The two pauses observed (lines) foster the depolarization of ventricular escape beats (arrows), which are ectopic ventricular complexes, of late inscription and morphology different from other QRS complexes of the base rhythm. The morphological similarity between the complex of sinus origin and of ventricular origin is explained by the origin of the ventricular ectopic focus from the sites originating in the ventricular myocardium close to the bundle of His. In the second escape, there is concomitant inscription of P wave, but there is no relationship between them.

CASE 61: Tracing (in D2) of a 13-year-old Cocker Spaniel.



1) What arrhythmias do we observe in the QRS complexes indicated (*)?
2) How can we evaluate the left ventricle, knowing that R and Q waves amplitudes are 2.6 mv (26q) and 0.6 mv (6q) respectively?

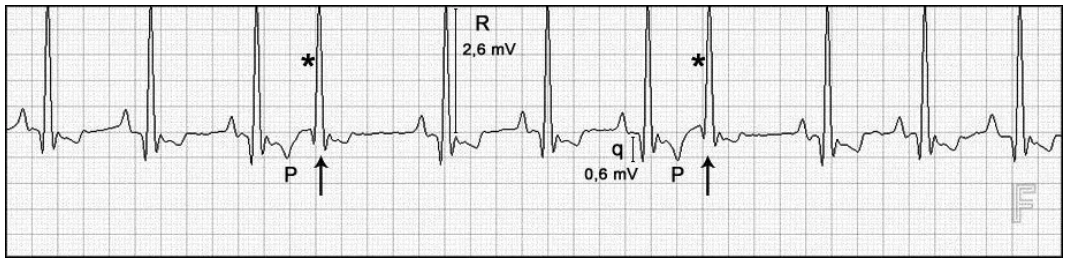
CASE 62: Tracing (in D2) of a 6-year-old female French Bulldog, weighing 17 kg. The animal was referred to the cardiology service because of the arrhythmia during auscultation in a routine test.



1) What is the rhythm of this tracing and why is it happening?

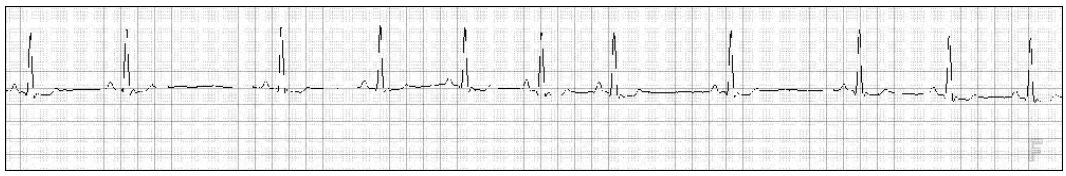
CASE 61:

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1) These are supraventricular extrasystoles with aberrant conduction. Is characterized by the early inscription of a negative P wave (P), that in this case fuses with the preceding T waves. Immediately after, QRS complexes are inscribed, very similar to those of the base rhythm. The aberrant conduction is shown by small deformities in these complexes (arrows); a consequence of the precocious impulse, being conducted in an anomalous way, due to finding the His bundle branches in different refractory periods. In fact, the aberration manifests only in the inscription of the first vector of the ventricular activation (low septum vector), altering only the Q wave of the QRS complex.
2) A QRS complex with increased R wave amplitude in D2 is compatible with left ventricular enlargement. The Q wave of amplitude above normality in D2 is usually found in septal hypertrophies.

CASE 62:



1) This is a sinus arrhythmia rhythm, secondary to a high vagal tone. This excessive parasympathetic stimulation is common during exhalation in healthy dogs; prominent in brachycephalic dogs and may also occur during rest or sleep.

CASE 63: Tracing (in D2) of a Fila, with no symptoms and presenting cardiac imaging tests with no alterations.

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1) What is the rhythm in this tracing?
2) What is its probable cause?

CASE 64: Tracing (in D2) of a Cocker Spaniel with diagnosis of mitral and tricuspid valves disease.



1) What is the rhythm of this tracing?
2) What is the relationship with the base disease?

CASE 63:



1) The irregular rhythm is atrial fibrillation, marked by the variations in R-R distances and associated to absence of P waves.
2) Not always the causes of atrial fibrillation are known. However, large or giant dogs may develop it spontaneously; i.e. in the absence of a base heart disease, being called lone atrial fibrillation in these cases.

CASE 64:

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1) This is atrial fibrillation, characterized by being an irregular rhythm, with variation in R-R distances associated to absence of P waves.
2) This is a frequent arrhythmia in dogs with severe heart diseases, as in chronic valve disease. It could be the consequence both of cardiac fibers stretching by chamber dilatation, as well as being caused by foci of fibrosis, ischemia, and other causes.

CASE 65: Tracing (in D2) of a 7-year-old great Dane with diagnosis of dilated cardiomyopathy.



1) What is the rhythm of this tracing?
2) Is this arrhythmia common in this disease?

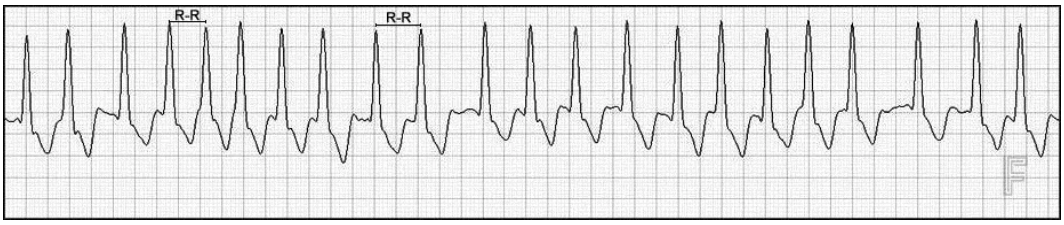
CASE 66: Tracing (in D2) of a 7-year-old Doberman, presenting cardiomyopathy. At the right, the same tracing enhanced.



1) What is the rhythm of this tracing?
2) Is a QRS complex with 80 ms (4q) of duration expected in this rhythm?

CASE 65:

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1) It is atrial fibrillation. Irregular rhythm where it is possible to see a variation in R-R distances, besides the absence of P waves in the tracing. The variation in R-R distances is due to the natural filtration of the atrioventricular junction, where numerous impulses "bomb" the atrioventricular node. Many are blocked and not conducted into the ventricles. There is concealed anterograde conduction, where impulses partially penetrate the AV junction, but they do not get to go through it; however, they interfere in the next beat, caused by the refractory state in the AV junction. It is a defense mechanism of the cardiac conduction system to protect the ventricles from high rates.
2) It is one of the most prevalent arrhythmias in dilated cardiomyopathy, a reflection of biatrial volume increase. There is loss of propulsive muscle motility in atrial fibers, with a group of them contracting independently and with the formation of multiple "fibrillation islets".

CASE 66:



1) Whenever there is a rapid and irregular rhythm, associated to absence of P waves, the first suspicion should always be atrial fibrillation rhythm.
2) In the rhythms of atrial origin, normally QRS complexes are narrow. However, in this case the QRS complexes are wider because of the left bundle branch block concomitant.

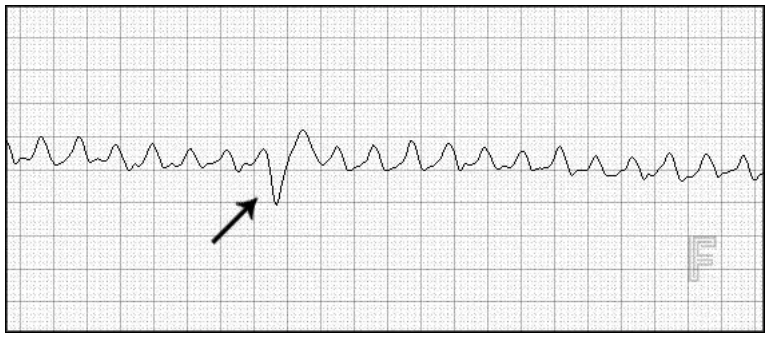
CASE 67: Tracing (in D2) of a 13-year-old Labrador.

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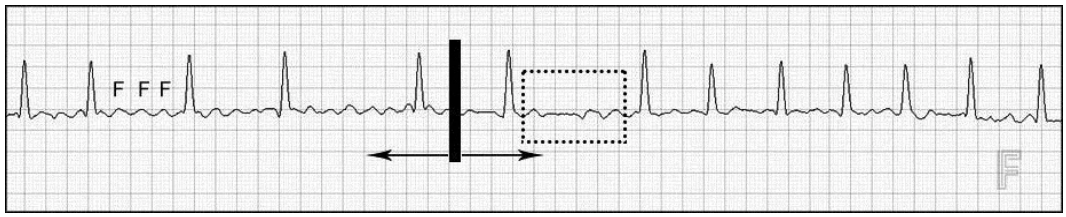
1) What is the rhythm in this tracing?

CASE 68: Tracing (in D3) of a 12-year-old mongrel with increase in potassium serum concentration.



1) What is the rhythm in this tracing?
2) How is the complex indicated by the arrow classified?

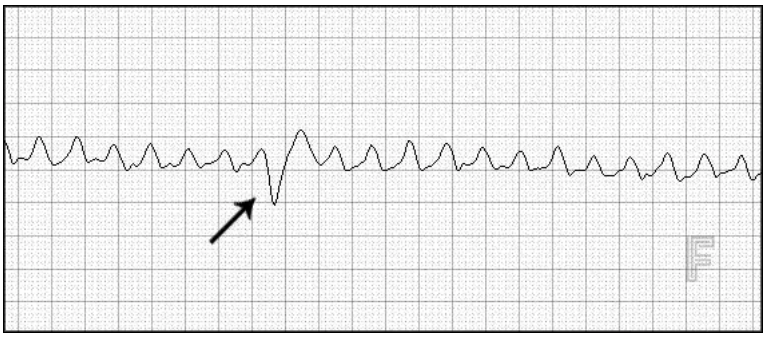
CASE 67:



1) This is a fibrillo-flutter. Irregular rhythm that presents episodes of atrial flutter and others of atrial fibrillation. We split the tracing in two parts to facilitate its interpretation. At the left of the division, it is possible to observe besides the variation in the R-R distances, waves with sawtooth appearance, characterizing an atrial flutter. At the right of the division, there is variation in R-R distances; however, without the presence of identifiable P waves, characteristics of atrial fibrillation. There is even a small stretch (rectangle) showing mixed forms (flutter waves and fibrillatory waves) between the QRS complexes.

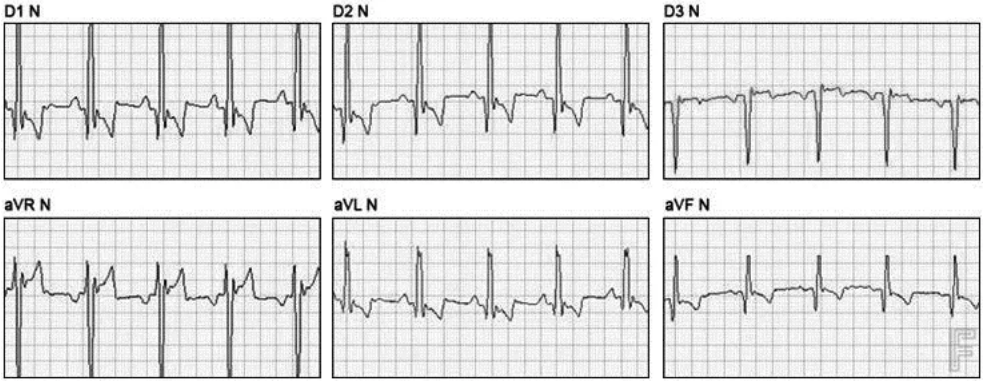
CASE 68:

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1) This is a ventricular flutter, a transition arrhythmia between tachycardia and ventricular fibrillation. There is a morphological modification of QRS/T, that fuse into a single, wide wave, with greater amplitude and that keep some degree of similarity to each other, assuming the aspect of a sine wave. P waves are not perceived, as they are concealed in these complexes.
2) It is an inscription that is related to a polymorphism that this arrhythmia can presents.

CASE 69: Tracing of an 8-year-old Pointer, with no symptoms.



1) What is the rhythm of the tracing?
2) What is the main suspicion after the analysis of the mean cardiac axis and the analyses of the waves amplitudes in the QRS complex? P wave in D1 with 60 ms (3q).

CASE 70: Tracing of an 8-year-old mongrel, with no symptoms.

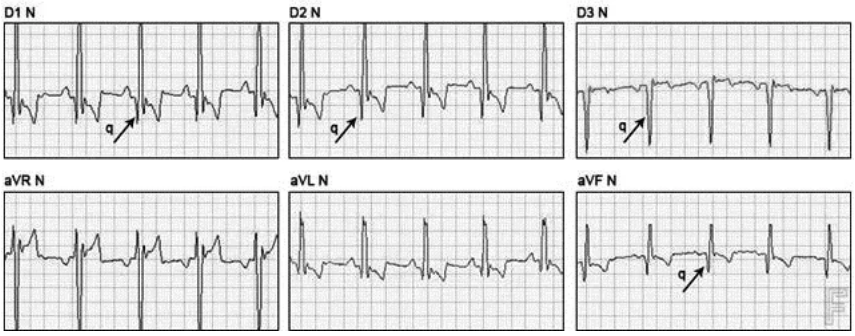


1) What is the rhythm of the tracing?

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2) What is the main suspicion after the analysis of the mean cardiac axis and of the wave's durations and amplitudes in the QRS complex?

CASE 69:



1) The rhythm is sinus with heart rate of 142 bpm.
2) Q waves of greater amplitude in D1, D2, D3 and aVF are highly suggestive of septal hypertrophy. The mean electrical axis of QRS is shifted to the left (from 0 to 30 degrees), a finding suggestive of left ventricular enlargement. A P wave with an increased duration indicates left atrial enlargement, an indirect sign that may occur when there is left ventricular enlargement.

CASE 70:



1) The rhythm is sinus arrhythmia with heart rate ranging from 120 to 150 bpm.
2) Q waves of greater amplitude in D1, D2, D3 and aVF are highly suggestive of septal hypertrophy. As the cardiac axis is shifted (from 90 to 120 degrees) to the right, there must be right hypertrophy in the interventricular septum, concomitant or not to right ventricular enlargement. Including, only the cardiac axis shift proper to the right, is a sign of right ventricular enlargement.

CASE 71: Tracing of a 7-year-old Siberian husky, weighing 20 kg and asymptomatic.

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1) What is the rhythm of the tracing?
2) Low voltage waves in several leads (maximum of 0.45 mv = 4.5q in D2) are normal findings in an electrocardiogram of a dog of this breed and weight?

CASE 72: Tracing (in D2) of a 13-year-old Poodle and diagnosis of mitral and tricuspid valves disease.



1) What is the relationship of a P wave with 60 ms (3q) of duration and 0.7 mv (7q) of amplitude, with the disease of the patient?
2) What can be said on the ST segment depression (0.4 mv = 4q), observed in this tracing?

CASE 71:

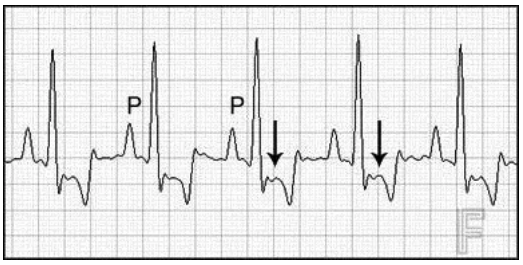


1) It is sinus arrhythmia with heart rate ranging from 115 to 142 bpm.
2) In any other breed, we could relate these waves of low voltage in all leads to symptoms of effusion (pleural and/or pericardial); or even to obesity. But we have observed this type of electrocardiographic pattern in dogs of this breed, with no disease associated. The main

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hypothesis of occurrence of this finding, would be the excess of fatty tissue accumulated in the pericardium, which occurs in these dogs coming from icy lands.

CASE 72:



1) A P wave that exceeds its limits (both in duration and amplitude) is highly suggestive of biatrial enlargement, which is usually secondary to volume enlargement provided by the regurgitation of atrioventricular valves, due to chronic mitral valve disease.
2) No, it is above the normal limits (arrows), therefore being, a strong indication of myocardial ischemia, an electrocardiographic finding relatively common in this breed.

CASE 73: Tracings (in D2) of a mongrel weighing 20 kg, during intoxication with amitraz (above) and one week later (below).



1) What electrocardiographic alterations did this patient present during the intoxication?

CASE 74: Tracing (in D2) of a 13-year-old mongrel, weighing 15 kg and with history of dry cough of the choking type for three months.

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1) How can we describe the morphology of P waves and what could this mean? P wave duration is 70 ms (3.5q).
2) A PR interval with 160 ms (8q) of duration, is within normality?
3) How to describe the beat marked with an asterisk and what is its relationship with the preceding P wave?

CASE 73:



1) Amitraz is an organophosphorus compound that may depress the cardiac conduction system in several ways. Nevertheless, the main alteration is 1st degree atrioventricular block (line). In this tracing, we also observe sinus pauses followed by atrial escape beats (*). A week after the intoxication, the rhythm turned into sinus arrhythmia and the PR interval returned to normality.

CASE 74:



1) P wave notches (arrows) are observed when there is asynchrony in the stimulus conduction between the right and the left atria. However, this finding should only be related to left atrial

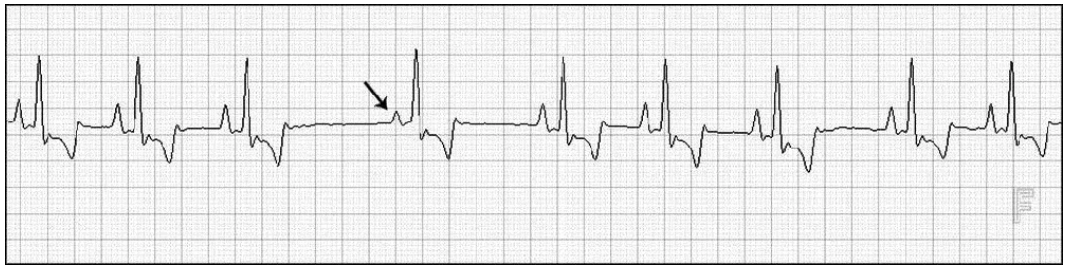
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enlargement if it is accompanied by increase in the duration of this wave, as in this tracing. This type of wave is called P "mitrale".

2) The PR interval (line) is above the duration expected, indicating that there is 1st degree atrioventricular block.

3) This is late premature ventricular contraction (telediastolic) originating in the left ventricle, as its polarity is negative in D2). There is no relation of this ectopy with the P wave preceding it. Before the extrasystole, there was a stimulus from the sinus node and the consequent inscription of a P wave. However, before this stimulus reached the ventricles, an ectopic focus appeared in the ventricular myocardium, characterized by a bizarre complex and with secondary changes in repolarization ventricular. The PR interval that precedes it has a different duration than the others on this tracing.

CASE 75: Tracing (in D2) of a 6-year-old Yorkshire, with clinical symptoms of pneumopathy.



1) What is the rhythm of the tracing?

2) Why is there a change in the morphology of P wave (arrow) in relation to the others?

3) What is the relationship of a P wave with 0.5 mv (5q) with the diagnosed disease?

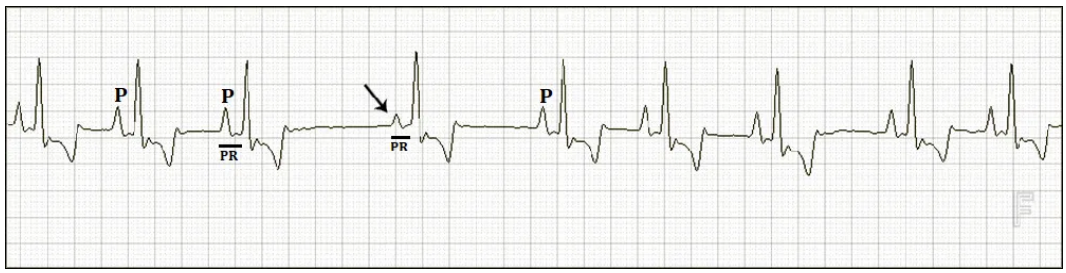
CASE 76: Tracing (in D3) of a 3-year-old Pinscher presenting acute pancreatitis.

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1) Is there a relationship of the rhythm of the tracing and of a QT interval with 260 ms (13q) with the condition of this patient?

CASE 75:



1) This is a sinus arrhythmia characterized by a variation of more than 10% in the R-R distances.
2) It is an atrial escape; i.e., characterized by P wave of late inscription and a morphology different than the others in the tracing (arrow), and its PR interval is shorter than the rest of the tracing, because it came from another site of the atrial myocardium.
3) P waves of high amplitude are called P pulmonale, because of their close relationship to pneumopathies.

CASE 76:

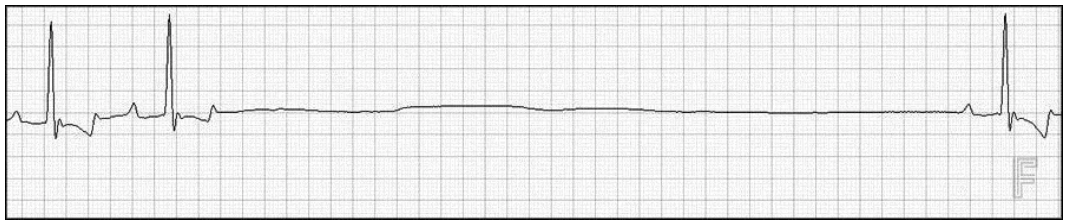


1) Heart rate is around 100 bpm (tending to sinus bradycardia, especially taking into account the breed and size of the dog); a finding that could be found in patients with pancreatitis, due to the

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release of a myocardium depressor factor, leading to a decrease in myocardial contractility and arrhythmias. The increased QT interval could be related to hypocalcemia, a type of electrolyte imbalance, that may also occur in this pathology.

CASE 77: Tracing (in D2), recorded from an 8-year-old Boxer with no symptoms.



1) What happened during this long pause with no inscription of any wave?
2) Is there any other interval measure that appears to be outside the standards of normality?

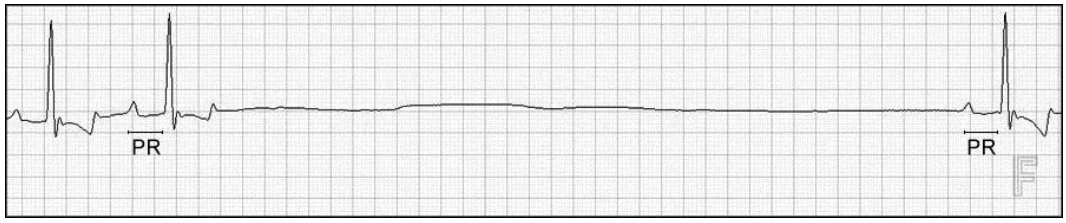
CASE 78: Tracing of a 12-year-old female mongrel weighing 5 kg. Clinical symptoms of discrete cough of the choking type. She also presents grade 3 murmur in auscultation and diagnosis of mitral valve degeneration, with discrete hemodynamic repercussion.



1) The R wave presents an amplitude of 2.5 mv (25q). Could this finding be a hint of left ventricular enlargement?
2) To what phenomenon do the waves identified by the arrows correspond?

CASE 77:

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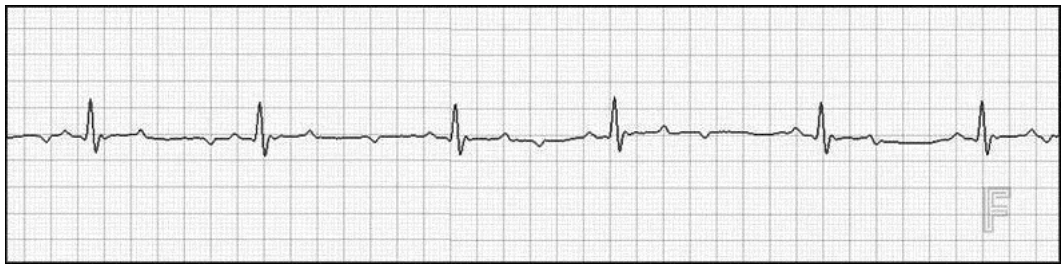
1) There is sinus arrest of 5 seconds, a scenario where there was no sinus node depolarization.
2) This patient also has increase in PR interval duration (180 ms = 9q), meaning there is 1st degree atrioventricular block, concomitant to sinus arrest, indicating that there is even conduction disorder (slowing down) in the atrioventricular node.

CASE 78:



1) In spite of R wave amplitude being at the edge of normality in this lead, we may suspect left ventricular enlargement.
2) These notches in the descending limb of the R wave are subsequent to microscopic intramural myocardial infarction, a reflection of diffuse myocardial microfibrosis. They are micro-infarctions in the branches of the intramural coronary arteries, near the papillary muscles of the left ventricle. The notches observed during the recording indicate a certain difficulty of the stimulus to spread into fibrous areas, a consequence of hyaline degeneration.

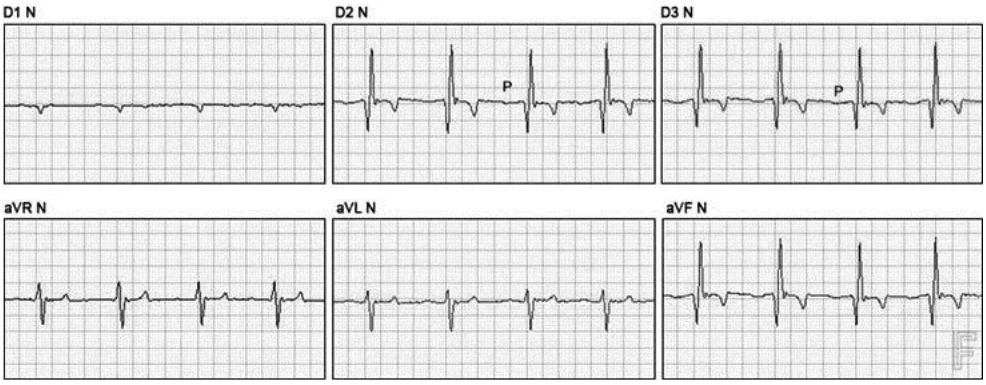
CASE 79: Tracing (in D2) of a 9-year-old mongrel (evaluated before undergoing anesthesia) and with no symptoms.



1) What is the rhythm of the tracing?

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CASE 80: Tracing of a 3-year-old German Shepherd evaluated to undergo anesthesia for elective surgery.



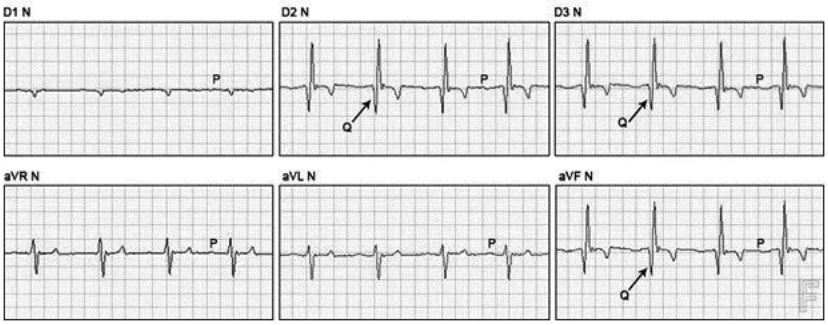
1) What is the rhythm of the tracing? P waves are identified; however, their voltage is low.
2) Is the presence of q waves in D2, D3 and aVF suggestive of a condition? Which one?
3) The cardiac axis is within the standards of normality?

CASE 79:



1) It is an interatrial dissociation, a condition where the two atria beat independently. The waves identified as P originate in the right atrium; while those identified as P' originate in the left atrium. These last shows great regularity, being triggered at a rate of 96 bpm.

CASE 80:



1) The rhythm is sinus with a heart rate of 125 bpm.
2) The presence of ample Q waves is a strong indication of septal hypertrophy, which could be, including related to hypertrophic cardiomyopathy. The clinical signs of this disease in this breed may

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vary from no symptoms, to heart failure, and even sudden cardiac death (even during the surgery).

3) The breeds of dogs that present a narrower chest (as German Shepherds) present a certain tendency to a more vertical heart, as in this example, where the mean QRS axis is close to 90 degrees.

CASE 81: Tracing (in D2) of a 9-year-old Labrador, that presented enlarged left ventricle in imaging diagnosis.



1) What is the rhythm of the tracing and what arrhythmia is observed in the 4th, 5th, and 6th heartbeats?
2) What could be the meaning of tall T wave (i.e., with amplitude greater than 25% of R wave) in this case?

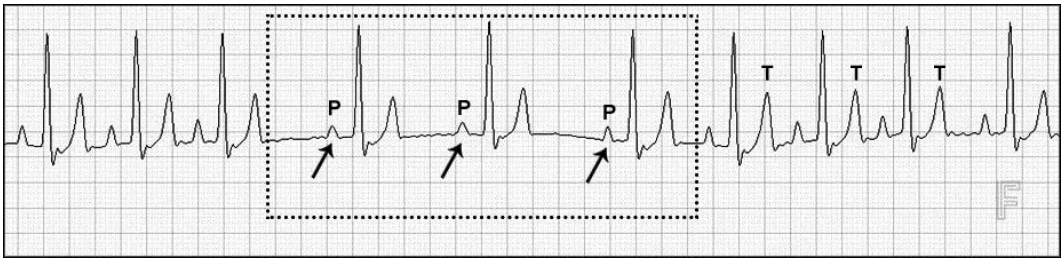
CASE 82: Tracing (in D2) of a 9-year-old mixed Pinscher, weighing 12 kg and presenting episodes of intense cough, not related to daily periods or physical exercises.



1) What is the rhythm of the tracing and what is the arrhythmia observed in the 5th, 6th and 7th heartbeats?
2) How can a P wave with 0.5 mv (5q) be related to the symptoms in this patient?

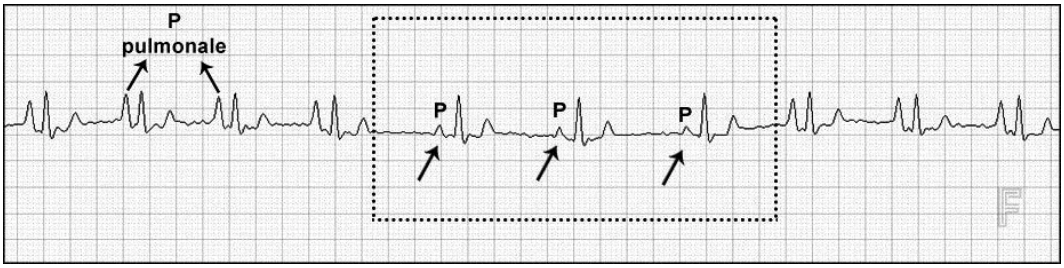
CASE 81:

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1) Sinus arrhythmia (mean heart rate of 150 bpm) is interrupted by three successive atrial escape beats (arrows), configuring an atrial escape rhythm. Check that in this small stretch (rectangle), the heart rate dropped to 110 bpm. When escape or substitution rhythm arises, the rate is always relatively inferior in comparison to the one under sinus node command.
2) Dogs presenting ventricular enlargement may display ventricular repolarization alterations, promoting increase in T wave amplitude.

CASE 82:



1) Sinus arrhythmia (with heart rate ranging from 150 to 166 bpm) is interrupted by three successive atrial escape beats (arrows) (called atrial escape rhythm). This substitution rhythm makes heart rate to drop to 119 bpm in this small stretch (rectangle). After this rhythm stops, the sinus node recovers its dominance, thus turning to sinus arrhythmia.
2) Dogs presenting tracheal collapse usually present P wave of amplitude greater than normal (called P pulmonale); suspected that were confirmed by chest X-ray.

CASE 83: Tracing (in D2) of a 6-year-old female Boxer, with no symptoms.

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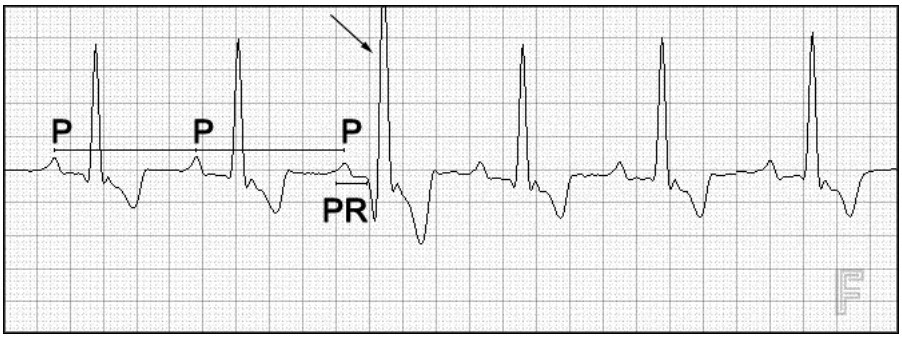
1) What arrhythmia is present in this tracing?
2) How can we classify it in terms of its precocity?

CASE 84: Tracing (in D2) of an 8-year-old Yorkshire presenting tachycardia in auscultation.



1) What arrhythmia can we see in this tracing?
2) Is there a relationship of this arrhythmia with the breed of this dog?

CASE 83:



1) This is premature ventricular contraction (arrow) originating in ectopic focus in the right ventricle (its polarity is positive in lead D2).
2) It is late premature ventricular contraction, also called telediastolic. The premature contraction arises after P wave of sinus origin; however, at this time, there is no cause-effect relationship between them, being momentarily dissociated. There is discrete shortening of R-R distance, associated to PR segment shortening (line) in relation to the other beats. Check also, that the distances between P waves (larger lines) do not change. We may say that this premature contraction "fell right in the middle" of the PR segment.

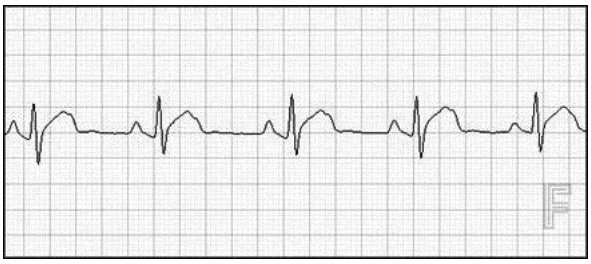
CASE 84:

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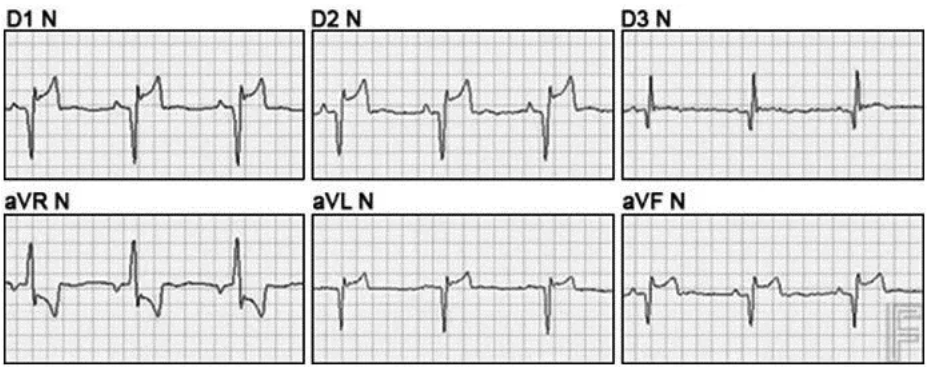
1) A tracing showing supraventricular tachycardia with the presence of a very short (or even absent) PR interval would lead us to think of ventricular pre-excitation (Low-Ganong-Levine syndrome). If a delta wave was not observed, it could be attributed to James' accessory pathways. But, as the anatomical substrate for this anomalous pathway has not yet been clearly established, there is no anatomical basis to prove this syndrome. Therefore, it could perfectly be a case of sinus tachycardia with accelerated atrioventricular conduction (accelerated AV conduction), which would be a variant of normality.
2) It is a relatively common finding observed in toy dogs, mainly in the yorkshire breed.

CASE 85: Tracing (in D2) of a Poodle with diagnosis of chronic mitral valve disease, left atrial enlargement and left ventricular hypertrophy, by echocardiogram.



1) What is the relationship of a P wave with 55 ms (2,75 q) of duration and ST segment/T wave morphology, with the findings in the echocardiogram?

CASE 86: Tracing of a 14-year-old Poodle, with no symptoms and evaluated before being bathed and buzzing his coat.

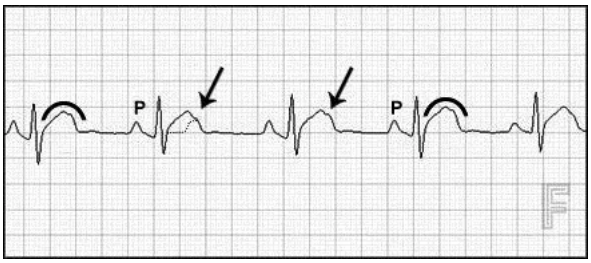


1) What is the rhythm of the tracing?

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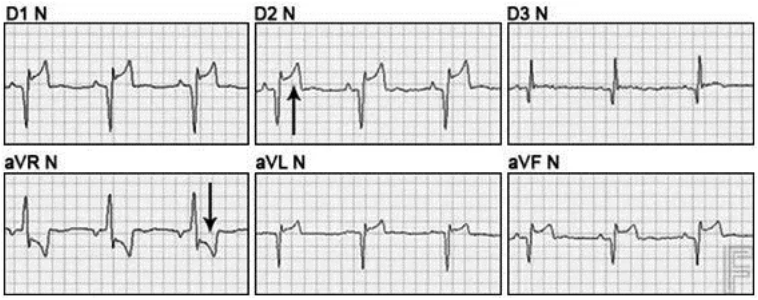
2) Why do we find ST segment depression and elevation in the same test?

CASE 85:



1) P wave presents an increased duration, which is directly related to left atrial enlargement, secondary to mitral valve regurgitation found in the aforementioned valve disease. We say that this ST segment is dome-shaped (markings), suggestive of myocardial hypoxia. If the magnitude of the phenomenon is greater than the electrical moment of repolarization, the T wave may be masked. The arrows indicate the peaks of the T wave and the dashed lines show how it would be inscribed if it were not hidden.

CASE 86:



1) The rhythm is sinus with heart rate of 88 bpm.
2) Both ST depression (observed in aVR), and ST elevation (observed in D2) are related to the same event: myocardial hypoxia. We call the reciprocal effect (or mirror effect) is the fact that in certain leads, there is ST segment depression and in others elevation, precisely because the electrodes are placed opposite to each other (diametrically) –in this case, D2 and aVR- thus recording the same phenomenon, but from different angles (arrows).

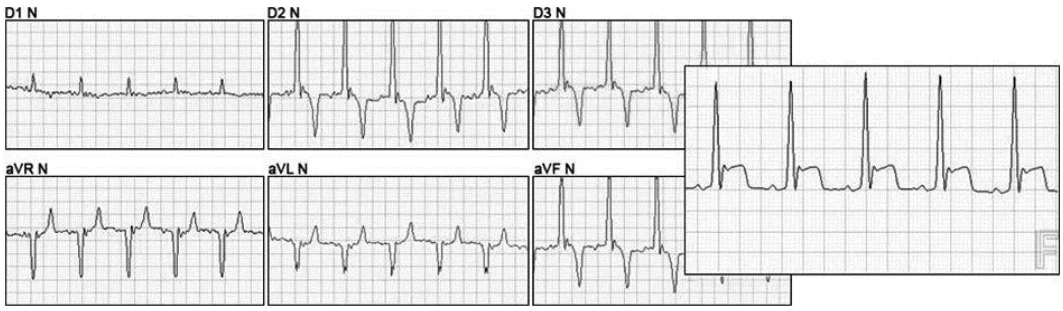
CASE 87: Tracings (in D2 and aVR, respectively) of a 7-year-old Yorkshire.

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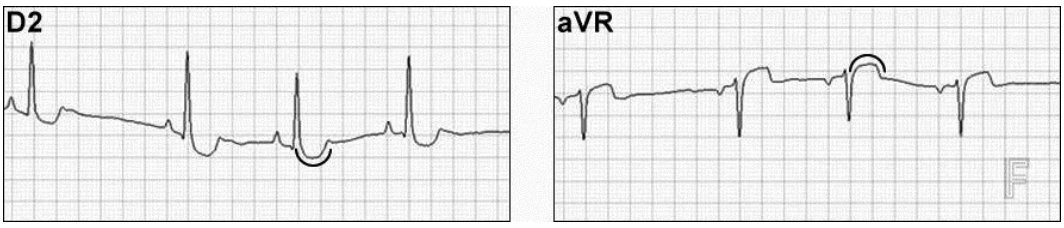
1) Is the ST segment morphology in the two leads presented an electrocardiographic finding within normality?

CASE 88: Tracings of a 9-year-old Dachshund with concentric ventricular hypertrophy observed in echocardiogram. The recording of a precordial lead in the left hemithorax is enhanced.



1) Are T waves within the standard of normality, as well as the ST segment in the left precordial lead?
2) The notches present in the QRS complexes in lead aVL could be related to what condition?

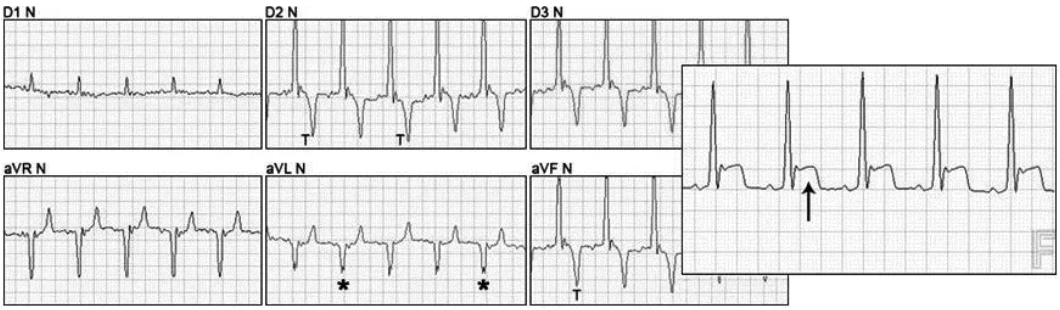
CASE 87:



1) In D2, an ST-segment depression with a "trowel" appearance is observed. This finding does not indicate digitalis intoxication, but rather a phenomenon that may occur with prolonged use of the medication, that is, digitalis impregnation. A reciprocal (or mirror) effect (ST dome in aVR) is observed, as the leads presented are diametrically opposed, but represent the same phenomenon.

CASE 88:

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1) No. These waves are deep and are a synonym of myocardial hypoxia, which could be related to the hypertrophy verified. For the same reason, ST segment elevation (arrow) observed in the left precordial lead, is subsequent to a possible inadequate coronary circulation.
2) It could be related to 1st degree left bundle branch block (*), indicating that the stimulus finds some difficulty to spread through the His bundle left branch, a ventricular conduction disorder that could also be related to left ventricular hypertrophy.

CASE 89: Tracing (in D2) recorded of a 3-year-old toy Poodle.



1) What is the rhythm of this tracing and what is its relationship to a P wave amplitude of 0.5 mv (5q)?

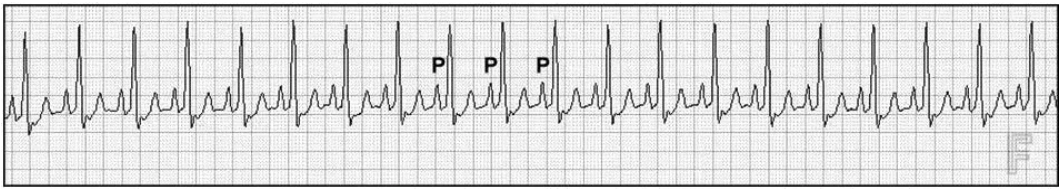
CASE 90: Tracing (in D2) of a 10-year-old Beagle, with body temperature of 40°C and positive diagnosis of monocytic ehrlichiosis.



1) What is the rhythm of the tracing and what is the relationship to the disease in this patient?
2) What arrhythmia do we observe in the indicated beat (arrow)?

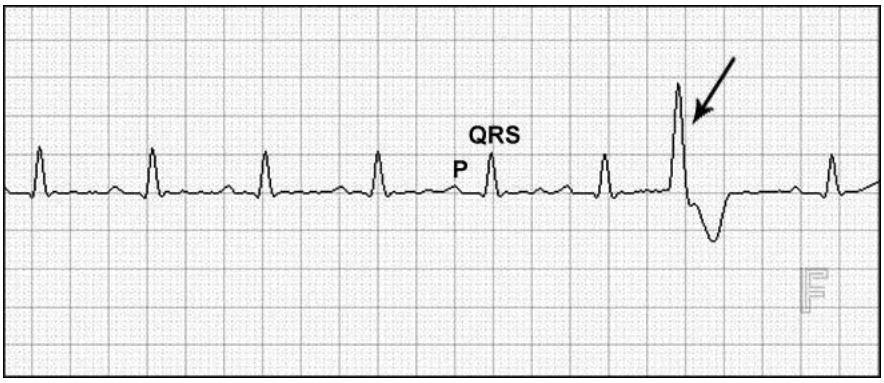
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CASE 89:



1) This is a rhythm of sinus tachycardia, with heart rate of 200 bpm. P wave at peak and with increased amplitude, it can be called wave P pulmonale, because it can be observed in pneumopathies, as it is in this case, since the patient had a diagnosis of bilateral bronchopneumonia, diagnosed by means of a chest X-ray. In contrast, sinus tachycardia can, by itself, cause a wave with the same characteristics, without necessarily representing cardiac or pulmonary pathology, but due to the increase in sympathetic tonus. In this case, it is just called a pseudopulmonary P wave.

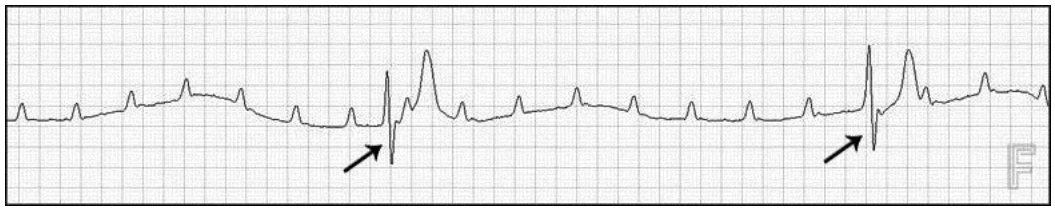
CASE 90:



1) This is sinus tachycardia, with heart rate of 214 bpm. Fever is a hypermetabolic state, increasing heart rate, not being necessarily related to heart disease, in spite of ehrlichiosis particularly having the potential of causing myocarditis in affected dogs.
2) It is a ventricular extrasystole. Chronic monocytic ehrlichiosis has an arrhythmogenic character, in which there is persistent myocardial damage and intense stimulation of the sympathetic nervous system in the heart, with a high frequency of arrhythmias.

CASE 91: Tracing (in D2) of a 14-year-old mongrel, weighing 16 kg, presenting lethargy and Stokes-Adams crises (term applied to syncopes associated to cardiac block, where there is bradycardia persistence or intermittence, caused by severe conduction disorders or impulse formation).

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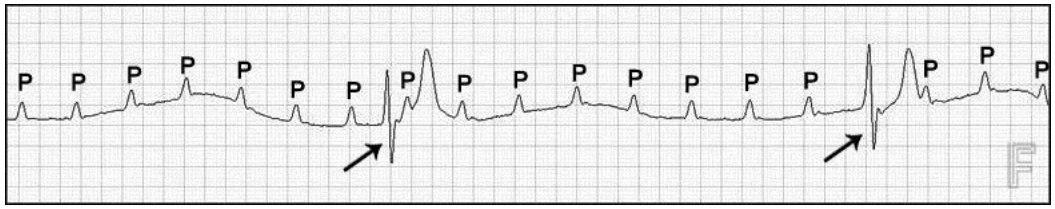
1) What is the rhythm of this tracing?
2) What do the complexes identified by an arrow mean, and why do they occur?
3) Why are there many P waves in this tracing?

CASE 92: Tracing (in D2) of an 11-year-old Poodle, presenting dyspnea and chronic cough.



1) What is the rhythm of this tracing, knowing that heart rate is at 187 bpm?
2) An ST segment (shown by the lines) with 0.4 mv (4q) is within the standards of normality?
3) What is the relationship between these two findings?

CASE 91:



1) It is 3rd degree (or total) atrioventricular block, since all P waves are blocked.
2) They are ventricular escape beats; that is to say, ectopic foci that depolarize in the ventricle. In spite of occurring at a low frequency, it is what preserves the heart from asystole.
3) The many P waves are subsequent to reflex sinus tachycardia; an attempt by the heart to "compensate" the low cardiac output of atrioventricular dissociation imposed by the block. However, no stimulus generated by the sinus node gets to stimulate the ventricles because of the block.

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CASE 92:



1) Sinus tachycardia is the rhythm of this tracing.
2) There is ST segment depression, suggesting ischemia hypoxia.
3) In spite of the myocardial contraction causing physiologically an intravascular compression (caused by the muscle mass proper of the ventricle), promoting a certain ischemia, before a tachycardia (which decreases the time of diastole and an adequate filling of the coronary arteries), a coronary artery disease may manifest electrocardiographically in this scenario.

CASE 93: Tracing (in D2) of a 14-year-old American Stafford, with no symptoms.



1) To what disease may we relate this tracing, knowing that the QRS complex has a duration of 100 ms (5q), the P wave a duration of 55 ms (2,75q) and the PR interval a duration of 140 ms (7q)?

CASE 94: Tracing (in D2) of an 18-year-old mixed-breed cat.



1) What is the base rhythm of this tracing?
2) The rhythm is interrupted by which arrhythmias?

CASE 93:

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1) Although we observe only the D2 recording (and not all leads in the frontal plane), this tracing is a right bundle branch block. A QRS complex that exceeds 80 ms (4q), mainly when its final portion is wider and the repolarization vectors tend to oppose the depolarization process ("QRS-T" discordant pattern), is an indication of this interventricular conduction disorder. P wave presents an increased duration, an indication of left atrial enlargement. PR interval duration (line) is equally increased, showing that there is concomitant 1st degree atrioventricular block.

CASE 94:



1) The rhythm is sinus tachycardia with heart rate of 252 bpm (observed at the onset and end of the tracing = lines).
2) There are 2nd degree atrioventricular blocks, Mobitz type II (minor arrows) and the presence of ventricular escape (*) of hissian origin (ventricular ectopy with a morphology similar to the QRS complexes of sinus origin). Also, there are escape beats originating from right ventricular foci (bigger arrows), since the greater deflection of these complexes is positive in D2. The escape beats occur due to atrioventricular blocks, that prevent the stimuli of sinus origin to reach the ventricles, and thus, the ventricular myocardium proper triggers the escape beats, as a defense mechanism to improve the cardiac output.

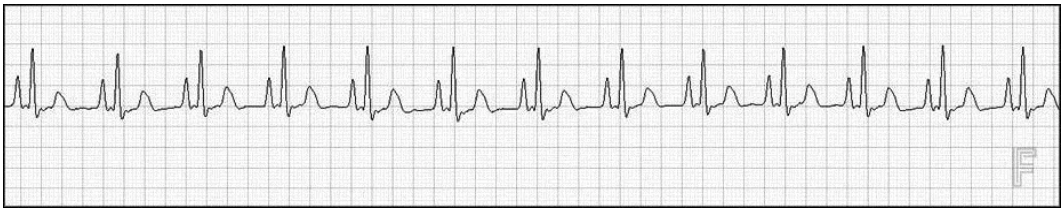
CASE 95: Tracing (in D2) of a 15-year-old mongrel, weighing 30 kg.
Preoperative examination.

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1) What is the rhythm of this tracing?

CASE 96: Tracing (in D2) of a 3-year-old Pinscher, presenting cough and cyanosis in clinical examination.



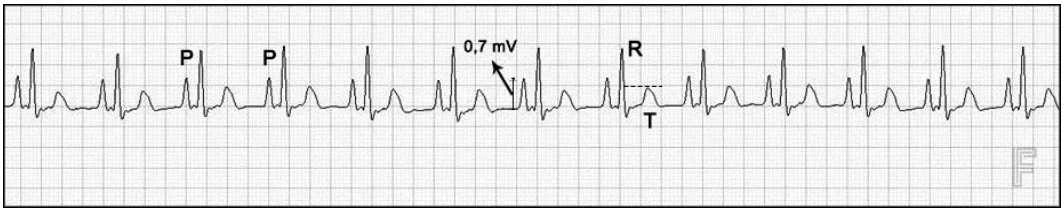
1) What is the rhythm in the tracing?
2) What does a P wave with 0.7 mv (7q) of amplitude represent?

CASE 95:



1) It is a right ventricular parasystole. The two ventricular extrasystoles (arrows) have different coupling periods (lines), and are repeated at regular intervals, maintaining the same distance and a mathematical proportionality, even with the complex proper identified by an ellipse, which is a fusion beat; another criterion to identify parasystole. We also verify longer pauses (lines below), that should be supracompensatory pauses (when the sum of pre- and post-extrasystolic intervals is more than twice the sum of normal sinus cycles), but we cannot rule out the possibility of relating them to sinus node dysfunction.

CASE 96:



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1) Sinus rhythm at a rate of 142 bpm.
2) When the P wave is above the standards of normality, it is called P pulmonale, precisely because of its close relationship to pulmonary diseases. After chest X-rays, it was confirmed that this patient was undergoing a bronchitis crisis. Even the T wave with amplitude greater than 25% than the R wave (dashed line) could be related to a certain hypoxia, which may occur in respiratory crises.

CASE 97: Tracing (in D2) of a 14-year-old Poodle with diagnosis of mitral valve endocardiosis.



1) What arrhythmia appears in this tracing?
2) The P wave is 60 ms (3q). What is the relationship with the disease of the patient?

CASE 98: Tracing (in D2) of a 4-year-old Shih Tzu.



1) What is the rhythm of this tracing?
2) How do we call the beat identified by an arrow?

CASE 97:



1) A rhythm with wide, bizarre QRS complexes at a rate of 125 bpm is compatible with accelerated idioventricular rhythm (RIV) (highlighted in the box).

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2) A P wave with its duration increased is an indication of left atrial enlargement.

CASE 98:



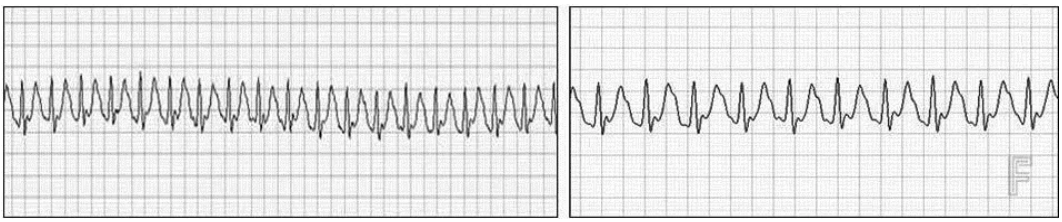
1) It is a junctional rhythm, a condition where the ectopic focus has its origin in the AV junction, producing atrial depolarization in the caudocranial direction, and consequently, negative P waves in lead D2.
2) It is a capture beat; i.e., it is an impulse generated in the sinus node that got a "physiological" depolarization, even with the heart under the command of a substitution rhythm.

CASE 99: Tracing (in D2) of a 4-year-old Poodle, presenting syncopes.



1) What arrhythmias are present in this tracing?

CASE 100: Tracing (in D2) of an 11-year-old Labrador, weighing 50 kg.
At the right, the same tracing enhanced.



1) What is the rhythm of the tracing?

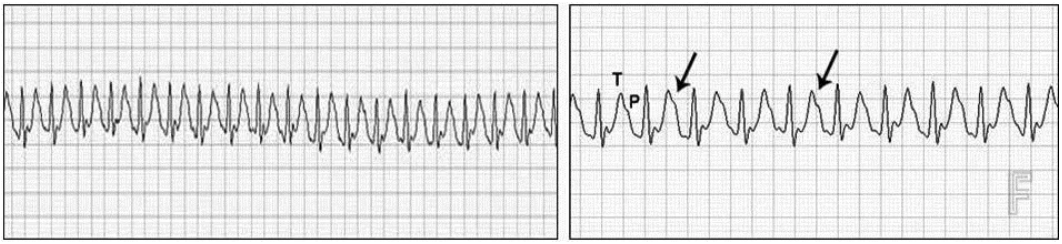
CASE 99:

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1) Measuring 180 ms (9q), the PR intervals (line) are increased in their duration, indicating that there is 1st degree atrioventricular block. Additionally, there are blocked P waves (arrows), typical of concomitant 2nd degree atrioventricular block, Mobitz type II.

CASE 100:



1) Sinus tachycardia (at a rate of 276 bpm) is the rhythm of this tracing. In sinus tachycardias with elevated rates, the P wave may touch and even overlap the T wave of the preceding complex. The time of overlapping could be identified by the P wave peak shown by the arrows.

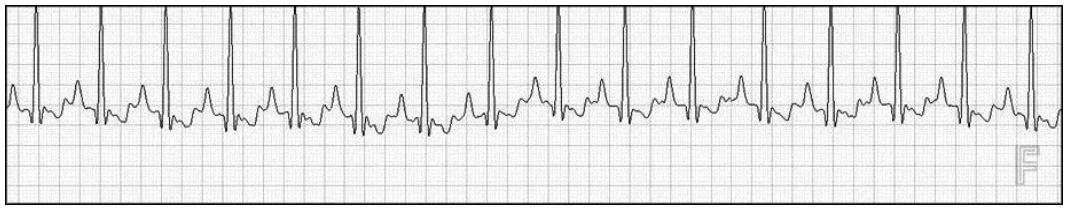
CASE 101: Tracing (in D2) of a 9-year-old Dachshund. Preanesthetic evaluation.



1) What is the rhythm of the tracing?
2) Any special care that should be taken into account in relation to the choice of the anesthetic protocol? Why?

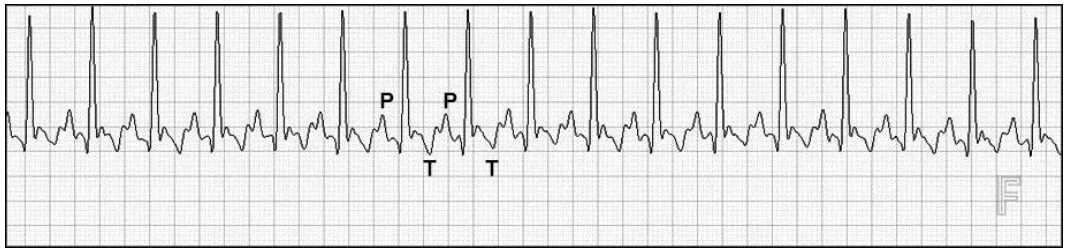
CASE 102: Tracing (in D2) of a 13-year-old Poodle, with clinical history of dry cough of the choking type.

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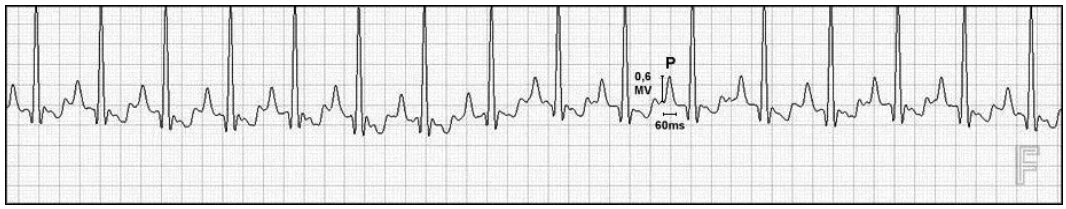
1) What is the rhythm of this tracing?
2) Knowing that the duration and amplitude of the P waves is 60 ms (3q) and 0.60 mv (6q) respectively, can we state that they are within the standards of normality for this breed? What could this finding indicate?
3) R wave with amplitude of 2.7 mv (27q) is within the standards of normality?
4) What do these electrocardiographic findings suggest?

CASE 101:



1) It is a rhythm of sinus tachycardia. The heart rate is 220 bpm.
2) Evidently, the choice of an anesthetic drug may also depend on other evaluations. But in general terms, in patients presenting this rhythm or with a high heart rate, we should avoid the use of dissociative anesthetics, due to the sympathomimetic effect.

CASE 102:



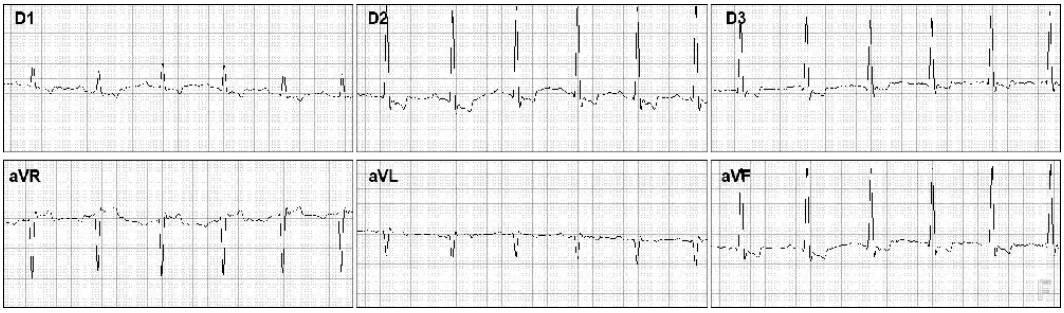
1) It is a rhythm of sinus tachycardia. Heart rate in this case is 190 bpm.
2) The P waves in this tracing exceed the standards of normality, both in duration and amplitude. These findings are indicative of biatrial enlargement.
3) R wave exceeding 2.5 mv (25q) in D2 is considered outside normality, indicating a possible left ventricular enlargement. This

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patient presents mitral and tricuspid valves endocardiosis, besides cardiomegaly observed in chest X-rays.

4) It suggests that this patient presents atrioventricular valves endocardiosis, confirmed by imaging tests.

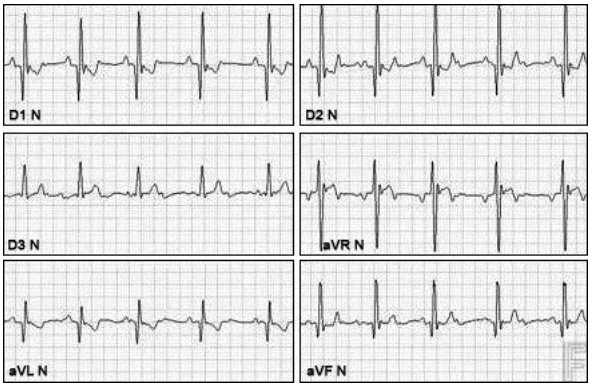
CASE 103: Tracing of a 9-year-old female Bull Terrier, weighing 25 kg and presenting the ideal body mass index for this breed.



1) What is the rhythm of this tracing?

2) Based only on the finding of an R wave with 3.0 mv (30q) of amplitude, can we suspect left ventricular enlargement in this case?

CASE 104: Tracing of a 13-year-old female Cocker Spaniel.



1) Knowing that this patient presents a cardiomyopathy confirmed by echocardiogram, which are the findings in this tracing that favor the possibility of this condition?

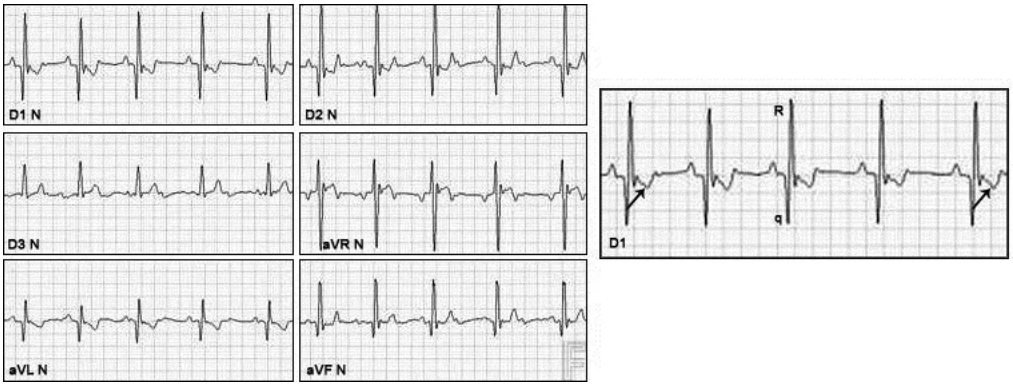
CASE 103:

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1) The rhythm is sinus with heart rate of 150 bpm.
2) If this was a cachectic dog, young (with an age of up to 2 years) or even of a breed presenting a narrow chest, we could dismiss only the increased amplitude of the R wave. Anyway, this is a finding that is significant, because in fact it indicates left ventricular enlargement, confirmed by echocardiogram.

CASE 104:



1) This tracing presents Q waves with increased amplitudes in D1, D2 and aVF, besides increase in R wave amplitude in D2, and the presence of ST segment convexity (in the enhanced tracing in D1). This is a tracing compatible with cardiomyopathy, that usually affects Cocker Spaniel dogs.

CASE 105: Tracing (in D2) of a 14-year-old mongrel. His keeper told that the dog presented tiredness in rest and weakness.



1) What is the arrhythmia observed in this tracing?

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CASE 106: Tracing (in D2) of unidentified dog. Test received by telemedicine service.



1) What is the rhythm of this tracing?

CASE 105:



1) The arrhythmia that is occurring is paroxysmal atrial tachycardia (double arrow), shown in the center of the tracing. The initial rhythm of the tracing is sinus arrhythmia (check the variation of more than 10% of R-R distances, indicated by the line). The episode of paroxysmal atrial tachycardia starts after premature atrial contraction (in the first arrow) and it ends in the second arrow. Later, there is a pause and return to a rhythm of sinus origin (S).

CASE 106:



1) The tracing starts with sinus rhythm and identifiable P waves. But after the fourth QRS complex there is an atrial extrasystole (arrow), followed by atrial tachycardia starts (see the shape of an inverted Z), with heart rate reaching 200 bpm. Additionally, there is increased PR interval (180 ms = 9q) throughout the tracing, a sign that there is concomitant 1st degree atrioventricular block (even also observed during atrial tachycardia run = line).

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CASE 107: Tracing (in D2) of a 15-year-old mongrel.



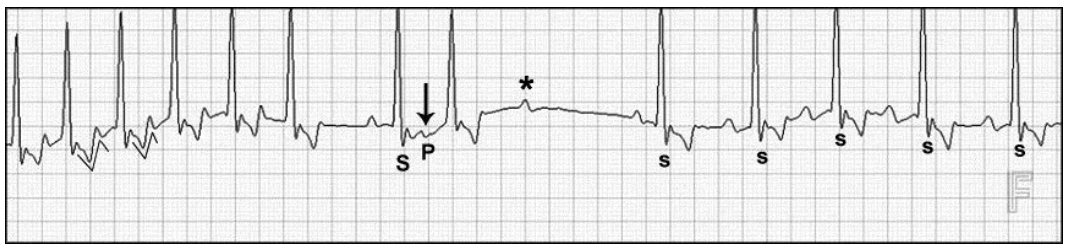
1) What arrhythmias appear in this tracing?

CASE 108: Tracing (in D2) of a 7-year-old, mixed Boxer. His keeper reported signs of tiredness and intolerance to exercise.



1) What is the rhythm in this tracing?
2) What is the arrhythmic event indicated by the arrow?

CASE 107:



1) The tracing starts with atrial tachycardia (inverted Z shape) that stops, and subsequently there is a recording of beat of sinus origin (S). Immediately afterward, there is a supraventricular extrasystole (P wave = arrow). 2nd degree atrioventricular block, Mobitz type II (*) is observed next. After this block, once again beats of sinus origin are recorded (S), displaying from then on, a sinus arrhythmia (variation of more than 10% of R-R distances).

CASE 108:



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1) It is a supraventricular tachycardia with a frequency of 230 bpm. When the beginning or end is not observed, it may be difficult to differentiate paroxysmal atrial tachycardia from sinus tachycardia.
2) It is a premature contraction originating in the right ventricle, characterized by early, bizarre ectopic complex, and with positive polarity in lead D2.

CASE 109: Tracing (in D2) of a 13-year-old Birman. Test received by telemedicine.



1) What is the rhythm in this tracing?
2) What can we state about this rhythm in cats?

CASE 110: Tracing (in D2) of a 10-year-old female mixed-breed cat. Preoperative test for an elective procedure.



1) What alteration in the interval could be seen in this tracing?
2) Knowing that in the original test there is left cardiac axis shift, what considerations should be taken into account for the report of this patient?

CASE 109:



1) It is sinus bradycardia, with heart rate of 78 bpm.

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2) Sinus bradycardia in cats is considered a severe rhythm, and nearly always it is a sign of a pathology, as electrolyte imbalances (hyperkalemia), for instance, often secondary to urinary tract obstruction disease. Additional tests should be made in this patient to find the cause.

CASE 110:



1) A normal PR interval in cats should be up to 90 ms (4.5q). However, in this tracing the interval is 100 ms (5q), indicating that there is 1st degree atrioventricular block.
2) We should avoid using alpha-2 adrenergic receptors (such as xylazine, medetomidin and dexmedetomidine, among others) in this patient. They increase the time of conduction of the stimulus through the atrioventricular node, and they may worsen the block. When there is left electrical axis shift, there is a strong sign of left ventricular enlargement. A Doppler echo test is indicated before the procedure.

CASE 111: Tracing (in D1) of a 10-year-old Siamese cat. Preanesthetic test.



1) What arrhythmias are observed in this tracing?

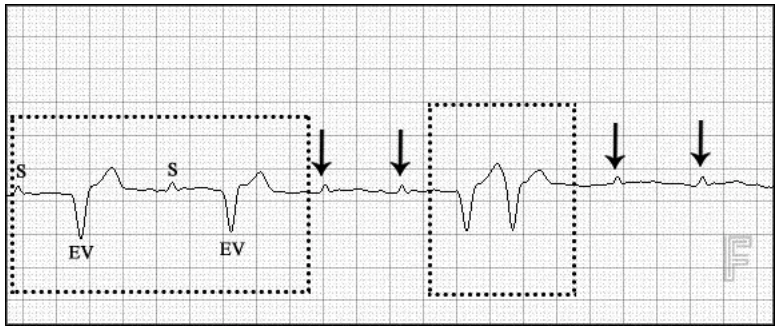
CASE 112: Tracing (in D2) of a 9-year-old female Persian cat.



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1) What is the rhythm of this tracing?
2) What heart disease is common in cats of this breed and what these alterations usually cause?

CASE 111:



1) In the bigger box, there is ventricular bigeminy; i.e., sinus beats (S) interspersed with premature ventricular contractions (PVC). In the smaller box, there are coupled ventricular extrasystoles (i.e., two successive ones). The identified complexes (arrows) are beats of sinus origin.

CASE 112:



1) This is an atrial fibrillation rhythm, because of not only the variations in R-R distances (irregular rhythm), as in the absence of P waves, but also the presence of fibrillation waves (f), manifested by tremors in the baseline.

2) Hypertrophic obstructive cardiomyopathy with increase in left atrial diameter.

CASE 113: Tracings (in D2 and D3) of a 10-year-old mixed-breed cat, and evaluated for an elective procedure.



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1) What is the rhythm in the tracing, knowing that the PR interval presents 120 ms (6q) of duration?
2) What does the beat identified by an arrow represent?

CASE 114: Tracing (in D2) of an 8-year-old Persian cat. Preanesthetic evaluation.



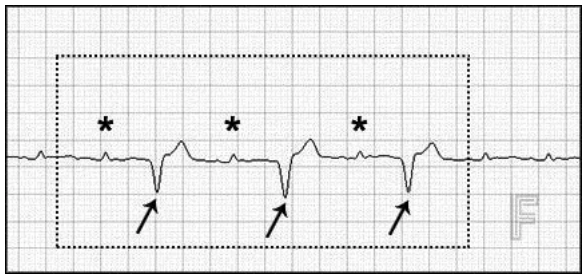
1) How can we classify the arrhythmias observed?

CASE 113:



1) It is sinus rhythm with heart rate of 200 bpm and 1st degree atrioventricular block (line).
2) It is a premature contraction (premature ectopic beat), originating in the left ventricle, since its polarity is negative in D2.

CASE 114:



1) It is ventricular bigeminy (highlighted), characterized by a beat of sinus origin (*) interspersed with ventricular extrasystoles (arrows). As the polarity of the ectopic beats is negative in D2, its origin is in the left ventricle.

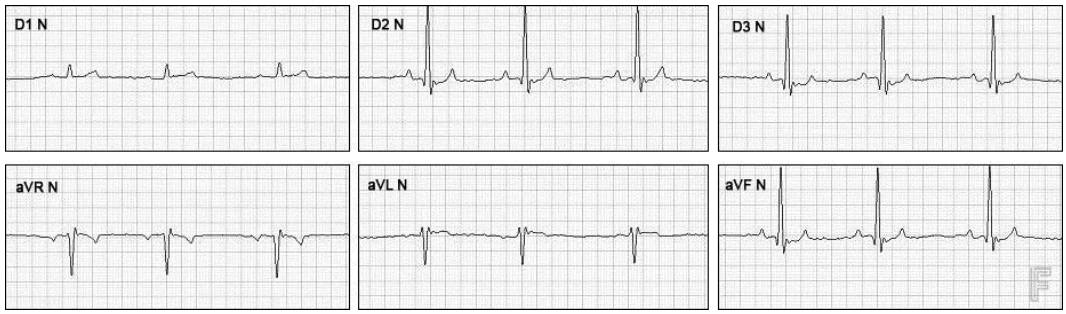
CASE 115: Tracing (in D2) of a 5-year-old female Boxer.

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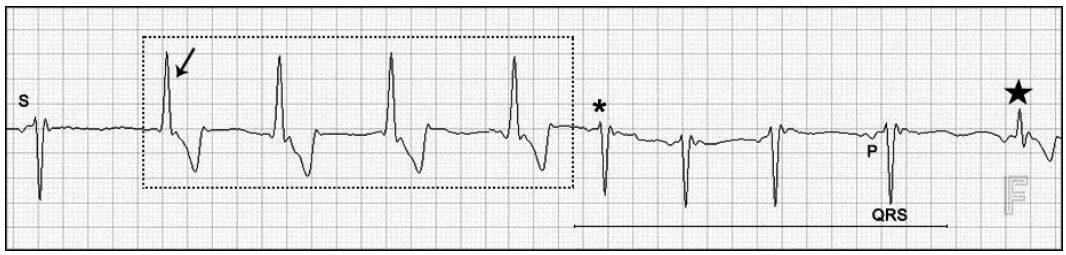
1) Describe the sequence of events in this tracing, knowing that in the electrocardiogram there are left cardiac axis shift.

CASE 116: Tracing of a 7-year-old female Golden Retriever, weighing 45 kg, body mass index 5 and asymptomatic. Routine test.



1) Knowing that R wave amplitude in D2 is 2.4 mv (24q), can we state that it is within the standards of normality?
2) Is it expected to find waves with this amplitude in obese dogs? How to investigate these findings?

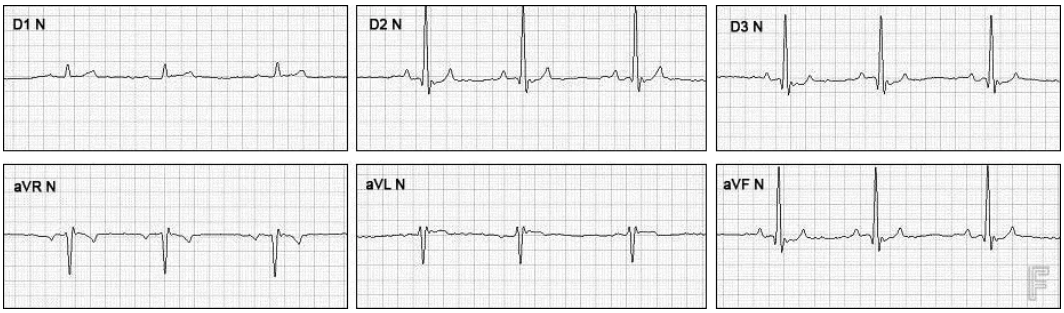
CASE 115:



1) The first beat is of sinus origin (S), followed by an episode of accelerated idioventricular rhythm (in the box). When heart rate is reduced, escape or substitution rhythms arise, as in this case. After this paroxysm, the sinus node recovers its dominance (*), with the inscription of an irregular rhythm (sinus arrhythmia with variation of more than 10% in the R-R distances, shown by the line). The last beat of the tracing (star) is a fusion beat; characterized by two "wavefronts", each of them depolarizing a part of the ventricular mass, registering QRS complexes of intermediate morphology.

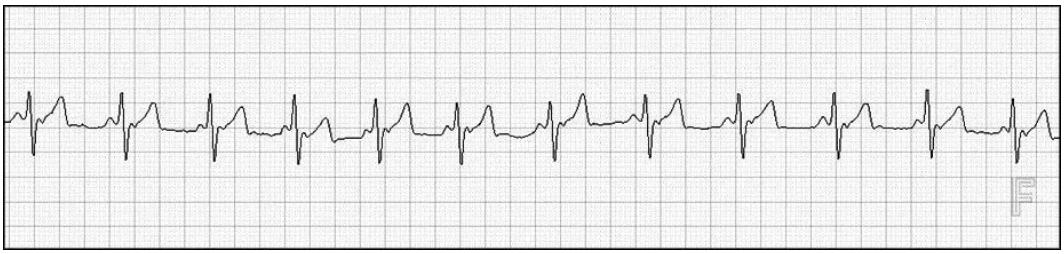
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CASE 116:



1) Yes, this wave is within the standards of normality, taking into account that the normal amplitude is up to 2.5 mv (25q) in D2.
2) No. Waves in obese dogs should have less amplitude (low voltage). In spite of the waves of this patient being within the limits of normality, her body mass index seems to be masking the real increase in amplitudes. Chest X-ray confirmed the suspicion, with the finding of a global increase in the cardiac area and with a vertebral heart score (VHS) of 11.5.

CASE 117: Tracing (in D2) of a 3-year-old Yorkshire. Evaluation for an elective procedure.



1) What is the rhythm observed in this tracing?
2) Are all tracing intervals within normal limits?

CASE 118: Tracing (in D2) of an 8-year-old Schnauzer.

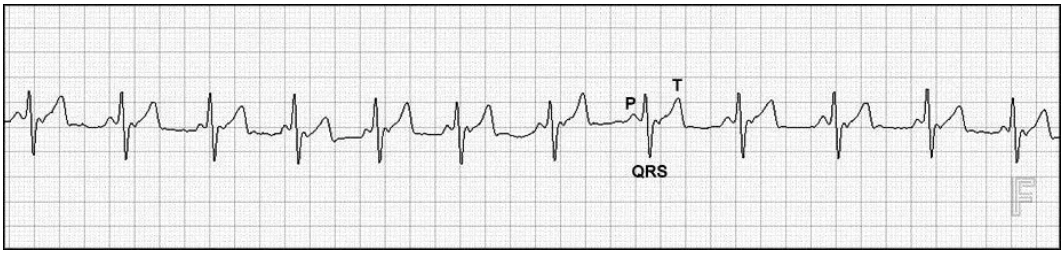


1) What is the rhythm in this tracing?
2) What is the diagnostic hypothesis for this patient?
3) Knowing that the P wave has a duration of 60 ms (3q), can we suspect left atrial overload? T wave with amplitude greater than 25% of R wave amplitude is a sign of what?

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4) What is/are the additional test(s) we should request for this patient?

CASE 117:



1) It is a sinus rhythm, with a heart rate of 166 bpm.
2) It is a short PR interval syndrome, because the PR segment practically does not exist. The diagnostic hypotheses are based on the presence of accelerated AV conduction (a variant of normality), or even the presence of ventricular pre-excitation.

CASE 118:



1) It is sinus bradyarrhythmia with heart rate ranging from 45 to 65 bpm.
2) In dogs of this breed and age range, sinus node dysfunction is prevalent. However, it is much more frequent in females (and not in males).
3) Yes, because P wave presents increased duration. Besides, the fact that T wave has a voltage above 25% of R wave, indicates alteration in ventricular repolarization, which could be observed also in cases of ventricular overloads.
4) To further clarify what is observed in this tracing, a Holter test would supplement it. For the suspicion of cardiac remodeling, an echocardiogram should be conducted for a better anatomical diagnosis.

CASE 119: Tracing (in D2) of 13-year-old mongrel, weighing 9 kg. He had been diagnosed with chronic mitral valve disease and increase in the left atrium in echocardiogram.

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1) What arrhythmias could be observed in this tracing?
2) Are the arrhythmias found related to the alteration observed in the imaging test'?

CASE 120: Tracing (in D2) of a 12-year-old Poodle. The history of the patient was not reported. Test received by telemedicine.



1) What is the rhythm of the tracing?
2) How can we classify the P waves in this tracing and what could they mean?
3) Knowing that in the electrocardiogram, there is left cardiac axis shift, what is the relationship of this finding the ST segment observed in the tracing?

CASE 119:



1) The rhythm of sinus arrhythmia (R-R distances variations = line) is interrupted by supraventricular extrasystole with atrial origin, with aberrant conduction. This early supraventricular beat (overlapped onto the preceding T wave = arrow) finds the His bundle in different refractory periods, inscribing in this way, then, a QRS complex of morphology different from the others (*).
2) There is no relationship between the sinus arrhythmia and heart disease, this being a variation being the normal rhythm in healthy dogs and related many times to the respiratory cycle. Nevertheless,

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the stretching of fibers because of volume enlargement could be one of the mechanisms explaining this atrial ectopy.

CASE 120:



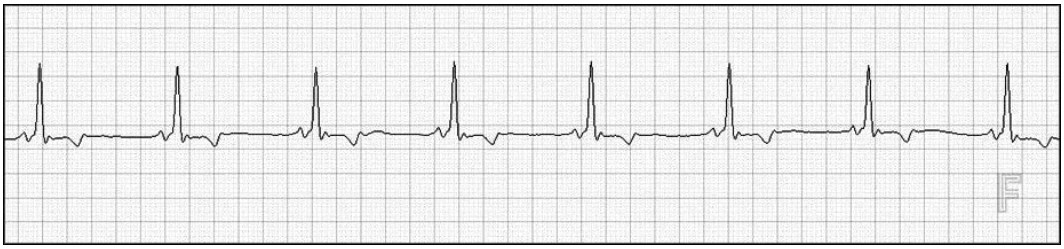
1) Sinus tachycardia at a rate of 200 bpm is the rhythm in this tracing.
2) These are notched P waves (*), showing there is conduction disorder between the right and left atria. If this finding is accompanied by an increase in the duration of this wave, there is a sign that there is left atrial enlargement associated (as in this case), since the total inscription time is 80 ms (4q).
3) Left axis shift is a hint of left ventricular enlargement. A tendency is observed in poodles, to presenting ST segment shifts (arrow), beyond normality, due to heart disease or lung disease.

CASE 121: Tracing (in D2) of a 10-year-old pinscher. Test received by telemedicine.



1) What is the base rhythm in this tracing?
2) What arrhythmia is observed during the sinus pause?

CASE 122: Tracing (in D2) of a 14-year-old Yorkshire. Asymptomatic patient, in routine test.



1) What is the rhythm in this tracing?
2) Is there any arrhythmia in this tracing?

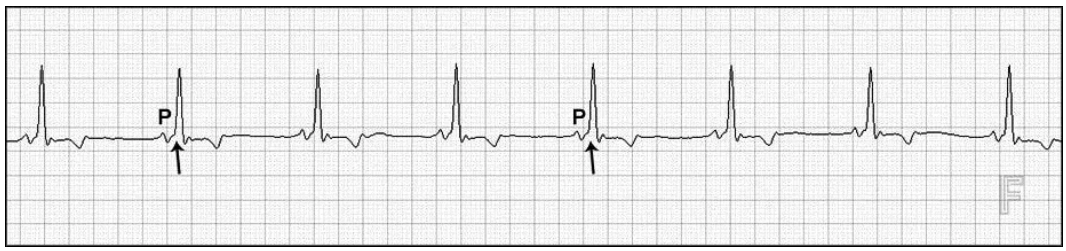
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CASE 121:



1) It is a rhythm of sinus tachycardia, with heart rate between 200 and 230 bpm.
2) It is atrial escape, characterized by P wave (arrow) of late inscription and with morphology different from the other P waves in the tracing. The atrial escapes occurs due to sinus node automatism depression ("not triggering") or a failure in the conduction of the stimulus originating in the sinus node (the impulse is not conducted).

CASE 122:



1) It is sinus rhythm at a rate of 107 bpm.
2) This is a ventricular preexcitation case, characterized by an accessory pathway that gets to activate the ventricles prematurely, represented in this example by Kent bundles, that are fibers that communicate the atria to the ventricles not going through the His bundle. The characteristic tracing presents short PR segment (in this example it is absent), the presence of delta wave (discrete QRS complex initial portion sloping = arrows) and QRS complex widening.

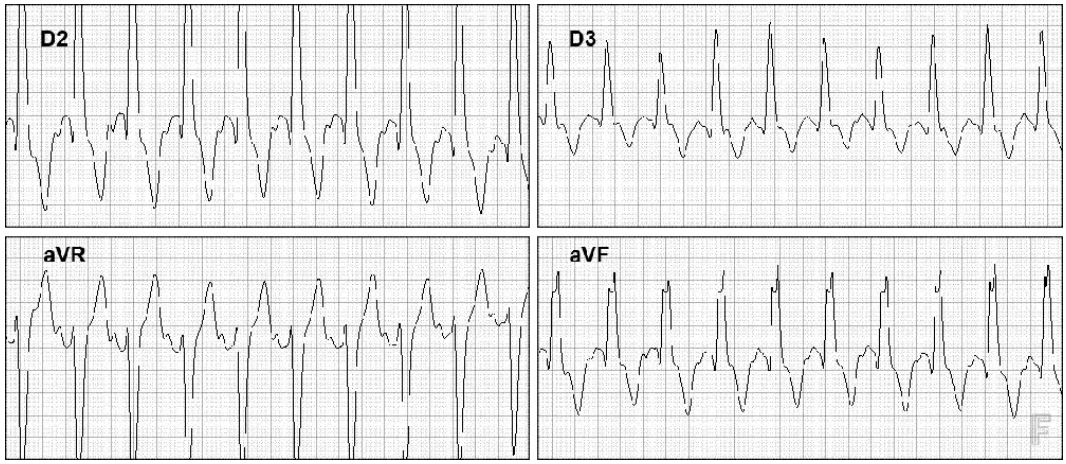
CASE 123: Tracing (in D2) of a 9-year-old Yorkshire. Test received by telemedicine.



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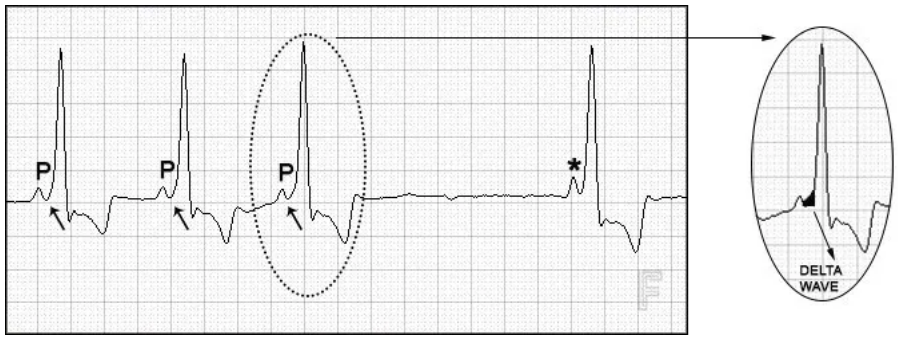
1) What alterations do the QRS complexes and PR segment present?
2) Is there any hemodynamic repercussion?
3) What happens in the longest pause in this tracing?

CASE 124: Tracing (identified leads) of a 10-year-old Whippet, weighing 12 kg.



1) What is the rhythm in this tracing, knowing that the QRS complex duration is 100 ms (5q)? The mean P wave axis is between -90 and -120 degrees, and the mean QRS complex axis is between 30 and 60 degrees?
2) What are the findings in this tracing the lead us to this diagnosis?

CASE 123:



1) These are typical findings of ventricular preexcitation, that is an accessory or anomalous pathway, that gets to prematurely activate the ventricles, represented in this example by the Kent bundles. These are connections that communicate the atria to the ventricles not going through the atrioventricular node. PR segment absence is observed, considering that the P wave joins the QRS complex. Also,

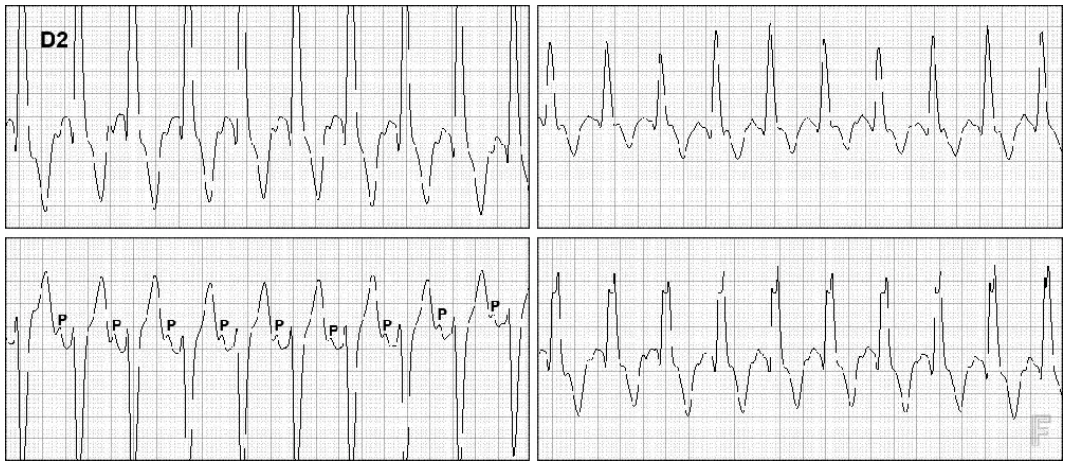
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the presence of delta wave, a deflection in the initial portion of the QRS complex (arrows).

2) There could be significant hemodynamic repercussions if the anomalous bundle triggers tachycardia by atrioventricular nodal reentry, usually at very high heart rates.

3) There is atrial escape; i.e., inscription of late P wave (*) and with a morphology different from the other P waves in the tracing.

CASE 124:

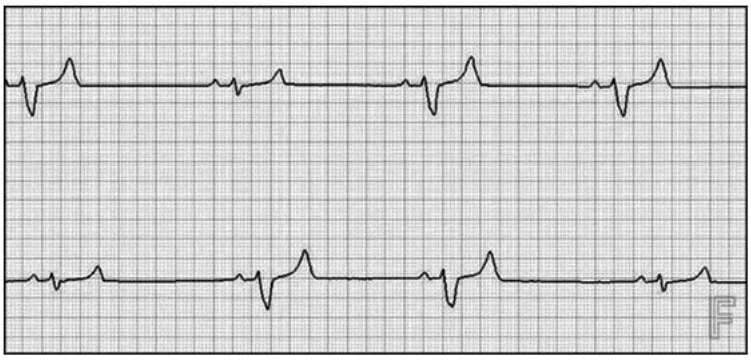


1) Supraventricular tachycardia with aberrancy is the rhythm in this tracing, with a 250 bpm heart rate.

2) The diagnosis of regular tachycardia and with wider QRS (that is a rapid and regular rhythm) is often a challenge for diagnosis. In this example, the wider QRS complex is due to aberrancy in the stimulus, and not to ventricular tachycardia (this is the differential diagnosis), precisely because we identify P waves in the aVR lead.

CASE 125: Tracings (in D2) of an 8-year-old female Pit Bull.
Postoperative test, with the patient still recovering from anesthesia with thiopental.

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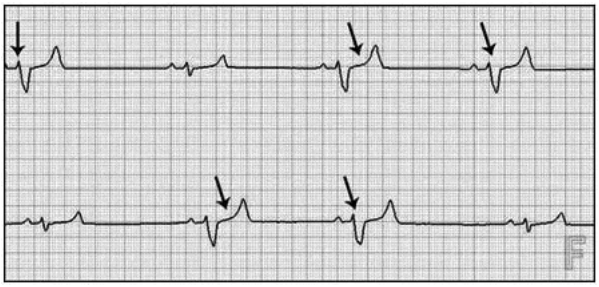
1) What is the rhythm in this tracing?
2) What conduction disorder is observed and what is the relationship with the clinical symptoms?

CASE 126: Tracing (in D2) recorded during surgery to fix jaw fracture in a 3-year-old female pinscher.



1) Even knowing that the temperature in this patient was 30°C, after observing this T wave pattern and QT interval duration, what care should we provide the patient besides warming her up?

CASE 125:



1) This is a sinus bradycardia rhythm, with heart rate of 62 bpm, expected because of vagal action by the drug used in anesthesia, which produces direct depression on the heart.
2) Intermittent right bundle branch block is present in these tracings. All QRS complexes are sinus (with preceding P waves). Nevertheless, there are QRS complexes (arrows) exceeding 80 ms (4q) of duration, that appear wider at the expense of their final portion and are associated to ventricular repolarization alterations, with T waves with polarities that are opposite to the QRS complexes. The stimulus

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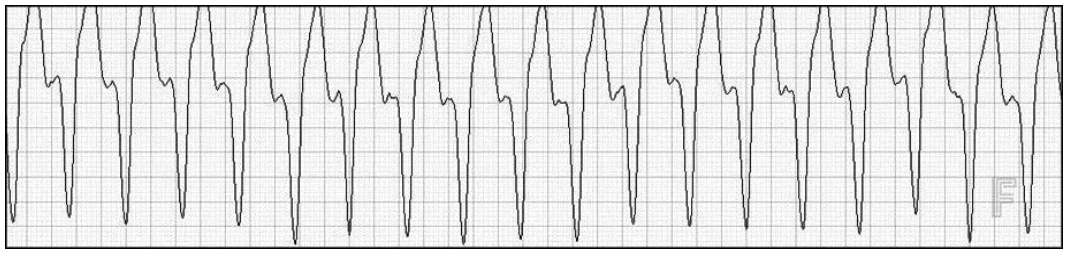
either goes through the right branch with difficulty, or normally. This is a finding where there is no relationship to any drug used for anesthesia. This intermittence may be found both in healthy dogs; however, as could also be related to right ventricular overload. Imaging tests are important to differentiate this situation.

CASE 126:



1) Measuring glycemia in a patient with QT interval increase and unspecific T wave alterations is always wise. The patient presented glycemia of 37 mg/dL, while she had been fasting for three days. Hypoglycemia is also one of those responsible for the appearance of so-called "cerebral" T waves (T wave with changes in its morphology - most often giant - accompanied by an increase in the QT interval).

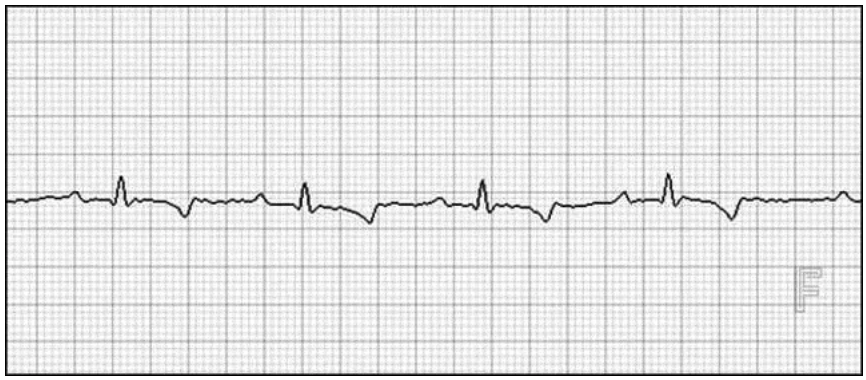
CASE 127: Tracing (in D2) of a 9-year-old great Dane.



1) What is the rhythm in this tracing?
2) What hemodynamic condition can we expect in a patient with this arrhythmia?

CASE 128: Tracing (in D1) of a 5-year-old female mongrel, weighing 7 kg. The patient was nursing, and presented symptoms of tachypnea, hyperthermia, decubitus and spastic limbs.

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1) Knowing that the patient presented typical symptoms of eclampsia, a tracing was recorded during the crisis, but because of the many artifacts, it was not possible to measure the duration and amplitude of waves. Thus, the tracing above was recorded 18 hours after the initial care, with the patient already clinically stable. In the measurement of the waves, even though an interval is at the limit of normality, it would explain a phenomenon. What would be this interval and what is the phenomenon?

CASE 127:



1) Ventricular tachycardia is the rhythm in this tracing. The keys to the diagnosis in this case are: wider QRS complex and dissociated P waves (arrows). The disease in this patient is dilated cardiomyopathy.
2) This arrhythmia occurs when there is severe aggression to the myocardium; in this case, with congestive heart failure.

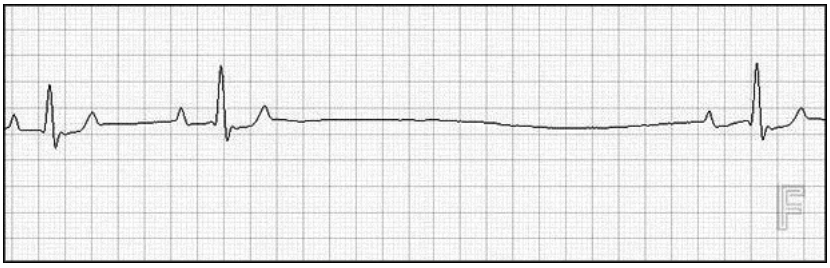
CASE 128:



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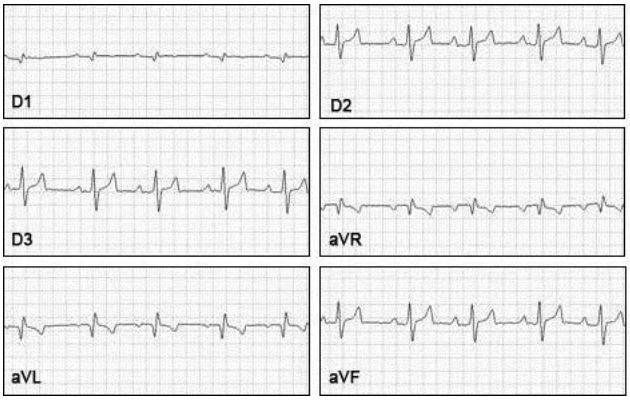
1) QT interval (indicated in the tracing) is on the limit of normality (at the expense of the ST segment), which is 250 ms (12.5q), caused by hypocalcemia, characteristic of this disease. ST segment is related to phase 2 (slow repolarization) of the action potential of cells of rapid response, and with Ca++ inflow in the muscle fibers, to ready them for the next contraction (depolarization). Because the calcium level in serum is low, there is time increase in this phase, for enough calcium to enter to be saved in the endoplasmic reticulum. The lower the calcium concentration in serum, the greater the ST segment duration. This means that if the QT interval is on the limit on normality 18 hours after reposition of IV calcium gluconate, during the crisis it was probably higher.

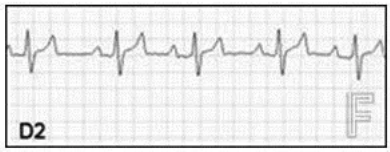
CASE 129: Tracing (in D2) of a 15-year-old Boxer and with history of neoplasia in the right cervical region.



1) What arrhythmias are present in this tracing?
2) Could some of these be related to the neoplastic scenario?

CASE 130: Tracing of a 12-year-old mongrel, that is asymptomatic.

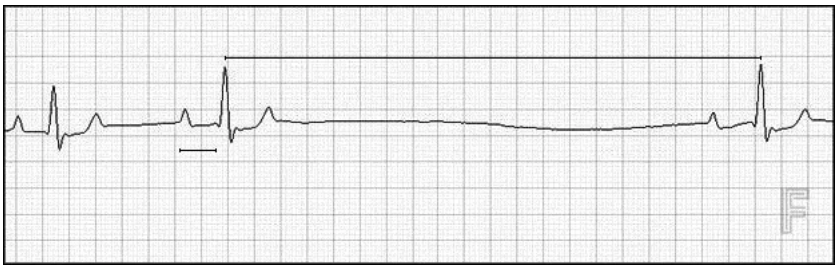




1) What is the mean cardiac axis of the QRS complex?
2) What other alterations could be observed in D2? (Enhanced at the right.)

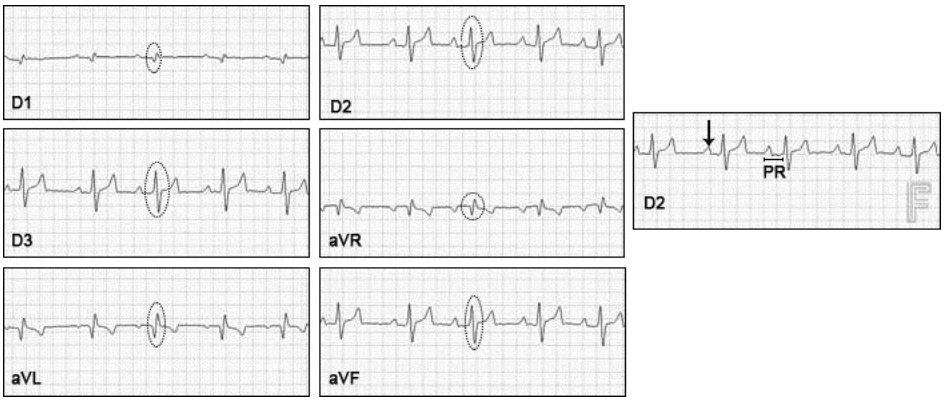
CASE 129:

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1) The patient presents 1st degree atrioventricular block, since the PR interval (shorter line) presents an increased duration (160 ms = 8q). There is also sinus arrest, characterized by a long pause (longer line), twice or more times greater than the R-R distance of the previous sinus beat, followed by P wave inscription with the same morphology as the previous ones. A condition where the impulse ceased to be generated by the sinus node (or was generated, but not conducted).
2) Cervical neoplasias may stimulate the vagus nerve, and reflectively decrease sinus node dysfunction, causing this arrhythmia, since its fibers innervate the sinus and atrioventricular nodes. The right vagus nerve has most of its fibers innervating the sinus node and some of them innervating the atrioventricular node. On the contrary, the left vagal nerve has most of its fibers innervating the atrioventricular node and some of them the sinus node.

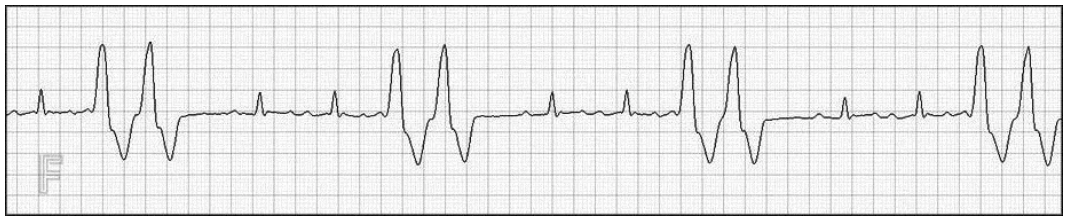
CASE 130:



1) When the QRS complexes appear to be isoelectric (or isodiphasic) in all leads (indicated in the tracing), the mean electrical axis should be evaluated as indeterminate and the heart considered to be in a horizontal position.
2) There is 1st degree atrioventricular block, as the PR interval (line) shows an increased duration; that is to say, exceeding 130 ms (6.5q).

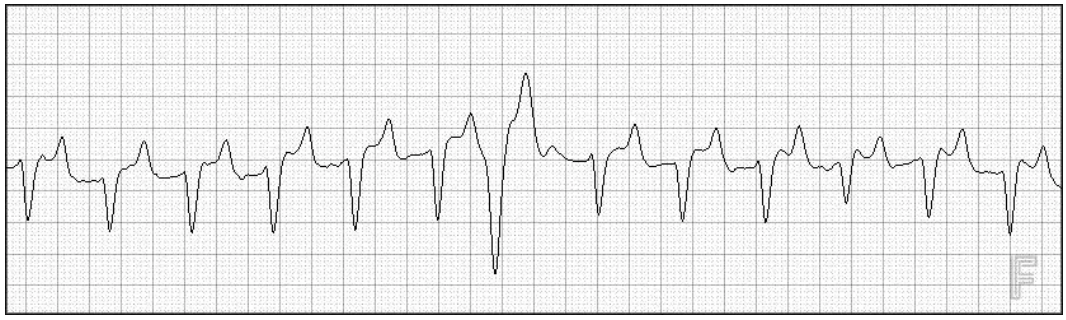
CASE 131: Tracing (in D2) of a 10-year-old Boxer. Asymptomatic patient.

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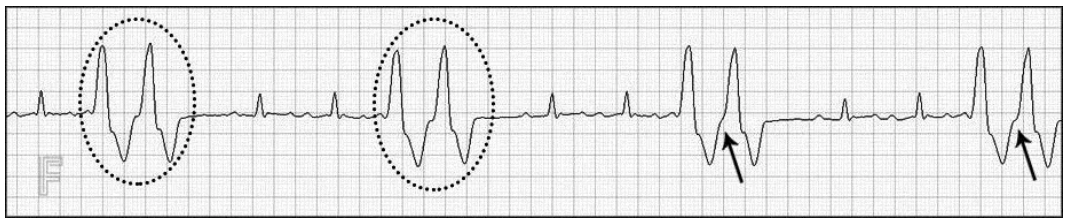
1) What arrhythmias could be observed in this tracing?
2) What is the particular characteristic of this arrhythmia and what is its clinical relevance?

CASE 132: Tracing (in D2) of a 13-year-old female mongrel, with clinical symptom of dyspnea.



1) What is the base rhythm in this tracing?

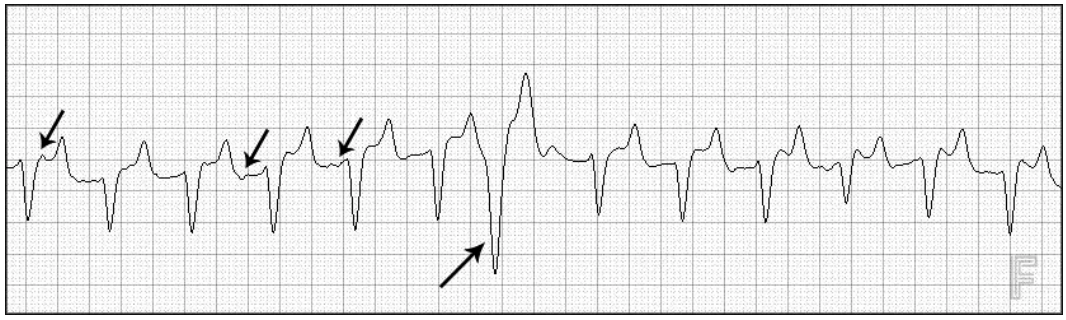
CASE 131:



1) They are premature contractions of ventricular origin that appear in couples; i.e., two consecutive ones (indicated in the tracing).
2) The peculiarity is the coupling period between them. It is short, almost reaching the point of the second ectopy overlapping the T wave of the first one (arrows), showing that there is a high ventricular rate. The clinical significance is the possibility of triggering ventricular tachycardia episodes; a quite severe arrhythmia.

CASE 132:

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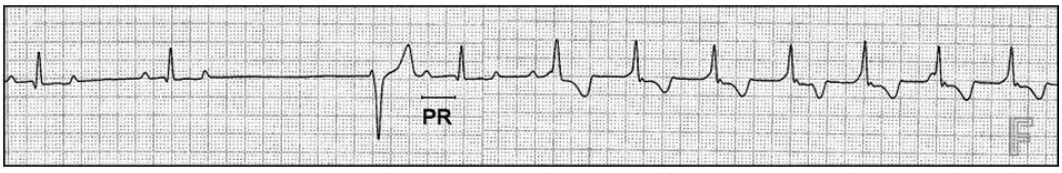
1) This is a ventricular tachycardia rhythm. Check the wider QRS complexes and also AV dissociation (arrows showing P waves). The larger arrow shows a beat from another ventricular focus; thus, being a polymorphic ventricular tachycardia.

CASE 133: Tracing (in D2) of a 14-year-old Cocker Spaniel. Presence of cardiomegaly in X-ray test.



1) What is the rhythm in this tracing?
2) What other arrhythmias could be observed?

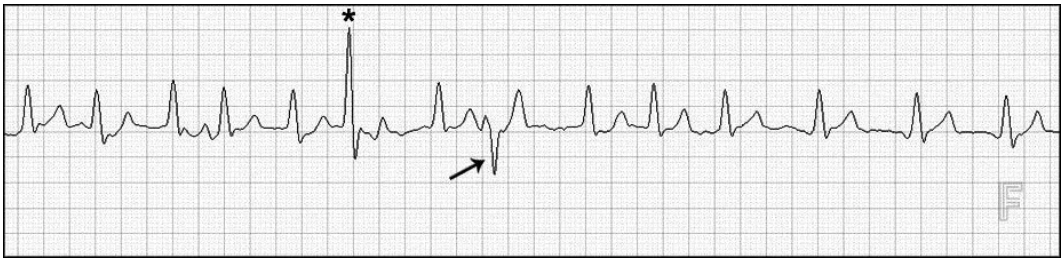
CASE 134: Tracing (in D2) of an 8-year-old Lhasa Apso. History of apathy and syncope.



1) What arrhythmias appear in this tracing?
2) Why this PR interval (identified) presents a duration greater than the two first sinus complexes in this tracing?

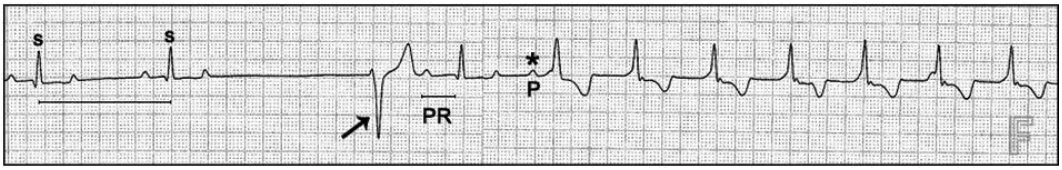
CASE 133:

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1) This is a rhythm of atrial fibrillation, characterized by variations in R-R distances (irregular rhythm), associated to absence of P waves and irregularity in the baseline.
2) There are premature ventricular contractions from two different foci, thus being polymorphic: in the right (*) and the left (arrow) ventricles.

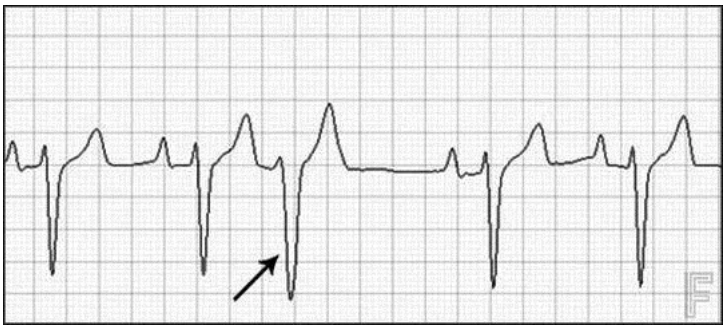
CASE 134:



1) In the two first sinus beats (S), a rhythm tending to sinus bradycardia is observed (heart rate of 80 bpm = line). Immediately after, there is a sinus pause followed by ventricular escape (arrow), which is an ectopic ventricular beat of late origin. The P wave (identified by the asterisk) is not related to the next beat, which comes from the ventricle and originates accelerated idioventricular rhythm, which continues until the end of the tracing. Conditions associated with this rhythm of ventricular origin include heart diseases and extra-cardiac pathologies.
2) Its duration is greater because there is retrograde concealed conduction. The ectopic ventricular beat got to "penetrate" retrogradely into the AV junction, thus modifying its excitability state, and promoting an increase in PR interval duration.

CASE 135: Tracing (in D2) of a 14-year-old Poodle. Presence of left chamber volume overload, diagnosed by echocardiogram.

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1) Is the arrhythmia observed (arrow) a hissian ventricular extrasystole or a supraventricular extrasystole with aberrant conduction? Why?

CASE 136: Tracing (in D2) of a 7-year-old pinscher. Routine test.



1) Why in the first QRS complexes, the relationship between the T and P waves is different from the last two QRS complexes?

CASE 135:

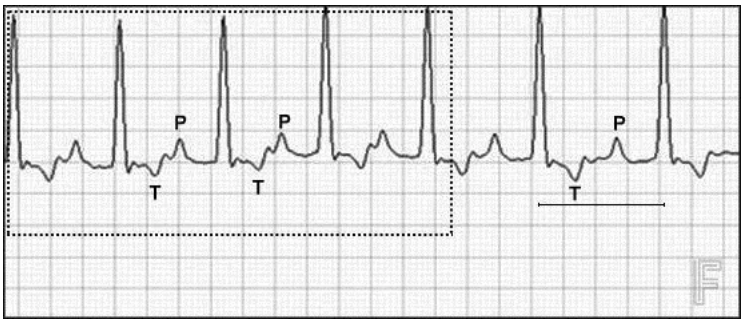


1) It could be a hissian ventricular extrasystole (originating from ectopic foci of the upper ventricles around the division of the bundle of His), because yours morphology presents discrete variations in relation to the QRS complexes of the base rhythm (*). However, the supraventricular origin with aberrancy is the answer. The T wave before the ectopic beat is a little higher than the others in the tracing, because of the fact there is a P wave "added" to the T wave. Also, the R wave of the ectopic beat (arrow) is a littler smaller than the others in the tracing, due to the aberrance in the stimulus conduction, represented by the first vector (middle septal) of ventricular depolarization. Also, the post-extrasystolic pause is incomplete (the

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sum of the pre- and post-extrasystolic intervals is less than the sum of two normal sinus cycles (2X).

CASE 136:



1) Check that in the first QRS complexes, the rhythm is sinus tachycardia (heart rate of 187 bpm = box). This causes P waves to tend to inscribed at the same time as the T waves of the previous QRS complex, a usual phenomenon in high rates. But, as heart rate decreases (between the two last complexes, it drops to 125 bpm = line), the P wave gets away from the previous T wave. Therefore, T-P distance is inversely proportional to heart rate. There is concomitance of a 1st degree atrioventricular block, since there is an increase in the duration of the PR interval.

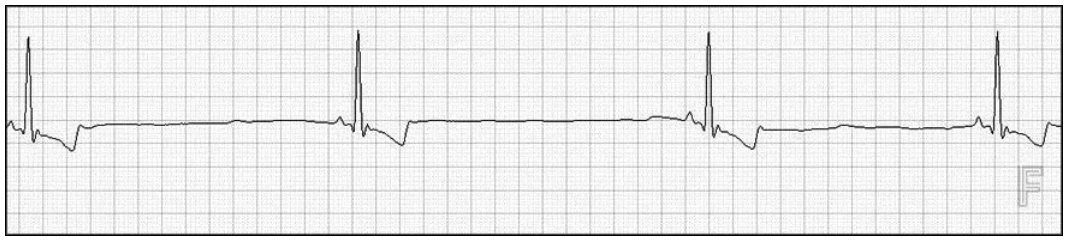
CASE 137: Tracing (in D2) of a 12-year-old Cocker Spaniel, with no symptoms.



1) What is the relationship of the PR segment increase (in this example at 180 ms = 9q) with the breed of this dog?
2) A P wave duration of 60 ms (3q) is within the standards of normality? What could this finding mean?

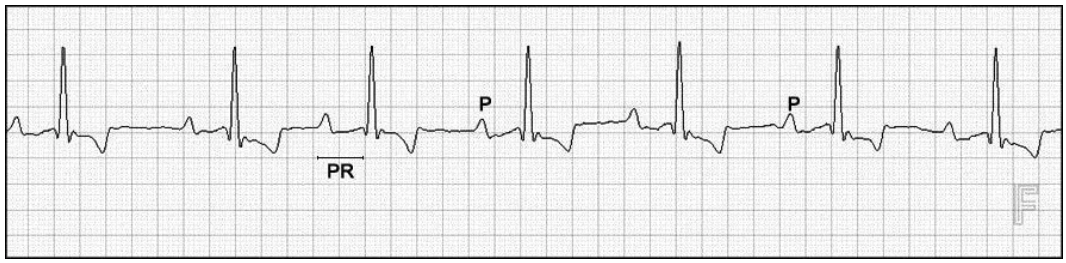
CASE 138: Tracing (in D2) of a 4-year-old female Yorkshire.

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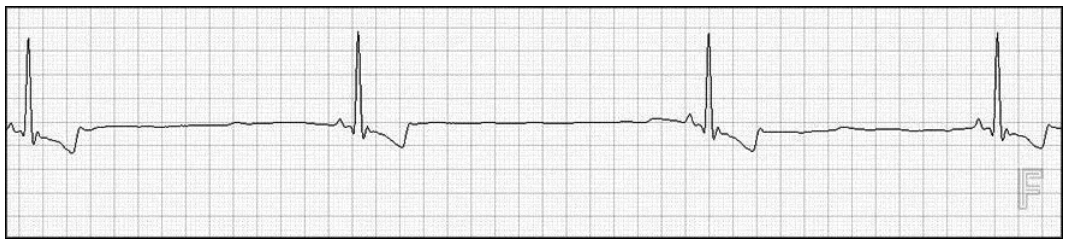
1) What is the rhythm of the tracing?
2) What is the main heart disease related to this rhythm, in dogs of this breed?

CASE 137:



1) There is a delay in stimulus conduction through the atrioventricular node. The dogs of breeds cocker spaniel and dachshund dogs tend to increase PR interval duration with age, due to degenerative alterations in the electrical system of the heart leading to conduction slowing through the atrioventricular node. This situation manifests in the electrocardiogram as first-degree atrioventricular block.
2) P wave duration is beyond the standard of normality, indicating a strong suspicion of left atrial enlargement.

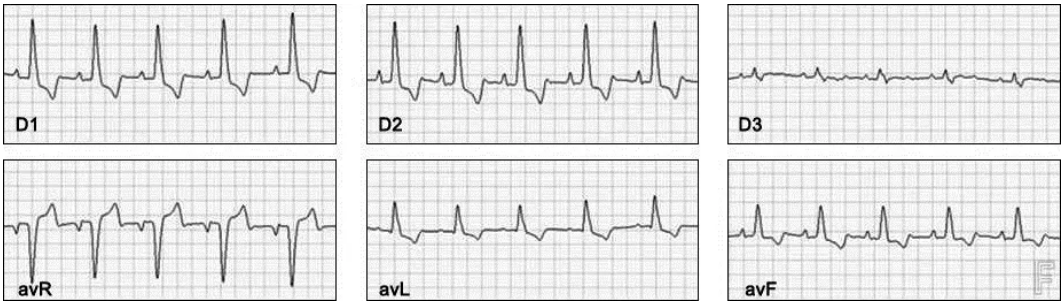
CASE 138:



1) It is a rhythm of sinus bradycardia. Heart rate varies from 43 to 50 bpm.
2) Whenever there is a persistent and accentuated sinus bradycardia rhythm, we should suspect of sinus node dysfunction, a pathology that significantly decreases nodal cells automatism.

CASE 139: Tracing of a 13-year-old Maltese. Asymptomatic patient.

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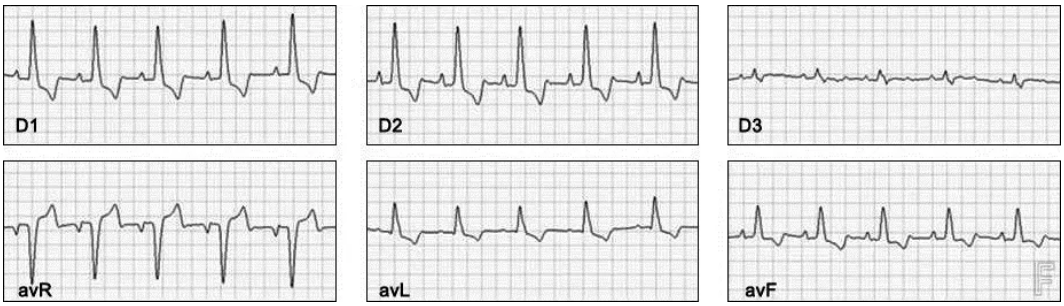
1) What is the rhythm in the tracing?
2) In this example, the QRS complex duration is 80 ms = 4q; does this finding lead us to the suspicion of left bundle branch block, or block secondary to left ventricular enlargement?

CASE 140: Tracing (in D2) of a 5-year-old female Poodle. Preanesthetic assessment.



1) What arrhythmias are present in this tracing, as the PR interval duration is 140 ms (7q)?

CASE 139:



1) The rhythm is sinus with heart rate of 130 bpm.
2) In this case, basing ourselves only in the QRS complex duration to differentiate left bundle branch from left ventricular overload is reckless. We should suspect left bundle branch block only with a duration greater than 80 ms (4q) for the QRS complex. An increase in QRS complex duration can only be taken into account (and used as one of the left ventricular overload criteria) when there is an increase in ventricular activation time (more than 40 ms, from the

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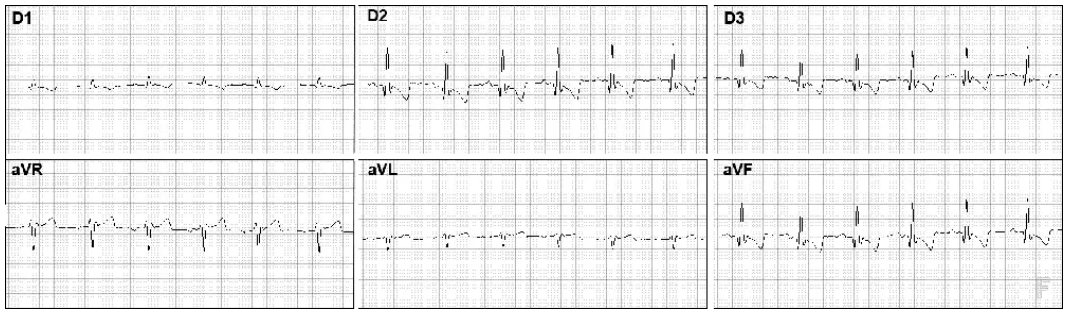
beginning of the QRS complex to the peak of the largest deflection of the QRS complex itself (usually the R wave)), observed mainly in the inferior and left precordial leads.

CASE 140:



1) The base rhythm is sinus arrhythmia, increased by 1st degree atrioventricular block; that is to say, a slowing in stimulus conduction through the atrioventricular node; however, always with ventricular response. But there is blocked atrial escape beat (arrow), indicating that the impulse at the time did not progress through the atrioventricular node, and consequently, did not depolarize the ventricles, and therefore, besides an ectopic P wave, there is also second-degree atrioventricular block associated.

CASE 141: Tracing of a 1-year-old Cavalier King Charles Spaniel, weighing 8 kg and asymptomatic. Presurgical test.



1) What is the rhythm of the tracing?
2) It is a breed and an age for us to worry about a heart disease?
3) T waves in D2, D3 and aVF present amplitudes greater than 25% of their respective R waves. Is this information relevant?

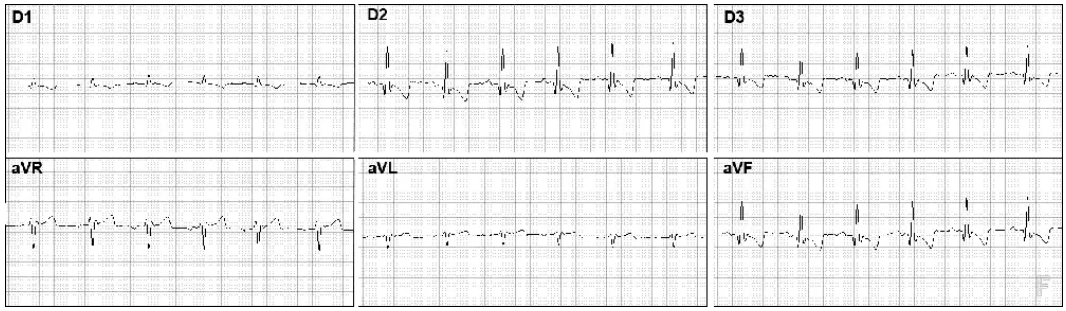
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CASE 142: Tracing (in D2) of a 7-year-old Poodle. Asymptomatic animal.



1) What is the rhythm of this tracing?
2) What is the clinical significance of this rhythm?

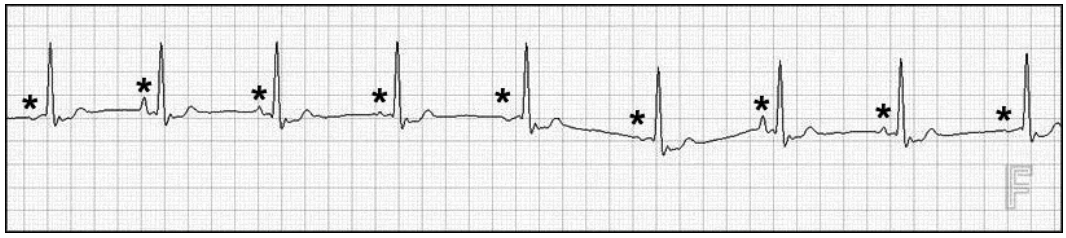
CASE 141:



1) Sinus tachycardia is the rhythm of this tracing, with a rate of 165 bpm.
2) This is the dog breed with a highest predisposition to develop chronic mitral valve disease. Because of their great genetic (and polygenic) tendency, it may appear in relatively young animals (from 3 to 5 years) and also may lead to early death. Although this is an acquired disease, it may even manifest in dogs since 1 year of age, and always require a research with additional tests, such as echocardiogram.
3) T wave amplitude should not be greater than 25% of their respective R waves, indicating ventricular repolarization alterations.

CASE 142:

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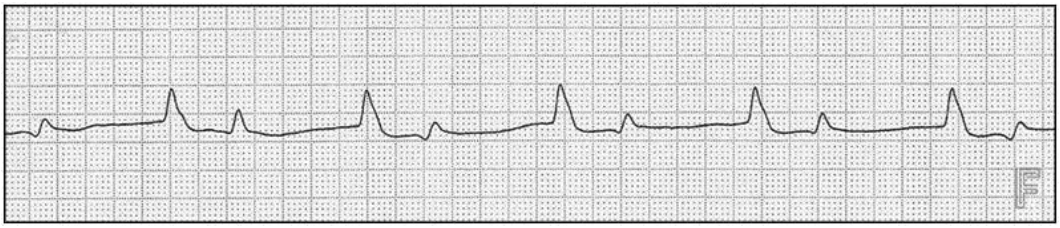
1) It is a rhythm of wandering pacemaker, characterized by the generation of impulses in different supraventricular foci (from the sinus node, atrial myocardium and even AV junction), that could be cyclic or not. The finding in the electrocardiogram is a change in P wave morphology (*), and also in their polarities varying between positive, biphasic, isoelectric or negative. The PR interval in this rhythm is generally constant.
2) It is a variation of sinus rhythm found in healthy dogs.

CASE 143: Tracing (in D2) of a 12-year-old mixed, Boxer and Rottweiler dog, weighing 44 kg and diagnosed with dilated cardiomyopathy.



1) What arrhythmias does this tracing present?
2) Are there signs of left atrial enlargement?

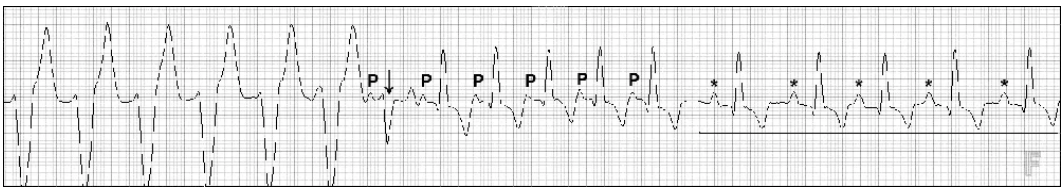
CASE 144: Tracing (in D2) of a middle-aged mongrel, with confirmed diagnosis of hypoadrenocorticism and serum potassium at 9.0 mEq/L.



1) What is the rhythm of this tracing and what is the main reason for the occurrence of this rhythm?

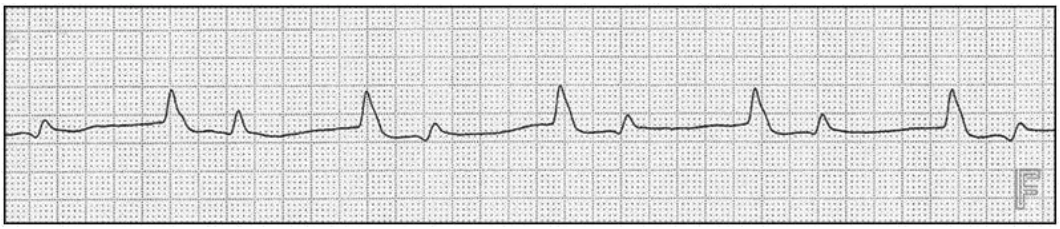
CASE 143:

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- At the onset of the tracing, there is ventricular tachycardia followed by supraventricular tachycardia (identified by P waves), which end after the sinus node recovers the command of the heart (line). There is also a fusion beat shown by the arrow.

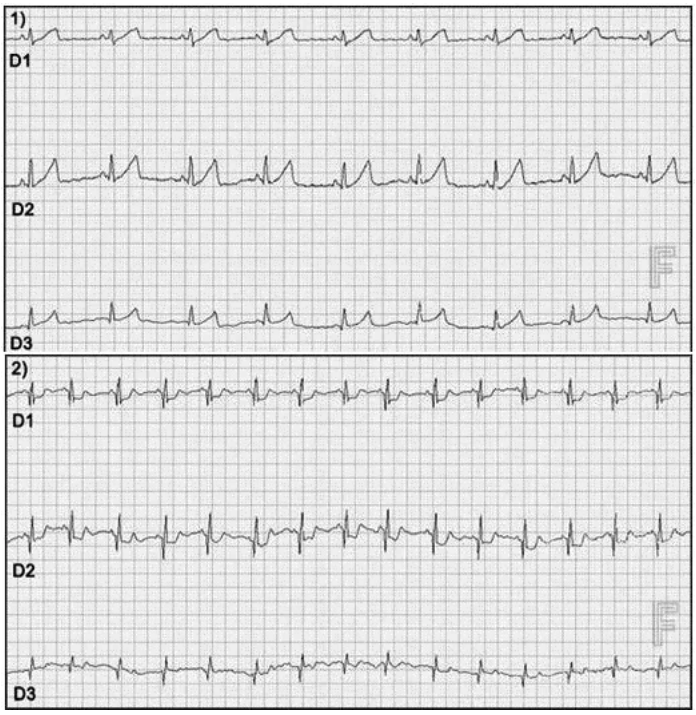
CASE 144:



- It is sinoventricular rhythm with atrial arrest. There is no atrial activity (absence of P waves), due to the atrial myocardium not depolarizing, besides a decreased heart rate, and there is inscription of wider QRS complexes. Hyperkalemia is the main cause, which leaves the atrial myocardium inexcitable, the reason why P waves are not inscribed.

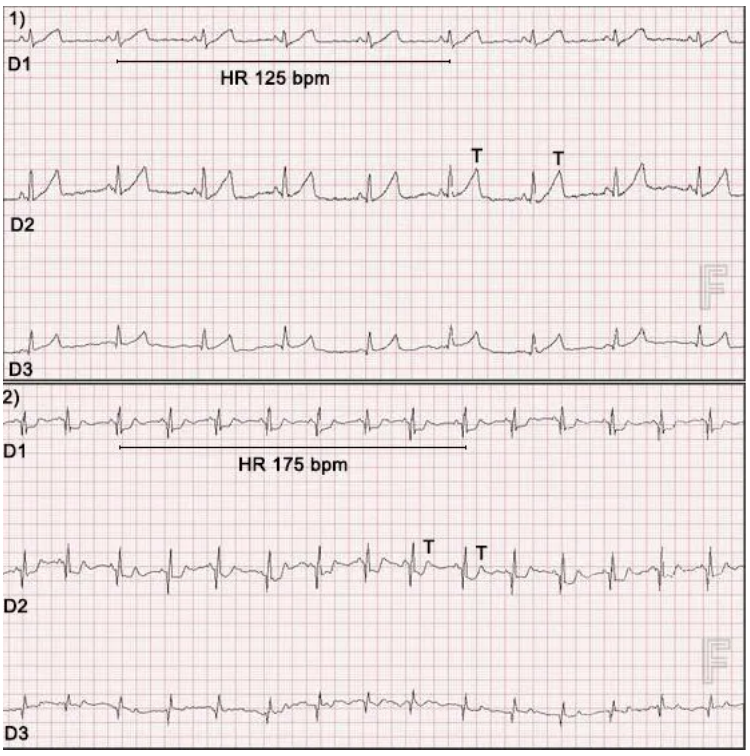
CASE 145: Tracings (in leads D1, D2 and D3) of a 3-month Yorkshire, intoxicated with tetrahydrocannabinol (plants of the Cannabis genus). The initial clinical symptoms were apathy, decubitus, ataxia, numbness and blepharospasm. Tracing No. 1 was recorded while attending the patient (1 hour after the intoxication). The patient was maintained in a regimen of hospitalization and a new recording (tracing No. 2) was made hours later, when his clinical state was better.

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1) What alterations can we see in tracing No. 1, that are no longer present in tracing No. 2?

CASE 145:



1) The substance found in the plants of this genre promote depression; that is to say, decrease the level of brain activity, leaving the organism more depressed. Check that during intoxication there is heart rate decrease (125 bpm), compared to 175 bpm observed 15 hours later. There are also ventricular repolarization alterations (increase in T wave amplitude and QT interval prolongation), indicating that there was myocardial aggression during intoxication,

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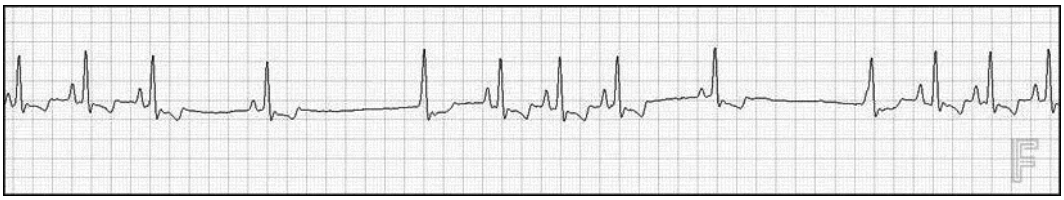
a finding that does not occur 15 hours later. The effect on blood pressure depends on the amount of weed instead. In low doses, it causes hypertension, in high doses, hypotension.

CASE 146: Tracing of a 14-year-old mongrel, weighing 12 kg. The patient presented left chambers volume overload, subsequent to chronic mitral valve disease, diagnosed by echocardiogram.



1) Before the imaging findings, and knowing that P wave and QRS complex durations are 60 ms (3q) and 100 ms (5q) respectively, what can we infer?

CASE 147: Tracing (in D2) of a 9-year-old female Pinscher, weighing 3 kg.



1) What is the base rhythm in this tracing?
2) What arrhythmias can we identify?
3) What is the relationship of a P wave that is found with an amplitude of 0.45 mv (4.5q) and the breed of this patient?

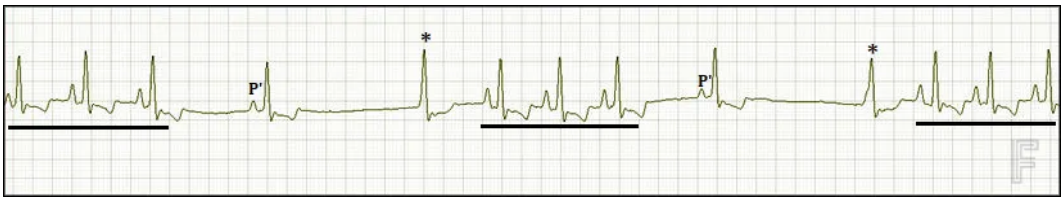
CASE 146:

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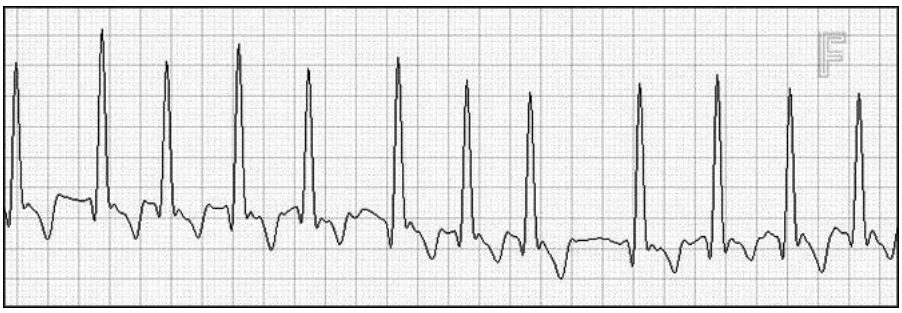
1) There is P wave duration increase, suggesting left atrial enlargement. However, the increased duration of the QRS complex duration shows that there is left bundle branch block. QRS complexes notches in aVF (arrows) reinforce the diagnosis.

CASE 147:



1) The base rhythm (indicated by the lines) is sinus tachycardia.
2) The P' waves are atrial escape beats (P waves of late inscription and morphology different from the rest), and QRS complex marked with asterisks are ventricular escape beats (ectopic complexes of late inscription, different morphology and not preceded by P waves). Both are late beats occurring as a response to sinus node automatism depression.
3) These P waves present increase in their amplitudes, can both be found in sinus tachycardias and are also seen in lung disease and very often found in small breeds affected by tracheal collapse.

CASE 148: Tracing (in D2) of a 7-year-old St Bernard. Clinical symptoms of ascites and dyspnea/tachypnea in clinical examination.



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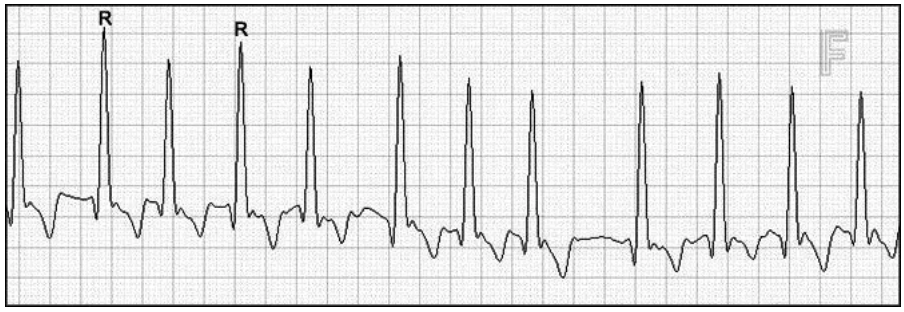
1) What is the rhythm in the tracing?
2) R wave amplitude 3.0 mv (30q) is normally accompanied by which structural alteration in the heart? Taking into consideration his size, the clinical symptoms and electrocardiographic findings, what is the diagnostic hypothesis and why?

CASE 149: Tracing (in D2) of a 13-year-old Labrador and diagnosis of acute renal failure.



1) What is the rhythm in this tracing?
2) What other alterations also can be mentioned in this tracing? Are these alterations related to the clinical condition of the patient?

CASE 148:



1) It is atrial fibrillation; a rhythm characterized by R-R distances variation, associated to P waves absence.
2) An R wave that exceeds the limits of normality, usually accompanied by left ventricular enlargement. Dilated cardiomyopathy (confirmed by echocardiogram) is one of the diseases associated to these findings.

CASE 149:



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1) The tracing starts with sinus rhythm, with a heart rate of 111 bpm. Later, there is atrial escape inscribed (arrow) = late ectopic atrial beat and with a morphology different than those P waves of sinus origin (P). Next, an atrial escape rhythm begins, characterized by three or more successive atrial escape beats (bigger arrow).
2) The P waves present increased duration, usually indicating left atrial enlargement. Besides this, there is ventricular repolarization disorder, shown by the T wave that presents increased amplitude, besides being symmetrical, in a tent shape and leaning on the QRS complex. This pattern is usually observed in cases of hyperkalemia (or hyperpotassemia). Hyperkalemia is a common finding in patients carriers of acute renal failure and it explains the alterations found.

CASE 150: Tracing (in D2) of a 12-year-old Scotch Terrier, presenting history of syncopes.



1) What is the rhythm in this tracing?
2) What is the possible relationship between this tracing and the clinical signs of the patient?

CASE 151: Tracing (in D2) of a 12-year-old female Pinscher. The patient presented dyspnea, dry cough of the choking type, ascites and jugular venous stasis.



1) What does the duration and amplitude of P wave being 60 ms (3q) and 0.8 mv (8q) respectively, mean? And what about the amplitude of the QRS complex being 2.8 mv (28q)? And the PR interval duration being 160 ms (8q)?
2) What is the relationship of the electrocardiographic findings with the clinical signs of the patient?

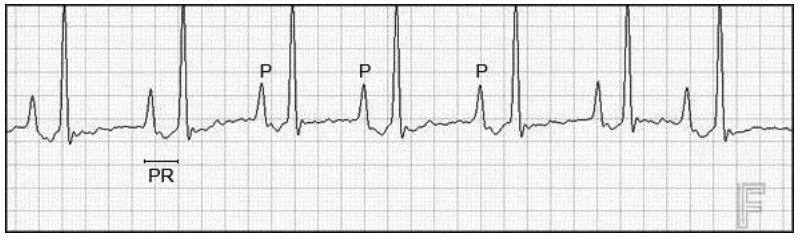
CASE 150:

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1) The tracing starts with a complex of sinus origin (S). But soon, ventricular escape rhythm arises (box), differentiated by the morphology of the wider and bizarre QRS complexes, with no presence of preceding P wave and heart rate below 40 bpm. Immediately after, this rhythm is replaced by a junctional tachycardia (arrow) (with frequency of 109 bpm), characterized by QRS complexes not preceded by P wave, but of morphology similar to the beat of sinus origin.
2) The rhythms assumed by the AV junction or by the ventricular pacemaker (the latter even more severe), generate stimuli with a rate lower than the physiological pacemaker (sinus). When these rhythms settle, they decrease the cardiac output and consequently, may cause syncopes by low brain irrigation.

CASE 151:



1) All the measures mentioned are above the value of reference. The increase in P waves amplitude and duration suggest biatrial enlargement, while R wave amplitude increase suggests left ventricular enlargement. The increase in PR interval duration (line) shows there is delay in the passage of the stimulus through atrioventricular node, characterizing 1st degree atrioventricular block.
2) The diagnostic suspicions of enlargement were confirmed by imaging diagnosis. Chest X-rays revealed cardiomegaly and echocardiogram, mitral and tricuspid valves endocardiosis. Besides this, this patient presents clinical signs of right (ascites and jugular venous stasis) and left heart failure (dyspnea).

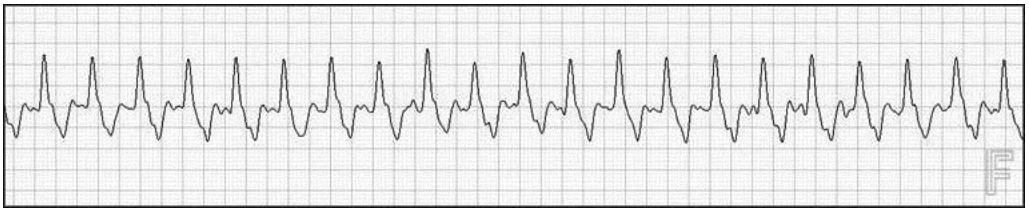
CASE 152: Tracing (in D2) of a 20-year-old mongrel.

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1) What is the rhythm in this tracing?
2) What arrhythmias are present?
3) What disease can we expect to find if faced with a QRS complex with 90 ms (4.5q) of duration and a T wave with this characteristic?

CASE 153: Tracing (in D2) of a 9-year-old Rottweiler. Test received by telemedicine.



1) What is the rhythm of this tracing?

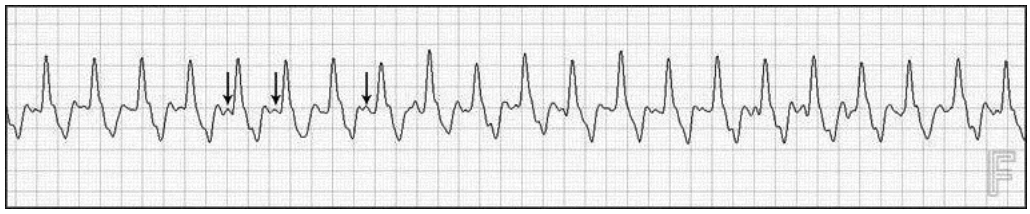
CASE 152:



1) The base rhythm (better observed by the line) is sinus arrhythmia, with heart rate ranging between 103 and 125 bpm.
2) The rhythm is interrupted by supraventricular extrasystoles triggering (arrows), that are premature ectopic stimuli with QRS complexes with configuration similar to the normal beats.
3) When there are QRS complexes with increased duration, we should think of intraventricular conduction disorders (like left bundle branch blocks). Ventricular repolarization alterations (repolarization vectors tend to oppose depolarization vectors ("QRS-T" discordant pattern)) are also typical of this conduction disorder.

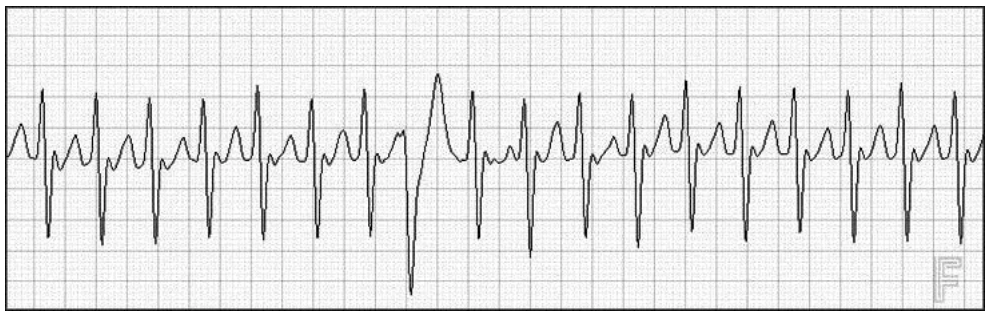
CASE 153:

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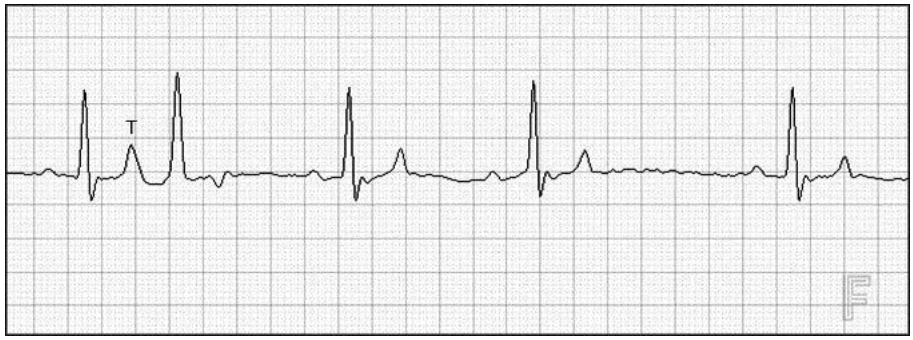
1) The rhythm is ventricular tachycardia, represented by accelerated rhythm with heart rate of 250 bpm. There are wider QRS complexes and even atrioventricular dissociation, with the arrows highlighting some P waves.

CASE 154: Tracing (in D1) of a 14-year-old female Cocker Spaniel. The patient presents biventricular increase in echocardiogram.



1) What is the rhythm in this tracing?
2) This rhythm is interrupted by what arrhythmia?

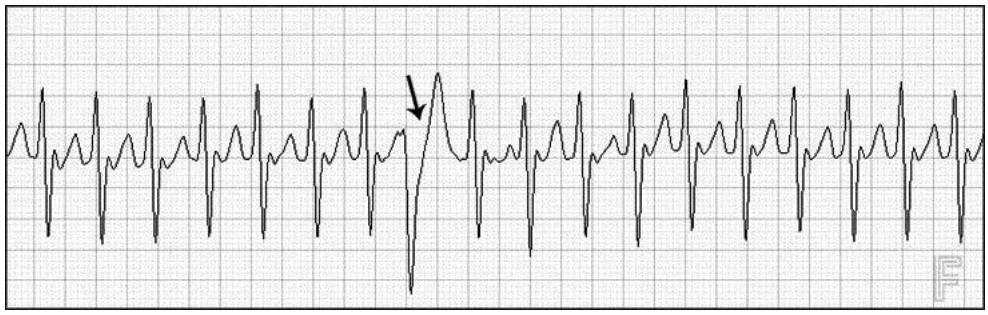
CASE 155: Tracing (in D2) of an 8-year-old mongrel. Asymptomatic patient.



1) What arrhythmia is observed in this tracing?
2) Why does the T wave in the first QRS complex present an increased amplitude in relation to the others in the tracing?

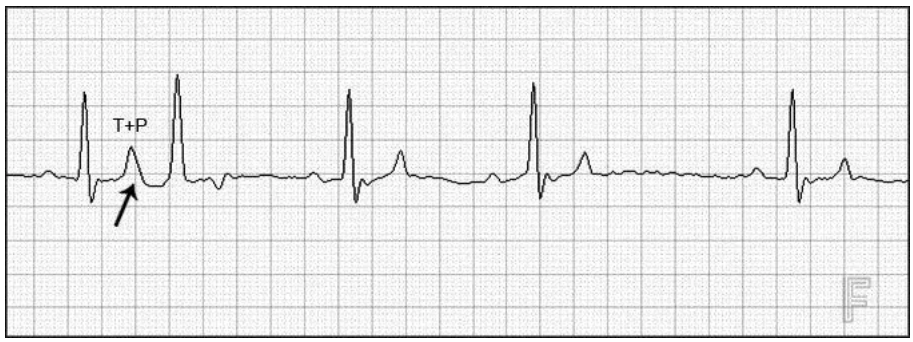
CASE 154:

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1) It´s a supraventricular tachycardia rhythm (rate of 340 bpm), since it originates above the ventricles. The supraventricular term can be used mainly when it is not possible to differentiate between sites of origin (whether atrial or junctional).
2) There is premature ventricular contraction (arrow), ectopic focus that got to be generated and spread through the myocardium, even in the presence of an arrhythmia with such a high rate.

CASE 155:



1) This is a premature contraction of supraventricular origin with aberrant conduction, as there is P wave (arrow) of early inscription, followed by QRS complex with a configuration different from the others. This indicates that the impulse was conducted to the ventricles in an anomalous fashion. The aberrance is just an impulse that finds the His bundle branches in different refractory periods, making its conduction difficult.
2) The increase is due to the T+P phenomenon; that is to say, the extrasystolic P wave is so early that is triggered overlapping onto the preceding T wave, altering its morphology. This phenomenon results in an addition of events (ventricular repolarization and atrial depolarization), so that there is a recording of a wave of greater amplitude.

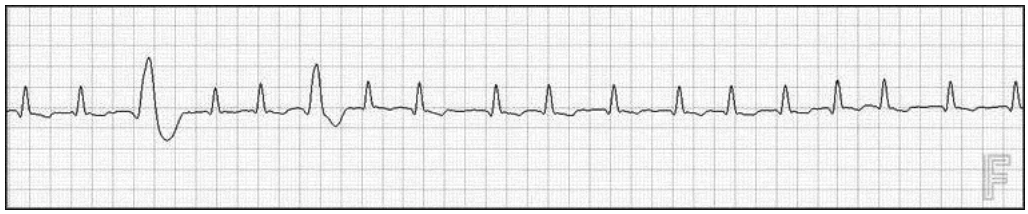
CASE 156: Tracing (in D2) of a 13-year-old Pit Bull (gender not reported), weighing 25 kg.

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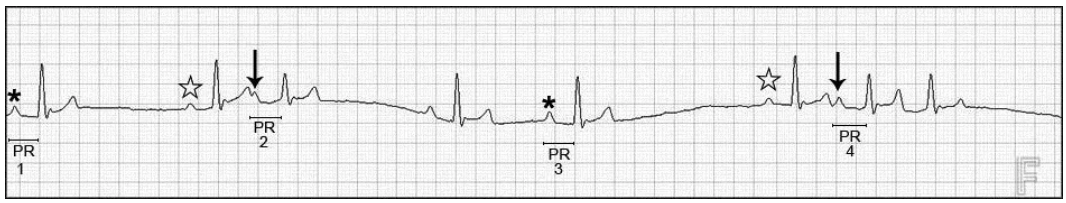
1) What arrhythmias can we see in this tracing?
2) The indicated PR intervals (lines) appear with 140 ms (7q) of duration. There are also other PR intervals with greater duration in this tracing. What does this fact explain?

CASE 157: Tracing (in D2) of a 7-year-old Boxer. Clinical symptoms of dyspnea. The patient was diagnosed with dilated cardiomyopathy, observed by echocardiogram.



1) What is the base rhythm in this tracing?
2) What arrhythmias appear in this tracing?
3) How can we relate these alterations to the base disease of the patient? Is there a possibility that this patient may have another associated disease?

CASE 156:

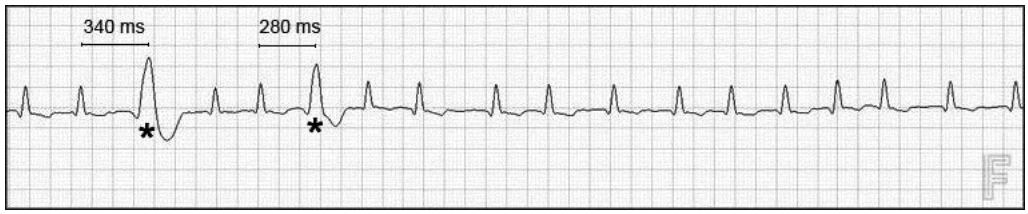


1) We observe atrial escape beats (stars), characterized by late inscription of P waves with morphologies different from those of sinus origin (*). The two arrows show atrial extrasystoles with aberrant conduction, because these atrial stimuli are so precocious that when the ventricle depolarizes, find part of the conduction system still in the refractory period.
2) The PR interval presents an increased duration (PR intervals 1 and 3), configuring 1st degree atrioventricular block. Nevertheless, PR intervals 2 and 4 are of greater duration. This phenomenon is explained by the precocity of the atrial stimulus, which finds part of

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the atrioventricular node still in the relative refractory period, thus slowing electric impulse conduction in this node.

CASE 157:



1) The base rhythm is atrial fibrillation, characterized by R-R distances variation; that is to say, irregular rhythm, and still associated to absence of P waves.
2) Also, we observe polymorphic ventricular extrasystoles (*), characterized by ectopic complexes of different morphologies and coupling periods (lines), indicating that they are impulses generated by different foci in the right ventricle (ectopic complexes with positive polarity in D2).
3) Atrial fibrillation is a rhythm frequently found in this heart disease, as atrial increase is one of the factors that predispose the occurrence of this arrhythmia. The presence of premature ventricular contractions may occur not just in dilated cardiomyopathy, but also in arrhythmogenic right ventricular dysplasia (a common disease in Boxer dogs), because the cardiomyocytes are substituted by fibrofatty tissue, which is a source generating of arrhythmias.

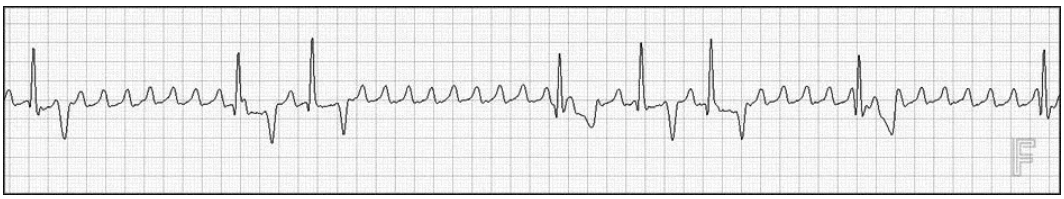
CASE 158: Tracing (in D2) of an 8-year-old Cocker Spaniel. He presented history of convulsive syncopes.



1) What is the rhythm in this tracing and what is the arrhythmia that appears after the pause observed?
2) What is the relationship between this rhythm and the symptom of the patient?

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CASE 159: Tracing (in D3) of a 12-year-old female Poodle.



1) What arrhythmia appears in this tracing?
2) What is the genesis of this arrhythmia?

CASE 158:



1) Accelerated junctional rhythm is the diagnosis of this tracing (whit heart rate of 100 bpm), characterized by narrow QRS complexes and preceded by negative P wave. After the sinus arrest, ventricular escape (*) is observed that manifested because this escape rhythm was interrupted suddenly.
2) This patient has sinus node disease. The dysfunction of his automatism leads to problems in the generation of impulses, forcing the subsidiary pacemakers (junctional and ventricular) to manifest as a defense mechanism to prevent asystole. The convulsive syncopes are due to low brain flow. This disorder causes a sudden and short loss of consciousness. When associating the clinical symptoms of this patient with the electrocardiographic test, we can conclude that the crises are triggered by sinus node dysfunction.

CASE 159:



1) This is atrial flutter with variable and irregular AV response (F waves highlighted by the lines). It is irregular because there is variable

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ventricular response (observed by R-R interval variation). The waves indicated by the arrows are also F waves, because it has the same morphology as other waves in the tracing, the typical "sawtooth" outline.

2) Atrial flutter is a type of supraventricular arrhythmia that originates from the electrical circuit of the macroreentry type, holding a large part of the right atrial tissue, including the septum, the roof, and crista terminalis region in the lateral wall and even the atrial floor near the septal fascicle of the tricuspid valve.

CASE 160: Tracing of a 14-year-old mongrel, weighing 6 kg. In echocardiogram, chronic mitral valve disease was verified, classified as class B2 (ACVIM consensus). On the right, lead D1 enhanced.



1) Does the tracing present any arrhythmia or conduction disorder? Where is the mean cardiac axis of QRS?

2) What is the relationship between the echocardiographic diagnosis and the mean cardiac axis, the duration of 70 ms (7q) of the P wave and the amplitude of 2.7 mv (27q) of the R wave?

CASE 161: Electrocardiographic tracing of a 12-year-old female mongrel, with no heart disease, and with clinical history of intense abdominal pain and vomits. The ultrasound showed symptoms of pancreatitis associated to pancreatic neoplasia. Death occurred two hours after the initial admission.

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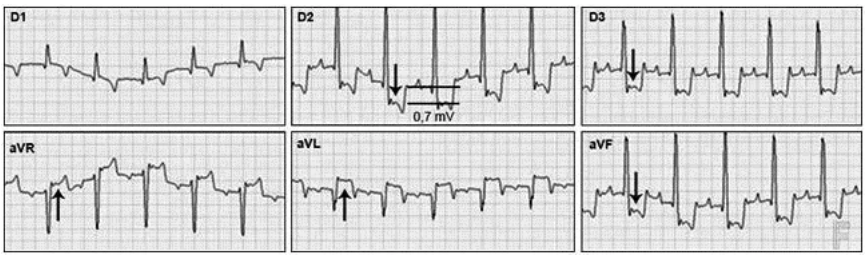
1) Is it possible to relate the electrocardiographic findings with the clinical condition/diagnosis of the patient?

CASE 160:



1) There are neither arrhythmias nor conduction disorders in this tracing. The rhythm is sinus with heart rate of 115 bpm and mean cardiac axis between 0 and 30 degrees.
2) In this tracing, the most expected findings in a patient with this echocardiographic diagnosis are found: P wave with increased duration (suggestive of left atrial enlargement), left cardiac axis shift and increase in R wave amplitude (usually seen in left ventricular enlargement). Lead D1 was chosen to be enhanced, because when there is left shift, the highest amplitude of R wave is observed in this lead (instead of in D2).

CASE 161:

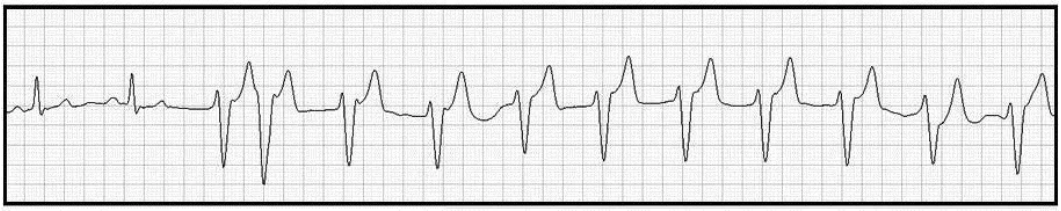


1) In the more severe cases of pancreatitis, systemic inflammatory response syndrome (SIRS) may develop. Pancreatitis can lead to

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coronary vasoconstriction, secondary to increased sympathetic traffic, promoting myocardial necrosis, including inducing thrombus formation in coronary arteries and also leading to atrial and ventricular arrhythmias and ST segment alterations. In this example, significant ST segment shifts (0.7 mv = 7q in D2) are observed in several frontal plane leads (arrows).

CASE 162: Tracing (lead D2) of a 7-year-old Boxer.



1) What arrhythmias are observed in this tracing?

CASE 163: Tracing of an 18-year-old Yorkshire. Clinical symptoms of chronic dry cough of the choking type and the presence of systolic murmur, IV/VI intensity in mitral focus. Chest X-rays showed pulmonary calcification and no signs of alteration in the cardiac area. There was clinical improvement after the administration of aminophylline, a drug promoting bronchodilation.



1) Comparing the clinical case to the electrocardiogram, what conclusion can we draw, knowing that P wave amplitude is 0.5 mv (5q) and QRS complex duration is 80 ms (4q), in lead D2?

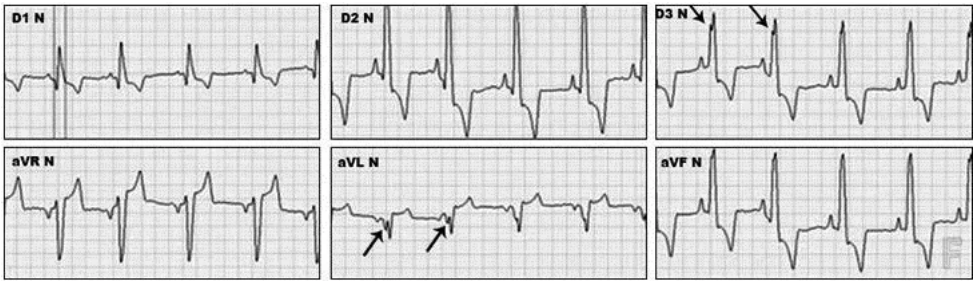
CASE 162:



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1) 1) After the two beats of sinus origin (S), and highlighted by the asterisk, there is the beginning of an accelerated idioventricular rhythm (frequently 137 bpm). The ectopic complex indicated by the arrow is a ventricular extrasystole originating in a site adjacent to the installed rhythm, as its morphology undergoes little variation (including in ventricular repolarization, with a slight difference in T wave amplitude). Furthermore, this ventricular extrasystole is so precocious that it overlaps the T wave of the preceding ectopic complex. This phenomenon is called R over T.

CASE 163:



1) The clinical case presented suggests chronic mitral valve disease; however, the electrocardiogram does not show the signs of the disease, such as P wave duration increase, but it does show increase in their amplitude (P pulmonale). There are also increase in QRS complexes duration (associated to QRS complexes notches –arrows- observed in some leads), findings indicative of intraventricular conductions disorders. Chest X-rays showed pneumopathy (responsible for the cough) and absence of alterations in the cardiac area, a fact that explains the electrocardiographic alterations.

CASE 164: Tracing (in D2) of an 11-year-old Cocker Spaniel and asymptomatic.



1) What is the rhythm and what is the arrhythmia present in this tracing, knowing that heart rate is 79 bpm and QRS complex duration is 90 ms (4.5q)?

CASE 165: Tracing (in D2) of a 6-year-old female Pit Bull. The animal did not have a history of heart diseases. Diagnosis of pyometra.

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1) What arrhythmia is present in this tracing?
2) Is there a relationship between this arrhythmia and the clinical condition of this patient?

CASE 164:



1) The rhythm is sinus. There are alterations suggesting right bundle branch block, as the QRS complex exceeds 80 ms (4q) and its final portion is wider, in addition to the ventricular repolarization alteration (increase in T wave amplitude that is opposite to the QRS complex) and even with predominance of negative area in D2, that is a common finding in this conduction disorder. P waves are of low voltage.

CASE 165:



1) Paroxysmal ventricular tachycardia is the arrhythmia that this tracing presents.
2) Yes. Any extracardiac condition causing symptoms of toxemia or hypoxia could be a triggering factor for this severe tachyarrhythmia, even though the patient may not be a heart disease carrier.

CASE 166: Tracing (in aVR) of a 2-year-old Siamese cat, presenting infection in his scrotum, hypothermia (T 30.5°C), dehydration

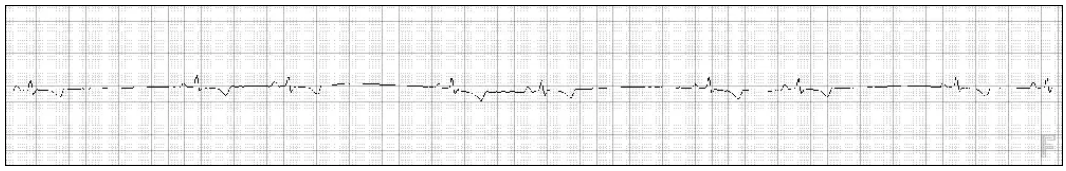
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and decubitus.



1) What arrhythmias are present in this tracing?
2) Is the ST segment leveled? Is there a relationship between the latter and the clinical state of the cat?

CASE 167: Tracing (in lead D2) of an 8-year-old female Shih Tzu, weighing 6 kg. She presented cough and dyspnea during the test.



1) What arrhythmias appear after the pauses.

CASE 166:

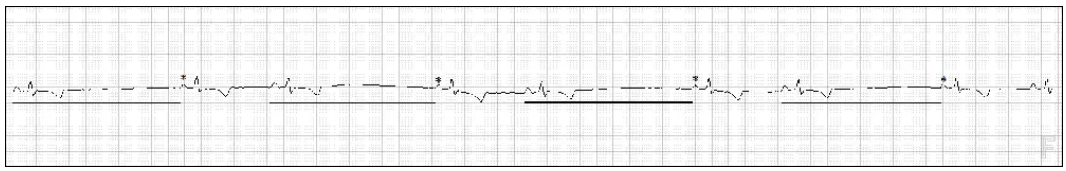


1) The tracing presents a premature ventricular contraction (asterisk) and also junctional extrasystole (first arrow of tracing). The presence of negativization of the T wave (T) in this supraventricular extrasystole is very suggestive of severe myocardial lesion, often by hypoxia.
2) No. There is ST segment elevation (last two arrows of tracing), that could be observed depending on the degree of hypothermia.

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Arrhythmias (mainly ventricular ones) may occur in this clinical condition.

CASE 167:



1) After the longer pauses (shown by lines), there are atrial escapes (asterisks). P wave morphology shown by the tracing, may indicate the origin of the site of right atrial depolarization. In this case, as the P wave of the escape beats presents a morphology similar to those of sinus origin, we could say that they originate at the crista terminalis (transverse muscular ridge, close to the sinus node).

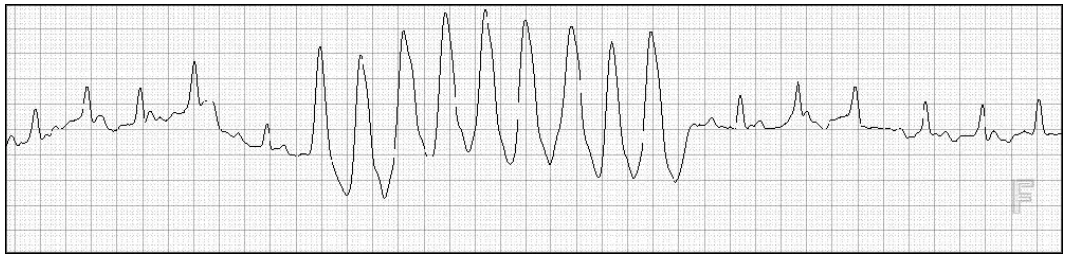
CASE 168: Tracing (in lead aVF) of a 9-year-old Whippet, weighing 15 kg.



1) What arrhythmias can we see in this tracing?
2) What can these mean these notches in the R waves mean?

CASE 169: Tracing (lead D2) of a 13-year-old female Boxer. She presented frequent syncopes and history of sudden cardiac death in her ancestors. Besides the arrhythmia, the electrocardiogram also showed axis shift to the right and the two-dimensional echocardiogram showed moderate increases in the right atrium and ventricle diameters.

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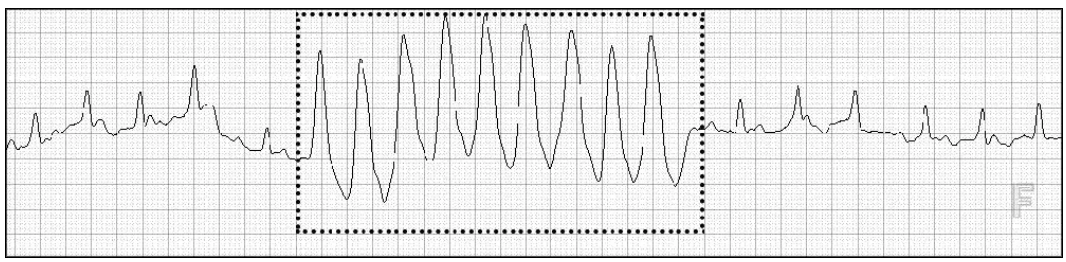
1) What is the diagnosis of this arrhythmia?
2) What is the main clinical suspicion?
3) What is the definitive diagnosis to confirm it?
41) Is the age of the patient related to the finding?

CASE 168:



1) The asterisks indicate premature atrial contractions; i.e. the presence of P waves of early inscription, leaning on the T waves of the beats that precede them (also check the shortening of R-R distances, indicated by the lines). There is junctional extrasystole too (star), characterized by negative and early P wave (smaller arrow). Just as with the premature atrial contraction, there is R-R distance shortening.
2) The notches indicate a non-specific disturbance of intraventricular conduction.

CASE 169:



1) The highlighted arrhythmia is an episode of nonsustained paroxysmal ventricular tachycardia.

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2) Dilated cardiomyopathy evolving with arrhythmias is the main suspicion. Anyway, we cannot dismiss the concomitance of arrhythmogenic right ventricular dysplasia.
3) Besides the clinical history and physical examination, some additional tests are useful to support the diagnosis, such as 24-hour Holter and echocardiogram.
4) The arrhythmogenic right ventricular dysplasia is a disease manifesting in adult animals, and the older they are, the more severe the arrhythmia.

CASE 170: Tracing (in D2) of a 12-year-old Poodle. The patient has a diagnosis of chronic mitral valve disease and left ventricular and atrial enlargement.



CASE 171: Tracing (in D2) of a 12-year-old Yorkshire. The patient has a diagnosis of chronic mitral valve disease with left ventricular and atrial enlargement.

1) What is the arrhythmia present in case 170? What is the arrhythmia present in case 171?



2) How can we differentiate electrocardiographically both arrhythmias?
3) What is the probable cause of the two arrhythmias?

CASE 170:

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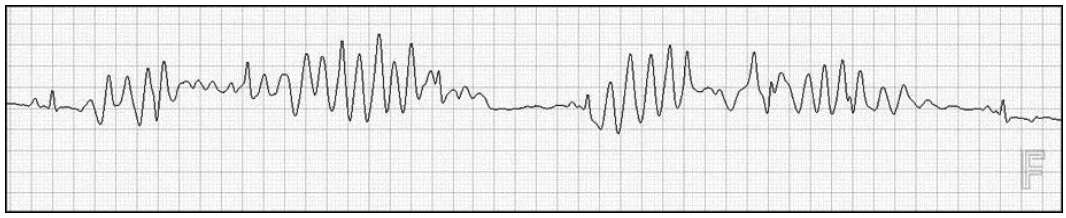
CASE 171:



1) In both cases, they can be considered as supraventricular tachycardias, and case 170 has all the characteristics of being of sinus origin, due to the amplitude of the P waves (the increase in the sympathetic tonus causes the pacemaker to migrate dominant for the posterosuperior portion of the sinus node, which may also increase the P wave voltage), whereas in case 171 the exact opposite is observed (low amplitude P waves, with probable origin in the lower atrial region), suggestive of of focal atrial tachycardia.
2) In the case 170 the rate is so high (230 bpm) that the P waves get to touch the T waves of the preceding beats; but the P waves are observed completely. However, in case 171, the heart rate is also high (215 bpm), but in this case the premature P waves are not perfectly visible and they get to fuse with the T waves of the preceding beats, forming a figure similar to an inverted Z (shown in the tracing). Even when neither the beginning nor the end of atrial tachycardia is identified, it may be difficult to differentiate it from sinus tachycardia itself.
3) Sinus tachycardia is a rhythm determined by the natural pacemaker of the heart (sinus node), which is high, because of exacerbated activity of the sympathetic nervous system. The cause of increased sympathetic tone could be a compensatory stimulus before the base heart disease, or be secondary to extracardiac causes. However, an atrial tachycardia is a more severe arrhythmia, that is usually started from a premature contraction of atrial origin, (usually secondary to heart disease) perpetuating in the atrial myocardium by exacerbated automatism (reentry phenomenon), with several consecutive premature atrial contractions being inscribed.

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CASE 172: Tracing (in D2) of a 4-year-old mongrel, connected to a cardiac monitor, after having been run over by a car.



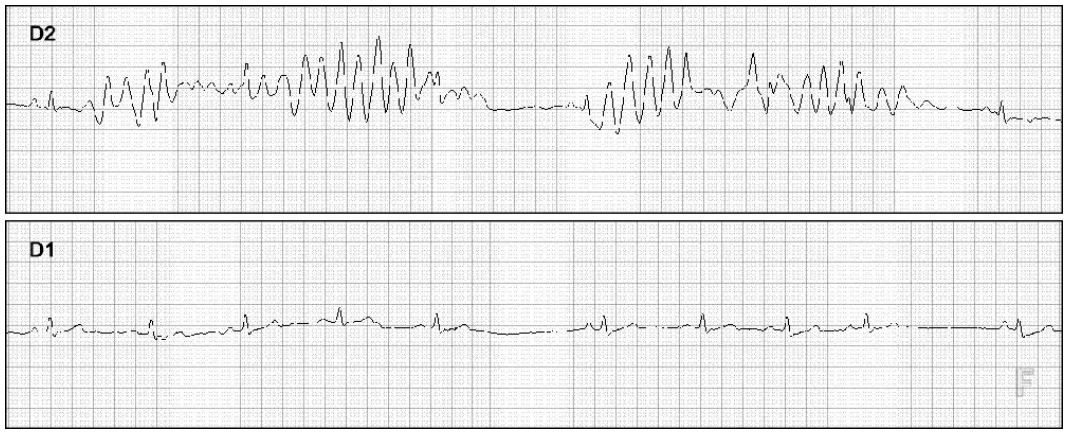
1) What alterations are present in this tracing?

CASE 173: Tracing of an 8-year-old Persian cat. Asymptomatic patient.



1) What would be the diagnostic hypothesis based on this tracing, knowing that the QRS complex measures are: duration 70 ms (3.5q) and R wave amplitude in D1 1.9 mv (19q)?

CASE 172:



1) The tracing suggests an episode of Torsade de pointes (a modality of polymorphic ventricular tachycardia), when only one lead in the cardiac monitor is evaluated. Anyway, when continuing with another lead (D1), it is observed that they are only technical artifacts.

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CASE 173:



1) The measures exceed the patterns of normality for a healthy cat. The increase in R wave amplitude, associated to cardiac axis at its limit for a left shift, are criteria strongly suggesting left ventricular enlargement, a fact confirmed by the echocardiographic test, which showed the presence of hypertrophic cardiomyopathy. We should take into consideration that the QRS complex exceeding 60 ms (3q) in cats, could be synonyms of lesions in the His bundle left branch, which would not be rare in this case, because of the hypertrophy caused by this heart disease.

CASE 174: Tracing (lead D2) of a 13-year-old mongrel. Clinical symptoms of pulmonary and back limbs edema, cyanosis and ascites.



1) What is the base rhythm in this tracing?
2) What is the arrhythmia present in this tracing?
3) Based solely on the base rhythm, what is the possible conduction disorder existing, before a QRS complex of negative polarity in D2 and with 100 ms (5q) of duration and why does it occur?

CASE 175: Tracing (in D2) of a 12-year-old Maltese. The presence of arrhythmia was detected in the clinical examination.

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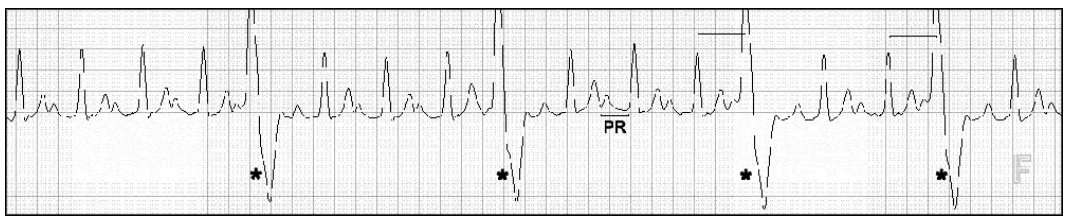
1) What is the base rhythm in this tracing?
2) Knowing that the PR interval duration is 140 ms (7q), what arrhythmias appear in this tracing?

CASE 174:



1) The base rhythm is sinus, observed in the first 7 QRS complexes.
2) We identified a supraventricular extrasystole (arrow) and immediately after, a beat of sinus origin (*). From the bigger arrow, a rhythm of supraventricular tachycardia starts (the QRS complexes even widened are of the same morphology as those of sinus origin).
3) QRS complexes with negative area predominance in D2 that exceeds 80 ms (4q), with their end portion wider and still associated to ventricular repolarization alteration (tall T waves and with polarity opposite to the QRS complex) is a finding very suggestive of right bundle branch block. In this case, this alteration should be occurring as a consequence of right ventricular overload.

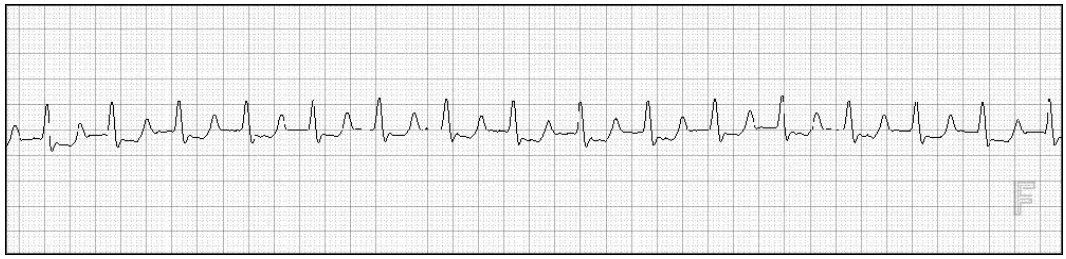
CASE 175:



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1) Sinus tachycardia with heart rate of 215 bpm. There is a clear increase in the RR segment configuring 1st degree atrioventricular block. Also, there are monomorphic ventricular extrasystoles (*) of positive polarities in D2, indicating that they originate in the right ventricle. As they are monomorphic extrasystoles and still present constant coupling intervals (larger markings), it suggests a reentry mechanism.

CASE 176: Tracing (in D2) of a 10-year-old Labrador. Clinical symptoms of apathy and tachycardia in cardiac auscultation.



1) What is the rhythm in this tracing?
2) Where is the P wave located and why?

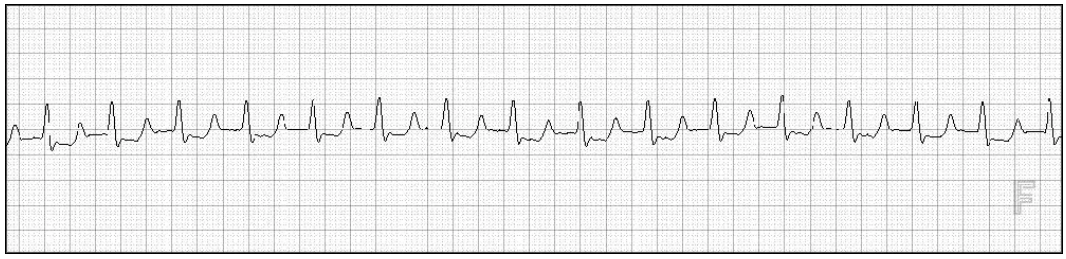
CASE 177: Tracing (lead D2) of a 1-year-old female Boxer. Recording made before sedation procedure.



1) What is the rhythm in this tracing?
2) By analyzing only the PR intervals duration, what conclusion can we draw?
3) What is the care required during the sedation of this patient?

CASE 176:

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1) It is a supraventricular tachycardia with a heart rate of 222 bpm.
2) Tachycardias with a narrow, regular QRS, and in which the P waves are not identified, nor can we observe the transition from the base rhythm, it is difficult to distinguish the exact place of their origin, because both in atrial tachycardia and in sinus tachycardia, the P wave may overlap with the preceding T wave. Even though intranodal tachycardia is an entity that is still suspected of its existence in dogs, the P wave can be found within the QRS (and without signs of P waves, which can deform the QRS), since the activation of the atria and ventricles is almost simultaneous. To distinguish them, maneuvers and/or drugs can be used to aid in a more accurate diagnosis.

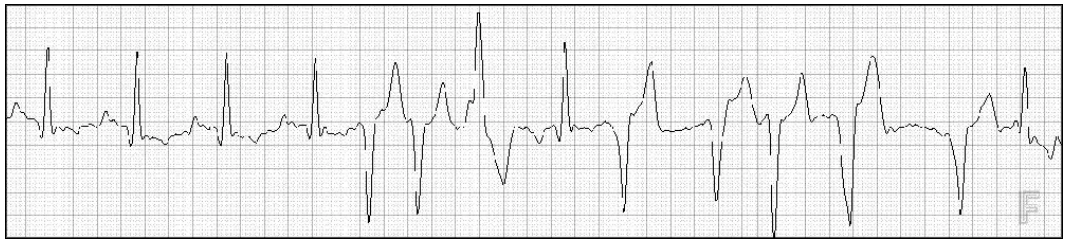
CASE 177:



1) It is a sinus arrhythmia, with heart rate ranging between 88 and 111 bpm.
2) Besides all PR intervals being beyond the limits of normality, these vary between 160 ms (8q) and 220 ms (11q). When there is variation in the duration of this interval, (within or outside normality), there are indeed, difficulties in the passage of the stimulus through the atrioventricular node, characterizing 1st degree atrioventricular block.
3) For patients presenting this condition, it is suggested to avoid alpha-adrenergic agonists, such as xylazine, medetomidine, and dexmedetomidine, among others, because of the depression exerted by these drugs on the AV junction.

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CASE 178: Tracing (in D2) of a 9-year-old Pointer. Clinical symptoms of frequent syncopes, dyspnea and apathy, after the onset of treatment with antiarrhythmic drugs.



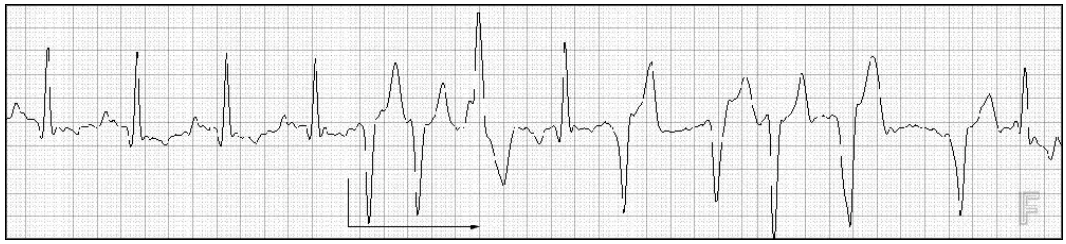
1) What is the initial base rhythm in this tracing?
2) What arrhythmia is observed next?
3) What is the probable cause of the arrhythmia?

CASE 179: Tracings (in D2) from the same patient: 12-year-old mongrel (gender not reported) and weighing 11 kg.



1) What is the rhythm of the first tracing?
2) What happened in the second tracing?

CASE 178:



1) The base rhythm is sinus, observed during the first four QRS complexes at a heart rate of 157 bpm.
2) Since the fourth complex (arrow), a rhythm of polymorphic ventricular tachycardia starts, characterized by the presence of at

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least two ventricular ectopic complexes with different morphologies in the same lead.

3) This is one of the types of ventricular tachycardia that may arise in patients that are using antiarrhythmic medications. This collateral effect is called proarrhythmic. Besides antiarrhythmic drugs proper, psychotropic drugs, such as cyclic antidepressants, antibiotics such as erythromycin and sulfamethoxazole-trimethoprim, and antihistamine drugs, may predispose the occurrence of events, as in this case.

CASE 179:



1) The rhythm is sinus with significant increase in the PR interval (smaller line), indicative of 1st degree atrioventricular block and still P waves of increased amplitude. In the first tracing, after the second complex, there is the presence of sinus pause (bigger line).
2) A sinus tachycardia has occurred, with the P waves inscribing at the same time as the preceding T waves.

CASE 180: Tracing (in D2) of a 12-year-old Poodle and weighing 9 kg. Patient diagnosed with chronic mitral valve disease. Clinical symptoms of cough, dyspnea and tachypnea.

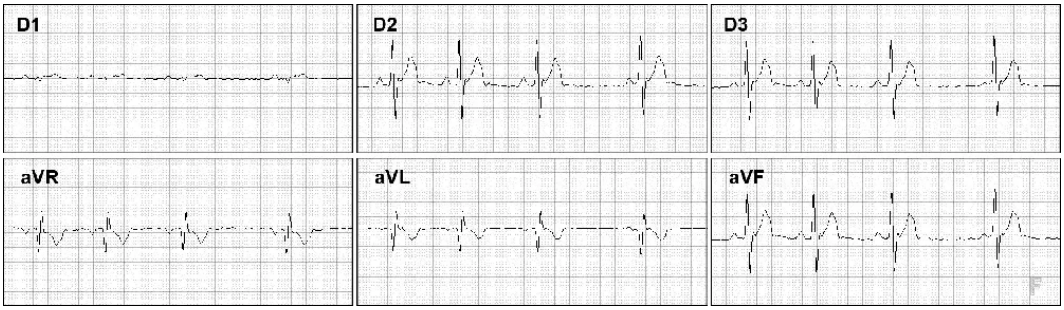


1) What is the rhythm in this tracing?
2) What other alterations are present in this tracing, knowing that P wave duration is 50 ms (2.5q)?

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3) What is the relationship of them with the finding in diagnosis by imaging?

CASE 181: Tracing of a 9-year-old female mongrel, weighing 5 kg and using enalapril.



1) What does the appearance of S waves mean in D2, D3 and aVF? What is the significance of this finding?
2) Can the increase in P wave duration, that in this case is 60 ms (3q), help us in the differential diagnosis?
3) Is there any arrhythmia in this tracing?

CASE 180:



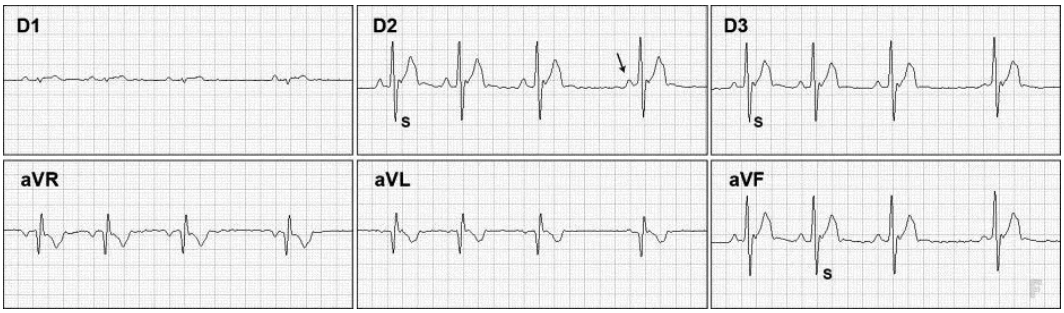
1) It is a rhythm of sinus tachycardia with heart rate of 166 bpm.
2) Besides the increase in P wave indicating that there is left atrial enlargement, the PR segment is very short and the P waves extremely close to QRS complexes. It is a short PR interval syndrome, because there is practically no PR segment. The diagnostic hypotheses are based on the presence of accelerated AV

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conduction (a variant of normality), or even on the presence of ventricular pre-excitation.

3) A wider P wave is expected to be found in dogs suffering mitral valve disease. However, short PR is not related to heart disease, being an electrocardiographic finding.

CASE 181:



1) The presence of S waves means activation delay of the basal portions of the heart, that are regions of the myocardium present both in the right ventricle and in the left ventricle, and also in the interventricular septum. The presence of S waves may indicate there is left or right ventricular enlargement and/or hypertrophy, or in both chambers. T waves with more than 25% of R waves amplitudes (mainly in D2), reinforce this suspicion, indicating that there is ventricular repolarization alteration.

2) There is P wave duration increasing, which could be related to left atrial enlargement. As left ventricular enlargement is usually accompanied by left atrial enlargement, the probable cause of S waves appearance would be left ventricular chamber increase.

3) There is a pause before the last cardiac beat, followed by atrial escape (arrow), characterized by delayed P wave inscription, with a morphology different from the rest.

CASE 182: Tracing (in D2) of a 15-year-old mixed Siamese cat.
Asymptomatic patient.



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1) What arrhythmia is present in this tracing?
2) Is it a common occurrence in cats?

CASE 183: Tracing (in D2) of an unidentified dog, from a test received by telemedicine. Figure 2 follows Figure 1.



1) What arrhythmias are observed in these tracings?

CASE 182:



1) It is a sinus bradycardia rhythm with a heart rate ranging between 120 and 150 bpm.
2) It is rarely observed in this species and is almost always a sign of pathology, and should be considered a serious rhythm. The heart rate variability observed may be related to an imbalance in the autonomic nervous system or a certain sinus node dysfunction.

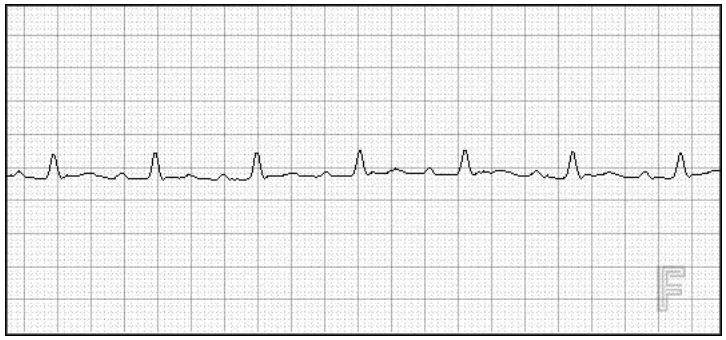
CASE 183:

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1) The tracing starts with sinus rhythm (S). After the second complex, a supraventricular extrasystole (P') is inscribed, probably of low atrial origin, due to its PR interval being longer than the PR interval observed in sinus rhythm. Then a rhythm of paroxysmal atrial tachycardia begins, (shown by the arrow).
2) This is interrupted by 2nd degree atrioventricular block (*). The sinus pause that follows indicates that the sinus node is still depressed by the pacemaker cells that dictated the previous rhythm, and because of absence of electrical activity, next an escape beat originating in the ventricular myocardium (star) is inscribed, which was not in the refractory period and that was capable of triggering an action potential. After this event, the sinus node recovers its dominance, observed by the last two complexes in the tracing (S).

CASE 184: Tracing (in D2) of a mixed cat, with unknown age. Preanesthetic test.



1) What can we state about the 100 ms (5q) duration of the PR interval, observed in this tracing?
2) Should we avoid using a sedative in this cat, before such finding?

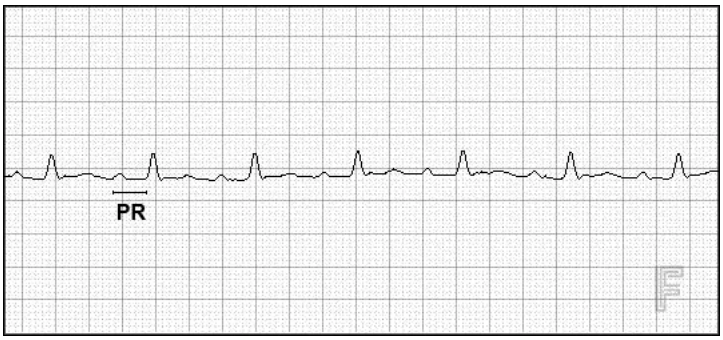
CASE 185: Tracing (in D2) of an 11-year-old female Pit Bull, weighing 33 kg.



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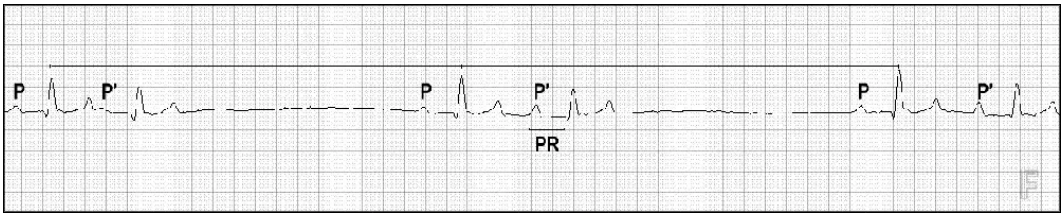
1) What arrhythmias appear in this tracing, knowing that P wave and PR interval duration is 60 ms (3q) and 180 ms (9q), respectively?

CASE 184:



1) We could state that the PR interval is beyond the limit of normality, as the normal value is up to 90 ms (4.5q), indicating that there is a 1st degree atrioventricular block.
2) The use of alpha-adrenergic agonists (e.g., xylazine, medetomidine and dexmedetomidine) should be avoided in this patient, as they reduce conduction through the atrioventricular node, and predispose the occurrence of more significant blocks, even total atrioventricular block.

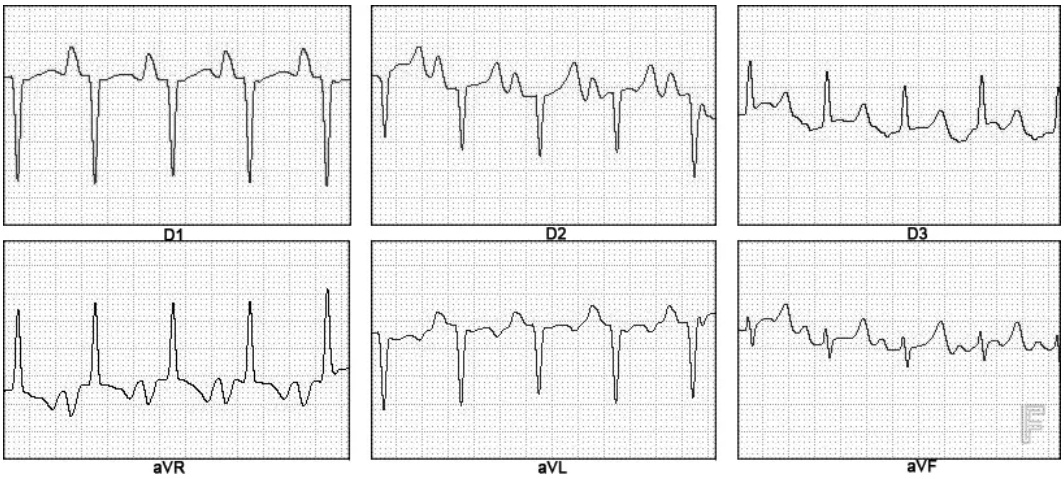
CASE 185:



1) The main arrhythmia that could be observed is bigeminy of atrial origin, characterized by the presence of P waves of early inscription (P') and morphology different from the P wave of sinus origin (P). Rhythm characterized by the presence of beats of sinusal origin interspersed with atrial extrasystoles (conducted with aberrancy). Additionally, all P waves, of sinus origin or of atrial ectopic focus, are conducted slowly through the atrioventricular node (increased PR interval duration), indicating that there is concomitant 1st degree atrioventricular block. It is worth emphasizing also, the presence of sinus pauses (lines), and P wave with increased duration, suggestive of left atrial overload.

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CASE 186: Tracing of a 45-day female Persian cat. Clinical symptoms of weight gain deficit since birth and dyspnea for approximately 3 days. Presence of holosystolic murmur in the sternal region. Diagnosed with ventricular septal defect in post-mortem examination.



1) With what can we relate the measures (observed in D1): QS pattern in QRS complex and with 1.9 mv (19q) of amplitude; P wave with 0.5 mv (5q) of amplitude and 60 ms (3q) of duration, and the finding in the necropsy?

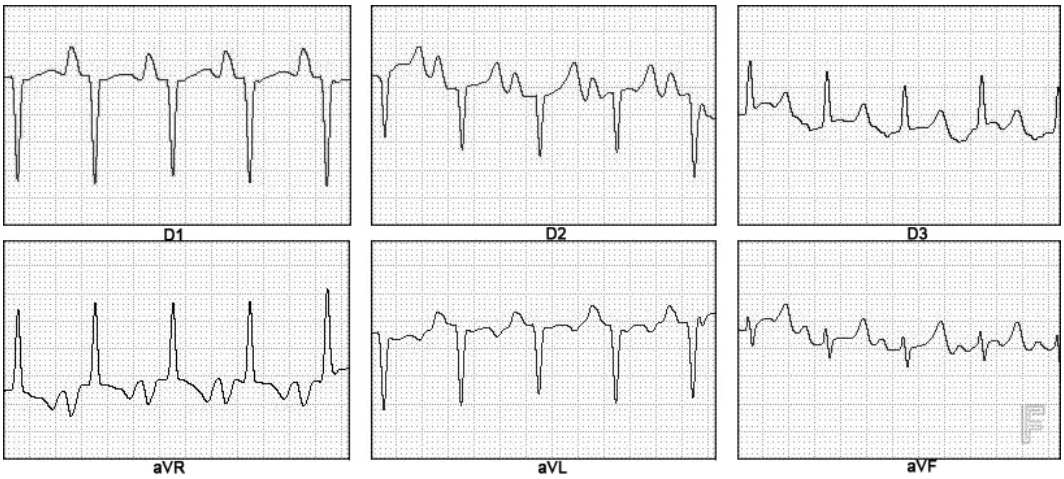
CASE 187: Tracing (in D2) of a 12-year-old female Poodle. Recording velocity 25 mm/s.



1) What is the cause of the PR and ST segments morphology in this tracing?

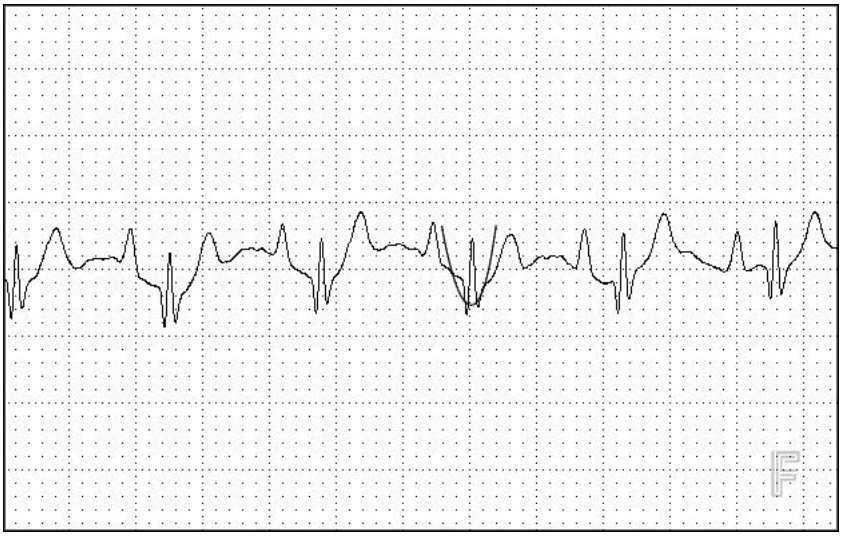
CASE 186:

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- Both the amplitude and duration of P waves are increased, indicating there is biatrial enlargement. The increase in QRS complex amplitude, associated with mean cardiac axis shift (180 degrees) is suggestive of biventricular enlargement. In fact, there was cardiomegaly in necropsy.

CASE 187:



- It is possible to notice that both segments (PR and ST) are depressed (arrows). This finding is due to ST segment pseudo-depression; that is to say, a "false" depression of the segment. This finding is related to the inscription of an atrial repolarization wave (Ta), usually secondary to right atrial enlargement. We know that ST segment shift does not come from myocardial ischemia, because atrial repolarization continuity is better visualized if we trace a parabola (illustrated in the tracing), showing the continuity of the two segments. Nevertheless, in human medicine this alteration is known as PR and ST with "anchor" shape and occurs in stressful situations.

CASE 188: Tracing of a 3-month-old Blue Heeler. Diagnosis confirmed of pulmonary valve stenosis and right ventricular hypertrophy,

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verified in echocardiogram.



1) Where is the mean QRS axis and what is your relationship with the data obtained from Doppler echo?
2) In the figure at the right, lead D2 is enhanced. What is the relationship of P wave amplitude measuring 0.8 mv (8q) with the clinical case?

CASE 189: Tracings of a 6-year-old female Labrador Retriever. The tracing at the left was recorded before the onset of therapy with doxorubicin and at the right, one week later.



1) Comparing the tracings recorded before and after using this chemotherapy, what alterations does the tracing recorded one week later present?
2) Are these alterations related to the use of this drug, which presents antineoplastic properties?

CASE 188:



1) The cardiac axis is at 180 degrees, showing that it is shifted to the right. This information suggests there is right ventricular enlargement, an alteration caused by symptoms of pulmonary valve stenosis.

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2) P wave amplitude is increased in its voltage (called P pulmonale), indicating there is right atrial enlargement, as a response to the increase in right ventricular impedance to the flow, through the pulmonary artery.

CASE 189:



1) Two ventricular extrasystoles (arrows) are observed, with origin focus in the right ventricle, due to your positive polarity observed in D2.
2) Yes, doxorubicin is cardiotoxic anevd the first alterations viewed immediately after its use are arrhythmias. For this reason, it is advisable to perform an electrocardiogram after each session applying this drug. Above all, its prolonged use may induce development of dilated cardiomyopathy in dogs. Thus, if arrhythmias are observed since the beginning of therapy, it is necessary to evaluate the possibility of interrupting the treatment with this drug.

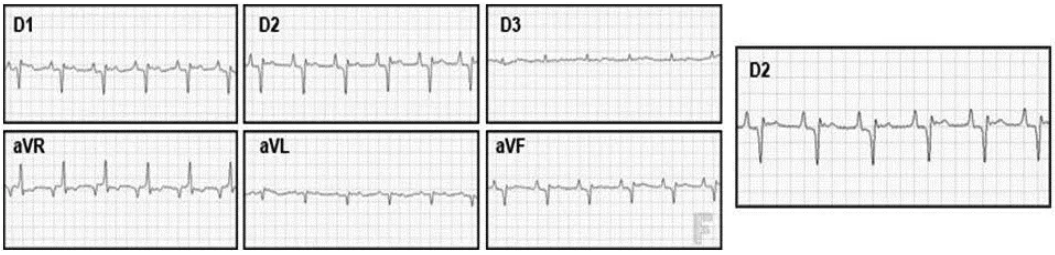
CASE 190: Tracing (in D2) of a 13-year-old Dachshund. Diagnosis of mitral and tricuspid valves disease by Doppler echo and cardiomegaly in chest X-ray.



1) What alterations are observed in this tracing? Measures: P wave with 80 ms (4q) of duration and 0.5 mv (5q) of amplitude; PR intervals reach 200 ms (10q).
2) How are they related to the heart disease of the patient?

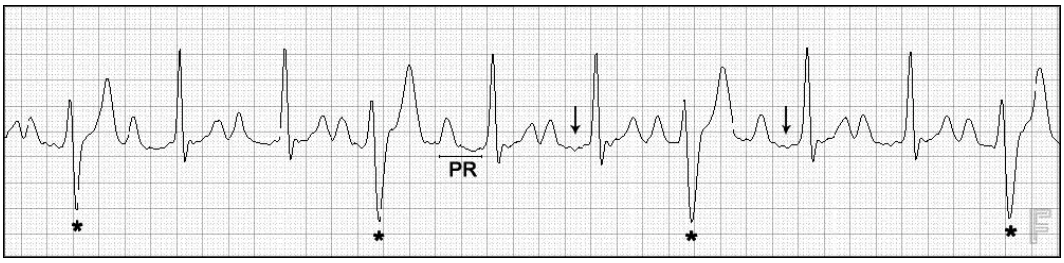
CASE 191: Tracing of a 13-year-old Maltese. Clinical symptoms of cough, cyanosis, dyspnea and intolerance to exercise. Diagnosed with pulmonary hypertension by Doppler echo.

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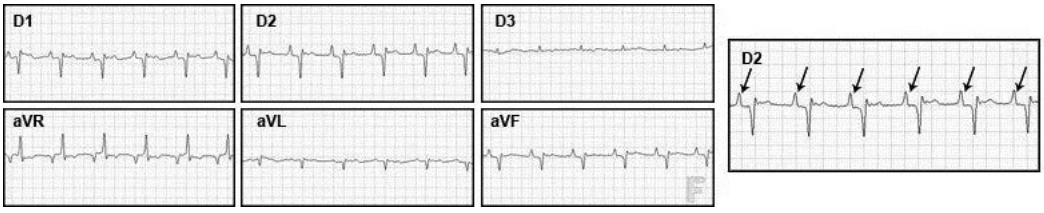
1) Where is the mean electrical axis of the QRS complex?
2) What is the relationship of the position of the axis with P wave amplitude 0.5 mv (5q), observed better in enhanced lead D2, with the condition of the patient?

CASE 190:



1) Both P wave measures are increased (duration and amplitude) suggesting there is biatrial enlargement. The PR intervals are beyond the normal values (lines), characteristic of 1st degree atrioventricular block. Also, extrasystoles are seen, originating from the left ventricle (negative polarity in D2 *). There is even PR segment depression (arrows), subsequent to the appearance of Ta wave (atrial repolarization), secondary to right atrial enlargement.
2) The findings found are compatible with the symptoms of the patient, as the increase in all chambers indicates that the heart disease is advanced. The genesis of the extrasystoles could be due to the aggression suffered by the fibers, due to cardiac remodeling (related to the appearance of ectopic foci).

CASE 191:



1) The cardiac axis is between -120 and -150 degrees; i.e. is shifted to the right.

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2) The electrical axis shifted to the right and the P wave exceeding the limits of normality (P pulmonale) are related to right ventricular and atrial enlargement, respectively. This patient presented even right congestive heart failure, of etiology still unknown.

CASE 192: Tracing (in D2) of an 8-year-old Siberian Husky.
Asymptomatic patient.



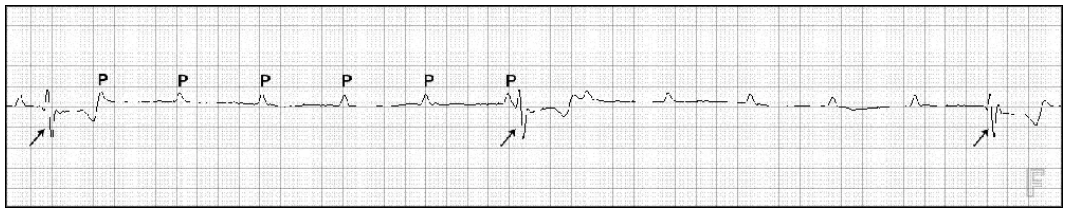
1) What arrhythmia is present in this tracing?
2) Is it expected to find this arrhythmia in an apparently healthy dog?

CASE 193: Tracing (in D2) of a 7-year-old female German Shepherd.



1) What is the rhythm in this tracing? Knowing that P wave and QRS complex duration are 60 ms (3q) and 100 ms (5q), respectively; and R wave amplitude is 2.8 mv (28q), the tracing suggests left ventricular enlargement or left bundle branch block?

CASE 192:



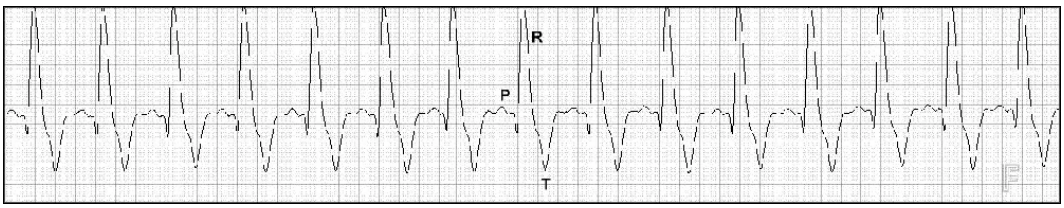
1) It is total or 3rd degree atrioventricular block, with ventricular rhythm of escape (arrows). The sinus node generates stimuli (P) at a

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rate of 150 bpm; however, they are all blocked. In this case, because of the low ventricular rate it is likely for the block to be in the His-Purkinje system. Ventricular escape beats are defense mechanisms of the ventricle to prevent the occurrence of asystole and to attempt to keep a minimum cardiac output.

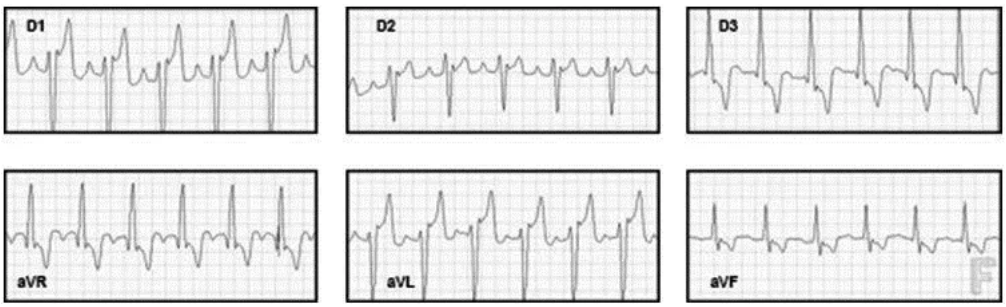
2) Absolutely not! According to the recorded tracing, cardiac output is extremely low (heart rate of 27 bpm) and this patient should be presenting evident clinical signs. The most efficient treatment for this type of disorder is to implant a permanent pacemaker.

CASE 193:



1) It is a rhythm of sinus tachycardia at a rate of 177 bpm. The QRS complexes presents R waves exceeding the limits of normality, as well as P wave duration increase, are strong indicators of left ventricular and atrial enlargement, respectively. However, a QRS complex reaching 100 ms (5q) of duration is compatible with left bundle branch block.

CASE 194: Tracing of an 8-year-old female Pit Bull. The patient presented diagnosis of dirofilariasis.



2) Analyzing only ventricular activation and repolarization (dismissing the measures of intervals and amplitude of the waves), associated to the position of the mean cardiac electrical axis of QRS, what is the relationship of the findings with the heart disease of the patient?

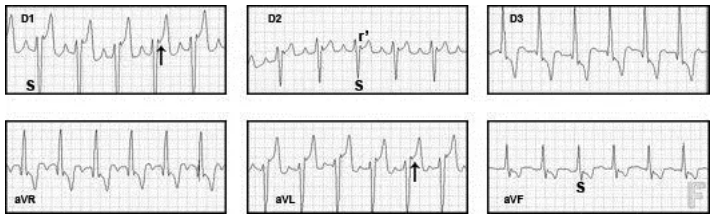
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CASE 195: Tracing (in D2) of a 6-year-old Boxer. He presents presyncopes and family history of arrhythmogenic right ventricular cardiomyopathy.



1) Based on the measures reported: P wave and QRS complex duration of 40 ms (2q) and 60 ms (3q) respectively, what alterations could be mentioned in this tracing?
2) What is the main clinical suspicion?
3) What diagnostic method(s) may help at this point?

CASE 194:



1) A cardiac axis shifted to the right (in this case between 150 and 180 degrees), and P wave amplitude increase, indicate there is right ventricular and atrial enlargement, respectively. When this enlargement evolves to the base of the heart or the right ventricular outflow tract, S waves could inscribe in D1, D2 and aVF (S). r' waves may indicate delay in right basal activation, a probable consequence of right ventricular enlargement. Also, there is ST segment elevation (arrows), and changes in ventricular repolarization suggesting myocardial hypoxia and normally associated to symptoms of pulmonary hypertension, such as cor pulmonale. Dirofilariasis is the most common cause both of chronic and acute cor pulmonale.

CASE 195:

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1) This is a tracing within normality for the species and breed, with no electrocardiographic alteration and presenting sinus arrhythmia.
2) Although there are several extracardiac causes, we should consider arrhythmogenic right ventricular dysplasia.
3) Besides the routine tests perofrmed, high resolution electrocardiogram is a noninvasive method that detects the presence of late potentials, signs of high frequency and low amplitude that occur at the end of the QRS complex and that correspond to the slow and fragmented ventricular activation areas, that may operate as substrates for the genesis of arrhythmias by reentry. They are not detected by conventional electrocardiogram, as their low amplitude is misinterpreted as artifacts produced by respiratory movements and muscle tremors. But when filtered and enhanced by this method, they are identified and used as a risk predictive factor for future arrhythmic events and even sudden cardiac death.

CASE 196: Tracing (in D2) of a 14-year-old Yorkshire. Asymptomatic patient.



1) What is the rhythm in this tracing? It the absence of PR segment (P wave leaning in the QRS complex) normal and what could it mean?
2) Should we take into consideration an ST segment depression of 0.3 mv (3q)? Why?

CASE 197: Tracing (in D2) of a 6-year-old female Boxer. Routine test. Asymptomatic patient.

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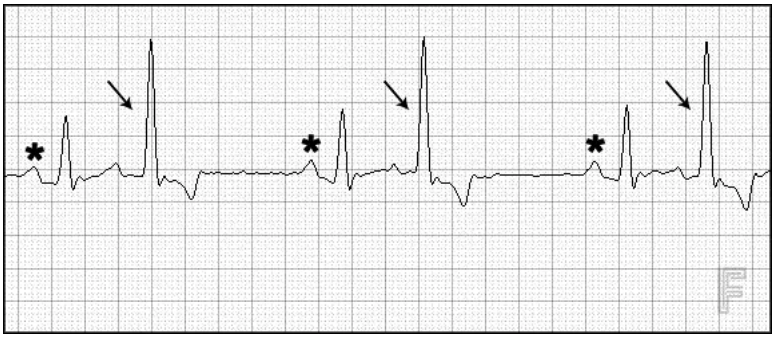
1) What arrhythmia is present in this tracing?
2) Could this patient have a heart disease?

CASE 196:



1) It is sinus arrhythmia. The heart rate ranges from 78 to 107 bpm. When the PR interval is very short (*), it may mean that the stimulus used an accessory pathway, prematurely depolarizing the ventricles. The short PR interval can also be due to the presence of accelerated AV conduction (a variant of normality).
2) ST segment shifts (arrows) that exceed 0.15 mv (1.5q) in the frontal plane leads, should always be considered pathological, because they generally indicate myocardial ischemia.

CASE 197:



1) There are premature contractions originating in the right ventricle of the bigeminy type. Are characterized by early ventricular ectopy of positive polarity in lead D2 (arrows) arise in pairs, intercalating with beats of sinus origin (*). There are small variations in the coupling

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periods, meaning that we could be before parasystole. Longer tracings may confirm the suspicion.

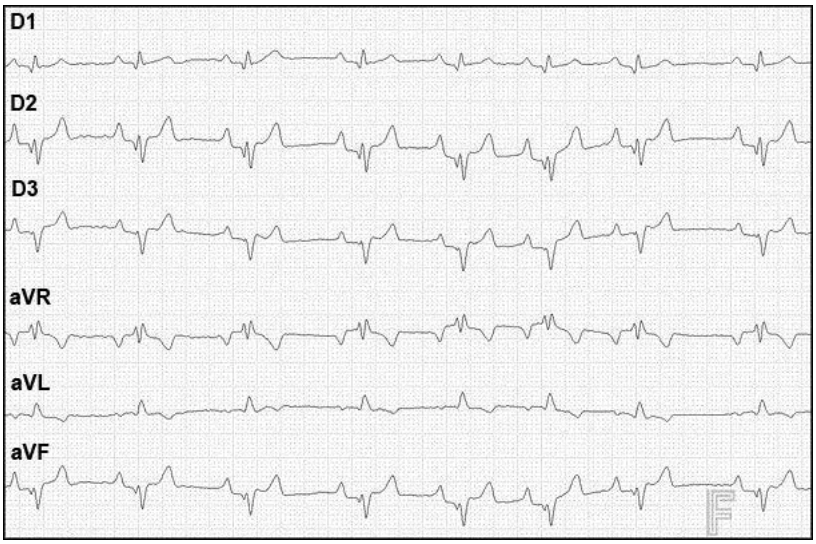
2) This patient may have arrhythmogenic right ventricular dysplasia, that in some cases is asymptomatic. The diagnosis could be confirmed by magnetic resonance and myocardial biopsy.

CASE 198: Tracing (in D2) of a 5-year-old Boxer. Asymptomatic patient.



1) What arrhythmias are observed in this tracing?

CASE 199: Tracing of a 6-year-old female miniature Pinscher, with no clinical complaints and no echocardiographic or chest X-rays alterations.



1) Where is the mean cardiac axis of QRS?

2) How can this alteration be explained?

CASE 198:

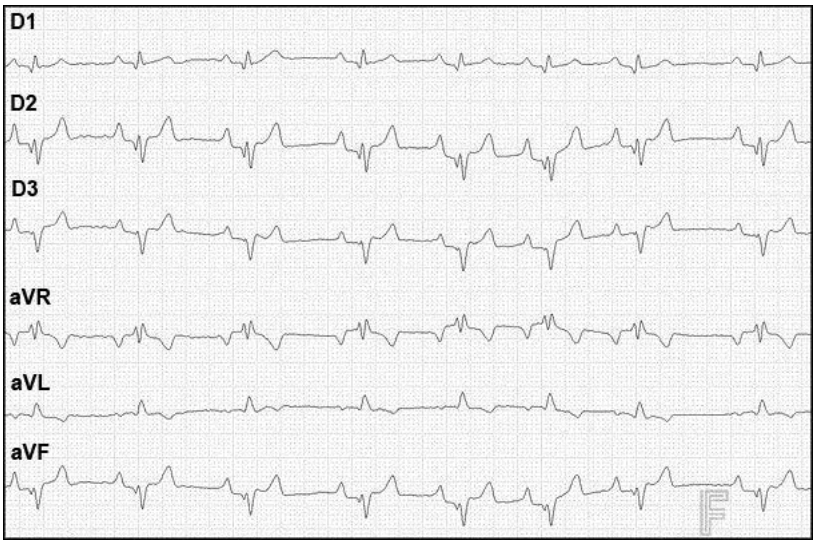


1) They are polymorphic extrasystoles; that is, those that originate in more than one ectopic focus. The ectopic complexes are morphologically different (arrows) and present variable coupling

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periods (minor lines). However, as polarity is the same; i.e., positive in D2, it indicates that both originate in the right ventricle. Also, can be visualized two sinus pauses (bigger lines), one of which includes one of the extrasystoles.

CASE 199:



1) The mean electrical axis is between -60 and -90 degrees, meaning there is a shift to the left.
2) Tracings with a mid-QRS axis above -30 degrees are suspected of presenting blockage of the anterosuperior fasciculus of the left bundle branch of His. However, among the main findings found in this conduction disorder, include qR-type complexes in aVL and rS in D3, indicating a change in the direction of ventricular depolarization. As it is not very characteristic in this electrocardiogram, only a vectorcardiogram could solve this doubt.

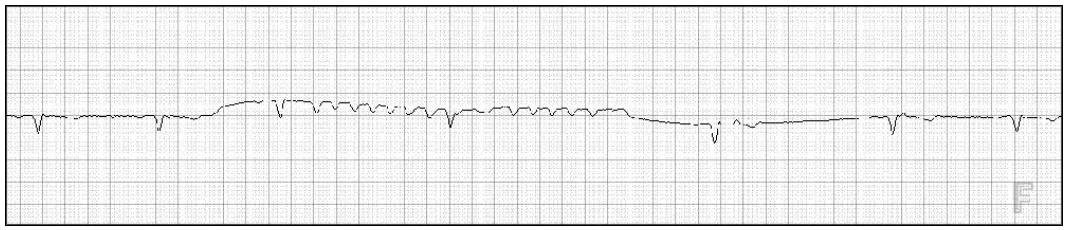
CASE 200: Tracing (in D2) of a 16-year-old Poodle, weighing 8 kg. He presents murmur grade 4 in auscultation and left mean QRS axis shift.



1) What is the rhythm of this tracing?
2) What other alteration does this tracing present?

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CASE 201: Tracing (in aVR) of a 10-year-old female Chow Chow, presenting only signs of apathy.



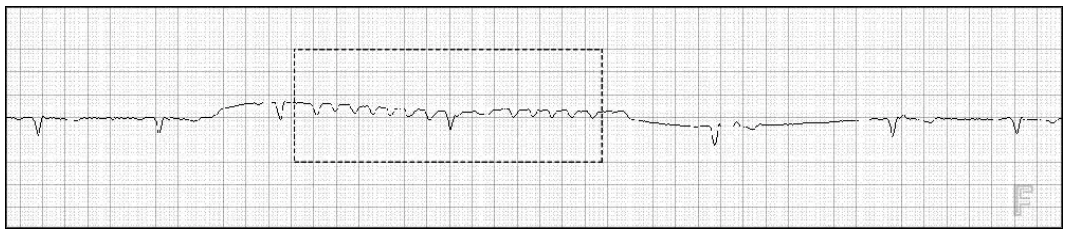
1) What arrhythmia is present in this tracing?

CASE 200:



1) It is a rhythm of sinus tachycardia with heart rate of 170 bpm.
2) It may seem electrical alternation in QRS complexes voltage, if this alternation was observed beat by beat (i.e., alternating). Anyway, in this tracing there are periodical oscillations in QRS complexes amplitudes, just caused by oscillations in respiratory movements.

CASE 201:

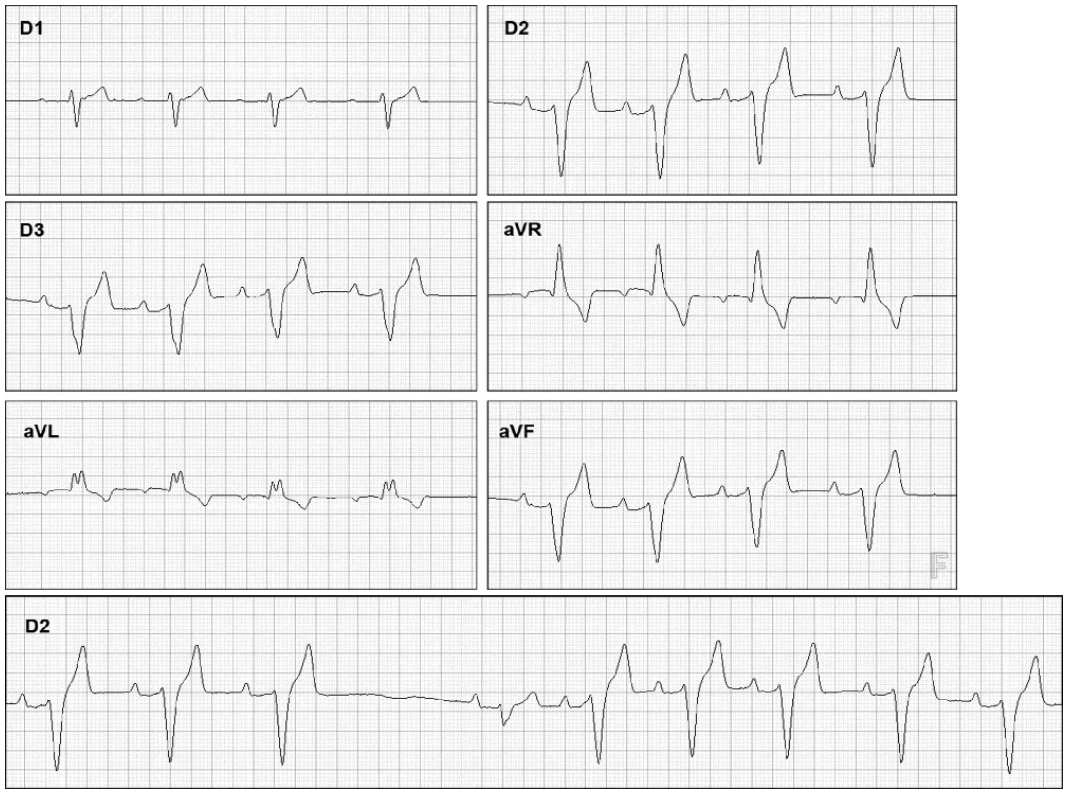


1) Intermittent atrial flutter (in the box) is the arrhythmia that appears in this tracing. Arrhythmia triggered by reentry mechanism, which triggers a regular atrial rhythm, translated by F waves (saw-toothed appearance). These are a fusion of ectopic atrial waves with atrial repolarization waves (Ta waves). This rhythm is not so prevalent in the clinical signs of these small animals, as atrial fibrillation is most common.

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CASE 202: Tracing of a 12-year-old mongrel, weighing 16 kg and asymptomatic. Preanesthetic test.

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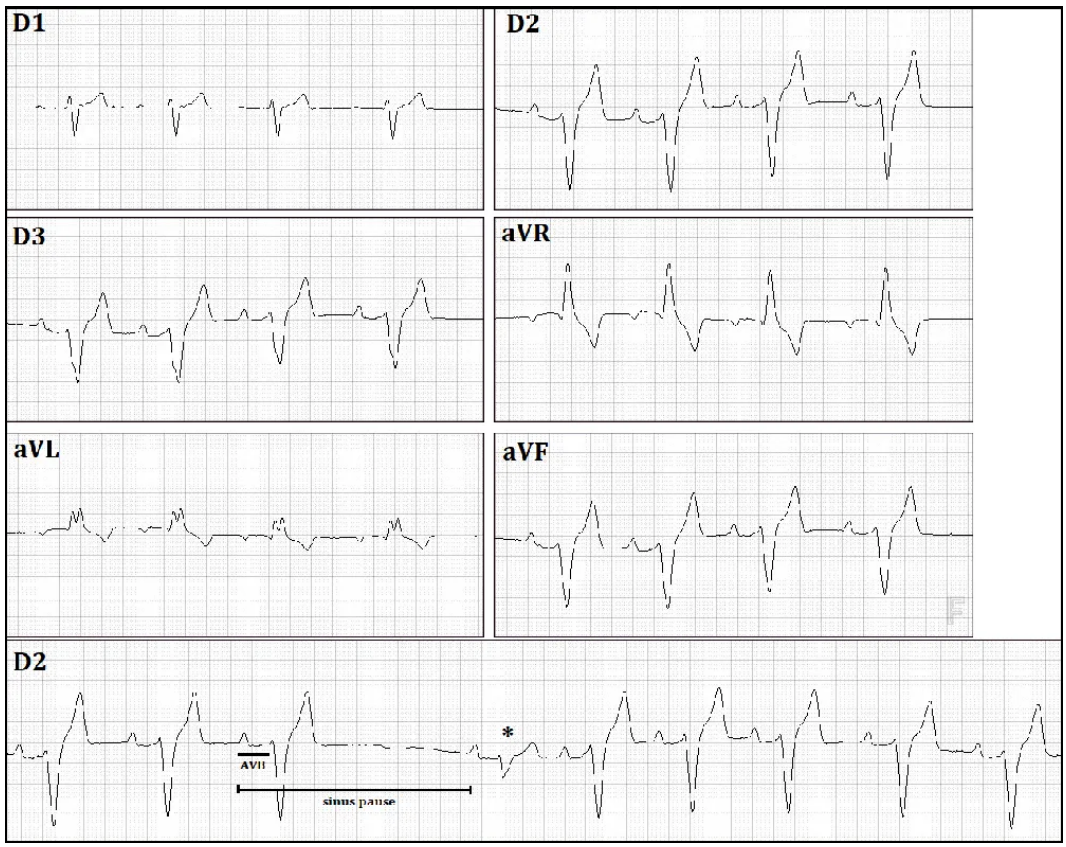


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1) Knowing that the PR interval duration is 160 ms (8q) and QRS complex duration is 100 ms (5q), which conduction disorders can we see in this tracing?
2) To what can we relate a QRS complex with an M shape in aVL?
3) What arrhythmias are observed in the tracing below (long D2)?

CASE 202:

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1) The increase in PR interval duration (AVB = line), shows there is 1st degree atrioventricular block. The increase in QRS complexes duration (in its final portion) associated to T waves that are opposite to the QRS complex and the right mean cardiac axis shift (between -90 and -120 degrees), are characteristic of right bundle branch block (RBBB).
2) In RBBB, the occurrence of QRS complexes with M outline is common (similar to bunny ears) in some leads, as a consequence of asynchrony in intraseptal conduction.
3) The longer pause (bigger line) followed by P wave with the same morphology as the previous ones, confirms the diagnosis of sinus pause. But immediately after (asterisk) there is ventricular escape beat. Due to PR interval that precedes it is equal to the previous beats of sinus origin, this ectopic complex may very well be a fusion beat (ventricles being activated simultaneously by two stimulus = one originating in an ectopic focus and one originating in the sinus node).

CASE 203: Tracing of a mixed-breed feline. Gender, age and weight of the animal were not reported.

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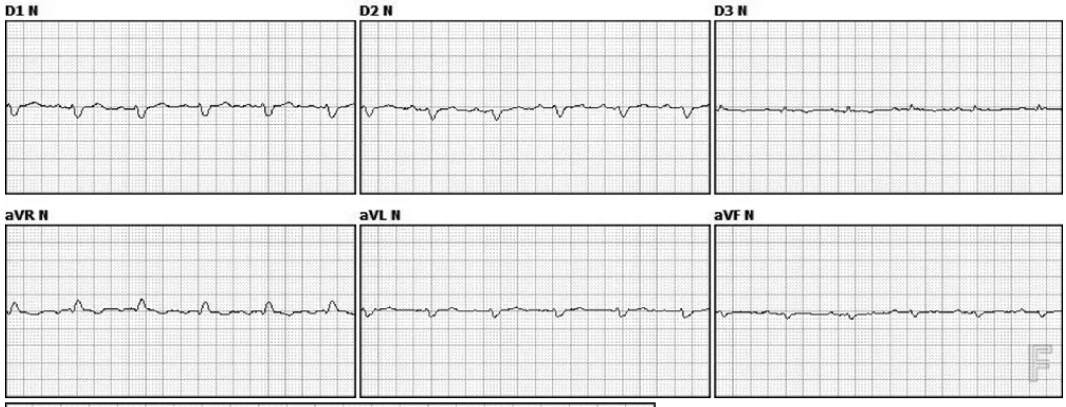


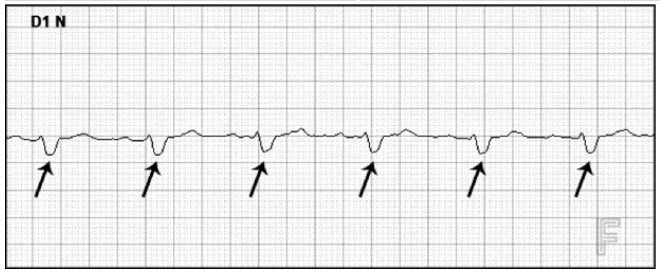
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1) What is the rhythm in this tracing?
2) In which position is the cardiac axis?
3) In lead D1 that is enhanced, the QRS complex presents a different morphology, besides a duration of 80 ms (4q). What is the reason for this morphology?

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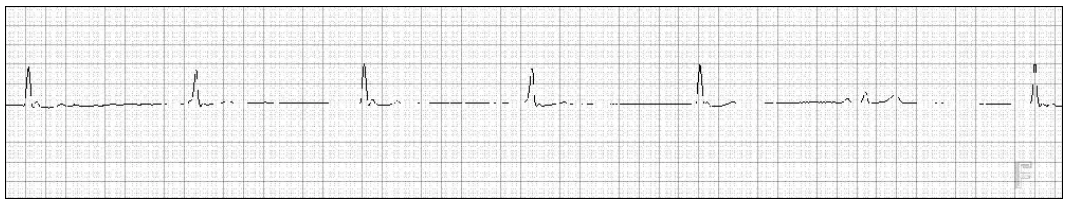




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1) Rhythm is sinus with a rate of 157 bpm.
2) The mean cardiac axis is shifted to the right and between -150 and -180 degrees.
3) These QRS complexes present increase in their duration (greater than 60 ms = 3q) and S waves with a "plateau" outline (arrows), that associated to mean cardiac axis shift are typical of right bundle branch block.

CASE 204: Tracing (in D2) of a 5-year-old mixed-breed cat. Preanesthetic evaluation.



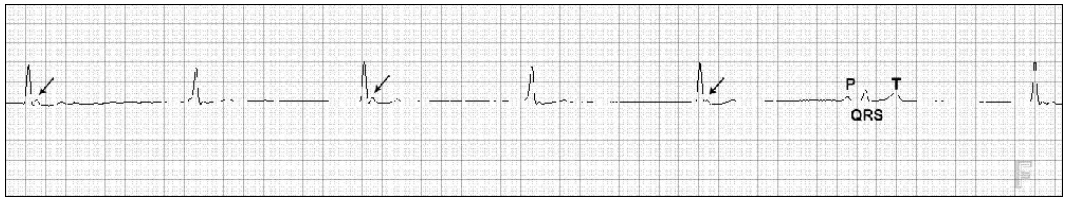
1) What is the rhythm of the tracing?
2) How can we call the next to last beat in the tracing?

CASE 205: Tracing (in D2) of a 7-year-old female Pinscher, weighing 3 kg. Tracing sent by telemedicine.



1) What type of arrhythmia is present in this tracing?

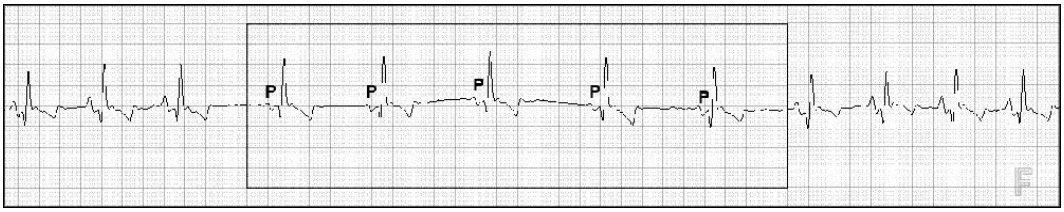
CASE 204:



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1) It is a rhythm of ventricular escape (or idioventricular), with rate of 70 bpm, settled as a defense mechanism, secondary to a significant automatism decrease, caused by severe aggression to the conduction system. There is concomitant AV dissociation, a condition where the atria are activated through the sinus node and the ventricles by ventricular ectopic foci, and therefore, there is no relationship between P waves (arrows) and ectopic ventricular complexes.
2) It is a capture beat, defined as an impulse originating in the sinus node (P-QRS-T), that reached a "physiological" depolarization before a heart under the command of escape or substitution rhythm.

CASE 205:



1) Known as coronary sinus rhythm, the escape focus originates in the inferior portions of the right atrium, represented by biphasic P wave, shown in the box.

CASE 206: Serial tracings (in D2) of a mixed German Shepherd, with no previous signs of heart disease and aged 4 years. The animal choked himself with his collar, being exposed to the sun for an hour before being helped. The clinical signs of the dog in the ER included lateral decubitus, tachypnea, mydriasis and body temperature of more than 45°C.

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1) What electrocardiographic alterations are present in these tracings?
2) Why a patient with no heart disease developed this extremely severe arrhythmia?

CASE 206:



1) In tracing No. 1 there is ventricular fibrillation rhythm. The electrocardiogram is chaotic: deformed, wider deflections, with several degrees of amplitude and morphology, not being possible to identify even a single wave. They are messy contractions that do not produce a pulse; i.e. depolarization waves that occur randomly in the ventricles. From the 2nd tracing onward, there is progressive

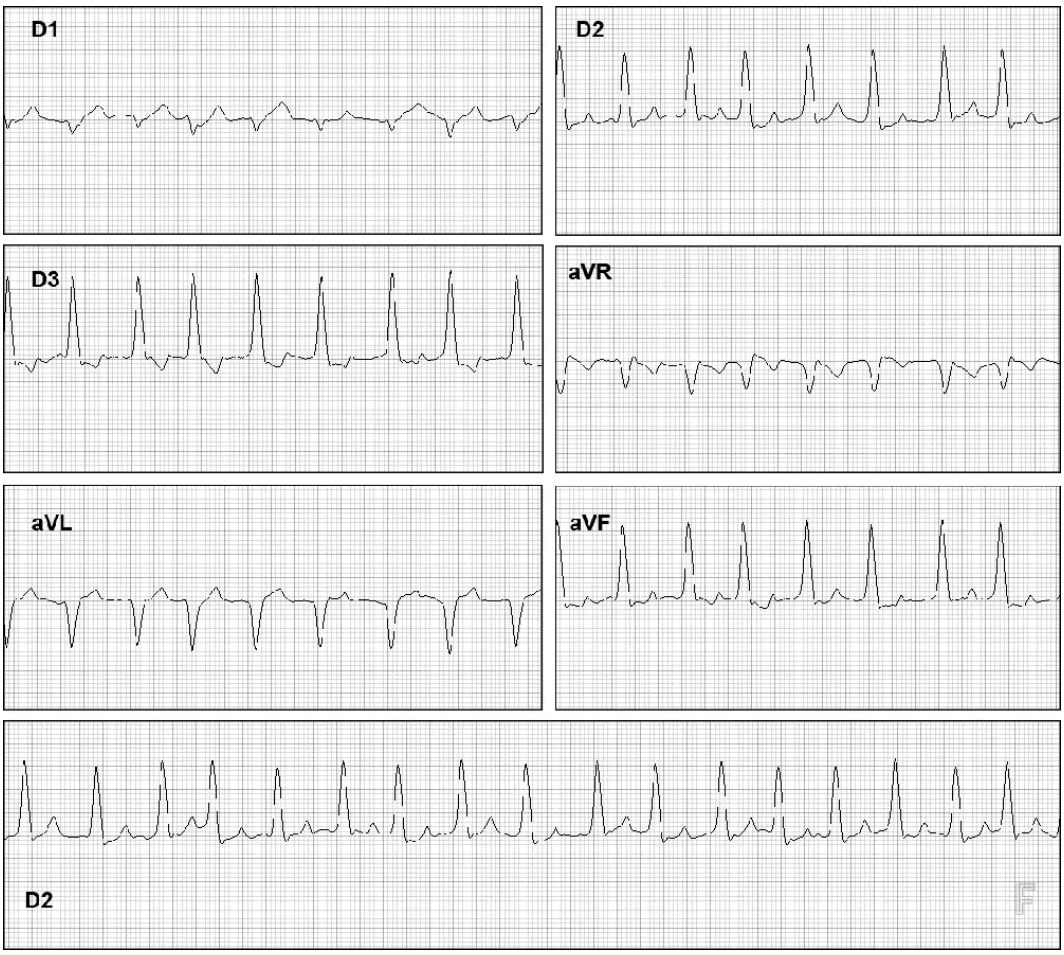
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decrease of waves amplitudes, indicating the electrical activity of the heart is ending, and that finally in tracing No. 4 is virtually in asystole, being possible to declare the death of the dog.

2) Even if the dog has no heart disease, the condition he was subjected to (such as hypoxia and severe hypotension caused by asphyxia and sunstroke) led him to ventricular fibrillation.

CASE 207: Tracing of a 2-year-old female German Shepherd. She presented clinical symptoms of dyspnea, ascites and arrhythmia in cardiac auscultation.

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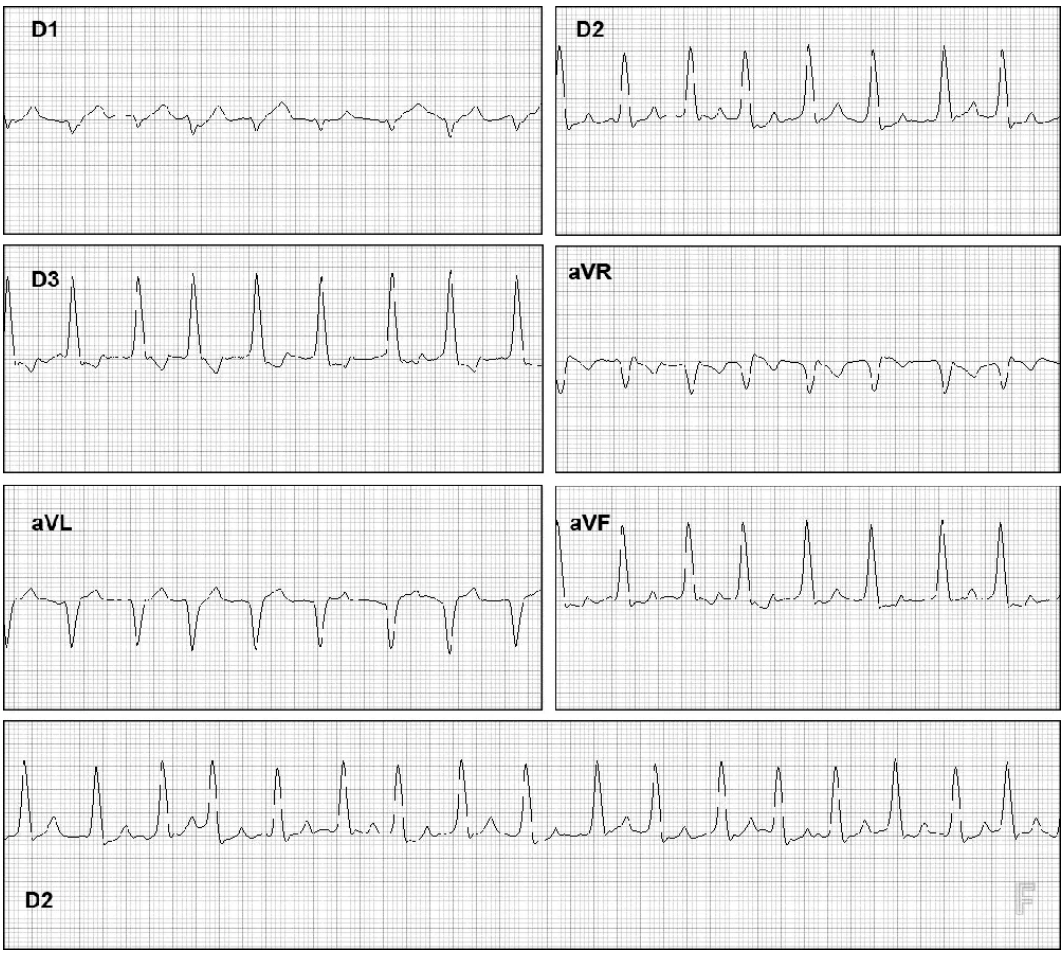


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1) What is the rhythm in this tracing?
2) Based on breed, history, symptoms and heart rhythm, and knowing that QRS complex duration is 80 ms (4q), which is the main heart disease that we may suspect before this scenario?

CASE 207:

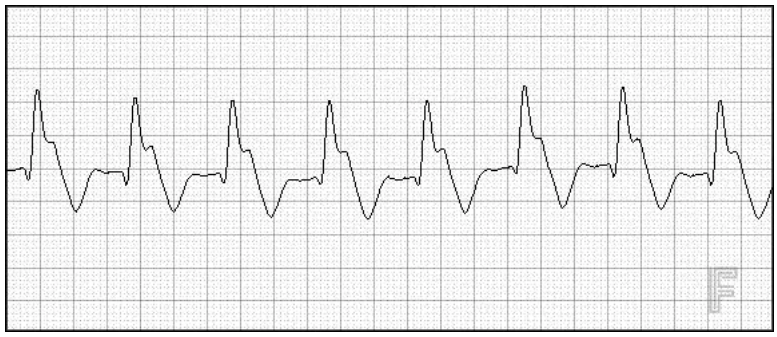
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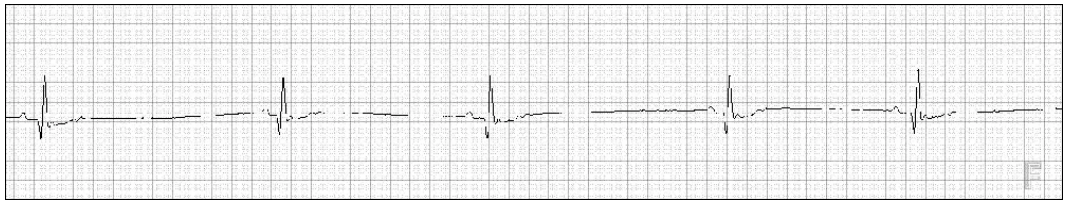
1) It is a tracing of atrial fibrillation. Check that the rhythm is accelerated, there is variation in RR distances and absence of P waves.
2) This rhythm is commonly found in cases of dilated cardiomyopathy. In spite of being confirmed by echocardiogram, the patient died after 15 hours. Even with significant chambers increase, increase in QRS complex amplitude was not observed. This fact could be explained by the final stage of the disease presenting overall myocardial degeneration.

CASE 208: Tracing in D2 of 12-year-old Weimaraner, weighing 35 kg. Test received through the telemedicine service.



1) What is the rhythm in this tracing?
2) Is ST segment elevation present?

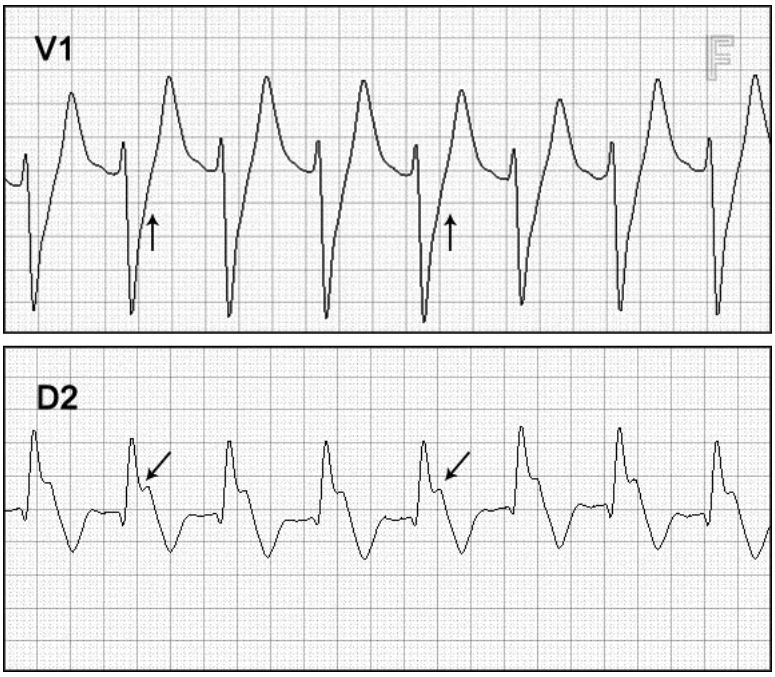
CASE 209: Tracing (in D1) of a 12-year-old poodle. The animal had chronic mitral valve disease and was being treated with diltiazem and digoxin.



1) What is the rhythm in this tracing?
2) Is there a relationship between the use of these drugs and this rhythm?

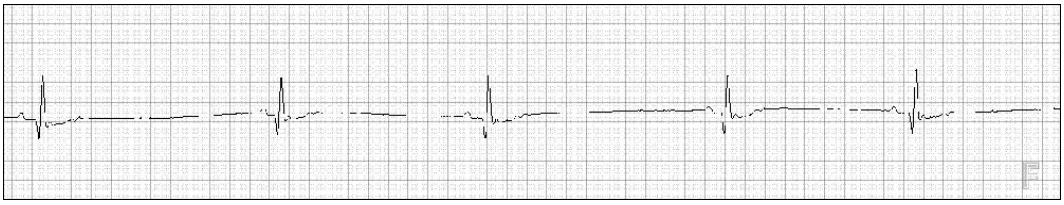
CASE 208:

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1) It is ventricular tachycardia rhythm, with a rate of 200 bpm.
2) Analyzing only one lead (D2), there seems to be ST segment elevation (arrows). However, when analyzing another lead (in this case, V1) recorded simultaneously, we can see that what seemed to be elevation, is indeed notching in the ectopic complex. Otherwise, in V1 the same shift should occur. This case shows the significance of analyzing the electrocardiogram in all its leads, and preferably in two planes, frontal and horizontal.

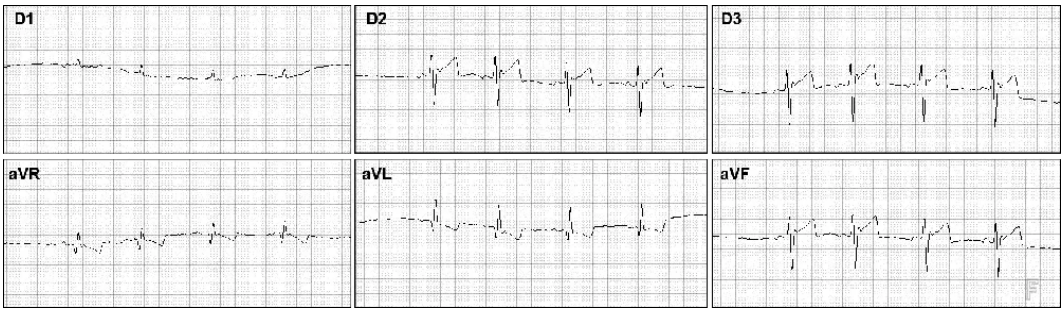
CASE 209:



1) It is sinus bradycardia rhythm, with mean heart rate of 50 bpm.
2) Yes, as the action of these drugs (even in therapeutic doses, because of a synergic mechanism) may yield a negative chronotropic effect, leading to bradycardia.

CASE 210: Tracing of a 10-year-old female Dachshund. Presence of left chambers enlargement, observed in echocardiogram.

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1) What is the location of the mean QRS axis and mean axis of the P wave?
2) Is there a relationship between the QRS axis and P wave with the enlargements, knowing that its duration is 60 ms (3q)?

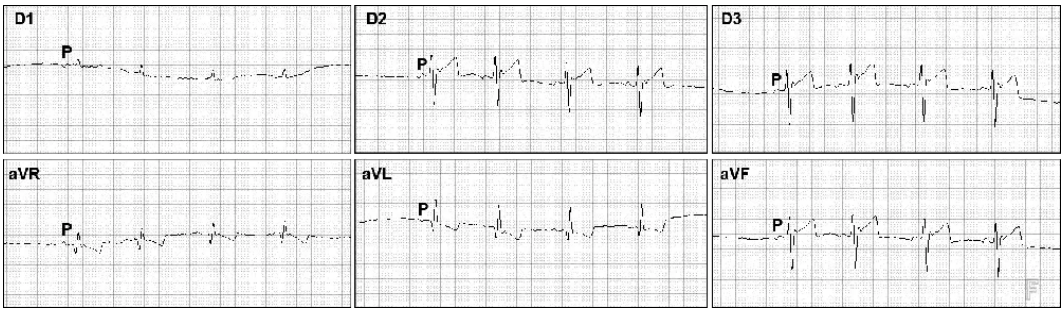
CASE 211: Tracing (D2) of a 3-year-old Labrador Retriever, weighing 28 kg and presenting clinical symptoms of epistaxis for an extended period of time. Systolic blood pressure is at 260 mmHg.



1) What is the relationship between the clinical symptoms of this dog and the tracing presented, knowing that P wave duration is 40 ms (2q) and the PR interval 100 ms (5q)? R waves amplitudes are 2.8 mv (28q) and q waves of 0.6 mv (6q).

CASE 210:

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1) The mean axis of the QRS complex is at -60 degrees; while the P wave axis is indeterminate (isoelectric or biphasic P waves in all leads).
2) The mean QRS axis is shifted to the left, a common finding in left ventricular enlargements. An indeterminate mean P wave axis is also a finding that we may find in left atrial enlargements. The increase in P wave duration reinforces what was observed in the echocardiogram.

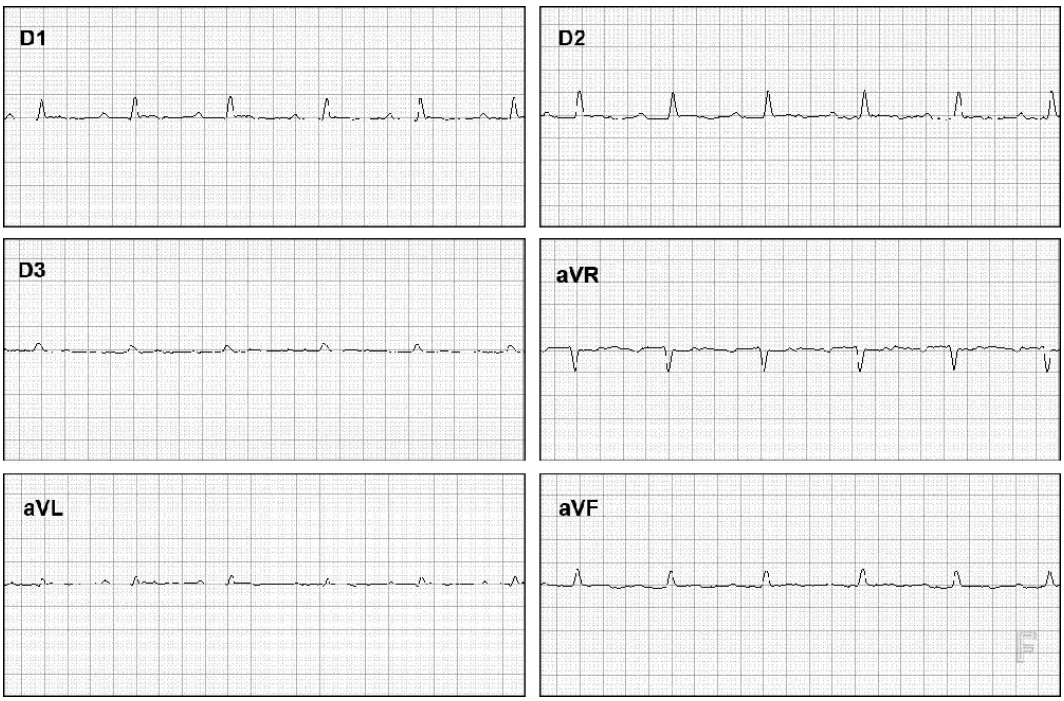
CASE 211:



1) Systemic arterial hypertension is one of the causes leading to left ventricular hypertrophy, due to increase in ventricular walls thickness and myocardial mass. At the onset of this clinical condition, the ECG could be normal. However, with its evolution there are electrocardiographic alterations like R wave amplitude increase, that in this case exceeds 2.5 mv. Also, there are alterations compatible with septal hypertrophy, represented by the increase in q waves amplitude (arrows).

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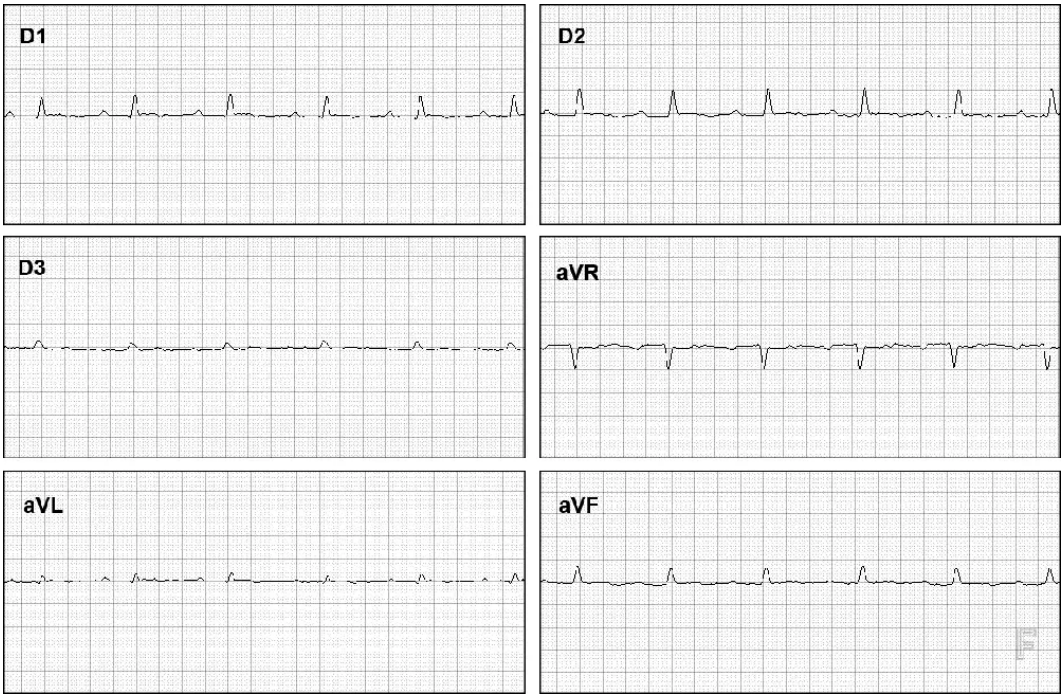
CASE 212: Tracing of a 12-year-old mongrel and weighing 8 kg. The clinical symptoms were signs of right congestive heart failure and anasarca among others.



1) What is the rhythm of this tracing?
2) Waves with low voltages in several leads are common findings in this scenario? Why?

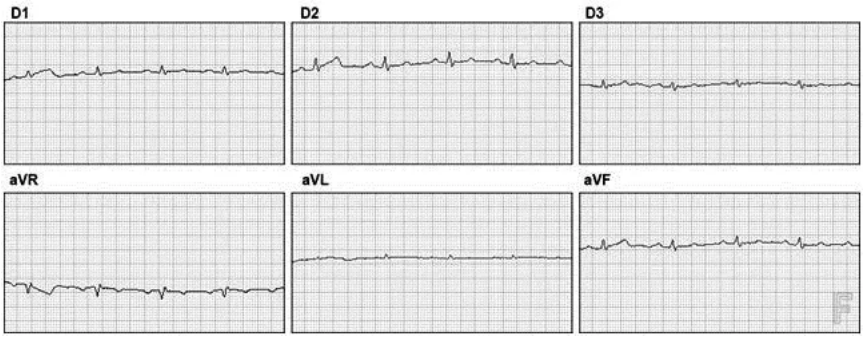
CASE 212:

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1) Rhythm is sinus with rate of 142 bpm.
2) The mechanism of this phenomenon is attributed to the peripheral dielectric factor, leading to attenuation of the potential recorded in the body surface, caused by subcutaneous tissue edema. Widespread edema could happen for several factors, among them, heart failure and oncotic pressure reduction by hypoproteinemia.

CASE 213: Tracing of a mongrel, picked in the street, of a medium size, cachectic, weighing 12 kg and presenting dyspnea. He coughed only when placed in lateral decubitus. Pulmonary and cardiac sounds muffled in auscultation.



1) Can we expect to find low voltage waves in dogs with these clinical symptoms?

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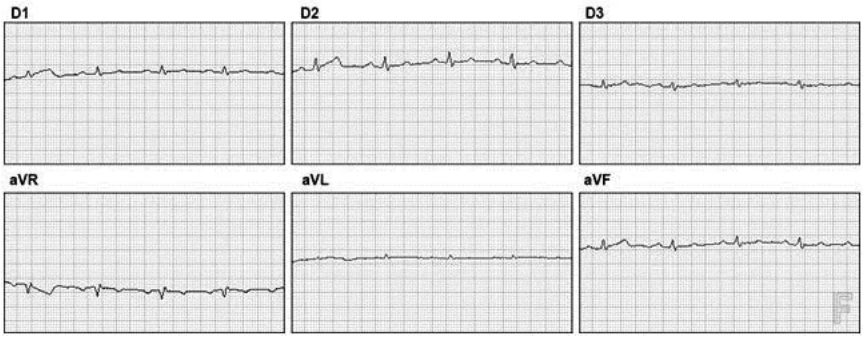
2) What is the main clinical suspicion and why?

CASE 214: Tracing of a female Yorkshire weighing 4.5 kg, with undefined age, and presenting left ventricular enlargement in echocardiogram.



1) Knowing that P wave duration is 60 ms (3q) and QT interval duration is 200 ms (10q), what electrocardiographic findings suggest there is left ventricular enlargement?

CASE 213:



1) In a medium-sized, cachectic dog, exactly the contrary should be expected: a recording of waves with greater amplitude, in comparison to those found in a dog with normal body mass index.
2) The main clinical suspicion is pleural effusion, that was confirmed by chest X-rays. 1.5 liters of liquid were extracted by puncture. After control X-rays, the presence of viscera was observed in the chest cavity, subsequent to diaphragmatic rupture, probably because of having been run over.

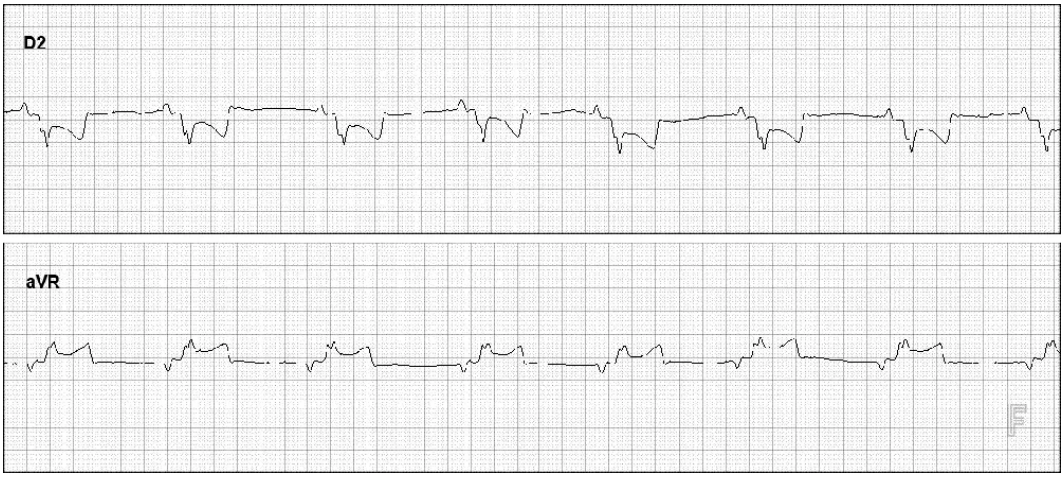
CASE 214:

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1) The findings that suggest left ventricular enlargement are: left cardiac axis shift (in this case -60 degrees) and ventricular repolarization alterations (seen by T wave amplitude increase in several leads). P wave with increased duration, in addition to suggesting left atrial enlargement, is an indirect sign of left ventricular enlargement.

CASE 215: Tracings (leads D2 and aVR) of a 15-year-old Schnauzer, weighing 7 kg. Preoperative test.



1) What is the rhythm in this tracing?
2) Knowing that the mean QRS axis is at -90 degrees, it is prudent to release this dog for surgery?

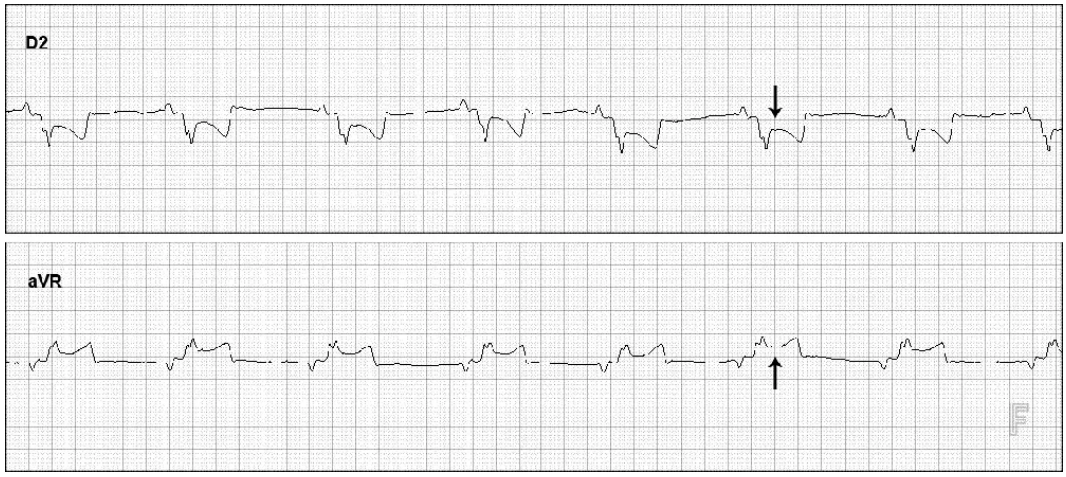
CASE 216: Tracing (in D2) of an 11-year-old Poodle and asymptomatic. Routine test.

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1) What rhythms can we see in this tracing?
2) ST segment with depression of 0.3 mv (3q), is a remarkable finding?

CASE 215:



1) Rhythm is sinus with rate of 96 bpm.
2) Just the fact that there is left cardiac axis shift justifies a more thorough cardiac investigation before releasing him for surgery. Besides this, there are significant ST segment shifts (arrows), which are probably related to myocardial ischemia.

CASE 216:



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1) The tracing starts with atrial bigeminy, defined as a rhythm at which stimuli of sinus origin are intercalated with atrial extrasystoles. Thus, they are observed P waves of sinus origin (P), followed by early P waves and with different morphology (P'), these, ectopic atrials. This rhythm ceases after the sinus node resumes its dominance (arrow).
2) Yes. A shift of this magnitude indicates there is myocardial ischemia.

CASE 217: Tracing in D2 of a 2-month-old female Persian cat.



1) What is the rhythm in this tracing?
2) Knowing that P wave duration is 60 ms (3q) and R and T waves amplitudes are 1.3 mv (13q) and 0.4 mv (4q) respectively, can we state that these measures are within the standard of normality for this species? What could they mean?

CASE 218: Tracing (D2) of a 12-year-old Rottweiler.



1) What rhythms are present in this tracing?
2) The presence of P waves and QRS complexes with a duration of 60 ms (3q) and 110 ms (5.5q) respectively, is a finding that we may relate to which heart diseases?

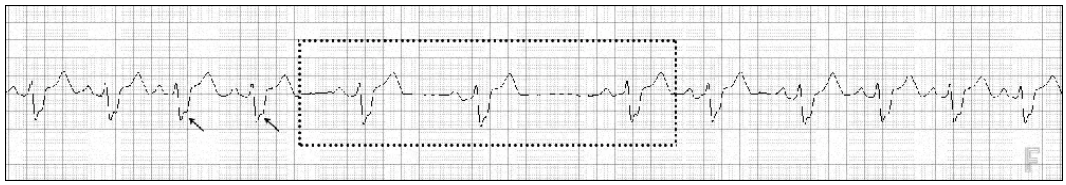
CASE 217:

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1) This is a sinus tachycardia, with a rate of 232 bpm.
2) These are beyond the standards of normality. The increase in P waves duration is related to left atrial enlargement, while R and T waves amplitude (this, related to ventricular repolarization alterations) suggests left chamber enlargement.

CASE 218:



1) The base rhythm is sinus arrhythmia, observed by the variation of more than 10% of P-P distances. However, in the central part of the tracing (rectangle) there is atrial escape rhythm, characterized by the presence of three P waves of different morphology and inscribed late.
2) QRS complexes that exceed 100 ms (5q) and negative in D2, suggest right bundle branch block. Another related finding is the presence of notches in the ascending portions of S waves (arrows). P waves with increased duration suggest the presence of left atrial enlargement.

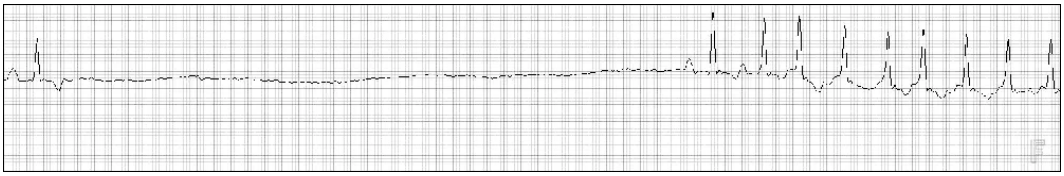
CASE 219: Tracings (in D3 and D2) of an 8-year-old Boxer.

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1) What is the rhythm of these tracings?
2) What other arrhythmias are observed in this tracing?
3) Is a QRS complex with 80 ms duration (4q), associated to notches in its morphology, a common finding in this rhythm?

CASE 220: Tracing (in D2) of a 13-year-old female Scotch Terrier with history of syncopes.



1) What arrhythmias are present in this tracing?
2) What heart disease is normally associated to these arrhythmias?
3) What can we state before the information that P wave and QRS interval durations are 60 ms (3q) and 160 ms (8q) respectively?

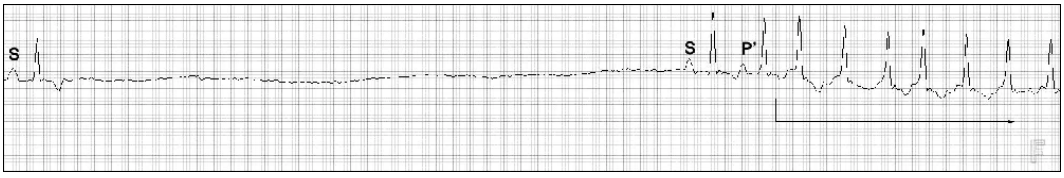
CASE 219:

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1) Both tracings present atrial fibrillation rhythm, characterized by R-R distance variation, associated to P waves absence.
1) In D2, a tracing (rectangle) is observed with episode of nonsustained ventricular tachycardia and at the end of tracing, an isolated ventricular extrasystole (asterisk), originating in the left ventricle, because its polarity is negative in this lead.
3) In arrhythmias of atrial origin, usually QRS complexes are narrow. Nevertheless, the increase in their durations, associated to notches (as seen in D2), indicate that there could be a certain degree of left bundle branch block associated.

CASE 220:



1) After the first stimulus of sinus origin (S), there is a large sinus arrest of 4 seconds. Later, another stimulus of sinus origin (S) and immediately after, premature atrial contraction is inscribed, identified by early P' wave. From this ectopic stimulus, atrial fibrillation rhythm starts (arrow), identified by R-R distances variation, associated to P waves absence.

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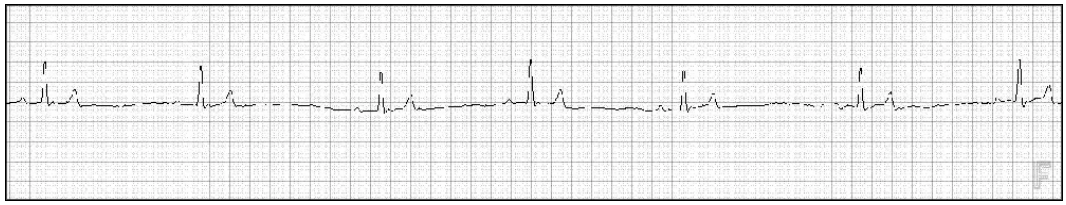
2) The sinus arrest observed is secondary to sinus node disease. The arrhythmias that follow are defense mechanisms of the heart before drop in cardiac output by bradyarrhythmia.
3) We can state that besides this, there is left atrial enlargement and 1st degree atrioventricular block.

CASE 221: Tracing (in D2) of a 13-year-old Yorkshire, weighing 6 kg and presenting constant syncopes.



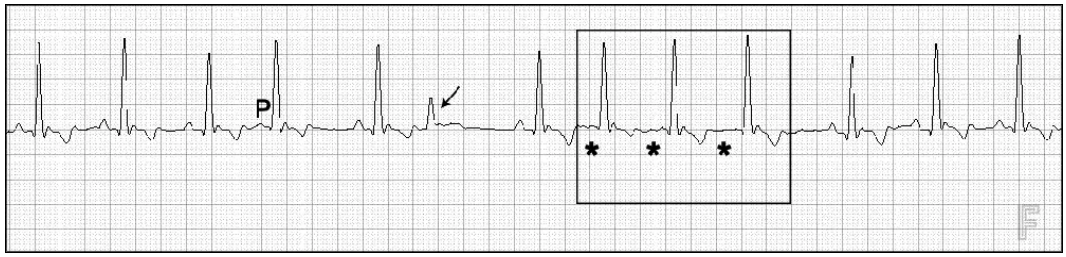
1) What is the arrhythmia present in this tracing?

CASE 222: Tracing (in D2) of a 15-year-old female German Spitz. Clinical symptoms of nodule in cervical region.



1) Knowing that heart rate in this tracing ranges from 66 to 78 bpm, is it possible to differentiate this rhythm between sinus bradycardia and sinoatrial block?
2) Is there any relationship between this finding and the clinical condition of this dog?

CASE 221:



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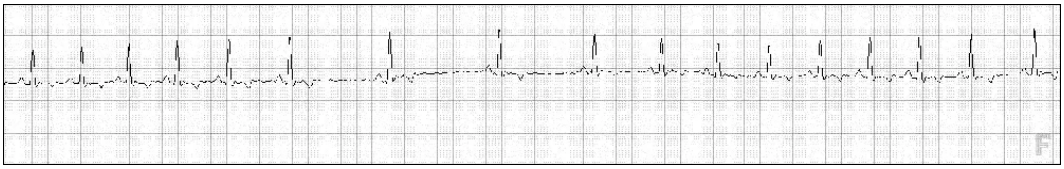
1) The identified P wave is related to premature atrial contraction (as it is early and of morphology different from the rest). Shown by the arrow, there is premature ventricular contraction (early ectopic complex and with different morphology). Within the box, there is a short episode of atrial fibrillation. Absence of P waves are seen (asterisks), as well as R-R distances variations and baseline tremors.

CASE 222:



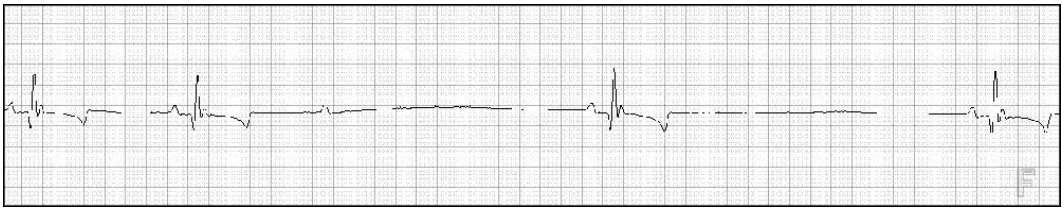
1) This is sinus bradycardia, since the sinoatrial block arises sporadically and not continuously, as in this case.
2) Yes. Cervical (and/or thoracic) neoplasias may affect the vagus nerve and thus, decrease cardiac batmotropism (by parasympathetic nervous system stimulation).

CASE 223: Tracing (in D1) of a 16-year-old Shih Tzu, with no symptoms.



1) What is the rhythm in this tracing and why does it occur?

CASE 224: Tracing (in D1) of a 12-year-old female Yorkshire. Clinical symptoms of tremors. Low serum concentration of albumin and calcium (the latter at 5.9 mg/dL).



1) What arrhythmias can we see in this tracing?

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2) Knowing the QT interval presents 310 ms (15.5q) of duration, what is the relationship of this interval with the lab findings?

CASE 223:



1) It is a respiratory sinus arrhythmia, with cyclic variation in the rate related to breathing, where heart rate increases at the end of inspiration and decreases at the end of exhalation (imbalance reflex between the sympathetic and parasympathetic nervous system). Besides this, the respiratory movement proper promotes oscillations in R waves amplitudes (arrows), related to the movement of the diaphragm during breathing.

CASE 224:



1) Sinus bradycardia rhythm with heart rate reaching 33 bpm. There is 2nd degree atrioventricular block, Mobitz type II (arrow).
2) QT interval is increased (line) –at the expense of ST segment-, which could be related to hypocalcemia. There is a significant amount of calcium linked to albumin. When there is hypoalbuminemia, the total level of serum calcium also drops. Although it represents more than 50 percent of hypocalcemia cases, low levels of calcium associated to hypoalbuminemia are not generally associated to symptoms. Anyway, in this case, the tremors of this dog were linked to hypocalcemia, which ended after IV injection of calcium gluconate.

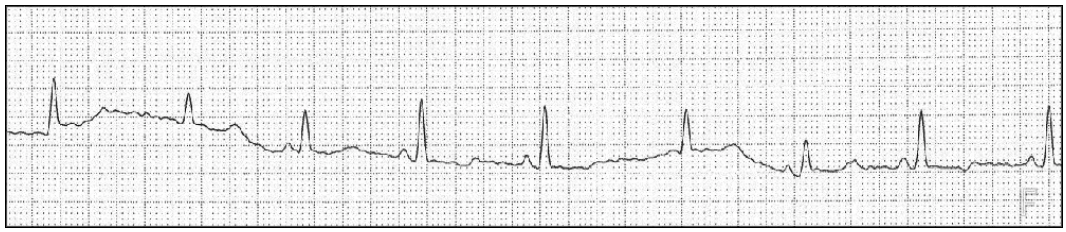
CASE 225: Tracing (in D2) of a 3-year-old female Yorkshire and weighing 1.8 kg. Diagnosis of tracheal collapse in X-rays.

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1) What is the rhythm in this tracing?
2) What arrhythmias are present in this tracing?
3) What is the relationship between the 0.5 mv (5q) amplitudes of P waves and tracheal collapse?

CASE 226: Tracing (in D2) of a 1-year-old mixed-breed cat. Recorded immediately after him having been run over by a car. He was admitted with dyspnea.



1) What is the rhythm in this tracing?
2) There is electrical alternation in QRS complexes voltages. Is this finding a common occurrence in cats? What is the main clinical suspicion?

CASE 225:

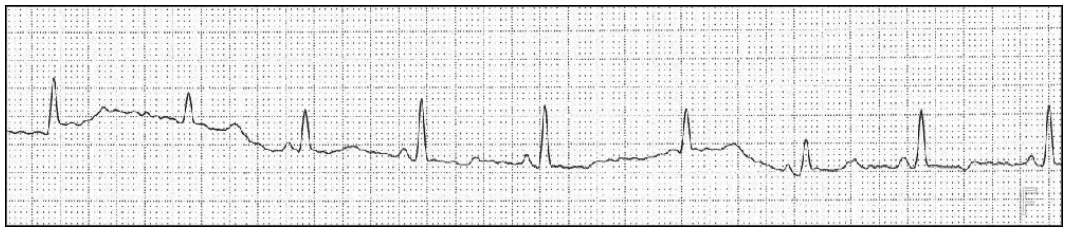


1) Although the baseline rhythm is a non-respiratory sinus arrhythmia (characterized by a variation of more than 10% between the P-P distances, highlighted in the box), stretches of sinus tachycardia are also observed, with a heart rate of 230 bpm (line).

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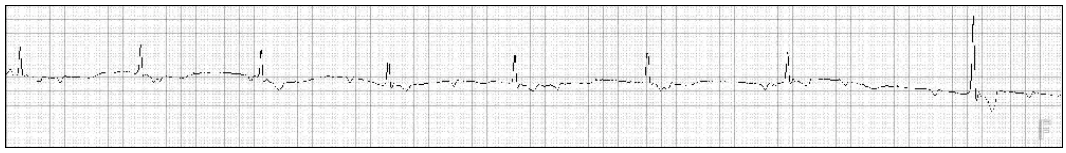
2) In the arrow, there is P wave not followed by QRS complex, indicating 2nd degree atrioventricular block, Mobitz type II. Immediately after (asterisk), there is P wave with morphology different from the others in the tracing and inscribed late; i.e., there is escape beat of atrial origin.
3) P waves that appear above the normal voltage (P pulmonale) are usually found in dogs who are affected by tracheal collapse.

CASE 226:



1) Although uncommon, it is sinus bradycardia with a frequency ranging from 120 to 145 bpm.
2) R waves and P waves amplitude variation is possibly caused by respiratory movements caused by the dyspnea that usually affects cats that develop post-trauma diaphragm rupture, and the subsequent migration of abdominal organs into the chest cavity.

CASE 227: Tracing (in D2) of a 3-year-old mongrel.



1) What is the rhythm in this tracing?
2) What arrhythmias can we see in this tracing?

CASE 228: Tracing of a 7-year-old female Yorkshire, weighing 12 kg, having undergone ovariohysterectomy and obese. Body mass index 8/9.

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1) What is the rhythm of the tracing?
2) When analyzing the maximum amplitude of QRS complex in this tracing, a value of 0.2 mv (2q) is observed. Can we expect to find low voltage in a female dog with this profile? Why?

CASE 227:



1) This is junctional rhythm, with rate of 73 bpm, characterized by inscription of narrow QRS complexes and not accompanied by preceding P waves.
2) There is 3rd degree atrioventricular block, as all P waves (arrows) are blocked. Consequently, there is atrioventricular dissociation. The complex identified by an asterisk is ventricular escape beat.

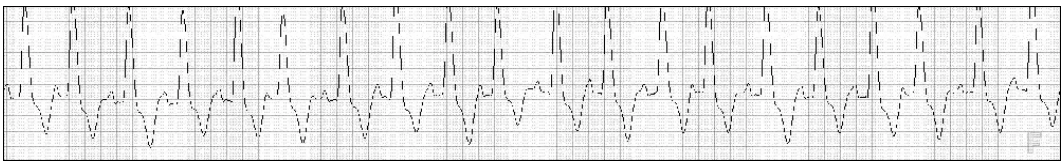
CASE 228:

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1) Sinus tachycardia with rate of 214 bpm is the rhythm in this tracing.
2) In patients with this BMI, it is common to see low voltage complexes in virtually all leads in the frontal plane. The greater the distance from the heart to the exploring lead, the lower the recorded potential value, reflected in deflections with less amplitude.

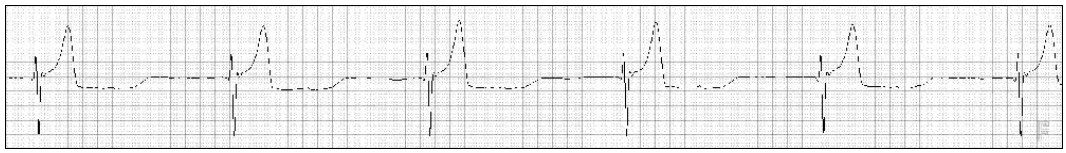
CASE 229: Tracing (in D2) of a 10-year-old Cocker Spaniel, weighing 15 kg. the patient has a cardiomyopathy associated to left ventricular enlargement, observed in echocardiogram. Recording sensitivity N/2.



1) What is the rhythm in this tracing?
2) What would be a significant differential electrocardiographic diagnosis and why?
3) What conclusion can we draw, knowing that R wave amplitude is 3.0 mv (30q) and QRS complex duration 100 ms (5q)?

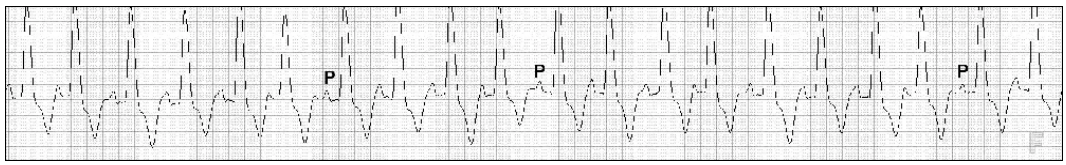
CASE 230: Tracing (in D2) of a 1-year-old mongrel and weighing 15 kg. Test received through telemedicine.

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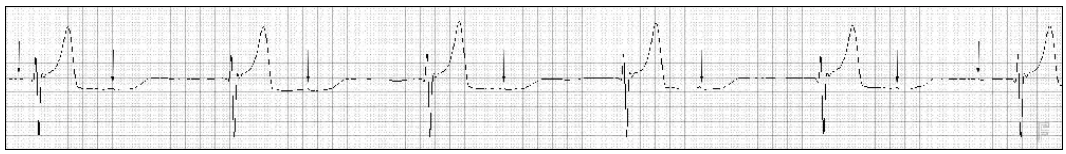
1) What is the rhythm in this tracing? Why does it happen?

CASE 229:



1) It is a rhythm of sinus tachycardia with rate ranging from 161 to 214 bpm.
2) It could be confused with atrial ectopic tachycardia, if we do not identify P waves detached from the preceding T waves, at the points where heart rate decreases a little. It is important to verify that the PR interval is constant.
3) R waves with markedly increased amplitudes (remember that the recording is at a sensitivity of N/2) are compatible with left ventricular enlargement. Nevertheless, the significant increase in QRS complex duration, besides 80 ms (4q), shows that there is left bundle branch block associated.

CASE 230:



1) It is a rhythm of junctional escape beat, presenting a heart rate of 44 bpm. This substitution rhythm manifests by AV junction focus, as a consequence of 3rd degree atrioventricular block. Besides the QRS

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complexes not being wider, there is the presence of small P waves (arrows), indicating there is atrioventricular dissociation.

CASE 231: Tracing (in D2) of a 5-year-old Persian cat. Clinical symptoms of cyanosis, lethargy and intolerance to exercise.



1) What is the rhythm in this tracing?
2) Knowing that P wave duration is 60 ms (3q) and that R wave amplitude is 1.8 mv (18q), what heart disease does the tracing suggest, and how can we confirm the suspicion?

CASE 232: Tracing (in D2) of a 13-year-old German Spitz. Clinical symptoms of cough and tiredness. Diagnosis of mitral and tricuspid valves degeneration in echocardiogram.



1) What arrhythmia is present in this tracing? Is it a common occurrence in this heart disease?
2) What is the relationship between this heart disease and the measures found in this tracing, namely: P wave duration of 50 ms (2.5q) and P, R and T waves amplitudes of 0.45 mv (5q), 1.3 mv (13q) and 0.6 mv (6q) respectively?

CASE 231:

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1) It is sinus rhythm with rate of 176 bpm.
2) The two measures mentioned are beyond the standard of normality. The findings suggest left chambers enlargement. The confirmation will always be by imaging tests. Echocardiogram shows left atrium and ventricle increase, besides symmetrical hypertrophy in the left ventricle of the concentric type in a moderate degree, and diagnosis of hypertrophic cardiomyopathy.

CASE 232:



1) Accelerated idioventricular rhythm is the arrhythmia observed in this tracing (box). Chronic mitral valve disease is a heart disease that has a high arrhythmogenic potential and could predispose the occurrence of rhythm or conduction disorders.
2) P waves duration and amplitude are increased and suggest there is biatrial enlargement. Also, T wave has an amplitude greater than 25% of R wave, a finding that could be related to left ventricular enlargement. The increase in the cardiac chambers may justify the occurrence of arrhythmias.

CASE 233: Tracing (in D2) of a 10-year-old Poodle and weighing 5 kg. History of dry cough and presence of holosystolic murmur grade IV/VI in auscultation.

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1) What is the possible relationship between P wave with 60 ms (3q) of duration and the clinical signs, as well as the murmur auscultation?
2) What is the rhythm in this tracing? Are there hints suggesting this dog has a heart disease?

CASE 234: Tracing of an 11-year-old female Dachshund and weighing 12 kg. There is cardiomegaly and hemodynamic repercussion in the four cardiac chambers, observed in chest X-rays and echocardiogram, respectively.



1) What arrhythmia can we see in this tracing?
2) What is the relationship between the P waves with a duration of 60 ms (3q) and amplitude of 0.7 mv (7q) respectively, and the imaging findings? How can we explain the appearance of S waves in leads D2, D3 and aVF?

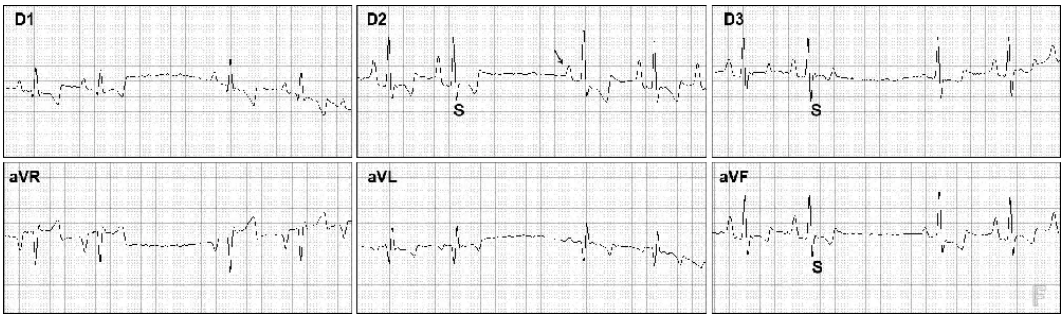
CASE 233:

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1) P wave presents a duration above normality, suggesting left atrial enlargement.
2) The base rhythm is sinus tachycardia, with rate of 214 bpm. Knowing that physiological and extracardiac conditions may trigger this rhythm, it is important to know that it could also be related to heart diseases. When they compromise the cardiac output, the heart puts into play compensatory mechanisms to recover it. One of them is the activation of the sympathetic nervous system and its main function is increasing the frequency of impulse generation. This mechanism explains the sinus tachycardia, that could be the first electrocardiographic finding related to cardiac decompensation.

CASE 234:

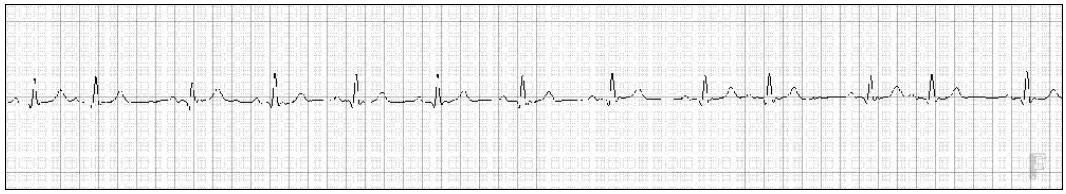


1) There is atrial escape beat (arrow), characterized by P wave inscription with a morphology different from the rest and late in relation to the base rhythm.
2) P wave that exceeds the limits of normality in duration and amplitude is strongly suggestive of biatrial enlargement, which was verified by imaging tests. The presence of S waves in these leads is

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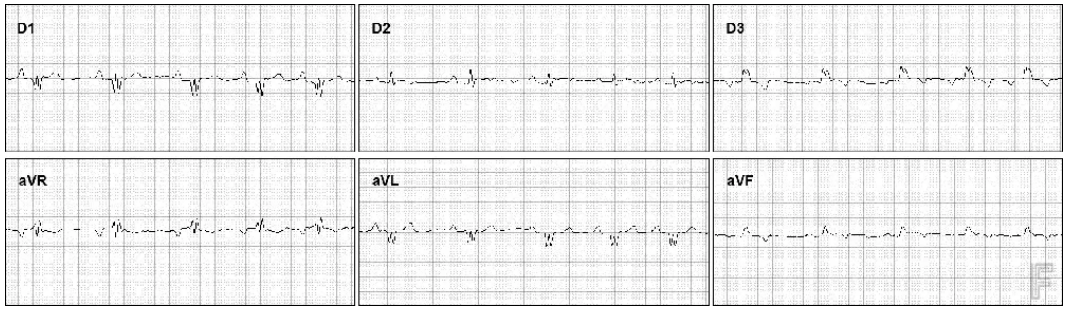
related to enlargement or hypertrophies in the basal regions of the heart, present in both ventricles.

CASE 235: Tracing (in D2) of a 17-year-old female mongrel. Her weight was not reported. The echocardiogram did not show chamber increase. Test sent by telemedicine.



1) What is the rhythm in this tracing?
2) What arrhythmias appear in this tracing and what is the main reason that it happens in a dog with no heart disease?

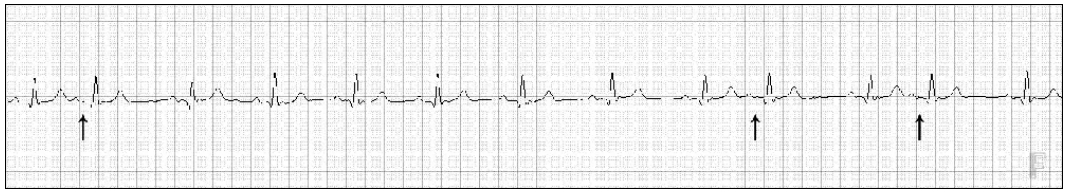
CASE 236: Tracing of a 3-year-old female dog, weighing 3 kg. Preanesthetic evaluation in healthy patient, but her biological father is a heart disease carrier.



1) What is the rhythm in this tracing?
2) Is the mean axis of the QRS complex within normality?
3) What can the QRS complexes morphologies mean in leads D1, D3 aVR and aVL?

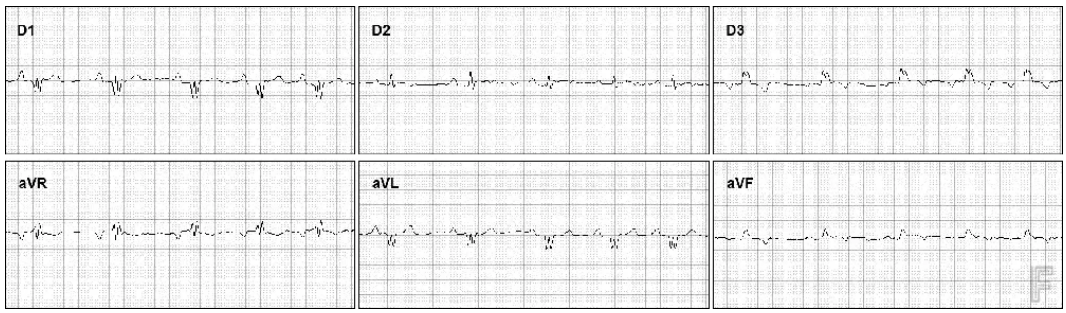
CASE 235:

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1) The base rhythm is sinus. Heart rate is around 136 bpm.
2) Premature atrial contractions (arrows) are observed, characterized by early inscription of P waves. Premature atrial contractions may occur in elderly dogs, as they are isolated and sporadic, and not necessarily linked to heart diseases.

CASE 236:



1) The rhythm is sinus arrhythmia, with heart rate varying between 115 and 157 bpm.
2) No. The mean QRS complex axis is between 120 and 150 degrees; thus, there is right axis shift.
3) These morphologies show a certain difficulty for the stimulus to spread through the right branch. They are polyphasic QRS complexes (arrows) in their morphology, but not wider yet. It is a transition between normal QRS complexes and those of classic bundle branch block

CASE 237: Tracings (all in D2) of an 8-year-old Golden Retriever weighing 49 kg. He presented cough.

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1) All P waves in the tracings have a 70 ms (3.5q) duration. However, in some of them (identified by asterisks) a phenomenon occurs. What is it?
2) What arrhythmias can we see in tracing number 2?
3) What happens with the PR interval (line) in tracing number 3?

CASE 237:

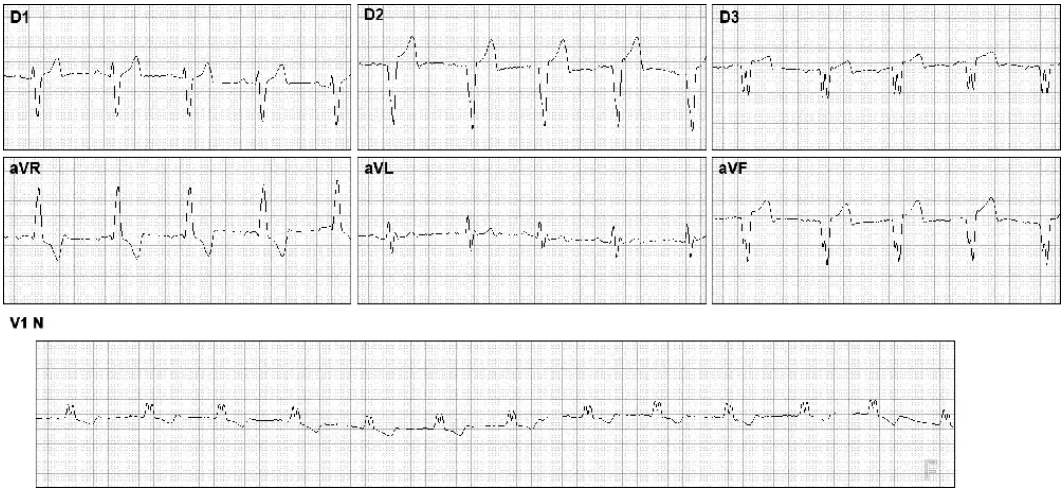
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1) The increase in the duration of all P waves is related to left atrial enlargement. However, the notches observed in some of them (asterisks) show that besides this, there is intermittent conduction disorder of the interatrial stimulus.
2) There are polymorphic ventricular extrasystoles, meaning they originate in more than one ectopic focus. The ectopic complexes are morphologically different (arrows) and present variable coupling periods. However, as the polarity remains the same; that is to say, negative in D2, it indicates that all originate in the left ventricle. There are also coupled premature contractions, indicated by the circle.
3) In this interval there is pseudo 1st degree atrioventricular block, caused by concealed retrograde conduction in the AV junction, observed in some cases after a premature ventricular contraction gets to penetrate retrogradely into the AV junction, thus interfering with its refractory period, resulting in this phenomenon.

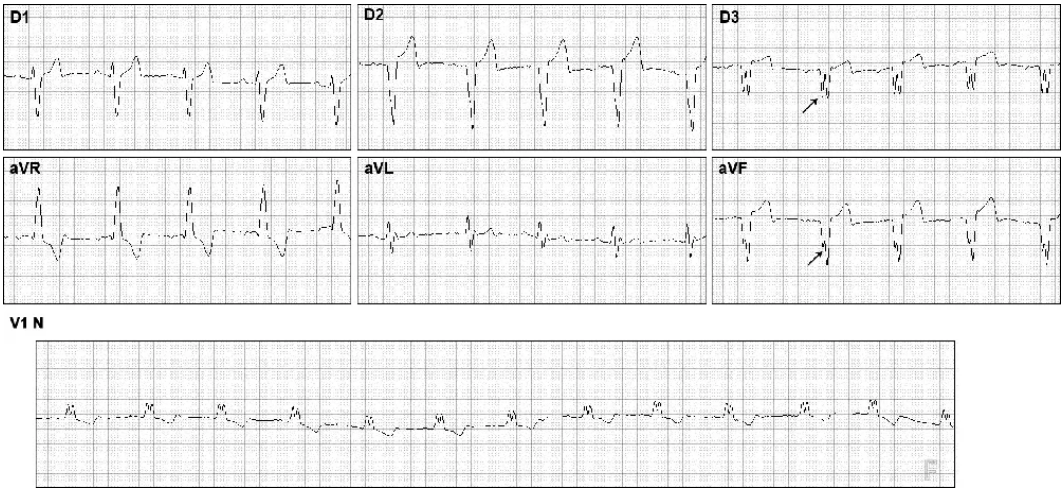
CASE 238: Tracing of a 1-year-old Sharpei, weighing 12 kg. The reason to request the test was not reported. Test received by telemedicine.



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1) This is a tracing typical of what conduction disorder? Measured, the QRS complex presented 90 ms (4.5q) of duration. V1 corresponds to a precordial lead placed in the right hemithorax.
2) Can we suspect that a dog of this age could be a carrier of heart diseases, in face of these alterations? If so, which?

CASE 238:



1) This is a typical tracing of right bundle branch block, as it presents all these electrocardiography features, namely:

A) QRS complexes exceeding 80 ms (4q), mainly when their final portion is wider.

B) Ventricular repolarization alteration (T wave polarity opposite to the QRS complex).

C) Right mean cardiac QRS axis shift (in this case at -120 degrees).

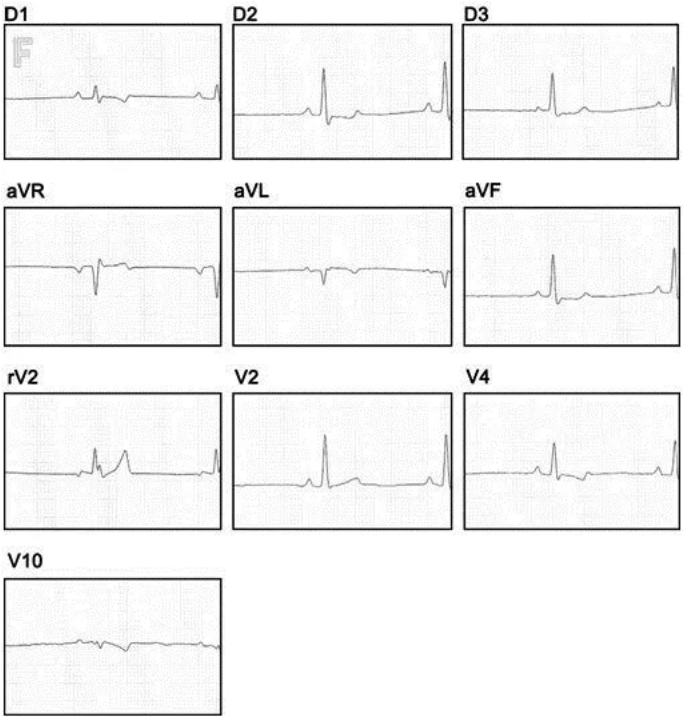
D) Presence of notches in some leads: D3 and aVF (arrows). The notches observed correspond to shortening of instantaneous vectors, during the process of ventricular activation, attributed to the appearance of fragmented ventricular potentials.

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E) QRS complexes outlined as an M in the right precordial lead (appearance of "bunny ears"), indicating there is stimulus conduction disorder through the interventricular septum.

2) Any condition promoting right ventricular enlargement may be associated to right bundle branch block. Before a patient in this age range, we could suspect at first of congenital heart diseases, as pulmonary stenosis, persistent arterial duct, atrial or ventricular septal defect. Anyway, we cannot rule out the possibility of chagasic cardiomyopathy or even dirofilariasis. Right bundle branch block is also found in a small percentage of dogs with no heart disease.

CASE 239:



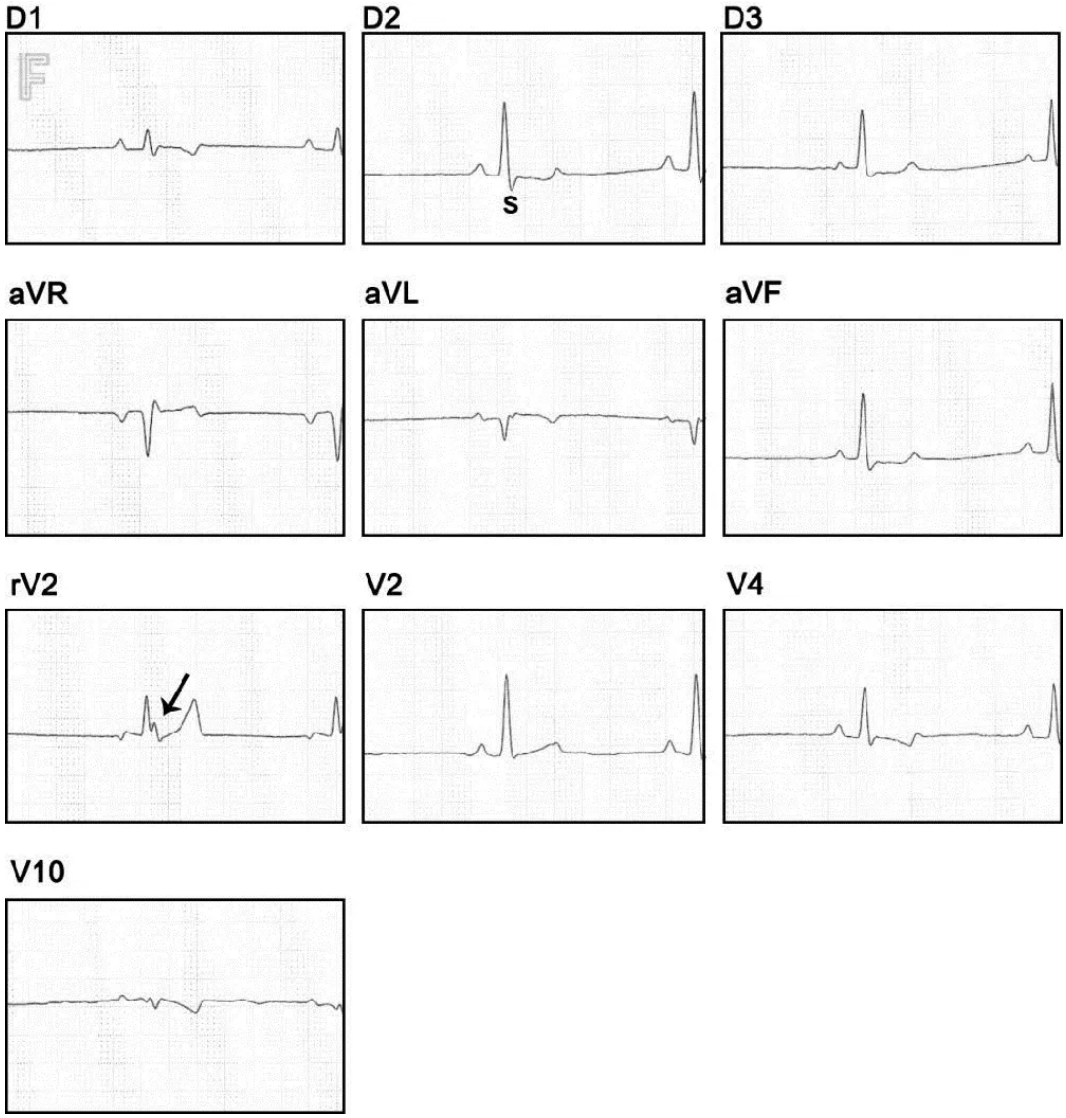
Tracing of a 2-year-old female Beagle. Preanesthetic test with the patient asymptomatic.

1) What would be the main suspicion before a QRS complex of the Rr' type in the precordial lead rV2 (recorded in the right hemithorax)?

2) Could this finding be related to this breed? What is the implication of this finding?

CASE 239:

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1) This QRS pattern in the right hemithorax (arrow) is compatible with right bundle branch block. When this happens, there is difficulty for the stimulus to spread through the His bundle right branch. S waves in the frontal plane leads (mainly in D2), are also hints of the difficulty of the stimulus to spread. As in veterinary electrocardiography there is still no defined pattern of the various degrees of blocks (or delay), there is the option of using the term "incomplete right bundle branch block", related to the small or medium degree of difficulty that the stimulus encounters to propagate in the right branch of the bundle of His.
2) The females of this breed may present right ventricular hypertrophy secondary to congenital heart diseases, as pulmonary stenosis. A follow-up must be conducted on the incomplete right bundle branch block, to verify whether it evolves.

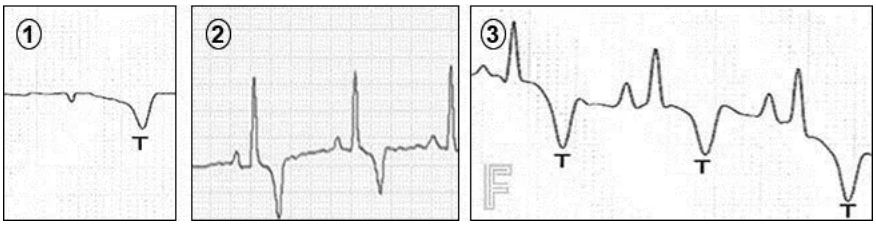
CASE 240: Tracing (in D2) of a 6-year-old female mongrel, weighing 17 kg and with symptoms of sepsis secondary to pyometra. In the lower tracing (also in D2), the recording was made 24 hours after ovariohysterectomy.



1) What is the rhythm of the electrocardiographic tracings?
2) Is there a relationship between the rhythm observed in the upper tracing with the clinical symptoms of the patient?

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CASE 241: These tracings belong to three different dogs: N° 1 is a 9-year-old mongrel, with increase in intracranial pressure. N° 2 is another mongrel, aged 13 years; the tracing was recorded after symptoms of stroke. N° 3 is a Poodle with symptoms of liver neoplasia; the tracing was recorded between convulsive crises.



1) What is the similarity between the T waves of these patients, knowing that all the recordings were made in lead D2?
2) What conditions could be related to these findings?

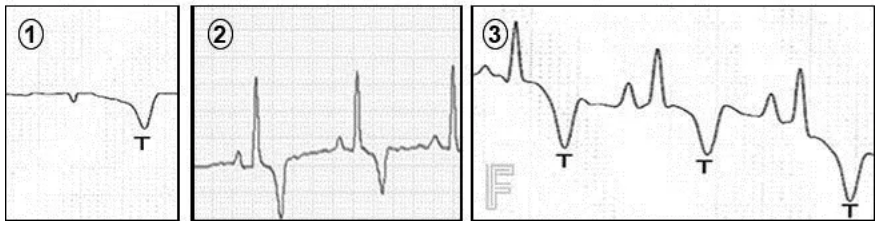
CASE 240:



1) Above, there is accelerated idioventricular rhythm, also called slow ventricular tachycardia, with a rate of 60 bpm. Below, the rhythm is sinus arrhythmia, with rate ranging from 66 to 100 bpm. In it, P wave and the QRS complex are within normality in terms of durations and morphologies.
2) Symptoms of toxemia may be aggressive to the myocardium and trigger severe arrhythmias. In this case, the rhythm returned to normality after withdrawing the aggressive factor to the organism and stabilizing the hemodynamics of the patient.

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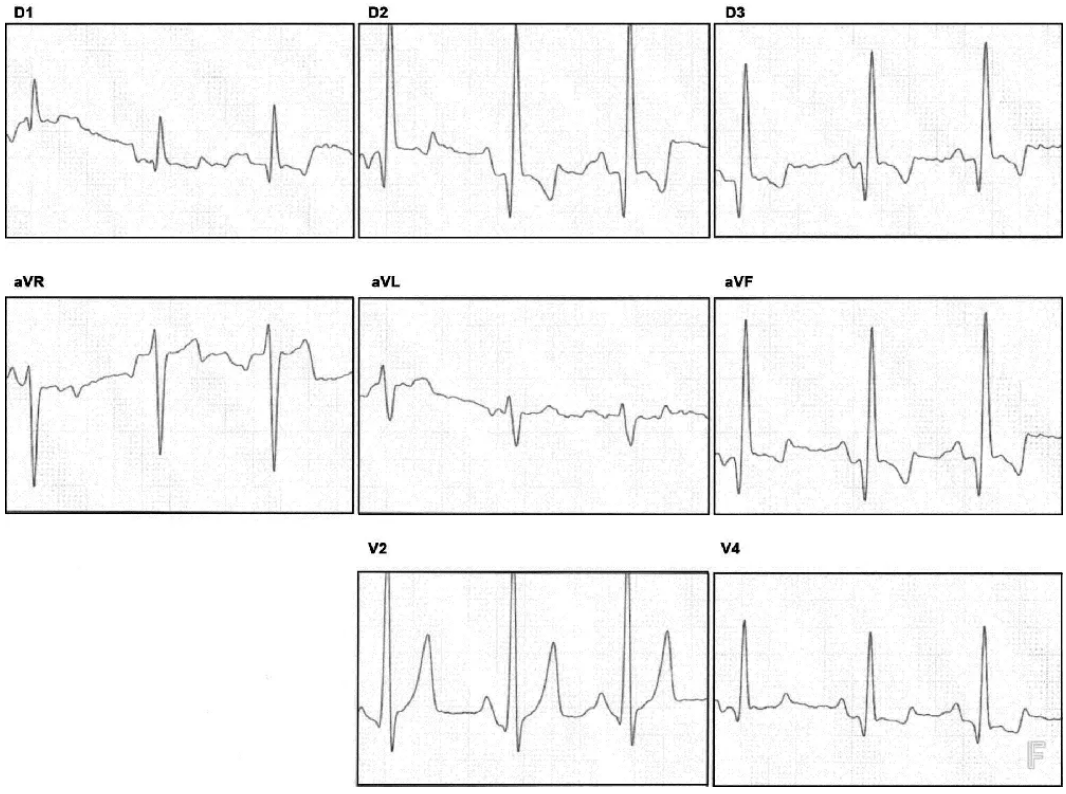
CASE 241:



1) All have in common the fact that T waves present as negative, deep and with amplitudes greater than 25% in relation to the QRS complexes.
2) Diseases affecting the central nervous system have been associated to them and may cause electrocardiographic alterations secondary to degeneration or disintegration of myocardial cells, with necrosis and mineralization. These lesions may appear on the third post-lesion day and remain for 5 to 10 days. These waves are called "cerebral T waves".

CASE 242: Tracing of a 5-year-old Greyhound. Healthy animal.

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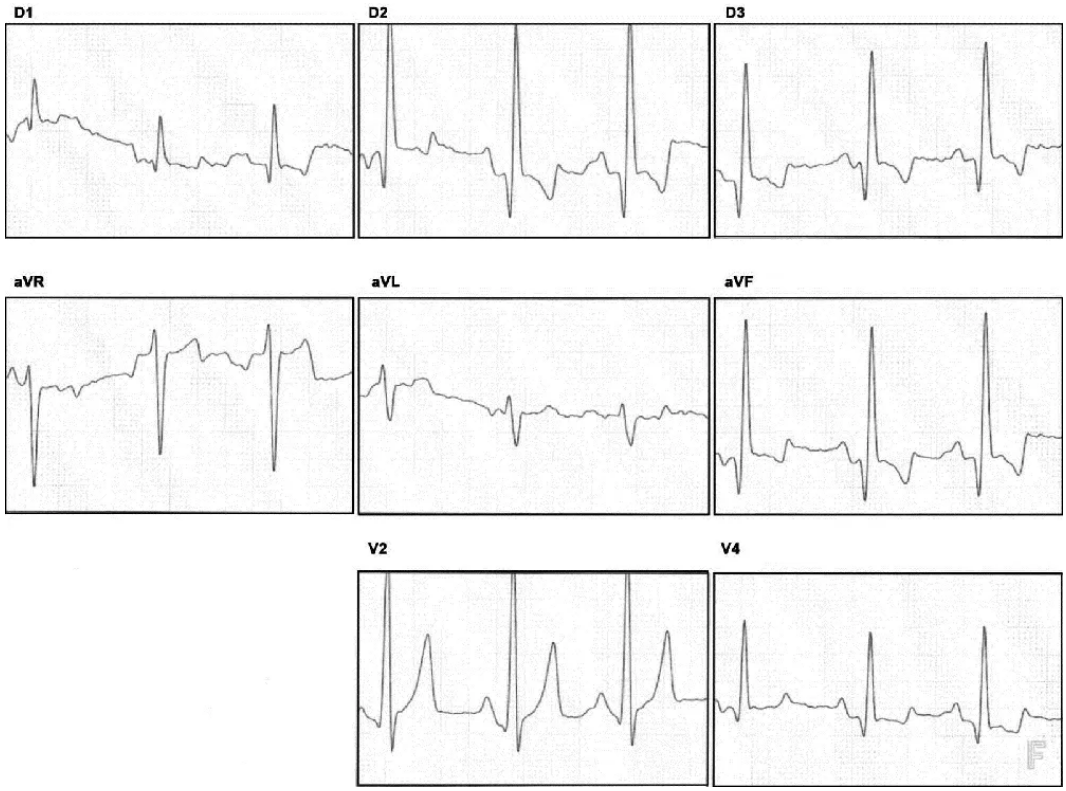


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1) Knowing there is P wave duration increase, R wave amplitude increase in D2, Q waves with equal increase in amplitude and QRS complex of increased duration, is this a tracing suggestive of chamber enlargement or compatible with conduction disorder?
2) Do the tracings of dogs in the group of Hounds, break away a little from the pattern of normality of other dogs? Why?

CASE 242:

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1) If we consider the pattern according to other breeds of dogs, this tracing would suggest left atrial and ventricular enlargement, besides left bundle branch block. However, the group of Hounds does not follow the same electrocardiographic pattern as other dogs. For them, P wave amplitude values may reach 0.8 mv (8q), of R wave 5.4 mv (54q), besides QRS complex duration reaching 75 ms (3.75q). The septal hypertrophy observed by the presence of Q waves with greater amplitude in D2, D3 and aVF are considered normal too.
2) These particular aspects occur then, as the dogs in this group are endowed with a differentiated cardiovascular system. In them, the heart is bigger (1:1.5 ratio in comparison to other dogs) because of the hypertrophy in the heart muscles and the increase in their chambers, secondary to the physiological adaptation of their differentiated cardiovascular system. There is increase in myocardial cell diameter, instead of an increase in the number of the cells proper.

CASE 243: Tracing (in D2) of a 14-year-old female mongrel, weighing 15 kg. Test received by telemedicine.



1) What arrhythmias are present in this tracing?
2) The last two P waves in the tracing present a duration of 60 ms (3q) and amplitude of 0.5 mv (5q). R wave amplitude is at least 2.7 mv (27q). What is the cause of these findings?

CASE 244: Tracing (in D3) of a 10-year-old Toy Poodle and weighing 2 kg. Test received by telemedicine.

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1) What is the rhythm in this tracing?
2) Knowing the tracing was recorded at an N/2 sensitivity, and the mean cardiac axis is at 120°, what can we expect for a patient that presents P wave and R wave with more than 0.5 mv (5q) and 1.8 (18q) of amplitude, respectively?

CASE 243:



1) The tracing starts with atrial flutter with variable ventricular response. F waves with "sawtooth" appearance are indicated by the first line. In the box, 2:1 AV response is observed, a dangerous ratio that reflects an accentuated increase of heart rate per minute, with cardiac output decrease and risk of loss of consciousness. After the atrial flutter ends, atrial escapes are inscribed (bigger line), until the sinus node recovers its dominance (shown by the two asterisks).
2) P wave with these measures is compatible with biatrial enlargement, while R wave amplitude increase is suggestive of left ventricular enlargement.

CASE 244:



1) 1) It is a supraventricular tachycardia rhythm, at a rate of 250 bpm.

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2) 2) Despite the difficulty in making the differential diagnosis of the exact origin of supraventricular tachycardia, due to the fact that the P waves are not fully identified by the rapidity of the tachycardia (and also because we cannot identify a transition from the base rhythm), the tachycardia must be of sinus origin, as sympathetic hypertonus can cause a sharp P wave with increased amplitude (and must be fused with the preceding T waves). Even if this fusion makes it difficult to measure the waves accurately, it is noted that the amplitudes of P waves and R waves are above normality (tracing in N/2 sensitivity), findings that are also compatible with overload of the right chambers. Mean cardiac axis deviation shifted to the right reinforces this suspicion.

CASE 245: Tracing in D2 of a 17-year-old cat (gender not reported) and weighing 4 kg. Clinical symptoms of dyspnea.



1) What arrhythmia is present in this tracing?
2) Can we relate a P wave with 60 ms (3q) of duration and an R wave with 0.9 mv (9q) of amplitude, to the diagnosis of hypertrophic cardiomyopathy observed in echocardiogram? Is there a relationship between the arrhythmia observed and the heart disease of the patient?

CASE 246: Tracing (in D2) of a 6-month-old German Shepherd. History not reported.



1) What is the rhythm in this tracing?

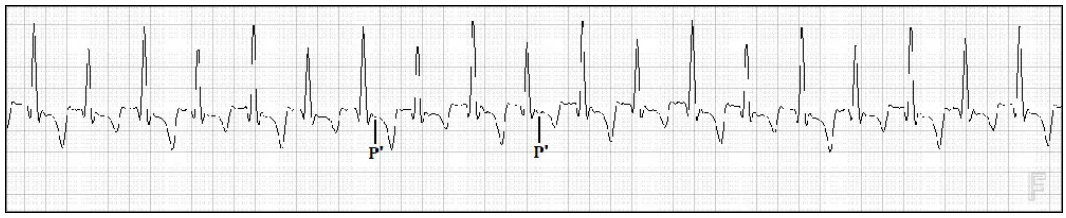
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CASE 245:



1) There is a very short PR interval and when this occurs, the P wave approaches the QRS complex significantly. There are also delta waves (arrows), responsible for the widening of the QRS complexes. Therefore, this is a case of ventricular pre-excitation conducted by the bundles of Kent, which are accessory pathways (atrioventricular connections) that connect the atria to the ventricles.
2) R wave at the upper limit of normality in this lead, may suggest left ventricular hypertrophy, that jointly with the P wave with increased duration is suggestive of left atrial enlargement. Ventricular preexcitation is a condition that could be associated to hypertrophic cardiomyopathy in felines.

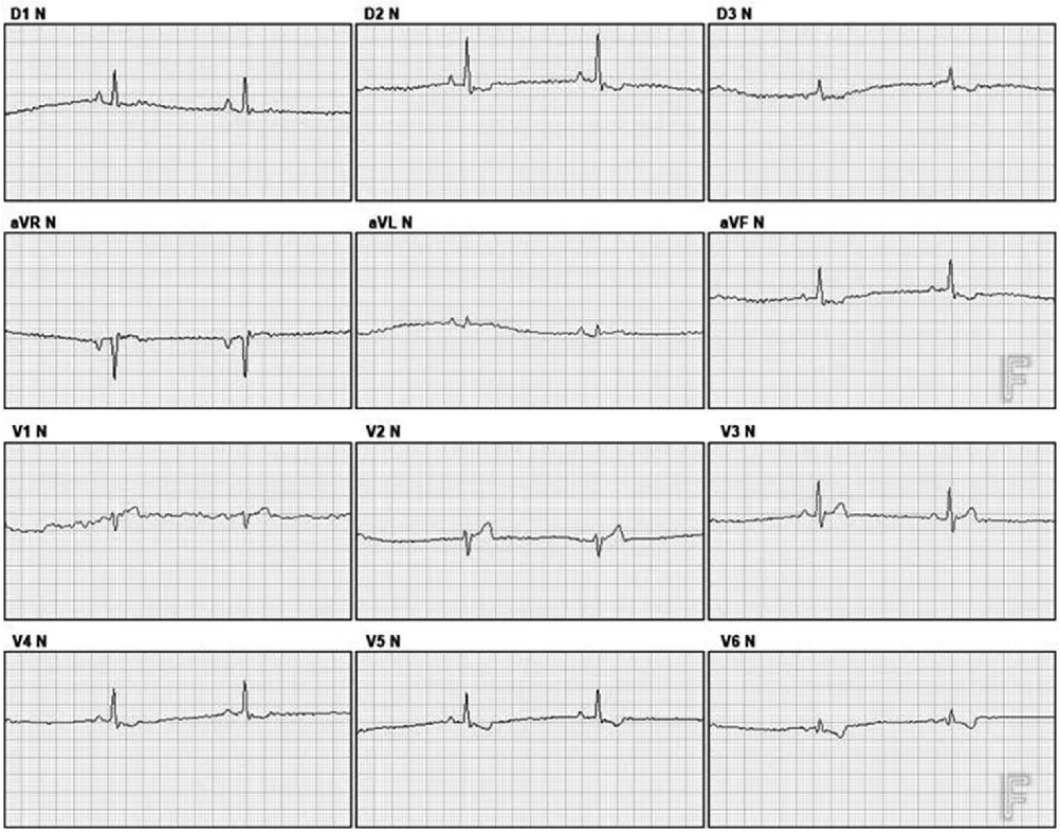
CASE 246:



1) It is an orthodromic atrioventricular reentrant tachycardia. It is a supraventricular tachycardia related to patients with an anomalous pathway to complete a reentry, but also using the atrioventricular node to sustain it. The R-R intervals are mostly regular, and usually causes electrical alternation with each beat, a phenomenon that may be related to oscillations in the refractoriness period of the His-Purkinje system. It commonly presents negative ectopic P waves (P') in the inferior leads, and identified in the ST segment or in the ascending branch of the T wave, which may lead to a depression of the ST segment.

CASE 247: Tracing of a 7-year-old Chihuahua. Healthy patient.

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1) Knowing that the V6N lead in this tracing corresponds to the V10 lead (recorded at the level of the 7th spinous process), T waves are observed with negative polarity in this lead. Is this a reflection of heart disease?

CASE 247:

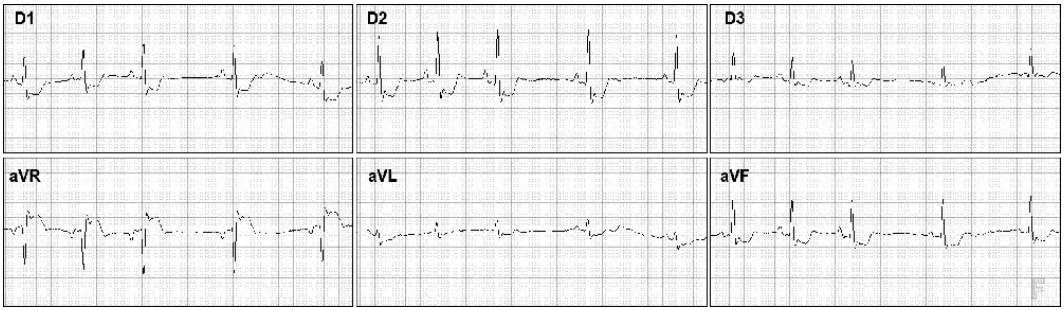
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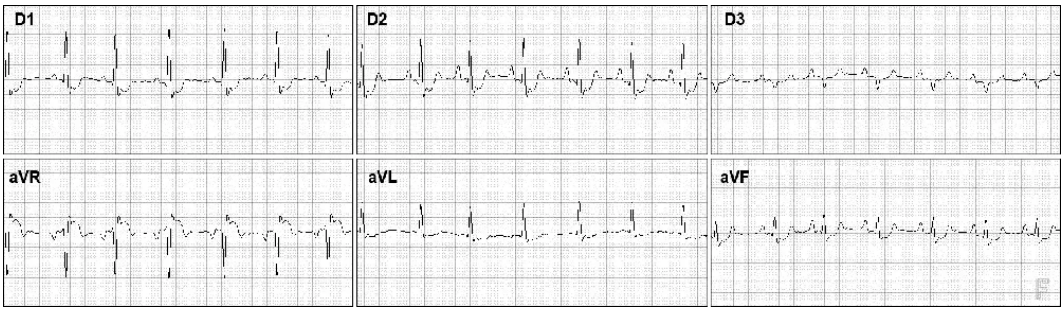
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1) According to most literature, T wave in lead V10 should always be negative, except for Chihuahas. However, Dijkstra and Szatmári in the year of 2009, showed in their studies, that even healthy Chihuahuas may present negative T wave too, not meaning the dog has a heart disease.

CASE 248: Tracing of a 10-year-old female Poodle, weighing 2.5 kg. She presented mild dyspnea and history chronic mitral valve disease with discrete regurgitation and left ventricular concentric hypertrophy, diagnosed by two-dimensional echocardiogram.



CASE 249: Tracing of a 4-year-old female Poodle, weighing 3 kg and presenting echocardiograms with no alterations. Preanesthetic test.

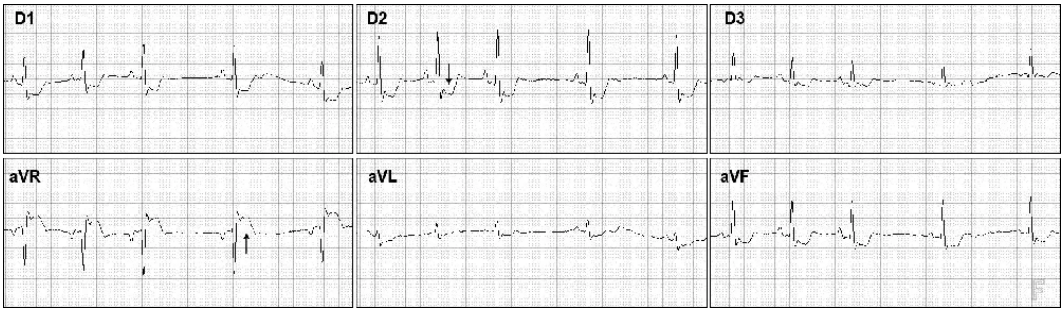


1) Define the rhythms in the tracings in cases No. 248 and No. 249.

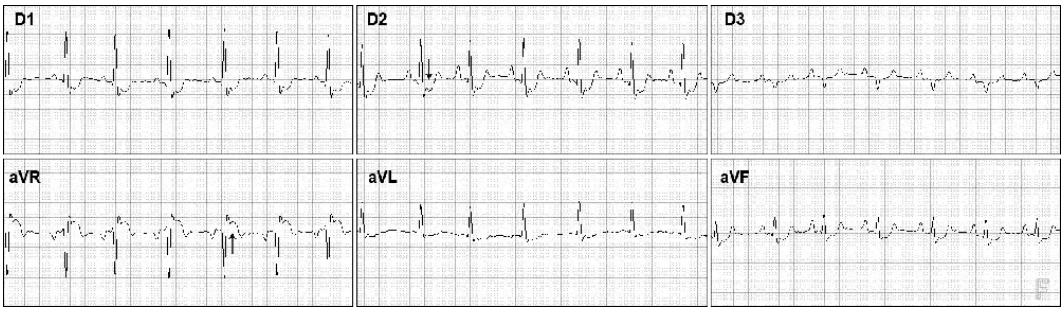
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2) Analyzing only the ST segments in both cases (mainly in leads D2 and aVF), it is observed that there is depression in relation to the baseline. Can we consider these findings as normal? What can make a 4-year-old dog present this alteration?

CASE 248:



CASE 249:



1) The rhythm in case No. 248 is sinus arrhythmia, with heart rate between 100 and 150 bpm. The rhythm in case No. 249 is sinus, with a rate of 166 bpm.
2) There is ST segment shift reaching 0.5 mv (5q), indicating there is myocardial ischemia. In case No. 248, the dog is 10 years old and already presenting clinical signs of heart disease. Also, there is

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concentric left ventricular hypertrophy, a condition that may increase intramural tension and compression of coronary arteries, reducing its flow and leading to myocardial hypoxia. This could justify the shifts. But, what would make a 4-year-old dog (case No. 249) present the same depression, but in absence of myocardial hypertrophy? If the patient was human, he would be unavoidably referred to ergometer test and/or cardiac catheterization to evaluate his coronary arteries.

CASE 250:

A) Tracing of a 14-year-old Pit Bull, weighing 35 kg and with history of syncopes. It was not possible to perform other supplementary tests because the was extremely angry.



B) Tracing (in D2) of the same dog, two weeks after being treated with amiodarone. The dog no longer presented syncopes.

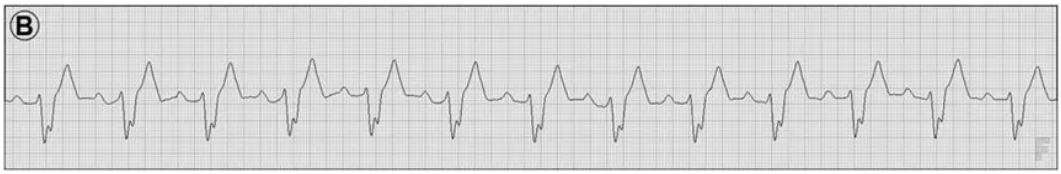


1) What is the rhythm and what arrhythmia is present in tracing A? Is it likely that there is a relationship between this arrhythmia and the syncopes?
2) What is the rhythm of tracing B?
3) Knowing that the QRS complex duration is 110 ms (5.5q), of P wave 80 ms (4q) and of the PR interval 160 ms (8q), to what conditions we may relate these findings?

CASE 250:

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1) The tracing presents sinus tachycardia rhythm, with rate of 166 bpm and yet one ventricular extrasystole (circle). Also related to them, there is also a phenomenon called R-on-T (arrow), characterized by a very early premature ventricular contraction, that gets to overlap onto the T wave from the preceding ectopic complex. This phenomenon could be a trigger of complex arrhythmias such as ventricular tachycardia, the probable cause for the syncopes.
2) The rhythm is sinus with a rate of 120 bpm.
3) Not just by the increased QRS complex duration, but also by presenting notches and mainly by the cardiac axis shift, this is a typical tracing of right bundle branch block, associated to 1st degree atrioventricular block (increased PR interval). The P wave with increased duration, suggests left atrial enlargement.

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