BASIC PRINCIPLES OF CANINE ELECTRO-CARDIOGRAPHY

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Electrocardiography is the recording of electrical activity of the heart. Electrocardiograph is the equipment for recording and electrocardiogram is the recorded paper.

The electrocardiogram is a graphic record of voltage produced by cardiac muscle cells during depolarization and repolarisation plotted against time. In 1895 Einthovan introduced the letters P-Q-R-S-T for the electrocardiographic deflections where P represents atrial depolarization, Q-R-S represents ventricular deploarisationand T represents ventricular repolarization.

USES OF ELECTRO CARDIOGRAPHY

Evaluation of Cardiac Diseases

Evaluation of Anatomic Cardiac Changes (Cardiac enlargement)
Evaluation of Arrhythmias
Evaluation of therapy
Drug therapy
Electrolyte disturbances
Pericardiocentesis
Evaluation of prognosis
Evaluation of progression of disease

Differentiation of Non specific Diseases that cause weakness, fatigue, fever, lethargy, collapse or seizures

Metbolic diseases with electrolyte alterations
Adrenal insufficiency
Diabetic ketoacidosis
Severe renal insufficiency
Eclampsia
Idiopathic hypokalemia
Cardiac syncope
Bradycardias
Tachycardias
Epilepsy
Endocarditis, myocarditis and Cardiac neoplasia
Systemic diseases with toxaemias

MONITORING DURING ANAETHESIA AND SURGERY

Monitors depth of anaethesia
Monitiors ventilation- oxygenation changes

ROUTINE BASIS

Yearly examination (Preventive medicine)
Evaluation of dogs that are scheduled to have anaesthesia and surgery
Evaluation of trauma cases

DOCUMENTATION OF DATA

Sharing information and seeking consultation service

GENESIS OF ELECTOCARDIOGRAM

The heart beat was normally initiated by specialized pacemaker cells of the sino-atrial (SA) node. The activation potential was propagated to the atrioventricular (AV) node by continuous spread over the atrial musculature, which produced a P wave. The P wave signified that the atria has depolarized (atrial contraction). Conduction was both slow and decremental through the AV node permitting completion of atrial excitation and enabling the ventricle to fill with blood before it contracted. The P-R segment of the electrocardiogram was the isoelectric or zero potential that followed the P wave, effecting the delay of the cardiac impulse in the AV node.

From the AV node, the impulse passed directly to the common bundle of His. Transmission through the common bundle of His, the right and left branches

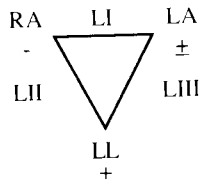
and the Purkinje fibres resulted in activation of al areas of the ventricles, giving rise to the QRS complex (ventricular contraction). Repolarization (ventricular relaxation) inscribed on the graph by either positive or negative deflection is know as T wave.

LEAD SYSTEMS IN ELECTROCARDIOGRAPHY

Various lead systems were developed to provide an accurate measurement of the electrical forces produced during cardiac contraction. Bailey's hexaxial lead system was the most useful and widely used in canine electrocardiography. It contained both the bipolar limb leads and augmented unipolar limb leads.

I. STANDARD BIPOLAR LIMB LEADS

Here one limb is positive and other limb is negative.



Lead I – Right forelimb negative to left forelimb positive

Lead II – Right forelimb negative to left hindlimb positive

Lead III- left forelimb negative to left hindlimb positive

II. AUGMENTED UNIPOLAR LIMB LEADS

Here one limb is positive and other two limbs are negative

Lead aVR – Right forelimb positive compared to left

forelimb and left hindlimb (negative)

Lead aVL – Left forelimb positive compared to right

forelimb and left hindlimb (negative)

Lead aVF – Left hindlimb positive compared to right

and left forelimbs (negative)

III. UNIPOLAR PRECORDIAL LEAD SYSTEM

Here an exploring electrode or 'V' electrode (positive) was placed on the thorax and the voltage was compared to the average voltage across the three standard limbs (negative). These leads provide additional information on right and left heart enlargement.

Precordial Leads	*Position of 'V' electrode*
V_{10}	Above the spinous process of 6th or 7th thoracic vertebrae
CV_6LU	Left side 6th intercostal space, costochondral junction
CV_6LL	Left side 6th intercostal space, sternal border
CV_5RL	Right side 5th intercostal space, sternal border

Interpretation of electrocardiogram

Four steps in the process of interpreting an electrocardiogram are

1. Determination of heart rate
2. Evaluation of heart rhythm
3. Measuring complexes and intervals
4. Determination of mean electrical axis

1. Determination of heart rate

From the electrocardiogram the heart rate can be determined by dividing 1500 (for a paper speed of 25mm/second) by the number of millimeters between two consecutive R waves. If the paper speed is 50mm/second, heart rate = 3000 ÷ number of mm between two R waves.

Heart rate was also determined by multiplying the number of QRS complexes in 3 second interval by 20 or in 6 seconds by 10.

2. Evaluation of heart rhythm

Heart rhythm can be evaluated by the analysis of electrocardiogram systematically and this showed whether the rhythm was the normal sinus rhythm or characteristic of a type of cardiac arrhythmia. Sinus arrhythmia and wandering pacemaker are normal variations in dogs.

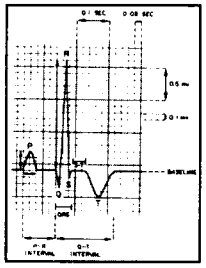
3. Measuring complexes and intervals

All measurements are done based on lead II unless otherwise indicated. Measurements included the height and width of P wave, the length of PR interval, the width of QRS complex, the height of R wave and T wave, Q-T interval and S-T segment pattern. Height of the wave is designated as amplitude (in mV) and width as duration (in seconds).

In 25mm/second 1 small column in X axis = 0.04 seconds

In 50mm/second 1 small column in X axis = 0.02 seconds

In 1 sensitivity, 1 small column in Y axis = 0.1 mV



Normal values of ECG in dogs

Lead II

Parameters	Small breeds		Large breeds		Remarks
	Below 1 yr	Above 1 yr	Below 1 yr	Above 1 yr	
P duration (sec)	0.02-0.04	0.02-0.04	0.04	0.04	
P amplitude (mV)	0.1-0.2	0.1-0.2	0.1-0.2	0.1-0.2	Not more than 0.4 mV
PR interval (sec)	0.08-0.14	0.12-0.24	0.10-0.14	0.08-0.12	
QRS duration (sec)	0.02-0.04	0.02-0.04	0.04	0.04	
R amplitude (mV)	0.9-2.1	1.2-2.7	1.0-2.9	0.9-2.8	
QT interval (sec)	0.16	0.16-0.26	0.16-0.24	0.16-0.22	
T wave (mV)	0.1-0.3	0.1-0.3	0.1-0.2	0.1-0.3	
ST segment (mV) (from baseline)	0.1	0.1	0.1	0.1	No depression Elevation/coving

Diagnosing cardiac chamber enlargement from ECG

Various cardiac chamber enlargements can be detected to some extend by ECG.

Right atrial enlargement – Tall P wave. P wave more than 0.4 mV.

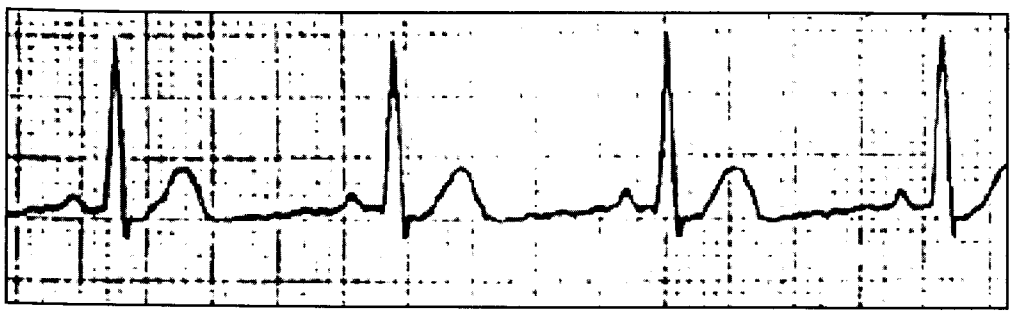
Left atrial enlargement – P duration more than 0.04 seconds. Sometimes a wide notched P wave.

Right ventricular enlargement – Deep S or deep Q waves. Deep S wave in lead I, II & III i.e. S1, S2, S3 pattern denotes right ventricular enlargement.

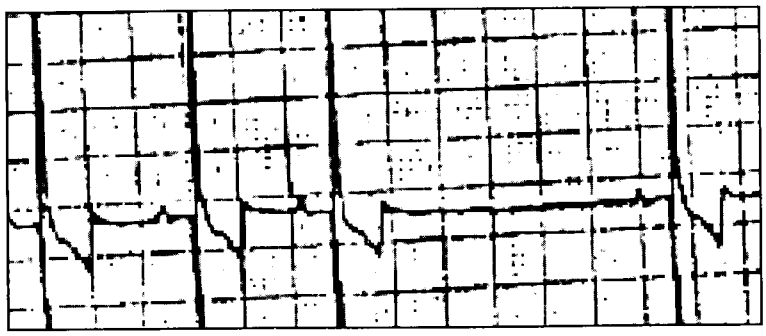
Left ventricular enlargement – R wave taller than 3mV in larger breeds or more than 2.5 mV in small breeds or QRS duration more than 0.04 seconds

COMMON CARDIAC ARRHYTHMIAS

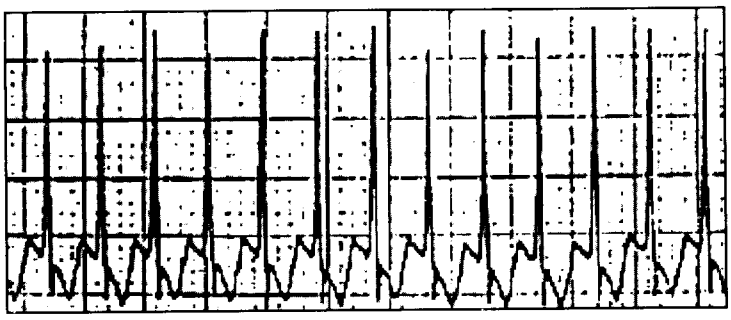
Sinus bradycardia – regular missing of PQRST complexes. In exercised dogs and due to vagal hypertonicity



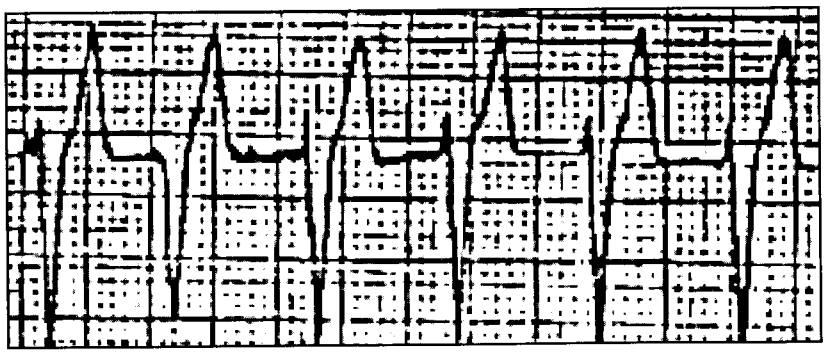
Sinus arrest – sinus bradycardia if it is not treated results in sinus arrest. There will be long gap between PQRST complexes



Supraventricular tachycardia – Abnormal P waves for each QRS complex. As the heart rate increases, P waves may be lost in preceeding T waves. Normal QRS complexes.



Ventricular premature complexes (VPC) – Commonest arrhythmia in veterinary practice. VPCs have no P wave and QRS complexes will be wide and bizarre compared with normal QRS complexes.



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VIEWS

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