CHARACTERISTICS OF THE REINDEER ELECTROCARDIOGRAM

Elektrokardiogram på ren.

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Abstract: The electrocardiogram (ECG) provides reliable information about heart rate, initiation of heart beat and also, to some degree, indirect evidence on the functional state of the heart muscle. A wide range of such information is readily obtainable from conventional scalar leads, even if the records are limited to a single plane. The present investigation deals with the normal reindeer ECG in the frontal plane. The technique used is the scalar recording technique based on the Einthovenian postulates. The P wave was positive in leads II, III and aVF, negative in lead aVL and variable in leads I and aVR. The direction of the P vector was 60 to 120°. The QRS complex was variable. The most common forms of QRS complex were R and rS in leads I and aVR; R, Rs and rS in lead aVL and Qr or qR in other leads. The most common direction of the QRS vector was 240 to 300°. The T wave was variable. The duration of various intervals and deflection depended on heart rate.

Rangifer *2 (2) : 36-40*

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Sammandrag: Elektrokardiogramet (EKG) ger tillförlitliga uppgifter om hjärtfrekvens, retledning och, indirekt, delvis även om hjärtmuskelns funktionella tillstånd. Största delen av denna information fås med normal skalar koppling även om registrering sker i ett plan. I detta arbete har renens normala EKG i frontalplanet undersökts. Kopplingarna har baserats på Einthovs postulat. P-vågen var riktad uppåt i koppling II, III och aVF, nedåt i koppling aVL och den varierade i koppling I och aVR. P-vektorns riktning var 60 - 120°. QRS-komplexet varierade. De vanligaste formerna var R och rS i koppling I och aVR; R, Rs och rS i koppling aVL och Qr eller qR i andra kopplingar. Vanligen var QRS-vektorns riktning 240 - 300°. T-vågen varierade. Avvikelserna och intervallernas längd var beroende av hjärtfrekvenssen.

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TIMITSJÄRVI, J., NIEMINEN, M. & NIKANDER, S. 1982. Poron sydänsähkökäyrän ominaisuuksia.

Yhteenveto: Sydänsähkökäyrästä saadaan luotettavaa tietoa sydämen syketiheydestä, sähköisestä johtumisesta ja välillisesti jossain määrin myös sydänlihaksen toiminnallisesta tilasta. Suurin osa tämänkaltaista tietoa voidaan saada tavanomaisia skalaarisia kytkentöjäkäyttäen, ja usein yhdessä tasossa tapahtuva rekisteröinti on riittävä. Tässä työssä on tutkittu porojen normaalia sydänsähkökäyrää ja sen eri poikkeamien suuntautumista frontaalitasossa, kun rekisteröinnissä on käytetty Einthovenin postulaattien mukaisia raajakytkentöjä. P aalto suuntautui ylöspäin kythkennöissä II, III ja aVF, alaspäin kytkennässä aVL ja vaihteli kytkennöissä I ja aVR. P vektorin suunta oli 60 - 120°. QRS kompleksi vaihteli. Tavallisimmat muodot olivat R ja rS kytkennöissä I ja aVR; R, Rs ja rS kytkennässä aVL ja Qr tai qR muissa kytkennöissä. Tavallisin QRS vektorin suunta oli 240 - 300°. T aalto vaihteli. Poikkeaminen ja intervallien kesto riippui sydämen syketiheydestä.

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INTRODUCTION

The electrocardiogram provides reliable information about heart rate, intiation of heart beat and also, to some degree, indirect evidence on the functional state of the heart muscle. In the case of the reindeer, there is, however, a lack of standardization of the proper electrocardiographic leads and, hence, the conventional scalar procedures based on the Einthovenian postulates and triangle hypothesis have been formerly employed when recording the scalar electrocardiogram of the reindeer (Timisjärvi et al. 1979). These recordings included calves and some older does and showed inter-individual variations in the frontal plane. The present paper will deal with the electrocardiogram of the reindeer calves, does and stags and it provides a more detailed description of the variability of the electrocardiogram. The technique employed is the usual scalar limb lead recording technique in the frontal plane.

MATERIAL AND METHODS

Altogether 45 reindeer of ages ranging from 5 months to 9 years (25 calves aged 5 to 10 months, 5 older does aged 3 to 9 years and 15 stags aged 3 to 8 years) and ranging in weight from 20 to 80 kg served as subjects in this investigation. All were in good health and free from detectable cardiovascular abnormalities.

Electrocardiograms were recorded with a four-channel direct-writing recorder (Mingograph EM 34, Elema-Schönander, Sweden) in the laboratory (calves) or with a three-channel direct-writing recorder (Minor 3, Siemens-Elema, Sweden) in the open (does) or with a three-channel direct-writing recorder (Hellige Multiscriptor EK 33, Hellige, BRD) in the open (stags). The paper speed was 25, 50 or 100 mm/s and the calibration setting 1 cm/mV. The standard limb leads I, II and III and the augmented unipolar limb leads aVR, aVL and aVF were recorded with needle electrodes inserted subcutaneously in the extremities at a distance of 10 to 15 cm from the main body. In selected cases an intracardiac tracing was recorded with a platinum electrode (oesophageal electrode Siemens-Elema, Type 61 05 712 EIOIE).

Diazepam alone (1.2 to 1.5 mg/kg) or with pentobarbital sodium (5 to 20 mg/kg) was employed as a tranquilizer in the laboratory (calves). When the recordings were carried out in the natural environment of the reindeer, no sedation was used. The older does were immobilized in a prone position with a special chute, whereas the stags were immobilized manually in the side position. The recordings were taken according to Friedman (1971) with 3 to 4 complexes and intervals being measured in each lead.

RESULTS

The mean heart rate of a six-month-old resting reindeer calf was 50 to 65 beats per minute but various irritants led to a rapid increase up to 250 beats per minute. The heart rate of the does, after capturing the animals, was from 57 to 85 beats per minute with a mean of 71 beats per minute. The heart rate of the stags was correspondingly from 50 to 139 beats per minute with a mean of 88 beats per minute.

The duration of the various intervals and deflections depended on the heart rate. The duration of the P wave was from 50 to 80 ms, that of the P-Q interval 80 to 200 ms, that of the QRS complex 50 to 80 ms, that of the T wave 60 to 120 ms, and that of the Q-T interval 200 to 340 ms.

The range of the maximal amplitude and direction of the main deflection of the P wave, QRS complex and T wave are given in Figures 1 to 3 representing the three groups of the animals. In the majority of the limb lead recordings the P wave was diphasic or bifid (Figures 4 to 6). The P-Q segment was isoelectric (Figure 6). The most common form of the QRS complex was R og rS in leads I and aVR; and R, Rs or rS in lead aVL; while the forms Qr og qR in some cases dominated in leads II, III and aVF. The direction of the T wave varied but was opposite to the direction of the main deflection of the QRS complex in standard limb leads, especially in lead I.

In all animals the P vector was 60 to 120°, but the QRS vector showed more variability, being 240 to 300° in 35 out of 45 animals and 60 to 120° in the remaining 10 animals, while the T vector was 0 to 270° in those showing a craniad orientation of the QRS vector and 60 to 300° in those having a caudad-orientated QRS vector in the frontal plane, respectively.

DISCUSSION

The principal directions of the QRS deflections showed considerable variations in the frontal plane but support the earlier concept of craniad orientation of the mean QRS vector in that plane (Timisjärvi et al. 1979). According to Hamlin and

Smith (1965) some domestic animals show a craniad-orientated mean QRS vector with the same species having a sub-epicardiac termination of the Purkinje fibres (Spörri 1975) while the others have the sub-endocardially terminating Purkinje fibres and a caudad orientation of the QRS vector. Our histological studies suggest a sub-epicardiac termination of the Purkinje fibres in the reindeer (unpublished results).

Macroscopically the reindeer heart lies a little closer to the left than to the right thoracic wall (Engebretsen 1975) in the angle formed by the sternum and diaphragm. The mass axis of the heart is directed nearly perpendicularly to the sternum as is the left ventricle (Figure 7). This gross anatomic heart position together with the arrangement of the conduction system indicates that the mean spatial QRS vector is nearly perpendicular to the frontal plane, as also suggested by recordings on a Wilson terminal (Timisjärvi et al. 1979). Thus, a slight angular shift of the mean spatial QRS vector causes a high directional variability of the main scalar QRS complex in the frontal plane. This means that the lead systems using the Einthovenian postulates and triangle hypothesis are insufficient in the case of the reindeer, as has also been observed in the cow by DeRoth (1980). Therefore, a special electrode saddle has been constructed for recording the ECG in large animals (DeRoth 1980, DeRoth and Therien 1978).

The T wave was the most variable deflection in the reindeer ECG, but nevertheless, it was opposite in direction to the QRS complex in most animals, although a diphasic T deflection was also seen in some animals. On the other hand, the T wave is susceptible to the same anatomic determinants as discussed in connection with the QRS complex.

T wave inversions are most often associated with oxygen deprivation induced by exercise. However, Holmes et al. (1975) have observed T wave changes in horses after acceleration of the heart rate. In the present material the animals showed heart rates from 50 up to 140 beats/min. In the resting reindeer the heart rate is about 50 beats/min or even lower (Timisjärvi 1978). The heart rate will rise easily because of exogenous factors (Timisjärvi et al. 1979) and the observed T wave inversions associated with sedation may be due to changes in the heart rate.

The P wave was the most stable deflection in the present material and agrees with the earlier findings, as do the durations of various deflections or intervals (Timisjärvi et al. 1979). A bifid or diphasic P wave, as observed in the reindeer, is also described in horses (Hamlin et al. 1970). The authors conclude that the initial peak of the P wave in the horse is produced by the activity of the right atrium and the second peak arises from the activation of the interatrial septum and associated structure. This statement may be valid also in the reindeer.

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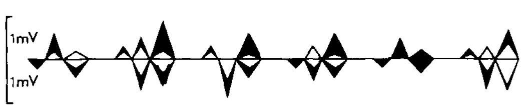
A

	I	II	III	aVR	aVL	aVF
+	3 6 3	8 2 6	9 - 8	- 5 4	- 8 2	9 - 5
+/–	2 - -	1 - -	- - -	2 - 1	1 - 1	- - 3
–	4 3 6	- 7 3	- 9 1	7 4 4	8 1 6	- 9 1

B

	I	II	III	aVR	aVL	aVF
+	4 2 4	6 6 3	6 6 3	- 2 3	1 2 1	6 6 3
+/–	2 - -	- - -	- - -	3 - 1	3 - 2	- - -
–	- 4 2	- - 3	- - 3	3 4 2	2 4 3	- - 3

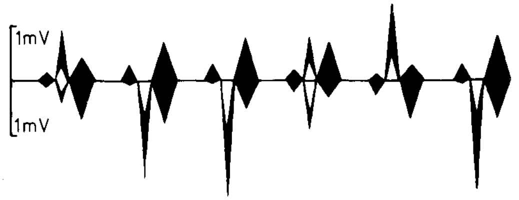
Figure 1. The amplitude and directions of the electrocardiographic deflections in the limb leads in reindeer stags. Intervals between the deflections are omitted. The shaded areas show the range of the amplitude in respect to the direction of the main deflection of P wave, QRS complex and T wave in 15 animals. The case numbers indicate the distribution of the directions (+, ± and -) of the deflection in each lead. Diagram A refers to the stags having a craniadorientated QRS vector and diagram B to those having a caudad-orientation of the QRS vector.



	I	II	III	aVR	aVL	aVF
+	- 4 1	5 3 2	5 - 2	- 1 4	- 4 2	5 1 2
+/-	1 1 -	- - -	- 2 1	1 - -	- 1 1	- 1 -
-	4 - 4	- 2 3	- 3 2	4 4 1	5 - 2	- 3 3

Figure 2. An analysis of limb lead recordings of ECG in 5 reindeer does. The figure is constructed as Figure 1.

A



	I	II	III	aVR	aVL	aVF
+	4 21 1	23 7	23 16	5 16 15	23 2	23 12
±/010- -		- - 1	- - 2	3 5 -	21 - 2	- - 2
-	9 2 22	-23 15	-23 5	15 2 8	2 - 15	-23 9

B

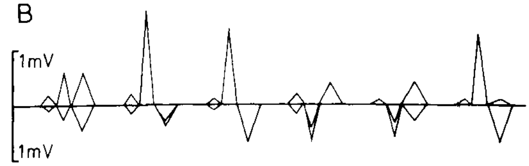


Figure 3. An analysis of limb lead recordings of ECG in 25 reindeer calves aged 6 months to one year. The Figure is constructed as Figure 1. The diagram B refers to two calves having a caudad-orientated QRS vector.

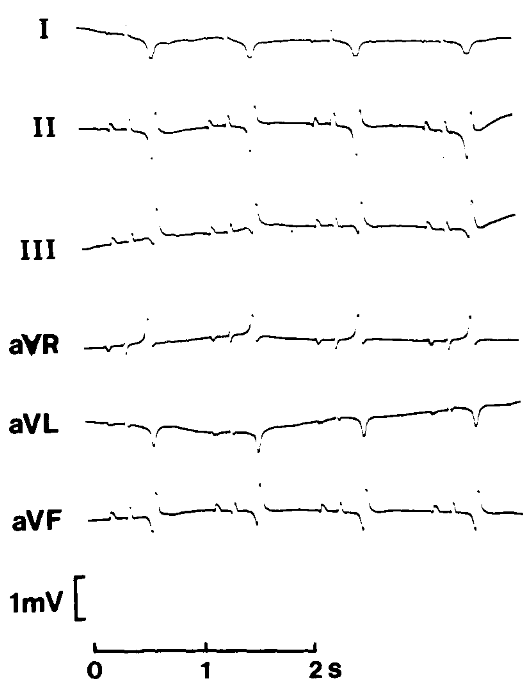


Figure 4. Electrocardiographic tracings for a 4-year-old male reindeer. The paper speed was 25 mm/s. Tracings taken in the open.

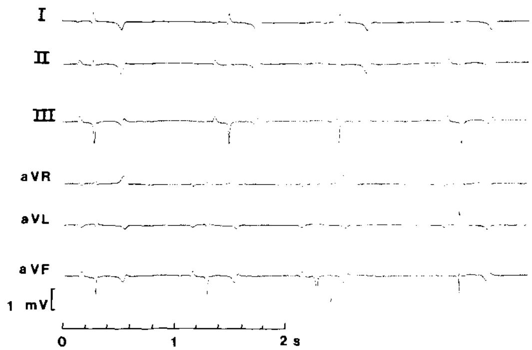


Figure 5. A normal electrocardiogram of a one-year-old male reindeer calf. Note the difference especially in leads II, III and aVF when compared with the corresponding tracings in Figure 4. The recording was carried out under laboratory conditions and at paper speed of 50 mm/s.

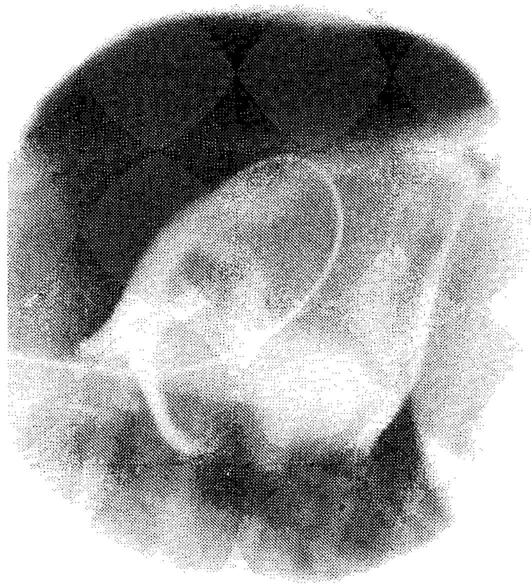


Figure 7. A X-ray view of a reindeer heart lying in the thoracic cage roughly perpendicularly to the sternum.

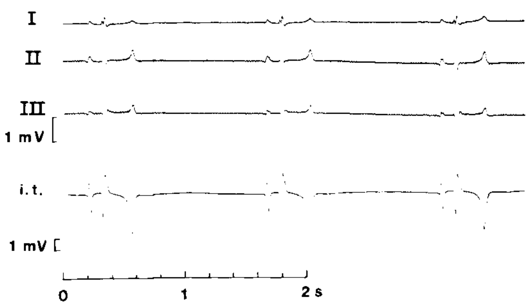


Figure 6. A normal electrocardiogram for a seven-month-old reindeer. Intracardiac tracing (i.t.) was recorded with a platinum electrode driven intravenously into the junction of the right atrium and the inferior caval vein. The tracing shows that atrial repolarization is superimposed by ventricular depolarization and is not therefore discernible. The temporal ventricular activation seems to be directed firstly away from the electrode and then towards it. The paper speed was 50 mm/s.