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STANDARD ELECTROCARDIOGRAPHIC PARAMETERS OF BASE APEX LEAD SYSTEM IN DIFFERENT AGE GROUPS OF CLINICALLY HEALTHY DROMEDARY CAMEL (*Camelus dromedarius*)

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ABSTRACT

Electrocardiographic parameters were measured in 93 apparently healthy dromedary camels (*Camelus dromedarius*) within age range from less than 6 months to 18 years old. The electrocardiograms were recorded in standard base apex lead system. Duration and amplitude of the P, QRS complex and T wave and the PR, RR, intervals, RT and ST segments and heart rate were measured and averaged from successive beats. The normal heart rate was 48±1.07 to 69±0.80 and 74±1.32 to 89±5.01 in adults and calves, respectively. The long atrioventricular node conduction time (the P-R interval) was also an important finding in this study. This parameter was 0.20-0.21 and 0.21-0.26 sec. in calves and adults, respectively. The R-T segment was 0.24-0.26 and 0.19-0.30 sec. in calves and adults, respectively. The results of the present study provide a good basis for judging the electrocardiographic parameters in the base apex lead system from different age groups of dromedary camel. It could be suggested that the base apex lead provides the most uniform electrocardiographic patterns than standard leads in dromedary camel.

Key words: Base apex lead, dromedary camel, electrocardiogram

Electrocardiography is a noninvasive, inexpensive technique that yields useful information in classification of arrhythmias, diagnosing conduction abnormalities and it also a valuable aid in prognostic and therapeutic considerations (Rezakhani and Papahn, 2002). The electrocardiogram (ECG) provides a record and measure of the time varying potential difference that occurs over the surface of the body as the result of electrical activity within the heart. This is associated with depolarisation and repolarisation of the myocardium. In the normal heart, depolarisation and repolarisation of the myocardium occurs in a definite pattern and sequence and then the ECG can be used to measure and time these events (Radostits *et al,* 2007). No single electrocardiographic lead system has been universally accepted for use in large animals. Bipolar leads (I, II, III, base-apex, X, Y and Z of the orthogonal lead system) and unipolar leads (aVF, aVR, aVL, thoracic) have been described, but the amplitude, duration and configuration of the different wave forms vary widely, depending on size, body type and sex. The lead system should be easy to apply and the tracing free of artifacts created by muscle tremors, skin movements, shifting of weight and change in limb position. For this purpose a single-channel machine can be used and the lead system chosen can be any that generates distinctive P, QRS and T complexes (Reef and McGuirk, 2009). Base apex lead have been used for large animals and it is shown to be an appropriate lead and ECGs recorded in this lead has clear and large waves and complexes and animal movement has a minimum effect on the recording (Deroth, 1980; Rezakhani and Moafpourian, 1993; Santamarina *et al,* 2001; Radostits *et al,* 2007). The potential use of electrocardiography in large animal medicine is well recognised and limited information exists regarding the evolution of the electrocardiogram in camel (Braun *et al,* 1958; Geddes *et al,* 1973, Rezakhani and Szabuniewicz 1977). Most ECG studies in ruminants have been carried out in cattle, sheep and goats (Rezakhani *et al*, 2004; Mohan

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et al, 2005; Ahmed and Sanyal, 2008) and there is little information in camel. As base apex lead system is used routinely in large animals and currently little information was provided on normal ECG of camel in this lead, the present study was undertaken to record ECGs in different age groups of dromedary camel in order to try to provide useful information on normal ECG parameters in base apex lead system of this breed. To the best of authors' knowledge, this is the first study on normal ECG parameters in base apex lead system of this breed.

Materials and Methods

The present study was conducted in November 2010 on 93 clinically healthy dromedary camel (*Camelus dromedaries*) in Yazd province centre of Iran. The animals were assigned into 8 age groups, comprising of less than 6 and 6-12 months old, 1-3, 4-6, 7-9, 10-12, 13-15 and 16-18 years old. The animals were examined prior to ECG recordings and were proved to be clinically healthy. The ECGs were recorded on a bipolar base apex lead, using limb lead I. Animals were kept in sternal position in the farm without sedation and minimal restraint. No clipping or shaving was carried out for electrode attachment. When the animals were thought to be in a quiet state, the ECGs were recorded, using alligator-type electrodes which were attached to the skin after cleaning it with ethanol and applying electrocardiographic jelly. The positive electrode (left arm) of lead I was attached to the skin of the left thorax at the fifth intercostal space, immediately caudal to the olecranon, and the negative electrode (right arm) was placed on the jugular furrow in the caudal third of the left neck (Radostits *et al,* 2007). All ECGs were obtained on a single channel electrocardiographic machine (Kenz-line EKG 110, Suzuken Co., Ltd., Japan) with the paper speed 25 mm/sec and calibration of 10 mm equal to 1 mV. Duration and amplitude of the P, QRS complex and T wave and the PR, RR, intervals, RT and ST segments and heart rate were measured and averaged from successive beats following the usual conventions. The precision of duration was 0.02 sec. and amplitude was 0.05 mV. Mean and standard error (SE) were calculated for all parameters in different age groups. The comparison of each parameter in each group, with the same parameter in other age groups was analysed by the one way ANOVA and Tukey Post Hoc, using SPSS software (SPSS for Windows, version 11.5, SPSS Inc, Chicago, Illinois). The correlations between electrocardiographic parameters were assessed by Pearson Correlation Coefficient. $P<0.05$ was considered statistically significant.

Results

The standard electrocardiographic parameters (Mean±SE) of base apex lead in different age groups of clinically healthy dromedary camels are shown in tables 1. The results of the one way ANOVA showed that P duration, P amplitude and S amplitude were different significantly between some of groups; the results of the Tukey Post Hoc mentioned that P duration was significantly different between 7-9 and 13-15 years old camels ($P<0.05$). P amplitude was different between 4-6 and 7-9 years olds, significantly ($P<0.05$). The results of the Tukey Post Hoc showed that there were significant differences between under

Table 1. The duration, interval (sec.) and amplitude (mV) values of standard electrocardiographic parameters (Mean±SE) of base apex lead in different age groups of clinically healthy dromedary camel (base apex lead, paper speed 25 mm/sec, sensitivity 10 mm/mV). The heart rate (beats/min.) is also presented for each groups. m: month; y: year.

Parameters	<6 m (n=5)	6-12 m (n=16)	1-3 y (n=4)	4-6 y (n=23)	7-9 y (n=25)	10-12 y (n=9)	13-15 y (n=9)	16-18 y (n=2)
P duration	0.08±0.01	0.08±0.01	0.08±0.01	0.07±0.01	0.06±0.01	0.07±0.01	0.09±0.01	0.09±0.01
P amplitude	0.10±0.01	0.08±0.01	0.10±0.01	0.09±0.01	0.06±0.01	0.07±0.01	0.08±0.01	0.07±0.01
P-R interval	0.21±0.01	0.20±0.01	0.26±0.01	0.23±0.01	0.22±0.01	0.21±0.01	0.23±0.01	0.22±0.01
R-R interval	0.69±0.04	0.86±0.01	0.95±0.0	0.89±0.01	0.83±0.01	1.05±0.02	1.10±0.03	0.90±0.12
R amplitude	0.12±0.01	0.18±0.01	0.12±0.01	0.13±0.01	0.12±0.01	0.16±0.01	0.21±0.01	0.10±0.03
S amplitude	0.55±0.02	0.38±0.01	0.22±0.01	0.28±0.01	0.29±0.01	0.36±0.01	0.42±0.02	0.40±0.14
T duration	0.07±0.01	0.08±0.01	0.07±0.01	0.07±0.01	0.10±0.01	0.08±0.01	0.08±0.01	0.08±0.01
T amplitude	0.22±0.01	0.15±0.01	0.07±0.01	0.12±0.01	0.12±0.01	0.12±0.01	0.15±0.01	0.32±0.15
R-T segment	0.24±0.01	0.26±0.01	0.30±0.01	0.28±0.01	0.26±0.01	0.27±0.01	0.28±0.01	0.19±0.01
S-T segment	0.17±0.01	0.17±0.01	0.22±0.01	0.20±0.01	0.20±0.01	0.20±0.01	0.19±0.01	0.17±0.01
Heart rate	89±5.01	74±1.32	60±2.86	68±0.84	69±0.80	60±1.66	56±1.54	48±1.07

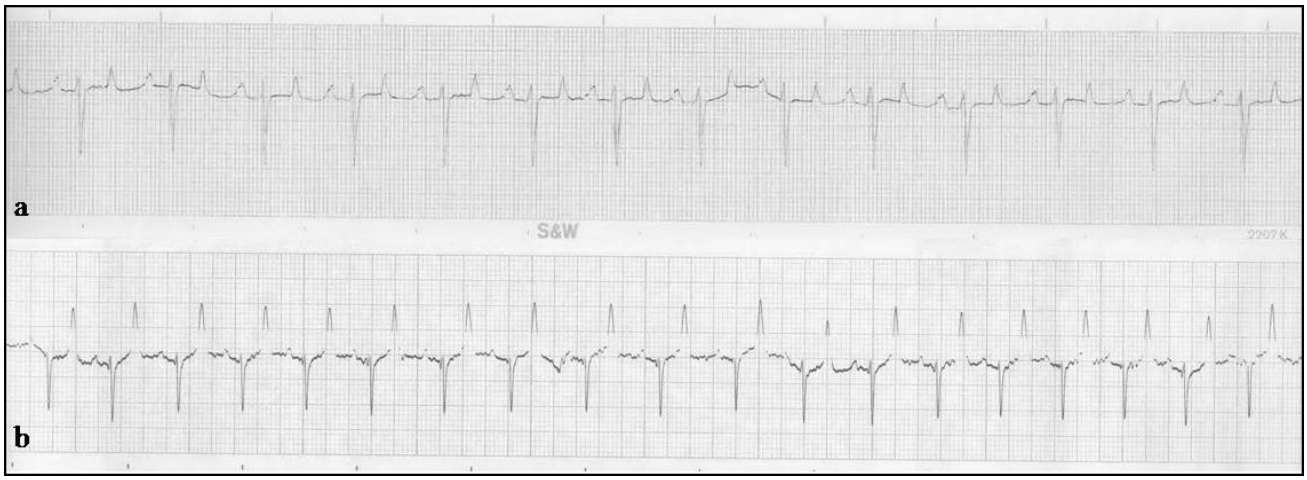

Fig 1. The normal electrocardiograms tracing from clinically healthy 10 years old male dromedary camel (a) and 8 months old male dromedary calf (b) in base apex lead system (paper speed 25 mm/sec, sensitivity 10 mm/mV). These electrocardiograms show that the base apex lead has clear waves and complexes and animal movements have minimum effects on the recordings.

6 months old camels and each 1-3, 4-6 and 7-9 years olds in S amplitude parameter ($P<0.05$). The results of the Pearson Correlation Coefficient mentioned that there was positive and significant correlation between age and R-R interval ($r=0.22$; $P<0.01$) and negative and significant correlation between age and heart rate ($r=0.28$; $P<0.01$).

Discussion

Electrocardiography is the clinical method of choice to evaluate cardiac problems associated with the initiation and conduction of waves of depolarisation and repolarisation (Santamarina *et al,* 2001). Compared with the numerous data available in the cattle, sheep and goat (Rezakhani *et al*, 2004, Mohan *et al,* 2005, Ahmed and Sanyal, 2008). The data on basic parameters of the standard camel ECG on base apex lead system in different ages which could be used as reference values are still scarce in the consulted literatures. There were independent studies which covered the normal different ECG parameters in healthy adult camel in electrocardiographic lead systems other than base apex lead such as standard bipolar (I, 11, 111), augmented unipolar (aVR, aVL, aVF) limb leads and unipolar V10 (Braun *et al*, 1958; Geddes *et al,* 1973; Rezakhani and Szabuniewicz 1977). The present study incorporated more ages of dromedary camels in a single wide study in 8 age groups from calves to 18 years old to specifically clarify the differences. The base apex lead appears to be most useful in measuring conduction times (i.e., durations of component deflections, intervals, and segments) because the origins and terminations of deflections could be identified easily (Santamarina *et al,* 2001). It has been reported that the base apex lead gave the least variable ECG tracings in all the animals; furthermore, the P waves, QRS complexes, and T waves in the base apex lead had the highest mean amplitude of all the leads recorded (Santamarina *et al,* 2001). The conductive properties of the body mass of ruminants, attributable to the volume of the gastrointestinal tract, also influence the distribution of body surface potentials comprising the ECG (Santamarina *et al,* 2001). This may explain the differences among different ECG parameters between the different ages in this study (Table 1). The gradual development of body mass may cause difficulty in reaching the waves to the body surface due to relative electrical insulation by increasing body mass and decrease of amplitude in adults (Kellerová *et al,* 2010). The results of the present study showed that there was negative and significant correlation between age and heart rate. The several studies in adult dromedary camel ECG, mentioned that the normal range of heart rate is between 24 to 77 beats/min. (Braun *et al,* 1958; Geddes *et al,* 1973; Rezakhani and Szabuniewicz, 1977). The results of the present study showed that the normal heart rate was 35-120 and 48-120 beats/min. in adults and calves, respectively. The duration of the intervals was out of proportion to the heart rate and was explained by the large mass of heart muscle and by the long paths of impulse conduction and it could be stated that the larger the heart, the slower the heart rate (Schmidt-Nielsen, 1997). The long atrioventricular conduction time (the P-R interval) was also an important finding in this study. This parameter was 0.20±0.01to 0.21±0.01 and 0.21±0.01 to 0.26±0.01 sec. in calves and adults, respectively; also, the results of the previous studies showed that the P-R interval is 0.21-0.27 sec. in adults

(Braun *et al,* 1958; Geddes *et al,* 1973; Rezakhani and Szabuniewicz 1977). It could be suggested that as the mass of heart in larger animals become larger in the process of growth, the duration of transfer of cardiac electrical activity also increases (Schmidt-Nielsen, 1997). The assessments of ECGs did not show any Q wave; and the QRS complexes were included R and S waves. The R-T segments were 0.16-0.32 and 0.16-0.40 sec. in calves and adults, respectively. The other researchers stated that this parameter is between 0.24 to 0.60 sec. in adult dromedary camels (Braun *et al,* 1958; Geddes *et al,* 1973; Rezakhani and Szabuniewicz 1977). It may be concluded that in the camel, as in most ruminant species, ventricular depolarisation is multifocal in character with great variability of cancellation of instantaneous vectors, which results in great variability of QRS complexes (Santamarina *et al,* 2001). It has been reported that this type of conduction in depolarisation process in the ruminant may be related to the deep implantation of the Purkinje network (Santamarina *et al,* 2001). It is possible that in camels there is a similar Purkinje network. Finally, present study indicated that the values of durations and intervals of ECG parameters were higher in older animals than younger ones, approximately, which could probably be due to the size of the heart in older camels. It is obvious that these data will provide a good basis for judging the ECGs in base apex lead system of different age groups in dromedary camel. In conclusion, the present study showed that the ECG has already proved to be helpful in camel diseases and the base apex lead is a suitable lead for monitoring heart rhythm of this animal, and these values could be accepted as normal ECG parameters in different age groups of this breed. In conclusion, a base apex lead system seems to be the best and standard lead for monitoring dromedary camel heart, because ECGs tracing in this lead have clear waves and complexes and animal movements have minimum effects on the recordings.

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