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A COMPARATIVE EVALUATION OF ELECTROCARDIOGRAMS RECORDED IN CLASSICAL LIMB AND EXPERIMENTAL METHODS IN NATIVE CATS OF ODISHA, INDIA

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ABSTRACT

The ECG was recorded in the leads I, II, and III by two methods of leads' positioning: the classical limb method and the experimental method (red electrode at back of the neck, yellow electrode in the sacrum area, green electrode in the area beneath the breastbone and black electrode on the skin fold of the knee joint of the right hind limb). The heart rates were 157.69 (S.E. $\pm$ 5.05) and 134.54 (S.E. $\pm$ 3.08) in classical limb and experimental methods respectively. The mean electrical axis (MEA) shifted from 47.74 (S.E. $\pm$ 3.75) ° in the classical limb method to 119.12 (S.E. $\pm$ 0.91) ° in the experimental method. The amplitude of P- and R-waves was negative in lead-I only. Since, it is often very difficult to restrain the cats with the electrodes attached to all its limbs, the values obtained in the experimental method could be used as reference values for this alternative way of ECG recording in adult cats.

INTRODUCTION

Cardiac abnormalities are very common in animals and electrocardiography is considered as an excellent diagnostic tool for their prediction (Oyama, 2011). ECG has been recorded in different body positions in different animals, e.g. right lateral recumbency in dogs and cats (Tilley, 1995), and standing position in ruminants (Deroth, 1980; Ahmed and Sanyal, 2008). Many researchers have also highlighted the effect of body positions like right lateral, left lateral and sternal recumbencies on electrocardiographic parameters in canines (Rishniw *et al*., 2002) and felines (Harvey *et al*., 2005). Some studies have also reported changes in electrocardiogram with a change in position of leads in small ruminants (Schultz and Pretorius, 1972; Torio *et al*., 1997).

Roberts *et al*. (1973) and Cinar *et al*. (2006) have even recorded ECG in pisces and avian species respectively. Susceptibility of poultry birds to stress-related immunological disorders (Senapati *et al*., 2015) and vulnerability of fishes to heavy-metal toxicity induced stress (Patnaik *et al*., 2010), have rendered them as unpopular candidates for studies on ECG. However, the normal values of ECG parameters for various breeds of dogs (Atmaca, N. and Emre, B. 2010; Mohapatra *et al*., 2015), horses (Ayala *et al*., 1998), cattle (Deroth, 1980), goats (Ahmed and Sanyal, 2008; Atmaca *et al*., 2014), sheep (Ahmed and Sanyal, 2008; Mohapatra *et al*., 2015) have been established, but only a few cases have been reported on cats (Atmaca *et al*., 2014).

It is often very difficult to restrain the cats with the electrodes attached to all its limbs. Previous studies have mainly focussed on the values in lead-II only (Atmaca *et al*., 2014) and therefore, we tried to put some light on leads I and III. The ECG parameters have been reported not to be affected by gender (Kilicalp and Cinar, 2003). So, we studied adult female cats, i.e., cats above 11 months of age by assuming that there exists a difference in electrocardiographic parameters between coronary and sagittal planes of the body. Studies on goats, cattle and sheep have presented significant difference in heart rate and mean electrical axis between both planes of the body (Schultz and Pretorius, 1972; Torio *et al*., 1997).

In our experiment, we tried to compare ECG parameters by positioning the electrodes at different sites other than the classical position. Again, changes in lead I and lead III of ECG have not been reported earlier in adult female cats which are also looked into in this study.

MATERIALS AND METHODS

Twenty, privately owned, non-pregnant, healthy queens aged between 11 and 60 months with a mean weight of 3.72 kg ($\pm$0.4 S.E.) were studied. They were fed a natural diet and judged healthy on the basis of history, physical examination, chest radiographs and an ECG. No obvious pathological disorders were evident.

A portable, 12-lead standard ECG recorder, Cardiart 108 T-MK VII-BPL India was set with a paper speed of 25 mm/s and sensitivity of 1 (1 cm = 1 mV) with the filter (50 Hz) turned "ON". The ECG was recorded in the leads I, II, and III by two different methods (as mentioned below) at the owner's house, with only the position of the black, or reference electrode remaining the same and in no case, anaesthetic, neuroleptic, tranquillising, hypnotic, or sedative drugs were used. The queens were restrained in right lateral recumbency with the legs positioned parallel to each other and perpendicular to the long axis of the body and keeping the head and neck flat on the wooden table (Tilley, 1995). The animals were allowed to calm down before ECG recording so as to avoid any excitement or stress.

According to Tilley (1995)'s classical limb method, the electrodes were placed on the limbs at appropriate positions, i.e., proximal to the olecranon on the caudal aspect of the forelimbs (yellow electrode on left forelimb and red electrode on right forelimb), and over the patellar ligament on the anterior aspect of the hind limbs (green electrode on left hind limb and black electrode on right hind limb) using alligator clips after applying cardiac gel.

The experimental method we adopted for cats was implemented by Schultz and Pretorius (1972) in goats and cattle, and Torio *et al.*,(1997) in Gallega breed of sheep. Accordingly, to place the Einthoven's triangle on a sagittal plane the electrodes were positioned on the back of the neck (red electrode), in the sacrum area (yellow electrode), in the area beneath the breastbone (green electrode) and on the skin fold of the knee joint of the right hind limb (black electrode). The values obtained were analyzed statistically adopting a significance level of 95 percent ($p<0.05$).

RESULTS

The values (mean ± S. E.) of electrocardiographic parameters that presented significant difference ($p<0.05$) are given in the Table 1. In lead-I, the duration of all the parameters except R-R interval, was significantly lower in the experimental method, and the amplitude of P- and R-waves was negative. But when lead-II was considered, all were significantly lower in the classical limb method except the duration of T-P segment and amplitude of R-wave. However, all the parameters of lead-III were found to be significantly higher in the experimental method. A lower heart rate (S.E. 134.54 ± 3.08) was found in the experimental method. The mean electrical axis shifted from 47.74 (S.E. ± 3.75) ° in the classical limb method to 119.12 (S.E. ± 0.91) ° in the experimental method. The electrocardiograms recorded by both the methods are shown in the Figure 1.

Table 1: Values of electrocardiographic parameters which varied significantly ($p<0.05$) between classical limb and experimental methods of adult female cats in native cats of Odisha

	Classical limb Method	*Experimental Method*
LEAD-I		
Duration (s)		
QRS-comple	0.08 ± 0.0001	0.068 ± 0.006
T-wave	0.08 ± 0.0001	0.148 ± 0.006
PR interval	0.08 ± 0.0001	0.136 ± 0.008
RR interval	0.29 ± 0.014	0.43 ± 0.011
LEAD-II		
Duration (s)		
P-wave	0.04 ± 0.001	0.06 ± 0.008
QRS-complex	0.04 ± 0.001	0.05 ± 0.006
T-wave	0.08 ± 0.0001	0.10 ± 0.008
PR interval	0.08 ± 0.0001	0.09 ± 0.006
QT interval	0.18 ± 0.006	0.25 ± 0.013
RR interval	0.38 ± 0.012	0.44 ± 0.009
PR segment	0.04 ± 0.001	0.11 ± 0.011
TP segment	0.2 ± 0.008	0.14 ± 0.008
Amplitude (mV)		
R-wave	0.53 ± 0.039	0.3 ± 0.021
T-wave	0.14 ± 0.016	0.34 ± 0.022
LEAD-III		
Duration (s)		
P-wave	0.05 ± 0.007	0.07 ± 0.007
PR interval	0.08 ± 0.005	0.12 ± 0.011
RR interval	0.32 ± 0.016	0.44 ± 0.014
PR segment	0.02 ± 0.008	0.05 ± 0.006
TP segment	0.18 ± 0.01	0.25 ± 0.01
Amplitude (mV)		
P-wave	0.12 ± 0.02	0.18 ± 0.013
R-wave	0.37 ± 0.064	0.82 ± 0.024
Heart Rate(beats per minute)	157.69 ± 5.05	134.54 ± 3.08
Mean electrical axis	47.74 ± 3.75	119.12 ± 0.91

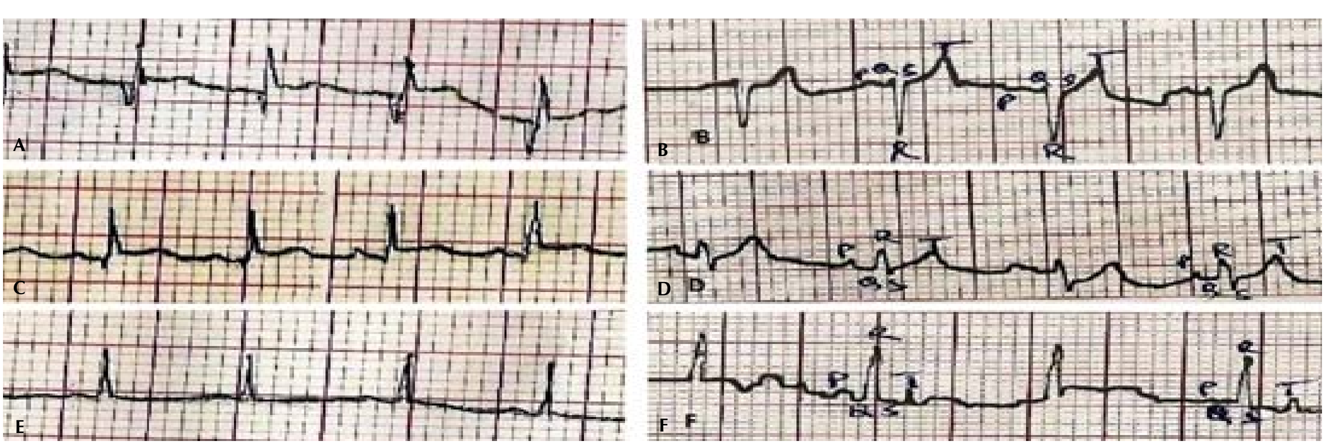

Figure 1: Electrocardiograms of adult female native cats of Odisha in bipolar limb leads, (A) standard lead position in L-I, (B) experimental lead position in L-I, (C) standard lead position in L-II, (D) experimental lead position in L-II (E) standard lead position in L-III and (F) experimental lead position in L-III.

DISCUSSION

Harvey *et al*. (2005) have revealed that body positions like right lateral, left lateral and sternal recumbencies affect the electrocardiogram. Changes in electrocardiogram with a change in position of leads in small ruminants have been reported by Torio *et al*. (1997). There was no report on the leads I and III, or on the experimental positioning of limb leads in cats so far. So, we have tried to elaborate our results with respect to reports on lead-II only.

Decrease in heart rate in the experimental method has been reported in Gallega sheep and it is a highly variable parameter as discussed by Torio *et al*. (1997) and Abbott (2005). According to Tilley (1995) and Torio *et al*. (1997), the shift in the electrical axis might be attributed to the change in axis of the lead in the experimental position with respect to the electrical axis of the heart. Again, this value in the classical limb method is a bit higher than that reported by Harvey *et al*. (2005) for cats in right lateral recumbency.

The lead-II QRS complex duration as well as P-R and Q-T intervals are compatible with that reported by Harvey *et al*. (2005) on cats in right lateral recumbency. The amplitude obtained for R-wave in lead-II is also quite similar to that obtained by Atmaca *et al*. (2014) in Angora breed of cats but literature on T-wave amplitude is only available on goats and sheep (Schultz and Pretorius, 1972; Torio *et al*., 1997). Although reports on S-T segment were available from a study on goats (Parry *et al*., 1982), no reference to this segment in adult cats or dogs was reported in the literature.

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