



DECIPHERING ELECTROCARDIOGRAM OF HEALTHY MALE GANJAM GOATS (*Capra hircus*)

Swagat Mohapatra¹, Soubhagya R. Pradhan³, Tushar Jyotirajan^{1*}, Pravas Ranjan Sahoo²,
A.P.K. Mahapatra¹ and A.K. Kundu¹

¹Department of Veterinary Physiology, ²Department of Veterinary Biochemistry, College of Veterinary Sciences & Animal Husbandry, Odisha University of Agriculture & Technology, Bhubaneswar - 751 003, Odisha (India)

³Veterinary Assistant Surgeon, Gambharimuda, Banapur. Khordha - 754 035, Odisha (India)

*e-mail: tusharranjan1991@gmail.com

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ABSTRACT

Electrocardiogram (ECG) of 49 healthy male goats (*Capra hircus*) was recorded in three bipolar standard leads (lead I, II and III) and three augmented unipolar limb leads (aVR, aVL and aVF). Taking the different ECG values of all the leads into consideration, the amplitude of P wave ranged from 0.04 mV to 0.15 mV while the P wave in the lead aVR was found to be inverted in all the cases and the mean value was measured to be 0.1 ± 0.02 mV. The duration of P wave ranged from 0.02 to 0.06 sec. The R wave amplitude ranged from 0.35 mV to 0.8 mV and the maximum numbers of upright R waves were traced in lead II, III and aVF while lead I and aVL showed inverted R wave in all the cases. The amplitude of T wave ranged from 0.1 to 0.3 mV. The P-R interval ranged from 0.04 to 0.30 sec. The QT interval varied between 0.18 and 0.36 sec while the R-R interval ranged from 0.44 to 0.84 sec. The heart rate varied from 80 to 130 beats min⁻¹.

Key words: Augmented limb leads, bipolar limb leads, ECG, Ganjam goat

INTRODUCTION

The inception of electrocardiogram (ECG) has revolutionized the field of diagnostic cardiology. The sophistication of cardiac diagnosis has improved over the last few decades (Houghton and Gray, 1997) and the study of ECG pattern has been found useful for the detection of abnormal heart conditions (Venkateswarlu *et al.* 1997). Ganjam goat (*Capra hircus*) is one of the twenty-two recognized goat breeds of India and is found in the southern parts of Ganjam district of Odisha and the regions bordering Andhra Pradesh, India (Rao *et al.* 2009). The search engines are considered as the greatest credentials of modern day scientific research. Even their failure to muster adequate information on the subject, testifies to our notion that electrocardiographic studies on Ganjam goats are quite uncommon. There is no report on electrocardiographic reference values of male Ganjam goats. Therefore, the present study was conducted to assess the alterations in ECG parameters of male Ganjam goats in different which may act as a source of reference for veterinary clinicians while interpreting the ECG.

MATERIALS AND METHODS

Male Ganjam goats (49) aged between 1 to 3 years with an average body weight of 15.3 kg were considered for the present study. A 12-lead standard ECG recorder (Cardiart 108 T-MK VII-BPL) was used for the purpose. The ECG machine was set with a paper speed of 25 mm sec⁻¹ and sensitivity of 1 (1 cm = 1 mv) with the filter (50 Hz) in turned “on” mode. The ECG was recorded in the standing position (Schultz and Pretorius, 1973; Pourjafar *et al.*, 2011). The anterolateral aspect, just below the elbow, and stifle joint were the preferred sites of the attachment of crocodile clips and the ECG tracings were taken in three bipolar standard leads (lead I, II and III) and the three-augmented unipolar limb leads (aVR, aVL and aVF) as described by Ahmed and Sanyal (2008). The mean $\pm$ standard error values of the data recorded were calculated by using Microsoft excel 2010 (Pradhan *et al.*, 2017).

RESULTS AND DISCUSSION

The mean $\pm$ SE value of the ECG waves and intervals are given in Table 1 and 2 and a normal electrocardiogram of Ganjam goat is given in Fig. 1. The amplitude of P wave was highest in lead II, lowest in lead III and inverted in lead aVR which is in agreement with Atmaca *et al.* (2014) who recorded positive amplitude of P wave in standard bipolar limb leads in Angora goats. The findings are in disagreement with Ahmed and Sanyal (2008) who recorded highest amplitude of P wave in lead I and lowest in aVL in case of Jamunapari goats. The difference may be due to the variation among the breeds as suggested by Dhanapalan *et al.* (1997) who reported different ECG values in different breeds of dogs. The duration of P wave was maximum in lead I and aVF. However, lowest P wave duration was calculated in lead III and aVR. The amplitude of P wave was positive in all the leads, except aVR which is in agreement with Atmaca *et al.* (2014) who recorded positive amplitude of P wave in standard bipolar limb leads in Angora goats. In lead aVR, the P waves were not discernible in a couple of cases and the rest were found inverted. Indiscernible P wave may be due to lack of coordinated atrial activity (Ahmed and Sanyal, 2008) and P wave negativity may be due to the direction of spread of electrical force and location of recording electrode being in opposite direction. Usually a negative P wave signifies that the impulse is originating from AV node instead of usual SA node. Negative P wave in lead aVR could not be considered a mark of abnormality here because P wave in all other leads are positive. The duration of P wave ranged between 0.02 to 0.06 sec considering all the leads which is in agreement with Mohapatra *et al.* (2012) who reported almost same range of P wave duration in Lead II ECG in healthy dogs.

ECG taken from all the cases showed inverted R wave in lead I, aVL and aVF. Maximum R wave amplitude was obtained in lead II and minimum in lead III. Mixed results were obtained for R wave amplitude in which the ECG of 30 goats (*Capra hircus*) out of 49 in lead II. The 25 goats out of 49 in lead III recorded positive amplitude whereas R wave was positive in all the cases in aVF and negativity was observed in all cases in lead I and aVL. Similar observations were made by Mohapatra *et al.* (2016) in bipolar limb lead II of Large White Yorkshire piglets. However, the highest amplitude was noticed in lead II probably because of electrical activity in lead II (from right forelimb towards left hind limb) being symmetrical with normal electrical axis of the heart. So, maximum current flows towards the electrode resulted in highest deflection. The variability in wave (form and amplitude) of ECG may be attributed to the determining factors like difference in topographic anatomy of heart within thorax, position of heart in relation to limbs and mechanism of activation of ventricles as reported by Breazile (1971).



Fig. 1: Lead I ECG of a Ganjam goat

Table 1: ECG values (mean $\pm$ SE) of male Ganjam goats in different leads

Lead	P amp. (mV)	P dur. (sec)	R amp. (mV)	QRS complex dur. (sec)	T amp. (mV)	T dur. (sec)	PR int. (sec)	QT int. (sec)	RR int. (sec)	Heart rate (beats min ⁻¹)	PR seg. (sec)	ST seg. (sec)	TP seg. (sec)
I	0.08 $\pm$ 0.01	0.06 $\pm$ 0.01	Inverted	0.05 $\pm$ 0.01	0.3 $\pm$ 0.02	0.07 $\pm$ 0.01	0.1 $\pm$ 0.01	0.32 $\pm$ 0.01	0.8 $\pm$ 0.05	89.7 $\pm$ 5.32	0.09 $\pm$ 0.01	0.2 $\pm$ 0.01	0.3 $\pm$ 0.03
II	0.1 $\pm$ 0.01	0.03 $\pm$ 0.01	0.74 $\pm$ 0.03	0.04 $\pm$ 0.01	0.23 $\pm$ 0.01	0.06 $\pm$ 0.01	0.11 $\pm$ 0.01	0.30 $\pm$ 0.01	0.83 $\pm$ 0.04	82.04 $\pm$ 4.53	0.08 $\pm$ 0.01	0.2 $\pm$ 0.01	0.33 $\pm$ 0.02
III	0.05 $\pm$ 0.01	0.02 $\pm$ 0.01	0.4 $\pm$ 0.01	0.04 $\pm$ 0.01	0.1 $\pm$ 0.01	0.03 $\pm$ 0.01	0.05 $\pm$ 0.01	0.29 $\pm$ 0.02	0.81 $\pm$ 0.04	86.88 $\pm$ 4.83	0.03 $\pm$ 0.01	0.21 $\pm$ 0.01	0.06 $\pm$ 0.01
aVR	Inverted	0.02 $\pm$ 0.01	0.50 $\pm$ 0.02	0.04 $\pm$ 0.01	0.22 $\pm$ 0.01	0.06 $\pm$ 0.01	0.07 $\pm$ 0.01	0.29 $\pm$ 0.01	0.69 $\pm$ 0.04	101.65 $\pm$ 4.83	0.05 $\pm$ 0.01	0.2 $\pm$ 0.01	0.12 $\pm$ 0.01
aVL	0.08 $\pm$ 0.01	0.03 $\pm$ 0.01	Inverted	0.05 $\pm$ 0.02	0.1 $\pm$ 0.01	0.05 $\pm$ 0.01	0.11 $\pm$ 0.01	0.30 $\pm$ 0.01	0.70 $\pm$ 0.04	98.32 $\pm$ 4.53	0.08 $\pm$ 0.01	0.21 $\pm$ 0.01	0.26 $\pm$ 0.02
aVF	0.1 $\pm$ 0.02	0.06 $\pm$ 0.01	Inverted	0.02 $\pm$ 0.01	0.1 $\pm$ 0.01	0.06 $\pm$ 0.01	0.28 $\pm$ 0.01	0.24 $\pm$ 0.01	0.48 $\pm$ 0.03	125 $\pm$ 5.85	0.2 $\pm$ 0.02	0.2 $\pm$ 0.01	0.12 $\pm$ 0.01

Amp = amplitude; dur = duration; int = interval; and seg = segment

Table 2: ECG values (negative) [mean $\pm$ SE] of male Ganjam goat in different leads

Leads	P amp when negative (inverted)	R amp when negative (inverted)	T amp when negative (inverted)
I	0	0.56 $\pm$ 0.03	0.12 $\pm$ 0.01
II	0	0.40 $\pm$ 0.02	0.10 $\pm$ 0.01
III	0	0.17 $\pm$ 0.01	0.10 $\pm$ 0.01
aVR	0.10 $\pm$ 0.02	0	0.10 $\pm$ 0.01
aVL	0	0.70 $\pm$ 0.02	0.20 $\pm$ 0.01
aVF	0	0.40 $\pm$ 0.02	0

Amp = amplitude

Considering the QRS complex duration, lead I and aVL showed maximum value. The duration of QRS complex ranged from 0.02 to 0.05 sec which is in agreement with the values obtained by Mohan *et al.* (2005) for Jamunapari goats.

Lead I showed the highest value of T wave amplitude. Lead III, aVL and aVF showed minimum T amplitude values. The T wave amplitude was positive in 50% cases in lead I and rest were negative which is

contrary to Mohapatra *et al.* (2015) who found positive T waves in all cases of lead I. It can be extrapolated from the findings of Venkateswarlu *et al.* (1997) on healthy dogs that a negative T wave can also be considered as normal. In leads II and III (75% cases recorded positive amplitude), lead aVR and aVL (60% cases positive) and all the Ganjam goats recorded positive amplitude in lead aVF. T wave duration was highest in lead I and lowest in lead III. The duration of T wave ranged from 0.03 to 0.08 sec which is in line with Ahmed and Sanyal (2008) who worked on Jamunapari goats.

The PR interval was longest in lead aVF and shortest in lead III. The PR interval is a measure of atrioventricular conduction time. This wide range of PR interval obtained may be due to difference in age groups of goats taken into consideration with varying heart rates. Lead I and lead aVF showed maximum and minimum QT intervals respectively. QT interval is a measure of total duration of ventricular electrical activity or total systole. Wide variation in QT interval may be due to its dependence on age, sex and heart rate (Luthra, 2004). In present study, lead II recorded maximum

RR interval and lead aVF recorded the minimum. The RR interval is inversely proportional to the heart rate which was aptly highest in aVF and lowest in lead II. However, the R-R interval values obtained were much higher than the values obtained by Mohan *et al.* (2005) for Jamunapari goats.

The heart rate (beats min⁻¹) was highest in lead aVF and lowest in lead II. PR segment was longest in aVF lead and shortest in lead III. ST segment was maximum in lead III and aVL. Lead II recorded the highest TP segment and lead III was with minimum. Consequently, the heart rates obtained in this study are lower than values obtained by other workers which may be due to extreme precautions being taken to make the animals feel comfortable and avoid anxiety and excitement amongst them.

Conclusion: ECG can prove a vital tool to diagnose cardiac problems in goats accurately and timely. The information provided by this study on the ECG of healthy male Ganjam goats can be of great help to figure out abnormalities in ECG recordings of caprine cases presented before the field veterinarians.

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