RESEARCH ARTICLE

Sokoto Journal of Veterinary Sciences

(P-ISSN 1595-093X: E-ISSN 2315-6201)

http://dx.doi.org/10.4314/sokjvs.v16i2.6

Azeez *et al*. /*Sokoto Journal of Veterinary Sciences*, **16**(2): 41 - 46.

Electrocardiographic parameters in West African Dwarf and Red Sokoto (Maradi) goats

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Publication History:
Received: 11-06- 2017
Accepted: 28-12-2017

Abstract

The aim of this study was to establish normal electrocardiographic (ECG) values for standard lead II in West African Dwarf goats (WAD) and Red Sokoto Goats (RS). Electrocardiographic study of 11 healthy WAD and 11 RS goats 10 months to 2 years of age was carried out with EDAN 10 Veterinary Electrocardiographic equipment. Record from Lead II showed the heart rate varied from 87 to 175 beats/min with a mean of 149.55 ± 51.13 beats/min for RS goats; and 142-272 with a mean of 171.5 ± 39.7 for WAD goats. The difference was significant between the heart rate of the two goat breeds ($P<0.05$). The P wave appeared prolonged and of multifocal atria rhythm. The mean P wave was 0.11 ± 0.24 in WAD goats and 0.11 ± .059 in RS goats. The mean QRS complex was 0.065 ± 0.21 sec in WAD goats and 0.059 ± 0.35 in RS goats. The QT was prolonged in the breeds, with appearance of U wave in some. The prolonged QT interval suggested prolonged ventricular repolarization which may be as a result of the deeply penetrating Purkinje system in ruminants that gave rise to explosive spread of waves in many directions from ventricular endocardium to epicardium.

Keywords: Electrocardiogram, Heart rate, Noninvasive, RS goats, WAD goats

Introduction

Electrocardiography is a noninvasive, inexpensive technique that yields useful information in classification of arrhythmias, diagnosing conduction abnormalities and it is also a valuable aid in prognostic and therapeutic considerations (Fregin, 1985). The electrocardiogram is the initial test of choice to evaluate cardiac problems associated with the initiation and conduction of waves of depolarization (Santamarina *et al.,* 2001). Most of the literature on electrocardiography in domestic animals, a method commonly used in the diagnosis of cardiac arrhythmias, is focused on dogs, cats and horses, (Mohan *et al.,* 2005). In the meantime, use of goats for biomedical research has demonstrated that they offer potential advantages. Goats are gaining acceptance as an established model for biomedical research and for surgical training and teaching (Linda *et al*., 1994). They are used in medical, orthopedic, psychological, chemotherapeutic and physiologic research. Goats can be gentle, easy to handle and transport, intelligent, affectionate, friendly, and clean, and they appear to be harder than other members of the ruminant family. Goats range in average adult size from the small Pygmy goat (40 lbs) to the larger Nubian (170 lbs) or Saanen (200 lbs) (Linda *et al*., 1994). Recently studies have been performed to investigate the normal ECG values in different goat breeds (Ahmed & Sanyal 2008; Mohan *et al.,* 2005; Pogliani *et al.,* 2010; Pourjafar *et al.,* 2012) and the effect of various chemicals on the goat heart (Kant *et*

al., 2010; Kinjavdekar *et al.,* 1999; Madan *et al.*, 2010;).

The West African Dwarf goats (*capra Djallonke hircus*) breed from coastal West and Central Africa is the progenitor of the African Pygmy and Nigerian Dwarf breeds (Wilson 1991). The West African Dwarf goat breed is from coastal West and Central Africa, markedly stunted and has a typical height of 30 to 50 cm (12 to 20 in). Adult males weigh 20 to 25 kg (44 to 55 lb) and females 18 to 22 kg (40 to 49 lb). Both sexes have horns, which curve outwards and backwards in males. Males also have beards, and sometimes manes. The neck is relatively long, the chest is broad and the back straight. The legs are short and the udder is small but usually well-shaped. Most types have short stiff hair, and the colour varies; dark brown with black points is probably the most common, but black, red, white, pied and multicoloured goats also occur (Wilson 1991). The Red Maradi goat or Red Sokoto goats (*Capra hircus*) is found in the South-West of Zinder in Niger; One of the Savanna goat group but its relatively small in size (Nwachukwu *et al.,* 2012). The major herd populations are found in Niger, in the Maradi region. However, based to its origin, the highest concentration of pure individuals is found in the district of Tessaoua suggesting that the cradle of the breed would be in Niger, although the confine of breeding area in the Hausa lands lies between the Niger and Nigeria common borders. The Red Maradi goat is distinguishable from other species by its much larger weight, conformation, prolificacy and especially its red colour from which it earned its name. The leg, shoulder and rump well fleshed are built on four rays thin joints, with a compact composure. The udder is always well developed and therefore becomes an additional obstacle to long distance walks. The tail, with more dense hair and often black, is short and elevated at the end.

The female reaches puberty at the age of 5-6 months. The gestation period is between 145 and 155 days. The first kidding occurs between 10 and 14 months with variations depending on the rearing conditions and the environment. Nearly 93% of first kidding occurs before the age of 12 months. The distribution of the heat seem quite irregular, from 15 to 30 days on average in the absence of detectable pathological cause. The red goat is very prolific as it can give birth to 2 or 3 kids or even 4 in some cases. The present study was undertaken to establish the ECG patterns in WAD goats and RS goats, and to provide information on the heart rate and rhythm, the duration and waves of ECG deflections.

Materials and Methods

This study was performed at the animal house of Faculty of Veterinary Medicine, University of Ilorin. A total of 11 WAD and 11 RS goats of mixed sex, 1 to 2 years were used for this experiment. The age of these animals were confirmed from their dentition. (The incisors were one pair and two pairs of permanent large sizes, which indicate yearling and two years respectively). All animals had free access to water and adequate daily ration, which was composed of hay and commercial concentrate. The ECG recordings were made in right lateral recumbent position for WAD goats and the RS goats in standing position, without sedation and under minimal restraint. This is because WAD goats were noisier and more restless compared with RS goats. EDAN 10 Veterinary electrocardiographic equipment made in China; with a 50 mm/s paper speed and a sensitivity of 10 mm/mV was used to measure the ECG. The forelimbs were kept parallel to each other and perpendicular to the long axis of the body, the five alligator clip electrodes were fixed directly to the skin, just above the elbow joint in the forelimbs, just above the stifle joint in the hind limbs, and the heart as described earlier by Szabuniewicz & Clark (1967). The EDAN was connected to the laptop, information about each goat was recorded and saved. This was followed by ECG recording for one minute and saved until it was done for all goats in the two groups. All the ECG recordings were made during the morning hours. Cardiac rhythm, heart rate, and durations of P, QRS and T waves, as well as the PR interval and QT interval, were recorded. The morphology and waves of P waves, QRS complexes, and T waves were analyzed.

Results

From table 1, the heart rate in WAD goats was insignificantly higher than that of the RS goats. There was no difference in the mean wave of P and PR interval. The difference in the mean value of QRS complex and QT were not significant. From Figures 1 and 4, the P wave appeared multifocal. There was no arrhythmia in any of the sampled animals R- R interval was regular in almost all the samples recorded. The percentage of those with inverted QRS complexes were about 10 % of the total sampled animals; and observed to be those below age 1 year as seen in Figure 2 and 6. The P in Figure 2 was almost flattened. Q in Figure 3 and 4 were below the electrical baseline.

The amplitude of the QRS in WAD (Figure 1) goats is higher than that of the RS goats (Figure 4). The mean

Table 1: Duration of waves for lead II in West African Dwarf (WAD) and Red Sokoto goats (RSG)

	WAD		Red Sokoto goats	
	Mean ± SD	Range	Mean ± SD	Range
HR (bpm)	171.5 ± 39.7	142-272	149.55 ± 51.13	87-175
P	0.11 ± 0.24	0.05- 0. 135	0.11 ± 0.59	0.068- 0.139
PR	0.14 ± 0. 27	0.07-0.15	0.14 ± 0.55	0.080- 0.16
QRS	0.065 ± 0.21	0.37-0.93	0.059 ± 0.35	0.32- 0.75
QT	0.25 ± 0.36.9	0. 19-0.29	0.29 ± 0.95	0.16-0.35
QTc	0. 41 ± 0.75	0.37- 0.48	0.45 ± 0.93	0.36-0.57

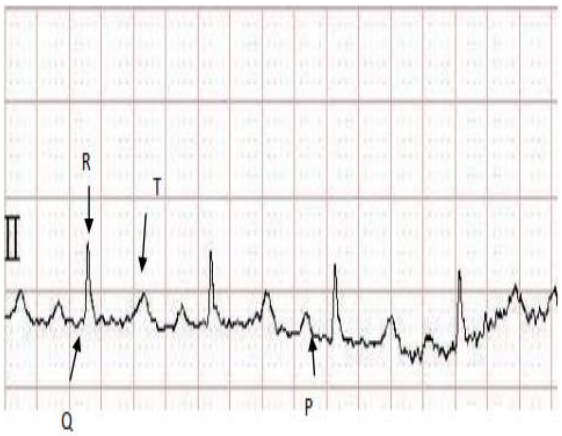

Figure 1: Electrocardiographic record of waves in lead II of WAD goats showing multifocal and inverted P wave

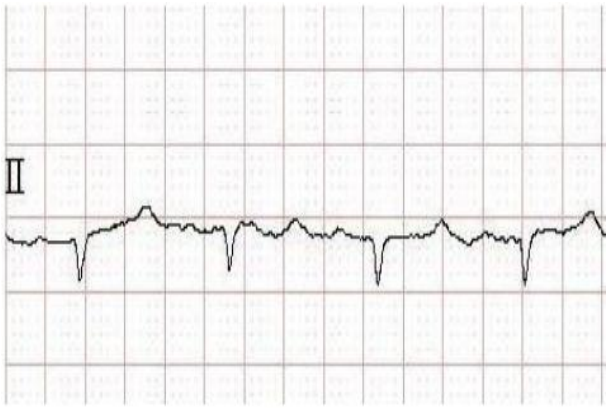

Figure 2: Electrocardiographic record of waves in lead II of WAD goats showing inverted R with QRS below iso-electric baseline in animals below one year old

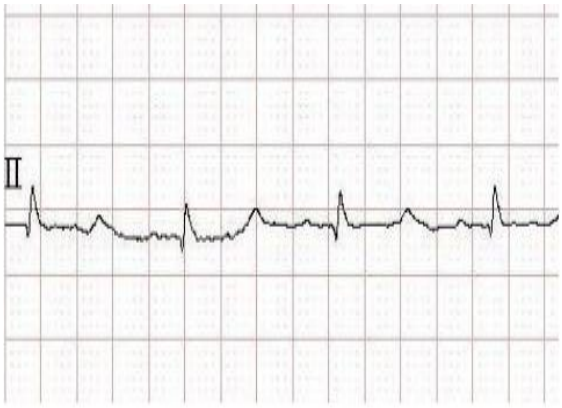

Figure 3: Electrocardiographic record of waves in lead II of WAD goats showing inverted Q, with the P, Q, S and T below iso- electric baseline

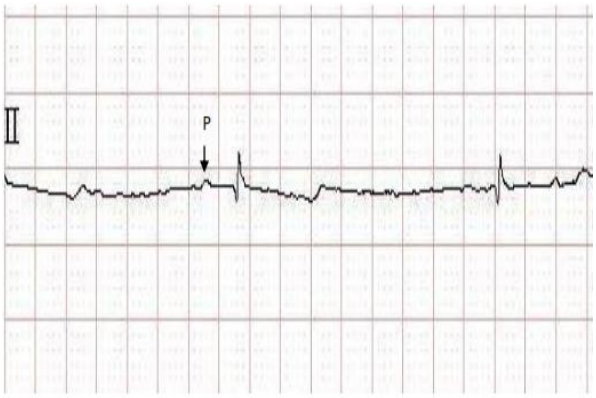

Figure 4: Electrocardiographic record of waves in lead II of RS goats with multifocal P, inverted Q and narrow R

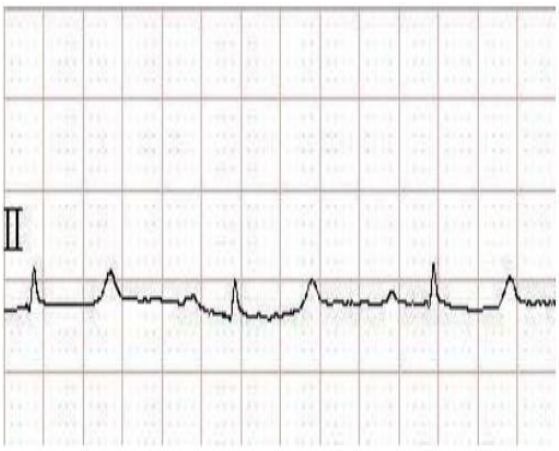

Figure 5: Electrocardiographic record of waves in lead II of RS goats with multi focal P wave, no obvious S or T wave

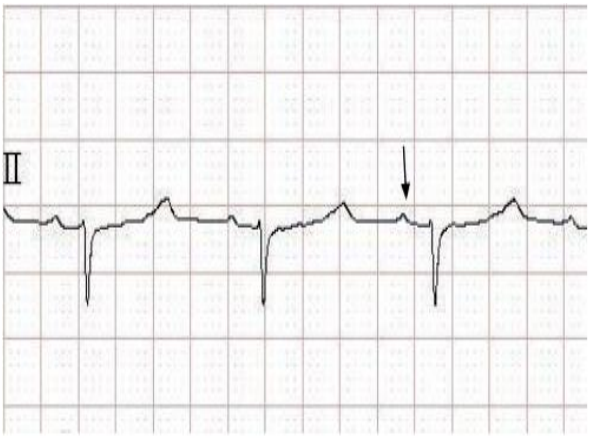

Figure 6: Electrocardiographic record of waves in lead II of RS goats with Inverted P, Q, R and S below the Iso-electrical baseline baseline in animals below one year old

heart rate was 171.5 ± 39.7 in WAD goats and 149.55 ± 51.13 in RS goats.

Discussion

The shape and size of goat heart vary according to its breed and body size. This variation is expected to be reflected in ECG parameters (Andrassy *et al*., 2005). WAD goats and RS goats were well-known native goats in Southern and Northern Nigeria respectively. Many Researchers have worked on the two goat breeds considering many factors such as health, Reproduction- Chukwuka *et al.* (2010); management- Ogebe *et al.* (2000); influence of environment on their well-being- Birteeb *et al.* (2015). There was no record of electrocardiographic measurement of the Nigerian local breeds of goats (e.g WAD and RS), in the Veterinary Literature. The Literature seen so far are on goat breeds found in other Countries such as Markhos goats in Iran (Farouk *et al.,* 2013), Saanen goats in Brazil (Fabio *et al.,* 2013), Jamnapari (or Jamunapari) in India Mohan *et al.* (2005) and so on. Therefore, we could only compare our results with ECG of these other breeds of goat by other Researchers. The lateral recumbent position when compared with standing position had no negative effect on the ECG records (Szabuniewicz & Clark 1967; Fabio *et al.,* 2013). The WAD goats ECG was recorded in lateral recumbence and that of RS goats recorded in standing position had no negative effect on the results. The present study included animals of similar age group (from 10 months to 2 years) and both sex in order to evaluate species-related differences. Our report consider Lead II recording because this is what is often used for clinical purposes.

The P waves in both breeds showed positive deflections. However, a few of the WAD showed Inverted P wave. Inverted P wave often referred to as retrograde conduction of the atrium is a Non-paroxysmal (gradual-onset) junctional tachycardia or a supraventricular rhythm with narrow QRS complexes and a regular rate, usually between 60–140 bpm. The distinguishing feature of this ECG is causing an inverted P wave, best observed in lead II. An important cause of non-paroxysmal junctional tachycardia is digitalis toxicity. The QRS amplitude is higher in some RS goats than WAD goats but not as high as in seen in dog and human. We suspect multiple ectopic pacemakers within the atria and/or Atrio- ventricular junction due to presence of multiple P wave morphologies. There is multifocal atria rhythm which may result into multifocal atria tachycardia (MAT) as seen in Figure 1. Atria depolarization proceeds sequentially from right to left, with the right atrium activated before the left atrium. The right and left atria waveforms summate to form the P wave. The first 1/3 of the P wave corresponds to right atria activation, the final 1/3 corresponds to left atria activation; the middle 1/3 is a combination of the two. There are some specific vagal influences on the sinus node as noted by Szabuniewicz & Clark 1967; which may be the cause of the multifocal atria rhythm. The PR interval from our results was longer than what was found in Makhoz and angola goats (Fakour *et al.,* 2013; Atmaca *et al.,* 2014). The PR interval begins from onset of the P wave and ends at the onset of the

QRS complex. This interval represents the time the impulse takes to reach the ventricles from the sinus node normally between 0.12-02 seconds. PR interval prolongation may be due to delayed conduction through the AV node. We suspected electrolyte imbalance in the goats since there was no record that they were given salt lick to supplement the body electrolyte and salt. Hyperkalemia is unique with PR prolongation, Flattening of P wave and inverted QRS complex as seen in our result.

The QRS showed shorter amplitude and narrower wave, which were lower than the values reported for dogs (Upeniece & Birgele, 2002; Atmaca *et al.,* 2014). The Purkinje system in ruminants is deeply penetrating, and depolarization spreads explosively in many directions at once from ventricular endocardium to epicardium. Activation of the free wall spreads even more rapidly than in carnivores and primates, whose Purkinje fibers penetrate only a quarter of the endocardial-to-epicardial distance along the free walls (Hamlin *et al*., 1984).

The heart rate in our result appeared higher than in Angora goats (Atmaca *et al.,* 2014), Jamunapari goats (Mohan *et al.,* 2005) or Saanen goats (Pogliani *et al.,* 2010; Fabio *et al.,* 2013), and to the black Bengal goats (Ahmed & Sanyal, 2008). This variation in the frequency of heart rate among the breeds might be due to differences in the shape and size of the heart.

The QT intervals were also longer compare with the value of other breeds studied earlier. The QT interval is measured from the beginning of the QRS complex to the end of the T wave. In Long QT Syndrome, the QT interval is prolonged. It represents the time between the start of ventricular depolarization and the end of ventricular repolarization. It is useful as a measure of the duration of repolarization. QT interval prolongation was suspected to be as a result of hypocalemia. Sometimes the QT interval will vary depending on the heart rate, age and gender. Fakour *et al*. (2013) reported that QT interval had significant changes with age groups of goats ($P<0.05$) and the same result has been reported in the study conducted by Montes *et al*. (1994).

In conclusion, this study provides baseline information regarding ECG parameters in WAD and RS goats. It reflects the effects of breed on ECG parameters and provides reference values of WAD and RS goats for clinical diagnosis.

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