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RESEARCH ARTICLE

Analysis of cardiac arrhythmias and electrocardiographic indices of clinically healthy Saanen goats in different sexes and age groups

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Klinik olarak sağlıklı farklı yaş ve cinsiyette olan Saanen keçilerinde kardiyak aritmi ve elektrokardiyografik göstergelerin analizi

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Öz

Amaç: Klinik olarak sağlıklı Saanen keçilerinden elde edilen elektrokardiyografik göstergeler değerlendirildi.

Gereç ve Yöntem: Araştırmada 47 adet klinik olarak sağlıklı Saanen ırkı keçi, erkek ile dişi (gebe olamayan) ve oğlak ile ergin olmak üzere iki gruba ayrıldı. Ayrıca keçiler yaşlarına göre üç gruba ayrıldı; G1 <1 yaş, 1 yaş≤ G2 <3 yaş ve G3 ≥3 yaş.

Bulgular: Kalp atım sayısı 71.4 – 187.5 atım/dakika (118.53±4.73) olarak belirlendi. Saanen keçilerin %32.2'sinde yaygın olarak tanımlanan sinus aritmisi belirlendi.

Öneri: Saanen keçilerinin elektrokardiyografik göstergelerinin diğer türlerden farklı olabileceği ve yaş ile cinsiyetin elektrokardiyografik göstergelere etkisinin belirgin olmadığı ifade edilebilir.

Anahtar kelimeler: Elektrokardiyografik göstergeler, kardiak aritmi, Saanen ırkı keçi

Abstract

Aim: Normal electrocardiographic indices taken from clinically healthy Saanen goats are evaluated.

Materials and Methods: Totally 47 clinically healthy Saanen goats were assigned to two comprising groups: male, female (non pregnant), kids and adults. Also, goats were divided into three groups according to their age, including: G1 <1 year, 1 year ≤ G2 <3 years, and G3 ≥3 years.

Results: The heart rate ranged from 71.4 to 187.5 beats/min (118.53±4.73). Sinus arrhythmia was diagnosed in 36.2% of Saanen goats, which was the most prevalent cardiac arrhythmia.

Conclusion: It may be stated that some value for the electrocardiographic indices of Saanen goats differ from that of other breeds, and little effect of sex and age on electrocardiographic parameters is reported.

Keywords: Electrocardiographic indices, cardiac arrhythmias, Saanen goat

Introduction

Electrocardiography (ECG) is a non invasive, inexpensive technique and diagnostic method to detect disturbances in the genesis and spread of the cardiac impulses (Escudero et al 2009, Pogliani et al 2013). ECG records have been introduced as an accurate and very helpful method for evaluation and comparison of cardiac function, diagnosis and classification of cardiac arrhythmias in small ruminants (Cebra and Cebra 2002, Escudero et al 2009). Acid-base and electrolyte imbalances, variation in autonomic nervous system discharge and myocardial disease can influence rate and rhythm of heart (Radostits et al 2007).

Goats, economically important producers of meat, hair and milk, have a high socio-economic role in many countries (Tajik et al 2013). The Saanen goat, one of the most famous breeds in the world, is raised in large numbers all around the world. This breed has its origin in Switzerland (Ishag et al 2012). Saanen goat is probably the most developed dairy breed among other goat breeds (Elitok 2012, Ishag et al 2012). The importance of obtaining normal values of ECG for specific breeds of animals besides the high variability in the ECG parameters in goats has been emphasized (Mohan et al 2005, Escudero et al 2009, Fakour et al 2013, Tajik et al 2013). On the other hand, lack of normal reference values and electrocardiographic patterns in clinically healthy goats, for a specific breed, can lead to failure in detection of other arrhythmias or heart injuries.

There is little information available regarding Saanen goat and to the best of our knowledge, there are a few previous studies regarding the normal ECG values and the effect of sex and age in this breed. The present study was undertaken to complete analysis of cardiac arrhythmias and normal ECG parameters, and to evaluate the probable effects of age and sex on cardiac rhythm and ECG parameters in this valuable breed.

Materials and Methods

The present study was carried out in October 2014 on 47 clinically healthy goats around Kerman, southeast of Iran (latitude 30°19'N and longitude 52°07'E). The animals were assigned to two comprising groups: Male, female (non-pregnant), kids and adults. Also, goats were divided into three groups according to their age, including: G1 <1 year, 1 year ≤ G2 <3 years, and G3 ≥3 years to evaluate the effects of aging on ECG parameters. Goats were reared under the same husbandry conditions in a same group pen. None of the animals used in this study had any clinical signs of heart disease.

The ECG was obtained from each goat (at least one minute) on a bipolar base apex lead using a single channel ECG machine (Cardiomax FX-2111, Fukuda, Japan) with a paper speed of 25 mm/s and calibration of 10 mm equal to 1 mV. The ECG was obtained when the animals were thought to be in a quiet standing position (without sedation and minimal restraint) using an alligator-type electrode attached to the skin. The positive electrode of lead I (left arm) was attached to the skin of the fifth intercostal space just caudal to the olecranon and the negative electrode (right arm) on the jugular furrow about the lower 1/3 of the left side of the neck, and the earth electrode was attached on withers (Rezakhani et al 2004). Alligator clips were fixed to the skin after application of methyl alcohol.

A magnifying glass was used for analyzing and measuring ECG parameters. Using this method of measurement, the precision of duration and amplitude was 0.02 s and 0.05 mV, respectively. The heart rate was calculated by measuring the average six R–R intervals of each trace. To describe the QRS complex, the first negative deflection was designated as Q, the first positive wave was named R and the negative deflection after R was designated as S. If the QRS complex was a single negative deflection, it was described as the QS pattern (DeRoth 1980, Rezakhani et al 2004, Tajik et al 2013). In the case of biphasic P or T waves (-/+ or +/-), the amplitude of two phases was summed.

Comparison of heart rate, wave amplitude and duration, and duration of P-R, Q-T and R-R intervals between the two sexes were performed using two sample t tests and for the purpose of comparison of the parameters between different age groups, analysis of variance (ANOVA) tests were used. Comparison of wave configuration between the two sexes and different age groups was performed using Fisher's exact tests (SPSS for Windows, version 12, SPSS Inc, Chicago, Illinois). Differences were considered significant at $P<0.05$.

Results

The heart rate ranged from 71.4 to 187.5 beats/min with an average of 118.53±4.73. The results of the measurement of ECG parameter comprising: Amplitude, duration and configuration of ECG waves in different genders and age groups of Saanen goats are shown in Tables 1 and 2. There was no significant difference in ECG parameter comprising: amplitude, duration and configuration between different age groups of Saanen goats and also between kids and adult Saanen goats (Tables 1 and 2). Furthermore, no significant correlation was found between age and major ECG parameters.

The age of female goats was significantly higher ($P<0.001$) than male goats (2.02±0.25 and 0.93±0.17, respectively). There were significant differences between two sexes in P-R intervals, QRS amplitude and duration ($P<0.05$), but there was no significant difference between two genders in other ECG indices (Table 1). The configurations of P and T waves were mainly simple positive and biphasic P and T waves

Table 1 Heart rate, amplitude of ECG waves, duration of ECG waves, and duration of P-R, Q-T and R-R intervals in different genders and age groups of Saanen goats.

Groups	Goats (n)	Heart rate (Beats/min)	P amplitude (mv)	P duration (Millisec)	P-R interval (Millisec)	QRS amplitude (mv)	QRS duration (Millisec)	Q-T interval (Millisec)	T amplitude (mv)	T duration (Millisec)	R-R interval (Millisec)
Male	15	126.60±10.40	0.24±0.09	106±0.06	206±0.06*	1.02±0.12*	100±0.00*	54.60±0.45	0.03±0.06	14.60±0.21	118.60±12
Female	32	114.70±4.90	0.15±0.00	103±0.03	246±0.08*	0.78±0.05*	131±0.09*	57.80±0.19	0.03±0.03	14.30±0.09	137.50±52
Kids	22	125.97±8.30	0.22±0.06	109±0.06	236±0.10	0.87±0.10	118±0.10	53.60±0.33	0.04±0.04	14.50±0.10	122.20±93
Adults	25	111.90±4.91	0.14±0.01	100±0.00	232±0.09	0.85±0.05	124±0.08	59.60±0.21	0.03±0.04	14.40±0.53	139.60±56
G1	22	125.97±8.30	0.10±0.00	109±0.06	234±0.10	0.87±0.09	117±0.10	53.90±0.31	0.04±0.04	14.30±.01	123.40±89
G2	12	105.40±4.40	0.10±0.00	109±0.06	225±0.13	0.91±0.08	116±0.11	61.60±0.27	0.02±0.04	14.10±0.25	145.00±58
G3	13	119.56±8.93	0.15±0.01	100±0.00	241±0.14	0.78±0.07	133±0.14	57.50±0.31	0.03±0.07	15.00±0.19	133.30±56
Total	47	118.50±4.70	0.18±0.02	104±0.02	234±0.06	0.86±0.05	121±0.06	56.80±0.19	0.03±0.03	14.40±0.09	131.40±53

G1: ≤1 year, G2: 1 years≤ and <3 years, G3: 3 years≤. * different from between sexes (P<0.05)

(-/+) were observed in 12 and 11 animals, respectively. Additionally, a few notched P waves were evident in ECG traces of 6 goats. QRS complex configuration was mainly triple phases, and biphasic QRS complex was seen in 15 cases (Table 2).

Sinus arrhythmia was the most observed irregularity on the ECG and was diagnosed in 17 goats (36.2%). Sinoatrial block was also found in 5 goats (10.6%), which was in combination with sinus arrhythmia in three cases. Atrioventricular block (first degree) in combination with sinus arrhythmia was evident in one goat (2.12%), and no arrhythmia was diagnosed in 30 (63.8%) cases (Figure 1). However, no clinical sign of heart problem or cardiac insufficiency was diagnosed in any animal. Furthermore, the heart rate was significantly higher (P<0.01) in goats without arrhythmias than with arrhythmias (127±5.9 and 102.6±6.3, respectively).

Discussion

Base apex lead has been proposed as the best and most standard lead for monitoring cardiac arrhythmias in large animal medicine and it is used routinely (Rezakhani et al 2004, Radostits et al 2007, Tajik et al 2013). There are few previous studies on normal ECG parameters in healthy Saanen goat (Pogliani et al 2013). Although Pogliani et al (2013) had evaluated ECG parameters just in 19 female adult goats (Pogliani et al 2013), to the best of our knowledge, this is the first complete analytic study which covered the effects of sex and age on ECG parameters and cardiac arrhythmias in clinically healthy Saanen goats.

Based on our results, the mean heart rate in Saanen goats was 118.53 beats/min (Table 1), which was within the reported normal range (70-110 beats/min for adult goats and 120-160 beats/min for kids) of goat by Smith et al (2009). However, this result was higher than the reported normal range (70-90 beats/min for goat) by Radostits et al (2007) and Smith (2009). The mean heart rate in Saanen goat was lower than Jamunapari goats (127 beats/min) (Mohan et al 2005), and higher than Cashmere goats (108 beat/min), Markhoz goats (110 beat/min), Black Begal goats (101 beat/min) and non-specified breed of goats (88 beats/min) (Rezakhani and Khajedehi 2001, Ahmed and Sanyal 2008, Fakour et al 2013, Tajik et al 2013). This might be due to high variability between different breeds of goats. Our results are a little different from Pogliani et al (2013) in normal range of heart rate for adult goats (129.42 beats/min), it could be related to more samples in our study.

In the current study, sinus arrhythmia was diagnosed in 36.2% of Saanen goats (Figure 1), and it was the most prevalent cardiac arrhythmia and higher than (10.53%) adult female goats (Pogliani et al 2013). Rezakhani and Khajedehi (2001) and Radostits et al (2007) reported that sinus arrhythmia is a common irregularity in goats. Rezakhani and Edjtehadi (1980), Tajik et al (2013) and Fakhour et al (2013) found the sinus arrhythmia as a common irregularity in fat-tailed sheep, Cashmere goat and Markhoz goat, respectively. In the current study, goats with sinus arrhythmia had lower heart rate. However, the difference was not statistically significant. Cardiac arrhythmia has also been reported as 53.3% in clinically healthy Najdi goats and 72.5% in Cashmere goats (Pourjafar et al 2012, Tajik et al 2013). They considered a heart rate higher than 120 in goats up to 1 year old and 90 in goats over 1 year old, as a sinus tachycardia. In the current study, 40.9% of Saanen goats in G1 group (up to one year old) and 80% of over 1 year old animals had, respectively, a heart rate higher than 120 and 90 and this could be considered as sinus tachycardia (61.7 % of all examined animals). We found no clinical sign of heart problem or cardiac insufficiency in any of the animals with cardiac arrhythmia. It has been suggested that occurrence of sinus tachycardia, sinus arrhythmia and sinoatrial block without the appearance of clinical signs of heart problem in goats as the physiologic

Table 2. Configuration of ECG waves in base-apex lead in different genders and age groups of Saanen goats.

Groups	Goats	P wave		QRS wave				T wave	
	(n)	+	-/+	Q	QR	QS	QRS	+	+/-
Male	15	13	2	1	14	0	0	12	3
Female	32	22	10	0	18	12	2	24	8
Kids	22	15	7	1	4	16	1	17	5
Adults	25	20	5	0	8	16	1	19	6
G1	22	15	7	1	16	4	1	17	5
G2	12	10	2	0	1	11	0	8	4
G3	13	10	3	0	7	5	1	11	2
Total	47	35	12	1	32	12	2	36	11

G1: ≤1 year, G2: 1 years≤ and <3 years, G3: 3 years≤.

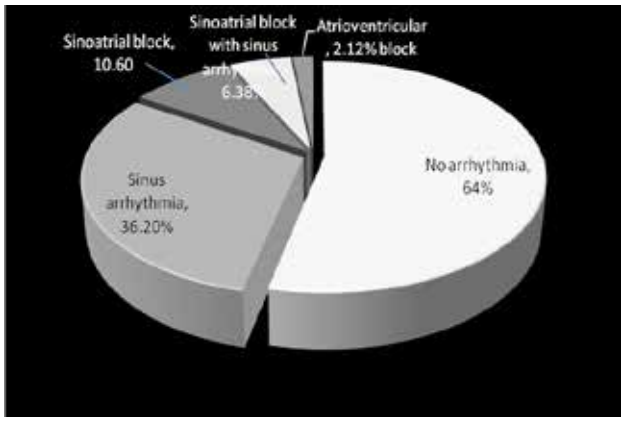

Figure 1. Prevalence of cardiac arrhythmias in clinically healthy Saanen goats.

cardiac arrhythmias, which may be due to fluctuations of the sympathetic or parasympathetic discharge on the sinus node (Pourjafar et al 2012, Pogliani et al 2013, Tajik et al 2013).

The P wave configuration in base apex lead in Saanen goats was mainly simple positive and biphasic configuration was also observed (Table 2). The same results regarding the P wave configuration in Jamunapari (Mohan et al 2005), Cashmere (Tajik et al 2013) and Bengal's goats (Ahmed and Sanyal 2008), and in Gallega sheep (Torio et al 1997) was reported.

The configuration of T wave in Saanen goats was mainly positive and showed little variability and a biphasic (-/+) T wave was observed only in 11 cases. Variable T wave has been reported in donkey (Escudero et al 2009), Cashmere goat (Tajik et al 2013), Markhoz goat (Fakour et al 2013), cattle (Rezakhani et al 2004) and sheep (Tajik 2012), and it is believed that T wave is variable in large animals and cannot be used in diagnosis of cardiac problems (Rezakhani et al 2004).

There was no significant difference between both sexes in amplitude of P and T waves in base apex lead in Saanen goats while QRS complex amplitude was significantly different between the two sexes and were similar to horses, donkeys and sheep (Escudero et al 2009, Tajik 2012). It is believed that higher myocardial mass in male animals may cause higher QRS wave amplitudes (Tajik 2012, Tajik et al 2013). Difference in QRS amplitude might be due to the differences in the topographic anatomy of the heart in the thorax, position of the heart in relation to the limbs and mechanism of the ventricular depolarization which can be the result of breed variation (Mohan et al 2005, Fakour et al 2013, Pogliani et al 2013). Furthermore, no significant difference was found between different age groups in amplitude of ECG waves and there was no significant correlation between the amplitude of ECG waves and age, which was similar to Cashmere goats (Tajik et al 2013). A negative correlation between age and amplitude of ECG waves has been reported in sheep (Tovar et al 1985, Tajik 2012) and camel (Pourjafar et al 2011). It is believed that gradual development of body mass may cause difficulty in the waves reaching the body surface in adults (Tajik 2012). Moreover, Rezakhani et al (2004) found a positive correlation between amplitude of P wave and age in base-apex lead in dairy cows.

Similarly, higher QRS complex duration in older animals compared to younger ones has been reported in sheep (Tajik 2012), dairy cattle (Rezakhani et al 2004) and horses (Physick-Sheard and Hendren 1983). Concurrent increment in myocardial mass relative to development of body mass has been proposed as the probable cause (Physick-Sheard and Hendren 1983). However, our results showed significant differences between both sexes but no significant difference was found between age groups in duration of ECG waves in base apex lead in Saanen goats.

Except for higher P-R interval in the females in comparison to males, there was no significant difference between both sexes of Saanen goats in P-R, R-R and Q-T intervals. There are a few previous studies considering the effects of age and sex on ECG intervals in animals. P-Q and Q-T intervals can have potential clinical value in evaluating heart activity (Mohan et al 2005, Fakour et al 2013). Longer P-R and Q-T intervals in

males in comparison to females have been reported in sheep (Tajik 2012) and horse (Alidadi et al 2002), and it is believed that there is a positive relationship between size and weight of heart and ECG indices duration (Tajik 2012, Fakour et al 2013). Furthermore, lower P-R, R-R and Q-T intervals in young animals in comparison to older animals have been reported in sheep (Tajik 2012), horse (Alidadi et al 2002) and camel (Pourjafar et al 2011) and larger myocardial mass in adults has been proposed as the cause (Pourjafar et al 2011). In the current study, we found no certain cause for higher P-R interval in females compared to males so it may be related to breed variation and little difference between different age groups in body weight. Less R-R interval in the G1 may be related to higher heart rate in this group. According to our results, these intervals and segments continue to be stable as they become adults.

Conclusion

The results of the present study showed that some values for the ECG indices of Saanen goats differ from other breeds previously reported and the effects of sex and age on ECG parameters in base-apex lead in Saanen goats were not very significant, which led us to propose this lead as the preferred lead for ECG evaluation in this breed. On the other hand, the measured ECG parameters can be used in detection and diagnosis of cardiac abnormality in Saanen goats.

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