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ELECTROCARDIOGRAPHIC PARAMETERS IN HEALTHY BALKAN DONKEYS (*EQUUS ASINUS*) IN BULGARIA

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ABSTRACT

The Balkan donkey is a traditional autochthonous breed, bred for centuries in the rural areas of Balkan Peninsula countries. The information on electrocardiographic parameters in clinically healthy Balkan donkeys in Bulgaria is limited. The study was performed with 16 clinically healthy animals (10 females and 6 males), from 18 months to 30 years of age and weighing 220-290 kg. The standard resting horse base-apex lead system was used. The average heart rate was 43 beats/min. The P wave in all donkeys was notched, with a duration of 0.083 sec. and an average amplitude for P1 - 0.108 mV, and for P2 - 0.183 mV. The duration of the RR interval was 1.427 seconds, and that of the PR interval: 0.242 sec. Two configuration forms of the QRS complex were present - QS (31.25%) and rS (68.75%) with average duration of 0.087 sec. The T wave configuration in 81.2% of the animals was biphasic and in 3 of them (18.8%) was only positive. No cardiac arrhythmias were registered in the study. Additional electrocardiographic studies are needed in order to establish reference values specific to the Balkan donkeys in Bulgaria.

Key words: electrocardiography, Balkan donkey, normal parameters.

Introduction

The Balkan donkey (BD) is a traditional autochthonous breed, bred for centuries in the rural areas of the Balkan Peninsula countries. In the past, it was used mainly as a working and draft animal and played an important role in the development of agriculture and the economy of rural areas (Djoković *et al.*, 2020). After the industrial revolution, a significant part of the human rural population migrated to large cities and for this reason the BD lost its main function. In Europe, as well as in the USA, there is a trend of reducing the absolute number of donkeys, but their importance as pets is progressively increasing (Escudero *et al.*, 2009). At the beginning of the 21st century, the status of the BD in Bulgaria is similar to that in most European countries - it is bred and used mainly as a companion animal, for tourist attractions, as well as for the production of milk and dairy products (Vlaeva *et al.*, 2019).

During the last decades, the population of the Balkan donkey in the Republic of Bulgaria is progressively aging, decreasing and even threatened with extinction. According to data from the Ministry of Agriculture and Forestry, the number of registered BDs in 2016 was 8,411, and their number for the previous 6 years has decreased more than four times (Vlaeva *et al.*, 2019). The trend towards decrease in the BD population over the last decade is similar. To preserve regional biodiversity and genetic resources, complex measures are necessary, an integral part of which is the population's health status. The interest in the health and welfare of the Balkan donkey is also a top priority for practicing veterinarians in Bulgaria. For the diagnosis of cardiovascular diseases in donkeys, apart the routine examination methods, some special techniques ones are also used, for

which the corresponding normal parameters are required. Electrocardiography an important diagnostic tool for assessing disorders in the genesis and propagation of the cardiac impulse is an integral part of the cardiological examination of donkeys (Escudero *et al.*, 2009) and therefore the most accurate method for detecting rhythm and conduction heart disorders (Fregin, 1985). In Bulgaria, as well as in most Balkan countries where Balkan donkeys are reared with the exception of Serbia (Djoković *et al.*, 2020), data on their electrocardiographic parameters are not available.

The aim of the present study was to investigate electrocardiographic parameters in healthy Balkan donkeys in Bulgaria, to compare them with other donkey and horse breeds, with regard to their use for diagnosis of cardiac arrhythmias.

Materials and Methods

All electrocardiographic procedures were performed in line with animal welfare standards adopted at the Faculty of Veterinary Medicine, Stara Zagora. The study included 16 local Balkan donkeys originating from 2 farms located in Central South Bulgaria. The group consisted of 6 male donkeys (jacks) and 10 females, 1.5-30 years of age, weighing 220-290 kg. The animals were reared in stalls and on pasture, under relatively equally climatic conditions. The donkeys were identified by microchip number, signalment data, hair colour. Their age was determined by teeth changes. The study was performed in March-April 2025 as part of routine prophylaxis programme. The donkeys were clinically healthy and with good body condition.

The auscultation of the heart revealed no pathological noises and cardiac arrhythmia was not suspected. ECG records were obtained in field conditions with EDAN VE – 300 compact 3-channel veterinary ECG device. ECG paper speed was 25 mm/s, and voltage was calibrated to 10 mm/1 mV. Each donkey was tested during three one-minute intervals. The animals were moved and restrained on rubber flooring in order to be electrically insulated from the ground. The donkeys were immobile, calm and before each record were allowed to rest for 10 minutes. The electrical contact between the electrodes and the skin was realised with alligator clips and standard conductive ECG gel. The standard resting horse base-apex lead system suitable for obtaining short ECH records and proved to yield the best results was used (Young, 2004; Verheyen *et al.*, 2010). The negative (red) electrode was positioned in the ventral third of the right jugular groove, corresponding to the heart base. The positive (green) electrode was located on the chest on the cardiac apex, caudally to the left elbow. The yellow (positive) electrode was on the middle of the left scapula and the inactive (black) electrode was in the right cervical region.

In each lead, the duration and amplitudes of ECG parameters were measured manually during three heartbeats, using the clearest and most comprehensible areas. ECG results were used for evaluation of the following ECG parameters: heart rate, RR interval (duration), P wave (shape, polarity, duration and amplitude), PR interval (duration), QRS complex (duration), ST segment (duration), QT interval (duration), Q wave (amplitude), R wave (amplitude), S wave (amplitude), T wave (shape, polarity, duration and amplitude). The cardiac rhythm was also evaluated according to the classification of equine cardiac arrhythmias described by Verheyen *et al.* (2010).

The mean and standard deviation were calculated for every ECG parameter.

Results

The results from determination of electrocardiographic parameters obtained in base-apex leads in the 16 Balkan donkeys from Bulgaria are shown in Tables 1 and 2. The ECG pattern of the same setting is presented on Fig. 1.

In all studied Balkan donkeys, a sinus heart rhythm was established without either respiratory sinus arrhythmia, or other forms of excitation and conductive disorders. The average heart rate was 43 ± 5.815 beats/min, varying in the range from 35 to 54. The P wave in all donkeys was notched, with average duration of 0.083 ± 0.009 sec. and an average amplitude for P_1 - 0.108 ± 0.025 mV, and for P_2 0.183 ± 0.058 mV respectively. The RR interval duration was 1.427 ± 0.182 seconds, and in individual donkeys it varied between 1.12 and 1.72 seconds. The conduction time, e.g. the PR interval, was 0.242 ± 0.030 sec.

In the base-apex lead, two different configurations of the QRS complex were observed - QS (31.25%) and rS (68.75%), with average duration of 0.087 ± 0.007 sec. The R wave amplitude in the individual animals ranged from 0 to 0.630 mV; 0.121 ± 0.184 mV on the average. The average ST interval was 0.265 ± 0.03 seconds, and the T wave length was 0.157 ± 0.043 seconds. The duration of the QT interval was 0.509 ± 0.03 s., with individual variations between 0.44 – 0.56 seconds. In all studied Balkan donkeys, the S wave was deep with an amplitude of 1.764 ± 0.332 mV. The T wave configuration in 81.2% of the animals was biphasic (positive and negative) and in three donkeys (18.8%) was only positive. Accordingly, the negative T wave amplitude of was 0.328 ± 0.364 mV, and that of positive T wave: 0.255 ± 0.137 mV.

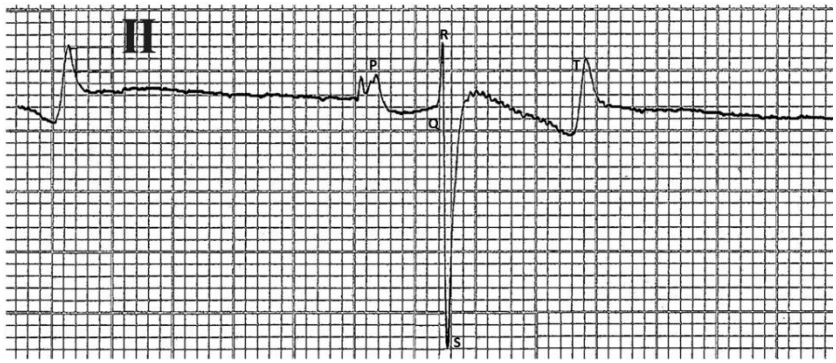

Figure 1: ECG tracing with base-apex lead: bifid P, rS configuration of QRS complex and biphasic T.

Table 1: Duration (s) of the base-apex lead electrocardiographic waves and intervals (range for the whole group; mean ± standard deviation).

Wave	Range (Min-Max)	Total number 16 -(Mean ± SD)
Heart rate (beats/min)	35 – 54	43 ± 5.815
RR interval (sec)	1.12 – 1.72	1.427 ± 0.182
P wave (sec)	0.066 – 0.100	0.083 ± 0.009
PR interval (sec)	0.200 – 0.300	0.242 ± 0.030
QRS segment (sec)	0.076 – 0,100	0.087 ± 0,007
ST interval (sec)	0.22 – 0.32	0.265 ± 0.03
QT interval (sec)	0.44 – 0.56	0.509 ± 0.03
T wave (sec)	0.096 – 0.228	0.157 ± 0.043

Table 2: Amplitude values (mV) of the base-apex lead electrocardiographic waves and intervals (range for the whole group; mean ± standard deviation).

Wave	Range (Min-Max)	Total number 16 -(Mean ± SD)
P_1 (mV)	0.05 – 0.15	0.108 ± 0.025
P_2 (mV)	0.1 – 0.3	0.183 ± 0.058
Q (mV)	–	–
R (mV)	0 – 0.630	0.121 ± 0,184
S (mV)	1.3 – 2.4	1.764 ± 0.332
Negative T (mV)	0 – 1.166	0.328 ± 0.364
Positive T (mV)	0.1 – 0.6	0.255 ± 0.137

Discussion

In the present study, all Balkan donkeys had a sinus heart rate, without excitation and conductive rhythm disturbances. The mean heart rate was 43 ± 5.815 beats/min, very similar to that described by Matthews and Taylor (2004) (42 beats/min), relatively lower than that in the Zamorano-Leones breed in Spain reported by Escudero *et al.* (2009) (52 ± 1.29 beats/min) and significantly lower than the values from Serbian Balkan donkeys, recorded by Djoković *et al.* (2020) (55 ± 5.21 beats/min). Although Bulgaria and Serbia are neighbouring Balkan countries and the reared donkeys have similar morphometric and breed features, the difference in heart rate is significant, probably because the animals selected for testing in our study have a higher live weight and higher average age. According to Holmes and Rezakhani (1975) and Escudero *et al.* (2009) some factors such as training, fear, vagal activity or excitement can also influence the studied parameter. The differences in heart rate between large and small breeds of donkeys can also be caused by differences in the chest and heart size (Ivanković *et al.* 2000).

In the base-apex lead, our results showed notched P waves in 100% of cases, which is dissimilar to the results of Kojouri *et al.* (2007), but comparable to the rates reported by Escudero *et al.* (2009) (93%) and not quite similar to data of Djoković *et al.* (2020) (50%). Notched P waves in donkeys have also been described by Guccione *et al.* (2014). These variations in P wave configuration may be due to breed-, age-related differences, the relationship between vagal tone and training (Ivanković *et al.*, 2002; Guccione *et al.*, 2014; Djoković *et al.*, 2020), as well as to the chest size, and the chest wall's shape and thickness (Ivanković *et al.*, 2000; Djoković *et al.*, 2020).

The amplitudes of the P_1 and P_2 waves in the base-apex lead showed values similar to those reported by Escudero *et al.* (2009) in donkeys but are lower than those described by Kojouri *et al.* (2007). The average P wave duration in our donkeys was 0.083 s, close to that found by Escudero *et al.* (2009) (0.095 s) in Spanish donkeys, shorter than that recorded by Djoković *et al.* (2020) (0.16 s) in Serbia, and than that in horses - 0.170 s (Van Loon and Patteson, 2012). These deviations in the P wave duration are due to differences in the heart rate of the animals in the individual studies, which is in turn negatively correlated with the breed size (Djoković *et al.*, 2020).

The different QRS complex morphology found in the present study has also been described by other researchers using both base-apex and standard bipolar Einthoven leads in donkeys and horses (Fregin 1985; Ayala *et al.*, 1998; Escudero *et al.*, 2009). In the present study, the average QRS segment duration was 0.087 s, which is intermediate between the value found by Escudero *et al.* (2009) in the Zamorano-Leones breed in Spain (0.11 s) and the value in the significantly smaller Serbian donkey breed reported by Djoković *et al.* (2020) (0.068 s). Again, the differences are related to the different heart rates established in larger and smaller donkey breeds.

In the base-apex lead, lower amplitudes in terms of deeper mean S-wave values were observed in Balkan donkeys compared to those reported by Escudero *et al.* (2009) in donkeys and by Kojouri *et al.* (2007) in horses. According to the cited authors, these differences may be due to the different species and breeds of donkeys and horses used.

According to Guccione *et al.* (2014) the T wave configuration in horses is usually positive or biphasic. In donkeys, a negative T wave is more often reported (Kojouri *et al.*, 2007). In a Serbian study on Balkan donkeys, it was found that 75% of animals had a negative T wave (Djoković *et al.*, 2020). In large Spanish Zamorano-Leones donkeys, Escudero *et al.* (2009) described a biphasic T wave in all animals in the base-apex lead. In the present study, a positive T wave was found in 18.8% of the animals (3 out of 16 donkeys), while the remaining 81.2% had biphasic T wave. It is assumed that the T wave polarity is the most variable in the equine electrocardiogram consequently to the influence of multiple factors (fear, excitement, vagal activity, etc.), as stated by Holmes and Rezakhani (1975) and later shared by a number of other researchers.

Conclusion

The electrocardiogram of the Balkan donkey in Bulgaria differs in terms of duration, amplitude and configuration of the ECG parameters from those published in other breeds of donkeys and horses, although of similar origin and geographical areas. The data confirm the statement unlike horses, cardiac arrhythmias in donkeys as an animal species are a rare finding. Additional electrocardiographic studies in more animals from all regions of the country are needed to create reference values specific to the Bulgarian Balkan donkey.

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