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RESEARCH ON THE VALUES OF ELECTROCARDIOGRAPHIC PARAMETERS IN DOGS, ACCORDING TO BREED

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Abstract

In this study, we recorded and analysed electrocardiograms of different dog breeds. All the animals included in the study were healthy in terms of cardiac pathology. Upon analysing the obtained results, we found that Labrador Retrievers exhibited the highest P wave amplitude (0.40±0.05 mV). Regarding the R wave amplitude, high values were observed both in medium-sized breeds (Beagle – 1.70±0.16 mV) and large breeds (Rottweiler – 2.43±0.30 mV). As for the T wave amplitude, high values were observed in small breeds (Yorkshire Terrier – 0.24±0.14 mV) and medium-sized breeds (Cocker Spaniel – 0.24±0.14 mV), while large breeds (Labrador and Rottweiler) had the lowest values (0.21±0.14 mV). Regarding the duration of the main ECG components, it was observed that the P wave had the shortest duration (0.02±0.01 s) in Beagles and the longest duration (0.08±0.04 s) in Labrador Retrievers. The PR interval had the shortest duration (0.04±0.01 s) in Beagles and the longest duration (0.10±0.02 s) in Rottweilers. The QRS complex had the shortest duration (0.02±0.01 s) in Beagles. The QT interval had the shortest duration (0.16±0.01 s) in Yorkshire Terriers. The T wave had the same duration (0.04±0.01 s) for all examined breeds. Regarding heart rate, it was observed that larger dogs have a lower heart rate compared to smaller dogs.

Key words*: amplitude, duration, electrocardiogram, breed.*

INTRODUCTION

The electrocardiogram (ECG) represents the graphic recording or visualization of the cardiac action current on an oscilloscope and its use in clinical practice is important for obtaining information regarding the heart functions (Ghiță et al., 2016; Codreanu, 2018). The ECG is commonly used to investigate the heart rate, detect abnormalities within the excito-conduction system's integrity and diagnosing cardiac arrhythmias (Kumar et al., 2014; Bodh et al., 2016; Reetu et al., 2017; Ghiță et al., 2023). In small animal practice, electrocardiography can be used to detect possible atrial dilations (by modifying the P wave) as well as ventricular dilations (by modifying the R wave) (Ghiță et al., 2007; Neagu et al., 2015). Furthermore, by examining the electrocardiogram recorded using 6 leads (I, II, III, aVR, aVL, and aVF), the value of the mean electrical axis of the heart can be determined (Ghiță et al., 2007). In research, ECG is used to evaluate the effect of training or substances on cardiac activity (Leca et al., 2017). ECG recording is of particular practical importance, being used to calculate the duration of waves, segments, and intervals, as well as the amplitude of electrocardiographic waves (Ghiță et al., 2016). The main objective of our study was to determine the ECGs parameters of dogs with different weights and sizes: small-sized breeds (Yorkshire Terrier and Pomeranian), medium-sized breeds (Beagle and Cocker Spaniel) and large-sized breeds (Labrador and Rottweiler). The resulting values were then compared between each breed. With this purpose, we determined the amplitude (mV) of the P, R, and T electrocardiographic waves and the durations (s) of the P wave, PR interval, QRS complex, QT interval, and T wave. Another parameter of interest was the cardiac frequency (calculated electrocardiographically based on the RR interval). At the end of the study, we compared our results with those reported by other authors in the scientific literature.

MATERIALS AND METHODS

In our research, we used a portable veterinary electrocardiograph with 6 channels, enabling simultaneous recording of the electrocardiogram

in 3 bipolar leads and 3 unipolar leads. To establish contact with the animal's skin, we used rubbing alcohol (easy to apply, and no cleaning of the skin was required afterward), and metal alligator-type electrodes (providing good contact with the skin).

We recorded electrocardiograms from clinically healthy dogs presented at the clinic for routine procedures: deworming, vaccination, nail trimming, anal gland expression, cosmetic interventions, etc. We examined a total number of 46 dogs of various breeds, as follows: 15 small-breed dogs (8 Yorkshire Terriers and 7 Pomeranians), 15 medium-breed dogs (8 Beagles and 7 Cocker Spaniels), and 16 large-breed dogs (8 Labradors and 8 Rottweilers).

To record the ECGs, we used two systems: bipolar leads (I, II, and III) and unipolar leads (aVR, aVL, and aVF), with electrodes placed on the body surface as follows: the red electrode on the skin in the axillary area (on the right side), the yellow electrode on the skin in the axillary area (on the left side), the black electrode on the skin in the region of the groin fold (on the right side), and the green electrode on the skin in the region of the groin fold (on the left side). Recordings were conducted under electrical isolation conditions (to prevent loss or distortion of electrocardiographic signals) by placing the dogs in right lateral position on an examination table covered with a rubber mat.

We determined the following electrocardiographic parameters: amplitude of the P, R, and T waves, duration of the following components: P wave, PR interval, QRS complex, QT interval, T wave, and cardiac frequency (calculated based on the RR interval). The electrocardiographic parameters used were paper speed of 25 mm/sec and millivolt amplitude of 10 mm.

The obtained results are presented in tables and graphs accompanied by interpretations and explanations. For the statistical analysis of the results, we used the T Student test.

RESULTS AND DISCUSSIONS

In Table 1 and Figure 1, we present the results obtained, regarding the values of the electrocardiographic wave amplitudes in dogs, categorised by breed.

Table 1. Values of Electrocardiographic Wave Amplitudes (mV), according to breed (values are expressed as mean ± Standard Error)

Breed	P wave	R wave	T wave
Yorkshire terrier	0.25±0.04	1.25±0.26	0.24±0.014
Pomeranian	0.26±0.02	1.40±0.10	0.23±0.014
Beagle	0.23±0.03	1.70±0.16	0.23±0.014
Cocker spaniel	0.21±0.10	1.55±0.25	0.24±0.014
Labrador Retriever	0.40±0.05	2.30±0.20	0.21±0.014
Rottweiler	0.39±0.04	2.43±0.30	0.21±0.014

Analysing the data presented in Table 1 and Figure 1, it is observed that the large breeds have the largest P-wave amplitude, which means that atrial depolarization generates a stronger current than in the case of medium and small breeds. The observed differences are not statistically significant.

Regarding the amplitude of the R wave (Table 1 and Figure 2), high values are observed in both medium breeds (Beagle) and large breeds (Labrador and Rottweiler). The highest value (2.43 mV) is observed in the Rottweiler breed, and the value obtained by us falls within physiological limits (the maximum value being 2.5 mV) (Gonul et al., 2002; Cotor et al., 2014).

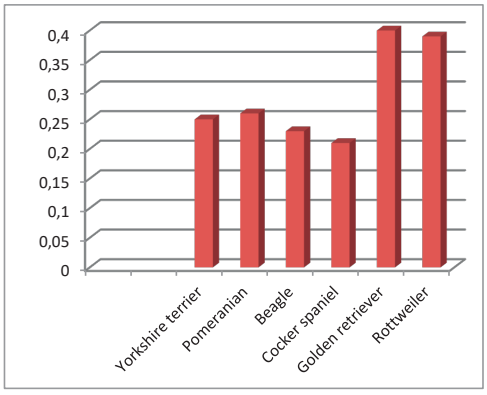

Figure 1. Mean values of the P wave amplitudes (mV), according to breed

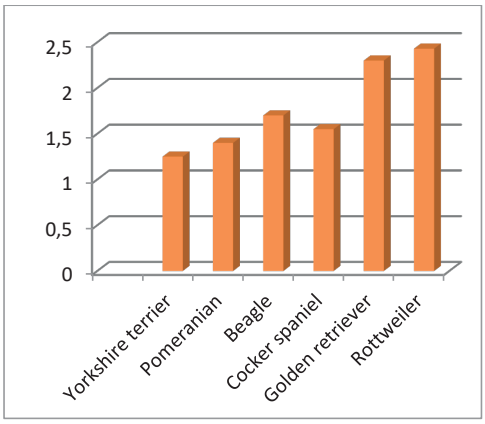

Figure 2. Mean values of the R wave amplitudes (mV), according to breed

Regarding the amplitude of the T wave (Table 1 and Figure 3), high values are observed in small breeds (Yorkshire Terrier) and medium breeds (Cocker Spaniel), while large breeds have the lowest values. For all studied breeds, the values fall within physiological ranges, with the T wave amplitude always being less than 1/4 of the R wave amplitude (Su et al., 2001; Mukherjee et al., 2015).

It should be emphasised that large breeds have the highest amplitude of the P and R waves and the lowest amplitude of the T wave.

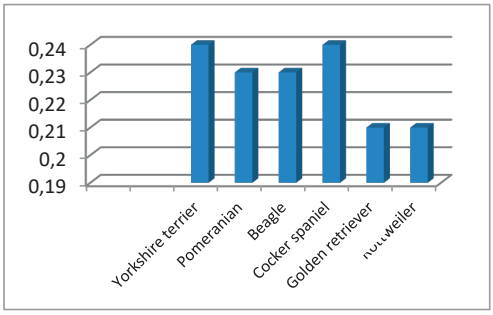

Figure 3. Mean values of the T wave amplitudes (mV), according to breed

In Table 2 and Figure 4, we present the results obtained, regarding the durations of the main electrocardiographic components in dogs, categorised by breed.

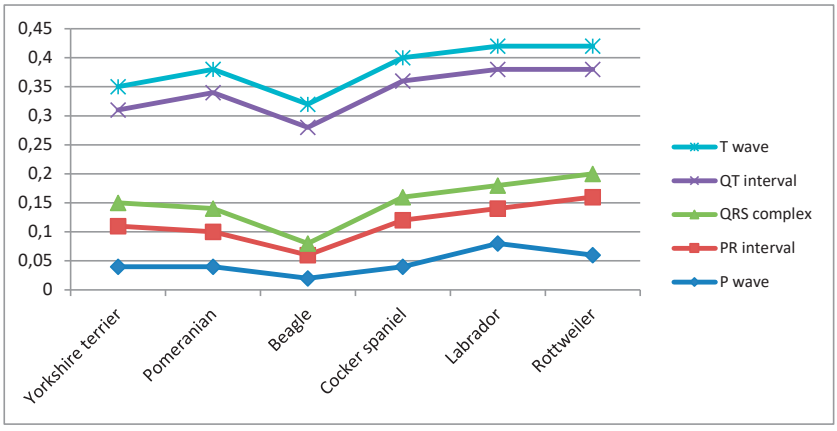

Figure 4. Mean values of electrocardiographic components, by breed

Analysing the details presented in Table 2 and Figure 4, the following distinctions can be made:

- The duration of the P wave ranges from 0.02 ± 0.01s (Beagle breed) to 0.060 ± 0.02s (Rottweiler breed) and 0.08 ± 0.04s (Labrador breed). In the case of these breeds, the differences are significant ($p < 0.05$) compared to the values recorded for other studied breeds.
- The duration of the PR interval is the shortest in the Beagle breed (0.04 ± 0.01s) and the longest in the Rottweiler breed (0.10 ± 0.02s). It is noteworthy that in the case of the Rottweiler breed, the differences observed by us are statistically significant ($p < 0.05$) compared to the values obtained for other breeds.
- The duration of the QRS complex was the same for all examined breeds (0.04 ± 0.01s), except for the Beagle breed where the obtained value was 0.02 ± 0.01, and this difference was not statistically significant ($p > 0.05$).
- The duration of the QT interval ranged from 0.16 ± 0.01s in Yorkshire Terrier to 0.18 ± 0.01s

for the Rottweiler, and 0.2 ± 0.01s in the other studied breeds. Statistical analysis did not reveal significant differences for any studied breed ($p > 0.05$).

- The duration of the T wave was 0.04 ± 0.01s for all studied breeds.

Table 2. Values of Electrocardiographic Component Durations (s) according to breed (values are expressed as mean ± Standard Error)

Breed	P wave	PR interval	QRS complex	QT interval	T wave
Yorkshire terrier	0.04±0.01	0.07±0.01	0.04±0.01	0.16±0.01	0.04±0.01
Pomeranian	0.04±0.01	0.06±0.01	0.04±0.01	0.2±0.01	0.04±0.01
Beagle	0.02±0.01*	0.04±0.01	0.02±0.01	0.2±0.01	0.04±0.01
Cocker spaniel	0.04±0.01	0.08±0.01	0.04±0.01	0.2±0.01	0.04±0.01
Labrador	0.08±0.04*	0.06±0.02	0.04±0.01	0.2±0.01	0.04±0.01
Rottweiler	0.06±0.02*	0.10±0.02*	0.04±0.01	0.18±0.01	0.04±0.01

In Table 3 and Figure 5, we present the results obtained by us regarding the heart rate duration in dogs, categorised by breed (calculated electrocardiographically based on the R-R interval).

Table 3. Heart rate values (bpm) according to breed (values are expressed as mean ± Standard Error)

Breed	HR
Yorshire terrier	135.00±10.2
Pomeranian	145.00±5.00
Beagle	106.25±3.75
Cocker spaniel	140.50±15.5
Labrador	115.00±12.3
Rottweiler	125.00±10.2

It is worth mentioning that for all analyzed breeds, the results fall within the values mentioned in the specialized literature (Sato et al., 2000; Hanton et al., 2006; Gugjoo et al., 2014). One possible explanation for this finding could be the presence of a more intense metabolism in small breeds, leading to a greater need for oxygen at the tissue level, which can also result in a more intense cardiac activity.

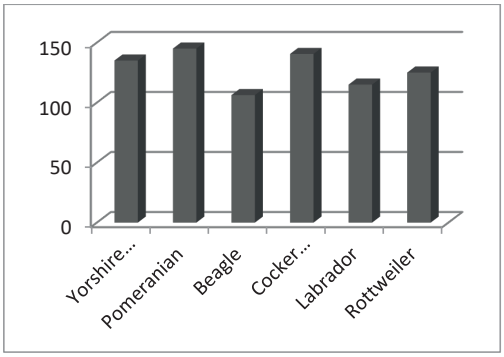

Figure 5. Mean heart rate values (bpm) in the studied dogs, according to breed

Table 4. Electrocardiographic wave amplitudes (mV) recorded in dogs (according to other authors)

Author	P wave	R wave	T wave
Tilley L.P. et al.	<0.40	<2.5 small breeds <3 large breeds	<¼ of R wave
Martin M.	<0.40	<2 small breeds <2.5 large breeds	<¼ of R wave
Kittleson M.D. et al.	<0.40	<3	-
Johathan A. et al.	0.40	2.5-3.0	<¼ of R wave
Mike W.S. şi col.	0.40	<2 small breeds <2.5 large breeds	<¼ of R wave
Philip R. Fox	0.40	<2.5 small breeds <3 large breeds	<¼ of R wave
Personal research	<0.26 small breeds <0.23 medium breeds <0.40 large breeds	<1.40 small breeds <1.70 medium breeds <2.43 large breeds	<0.24 small breeds <0.24 medium breeds <0.21 large breeds

Comparing our data (Table 1) with those reported in the specialised literature (Table 4), it is observed that our data fall within the standard limits mentioned. Regarding the durations of certain electrocardiographic components, we compared our values with those obtained by

various authors. In the present study, we determined the durations of the P wave (representing atrial depolarisation), PR interval (representing atrial electrical systole), QRS complex (representing ventricular depolarisation), QT interval (representing ventricular electrical systole), and T wave (representing ventricular repolarisation).

Table 5. Duration of electrocardiographic components (seconds) recorded in dogs (according to other authors)

Author	P wave	R wave	T wave
Tilley L.P. et al.	<0.40	<2.5 small breeds <3 large breeds	<¼ of R wave
Martin M.	<0.40	<2 small breeds <2.5 large breeds	<¼ of R wave
Kittleson M.D. et al.	<0.40	<3	-
Johathan A. et al.	0.40	2.5-3.0	<¼ of R wave
Mike W.S. et al.	0.40	<2 small breeds <2.5 large breeds	<¼ of R wave
Philip R. Fox	0.40	<2.5 small breeds <3 large breeds	<¼ of R wave
Personal research	<0.26 small breeds <0.23 medium breeds <0.40 large breeds	<1.40 small breeds <1.70 medium breeds <2.43 large breeds	<0.24 small breeds <0.24 medium breeds <0.21 large breeds

Comparing the results obtained by us (Table 2) with those obtained by other authors (Table 5), we observe that there are no major differences between our results and those encountered in specialized literature.

CONCLUSIONS

Regarding the amplitude of the electrocardiographic waves, we observed that the P wave has the highest value in large breeds (Labrador), the R wave has high values both in medium breeds (Beagle) and in large breeds (Rottweiler), and the T wave has high values in small breeds (Yorkshire Terrier) and medium breeds (Cocker Spaniel), with large breeds (Labrador and Rottweiler) having the lowest values.

Regarding the duration of ECG components, we observed that the duration of the P wave is the shortest in the Beagle breed and the longest in the Labrador breed. The duration of the PR interval is the shortest in the Beagle breed and the longest in the Rottweiler breed. The duration of the QRS complex was the same for all examined breeds except for the Beagle breed, where it was shorter. The duration of the QT interval was the shortest in Yorkshire Terriers. The duration of the T wave was identical for all studied breeds.

Regarding heart rate, we observed that large-sized dogs have a lower heart rate than small-sized dogs.

REFERENCES

Bodh, D. Hoque, M., Saxena, A.C., Gugjoo, M.B., Bist, D. (2016). Diagnosis of dilated cardiomyopathy and pericardial effusion in two dogs. *Indian J. Vet. Surg*. 37(1):48–50.

Codreanu, I. (2018). *Textbook of animal physiology*. Bucharest, RO: Printech Publishing House.

Cotor, G. Ghiță, M. (2014). *Fiziopatologia specială a animalelor domestice*. Bucharest, RO: Printech Publishing House.

Gonul, R.. Kaymaz, A.A. (2002). Estimation of electrocardiographic values in healthy Karabash dogs. *Turk Veterinerlink ve Hayvancilik Dergisi*. 26. 3. 511-515.

Ghiță, M.. Rotaru, A.. Petcu, C.D.. Nicolae (Călin), S., Mihai, O.D., Cotor, G. (2023). Research on the values of some electrocardiographic parameters in goat recorded using Dubois leads. *Scientific Works. Series C. Veterinary Medicine.* LXIX (1):19-24.

Ghiță, M.. Tobă, G.F.. Cotor, G.. Tobă, L.G. (2016). Research on changes in ECG waves' amplitude in cows using more leads systems. *Scientific Works. Series C. Veterinary Medicine*. LXII(1):18-21.

Ghiță, M.. Cotor, G.. Bălăceanu, R.. Tobă, L.G. (2016). Determination of values of the electrocardiogram's main components registered on calves at different ages. *Scientific Works. Series C. Veterinary Medicine*. LXII(2):34-37.

Ghiță, M.. Cotor, G.. Brăslaşu, C.. Botezatu, R. (2007). Researches on the variation of the Mean Electrical Axis in dogs depending on the recording pozition. *Lucr. Ştiinţ.. Medicină Veterinară. Timişoara*. XL:389-392.

Ghiță, M.. Cotor, G.. Brăslaşu, C.. Botezatu, R. (2007). Studies on the duration of some ECG parameters in cats. *Lucr. Ştiinţ.. Medicicină Veterinară. Timişoara*. XL:393-396.

Gugjoo, M.B. Hoque, A.C. Zama, M.M.S. (2014). Reference values of six-limb-lead electrocardiogram

in conscious Labrador retriever dogs. *Pak. J. Biol. Sci.* 17(5):689–695.

Hanton, G. Rabemampianina, Y. (2006). The electrocardiogram of the Beagle dog: Reference values and effect of sex, genetic strain, body position and heart rate. *Lab. Anim*. 40(2):123–136.

Kumar, A., Dey, S., Mahajan, S. (2014). Incidence and risk assessment of cardiac arrhythmias in dogs with respect to age. breed. sex and associated biochemical changes. *Adv. Anim. Vet. Sci.* 2(5):277–281.

Leca, F.. Mihai, A.S.. Dojana, N. (2017). Correlations between heart rate and lactic acid during submaximal exercise in dog. *Scientific Works. Series C. Veterinary Medicine*. LXIII(1):119-122.

Mukherjee, J., Das, P.K., Ghosh, P.R., Banerjee, D., Sharma, T., Basak, D., Sanyal, S. (2015). Electrocardiogram pattern of some exotic breeds of trained dogs: A variation study. *Vet. World.* 8(11):1317–1320.

Neagu, A.G. Tudor, N., Vlăgioiu, C. 2015. Measuring the heart size of dogs with VHS method. *Scientific Works. Series C. Veterinary Medicine.* LXI:92-94.

Reetu Hoque, M., Saxena, A.C., Pawde, A.M., Verma, N.K., Kalaiselvan, P., Dey, S. (2017). Incidence of cardiac diseases in dogs:A retrospective study. *Indian J. Vet*. Med., 37(1-2):64–67.

Sato, H., Fujii, Y., Wakao, Y. (2000). Standard electrocardiographic values in normal retrievers. *Adv. Anim. Cardiol.*, 33(1):11–15.

Su, W.L., Too, K., Wang, M.H., Jiang, Y.N., Pan, M.J. (2001). Reference values of six-limb-lead ECG in conscious Taiwanese dogs. *Adv. Anim. Cardiol*. 35(2):86–95.