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COMPARATIVE RESEARCH ON THE ECG WAVES' AMPLITUDE RECORDED IN GOAT USING TWO SYSTEMS OF LEADS

CERCETĂRI COMPARATIVE PRIVIND AMPLITUDINILE UNDELOR ECG ÎNREGISTRATE LA CAPRĂ FOLOSIND DOUĂ SISTEME DE DERIVAȚII

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ABSTRACT

The main aim of our research was to determine the amplitude of ECG waves in goats. Thereby, we investigated two lead systems: limb leads and Dubois leads. We mention that the values obtained were compared with each other in order to determine which is the optimal lead system for ECG recording in this species. The obtained results showed that the limb leads are superior to the Dubois leads only in lead I, the values obtained being: 0.089 mV ± 0.018 for the P wave, 0.228 mV ± 0.029 for the ventricular complex, and 0.128 mV ± 0.015 for the T wave. The Dubois leads are superior to the limb leads, the values obtained being: 0.107 mV ± 0.013 for the P wave, 0.292 mV ± 0.018 for the ventricular complex, and 0.389 mV ± 0.022 for the T wave (recorded in lead II); 0.071 Mv ± 0.011 for the P wave, 0.292 Mv ± 0.018 for the ventricular complex, and 0.335 mV ± 0.017 for the T wave (recorded in lead III); 0.064 mV ± 0.012 for the P wave, 0.189 mV ± 0.009 for the ventricular complex, and 0.210 mV ± 0.017 for the T wave (recorded in aVR); 0.028 mV ± 0.008 for P wave, 0.192 mV ± 0.010 for ventricular complex, and 0.178 mV ± 0.014 for T wave (recorded in aVL); and 0.078 mV ± 0.010 for the P wave, 0.246 mV ± 0.015 for the ventricular complex, and 0.296 mV ± 0.023 for the T wave (recorded in aVF).

Keywords: amplitude, electrocardiography, goat, lead

REZUMAT

Preocuparea principală a cercetărilor noastre a fost reprezentată de determinarea amplitudinii undelor ECG la capră. În acest scop am investigat două sisteme de derivaţii: sistemul de derivaţii ale membrelor și sistemul de derivaţii Dubois. Menționăm că valorile obținute au fost comparate între ele pentru a putea stabili care este sistemul de derivații optim pentru înregistrarea ECG la această specie. Rezultatele obținute au aratat că derivațiile membrelor sunt superioare derivațiilor Dubois numai în DI, valorile obținute fiind de: 0,089 mV±0,018 pentru unda P, 0,228 mV±0,029 pentru complexul ventricular și de 0,128 mV±0,015 pentru unda T. Derivațiile Dubois sunt superioare derivațiilor membrelor, valorile obținute fiind de: 0,107 mV ± 0,013 pentru unda P, 0,292 mV ± 0,018 pentru complexul ventricular și de 0,389 mV ± 0,022 pentru unda T (înregistate în D II); 0,071 mV ± 0,011 pentru unda P, 0,292 mV ± 0,018 pentru complexul ventricular și de 0,335 mV ± 0,017 pentru unda T (înregistate în D III); 0,064 mV ± 0,012 pentru unda P, 0,189 mV ± 0,009 pentru complexul ventricular și de 0,210 mV ± 0,017 pentru unda T (înregistrate în aVR); 0,028 mV ± 0,008 pentru unda P, 0,192 mV ± 0,010 pentru complexul ventricular și de 0,178 mV ± 0,014 pentru unda T (înregistrate în aVL); și de 0,078 mV ± 0,010 pentru unda P, 0,246 mV ± 0,015 pentru complexul ventricular și de 0,296 mV ± 0,023 pentru unda T (înregistrate în aVF).

Cuvinte cheie: amplitudine, electrocardiografie, capre, derivație

The electrocardiogram represents the graphical recording of the cardiac electric activity during the cardiac revolutions (6, 13). The electrocardiogram is a non-invasive method frequently used for the study of the heart's activity that allows us to investigate certain aspects of the healthy heart's function (excitoconductory system's integrity, duration and frequency of the atrial and ventricular systole) and the occurrence of certain heart diseases such as rhythm disorders or the effect of some substances on the heart (2, 7, 8, 14). The proper execution of the electrocardiogram is extremely important from practical point of view, as it is recommended in the clinical practice to calculate the heart rate, determine the heart rhythm, as well as to calculate the duration (for waves, segments, and intervals) and the amplitude (for waves) of some components. Lastly, the EKG is used to determine the cardiac electrical axis (9). In our research, we recorded

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electrocardiograms in goats using two systems of leads in order to determine the values of the wave amplitudes, the speciality literature being very poor in such data regarding this species. Studying the literature, we found very few scientific works on this subject, most of the authors being from Asia (where the interest in raising this species is higher), the research being made on adult goats of different breeds (usually local breeds). The aim of our research was to determine the main electrocardiographic parameters in goats using two systems of leads (limb lead system and Dubois lead system). Regarding the amplitude of the electrocardiographic waves, it was determined for both systems used to record electrocardiograms. We mention that the values obtained were compared to each other in order to determine which is the optimal lead system for recording the electrocardiogram in this species. In the case of the kids, we used only the limb leads system.

MATERIALS AND METHODS

The logistics required to record the electrocardiogram in goats are represented by the following equipment: electrocardiograph, metal collectors, and conductive media. In our research, we used an Innomed heart mirror portable electrocardiograph. The role of EKG detectors is to capture the cardiac action current at the surface of the skin. For our research, we used alligator-type sensors for the advantages that they provide, such as their ease of use, being easy to attach on the animal's skin, even if the hair is not trimmed. The role of electric conducting media is to facilitate the transmission of the cardiac action current from the skin to the metal collector. Thus, currently, saline solutions, gels, sanitary alcohol, and many others are used. In our research we used sanitary alcohol due to the fact that it is easy to apply, does not irritate the skin and, after its application, it is not necessary to clean the skin (unlike the ultrasound gel which must be removed after application). As concerning the patients, twenty French Alpine goats from the farm RO 1791410077, Glina village, Ilfov county were used in our research. In our research, we recorded electrocardiograms in goats using limb leads and Dubois leads. In order to record electrocardiograms in goats using limb leads, the electrodes are placed on the body surface as follows: red electrode on the skin in the axillary area, on the right forelimb, yellow electrode on the skin in the axillary area, on the left forelimb, black electrode on the skin on the right hindlimb, the green electrode on the skin on the left hindlimb. Regarding the Dubois leads, they involve placing electrodes on the surface of the body, as follows: the red electrode in front of the right shoulder, the yellow electrode in front of the left shoulder, the green electrode between the xiphoid appendage and the umbilical scar, the black electrode anywhere on the body surface, but not on the surface covered by active electrodes.

For the statistical analysis of the values obtained, we used the T-test (Student test).

RESULTS AND DISCUSSION

Analyzing the recordings obtained using limb leads, we noticed that they are often disturbed by artifacts from the limb muscles' contraction. There can also be observed a small amplitude of the electrocardiographic waves due to the long distance from the electrodes to the heart. In Table 1 and Fig. 1, we present the average values of all electrocardiographic waves' amplitudes obtained by using limb leads.

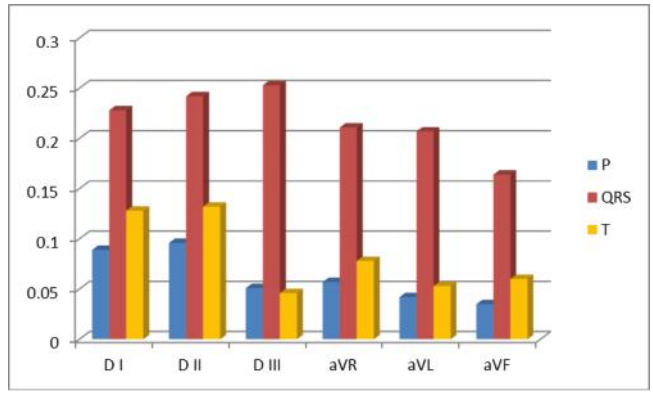

Fig. 1. The average amplitudes of the P-wave, ventricular complex and T-wave, recorded using limb leads in goats

From the data presented, it can be seen that among the limb leads, the following derivations can be used to record the electrocardiogram in goat: II (which provides the highest amplitude of the P and T waves), III (which provides the highest amplitude of the QRS complex), and I (provides recordings with amplitudes that allow interpretation). The other leads offer low-

Table 1

The average amplitudes of the electrocardiographic waves (mV) recorded in goats using limb leads

Wave	I	II	III	aVR	aVL	aVF
P	0.089	0.096	0.051	0.057	0.042	0.035
QRS	0.228	0.242	0.253	0.211	0.207	0.164
T	0.128	0.132	0.046	0.078	0.053	0.060

Table 2

The average amplitudes of the electrocardiographic waves (mV) recorded in goats using Dubois lead

Wave	I	II	III	aVR	aVL	aVF
P	0.042	0.107	0.071	0.064	0.028	0.078
QRS	0.196	0.292	0.292	0.189	0.192	0.246
T	0.121	0.389	0.335	0.210	0.178	0.296

amplitude electrocardiographic recordings, which is why the electrocardiogram is difficult to interpret.

Comparing our results with the results obtained by other authors in the speciality literature, we observe they obtained:the highest amplitude of the P wave, in I and aVR (4), in I (10) and II and aVF (11), the highest amplitude of the QRS complex, in II (12), III and aVR (1), in II and III (4) and II (3), the highest amplitude of the T wave in II (12), in II and III (1) and III (11).

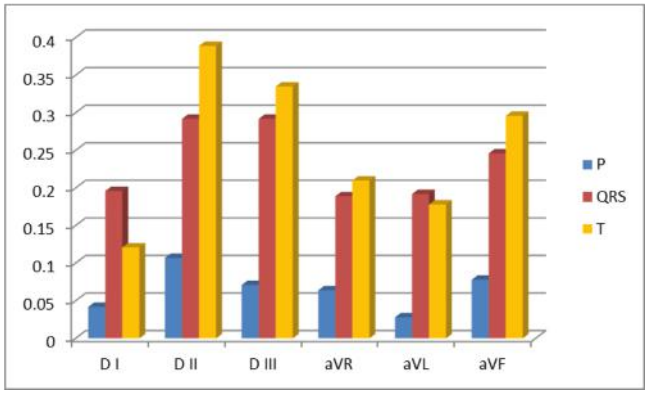

Fig. 2. The average amplitudes of the electrocardiographic waves recorded in goats using Dubois leads

In Table 2 and Fig. 2, we present the average values of the amplitudes of all electrocardiographic waves, obtained using Dubois derivations. This lead system differs from the limb lead system in that the triangle in the center of which the heart is located is smaller, so the amplitude of the recorded waves is larger. Analyzing the obtained electrocardiograms, we noticed that they presented an easily interpretable recording, without artifacts, and the amplitude of the electrocardiographic waves is higher (compared to the waves recorded using limb leads).

Analyzing the data presented in Table 2 and Fig. 2 we can conclude that for the recording of the goat electrocardiogram in the Dubois lead system, we can successfully use the II and III leads for the ventricular complex and the T wave, and II and aVF leads for the P wave. From our point of view, the aVR and aVL leads have a limited recommendation, and I cannot be used to record the electrocardiogram because it provides electrocardiographic waves with an extremely small amplitude, making the electrocardiogram uninterpretable. Comparing our results with the results communicated by other authors, we observe that they obtain: the highest amplitude of the P wave, in I, II, and aVF (1), in I (10) and in II and aVF (11), the highest amplitude of the QRS complex, in II (12), III and aVR (1) and in II and III (4), the highest amplitude of the T wave in II (12), II and III (5), and III (11).

In tables 3, 4, and 5 and figures 3, 4, and 5, we present the comparative analysis of the average amplitudes of the P wave, the QRS complex and the T wave, recorded in goat using the two leads systems.

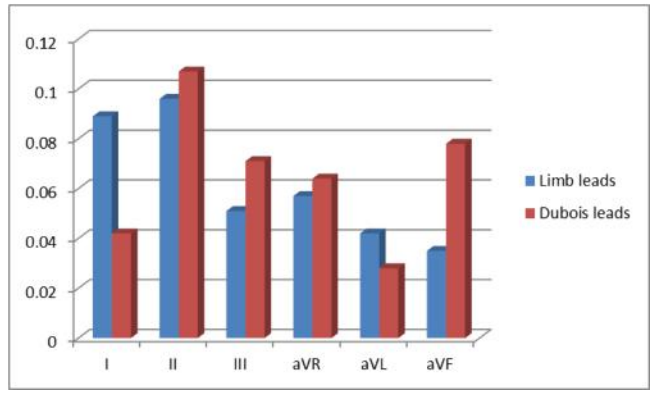

Fig. 3. Comparative graph of the average amplitude of the P wave recorded using the two leads systems in goats

Analyzing the data presented in Table 3 and Fig. 3, the following were observed regarding the average amplitude of the P wave (recorded in goats using the

Table 3

Comparative aspects regarding the average P wave (mV) amplitudes recorded using the two leads systems in goats

Lead system	I	II	III	aVR	aVL	aVF
Limb lead	0.089*	0.096	0.051	0.057	0.042	0.035
Dubois lead	0.042	0.107	0.071	0.064	0.028	0.078*

$p<0.05$ – statistically significant differences

Table 4

Comparative aspects regarding the average amplitude of the QRS complex (mV) recorded using the two lead systems in goats

Lead system	I	II	III	aVR	aVL	aVF
Limb leads	0.228*	0.242	0.253	0.211	0.207	0.164
Dubois leads	0.196	0.292*	0.292	0.189	0.192	0.246*

p<0.05 – statistically significant differences

Table 5

Comparative aspects regarding the average T wave (mV) amplitudes recorded using the two leads systems in goats

Lead system	I	II	III	aVR	aVL	aVF
Limb leads	0.128	0.132	0.046	0.078	0.053	0.060
Dubois leads	0.121	0.389*	0.335*	0.210*	0.178*	0.296*

p<0.05 – statistically significant differences

two lead systems in comparison): in I, 111.9% higher in favor of limb leads, with statistically significant difference (*p<0.05*), in II, higher by 11.46% in favor of Dubois leads, in III, higher by 39.22% in favor of Dubois leads, in aVR, higher by 12.28% in favor of Dubois leads, in aVL, higher by 50% in favor of limb leads, in aVF, higher by 122.86% in favor of Dubois leads, with statistically significant difference (*p<0.05*).

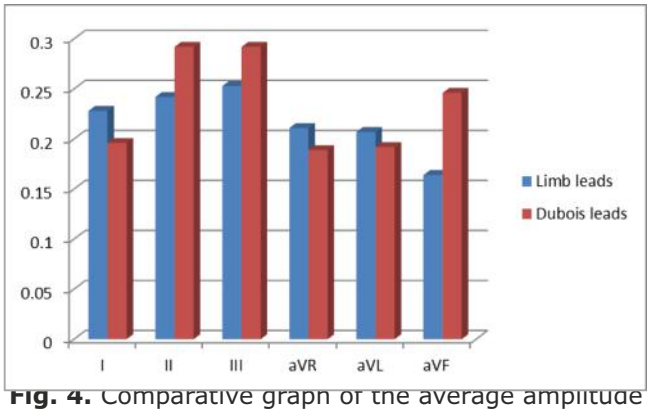

Fig. 4. Comparative graph of the average amplitude of the QRS complex recorded using the two leads systems in goats

Analyzing the data presented in Table 4 and Fig. 4, the following were observed regarding the average amplitude of the ventricular complex recorded in goats (using the two derivation systems in comparison): in D I, higher by 16.33% in favor of limb leads, a statistically significant difference (p<0.05), in D II, higher by 20.66% in favor of Dubois leads, a statistically significant difference (p<0.05), in D III, higher 15.42% in favor of Dubois leads, in aVR, higher by 11.64% in favor of limb leads, in aVL, higher by 7.81 in favor of limb leads; in aVF, higher by 50% in favor Dubois leads, a statistically significant difference (p<0.05).

Analyzing the data presented in Table 5 and Fig. 5, the following were observed regarding the average amplitude of the T wave (recorded in goats using the two derivation systems in comparison): in I, higher by 5.79% in favor of limb leads, in II, higher by 194.70% in favor of Dubois leads, with statistically significant differences (*p<0.05*), in III, higher by 628.26% in favor of Dubois leads, with statistically significant differences (*p<0.05*), in aVR, higher by 169.23% in favor of Dubois leads, with statistically significant differences (*p<0.05*), in aVL, higher by 235.85% in favor of Dubois leads, with statistically significant differences (*p<0.05*), in aVF, higher by 393.33% in favor of Dubois leads, with statistically significant differences (*p< 0.05*).

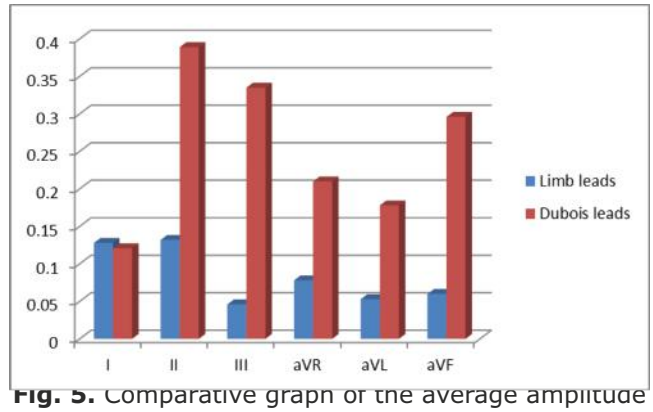

Fig. 5. Comparative graph of the average amplitude of the T wave recorded using the two leads systems in goats

CONCLUSIONS

During our study, the limb leads system proved to be superior to the Dubois leads in I in goats, whereas Dubois leads are superior to limb leads in: II, III, aVR, aVL, and aVF in this species.

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