

RESEARCH ON THE AMPLITUDES OF ELECTROCARDIOGRAPHIC WAVES IN KIDS CERCETĂRI PRIVIND VALORILE AMPLITUDINILOR UNDELOR ELECTROCARDIOGRAFICE, LA IED

M. GHIȚĂ^{1*)}, G. COTOR¹⁾,
D. POPESCU¹⁾,
Simona CĂLIN (NICOLAE)

ABSTRACT | REZUMAT

Electrocardiogram (ECG) is the graphical recording of cardiac current during the cardiac revolution, which is a widely used medical examination technique, nowadays. In our research, we focused on the analysis of the obtained electrocardiograms, but also on the determination of amplitudes of electrocardiographic waves (in bipolar leads: I, II, and III, as well as in the unipolar leads: aVL, aVR and aVF). To achieve the proposed aims, we recorded electrocardiograms in healthy kids, aged 1-1.5 months, using limb leads. From our research, we can recommend the limb leads for the recording of the electrocardiogram in kids (because they give the electrocardiograms an optimal aspect and they can be analysed and interpreted easily). The maximum amplitude of the electrocardiographic waves was recorded in D I. The P wave was 0.115 ± 0.010 mV, the QRS complex was 0.625 ± 0.078 mV and the T wave was 0.460 ± 0.045 mV.

Keywords: amplitude, electrocardiogram, lead, kid

Electrocardiograma (ECG) reprezintă înregistrarea grafică a curentului de acțiune cardiac pe parcursul derulării revoluțiilor cardiace, fiind în prezent o tehnică de examinare a cordului cu largă utilizare în medicină. În cadrul cercetărilor noastre am fost preocupați de analizarea aspectului electrocardiogramelor obținute, precum și de determinarea valorilor amplitudinilor undelor electrocardiografice (în derivațiile bipolare: I, II, și III, precum și în derivațiile unipolare aVL, aVR și aVF). Pentru realizarea obiectivelor propuse am înregistrat electrocardiografe la iezi clinic sănătoși, cu vârsta cuprinsă între 1-1,5 luni, utilizând derivațiile membrelor. În urma cercetărilor întreprinse putem recomanda că pentru înregistrarea electrocardiografe la iezi se pot folosi cu succes derivațiile membrelor (deoarece conferă electrocardiogramelor un aspect optim acestea putând fi analizate și interpretate cu ușurință). În ceea ce privește amplitudinea maximă a undelor electrocardiografice aceasta s-a înregistrat în D I, unda P având valoarea de $0,115 \pm 0,010$ mV, complexul QRS având valoarea de $0,625 \pm 0,078$ mV și unda T având valoarea de $0,460 \pm 0,045$ mV.

Cuvinte cheie: amplitudine, electrocardiogramă, derivație, ied

The electrocardiogram is a non-invasive method in order to study the heart that allows us to investigate certain aspects of a healthy heart function (excitement system integrity, duration and frequency of atrial and ventricular systole) (3) and heart diseases (rhythm disorders, the effect of some substances on the heart) (6). Although the method is not very new, it is one of the most used methods for investigating heart activity, nowadays (along with echocardiogram and Holter monitoring) (2).

In the clinic, the electrocardiogram has great importance, being recommended for calculating heart

rate, determining heart rhythm and calculating the duration (for waves, segments and intervals) and the amplitudes (for waves) of electrocardiographic components. It can also be used to determine the cardiac electrical axis (4).

In veterinary medicine, the ECG is extensively used in the pet animal clinic, but in the literature there are numerous works on dogs (13), cats (12) and horses (8).

Regarding the use of the electrocardiogram in goats, the literature (1, 5, 10) is quite poor.

Studying the literature in the field, we found very few works on this topic, most of the authors being from Asia (7, 9, 11), where the interest in growing this species is higher). In Romania, the electrocardiograms on kids has not been studied.

In this research, we recorded electrocardiograms

1) University of Agronomic Sciences and Veterinary Medicine, Faculty of Veterinary Medicine, Bucharest, Romania

2) The General Association of Romanian Veterinarians, Bucharest, Romania

*) Corresponding author: marianvet@yahoo.com

on kids using the limb leads in order to determine the values of the P, QRS and T wave amplitudes because the literature is very poor in such data.

METHODS AND MATERIALS

We used a portable electrocardiograph INNOMED HEART MIRROR, the electrodes were equipped with alligator catchers and we used alcohol as contact medium between the animal's skin and the electrodes.

All ECGs were recorded using limb leads and the re-cording parameters were: 25 mm/sec for speed of paper and 10 mm for the amplitude of millivolt.

RESULTS AND DISCUSSIONS

The aspect of the ECGs in kids (recorded in I, II, III, aVR, aVL and aVF leads) can be observed in Fig. 1, 2, 3, 4, 5 and 6.

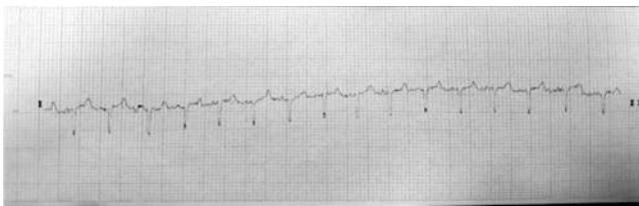


Fig. 1. ECG in kids recorded in lead I (big amplitude and negative orientation of QRS complexes)



Fig. 2. ECG in kids recorded in lead II (high and positive T wave)

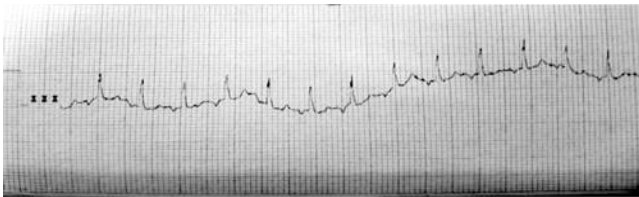


Fig. 3. ECG in kids recorded in lead III (high and positive QRS complex)

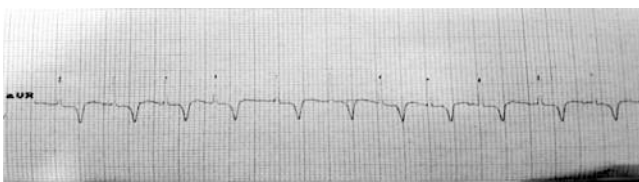


Fig. 4. ECG in kids recorded in lead aVR (high and positive QRS complex and negative T wave)

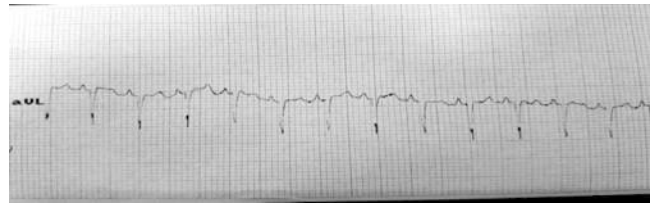


Fig. 5. ECG in kids recorded in lead aVL (deep and negative QRS complex, sometimes with bifid aspect)

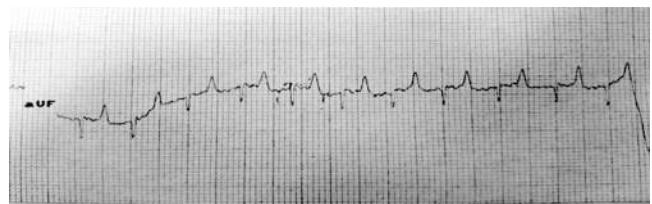


Fig. 6. ECG in kids recorded in lead aVF (small QRS complexes, high and positive T wave)

The values of the P-wave amplitudes, the QRS complex and the T wave obtained in our investigations are presented below, in Tables 1, 2, 3 and Fig. 7, 8, 9.

Regarding the P wave (Table 1 and Fig. 7), we observed that it has a maximum average amplitude in D I (0.115 mV), the variability being small (variance 0.001 and standard deviation 0.033). Relative high amplitudes of P wave are also observed in D II and aVL leads with the same average value of 0.071 mV (with 0.002 variance values and 0.048 standard deviation).

Regarding the QRS complex (Table 2 and Fig. 8), it is observed that its highest amplitude is also recorded in D I, with an average value of 0.625 mV, the variability is big (variance 0.061, standard deviation 0.248). High amplitudes of the ventricular complex are also observed in aVL having an average of 0.540 mV. In D II and aVR they have also the same value of 0.455 mV, their variables being different (variance 0.008 and standard deviation 0.089) for D II and variance 0.042 and standard deviation of 0.205 for aVR.

Regarding the T wave (Table 3 and Fig. 9), its highest amplitude is also observed in D I, with an average of 0.460 mV, but the variability is small (variance 0.020 and standard deviation 0.142). High average amplitudes are also observed in D II, with an average value of 0.430 mV with small variability (variance 0.006 and standard deviation 0.082), but also in aVR they have an average value of 0.356 mV with small variability (variance 0.031, standard deviation 0.176).

Analysing the data on the electrocardiographic waves amplitudes presented in the previous tables and figures, we note the following:

- the average amplitude of P wave was between

Table 1

P wave amplitude (mV) in kids

Number Kid	D I	D II	D III	aVR	aVL	aVF
1	0,15	0,15	0,05	0,15	0,1	0,05
2	0,1	0	0	0,05	0,05	0,05
3	0,1	0,1	0,05	0,05	0,05	0,05
4	0,1	0,05	0,05	0,05	0	0
5	0,1	0	0,05	0,05	0,05	0,05
6	0,15	0,05	0	0,05	0,05	0
7	0,05	0,05	0	0	0,05	0,05
8	0,15	0,1	0,1	0,1	0,05	0
9	0,1	0,1	0,1	0,1	0,15	0,05
10	0,15	0,1	0,15	0,05	0,15	0,05
AVERAGE	0,115	0,071	0,055	0,065	0,071	0,035
Standard error	0,010	0,015	0,015	0,013	0,015	0,007
Standard deviation	0,033	0,048	0,049	0,041	0,048	0,024
Variance	0,001	0,002	0,002	0,001	0,002	0,001

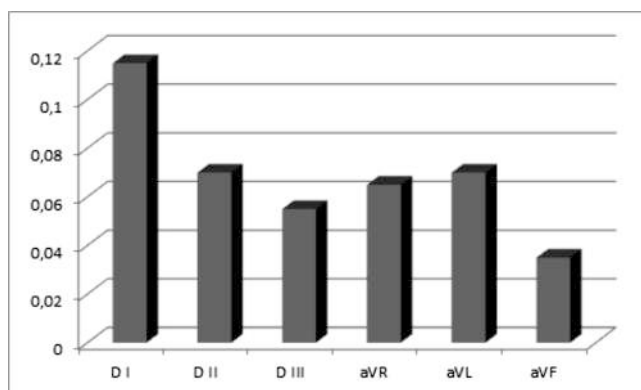


Fig. 7. Average amplitude of the P wave recorded in kids

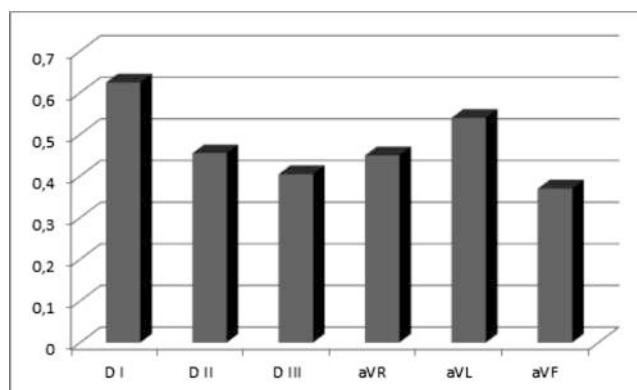


Fig. 8. Average amplitude of QRS complex recorded in kids

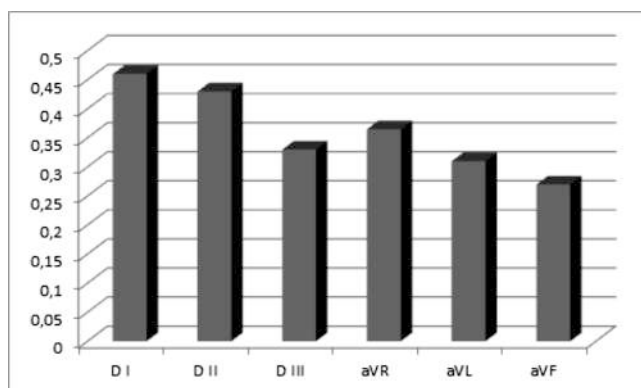
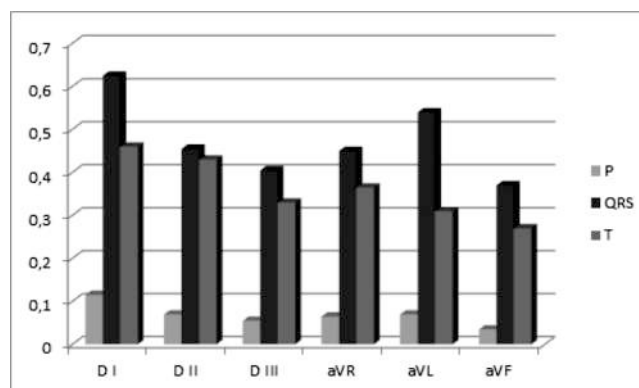
Table 2

Amplitude of the QRS complex (mV) in kids

Number Kid	D I	D II	D III	aVR	aVL	aVF
1	0.9	0.5	0.3	0.7	0.8	0.5
2	0.6	0.5	0.25	0.8	0.5	0.4
3	0.25	0.5	0.5	0.25	0.35	0.5
4	0.5	0.35	0.4	0.4	0.3	0.2
5	0.6	0.5	0.5	0.3	0.4	0.35
6	0.8	0.4	0.3	0.5	0.7	0.35
7	0.3	0.5	0.4	0.4	0.35	0.5
8	0.8	0.6	0.3	0.4	0.6	0.2
9	1	0.4	0.6	0.5	0.9	0.25
10	0.5	0.3	0.5	0.25	0.5	0.45
AVERAGE	0.625	0.455	0.405	0.455	0.540	0.370
Standard error	0.078	0.028	0.036	0.057	0.064	0.038
Standard deviation	0.248	0.089	0.116	0.182	0.205	0.120
Variance	0.061	0.008	0.013	0.033	0.042	0.014

Table 3**Amplitude of T wave (mV) in kids**

Number Kid	D I	D II	D III	aVR	aVL	aVF
1	0.7	0.4	0.7	0.7	0.6	0.4
2	0.2	0.4	0.3	0.4	0.5	0.4
3	0.3	0.35	0.25	0.15	0.1	0.25
4	0.5	0.5	0.2	0.1	0.1	0.15
5	0.5	0.6	0.3	0.3	0.2	0.4
6	0.6	0.5	0.6	0.5	0.4	0.4
7	0.5	0.4	0.3	0.4	0.3	0.25
8	0.4	0.35	0.2	0.5	0.4	0.15
9	0.5	0.45	0.2	0.3	0.2	0.15
10	0.4	0.35	0.25	0.3	0.3	0.15
AVERAGE	0.460	0.430	0.330	0.365	0.310	0.270
Standard error	0.045	0.026	0.055	0.055	0.052	0.037
Standard deviation	0.142	0.082	0.175	0.176	0.166	0.118
Variance	0.020	0.006	0.030	0.031	0.027	0.014

**Fig. 9.** Average amplitude of T wave recorded in kids**Fig. 10.** Average amplitudes of electrocardiographic waves recorded in kids**Table 4****Average amplitudes of electrocardiographic waves (mV) recorded in kids**

WAVE	D I	D II	D III	aVR	aVL	aVF
P	0.115	0.070	0.055	0.065	0.070	0.035
QRS	0.625	0.455	0.405	0.450	0.540	0.370
T	0.460	0.430	0.330	0.365	0.310	0.270

0.115±0.010 mV (average ± standard error of average) in D I (the highest value), 0.055±0.015 mV (average ± standard error of average) in D III (the lowest value);

- the total amplitude of the QRS complex was between 0.625 ± 0.078 mV in D I (the highest value) and 0.370 ± 0.038 mV in aVF (the lowest value);

- the average amplitude of the T wave was between 0.460 ± 0.045 mV (average ± standard error of the average) in D I (the highest value) and 0.270 ± 0.037 mV (average ± standard error of the average) in aVF (the lowest value).

In Table 4 and Fig. 10 we present the values of the average amplitudes of P wave, QRS complex and T wave, resulting from our investigations. As shown, we can use the following leads to record electrocardiograms for kids in descending order of the resulting amplitude values: D I, aVL, D II, aVR, D III and aVF.

By comparing the data presented above (Table 4) with those presented by various authors (1), it is found that they frame the values mentioned by the literature, especially regarding the amplitude of the electrocardiographic waves.

CONCLUSIONS

The limb leads can be used successfully to record electrocardiograms in kids because they confer an easy interpretable appearance to the recordings.

The highest amplitude of the electrocardiographic waves is recorded in the lead I, with the values of $0.115 \text{ mV} \pm 0.010$ for the P wave, $0.625 \text{ mV} \pm 0.078$ for the QRS complex and $0.460 \text{ mV} \pm 0.045$ for the T wave. Higher amplitudes of the electrocardiographic waves are recorded in the lead aVL with $0.071 \text{ mV} \pm 0.015$ for P wave, $0.540 \text{ mV} \pm 0.064$ for the QRS complex and $0.310 \text{ mV} \pm 0.052$ for the T wave and the lead II with the values of $0.071 \text{ mV} \pm 0.015$ for P wave, $0.455 \text{ mV} \pm 0.028$ for QRS complex and $0.430 \text{ mV} \pm 0.026$ for T wave.

The smallest amplitude of the electrocardiographic wave is recorded in the lead aVF, so this derivation is not viable to be used for ECG recording in kids.

REFERENCES

1. *Atmaca N., Simsek O., Emre B.*, (2014), Some electrocardiographic values of Angora goats. Ankara Üniv, Vet Fak Derg, 61(1):15-19
2. *Brăslășu M.C.*, (2000), Electrocardiographic research in newborn calves (in Romanian). Revista Romana de Medicina Veterinara, 10(4):401-405
3. *Codreanu I.*, (2018), Textbook of veterinary physiology, (Ed.) Printech, Bucharest, Romania, 217-248
4. *Codreanu I., Călin S., Vasian L.*, (2019), General aspects regarding the haematological profile in ewes during pregnancy and puerperium. Revista Romana de Medicina Veterinara, 29(2):37-40
5. *Fakour S., Mokhber D.M.R., Nadalian, M.G., Reza-khani A., Lotfollah Z.S.*, (2013), Electrocardiographic parameters of Markhoz goat using base apex lead and six standard limb leads. Iranian Journal of Veterinary Research, 14(3):241-244
6. *Goran G.V.*, (2018), Veterinary Toxicology, vol. 1, (Ed.) Ex Terra Aurum, Bucharest, Romania, 61-62
7. *Jafrin A.A., Nawab N., Anand K. P.*, (2016), The normal electrocardiogram of non-migratory bakarwali goats. Bhartiya Krishi Anushandhan Patrika, 31(1):69-73
8. *Mitchell K.J.*, (2019), Equine Electrocardiography. Vet Clin North Am Equine Pract, 35(1):65-83
9. *Mohan N.H., Niyogi D., Singh H.N.*, (2005), Analysis of normal electrocardiograms of Jamunapari goats, J Vet Sci, 6(4):295-298
10. *Pradhan R.R., Mohapatra A.P.K., Mohapatra S., Jyotiranjana T., Kundu A.K.*, (2017), Electrocardiographic reference values and configuration of electrocardiogram waves recorded in Black Bengal goats of different age groups. Vet World, 10(9): 1020-1025
11. *Pogliani F.C., Birgel J.E.H., Monteiro B.M., José H.H., Raimondo F.S.*, (2013), The normal electrocardiogram in the clinically healthy Saanen goats, Pesq Vet Bras, 33(12):1478-1482
12. *Sarangi S., Mahapatra A.P., Mohapatra S., Kundu A.K.*, (2016), Age-specific changes in electrocardiographic parameters in bipolar limb leads of conscious female native cats of Odisha. Vet World, 9(2):147-150
13. *Stern J.A., Hinchcliff K.W., Constable P.D.*, (2013) Effect of body position on electrocardiographic recordings in dog. Aust Vet J, 91(7):281-286
14. *Țugui A., Crivineanu M., Nae R., Codreanu I., Constantinescu R., Codreanu M.D.*, (2016), Cardiac and extracardiac ultrasound changes in canine dilated cardiomyopathy. Revista Romana de Medicina Veterinara, 26(2):23-27.