Research on the duration of electrocardiogram components in pregnant goats

✉ MARIAN GHIȚĂ, ✉ IULIANA CODREANU, ✉ CARMEN PETCU,
✉ ADRIAN RĂDUȚĂ, ✉ DRAGOȘ POPESCU, ✉ GABRIEL COTOR

Faculty of Veterinary Medicine, University of Agronomical Science and Veterinary Medicine, 050097, Bucharest, Romania

Received 13.10.2021

Accepted 05.12.2021

Ghiță M., Codreanu I., Petcu C., Răduță A., Popescu D., Cotor G.

Research on the duration of electrocardiogram components in pregnant goats

Summary

The electrocardiogram is a graph recording of heart's electric activity, so it is used in medical practice mainly in order to observe the heart's activity. The values of the main components of the electrocardiogram in pregnant goats were determined within the current research. All of these were performed in three different stages of pregnancy (the beginning, the middle and the ending), being focused on the variation of these values during the pregnancy. The gestation diagnosis was confirmed by ultrasound-exam. During the pregnancy, the following values for the duration of the main ECG's components were found: the P wave (0.045-0.044 s), the P-R segment (0.061-0.048 s), of the P-R range (0.105-0.086 s), of the QRS complex (0.042-0.040 s), of the Q-T range (0.242-0.218 s), of the P-T range (0.377-0.368 s), of the R-R range (0.465-0.431 s), the T wave (0.091-0.104 s) and of the T-P segment (0.097-0.101 s).

Our results show that during the pregnancy the duration of: the P wave, the P-R segment, the P-R range, the QRS complex, the Q-T range, the P-T range and the R-R range, decrease, while the duration of the T wave and the T-P segment increase.

Keywords: duration, diastole, electrocardiography, goat, systole

The electrocardiogram (ECG) is widely used in medical practice to examine the heart and obtain data about healthy heart function (6, 10, 15) and heart diseases (12). In the clinic, ECG is used for calculating the heart rate (3, 7), determining the heart rhythm (10, 14), calculating the duration (waves, segments and intervals) and the amplitudes (waves) of electrocardiographic components (5, 11), as well as determining the cardiac electrical axis (7, 8). In veterinary medicine, ECG is extensively used in small animal practice. The purposes of the current research were to record electrocardiograms in pregnant goats (the gestation diagnosis was confirmed by ultrasonography) and to determine the duration of the main events in the heart (atrial systole, atrial diastole, ventricular systole, ventricular diastole) during the cardiac cycle. The duration of a cardiac revolution and of a break between two successive cardiac revolutions were also determined. There were three different moments of recording: at the beginning, in the middle and at the ending of pregnancy. The main aim was to determine the manner in which the duration of all the parameters was changing during pregnancy. The results obtained demonstrated

that the durations of atrial depolarization, atrial repolarization and ventricular depolarization decreased during pregnancy, while the duration of ventricular repolarization increased. Furthermore, the duration between two successive cardiac revolutions decreased during the evolution of gestation, which showed an increase in the heart rate.

Material and methods

Fourteen pregnant goats of the Saanen breed were used in the study. The age was between 12-15 months old and the body mass was around 40-50 kilos.

The pregnant diagnosis was confirmed by transrectal ultrasound at 30 days (the beginning of pregnancy), 90 days (the middle of pregnancy) and 135 days (the end of pregnancy) after mating. For this purpose an Esaote Tringa Linear Vet ultrasound scanner with a 7.5 mHz endocavitary linear multifrequency electronic transducer was used. Since the pregnant uterus was examined by the transrectal approach a rigid accessory was used to insert the transducer. The accessory was previously lubricated in order not to damage the rectal mucosa. The first check was carried out on the 30th day after natural mating and 13 animals were found pregnant, but the gestation of the last goat was uncer-

tain and the embryo could not be seen. On the 90th day after mating, gestation was confirmed in all 14 animals. Perifetal fluids were quantitatively assessed and the development of each fetus was evaluated. The last check was made after 135 days, and all the parameters were within physiological limits. After this check, the animals were moved into individual farrowing crates and the feed ration was changed to prepare the goats for a new lactation period.

The electrocardiogram was recorded with an Innomed Heart Mirror, a portable electrocardiograph with 6 channels, using limb leads. The electrodes were placed as follows: the red electrode on the right axillary area, the yellow electrode on the left axillary area, the green electrode on the left hind leg and the black electrode on the right hind leg. In order to ensure good contact between the animals' skin and the metallic adaptors (alligator clips) the fur was removed and saline solution was used. The settings of ECG machine was: speed of recording 25 mm/sec and the amplitude of millivolt 10 millimeter. The electrocardiograms were recorded in three different moments of pregnancy: after 30 days of pregnancy, after 90 days of pregnancy and after 135 days of pregnancy. The II lead was used to determine the duration of the ECG's components. The electrographic waves in this lead have relatively high amplitudes and are easily revealed. The duration of the following components was determined within the research: P wave, P-R segment, P-R interval, the ventricular complex (QRS), Q-T interval, T wave, P-T interval, T-P segment, S-T segment and R-R interval. The statistical analysis of the obtained results was performed using t test (Student), $P < 0.05$ considered statistically significant.

Informed consent: Informed consent was obtained for client-owned animals included in this study.

Results and discussion

In this study we wanted to see how the pregnancy modifies the main ECG's components values (Tab. 1).

At the beginning of pregnancy, the recorded values were 0.045 s for the atrial depolarization, 0.042 s for the ventricular depolarization, 0.091 s for the ventricular repolarization, 0.105 s for the atrial systole and diastole, 0.242 s for the ventricular systole and

diastole, 0.377 s for the cardiac revolution. In the middle of pregnancy, the recorded values were 0.045 s for the atrial depolarization, 0.041 s for the ventricular depolarization, 0.095 s for the ventricular repolarization, 0.102 s for the atrial systole and diastole, 0.230 s for the ventricular systole and diastole, 0.374 s for the cardiac revolution. At the end of pregnancy, the recorded values were 0.044 s for the atrial depolarization, 0.040 s for the ventricular depolarization, 0.104 s for the ventricular repolarization, 0.086 s for the atrial systole and diastole, 0.218 s for the ventricular systole and diastole, 0.368 s for the cardiac revolution.

Regarding the differences between the values of the electrocardiogram's components in pregnant goats, the following was observed after the statistical analysis: the P wave (atrial depolarization) had the same value for the beginning and the middle of pregnancy and the values were with 2.22% lower at the ending of pregnancy ($P = 0.79$), so the difference was statistically insignificant ($P > 0.05$). The duration of the QRS complex (ventricular depolarization) decreased with the evolution of pregnancy: compared to the beginning of pregnancy, the values were 2.38% lower during the middle of pregnancy ($P = 0.21$) and 2.44% lower during the ending of pregnancy ($P = 0.16$). In both situations, the differences were statistically insignificant ($P > 0.05$). The duration of T wave (ventricular repolarization) increased with the evolution of pregnancy: compared to the beginning of pregnancy, the values were 4.4% higher during the middle of pregnancy ($P = 0.26$) and 14.29% during the ending of pregnancy ($P = 0.03$), the second differences were statistically significant ($P < 0.05$). The P-R interval (atrial systole and diastole) decreased with the evolution of pregnancy: compared to the beginning of pregnancy, the values were 2.86% lower during the middle of pregnancy ($P = 0.29$) and 18.10% lower during the ending of pregnancy ($P = 0.02$), the second difference being statistically significant ($P < 0.05$). Considering that the P-R interval is composed of P wave (which had almost the same

Tab. 1. Duration (seconds) of the ECG's components in pregnant goats, at 30, 90 and 135 days after the mating (average and standard deviation)

Moment of the recording	30 days after the mating	90 days after the mating	135 days after the mating
P wave	0.045 ± 0.014	0.045 ± 0.014	0.044 ± 0.011
P-R segment	0.061 ± 0.020	0.057 ± 0.020	0.048 ± 0.017
P-R interval	0.105 ± 0.019	0.102 ± 0.020	0.086* ± 0.028
QRS complex	0.042 ± 0.010	0.041 ± 0.005	0.040 ± 0.007
Q-T interval	0.242 ± 0.090	0.230 ± 0.080	0.218* ± 0.029
T wave	0.091 ± 0.018	0.095 ± 0.019	0.104* ± 0.019
P-T interval	0.377 ± 0.043	0.374 ± 0.043	0.368* ± 0.042
T-P segment	0.097 ± 0.020	0.100 ± 0.026	0.101 ± 0.024
S-T segment	0.122 ± 0.036	0.125 ± 0.041	0.125 ± 0.051
R-R interval	0.465 ± 0.046	0.462 ± 0.048	0.431* ± 0.042

Explanation: * – $P < 0.05$

value) and P-R segment, the result is that this decreasing is exclusively caused by the reduction of the required time corresponding to the atrial repolarization. The Q-T interval (ventricular systole and diastole) decreased as the pregnancy progressed: compared to the beginning of pregnancy, our values were 4.96% lower at the middle of pregnancy ($P = 0.14$) and 9.92% lower at the ending of pregnancy ($P = 0.01$), the second difference being statistically significant ($P < 0.05$).

Tab. 2. Duration (seconds) of electrocardiogram's components in goats

ECG parameter	Fabio et al. 2013	Atmaca et al. 2014	Mohan et al. 2005	Jafrin et al. 2016	Fakour et al. 2013	Azeez et al. 2018	Pradhan et al. 2017
P wave	0.030	0.020	0.050	0.060	0.039	0.050-0.068	0.040
P-R interval	0.080	0.090	0.085	0.120	–	0.070-0.080	0.060-0.070
QRS complex	0.050	0.040	0.030	0.050	0.063	0.059-0.065	0.056
Q-T interval	0.260	0.250	0.230	–	0.267	0.350-0.369	0.027-0.034
T wave	0.060	0.060	0.113	0.110	0.075	–	0.060-0.090
R-R interval	0.030	–	0.480	–	–	–	–

The P-T interval (duration of a cardiac revolution) decreased with the evolution of pregnancy: compared to the beginning of pregnancy, the values were 0.8% lower at the middle of pregnancy ($P = 0.16$) and 2.39% lower at the ending of pregnancy ($P = 0.04$), in both situations the second difference being statistically significant ($P < 0.05$). The T-P interval (duration of general diastole) increased with 3.09% at the beginning of pregnancy ($P = 0.56$), so the difference was statistically insignificant ($P > 0.05$), and decreased with 6.19% at the ending of pregnancy ($P = 0.24$), the difference being statistically insignificant ($P > 0.05$). The decreasing of T-P range indicates an increase of the heart rate. The R-R range (the distance between two cardiac revolutions) decreased during the pregnancy: compared to the values from the beginning of pregnancy, it was observed a 0.65% decrease at the middle of pregnancy ($P = 0.42$) and 7.31% decrease at the ending of pregnancy ($P = 0.01$), the second difference being statistically significant ($P < 0.05$). These changes clearly indicate that the heart rate increased during the pregnancy.

In this study we aim to compare our results (Tab. 1) to the data presented by other authors (Tab. 2).

Therefore, depending on the different moments of pregnancy, the results from other authors varied as follows. Regarding the P wave (1, 4, 6, 13), the communicated values are between 0.020 and 0.068 s, and the values from the current research (0.045-0.045 s) are therefore within the limits. The values for the ventricular complex from other authors were between 0.030 s (9) and 0.065 s (2). For the values of T wave, the communicated values were between 0.060 s (1, 4, 13) and 0.113 s (9) and the values from the current research (0.091-0.114 s) therefore within the limits. In the case of P-R range, the values from literature were between 0.060 s (13) and 0.120 s (6), thus the values from the current research (0.086-0.105 s) are in accordance with them. The Q-T range was between 0.230 s (9) and 0.369 s (2), the values from this research are between 0.218 s and 0.242 s, therefore within the communicated limits. Regarding the R-R range, the communicated values from the literature in the filed were 0.030 s (4) and de 0.480 s (9), so the values obtained from the current research (0.431-0.465) are

within those limits. Our study showed that during the pregnancy, the duration's values of P wave, P-R segment, P-R interval, QRS complex, Q-T interval, P-T interval, and R-R interval decrease, while T wave and T-P interval increase. We consider that all the observed aspects are useful in the clinic of the small ruminant, especially when it is intended to monitor the evolution of pregnancy.

References

1. Atmaca N., Şimşek O., Emre B.: Some electrocardiographic values of Angora goats. Ankara Üniv. Vet. Fak. Derg. 2014, 61, 15-19.
2. Azeez O. M., Basiru A., Akorede G. J., Adah S. A.: Electrocardiographic parameters in West African Dwarf and Red Sokoto (Maradi) goats. Sokoto J. Vet. Sci. 2008, 16, 41-46.
3. Brăslăşu M. C., Brăslăşu D. E., Simiz F., Ghiţă M., Tudor P., Cotor G.: Electrocardiographic studies on adult cattle. J. Biotech. 2015, 208, 90.
4. Fabio C., Pogliani E. H., Birgel J., Bruno M., José H. H.: The normal electrocardiogram in the clinically healthy Saanen goats. Pesq. Vet. Bras. 2013, 33, 1478-1482.
5. Fakour S., Mokhber D. M., Nadalian M. G., Rezakhani A., Lotfollah Z.: Electrocardiographic parameters of Markhoz goat using base apex lead and six standard limb leads. Iran. J. Vet. Res. 2013, 3, 241-244.
6. Jafrin A. A., Nawab N., Anand K. P.: The normal electrocardiogram of non-migratory bakarwali goats. Bhartiya Krishi Anushandhan Patrika 2016, 31, 69-73.
7. Jordanow O. S., Czopowicz M., Szpinda O., Mickiewicz M., Moroz A., Kaba J., Garncarz M., Frymus T.: Agreement between ECG values obtained in the sternal recumbent position and right lateral recumbency in goats. Med. Weter. 2021, 77, 79-81.
8. Kumar V., Hoque M., Saxena A., Bodh D., Mahendran H., Verma M.: Electrocardiographic and serum biochemical reference values of Black Bengal goats. Indian J. Vet. Med. 2016, 36, 10-14.
9. Mohan N., Niyogi D., Singh H.: Analysis of normal electrocardiograms of Jamunapari goats. J. Vet. Sci. 2005, 6, 295-298.
10. Pogliani F., Birgel Junior E., Monteiro B., Grisi Filho J., Raimondo R.: The normal electrocardiogram in the clinically healthy Saanen goats. Pesq. Vet. Bras. 2013, 33, 1478-1482.
11. Popadiuk B., Holopura S.: Normal QT interval in Ukrainian Riding Horses at rest and during exercise. Med. Weter. 2021, 77, 16-22.
12. Pourjafar M., Badii K., Sanati A., Shahbazi A., Badkobe M., Bagheri M.: Age-related cardiac arrhythmias in clinically healthy Iranian Najdi goats. Bulg. J. Vet. Med. 2012, 15, 37-43.
13. Pradhan R., Mohapatra A., Mohapatra S., Jyotiranjan T., Kundu A.: Electrocardiographic reference values and configuration of electrocardiogram waves recorded in Black Bengal goats of different age groups. Vet. World 2017, 10, 1020-1025.
14. Samimi A., Tajik J., Bakhshaei S., Mirjordavi A.: The effect of short term rest after handling stress on electrocardiogram indices in goat. Vet. Sci. Dev. 2015, 5, 127-129.
15. Tajik J., Samimi A., Tajik T.: Electrocardiographic parameters in clinically healthy Cashmere goats. Online J. Vet. Res. 2013, 17, 528-533.

Corresponding author: Carmen Petcu, DVM, PhD, Splaiul Independentei 105, 050097, Bucharest, Romania; e-mail: researchfymb@gmail.com