CHANGES IN ELEKTROCARDIOGRAMM OF COCKER SPANIEL AND GERMAN SHEPHERD DOGS DURING ANAESTHESIA

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Summary. Research was performed on 34 healthy German Shepherds and 32 Cocker Spaniels practically healthy dogs. The thesis focuses on the relations between breed or gender as conditional "factors" on the one hand and changes of distinct ECG parameters during premedication and general anaesthesia on the other hand. SHILLER's electrocardiograph AT – 1 Veterinary produced in Germany witch allows simultaneous work with 10 electrocardiograph leads. The premedication was achieved by means of 0.054 % atropine sulphate solution (0.02 mg kg^{-1}) in combination with 1% acepromazine maleate solution (0.06 mg kg^{-1}) of injection intramuscular and general anaesthesia (narcosis) was achieved by means of 5% ketamine hydrochloride solution (6 mg kg^{-1}) in combination with 0.5% diazepam solution (0.6 mg kg^{-1}) of injection intravenous. Being the most informative, ECG standard lead II was chosen for detailed analysis. The following parameters of ECG have been analyzed: P wave, Q, R and S waves of QRS complex, as well as PQ, QRS and QT intervals. It was found that separate parameters of ECG II standard lead premedication and general anaesthesia for dogs mainly related with the animal's breed, but less so its gender.
Keywords: dogs; breed; ECG; drug combinations.

EKG POKYČIAI, ATSIRADĘ VOKIEČIŲ AVIGANIŲ IR KOKERSPANIELIŲ VEISLIŲ ŠUNIMS BENDROS NEJAUTROS METU

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Santrauka. Tyrimas atliktas su sveikais 34 vokiečių aviganių ir 32 kokerspanielių veislių šunimis. Darbe analizuojamas ryšys tarp veislės ir lyties, kaip sąlyginių veiksnių (iš vienos pusės), bei pokyčiai tarp atskirų EKG rodiklių (iš kitos pusės) premedikacijos ir bendros nejautros metu. Vienu metu elektrokardiografu „SHILLER AT-1 Veterinary" (Vokietija) buvo užrašoma 10 EKG derivacijų. Premedikacijai naudotas 0,054 proc. atropino sulfato tirpalas (0,02 mg/kg) kartu su 1 proc. acepromazino maleato tirpalu (0,06 mg/kg) sušvirkščiant į raumenis, o bendra nejautra sukelta švirkščiant į veną 5 proc. ketamino hidrochlorido tirpalą (6 mg/kg) kartu su 0,5 proc. diazepamo tirpalu (0,6 mg/kg). Detalesnei analizei pasirinkta labiau informatyvi II EKG derivacija. Buvo analizuojami šie EKG rodikliai: P dantelis, QRS komplekso Q, R ir S danteliai, taip pat PQ, QRS ir QT intervalai. Nustatyta, kad atskiri EKG rodikliai II derivacijoje premedikacijos ir bendros nejautros metu daugiausia buvo susiję su šunų veisle, mažiau priklausė nuo gyvūno lyties.
Raktažodžiai: šunys, veislė, EKG, vaistų kombinacijos.

Introduction. Since veterinary medicine for small animals is developing in Latvia, it has become important to study currently used fast-acting general anaesthesia agents. Non-inhaled (intravenous) general anaesthesia agents make it easier to perform surgical manipulations. Non-inhaled general anaesthesia is regarded as the most human of all anaesthesia types in the world (Машковский, 2000; Lemke, 2004; Hewson et.al., 2006; Welberg et al., 2006; Fossum et. al., 2007;etc.)

Taking into account all above-mentioned we decided to focus on the research of the effect of most commonly used anaesthetic agents on cardiac biopotentials in dogs.

Material and methods. Research was performed on 34 German shepherds and 32 Cocker spaniels. QT interval of ECG lead II in dogs was examined at initial state, during premedication and during general anaesthesia. Distribution of ECG waves, interval and cardiac conduction system of beats registrated lead II on are seen in Figure 1 (Мартин, Коркорэн, 2004; Kalvelis, 2005; Tilley, 2008; etc.).

We used the "SCHILLER" electrocardiograph AT–1 produced in Germany. This equipment allows working to registrate 10 ECG leads simultaneously (ECG was registered at the speed of 50 $mm \cdot s^{-1}$). The animals were examined while lying in the dextrolateral position-forelimbs placed parallel to each other and perpendicular to the longitudinal axis of the body (Avdoško, 2007; Tilley, 2008; etc). ECG data were registered and

simultaneously processed by means of special software. QT interval, of ECG (s) and amplitude in milivolts (mV) were registered automatically.

For premedication has been used 0.054 % atropine sulphate solution (0.02 mg·kg^{-1}) in combination with 1% acepromazine maleate solution (0.06 mg·kg^{-1}) administered intramuscularly. The general anaesthesia (narcosis) was induced by 5% ketamine hydrochloride solution (6 mg·kg^{-1}) together with 0.5% diazepam solution (0.6 mg·kg^{-1}). This combination is widely approved in veterinary medicine (Foosum, 2007). We administered the anaesthetics in the cephalic vein (*v. cephalica)*. ECG was established immediately (1 minute) after intravenous injection, as well as at the 15th, 30th, 45th and 60th minute. The dogs were included into examination after clinical tests: rentgenography of heart and major blood vessels (lateral and dorsoventral projection), as well as blood morphological and biochemical analyses. All dogs involved in the study were healthy.

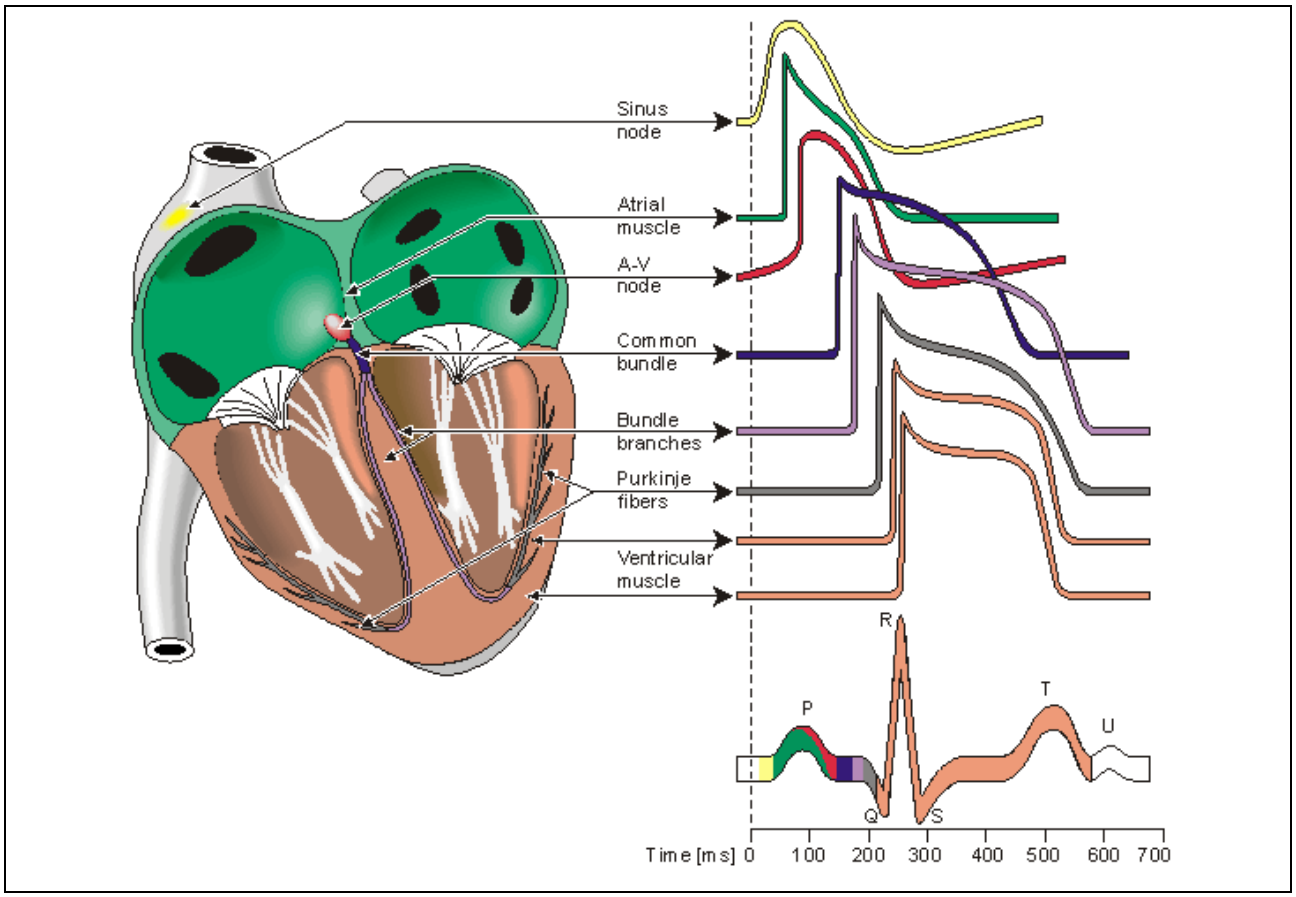

Figure 1. **Schematic reproduction of electrocardiogram and the cardiac conduction system as an electrical impulse travels from the sinoatrial** (SA) **node to the ventricular Purkinje network. ECG standard lead II, 50 mm s^{-1} paper speed**

The statistical significance between the initial values and values observed during both the premedication and general anaesthesia was calculated by the Student's t – test. Group comparisons (breed and sex) were performed by ANOVA. The Fisher (F) exact test was applied. *P*-values < 0.05 were considered as indicating significant differences (Torre *et al*., 2000; Miller, 2000). All statistical analyses of ECG data and tests were run using the SPSS statistical package.

This study was carried out in a period of 1995 – 2003 and was approved by the Ethics Committee at the Latvian Council of Sciences.

This study aims to establish the effect of currently widely used anaesthesia substances on the functional parameters of the hearts of Cocker Spaniel and German Shepherd dogs.

Results and discussion. Development of parameter in electrocardigramm II lead recorder in German Shepherd and Cocer Spaniels dogs at initial state, premedication and different time anaesthesia is reproduced in Table 1 and Table 2.

It is evident that already in the initial state the heart rate frequency of Cocker Spaniels is slightly lower than the heart rate of German Shepherd dogs ($P < 0.05$). Ten minutes after administration of premedication agents atropine sulphate in combination with acepromazine maleate the heart rate of German Shepherd dogs lowered (in average by ten beats per minute), where as the heart rate of premedicated Cocker Spaniels lowered by seven beats per minute.

After administration of general anaesthesia agents ketamine hydrochloride and diazepam a drastic increase

of heart rate was observed. Already in the first minute after administration of general anaesthesia agents the heart rate of German Shepherd dogs in average increased to 148.0000 ± 7.1212 beats per minute, whereas the heart rate of Cocker Spaniels reached even 162.429 ± 8.39 beats per minute ($P < 0.02$). Fifteen minutes after administration of general anaesthesia agents the heart rate recorded in animals of both breeds turned out to have still increased: The heart rate of German Shepherd dogs had increased to 151.375 ± 9.1560 beats per minute, where as the heart rate of Cocker Spaniels had reached 167.333 ± 7.0708 beats per minute.

Table 1. **Parameter in electrocardigramm II lead of German Shepherd and Cocer Spaniels dogs at initial state, premedication and different time anaesthesia**

Time of observation	Mean values of heart rate frequency ± SE		Mean values of EKG wave amplitude (mV)							
			P		Q		R		S	
	German Sheperds	Cocer Spaniels	German Sheperds	Cocer Spaniels	German Sheperds	Cocer Spaniels	German Sheperds	Cocer Spaniels	German Sheperds	Cocer Spaniels
Inital state	119 ± 6.5	97.5 ± 5.7000*	0.203 ± 0.0177	0.170 ± 0.0213	-0.131 ± 0.1402	-0.703 ± 0.2535*	1.908 ± 0.1509	2.632 ± 0.1847*	-0.005 ± 0.0119	-0.020 ± 0.0200
Premedication 10 minute	110.625± 5.8535	90.867± 7.2020*	0.158 ± 0.0186	0.174 ± 0.0221	-0.148± 0.1426	-0.835 ± 0.2787*	1.964 ± 0.1193	2.758 ± 0.1881*	-0.038 ± 0.0311	-0.043 ± 0.0319
Anaesthesia 1 minute	148.000 ± 7.1212×	162.429 ± 8.3900*×	0.221 ± 0.0229	0.275 ± 0.0260*×	-0.208± 0.1426	-0.869 ± 0.3007*	2.085 ± 0.1105	2.853 ± 0.1995*	0.004 ± 0.0242	-0.093 ± 0.0470*
Anaesthesia 15 minute	151.375 ± 9.1560×	167.333 ± 7.0708*×	0.188 ± 0.0264	0.296 ± 0.0246*×	-0.258± 0.1461	-0.757 ± 0.2258*	1.800 ± 0.1172	2.733 ± 0.1878*	-0.024 ± 0.0228	-0.057 ± 0.0319×
Anaesthesia 30 minute	161.826 ± 8.1417×	169.714 ± 6.9475×	0.221 ± 0.0212	0.333 ± 0.0289*×	-0.280± 0.1170	-0.683 ± 0.2197*	1.772 ± 0.1338	2.775 ± 0.1914*	-0.037 ± 0.0171	-0.143 ± 0.0636×*
Anaesthesia 45 minute	166.478 ± 7.3166×	166.333 ± 8.1285×	0.251 ± 0.0247	0.308 ± 0.0255*	-0.368± 0.1632	-0.650 ± 0.2084	1.814 ± 0.1176	2.713 ± 0.2251*	-0.042 ± 0.0140	-0.073 ± 0.0374×
Anaesthesia 60 minute	166.182 ± 9.1120×	153.429 ± 10.7206×	0.271 ± 0.0220*	0.279 ± 0.0255*	-0.366± 0.1603	-0.684 ± 0.2031	1.853 ± 0.1274	2.716 ± 0.2464*	-0.040 ± 0.0169	-0.189 ± 0.0919*

* – Fisher's test of EKG interval between German Shepherd dogs and Cocker spaniels is statistically significant
× – The difference compared to initial state (t – test) it statistically significant ($P < 0.05$)

Table 2. **Parameter in electrocardigramm II lead of German Shepherd and Cocer Spaniels dogs at initial state, premedication and different time anaesthesia**

Time of observation	Mean values of EKG interval (s)					
	PQ		QRS		QT	
	German Sheperds	Cocer Spaniels	German Sheperds	Cocer Spaniels	German Sheperds	Cocer Spaniels
Inital state	0.107 ± 0.0041	0.090 ± 0.0048*	0.060 ± 0.0015	0.058 ± 0.0015*	0.209 ± 0.0037	0.209 ± 0.0055
Premedication 10 minute	0.117 ± 0.0038×	0.092 ± 0.0055*	0.061 ± 0.0009	0.056 ± 0.0017*	0.215 ± 0.0040×	0.219 ± 0.0061×
Anaesthesia 1 minute	0.100 ± 0.0022×	0.083 ± 0,0068*	0.061 ± 0.0014	0.056 ± 0.0012*	0.202 ± 0.0038	0.206 ± 0.0057
Anaesthesia 15 minute	0.097 ± 0.0049	0.073 ± 0.0077*	0.060 ± 0.0014	0.058 ± 0.0016*	0.205 ± 0.0044	0.196 ± 0.0058
Anaesthesia 30 minute	0.096 ± 0.0049	0.086 ± 0.0089*	0.063 ± 0.0019	0.054 ± 0.0019*	0.203 ± 0.0036	0.189±0.0057×*
Anaesthesia 45 minute	0.093 ± 0.0047×	0.077±0,0034×*	0.061 ± 0.0016	0.058 ± 0.0012*	0.198 ± 0.0038×	0.195±0.0054×*
Anaesthesia 60 minute	0.094 ± 0.0053×	0.079 ± 0.004×*	0.063 ± 0.0018	0.055 ± 0.0019*	0.199 ± 0.0046×	0.197 ± 0.0062

* – Fisher's test of EKG interval between German Shepherd dogs and Cocker spaniels is statistically significant
× – The difference compared to initial state (t – test) it statistically significant ($P < 0.05$)

Differences between the heart rate of German Shepherd dogs and that of Cocker Spaniels during premedication and general anaesthesia are more clearly reproduced in Figure 2.

The relatively significant differences of heart rate between both breeds are apparent both in the initial state and after administration of general anaesthesia agents.

It is evident that already in the P wave values recorded

in ECG standard lead II in German Shepherd dogs already in the initial state were different from values recorded in Cockers Spaniels. P wave of German Shepherd dogs was 0.203 ± 0.0177 mV, whereas P wave of Cocker Spaniels was – 0.170 ± 0.0213 mV.

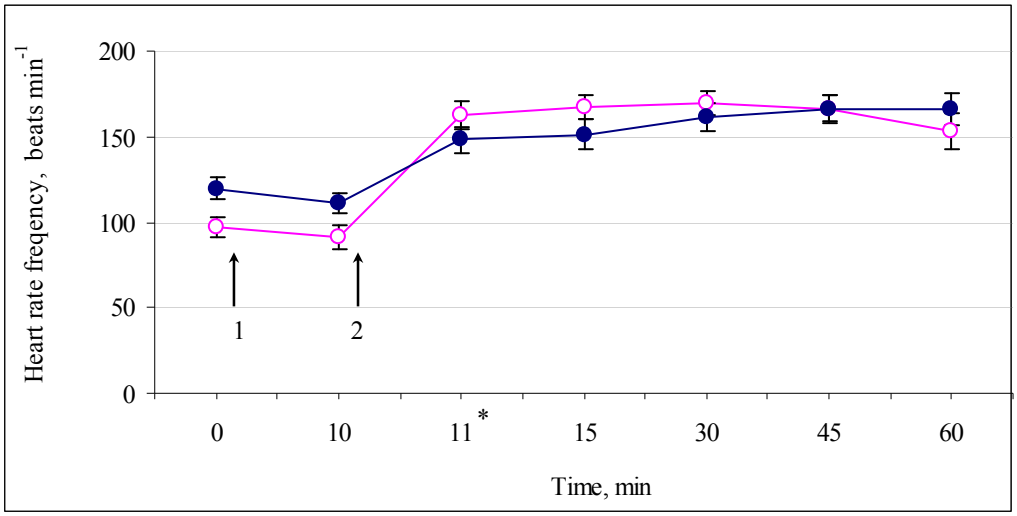

Figure 2. **Heart rate frequency (beats per min) of lead II ECG in German shepherd (-●-) and Cocker spaniel (-○-) dogs of initial state (1), 10 min. after premedication (2) as well as during general anaesthesia**

11* – first minute after administration of ketamine hydrochloride and diazempam

1 – premedication (0.054% atropine sulphate solution (0.02 mg kg^{-1}) in combination with 1% acepromazine maleate solution (0.06 mg kg^{-1});

2 – general anaesthesia (5% ketamine hydrochloride (6 mg kg^{-1}) in combination with 0.5% diazepam (0.6 mg kg^{-1})

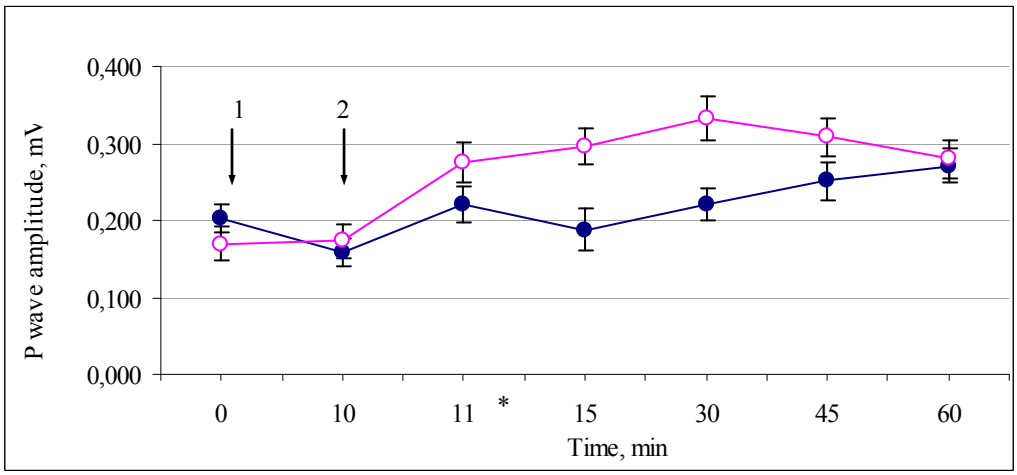

Figure 3. **P wave amplitude (mV) of lead II ECG in German shepherd (-●-) and Cocker spaniel (-○-) dogs of initial state (1), 10 min. after premedication (2) as well as during general anaesthesia**

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2 – general anaesthesia (5% ketamine hydrochloride (6 mg kg^{-1}) in combination with 0.5% diazepam (0.6 mg kg^{-1})

Ten minutes after administration of premedication agents atropine sulphate and acepromazine maleate P wave of either breed also developed according to different pattern. while the P wave amplitude recorded in ECG standard lead II in German Shepherd dogs decreased, Cocker Spaniels demonstrated just the opposite tendency - the P-wave amplitude recorded in these dogs slightly increased (see Figure 3).

After intravenous administration of general anaesthesia agents, ECG-P wave amplitude recorded in Cocker Spaniels drastically increased already within the first minute, the values recorded in German Shepherd dogs however demonstrated only slight increase ($P < 0.05$).

The following development of P wave in the course of general anaesthesia developed differently according to the breed of animal. The increase of ECG-P wave amplitude recorded in Cocker Spaniels continued till the 30th minute

of examination, followed by slight decrease during the next 30 minutes, however the resulting amplitude of P-wave was still larger than in the initial state. However the amplitude ECG-P-wave recorded in German Shepherd dogs was slowly decreasing since the first minute of general anaesthesia till the 15^{th}-30^{th} minute ($P < 0.001$) when the opposite development set in to continue till the 60^{th} minute of examination.

We established that amplitude of ECG-P wave recorded in German Shepherd dogs was related to the heart rate. The pattern was following: the slower was heart rate, the smaller was amplitude of P wave recorded in ECG standard lead II.

The general relation of the ECG-P wave recorded in German Shepherd dogs the heart rate of particular animal has been established also by other authors (Upeniece, 2004; Tilley et. al., 2008; French 2008).

Cocker Spaniels did not demonstrate such relationship between the development of P wave amplitude (recorded in ECG lead II) and heart rate during premedication. It may have happened because P wave amplitude recorded in ECG in these dogs was significantly lower compared to the other breed (Upeniece, 2004; Tilley et. al., 2008). However the close relationship between the height of ECG-P wave and heart rate developed in Cocker Spaniels after intravenous administration of ketamine hydrochloride and diazepam.

The results suggest that already in the initial state the depth of Q wave recorded in ECG standard lead II in the dogs of one breed differed from that recorded in the dogs of other breed. The Q wave recorded in Cocker Spaniels was relatively deeper in comparison with that recorded in German Shepherd dogs-0.703 ± 0.2535 mV and -0.131 ± 0.1402 mV respectively ($P < 0.05$). These data to some extent correspond the trends observed by other authors (Nunes et al., 1990; Upeniece, 2004; Tilley et. al., 2008; French 2008).

On the whole the depth of ECG-Q wave suffered relatively minor changes during premedication and general anaesthesia and these changes were not significantly credible, however the difference in depth of Q wave according to the breed remained constant during premedication and general anaesthesia ($P < 0.05$). This could be associated with activation of atriums and ventricles (Tilley et. al., 2008), which is apparently more pronounced in Cocker Spaniels compared to German Shepherd dogs. In addition it has been proved that values of ECG parameters are generally lower in larger dogs compared to smaller dogs (Torre et al., 2000; Upeniece, 2004; Tilley et. al., 2008; French 2008).

The data we obtained on another element of QRS complex - R wave suggest that it was always positive in ECG standard wave II in dogs of all breeds both during premedication and general anaesthesia (Table 1). We established that R wave amplitude recorded in Cocker Spaniels in ECG standard lead II already in the initial state was statistically true larger than that recorded in German Shepherd dogs ($P < 0.01$). The development of R wave in the course of premedication and general anaesthesia proceeded on the whole equally in dogs of both breeds – the amplitude of R wave increased in both German Shepherd dogs and Cocker Spaniels (see Table 1). The only statistically true difference was the absolute height of R wave ($P < 0.001$).

First it must be pointed out that S wav**e** amplitude recorded in German Shepherd dogs during general anaesthesia suggests different pattern of development form S wave amplitude recorded in Cocker Spaniels. We established that development of S wave is to large extent related to the breed "factor" of the dog. the different development of S wave became apparent already one minute since administration of general anaesthesia agents ketamine hydrochloride and diazepam, when the S wave recorded in German Shepherd dogs became positive, where as the S wave recorded in Cocker Spaniels became even more negative ($P < 0.05$).

While the general anaesthesia proceeded S wave recorded in German Shepherd dogs became more negative than in the initial state. The amplitude of S recorded in Cocker Spaniels however demonstrated markedly waveform development, that is the deepening of the wave was followed by its becoming more shallow ($P < 0.05$), which signals about certain repolarization disorders in cardiomyocytes (Kalvelis, 2005; Tilley et. al., 2008; French 2008). It is possible, that these opposite trends in the S-wave development recorded in ECG standard lead II in animals subjected to premedication and general anaesthesia, are directly associated with the different physique of both breeds, in some way affecting electrophysiologic parameters during ventricular systole. While there are very little data on changes of ECG-S wave amplitude induced by any of the factors, the research of this aspect must be continued.

To describe development of PQ interval in dogs during premedication and general anaesthesia, it is important first of all mention, that length (duration) of PQ interval reflects conduction of excitation from atriums to ventricles. Thus the length of this interval is closely related to the heart rate, which is also confirmed by other publications (Медведева, 2001; Upeniece, 2004; Tilley et. al., 2008; French 2008).

Our research suggests that PQ interval recorded in ECG standard lead II in dogs of one breed differs from that recorded in dogs of the other breed and these differences are present both in the initial state as well as in the course of premedication and general anaesthesia (Figure 4).

The role of "breed" becomes apparent already in the initial state when the average PQ interval recorded in German Shepherd dogs was 0.107 ± 0.0041 s, whereas the same interval in Cocker Spaniels was just 0.090 ± 0.0048 s ($P < 0.01$).

The different development of ECG-PQ intervals was observed also by 10 minutes after administration of premedication agents (see Figure 4), when the length of PQ interval recorded in German Shepherd dogs turned out to have significantly increased, whereas in Cocker Spaniels it had become only slightly longer. We would like to remind that heart rate of German Shepherd dogs subjected to premedication agents significantly slowed down, which suggests close relationship between both

functional parameters –ECG-PQ interval and heart rate.

German Shepherd dogs demonstrated very drastic shortening of PQ interval already in the first minute of general anaesthesia in comparison with Cocker Spaniels (see Figure 4). After the 15th minute of general anaesthesia, the length of ECG-PQ interval recorded in standard lead II continued to decrease slightly, but in more or less uniform manner. At the same time the length of PQ interval in Cocker Spaniels suffered both increases and decreases (see Figure 4).

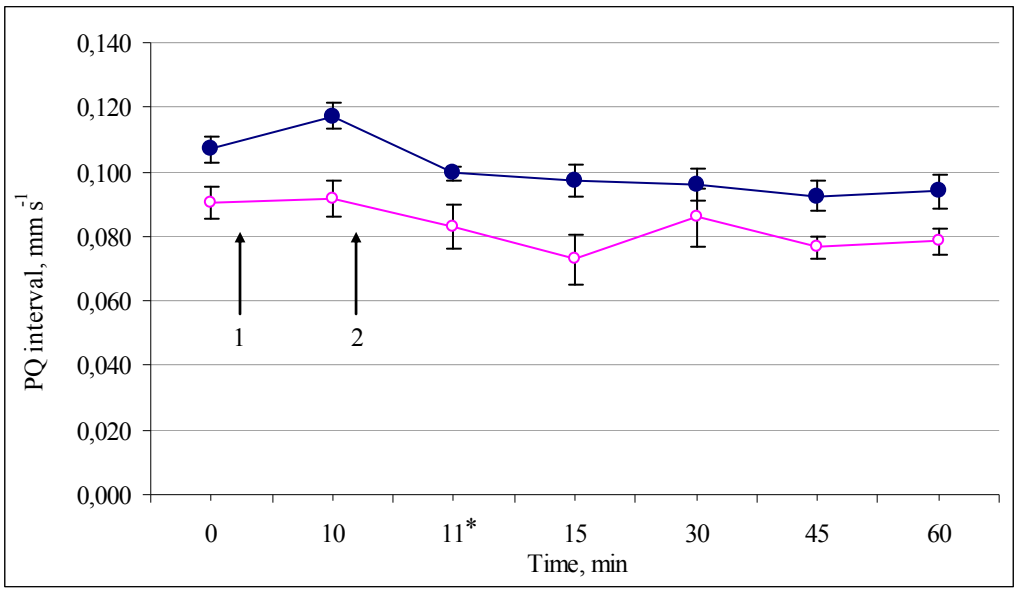

Figure 4. **PQ interval (s) of lead II ECG in German shepherd (-●-) and Cocker spaniel (-○-) dogs of initial state (1), 10 min. after premedication (2) as well as during general anaesthesia**

11* – first minute after administration of ketamine hydrochloride and diazempam

1 – premedication (0.054% atropine sulphate solution (0.02 mg kg^{-1}) in combination with 1% acepromazine maleate solution (0.06 mg kg^{-1});

2 – general anaesthesia (5% ketamine hydrochloride (6 mg kg^{-1}) in combination with 0.5% diazepam (0.6 mg kg^{-1})

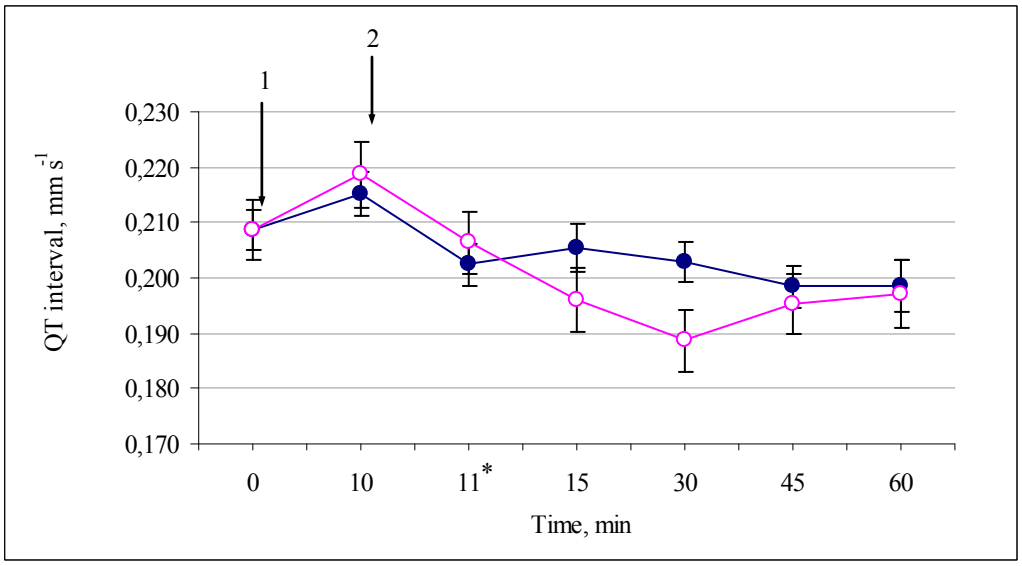

Figure 5. **QT interval (s) of lead II ECG in German shepherd (-●-) and Cocker spaniel (-○-) dogs of initial state (1), 10 min. after premedication (2) as well as during general anaesthesia**

11* – first minute after administration of ketamine hydrochloride and diazempam

1 – premedication (0.054% atropine sulphate solution (0.02 mg kg^{-1}) in combination with 1% acepromazine maleate solution (0.06 mg kg^{-1});

2 – general anaesthesia (5% ketamine hydrochloride (6 mg kg^{-1}) in combination with 0.5% diazepam (0.6 mg kg^{-1})

The length of PQ interval recorded in dogs of one breed was very different from that recorded in dogs of the other breed also 60 minutes after administration of ketamine hydrochloride and diazepam ($P < 0.001$).

We can conclude that development of ECG-PQ interval in dogs subjected to premedication agents and general anaesthesia agents used in this research very much depends on the breed "factor" of animal. In addition it was confirmed that the slower is heart rate of the dog, the longer is PQ interval recorded in ECG standard lead II, and, just the opposite- the faster is heart rate of the dog, the shorter is PQ interval.

It has been established that length (duration) of QT interval recorded in dogs reflects time period between the beginning of Q wave and end of T wave and is regarded as ECG depiction of all electrophysiologic processes happening in ventricular musculature during depolarisation and repolarization (Campbell, Atwell, 2002; Tilley et. al., 2008; French 2008).

Changes of QT interval recorded in ECG standard lead II in German Shepherd dogs and Cocker Spaniels are reproduced in Figure 5.

We established that the length of QT interval recorded in ECG standard lead II in German Shepherd dogs and Cocker Spaniels was practically identical in the initial state. It was similar to the normal length of this interval recorded in ECG standard lead II as described in literature – 0.15 - 0.25 s (Upeniece, 2004 Tilley et. al., 2008). The length of QT interval recorded in ECG standard lead II is presumably to great deal independent of the living weight of animal, because the length of QT interval recorded in animals of both breeds was equal despite the different physique of these animals. Similar idea was expressed by other authors who had studied mongrel dogs (Oguchi, Hamlin, 1993; French 2008).

Our research suggests that premedication agents atropine sulphate and acepromazine maleate induce growth of ECG-QT interval, which was equal in German Shepherd dogs and Cocker Spaniels for whom the absolute values of QT interval differed only slightly. It is important to mention that the growth of QT interval in German Shepherd dogs during premedication happens almost simultaneously with decrease of heart rate. It has been suggested that distinct growth of QT interval indicates slower repolarization of the myocardium and diffuse desynchronization, which may lead to cardiac rhythm disorders (Kalvelis, 2005). We did not observe this in dogs.

We established that the total effect on the ECG-QT interval of general anaesthesia agents ketamine hydrochloride and diazepam administered subsequently to premedication agents was equal in animals of both breeds. The first minute after administration of general anaesthesia agents came with drastic decrease of QT interval compared to the values of premedication period and this happened in both German Shepherd dogs and Cocker Spaniels. In the course of general anaesthesia, QT interval was getting even shorter and this was more pronounced in Cocker Spaniels. The growth of QT interval recorded in German Shepherd dogs however became statistically true starting with 45^{th} minute. It must be pointed out, that although the length of QT interval was on the way to becoming normal, it remained shorter than in the initial state even one hour after administration of general anaesthesia agents.

On the whole we want to remind everybody interested in the currently commonly used non-inhaled general anaesthesia model that atropine sulphate and acepromazine maleate causes bradycardia in dogs, thus expanding QT-interval, whereas combination of ketamine hydrochloride and diazepam manifests just the opposite way by inducing tachycardia and, as a consequence, shortening of QT interval during general anaesthesia.

Our research shows that the length of QRS interval recorded in ECG standard lead II in German Shepherd dogs already in the initial state differed from this length recorded in Cocker Spaniels ($P < 0.02$): QRS interval recorded in Cocker Spaniels was relatively shorter compared to German Shepherd dogs. These data correspond to the results of L. Tilley research on the length of ECG-QRS complex in dogs of various breeds (Upeniece, 2004; Tilley et. al., 2008; French 2008).

We established that premedication agents had different effect on QRS complex. The length of QRS complex recorded in ECG lead II in German Sherpherd dogs 10 minutes after administration of premedication agents had increased whether as the length of QRS complex in Cocker Spaniels –was smaller than in the initial state (Figure 6).

The different development of QRS interval became apparent 15 minutes after administration of general anaesthesia agents ketamine hydrochloride and diazepam (see Figure 6). The length of QRS interval in German Shepherd dogs slightly decreased where as in Cocker Spaniels it increased ($P < 0.02$). This opposite development of QRS interval was recorded also in the 30^{th}, 45^{th} and 60^{th} minute of general anaesthesia , when QRS interval had either slightly increased or decreased and results obtained in one breed differed in statistically true way from results obtained in the other breed.

Thus we can conclude that length of ECG-QRS interval in dogs both in the initial state as well as in the course of premedication and general anaesthesia very much depends on the "breed" factor.

Speaking about the other factor "sex of the animal", our research on the whole suggests that values of ECG waves and intervals recorded in standard lead II are to great extent similar in animals of both sexes both in the initial state as well as in the course of premedication and general anaesthesia. Thus these ECG parameters being subjected to premedication agents and general anaesthesia agents develop independently of the "sex" factor.

In the end we must stress that on the whole we managed to reveal the effect of premedication agents (atropine sulphate and acepromazine maleate) and subsequently administered general anaesthesia agents (ketamine hydrochloride and diazepam) on the particular ECG-Parameters of dogs and relationship of these parameters to the breed and sex of particular animal.

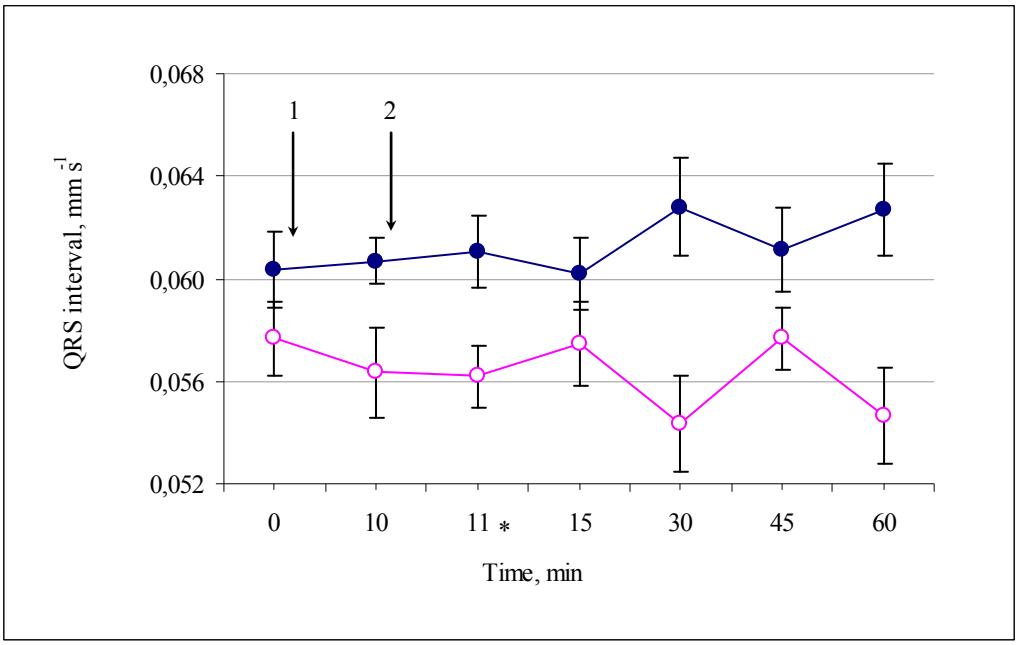

Figure 6. **QRS interval (s) of lead II ECG in German shepherd (-●-) and Cocker spaniel (-○-) dogs of initial state (1), 10 min. after premedication (2) as well as during general anaesthesia**

11* – first minute after administration of ketamine hydrochloride and diazempam

1 – premedication (0.054% atropine sulphate solution (0.02 mg kg^{-1}) in combination with 1% acepromazine maleate solution (0.06 mg kg^{-1});

2 – general anaesthesia (5% ketamine hydrochloride (6 mg kg^{-1}) in combination with 0.5% diazepam (0.6 mg kg^{-1})

Conclusions

1. Premedication agents atropine sulphate and acepromazine maleate did not have significant effect on the heart rate of Cocker Spaniels and German Shepherd dogs, however subsequently administered general anaesthesia agents ketamine hydrochloride together with diazepam generated significant increase of heart rate, which was more pronounced in Cocker Spaniels-already in the first minute after administration of general anaesthesia agents.

2. According to the records done in ECG standard lead II, P wave in dogs subjected to premedication and general anaesthesia developed very much in line with the heart rate and according to the breed of particular animal. Premedication agents altogether did not change P wave much, whereas the total effect of anaesthesia agents manifested as statistically true increase of P wave amplitude – apparent already in the first minute of general anaesthesia of Cocker Spaniels, and only in the 60th minute of general anaesthesia of German Shepherd dogs.

3. According to the records done in ECG standard lead II, the depth of Q wave and height of R wave in dogs subjected to premedication and general anaesthesia remained almost stable. The Q wave of Cocker Spaniels was altogether much deeper ($P < 0.05$) and the R wave-much higher compared to German Shepherd dogs ($P < 0.001$).

4. The depth of S wave recorded in dogs in ECG standard lead II increased only slightly during premedication. The effect of general anaesthesia agents on Cocker Spaniels manifested as both increase and decrease of the absolute value of S wave ($P < 0.05$), which remained relatively stable in German Shepherd dogs. S wave recorded in ECG standard lead II was always deeper in Cocker Spaniels compared to German Shepherd dogs.

5. Premedication agents significantly increased ECG-PQ interval in German Shepherd dogs ($P < 0.01$), and had little effect on ECG-PQ interval of Cocker Spaniels. This pattern conformed with the changes of heart rate recorded in dogs of both breeds during premedication. The total effect of general anaesthesia agents ketamine hydrochloride and diazepam (after the effect of premedication agents took place) manifested in dogs as shortening of PQ interval, however the pattern of shortening was different for each of the breeds, and this conformed to the changes of heart rate of these animals during general anaesthesia.

6. Premedication agents atropine sulphate and acepromazine maleate significantly increased QT interval recorded in ECG standard lead II ($P < 0.05$) in animals of both breeds. The total effect of general anaesthesia agents (after the effect of premedication agents had taken place) altogether manifested as shortening of QT interval: during the first minute of general anaesthesia changes were equally fast in animals of both breeds, however during the next 15-30 minutes this process developed according to different pattern depending on the breed of animal.

References

1. Avdoško, G. (2007) *Development of electrocardiophysiological parameters in anaesthesied dogs*. Dissertation work for doctoral

scientific degree. Jelgava, LLU, 106 pp.

2. Campbell, P. E. and Atwell, R. B. (2002) Long QT syndrome in dogs with tick toxycity (*Ixodes holocyclus*). *Australian Veterinary Journal*, V. 80, No. 10, pp. 100-109.

3. Fossum, T.W., Hedlund, C.S., Johnson, A.L., Schulz, K.S., Seim, H.B., Willard, M.D., Bahr, A., Carroll, G. L. Small animall surrgery. 3rd edition, Mosby Elsevier, St. Lois–Missouri 63146. 2007. pp. 1610.

4. French A. Introduction to electrocardiography. World Small Animal Veterinary Association Congress 2008 programme and scientific proceedings. 2008. 1: 116-118.

5. Hewson, C. J., Dohoo, I. R., and Lemke, K. A. Perioperative use of analgesics in dogs and cats by Canadian veterinarians in 2001., *Canadian Veterinary Journal*. 2006. 47: 352-359.

6. Kalvelis, A. *Nearitmiskā elektrokardioloģija.* Izdevniecība: SIA Nacionālais apgāds. 2005. 176 lpp.

7. Lemke, K. A. Perioperative use of selective alpha-2 agonists and antagonists in small animals. *Canadian Veterinary Journal.* 2004. 45: 475-480.

8. Miller, R.D. Anesthesia. - Philadelphia: Churchill Livingstone, 2000. - 797 pp.

9. Nunes, A. A., Moffa, P. J., and Iwasaki, M. Standartisation of a new precordial chest lead system in the dog. *Brazilian Journal of Veterinary Research and Animal Science*. 1990. 27: 233-246.

10.Oguchi, Y. and Hamlin, R. L. (1993) Duration of QT interval in clinically normal dogs. *American Journal of Veterinary Research*.1993. 54:2145-2149.

11.Tilley, L.P., Smith, F.W.K., Oyama, M.A., Sleeper, M.M. Manual of canine and feline cardiology. 4rd edition, Saunders Elsevier, St. Lois–Missouri 63146. 2008. pp. 443.

12.Torre, D., Kirby, A.C., Church, D.B., and Malik, R. Echocardiographic measurements in Greyhounds, Whippets and Italian Greyhounds – dogs with similar conformation but different size. *Australian Veterinary Journal*, 2000, 78: 49-55.

13.Upeniece, D. *Sirds elektrofizioloģiskie parametri Kokerspaniela, Rotveilera un Vācu aitu šķirnes suņiem*. Promocija darbs doktora grāda ieguvei. Jelgava, LLU, 2004, 96 lpp.

14.Welberg, L. A., Kinkead, B., Thrivikraman, K., Huerkamp, M. J., Nemeroff, C. B., and Plotsky, P. M. Ketamine-xylazine-acepromazine anesthesia and postoperative recovery in rats. *J. Am. Assoc. Lab. Anim. Sci.*, 2006, 45: 13-20.

15.Мартин, М. В. С., Коркорэн, Б. М. (2004) *Кардиореспираторные заболевания собак и кошек*. Аквариум ЛТД, М., 482 с.

16.Машковский, М. Д. Лекарственные средства. Т. 2, - 14-е изд., перераб., испр. и доп. М.: ООО„Издательство Новая Волна", 2000, 540 с.

17.Медведева, А. С.(2001)*Клиническая электро-кардиография*. СП. - Питер,384 с.

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