

PHYSIOLOGICAL VALUES OF P-WAVE DISPERSION IN SILESIAN BREED HORSES AND POLISH PRIMITIVE HORSES

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Abstract

Electrocardiographic examinations were performed on 45 Silesian breed horses (group K, 3-16-year-old, 16 stallions, 29 mares) and on 25 Polish Primitive breed horses (group P, 1.5-19-year-old, two stallions, six geldings, 17 mares). Einthoven and chest leads were used. P-wave dispersion was electronically evaluated. There was no correlation between P-wave dispersion and other ECG parameters, age, sex, body mass, or month of pregnancy. The average value of P-wave dispersion for all horses was 30.77 ms (SD 3.92 ms), however in particular groups it was: in group P - 31.89 ms (SD 3.07 ms), and in group K - 30.15 ms (SD 4.27 ms). The maximum value of P-wave dispersion in the studied population was 40 ms, in groups P and K - 37.6 ms and 40 ms, respectively. The physiological value of P-wave dispersion for the group of horses was below 45 ms.

Key words: Silesian breed horses, Polish Primitive horses, ECG, P-wave dispersion.

P-wave dispersion is an index that is evaluated both in human and veterinary medicine (8, 14, 16, 17). The index is described as the difference between the longest and shortest duration time of P-wave measured in all ECG leads. It is stated that the duration time of P-wave and the P wave dispersion (P_d) are electrophysiological reflections of atrial features. The changes in these parameters may indicate inhomogeneous propagation of the sinus node impulse and disturbances of the intra-atrial conduction between the left and right atria (17).

In small animals and people, P-wave is characterised as a single, one-phase wave of positive polarisation; however, in horses it appears as an electrocardiographically polymorphic value. Under physiological conditions, one and two-peak waves can be observed, usually of heterogeneous depolarisation, often being two- or even three-phased (15). This refers to a specific for horses depolarisation process of the atrial muscles, which does not have such a schematic course as in humans and small animals. This specific P wave morphology is probably due to the electrical impulse conduction through different inter-atrial tracts with the exception of the Bachmann's bundle. In addition to the lack of Bachmann's bundle conduction, fast and avalanche induced depolarisations are forced by a huge mass of myocardium and the need of synchronous atrial systole.

In human medicine, P-wave dispersion was evaluated as a prognostic factor of the presence of atrial fibrillation (AF). It was confirmed that there is a possibility of diagnosing patients with a higher risk of AF, who do not have a significant cardiac disease.

In veterinary medicine, P-wave dispersion has been characterised only in dogs. Reference values for healthy dogs were described and were compared with values in dogs with chronic valvular disorders and those with disorders of supra-ventricular conduction. It was confirmed that in control dogs this index is a parameter independent from age, breed, body mass, and sex (16).

The aim of the study was to describe P-wave dispersion in Silesian breed and Polish Primitive horses and to evaluate the correlation between this parameter and other electrocardiographic parameters and features such as sex, age, breed, body mass, and pregnancy period.

Material and Methods

The study was performed on 70 horses divided into two groups. The first group (K) included 45 horses of Silesian breed from the Stallion Stud in Książ and the second group (P) included 25 Primitive Polish horses from the Research Station PAN in Popielno. In the first group, the body weights were between 553 and 730 kg, with age ranging from 3 to 16 years. There were 16

stallions and 29 mares, 25 of which were pregnant (2-6.5 months of pregnancy). Most of the stallions were intensively exercised. In the group of Primitive Polish horses body weights were between 350 and 430 kg, with age ranging from 1.5 to 19 years. There were 17 mares, six geldings, and two stallions. The geldings were used recreationally.

No abnormalities were detected in all horses during clinical examination, ECG, echocardiography, and blood evaluation (blood morphology and specific biochemical parameters – urea, creatinine, GGT, TG, glucose, Na, Cl, Mg, Ca, Fe were analysed).

The horses were examined at the stables. The ECG examination was performed using BTL SD08 machine equipped with a net filter and different frequencies of muscular filters. The ECG recording was obtained from horses in standing positions during rest, with a paper speed of 25 mm sec⁻¹ and a sensitivity of 10 mm mV⁻¹. Alligator clips fixed to the electrocardiographic leads were attached directly to the skin. The sites of electrodes attachment were cleaned with alcohol but not shaved and electrode gel was applied. The electrodes on the forelimbs were placed over the elbows, on the hindlimbs - over the knee, and on the chest - right and left 5th intercostal space (i.c.s.), on the humeral joint line, and on the sternum on the ventral midline directly over the xiphoid cartilage approximately 5th i.c.s. Einthoven and precordial leads (I, II, III, aVR, aVL, aVF, CV₁, CV₂, CV₄) were used.

Basic electrocardiographic parameters were evaluated (P wave time, P wave amplitude, PQ interval, QRS interval, R wave amplitude, QT interval and HR). Afterwards, the recording was analysed to calculate the P-wave dispersion. The evaluation of P-wave duration was done on 9 ECG leads (I, II, III, IV, aVR, aVL, aVF, V₁, V₂, V₄) for five cardiac cycles. The assessment was performed by electronic markers on the computer screen after a 200 times enlargement of the ECG recording. In each evaluated lead, the duration of P-wave was measured as the distance between the onset (positive or negative deflection from the isoelectric line) and the offset (return to the isoelectric line) with precision to 1 ms. Next, minimum (P_{min}) and maximum (P_{max}) values of P-wave were set. The dispersion of P-wave was calculated as the difference between P_{max} and P_{min} and then the average from five measurements was obtained.

When the electrocardiographic measurements were completed, all data were subjected to statistical analysis using the STATISTICA PL ver. 9.0 programme. The correlation between specific electrocardiographic parameters was calculated and between the parameters of ECG curve and the age, sex, body mass, and the month of pregnancy. A statistical significance was accepted when $P < 0.05$.

Results

The P-wave dispersion values are presented in Table 1 (group K) and Table 2 (group P).

No correlation between the P-wave dispersion and other ECG parameters, age, sex, body mass, and month of pregnancy was detected.

The average value of P-wave dispersion was 30.77 ms (SD 3.92 ms); however, in particular groups it was as follows: in group P - 31.89 ms (SD 3.07 ms), in group K - 30.15 ms (SD 4.27 ms). The maximum value of P-wave dispersion was 40 ms (37.6 ms and 40 ms in group P and K, respectively). The minimum value of P-wave dispersion was 21.2 ms (26.8 ms and 21.2 ms in groups P and K, respectively).

A normal value for P-wave dispersion was accepted to be below 45 ms.

Discussion

P-wave dispersion is an electrocardiographic parameter that is used in human medicine to predict the risk of supraventricular arrhythmia, specifically to diagnose patients at risk for atrial fibrillation (3, 7, 8, 14). This parameter can also be successfully used in the veterinary medicine. Despite the fact that atrial fibrillation is one of the most common types of supraventricular arrhythmia in horses, P-wave dispersion has not been carefully analysed to date. In adult horses, no correlation was observed between P-wave dispersion and age or sex, which is similar to the findings in people and dogs. The observed group of pregnant mares of Silesian breed confirmed that there was no dependency between P_d and the phase of pregnancy. There was no correlation between the body mass and P_d; however, in the group of Primitive Polish horses, P-wave duration was lower than in the group of Silesian breed horses. On the other hand, due to significantly lower values of P_{max} and P_{min}, P-wave dispersion was similar in both groups. The difference between the P-wave duration might be due to the different body mass and, at the same time, different weight of myocardium. Similar conclusions were noted in group of healthy dogs, where despite of the different body mass, between 3 and 70 kg, P-wave dispersion was fairly constant and below 36 ms (16).

Because P-wave dispersion is independent from physical factors such as age, sex, and body mass, it can be assumed as a standard value for healthy horses, which do not show any signs of supraventricular arrhythmia or atrial enlargement. This index seems to be a good indicator of inter- and intraventricular conduction disorders, which was confirmed by tests performed on dogs (11).

An increase in P-wave dispersion was noticed in children with stable asthma bronchiale (26). Since chronic respiratory diseases can be often observed in horses, especially recurrent airway obstruction (RAO), P_d analyses seems to be a must in this species. In children with stable asthma bronchiale the correlation between P-wave dispersion and age, body mass, and height was observed. No such correlation was observed in dogs (16) or horses, which can be explained by a very intensive change in body mass in children related to age. The study was performed on adult horses.

Table 1
P-wave dispersion – group K

No	Age (years)	Sex	Mass (kg)	Month of pregnancy	P wave dispersion (ms)
1	8	f	660	3	32
2	7	f	669	2	32.6
3	11	f	620	6	28
4	6	f	553	3	21.2
5	3	f	677		28.4
6	16	f	580	3	35.2
7	5	f	610		29.2
8	6	f	610	4.5	25.2
9	9	f	704	3	28.8
10	6	f	643	2.5	33.6
11	11	f	620		22.8
12	6	f	585	3.5	33.6
13	4	f	717	6	29.6
14	3	f	667	4	27
15	4	f	730	3.5	27.2
16	12	f	610	2	25.6
17	6	f	585	5.5	33.2
18	3	f	634	6.5	33
19	20	f	704	3	30
20	7	f	658	3.5	28.8
21	3	f	635		26.4
22	4	f	660	5.5	25.6
23	3	f	717	6.5	27.6
24	9	f	677	3	26.8
25	5	f	636	3	38.8
26	12	f	698	5	36.8
27	3	f	622	5.5	26.4
28	8	f	713	3	33.6
29	8	f	600	6	26.8
30	10	m	660		33
31	12	m	704		25
32	6	m	652		30.8
33	2	m	677		33.6
34	8	m	620		37
35	8	m	620		29
36	7	m	628		32
37	7	m	704		30
38	7	m	660		34
39	6	m	660		31.6
40	8	m	620		30
41	3	m	628		25.6
42	3	m	567		29.2
43	3	m	610		40
44	6	m	652		37
45	3	m	626		25.2
average					30.15
SD					4.27

Table 2
P-wave dispersion – group P

No	Age (years)	sex	P wave dispersion (ms)
1	4	f	37.6
2	19	f	33.6
3	8	f	34.8
4	5	f	26.8
5	19	f	30.8
6	4	f	27.6
7	11	f	34.4
8	6	f	35.2
9	10	f	32.4
10	6	f	36.8
11	11	f	28.0
12	14	f	32.4
13	9	f	32.0
14	3	f	29.6
15	11	f	30.4
16	4	f	32.0
17	7	f	27.2
18	1.5	m	29.6
19	13	m	28.0
20	11	m	30.8
21	8	m	32.0
22	7	m	32.0
23	5	m	34.0
24	6	m	36.8
25	10	m	32.4
average			31.89
SD			3.07

In human medicine changes in P-wave duration and dispersion were only observed in disorders related to the atria. An increase in P-wave dispersion is observed during ischaemic heart disease, dilated cardiomyopathy, coronary slow flow, stricture of the left atrioventricular ostium opening, hypertension, and some congenital defects like pulmonary stenosis (8, 9, 12, 13, 18-20). An increase in this parameter was also observed in patients with a diastolic dysfunction; however, the increase was not in proportion to the severity of the disease (8). The speed of the impulse conduction in the myocardium depends on the activity of the immune system and the presence of ischaemia (4, 6). Additional factors that can increase P_d and that should be taken into account while interpreting results related with atrial conduction include endocrine disease, such as diabetes, thyroid hyperfunction, and the terminal stadium of renal failure (2, 5, 10, 21-23, 25). In people, changes of P-wave dispersion were also observed during changes in the tension of the autonomic nervous system, for example while conducting the Valsalva maneuver (1) or in connection with panic attacks (24). Despite the fact that all of the mentioned above disorders are very rare in horses, the interpretation of any electrocardiographic parameters should always be followed by a clinical examination and pertinent additional tests.

In conclusion, P-wave dispersion is a constant index in healthy horses of Silesian bread and Primitive Polish horses, independent from body weight, sex, age, and pregnancy period, and is below 45 ms.

The study was performed only on a group of healthy, adult horses. There is no information concerning the relation between the P-wave dispersion and the changes of the body mass during the growth period of foals until they obtain the weight of an adult horse. It seems to be important to continue the study also on other breeds of horses, especially on Ponies, in order to confirm the homogeneity of this parameter in terms of one species and its independency from body mass. The paper is an introduction to more specific clinical observations to establish the value of P-wave dispersion in horses with different types of arrhythmias, especially supraventricular, and the usefulness of this index as a prognostic factor. This index might be also useful to evaluate the severity of chronic respiratory diseases in horses and its influence on the functioning of the myocardium.

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