

CORRELATIONS BETWEEN HEART RATE AND LACTIC ACID DURING SUBMAXIMAL EXERCISE IN DOG

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Abstract

Five healthy Golden Retrievers aged from 1.5 to 3 years old, three males and two females, were studied during a normal "playing" time considered as submaximal exercise, under ordinary circumstances, preserving the usual routine (location, normal weather conditions, to the same group). From the medical history, it was excluded previous symptoms as fatigue or other cardiac related symptoms based on subjective observations. Each individual heart rate was measured ten minutes intervals, during 60 minutes exercises, using a heart rate monitor device. Blood lactate was measured with fast strip, at the beginning and at the end of the test. The results showed that heart rate was normal in 4 cases, ranging between 101 and 173 beats per minute (bpm), and abnormal in one dog reaching the maximal heart rate during a submaximal test, with four consecutive values between 215 and 245 bpm. The lactate values were normal for all the subjects, at the end of the test, none of the dogs achieving the superior lactate threshold. After performing a cardiac examination in all five subjects (including Doppler echocardiography and Holter electrocardiogram), a good correlation was observed between heart rate values of the dog that reached maximal heart rate and a suspicion of a cardiac problem (preclinical case of dilated cardiomyopathy), but no evidence of altered or a raise in blood lactate under this submaximal test.

Keywords: dog, exercise, heart rate, lactic acid.

INTRODUCTION

Numerous studies have been conducted in order to establish a gradual scale of different types of exercise in dogs and horses (Dojana *et al.*, 2008), using human medicine protocols adapted in veterinary medicine. These adapted protocols (for example Bruce's protocol) are based on the assumption that a normal and gradual cardiovascular response is obtained in otherwise healthy subjects. Instead, an abnormal response will be recorded in dogs affected by different cardiac conditions, such as decompensate heart diseases (degenerative mitral valve disease, cardiomyopathy etc.) or occult diseases (paroxysmal arrhythmia, occult stage of dilated cardiomyopathy etc.). The variety of breeds that are prone to develop heart disease raised the issue of intraoperative variability when a cardiovascular stress test is performed, especially on the individual response. In dogs, we are confronting with a large variation in effort tolerance, both in fast running or endurance, starting from the top "athletes" like the Alaskan Sled Dogs to

brachycephalic breeds, such as French Bulldogs, or "sprinters" as Greyhounds. Another important variable is the composition or type of muscle fiber, as an adaptive response to training (Toniolo *et al.*, 2006).

The major difference between breeds, and their performances are due to prevalence of "fast twitch fiber" or Type II, and "slow twitch fiber", or Type I (Dojana *et al.*, 2013), but integrity of cardiopulmonary or hepatic functions play an important role also. At this time, there are several protocols that can be used in veterinary medicine, but as is stated before, most of them are adapted from human medicine. The 6 M.W.T. - six minute walk test (Boddy *et al.*, 2004; Swimmer *et al.*, 2011) is used at this time to reduce the variability of data received from the patients, when they were asked about at which level of fatigability arrived the dogs during perform simple tasks. The 6 M.W.T. and submaximal exercise (Kittleson, 1996) are used at the moment for dogs that already have a cardiopulmonary pathology (for example decompensate heart disease, idiopathic pulmonary fibrosis etc.).

But this protocol is not reliable in Alaskan Sled Dogs (Stepien, 1998), or other breeds that are known to sustain maximal effort over a short period of time (for example breeds that are participating in Mondioring or Agility Competition).

The purpose of this study was to investigate the correlative evolution of heart rate and lactate during a normal session of “playing”, in natural conditions or psychical stimulation. In order to obtain a reference and objective guiding values that can be used to define fatigability in Golden Retrievers, we aimed to observe the fluctuation of heart rate and blood lactate during 60 minutes of exercise.

MATERIALS AND METHODS

Five healthy Golden Retrievers, 3 males and 2 females, ranging from 1.5 to 3 years old were included in this study. The owners were instructed answer a short list of questions, which are normally asked in the veterinary practice during anamnesis, and to estimate without any other data the “fitness” condition of each dog. Based on the recent medical history, and the absence of clinical signs, all five dogs were considered healthy, fit and in excellent condition. Four were stated also that signs of fatigue appear after 1-2 hours of intense playing, running or swimming. Just in one dog was stated that signs of moderate exercise intolerance appear after 30 minutes of playing. None of the dogs were used with the medical device, but they were used with ordinary restraining belt.

There were none specific exercises with the intended purpose to achieve a premature state of fatigue. The dogs were allowed to play as usually, with each other and they were free in open park (Figure 1), not restrained in the leash, except for the brief moment when we collected the blood sample. The Sports Watch device has the advantage of easy reading of heart rate in real time, during exercises. The stress test is safer, allowing the abrupt termination of the test if the heart rate rises at a level beyond maximal limit.

Heart rate was measured in real time using this adapted device, which consist in two units, a belt used to receive impulses from the precordial area and a watch with real time display of heart rate. The belt has two sensors

that need to be lubricated with simple water, in order to assure a better electric communication between the device and the dog’s chest (Figure 2). After the heartbeat was captured, the belt was secured with co-adhesive elastic bandages. The heart rate was measured from 10 to 10 minutes, in each dog, during 60 minutes of session. The measurements were made during running or walking or under 30 seconds from the beginning of the rest period in order to obtain a reliable value, with no other influences from physiological recovery heart rate, which is a component of balance between sympathetic and parasympathetic nervous stimulation.



Figure 1. 60 minutes of free exercises and playing



Figure 2. The “Sports watch” device

The blood lactate was measured using the fast strip “Accutrend Lactate and Glucose”, by venous puncture, at the beginning and at the end of the program, just before the recovery period, in order to obtain the values of lactate before capillary transport and hepatic biotransformation.

RESULTS AND DISCUSSION

Measurements of the heart rate, during the 60 minutes were taken for each of the dogs, in 4 cases the average value was 156 bpm, 115 bpm, 162 bpm, and respectively 134 bpm, and in one case 193 bpm, above the normal superior range, with a maximal heart rate of 245 bpm (Table 1).

Table 1- Heart rate values (bpm), during 60 minutes of sub maximal exercise, measured from 10 to 10 minutes

Time (min)	dog 1	dog 2	dog 3	dog 4	dog 5
10	144	117	123	160	102
20	159	238	101	149	133
30	157	243	120	171	133
40	170	245	113	173	125
50	151	215	133	153	131
60	156	103	104	167	180
Mean ± SEM	165± 8.5	193.5± 7.6	115.6± 11.3	116.1± 10.4	134.0± 8.8

Four dogs had values between the expected range during submaximal exercises, and they not achieved a maximal heart rate as in incremental exercise test on treadmill observed in Labrador Retrievers (Ferasin *et al.*, 2009). In one case, the heart rate was above the average with a mean value of 193 bpm, with 4 consecutive values above 200 bpm. Based on the fact that none of the dogs did a maximal test, observing them during one hour, was assumed that the dog that reached a higher heart rate, had a cardiac pathology, unobserved until then. In the individual chart completed before the test, the owner of this dog stated that after 30 minutes of normal playing, it showed signs of fatigue, adopting a sternal recumbence, presenting tachypnea and reluctance to walk. After performing a complete cardiac exam, measuring the blood pressure, the 5 minute 12 lead electrocardiography, the 24 hour Holter electrocardiography, the transthoracic 2D-two dimensional echocardiography, TM-time motion method, and Spectral Doppler (CWD-continuous wave Doppler, PWD- pulsed wave Doppler), it was concluded that this dog didn't had decompensate cardiac problem. Some small lesion were observed, at a valvular level, valve with a modified aspect of the ending parts of the leaflets and with minor regurgitate jet on the mitral with a central pattern, and a small regurgitate jet at the tricuspid valve. Calculating the score for DCM- dilated

cardiomyopathy according to Dukes (2003), the patient was negative (normal sphericity index, normal ejection fraction measured by Biplane Simpson method, shortening fraction and ventricular volumes). The 12 EKG lead were normal, and the Holter exam also was negative for cardiac arrhythmia, with no ventricular extra systole noted.

Table 2- Lactic acid values (mmol/L) in the 5 dogs during the 60 minutes of submaximal exercise measured during resting and at the end of the normal maximal

No. of the dog	dog 1	dog 2	dog 3	dog 4	dog 5
Resting values	1.2	1.3	1.0	1.5	0.9
Values at the end of the exercise	1.1	1.7	0.8	1.2	2

The blood lactate values obtained were in normal reference ranges for dogs, and the threshold was considered achieved when the resting values were above the maximal with 1 mmol/l (Yoshida *et al.*, 1987). None of the five dogs reached the lactate threshold, after 60 minutes of normal play, and in all the cases the resting values were normal. The values of lactate did not correlate with the increased maximal heart rate observed in one of the dogs. Based on the amount of data from human medicine, normally is tend to apply the same protocols in dogs, (ex. 6 Minute Walk Test), but the numerous variable that we deal with regarding the peculiar physiology of dogs (ratio between types of muscular fiber contained in the muscle involved in locomotion, individual and breed endurance, normal hemodynamic etc.) (Toniolo, 2006), this test must be "adjusted" to every breed on a base protocol. The opportunity of this test is suggested by the lack of specificity in case of routine practice, were the symptomatology described is very ambiguous. Fatigue or lack of energy varies from a subjective point of view in each case, most of the time the owners making a parallel with human endurance. In some cases, they describe the fatigue based on experience, and this could be applied in older dogs, but in young dogs (1-3 years), the data received are very confusing. Another aspect is the reduced psychological need to play in dogs when they reach the "adult" age, between 1.5 and 2 years, leaving a window of 12-24 months when we

are not able to quantify the measure of fatigue. At this time protocols exist for majority of the breeds used in competitions, like Alaskan Sled Dog or Greyhound, but with no real use in daily practice (Stepien *et al.*, 1998).

The fact that none of the five dogs, reached the lactate threshold during 60 minutes of normal play, even if one dog achieved the maximal heart rate, suggested that Golden Retriever are less prone to show fatigue in a normal session or in a daily routine, obscuring in that way one of the first symptoms of heart disease. On the other hand, the signs of fatigue during 60 minutes or less, presented by this breed, on young and "healthy" dogs, should be considered as a sign of potential heart disease.

CONCLUSIONS

The lactate threshold and maximal heart rate in these dogs performing a 60 minutes daily routine was not achieved under normal conditions, and the maximal heart rate observed in one case did not correlate with lactate threshold.

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