ESTIMATION OF THE LACTATE THRESHOLD FROM CARDIAC CYCLE CHANGES MEASURED BY THE HEART SOUND DURING A RAMP EXERCISE.
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Introduction
The heart sound is a noninvasive technique for assessing cardiac performance. A previous study reported that the amplitude of the first heart sound (S1) during exercise accelerates above the lactate threshold (LT). This technique also might provide further valuable information regarding cardiac stress due to increasing workload, such as cardiac systolic and diastolic time. The systolic time, which can be determined by the appearance time of the S1 and that of the second heart sound, may vary with the change in a volume of venous return, cardiac contractility and total peripheral resistance. Most of the parameters, which influence the systolic time, are affected by the sympathetic nerve activities. The purpose of this study was to investigate whether cardiac cycle changes including the systolic and diastolic time intervals during exercise could be applied for an alternative index of the LT. In addition, the possibility to be an application of an exercise prescription was explored.

Methods
Nine males, aged 26+/-5 years and 22+/-2 kg/m2 of body mass index, underwent a continuous ramp test using a cycle ergometer. This test consisted of 4 minutes at 10 watts followed by a ramp slope at 1 watt every 4 seconds (i.e.15 watts/minute) until the heart rate reached 85% of its maximum expected for the age. The heart sound was monitored beat-by-beat throughout the exercise test. The lactate concentration was measured in blood samples from an earlobe in order to determine the LT. The cardiac cycle changes were calculated beat-by-beat throughout the exercise and then averaged for 10 consecutive cycles. The correlation coefficients and regression line below and above the LT was individually calculated between the systolic or diastolic time and the cardiac cycle.

Results
The average of LT was 107.2+/-25.1 watts. The systolic time shortened above the LT in all subjects, thus resulting in the existence of a break point of the systolic time against cardiac cycle. The slope of regression line in the systolic time against the cardiac cycle was found to be steeper above the LT in all cases. The value of slope of regression equation above LT was doubled on average (0.19+/-0.08 in below LT vs 0.40+/-0.07 in above LT, p<0.01). The average of the systolic time break point was no significantly difference in the work rates corresponding to LT(-4.0+/-27.8, p=0.67).

Discussion/Conclusion
These results suggested that cardiac time distinctly changes above the LT, especially the systolic time starts to shorten sharply. Since the augmentative effects of the sympathetic nerve activity may accelerate the cardiac contractility. Monitoring heart sound during a ramp exercise test could provide us with valuable information regarding exercise stress and effectively apply for an exercise prescription.

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