RELATIONSHIP BETWEEN BLOOD LACTATE CONCENTRATION AND SWIMMING SUCCESS

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Abstract

The purpose of this study was to analyse efficacy of swimmers. Twenty-eight best Slovenian male swimmers took part in the study. Swimming velocity at the individual lactate threshold of 4mmol/l lactate concentration during the 5x (3x 200m) crawl test with increasing speed was significantly correlated with swimming velocity in 400m crawl (r=0.59, r=0.69, P<0.05) and 100m crawl (r=0.85, r=0.74, P<0.05). Velocity of breaststroke swimming at individual 4 mmol/l level, computed from the crawl swimming velocity at 4mmol/l lactate level, was correlated with swimming velocity in 100m (r=0.75, P<0.05) and 200m (r=0.86) breaststroke.In the same way, the computed velocity for butterfly was correlated with 200m butterfly (r=0.87, P<0.05).

Submaximal and maximal velocity in the 2x200m crawl test were not significantly correlated with the swimming efficacy criteria.

Keywords: *swimming, physiology, lactate, successs*

Zusammenfassung

VERBINDUNG ZWISCHEN BLUTLAKTATKONZENTRATION UND EFFEKTIVITÄT BEIM SCHWIMMEN

Das Ziel dieser Forschung war die Analyse der Leistung von Schwimmern. Das Muster bestand aus 28 besten slowenischen Schwimmern.

Die Schwimmgeschwindigkeit an der Laktatschwelle und bei der Laktatkonzentration von 4 mmol/l beim 5 x (3 x 200m) Kraulen mit der steigenden Geschwindigkeit steht in bedeutender Korrelation mit der Schwimmgeschwindigkeit beim 400m-Kraulen (r=0.59, r=0.69, P<0.05), 100m (r=0.85, r=0.74, P<0.05). Die Geschwindigkeit beim Brustschwimmen am Laktatniveau von 4 mmol/l, das aufgrund der Kraulschwimmgeschwindigkeit am 4 mmol/l Laktatniveau errechnet wurde, korrelierte mit der Schwimmgeschwindigkeit beim 100m- (r=0.75, P<0.05) und 200m-Brustschwimmen (r=0.86, P<0.05). Ebenso wurde die errechnete Geschwindigkeit beim Schmetterlingschwimmen mit dem 200m-Schmetterlingschwimmen (r=0.87, P<0.05) korreliert.

Die submaximale und die maximale Geschwindigkeit bei dem 2 x 200m Kraul-Test korreleirte nicht bedeutend (P<0.05) mit Leistungskriterien.

Schlüsselwörter: *Schwimmen, Physiologie, Laktat, Erfolg*

Introduction

Determination of lactate concentration in blood (LA) after different exercise efforts has frequently been used for assessment of swimmers' glycolytic metabolism and performance.[1,2,3] Two strategies are usually used for assessment of (LA) kinetic: Lactate Threshold and Onset of Blood Lactic Acid (OBLA) determination[2], and the other for assessment of Lactate Capacity[3]. The first strategy enables evaluation of endurance performance, while the second one is used for better understanding of speed endurance.

Competitive swimming consists of four basic swimming styles, strokes, that allow swimmers to propel (swim) through water in four different ways. Four different biomechanical patterns activate different muscle groups at different energy expenditure levels. The aim of the study was to determine whether the different swimming styles of various distances lead to the peak of maximal (LA) increase. In the research the special interest was directed to the relationship between speed of swims of various distances and swimming styles at LT and OBLA and (LA).

Materials and methods

A group of 28 best Slovenian male swimmers participated in international competition races in their specific swimming events. Soon after the competition they all took part in the 200m crawl test, regardless of their stroke or event specialisation. All the swimmers signed the letter of consent for participating in the study before testing.

TEST A consisted of two 200m crawl swim trials. In the first race subjects were instructed to perform 200m crawl style swim at approximately 90% of estimated speed. After the completion of trial swimmers rested for two minutes and afterwards they performed the second 200m race, this time with maximal effort.

TEST B consisted of 5 sets of 3x200m series with the controlled increase of swimming velocity between sets, but the controlled and constant speed in each series. Duration of pauses between each race in series was 30 seconds. There were up to 3 minutes long pauses between series.

To estimate LT, two component regression methods were used, originally developed by Beaver et al. in 1980 and adapted for running[4]. Both methods use the intersection point of two exponential regression curves, which is the best approach to anaerobic threshold estimation in diagrams of (LA) dependency on swimming speed. It was defined as swimming speed at individual anaerobic threshold (VLT). The OBLA criterion used the calculated swimming speed at (LA) steady state level of 4 mmol/l (VOBLA).

The swimming velocity in breaststroke at 4 mmol/l lactate level (VOBLABR) and the swimming velocity in butterfly stroke at 4 mmol/l lactate level (VOBLABU), were calculated from the crawl swimming velocity at 4 mmol/l lactate level (VOBLA) in the following manner: the best (maximal) 200m breaststroke or butterfly swimming velocity was divided by coefficient A. The coefficient A was the maximal swimming velocity at 200m crawl divided by the crawl swimming velocity at 4 mmol/l lactate level (VOBLA).

The maximal lactate concentration (LAC200) was represented as (LA) after the A TEST. The maximal lactate concentration after the competition was represented as (LACcom).

Each swimmer participated in international swimming competition race 3 - 5 days before the A TEST. Among the subjects, there were 12 crawl specialists. At the competition they took part in 100m and 400m races. The other 6 were specialists in 100m and 200m breaststroke events and the rest of the subject group (n=8) participated in 200m butterfly race.

Blood samples were taken from hyperemied ear lobe. Kontron - Roche 640 Lactate Analyser (Kontron, Austria) was used for lactate level measurements. Samples were taken 3 minutes after completion of the competition race and A TEST, and the other samples were taken immediatelly after the B TEST.

Results

LAC200 was similar in different swimming groups. Event specialisation seemed to have no significant effect on LAC in A TEST.

It seemed that LACcom after 100m crawl and 200m butterfly swim showed slightly decreased (not significantly) levels in comparison with the levels in other swimming events. The differences between LAC200 and LACcom in crawl swim were not significant, except for the difference between LAC200 and LACcom after 100m crawl, which was 3 mmol/l approximately ($P<0.05$). Out of that data it was possible to conclude that 100m crawl can not lead (LA) to the peak level.

In breaststroke swim there was no significant difference between LAC200 and LACcom after 100m and 200m distances. (LA) was similar despite different swimming speeds and times in both races.

In butterfly swim there was no statistically significant difference between LAC200 and LACcom after 200m competition distance.

VLT and VOBLA were significantly correlated with the swimming velocity in 400m crawl ($r=0.59$, $r=0.69$), 100m ($r=0.85$, $r=0.74$) and 200m ($r=0.86$, $r=0.84$) breaststroke and 200m butterfly ($r=0.85$, $r=0.80$). The VOBLABR was significantly correlated with the swimming velocity in 100m ($r=0.75$) and 200m ($r=0.86$) breaststroke. The VOBLABU was correlated with 200m butterfly ($r=0.87$).

The LAC200 was not significantly ($P<0.05$) correlated with the swimming efficacy criteria.

There were significant correlations between swimming results and LACcom in 100m crawl ($r=0.65$). A very close correlation was found between swimming results and LACcom 100m ($r=0.81$) and 200m ($r=0.92$) breaststroke swimming events. There was no significant correlation between swimming results and LACcom in 200m butterfly and 400m crawl ($P<0.05$).

Discussion

The increase of (LA) during exercise depends on factors that affect the lactate metabolism, and especially on production rates and exercise effort duration time. The last factor might be the reason for the fact that (LA) had not reached maximal values in 100m crawl race. This was an unexpected result, because approximately 1 minute of maximal effort exercise usually provoked very intense lactate production with low rates of oxygen uptake and enough time for (LA) to reach the peak level.[5] According to that experience the crawl swim must be specific. Other reports were congruent with the presented result.[2] They showed similar LACmax=12.8 mmol/l.[1] The importance of swimming time for development of high lactate accumulation in blood might be seen in 400m crawl event. There was (LA) similar to LACmax in A TEST, with no regard of significantly lower swimming speed (lower rate of lactate production) than in 100m crawl. This result supported the experience that 200m crawl could be useful for the assessment of maximal lactate capacity (LAC).[2]

In breaststroke swim the situation is slightly different. The significant reduction of swimming velocity between 100m and 200m events did not affect (LA) significantly. In both disciplines (LA) reached LACmax levels. There was also very close relation between (LA) and swimming times in both events, especially in the longer one. The tendency for higher correlation coefficients at longer distances in crawl and breaststroke events might be similar to the relation between swimming intensity and duration. It seemed that maximal intensity and short duration time (1 minute) did not affect LACmax. Lower intensity but longer duration time, where lactate accumulation occured at slower rate but for a longer period, might be more suitable for (LA) increase to the peak LACmax levels.

Thirdly, the butterfly swim showed a specific situation in the relationship between (LA) and swimming results. More than 2 minutes long intense exercise led to (LA) concentration which was not statistically lower than LACmax but showed tendency to be lower. There was also no significant relationship between (LA) and swimming results in 200m event. So the question concerning duration (distance) of swimming which caused LACmax, remained open. On the basis of obtained correlations it could be concluded that crawl swimming at the individual lactate threshold and at the lactate level of 4 mmol/l improved swimming performance not only in crawl but in breaststroke and butterfly swimming as well. The positive mutual correlation indicated the existence of common aerobic capacities in case of increased efforts demanded at 4 mmol/l lactate level.

Conclusion

The endurance component of competition results can be evaluated fairly accurately. The B TEST, 5x (3x200m) crawl increased, is appropriate for evaluating the efforts at the lactate threshold of 4 mmol/l lactate concentration and partly for the efforts representing lactate tolerance.

The component of competition results related to the velocity endurance and lactate tolerance can be evaluated less accurately. Therefore we can suggest that the information concerning swimmer's tolerance to lactate concentration in blood should be completed by testing series which is to be performed in specialised swimming styles. The pace, heart rate, and lactate concentrations should be monitored throughout the series.

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