Studies on lactate peak in blood following judo match

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Summary

Introduction. Physiologists are of the opinion that measurements of blood lactate (LA) following a single judo match provide information about mode and intensity of an exertion. However, LA determination in single blood sample after effort ignore lactate kinetics over short-lasting recovery, thus, it is hard to predict the time of achievement of maximal lactate level (peak), and optimal time point of blood sampling. That difficulties appear especially after interrupted exercise of various rest intervals. To detect appearance of peak LA we investigated time course of LA after official judo matches of various durations.

Material and methods. The study has been conducted among male twenty nine polish senior judokas taking part in one-day international judo tournaments. Blood was sampled several times following a first contest of competition. The time points of blood sampling were 1, 3, 5, 7, 9, 11 and 15 minute after contest.

Results. Our finding revealed two-stage change of LA (rise and drop) which may be approximated by U-converted curve (parabola). It had a vertex, which coordinates were corresponded to the peak LA and the time of its appearance respectively. After a match LA rose from +1 min and attained maximal value. Peak LA and its time appearance depended on match duration. After a match of longer match duration (3.5-5 min) mean peak LA was higher and earlier than that following shorter one. Also integrated data over examined time recovery AUC (area under curve) showed significantly higher acidosis after longer matches. AUC and maximal LA significantly correlated with match duration (r=+0.447, r=+389).

Conclusions. The results of our study showed the effect of match duration on post-match LA behaviour following judo match. Further studies should be directed toward finding effect of match`s time structure, especially durations of passive and active phases throughout the whole effort on lactate kinetics.

Introduction

The physiological responses to exertions undergoing by judo players during a match, have been widely explored over last decade. Typical judo contest characterises itself by number of sudden, explosive, few-second actions, separated by short-lasting interruptions. These actions (attacks and/or counterattacks) engage muscles of lower and upper limbs, and of trunk to undergo maximal anaerobic exertions. According to the rules, the overall duration of active actions lasts 5 minutes (full time), but shorter duration of contest takes place when one competitor demonstrates clear predominance over his/her opponent, that makes him/her a winner before a time. Concentrations of blood lactate level (LA) were extensively examined during competitions of martial arts, since in anaerobic exertions that parameter is informative for evaluation of contribution of energy derived from glycolysis. Studies on a wrestling matches, which actions intensities and work-time structure are similar to these of judo combats revealed, that average overall duration of non-active periods is one-third that of active periods. The increment of LA rise induced by various duration is hard to predict, but the longer the duration, the higher LA [1]. Moreover, besides of duration of whole active periods, also profile-time of non-active period contribute to the end-match LA. It seems, that interruptions during an official match play a similar physiological role as short lasting post-effort recovery i.e. they promote partly LA recovery during an effort. It was found, that the type of exertions performed in the two styles in wrestling is almost the same, however, somewhat higher mean end-match LA was noted in

Greco-Roman (14.8) compared to that in free style (12.5 mmol/L) [2]. Very high mean LA levels were recorded among wrestlers following five, 5-minute successive wrestling matches played over two days. The first match generated mean LA levels of 20.0 mmol/L, while the last one produced the level of 17.1 mmol/L [3].

The LA behaviour among judo competitors was not investigated as comprehensively as in wrestlers. Franchini E et al. reported [4], that during active post 5-min judo combat test recovery, the rate of LA removal was higher than that during passive one, but type of these recoveries did not affect performance of anaerobic task. Serrano MA et al. found positive correlation of overall perceived exertion during judo competition with maximal recorded LA, but not match duration [5]. The study by Sbriccoli et al. who examined Italian Olympic male and female judo players during laboratory anaerobic test (Wingate 30 s) and 5-minute combat test showed lower post Wingate mean LA (6.9 and 6.1 mmol/L) than those post 5-min combat test (9.9 and 9.2 mmol/L) [6]. However, these results seem to be underestimated compared with those reported by Degoutte et al. [7] who reported mean post 5-minute judo match LA of 12.3 (0.8) mmol/L.

None of the mentioned study considered effect of time sampling on recovery LA levels. Majority studies on LA levels assumed blood sampling at 3-5 minute after judo match, and some of them reported also the state 1 h after match. Such as study protocol is not sufficient for determination real lactate acidosis, for the moment when peak occurs is unpredictable [8] because of non-linear time course of LA. The goal of this study was determination of peak lactate after judo match with respect to match duration.

Material and methods

This study includes observations of post contests blood lactate levels in 29 male senior judo players, aged 24-28 y, of various weight category excluding the heaviest participants. Examined athletes took part in international tournaments. Capillary blood from earlobe was taken 7 times within 15-minute passive recovery period following first match of competition. The observations of LA included matches of durations (summarised time of active phases) were no shorter than 2 minutes. LA was measured by commercial kit DR LANGE, GERMANY, on the field condition and immediately after blood sampling. The time points of blood sampling were as follows:

+1, +3, +5, +7, +9, +11, +15 minutes of recovery period. Based on curve shape representing LA changes during short-term recovery, parabola seems to be the best approximation of La time course, when parabola vertex represents peak LA. Its co-ordinates were calculated by the formulas: time of peak LA$=-b/2c$, value of peak LA$=(b^2-4ac)/4c$, and the formula of the function is: LA(time)$=a+b*time+c*(time)^2$. Statistical significance for linear coefficient of correlation and differences between means was establish on the level of $p<0.05$. Calculations were performed using the package version 9 (STATISTICA, STAT SOFT). The protocol of this study was approved by the Ethical Commission at Institute of Sport, Warsaw.

Results

Whole group 1 (n=29) competitors was divided on two subgroups 2 and 3. Subgroup 2 comprised 18 judokas whose matches came to the end their match within the period 3.5-5 minutes, and 11 ones (subgroup 3) for whom match durations were shorter, 2-3.5 minutes. The numerical results of measurements of LA at time course for mentioned groups are displayed in Table 1. Figures 1-3 demonstrate shape of the curve representing mathematical function: LA(time) following judo match durations included in three time intervals: 2-5, 3.5-5 and 2-3.5 minutes respectively.

The results showed somewhat higher mean peak LA in the subgroup 2 (longer match duration) than in subgroup 3 (shorter match duration), however the differences (by 1 mmol/L) was not significant because of small number of compared results, especially in subgroup 3. However, mean LA2 (13.4±5.2 mmol/L) calculated from 126 individual results (18 subjects x 7 time points) was significantly higher than LA3 (12.0±4.1) which value was obtained from 77 (11 subjects x 7 time points) individual results. Moreover, mean peak time of LA3 appearance was delayed almost by 2 minute compared to that that of LA3. For the whole group (n=29) area under curve representing LA time course from 1 to 15 minute as well as peak LA correlated with duration of match (r=+0.447, r=+389).

Discussion

Beneke and co-authors [8] utilised compartmental analysis with experimental data to determinate numerical parameters for mathematical modelling of blood lactate appearance and disappearance. They approximated post Wingate LA dy-

Tab. 1. Mean time course of LA over post match short-term recovery period in judo competitors. LA1 match duration lasting from 2 to 5 minutes, LA2 from 3.5 to 5 minutes, LA3 from 2 to 3.5 minutes

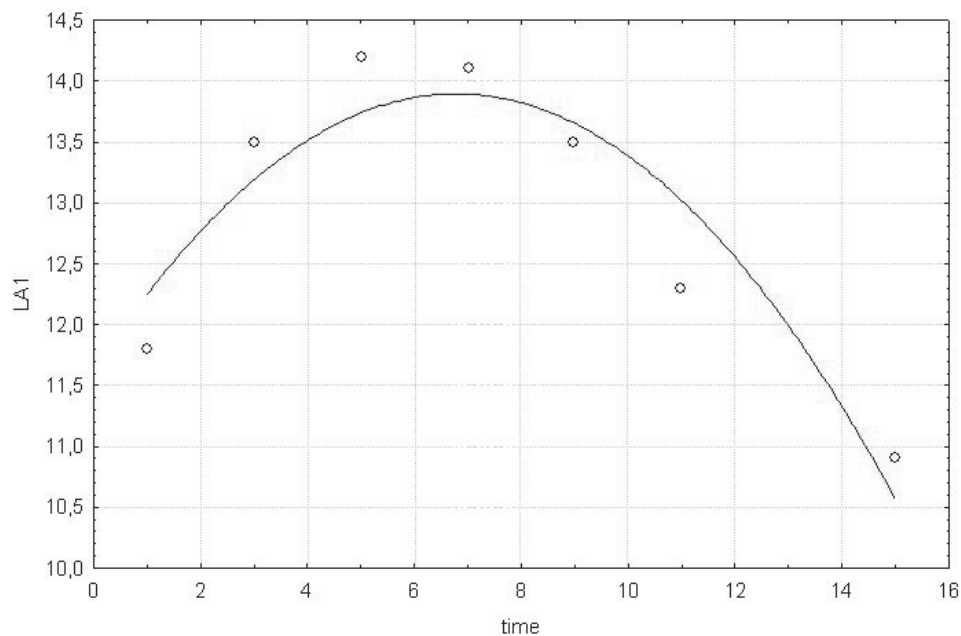| LA	+1 min	+3 min	+5 min	+7 min	+9 min	+11 min	+15 min
LA1, n=29 (SD)	11.8* (3.4)	13.5 (3.5)	14.2 (3.8)	14.1 (4.5)	13.5 (3.7)	12. 3 (3.4)	10.9* (3.2)
LA2, n=18 (SD)	12.8 (2.3)	14.6 (2.9)	14.8 (3.5)	14.2 (3.3)	13.6 (2.7)	12.6 (2.5)	11.4 (2.4)
LA3, n=11 (SD)	10.2 (2.2)	11.6 (2.3)	13.2 (2.6)	13.8 (2.9)	13.3 (2.7)	11.7 (2.6)	10.0 (2.3)

* The values significantly differ from the others

Fig. 1. Mean LA time course following matches lasting from 2 to 5 minutes. LA=11.63+0.67*time -0.049*time^2, (R=0.934). Peak LA value is 13.9, its time attaining is 7.1 minute of the recovery
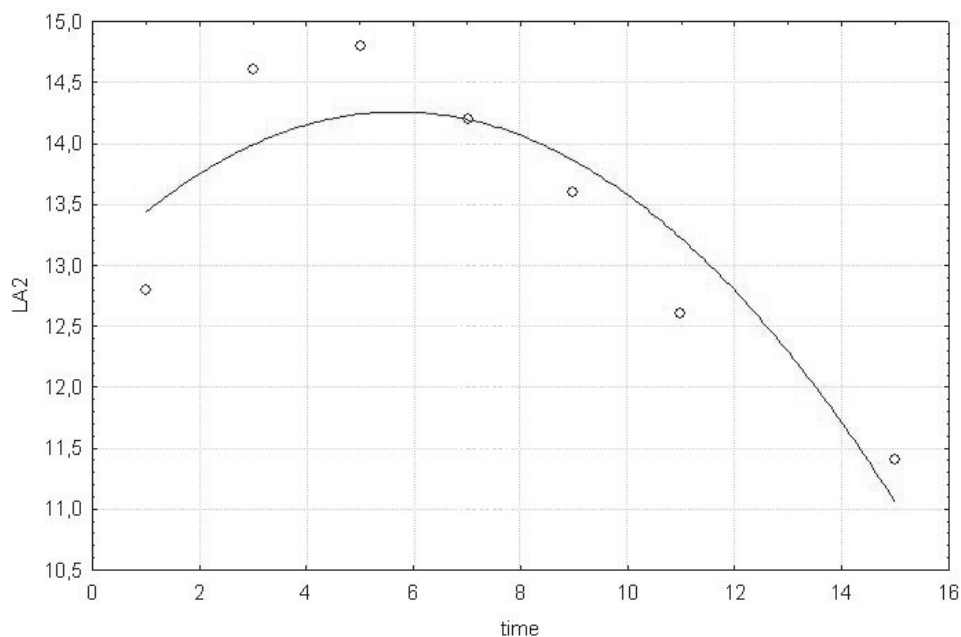

Fig. 2. Mean LA time course following matches lasting from 3.5 to 5 minutes. LA2=13.05+0.42*time -0.037*time^2, (R=0.904). Peak LA value is 14.3, its time attaining is 5.7 minute of the recovery

namics by the bi-exponential function. Based on our LA ob-servations carried out over narrow time interval obtained, we assumed, that parabola may by sufficient function for identifi-cation of time appearance of peak LA and its value. Mean LA2 in our study and its behaviour, bi-phase change with attained maximal value over short term post-match recovery was sim-ilar to the results recorded among athletes after laboratory supra maximal continual exertions, like Wingate test [9-16]. However the ranges of LA2 (9.9-19.3 mmol/L) and LA3 (8.5-16.8 mmol/L) were much more wider than those after stan-dardised, laboratory exertion. In 4/29 cases maximal LA1 reach the level of above 18.0 mmol/L. Such wide range of LA (10.2-20.7 mmol/L) was recorded by others [17] among ath-letes of mixed martial arts following contest, and somewhat
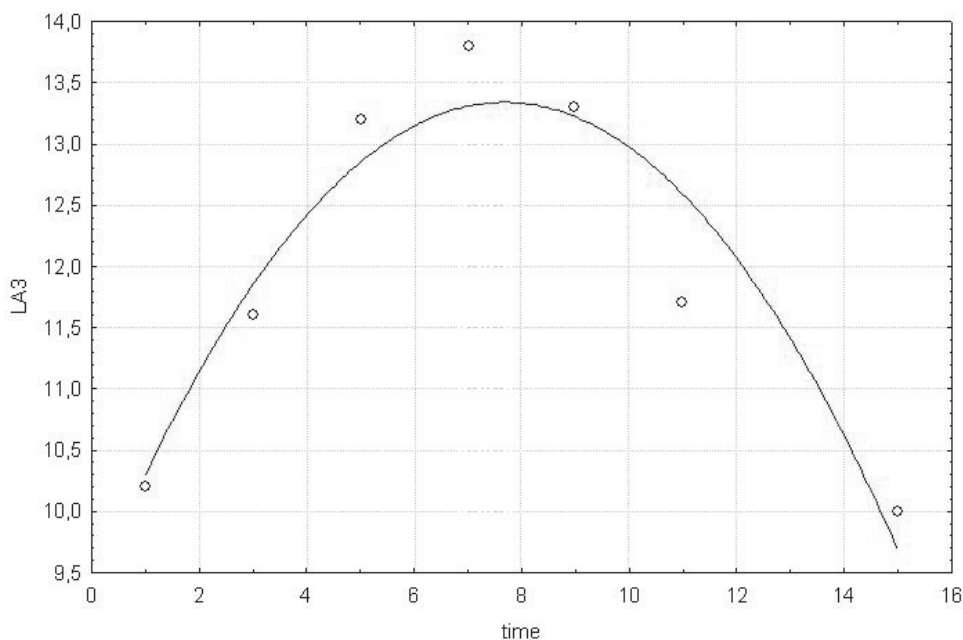
Fig. 3. Mean LA time course following matches lasting from 2 to 3.5 minutes. $LA2 = 9.32 + 1.05*time - 0.068*time^2$, (R=0.951). Peak LA value is 13.3 at 7.7 minute of the recovery

lower LA following intensive training (8.1-19.7 mmol/L). Likewise, wide range of LA (6.8-20.6 mmol/L) was recorded after an official wrestling matches of total durations from 324 to 535 s, where mean work and rest period were 317 and 110 s respectively [1]. That considerable differences as to variability of post-standardised tests and post-matches LA may be elicited by various work: rest durations of matches. Moreover, in our study effect of a match duration on its post-match LA corresponded with finding reported by others [1]. On the other side, it is worth to notice, that despite significant correlation between match duration and recovery LA in our study, in general, linear function poorly describes that relationships, even for continual, standardised tests. It has been reported, that 6 s maximal bout produces LA level of 5.4±0.4, but 5-fold longer Wingate only 12.3±0.9 mmol/L [18].

Our study revealed also considerable individual differences between time of LA peak appearance, even in competitors who underwent efforts of similar work durations. That variability may be elicit only in part by various rest intervals, since after Wingate test peak LA also appeared within relative wide range period, from 5 to 8 minutes [11-16].

It is worth to stress some limitation our study design. Firstly, because of lack of sufficient data, we had to ignore in our deliberations not only duration of non-active phase of each match, but also possible changes of work; rest ratio occurring over match, and possible differences-if exist- in intensity of attacks and counterattacks. We may expect, that some of fatigued judokas are prone to seek occasion for any rest period, or to lower intensity of exertion, in spite of increased risk of penalty (*shido*) for passive behaviour. For instance, we notice somewhat longer time utilized for correction of the uni-

form, or large number of simulated offensive actions performed in exhausted competitors, especially near the end of longer contest. Lower work-to-rest duration affect post-effort LA. Results of study on effect of duration of interruption separating repeated 40 s bouts of resistance exercises showed in exercising judokas the earlier peak LA and its lower value when interruptions were longer [19]. According to the study by Price and et al [20] overall perception of repeated bouts correlated with LA, and both of them were higher following longer effort. Similar relationships LA-RPE were found in training and competing athletes of mixed martial arts [17]. The other study showed the same exercise LA, but lower perception of repeated efforts, when recovery time periods were self-selected by runners in comparison when protocol of effort were compulsory, and established in advance (shorter rests) by researchers [21]. That seems to confirm hypothesis that obligatory, uncontrolled by performers exercise like judo match is physically stressful event.

The next limitation is ignored possible effect of unknown pre-match LA on post-match LA. Each competitors underwent worming-up prior to the first match of a tournament. Intensity of that pre-match work and induced by it LA is hard to estimate. Finally, we do not know changes of blood volume shift and in turns effect of the changes of haemoconcentration over recovery period on measured LA. It is known, that after continuous supra maximal test Wingate 30 s) plasma volume decreases on average from 12.0±3.4 [16] to 17.4±2.6% [22]. That effects may be take into consider if instead of LA level, absolute amount of LA in blood is assumed as a marker of post-exercise glycolysis.

Conclusions

Male judo competitors reach higher blood lactate levels following longer match duration.

Peak lactate appeared earlier and its value was higher after longer match duration.

A parabola, U-converted shape curve, well represents LA time course of recovery period until 15-minute after end-match.

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