

RELATIONSHIP BETWEEN PHYSIOLOGICAL AND TECHNICAL PARAMETERS DURING AN EXHAUSTIVE TEST IN HIGH LEVEL SWIMMING

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INTRODUCTION

In swimming, numerous articles focused on the physiological aspect of fatigue (Keskinen and Komi 1988, 1993; Keskinen 1989) although only few authors studied the kinematic aspect of fatigue (Deschodt 1999). As concluded by Deschodt (1994;1999) who observed only sagittal view of the hand trajectory, fastest swimmers had the greatest fingertip coordinate on antero posterior (F) and on vertical axis (D). Under fatigue, a decrease of stroke velocity (SV), stroke rate (SR), stroke length (SL) was observed (Craig and Pendergast 1979; Keskinen 1989; Keskinen and Komi 1988 and 1993) and in hand displacement for F and D (Deschodt 1999). In order to understand the evolution of kinematic parameters under fatigue, the aim of this study was to investigate the relationship between fatigue and the 3-D kinematic parameters in elite swimmers.

METHODS

Ten male international swimmers (1.87 m \pm 7.54, 79 kg \pm 6.53, 22.5 yrs \pm 2.29) participated in this study. The 100m freestyle performance ranged from 49,07s to 53,98 (50,63s \pm 2,12). Each athlete performed 4*50 m in freestyle at maximal velocity separated by a 10 s rest period corresponding to a broken 200 m. Capillary blood sample (5 μ l) was taken before and immediately after the test. Two digital cameras filmed frontal and sagittal views of aquatic stroke. Right hip joint and fingertip were digitized frame by frame to determine the swimmer displacement and the hand trajectory. Stroke parameters measured were SR, SL and SV. According to Maglischo (1986), different maximal coordinates of the fingertip trajectory were studied (F) on the antero-posterior axis, (D) on the vertical axis, maximal outward (O) and inward (I) on the transversal axis. The effects of fatigue was evaluate from the comparison of the different parameters between the 1st and the 4th 50 using a Wilcoxon test ($p < 0,05$). The parameters significantly different were computed into a principle component analysis (PCA).

RESULTS AND DISCUSSION

[L_{max}] attained 12.98 \pm 2.79 mmol.l⁻¹ at the end of the test and was comparable to 200m race (Bonifazi

and Carli, 1993). This physiological parameter indicated a peripheral fatigue (Hermansen 1981) and the decrease in velocity between the 1st and the 4th 50m (14,02% \pm 6,06) attested the reaching of fatigue (Bonnard et al. 1994). At the end of the test, SR, SV, O(t) and I(t) decreased significantly (Table 1). In agreement with Toussaint and Beek (1992), the SR decrease could result from a decrease in force production engendered by a peripheral fatigue (Hermansen 1981) or by a failure in neural activation (Keskinen and Komi 1993). At the opposite, spatial parameters did not changed under fatigue. The maintaining of the hand trajectory suggested the existence of a robust spatial pattern in accordance with Rodacki et al. (2001). The closed position of [L_{max}], SR and SV in the PCA diagram indicated that the fastest swimmers presented the higher [L_{max}] associated to higher SR (Figure 1). These results confirmed previous studies (Keskinen and Komi 1988 and 1993; Cappaert et al. 1995). Weiss et al. (1988) underlined the importance of SR and lactate tolerance capacity for high level swimming. The opposite situation of SV, SR, [L_{max}] to O(t), I(t) indicated that best swimmers presented the lower duration of the insweep phase. They spent less time for similar spatial trajectory, and as a result presented higher hand velocity. Schleihauf et al. (1983) observed that elite swimmers were characterized by the most rapid hand actions during the insweep phase. The present study confirmed this result in fatigue situation.

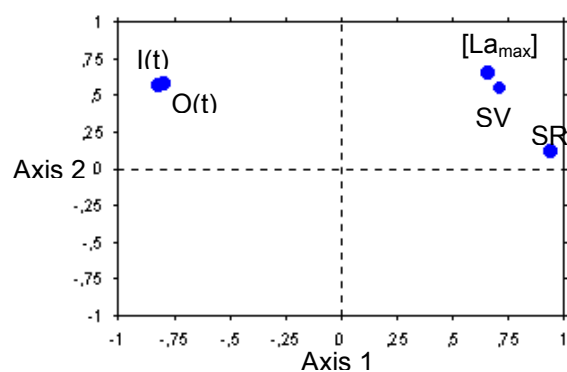


Figure 1: PCA representation of stroke and physiological parameters.

Table 1 : Mean and standard deviation for physiological and stroke parameters during the 1st and the 4th 50m. (*p<0.05; **p<0.01).

Parameters	1 st 50m	4 th 50m	z	p
Lactate(mmol ^l)	1.03±0.13	1298±279	-2.80	0.005**
SR(cycmin ⁻¹)	34.5±5.91	31.45±4.4	-2.19	0.023*
SL(m)	2.26±0.29	2.08±0.2	-1.58	0.114 N.S.
SV(ms ⁻¹)	1.29±0.2	1.08±0.9	-2.80	0.005**
Forward(X)(cm)	68±24	68±26	-0.18	0.086 N.S.
Depth(Z)(cm)	-67±8	-68±8	-0.51	0.610 N.S.
Outward(Y)(cm)	-1±12	-10.3±23.7	-1.07	0.284 N.S.
Inward(Y)(cm)	-23±15	-24±23	0.15	0.878 N.S.
Forward(t)(s)	0.47±0.16	0.5±0.15	-0.81	0.414 N.S.
Depth(t)(s)	0.70±0.16	0.73±0.20	-0.56	0.575 N.S.
Outward(t)(s)	0.82±0.15	0.93±0.16	-2.17	0.03*
Inward(t)(s)	0.59±0.13	0.70±0.16	-2.24	0.025**

SUMMARY

The fatigue of highly skilled swimmers was characterized by a stable spatial hand pattern associated with an increase of time pattern for O and I. The maintaining of the hand trajectory even the fatigue suggested the existence of a robust spatial pattern.

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