KINEMATICAL ANALYSIS OF SWIMMING FREESTYLE HAND-PATH WITH AND WITHOUT HAND-PADDLES

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INTRODUCTION

Hand-paddles (HP) have been widely used as overload devices for specific resistance training in swimmers. However, the specificity level of training that can be achieved with such devices is still a matter of scientific controversy and a topic of sport science research.

Swimming with and without HP was compared by different authors using different parameters: intersegmental angles, hand distance and stroking times (Stoner and Luedtke, 1979); qualitative comparison of hand-paths and stroking times (Welch, 1981); EMG patterns (Bollens and Clarys, 1984; Monteil and Rouard, 1990) and energetics and propulsive efficiency (Toussaint et al., 1989).

Despite the number of reports published, only few kinematic quantitative data are available concerning this topic.

The purpose of this study was to compare the kinematical characteristics, in the sagital plan, of the hand-path of the front crawl stroke, when performed with and without HP.

METHODOLOGY

Six male junior and senior portuguese national level swimmers were studied. Mean age, weight and height were respectively 19.7 (±3.50) years, 77.4 (±9.91) kg and 178.1 (±6.36) cm.

Each subject performed 6 times 25m, at maximal speed starting from the wall, in a indoor swimming-pool were the light was reduced as much as possible without compromising swimmers spacial orientation. Three of the 25m lenghts were performed with *Win* 12x19cm rectangular HP, and 3 without them. Before each 25m exertion, a rest period of at least 3 min was observed.

Hand-path was assessed using the light-trace method (Lewillie, 1971), which consists on the photographic registration, with prolonged exposure, of a light trace produced by a 6v (0.05A) lamp, adapted to the distal phalange of the middle finger of the right hand, or to the distal border of the hand-paddle in the same position in relation to the finger. The lamp was powered by a 9v battery fixed to the forearm of the swimmer.

Photographs were taken with a *Cannon* underwater camera, with a 35 mm objective, set for permanent exposure. Films were *Kodacolor 1000 ASA*. The camera was placed on the

Subjects	H (free)	H (HP)	V (free)	V (HP)	T (free)	T (HP)	H/V (free)	H/V (HP)
1	76.69	67.11	71.76	68.56	242.12	220.34	1.07	0.98
2	83.84	71.78	92.36	79.13	258.24	231.57	0.91	0.91
3	69.77	57.42	70.82	61.52	204.65	185.98	0.99	0.93
4	96.48	88.74	89.04	87.12	264.22	242.30	1.08	1.02
5	63.62	49.24	79.24	77.74	211.42	199.87	0.80	0.63
6	73.53	65.95	87.83	86.05	245.03	241.25	0.84	0.77
Mean	77.32	66.71*	81.84	76.69	237.61	220.22*	0.95	0.87*
SD	11.57	13.44	9.25	1.00	24.42	23.00	0.12	0.15

*($p<0.05$)

Table 1. Individual data, mean and standard deviation (SD) for horizontal (H), vertical (V) and total (T) amplitudes (in cm) of the hand-path on the sagital plan, obtained with (HP) and without hand-paddles (free). H/V ratio with and without hand-paddles are also shown.

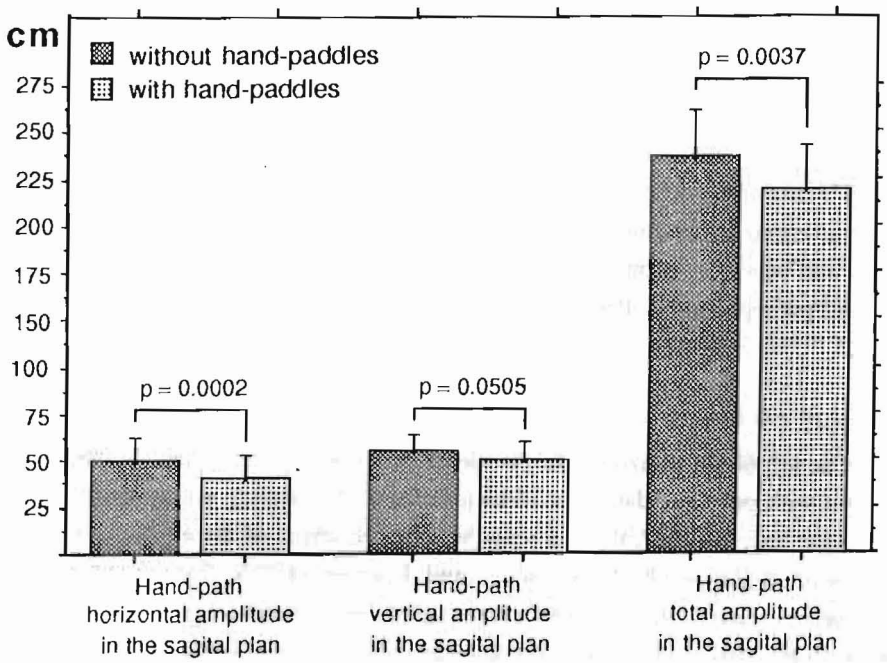

Figure 1. Mean and standard deviation values for horizontal, vertical and total amplitudes of the hand-path on the sagital plan, obtained with and without hand-paddles.

lateral wall of the swimming-pool at a 20 cm depth and at a 5 m distance from the longitudinal axis of swimmers displacement. The optical axis of the camera was placed perpendicularly to the swimmers movement direction.

Photos were digitized using a *Calcamp* digitizing table, the *Sigma Scan* software and a PC computer. Calibration for distance was obtained using a photograph of a distance calibration bar, which contains two lamps placed 50 cm apart, that was photographed in the longitudinal axis of the swimmers movement.

After digitizing, hand-path horizontal, vertical and total amplitudes were calculated for the front crawl performed with and without HP by each subject. Horizontal amplitude / vertical amplitude ratios (H/V) were also calculated, both for free and HP swimming.

Mean (X), standard deviation (SD) and two tail Student t-test ($\alpha = 0.05$) were used for statistical analysis of data.

RESULTS

Table 1 presents the individual data, mean and standard deviation values for all quantitative parameters studied. Figure 1 presents the results graphicaly.

For all subjects and for all the parameters, values were higher when front crawl was performed without HP. However, mean values were significantly different ($p<0.05$) only for horizontal amplitude, total amplitude and H/V ratios. For the vertical amplitude of the hand-path, differences were not significant ($p=0.0505$), despite p value was quite low considering $\alpha = 0.05$.

Qualitative analysis of hand-paths show that: (i) swimming freely, not all subjects reveal a exit point of the hand placed ahead of the entry point, which was observed in all cases when front crawl was performed with HP; (ii) in the photographs, the insweep phase is clearly characterized by a reduction in light trace intensity, which reflects an inside orientation of the lamp and was more pronounced in all cases when swimmers performed freely, and (iii) general hand-path profile in the sagital plan, with and without HP, were similar for all swimmers.

DISCUSSION

Reduction of the horizontal amplitude of the hand-path when performing with HP, is in agreement with previous data from Welch (1981). This finding seems also supported by the observation that, with HP, the exit point was placed ahead of the entry point in all cases, which agree with the results from Stoner and Luedtke (1979), that shown a significant difference between left hand entry and exit points in both situations. The reduced H/V ratios observed with HP also suggests that they induces a higher antero-posterior hand stabilization, which seems to agree with the higher distance per stroke observed by Toussaint et al. (1989) in this situation.

Reductions in amplitudes observed in the sagital plan are also congruent with the increased light intensity during the insweep for HP swimming, which suggests a reduction of the hand-path amplitude also in the frontal plan. This reduction in hand-path amplitudes is also congruent with the findings and arguments of Toussaint et al. (1989), despite these authors assumed that hand-path is unchanged when HP are used.

The similarity of the general profiles of the hand-paths in both tested situations is in agreement with reports from Andersen (1976) and Welch (1981). Despite this similarity, differences in amplitudes suggest that HP are not completely specific overload devices for swimmers. This view seem to be supported by the results from Bollens and Clarys (1984), which concluded that not all types of HP allow the reproduction of the EMG pattern of the free front crawl technique. EMG data from Monteil and Rouard (1990) also pointed out that swimming technique may be disturbed by the use of HP, specially in sprint swimmers.

A possible training solution for this problem may consist in the simultaneous improvement of body drag, for instance with drag suits. However, further research is needed to confirm this hypotesis.

CONCLUSIONS

HP are not completely specific overload devices for swimmers, since, when compaired with free front crawl swimming, they seem to improve antero-posterior hand stabilization and reduce hand-path amplitudes, at least in the sagital plan.

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