Characterisation of hand's velocity in butterfly stroke according to the breathing technique

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1. INTRODUCTION

The study of the hand's kinematics, specially his path, is one of the major points of interest for researchers in biomechanics of swimming.

For exemple, Martins-Silva et al. (1999) showed the importance of all components of the hand's velocity in the intracyclic variations of the velocity of the centre of mass in butterfly.

However, only a few studies performed an analysis of the mean hand's velocity along the different phases of the butterfly stroke cycle, and/or a 3D kinematical analysis instead of a 2D type.

Moreover, there are no studies available in the literature describing the behaviour of the hand's velocity according to the breathing technique adopted by the butterfliers.

Therefore, the propose of this investigation was to characterise, from a 3D perspective, the hand's velocity in butterfly stroke, and to compare it according to the breathing technique adopted by the swimmers.

5. REFERENCES

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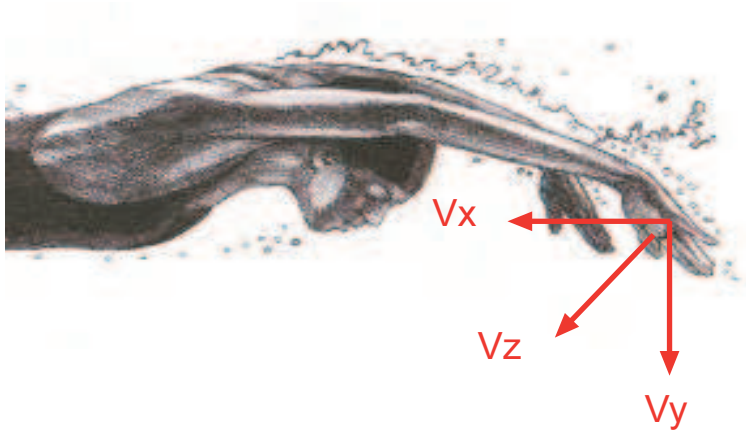
2. METHODS

7 male swimmers (18.4+/-1.9 years old; 68.600+/-6.828 Kg of body mass; 175.8+/-6.2 cm of height) of national and international level were studied.

Each swimmer performed 3 sets of 3x25 meters with a in water start, at a constant velocity and as close as possible to their maximal speed, using exclusively frontal breathing cycles, lateral breathing cycles and non-breathing cycles in each set.

For the 3D analysis of the stroke cycles, it was used the recording and analysis procedures described by Barbosa et al (2002a; 2002b), wich included images from 4 oblique planes (including 2 “dual media images”).

The study comprised the analysis of complete stroke cycles in Butterfly using the “Ariel Performance Analysis System” from Ariel Dynamics Inc. and a VCR (Panasonic AG 7355) at a frequency of 50 Hz. It was adopted the Zatsiorsky’s model adapted by de Leva (1996) with 22 anatomical points of reference. The 3D reconstruction of the digitised images was performed using the “Direct Linear Transformation” procedure (Abdel-Aziz and Karara, 1971).



The variables in study were the three components (horizontal, vertical and lateral) of the hand's velocity and the resultant velocity, in each phase of the subaquatic path (entry, downsweep, insweep and upsweep).

Differences on the hand's velocity between the breathing techniques were tested using the "ANOVA for repeated measures" technique ($p<0.05$).

3. RESULTS

We only observed two situations where it was found significant differences in the hand's velocity, according to the breathing technique adopted by the swimmers.

The horizontal component of the hand's velocity presented higher values during the entry using lateral inspiration than when the frontal breathing technique was used [$F(1;6)=6.296$, $p=0.0460$]. The horizontal component of the hand's velocity was significantly higher using non-breathing cycles than using the frontal breathing technique [$F(1;6)=14.462$, $p=0.0089$].

However, in the most propulsive phases of the stroke cycle, the insweep and the upsweep, there were no significant differences on the velocity of the hands, both in any of the three components or in the resultant velocity. With a careful observation, it was observed a high values for the standard deviation in all the dependent variables in study.

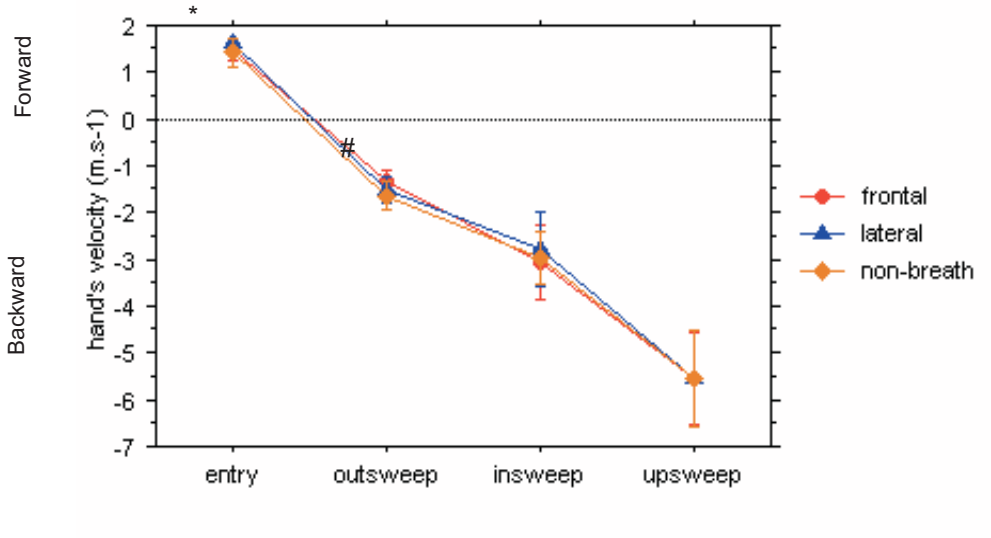


Figure 1. The intracyclic variation of the horizontal hand's velocity using the three breathing techniques in butterfly.

* - p<0.05 between frontal and lateral breathing

- p<0.05 between frontal and non-breathing

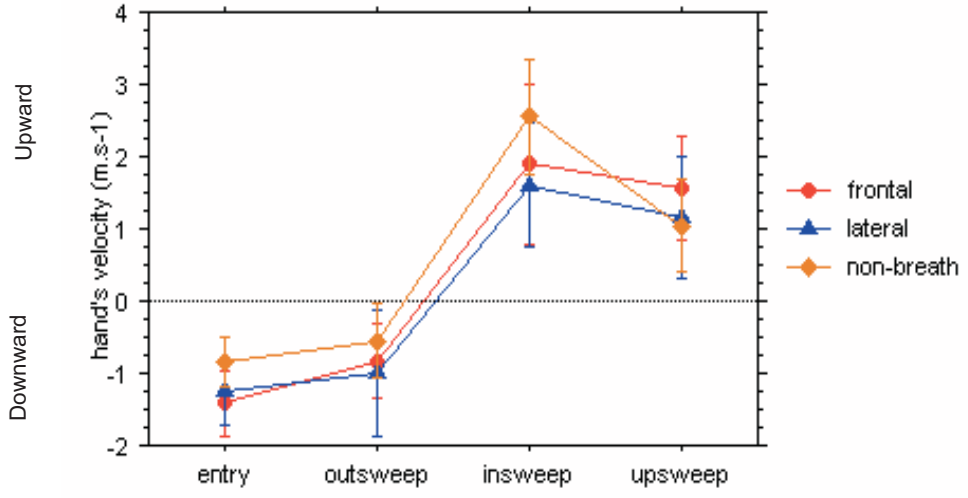


Figure 2. The intracyclic variation of the vertical hand's velocity using the three breathing techniques in butterfly.

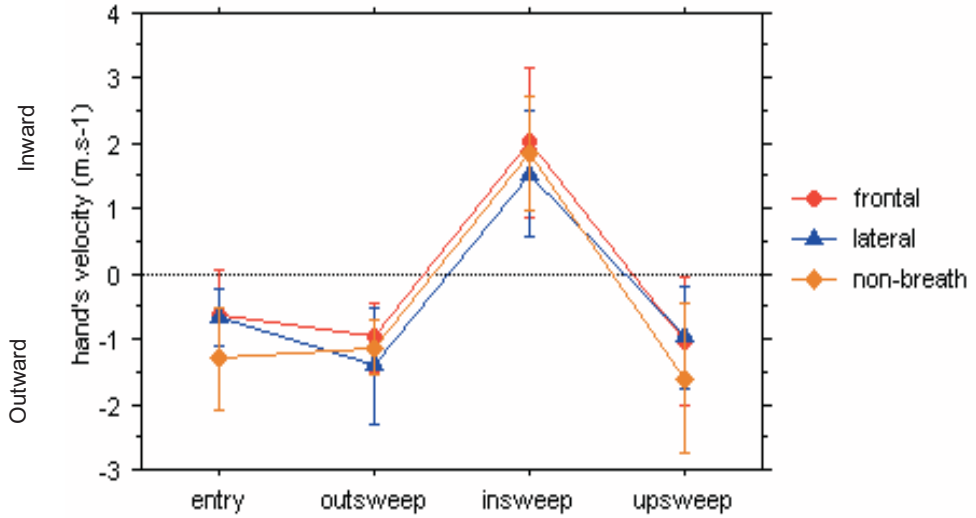


Figure 3. The intracyclic variation of the lateral hand's velocity using the three breathing techniques in butterfly.

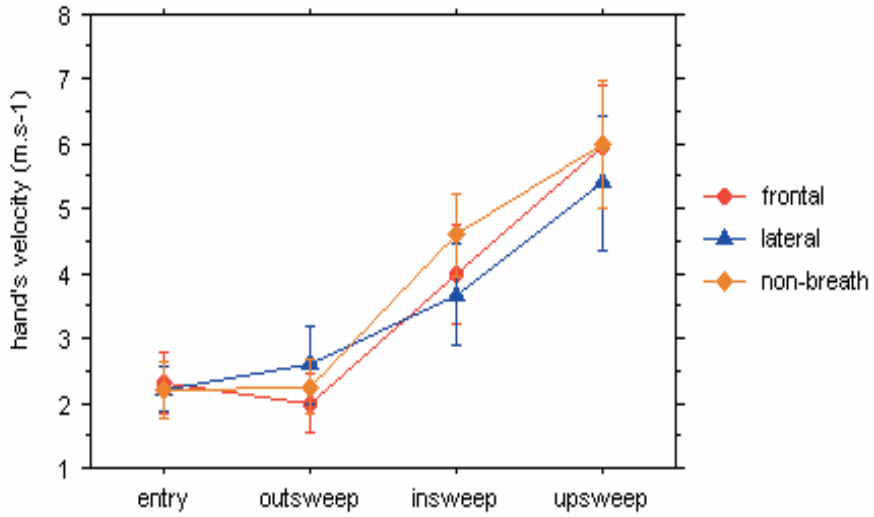


Figure 4. The intracyclic variation of the resultantl hand's velocity using the three breathing techniques in butterfly.

4.3. DISCUSSION/CONCLUSIONS

The analysis of the resultant of the velocity of the hands revealed that, in all the breathing techniques, there was a some what exponential increase of the variable during the stroke cycle.

The higher value was achieved during the upsweep, as Schleihauf et al. (1988) reported. The higher values of the horizontal component of the hand's velocity, during entry, using lateral breathing when compared with the frontal breathing technique, might produce an increase of the turbulence and of the wave drag (Clarys, 1979). This, probably will decrease the horizontal velocity of the centre of mass and will increase his intracyclic variation.

The higher values of the horizontal component of the velocity of the hands using a non-breathing technique instead of the frontal breathing technique specially during the downsweep, might be due to a great production of Propulsive Drag, instead of Lift Force (Schleihauf et al, 1988). In fact, this phenomena is probably related with the higher horizontal amplitude of displacement of the hand, and the less vertical amplitude observed in the non-breathing cycles.

The high standard deviation observed in almost every components and resultant of the velocity of the hands, using the three breathing techniques, might be a result of inter-individual differences in the hands path of the swimmers (Martins-Silva et al., 1999).

In conclusion, there are reduced evidences of significant modifications in the hand's velocity according to the breathing technique adopted in the butterfly stroke.