

An analysis of kinematics parameters in finswimming.

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Introduction:

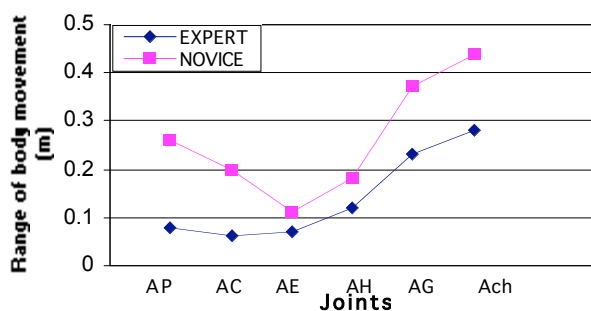
Finswimming is a sports discipline, which is practiced at surface and at underwater. Alike the motion of dolphin, propulsion in this activity is based on the undulatory motion of the whole body, completed by a monofin of average size (Plaut, 2000). Finswimming technique excludes the use of the arms for propulsion purposes. In fact, propulsion is entirely due to lower limb oscillations, which initiate at the hip level (Baly and coll., 2001). Current scientific knowledge about finswimming comes especially from an analogy with fish kinematics (Drucker and coll, 2000) or with the butterfly stroke (Sanders and coll, 1995). Notwithstanding, some studies analysed finswimming dynamics (Rejman and coll, 1997) and defined ankle flexibility as the utmost criterion for efficiency (Kerll, 1986). The aim of the present is to understand through a kinematics analysis how finswimmers limit drag. In addition, such an analysis still remains the only means of validation of mathematical models under development.

Method:

Eight finswimmers, including four high-level experts, participated to the experience in a 25 meters pool. With body marks (wrist; elbow; shoulder; hip; knee; ankle), they were filmed in the sagittal plan by a numerical camera (50Hz) immersed in a watertight box. Finswimmers swam 25 meters on the surface at a maximal speed, equipped with a monofin specific to their gender. The space of measurement was gauged. Then it was calibrated with respect to an object of known size at the subjects' expected level of passage. The underwater video frames were then digitised at the end of the three trials performed per individual, so that kinematics (speed, position and angular acceleration of the markers) were obtained.

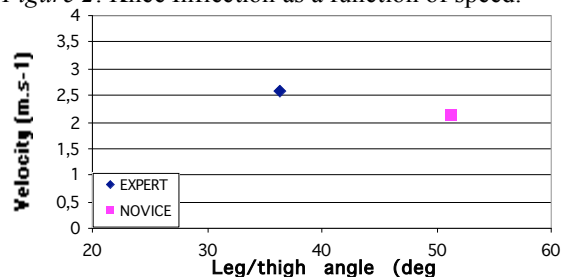
Results:

Figure 1: Joint amplitudes



For expert swimmers, velocity ($2.59 \pm 0.31 \text{ m.s}^{-1}$) was higher ($2.13 \pm 0.11 \text{ m.s}^{-1}$), and their body oscillations were smaller than for beginners (see Figure 1). Moreover, hip inflection was more substantial for beginners ($51.23 \pm 7.97 \text{ deg.}$) than for experts ($36.27 \pm 2.02 \text{ deg.}$) (see Figure 2). Another difference in stroke style pertained to wrist (AP) and the knee (AG) longitudinal amplitudes. Beginners were characterized by high joint amplitudes ($0.26 \pm 0.06 \text{ m}$ for AP and $0.37 \pm 0.09 \text{ m}$ for AG), as compared to experts ($0.08 \pm 0.04 \text{ m}$ for AP and $0.23 \pm 0.08 \text{ m}$ for AG).

Figure 2: Knee Inflection as a function of speed.



Discussion:

Our study aimed to identify the mechanisms brought about by expert finswimmers to limit drag, thereby improving performance. Our results showed that a first strategy bears on minimal knee inflection and low wrist amplitude. Second, high-level finswimmers also reduce their body pitch, because during the race the trajectory of the upper girdle remains relatively rectilinear. They preserve an optimal girdling in a short sprint (25 m). As well, expert finswimmers' technique enables them to benefit from a significant propelling surface without slowing down (angular acceleration at the level of the hip of the skilled: $3.19 \pm 0.90 \text{ rad.s}^{-2}$ against $2.08 \pm 0.61 \text{ rad.s}^{-2}$ among beginners). An ongoing survey will analyse stroke frequency and the joint sequencing.

Conclusion:

Expert finswimmers limit the maximum body pitch, as well as knee inflection to reach a high speed. High performance does not only reside in muscular power output, but also on an efficient stroke technique, optimized by an effective tonicity.

References:

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