THE LIFT COMPONENT PRODUCED BY THE UPPER LIMBS DURING THE BREAST STROKE

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INTRODUCTION

It is known that a breaststroke swimmer's speed varies during a stroke cycle. Immediately after the leg drive (see Figure 1) the swimmer experiences a negative acceleration (-a) phase because the water resistance (R) is temporarily greater than the propulsive forces generated by the swimmer. This is followed by a phase of positive acceleration produced by the forces generated by the upper limbs.

The purpose of this study was to determine the relative contributions of the lift and drag components of the forces produced by the upper limbs in causing the observed positive accelerations of the body. It was assumed that the lift component would be the greatest during lateral limb movements and that the drag component would be the greatest during backward limb movements. It was also assumed that the greatest positive acceleration of the swimmer would occur during the time of greatest positive tangential force production by the limbs (re. Newton's Second Law). A positive tengential force is one that acts in the same direction as the movement of the swimmer's body and that has a magitude greater than that of the resistive forces opposing the body's motion.

PROCEDURE

The subjects used in the study were three members of the Women's Varsity Swimming Team at the University of Northern Colorado. The subjects were told to move their upper limbs in a regular breaststroke pattern and to hold their lower limbs straight behind their bodies without movement. Thus, the propelling force could only be generated by the upper limbs. A top view of each swimmer was filmed at 100 frames per second using a Photo-Sonics camera and it was digitized on a Vanguard Motion Analyzer. The body acceleration data were derived from data obtained by digitizing the position of the left shoulder joint of each swimmer. An underwater hand-path was obtained by digitizing the positions of each swimmers left hand. An absolute coordinate system was used in the digitizing process.

RESULTS

The underwater hand-paths of the swimmers were similar and a typical path is that shown in Figure 2. Also shown in Figure 2 is the phase of the hand movement where the greatest positive acceleration of the swimmer was observed.

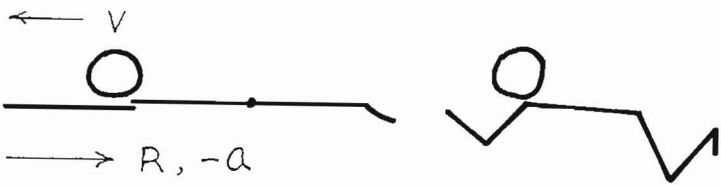

Figure 1. The negative acceleration (-a) phase that follows the leg drive.

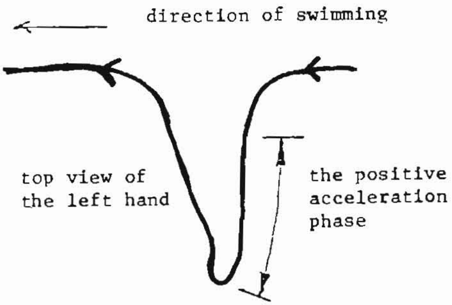

Figure 2. The underwater hand-path and the location of the positive acceleration (+a) phase

During this phase the movement of the hand is outward or lateral to the body and perpendicular to the direction of the swimmer's movement.

CONCLUSION

Since the hand movement during the phase of greatest positive acceleration of the swimmer's body was outward and perpendicular to the direction of the swimmer's motion, it was concluded that the hand's drag force, which also has a direction perpendicular to the direction of the swimmer's motion, would have no effect in producing the observed increase in speed. Also since it is known that the lift component of a fluid is generated perpendicular to the direction of a object's motion through that fluid, it was concluded that it was the lift component of the hand movement that generated the positive tangential force that produced the increase in speed and positive acceleration of the swimmer.