KINEMATIC CHARACTERISTICS OF THE BACKSTROKE START

Hideki Takagi and Satoru Adachi

Graduate School of Comprehensive Human Sciences, University of Tsukuba
Email: takagi@taiiku.tsukuba.ac.jp

INTRODUCTION

The backstroke start is the only start from the water in the competitive swimming events. The reason why it is difficult to analyze both motions on the water and under water simultaneously, has been minimizing the number of paper compared to a normal start on the block. The backstroke start is unique motion in the following respect, the swimmer's back is arched during the airborne phase so that only the feet and the hands touch the water while the rest of the body is above the water line. Due to few in number of paper, it has not been illustrating kinetic/kinematic characteristics of the backstroke start. Therefore, the purpose of this study was to clarify the features of the backstorke strat by using varied subjects.

METHODS

The subjects were a total of 13 backstroke swimmers. The breakdown was 8 males and 5 females; 5 juniors (at age 18 years or younger) and 8 seniors; 7 intermediaries and 6 experts (including an Olympic swimmer). All subjects were informed of the research intent, content, and existence of risk prior to commencing research, and their written consent to participate was obtained. Each subject was requested to execute a start three times, and after completing the underwater dolphin kicking, they surfaced and swam full speed until the 15m line.

The starting motion is primarily a movement of the sagittal plane and is nearly a bilaterally symmetrical movement. Therefore, the action was analyzed on a 2-dimensional plane from the swimmer by using the video analysis software (Frame DIAS II, DKH). Four CCD cameras were placed at both above water and under water to acquire the whole-body images of the swimmer. The body center of gravity (CG) coordinate was calculated, and the barycentric velocity was obtained utilizing Lagrange polynomial interpolation through numeric differentiation. A total body angular momentum (L) was calculated by the equation (1).

$$L = \sum_i (R + r_i) \times m_i (V + v_i) \qquad (1)$$

where r_i is the distance of particle i from the reference point, m_i is its mass, and v_i is its velocity.

RESULTS AND DISCUSSION

A relationship of the push-off angle (an angle between the velocity vector of the CG and the horizontal vector) to the body angle (an angle between the line segment from the toe to the CG and the horizontal line) at the take-off moment, is shown in Fig.1. The push-off angles were all of negative values, and there was a significant relationship ($p<0.01$) between the push-off angle and the body angle. These results reveal that backstroke swimmers controlled the push-off angle by degree of the body incline during starting motion. In addition, the swimmers made moment to bow their head at the take-off. An example of changes of the total body angular momentum about the CG and stick diagrams of motion at every 0.2-second are shown in Fig.2. An expert made larger angular momentum than an intermediary from the beginning to the end. In particular from 0.4 to 0.6 seconds, the expert produced lager angular momentum than the intermediary by inclining his neck backward. The stick diagrams indicate that the expert's back was more arched during the airborne so that drag against the water was reduced rather than the intermediary.

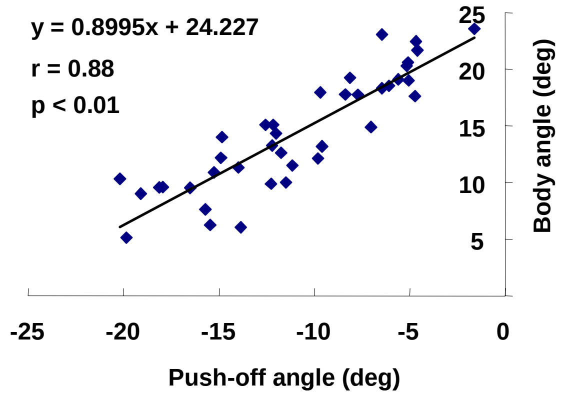

Figure 1: A relationship between the push-off angle and the body angle at the take-off moment

CONCLUSIONS

The backstroke start is relatively similar to the Fosbury Flop in high jump but seems to be very unusual motion. Therefore, the level of starting skill possibly makes large difference for a total performance in the backstroke. Moreover there is room for further research into kinetic analysis of the backstroke start to improve the performance.

REFERENCES

1. Wilson, B. D. and Howard, A. Movement Pattern-Recognition in Description and Classification of the Backstroke Swim Start, *Journal of Human Movement Studies*. **9**(2): 71-80, 1983.

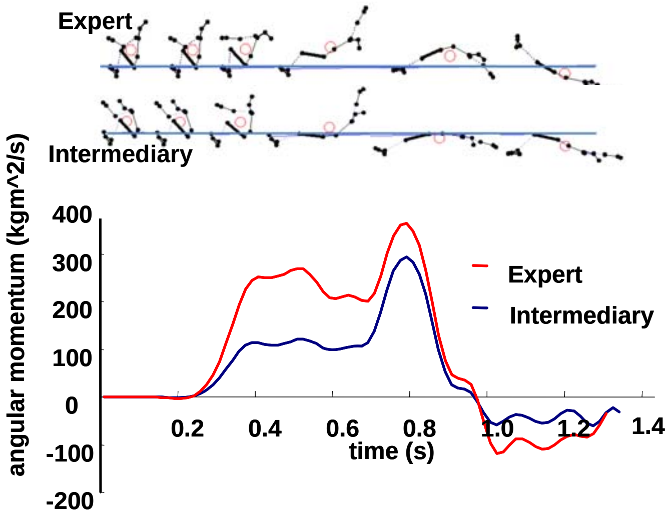

Figure 2: An example of changes of the total body angular momentum and stick diagrams for an expert and an intermediary.