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BIOMECHANICAL ANALYSIS OF LOWER LIMBS DURING UNDERWATER GLIDING AND DOLPHIN KICK MOVEMENT IN SWIMMER

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SUMMARY

The purpose of this study was to analyze the underwater gliding and dolphin kick movement in collegiate competitive swimmer. Six male collegiate swimmers were monitored with a video camera (SK-2130, SONY, Japan) with a sampling frequency of 60Hz in the sagittal plane to measure the angular displacement of their different joints. The wireless electromyography system (Biolog DL-5000, S&ME, Japan) was used to collect the muscle activities from the rectus abdominis, rectus femoris and hamstrings. A motion analysis system (Frame-DIAS4, DKH, Japan) was used to digitize ten body landmarks. The following results were obtained: the highest speed was maintained during the gliding movement when the knee and the hip joint angles of 180 degrees were maintained from push off the wall to 0.8sec. In addition, swimming speed slowed down when the flexion-extension movements in the knee and the hip joints were observed during the gliding movement. These results suggested that the subjects could not maintain the knee and the hip joint angles of 180 degrees during the gliding movement, as the results, might try to maintain the body balance by the flexion-extension movements in the knee and the hip joints. Moreover, the swimmer who maintained a superior streamline maintained the high velocity in the phase that the dolphin kick was performed. Therefore, during the underwater phase during starts and turns, it is a necessity that the swimmer maintained a streamline posture.

INTRODUCTION

The improvement of swimming performance is related not only to the effect of stroking but also gliding movement of the start and the turn phase. Furthermore, it is important that the momentum created by a swimmer in swimming direction is larger than against swimming direction. Passive drag is produced by measuring the force necessary to tow a swimmer through the water at a constant speed with his body in a prone position [1]. The underwater gliding movement during the start and turn phases are important for the total race time in modern swimming [2]. We hypothesized that acceleration by underwater dolphin kick movement would assist to increase the swim speeds, consequently, swimmers need to keep a better body position and higher speed during underwater gliding movement. The purpose of this study was to analyze the underwater gliding and dolphin kick movement in collegiate competitive swimmer.

METHODS

Six healthy male collegiate swimmers (age 19.7±1.1yrs, height 174.2±5.2cm, body weight 68.3±3.6kg, BMI 22.9±1.8) volunteered to participate in this study. The subjects performed underwater gliding movement as fast as possible after the start wall kicking. During the underwater phase of gliding movement, the swimmers were to hold the streamlined position [3]. Head of the subjects had been completely submerged during gliding movement. In addition, dolphin kick performed by maximum effort. For each subject, only the best gliding movement has been analyzed. The subjects were monitored with an underwater video camera (SK-2130, SONY, Japan) with a sampling frequency of 60Hz in the sagittal plane to measure the angular displacement of their different joints. The underwater area covered by the camera ranged from the start wall to the 5-meter point. For measurement of muscle activity patterns, surface electrodes were attached after cleaning and gentle abrasion of the skin. The wireless electromyography system (Biolog DL-5000, S&ME, Japan) was used to collect the muscle activities from the rectus abdominis, rectus femoris and hamstrings. All subjects received a written and verbal explanation of the study and gave their written informed consent for participation. Approval was granted from the institutional human ethics committee and the study was conducted in conformity with the Declaration of Helsinki for medical research involving human subjects. A motion analysis system (Frame-DIAS4, DKH, Japan) was used to digitize ten body landmarks. The ten anatomical landmarks chosen and identified are as follows: finger tips, head, tragus, acromions, elbow, wrist, large trochanter, knee, lateral malleolus, and toes. The angular displacement of the joint are defined as internal joint angles.

RESULTS AND DISCUSSION

The swimming speed of the subjects showed that the highest speed was maintained during the gliding movement when the knee and the hip joint angles of 180 degrees were maintained from the push-off the wall to 0.8sec (Figure 1). On the other hand, the lower limb joints of the non-elite swimmer did not become straight (Figure 2). The main aim of this study was to analyze the underwater gliding movement in collegiate competitive swimmer and investigate whether the streamline of body could maintain the knee and the hip joint angles of 180 degree. The underwater gliding movement of the swimmer is said a significant role in the start and the turn phase. During these phases, reducing underwater resistance force leads to the improvement of the swimming performance. The swimmer who maintained a superior streamline maintained the high velocity in the phase that the dolphin kick was performed (Figure 3). On the other hand, the non-elite swimmer decreased swim velocity by large angular displacement (Figure 4). During the underwater gliding movement, the elite swimmers have to hold a streamlined posture. This posture directly influences the modification of the hydrodynamic resistance created by the swimmer [4]. Elipot et al [3] showed that, to hold a streamlined position, a kinematical synergy of the three principal joints' action is an essential. This synergy is characterized by a combination of the three joints. To stay in the best streamlined position, and to glide longer at high speed. The return to the water surface should rather be initialized by a progressive and synchronize action of the three joints [3].

CONCLUSIONS

The result of this study was that the highest speed was maintained during the gliding movement when the knee and the hip joint angles of 180 degrees were maintained from the start to 0.8sec (Figure 1). In addition, swimming speed slowed down when the flexion-extension movements in the knee and the hip joints were observed during the gliding movement (Figure 2). These results suggested that the subjects could not maintain the knee and the hip joint angles of 180 degrees during the gliding movement, as the results, might try to maintain the body balance by the flexion-extension movements in the knee and the hip joints. Moreover, the swimmer who maintained a superior streamline maintained the high velocity in the phase that the dolphin kick was performed (Figure 3). Therefore, during the underwater phase during starts and turns, it is a necessity that the swimmer maintained a streamline posture.

ACKNOWLEDGEMENTS

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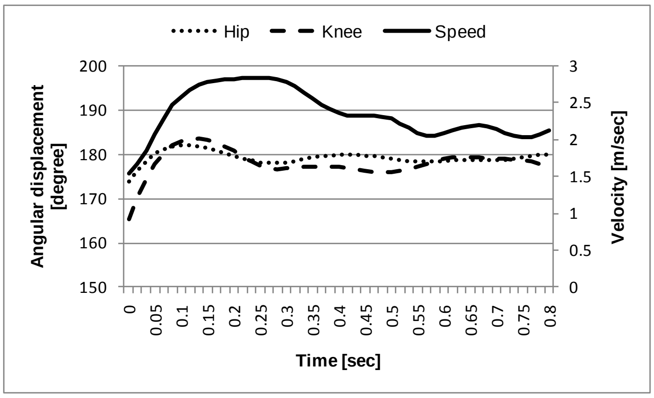

Figure 1: Relationship between the angular displacement and the velocity for the gliding movement in elite swimmer.

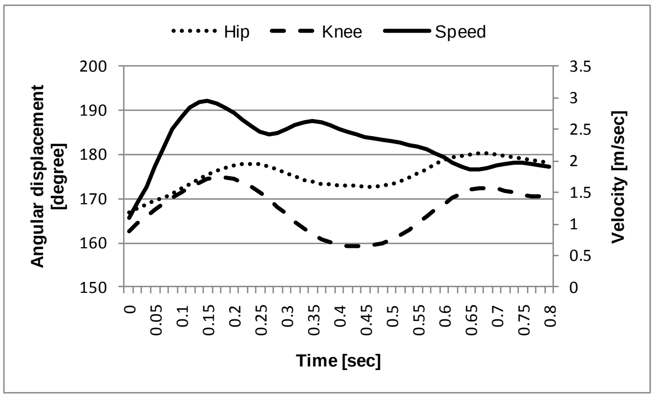

Figure 2: Relationship between the angular displacement and the velocity for the gliding movement in non-elite swimmer.

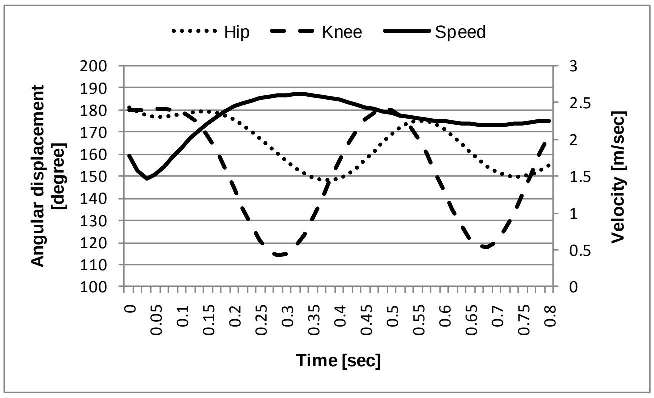

Figure 3: Relationship between the angular displacement and the velocity for the dolphin kick movement in elite swimmer.

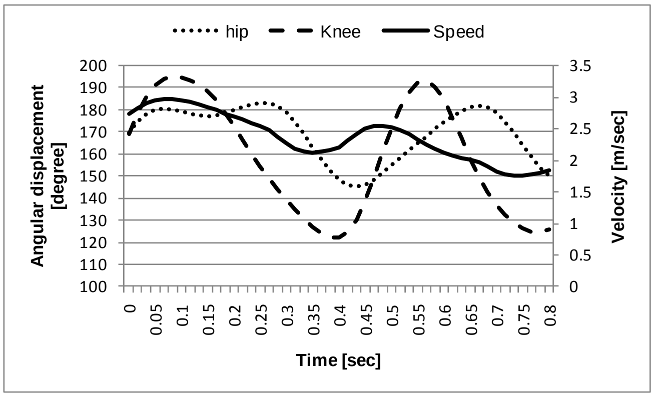

Figure 4: Relationship between the angular displacement and the velocity for the dolphin kick movement in non-elite swimmer.

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