INVESTIGATING KINEMATIC OF THE FLIP TURN TECHNIQUE IN FRONT CRAWL SWIMIMNG

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The purpose of this study was to biomechanically describe the tumble turn kinematics variables in front crawl. Ten experienced swimmers were recruited in this study. During freestyle tumble turns, selected kinematic variables were recorded. Kinematics weres calculated using underwater videography. Correlation s between these variables showed that there were good relations between speed-in and wall contact time, time-in and speed-in, time-out and speed out, time in and wall contact time, speed out and wall contact, time-out and wall contact time, time-out and time streamlining, and wall contact time and time streamlining. However an optimal combination of reduced streamlining time and increased wall contact time are conducive to improve performance.

KEY WORDS: kinematic variables tumble turn, front crawl, correlation and videography.

INTRODUCTION: At the elite swimming level, the opportunity for performance improvements is relatively restricted. However, one possible area is to enhance turning efficiency throughout the push-off, glide and stroke resumption phases. However, little is known about the mechanics of an effective turn technique. The advent of vertically mounted force plates has led to various studies investigating wall push-off kinetics, although the results of these studies were mainly descriptive in nature (Takahashi, Yoshida, Tsubakimoto & Miyashita 1982; Blanksby, Gathercole & Marshall, 1996; Lyttle & Mason, 1997). So far there have been many studies conducted on the push-off, glide, and stroke resumption phases (Blanksby et al.,1996; Lyttle & Mason, 1997; Blanksby, 1998; Lyttle, 1999; Shahbazi-Moghaddam, Sanders, and Naemi 2004). However, little is known about the mechanics of an effective turn technique. Nevertheless, Shahbazi et al. (2005, 2006) studied the tumble turn mechanism through mathematical and mechanical modelling. Despite the importance of turns in the overall performance for competitive swimming, relatively few studies have been carried out. This is probably because there are no simple, accurate and versatile investigatory methods available. This study examined the relationship between various kinematic measures and the 7.5-m round trip turn times (7.5-m RTT) for freestyle turns. This study also examined the reliability of the proposed study during tumbling and the consistency of temporal and kinematic aspects of swimmers' turning performance.

Execution of a tumble turn requires a swimmer complete a series of complex movements to allow them to change direction. Descriptions of tumble turn technique and performance are found to vary slightly within the literature. Costill et al. (1992) described the process of performing a flip or tumble turn using five separate movement phases. These five turn phases are the approach; the turn; the push-off; the glide; and the pull-out. Maintaining swim speed is considered an important component of the approach to the turn.

According to Costill et al. (1992), the turn phase incorporates the somersault change of direction movement. To achieve this, the swimmer keeps the opposite arm in the water at the hip when beginning the final arm stroke. Forward rotation of the body is initiated by flexion of the head and a simultaneous small dolphin kick, during the final arm stroke. The legs are drawn to the chest by flexing the hips and knees. This movement causes a decrease in the moment of inertia around the axis of rotation, allowing the swimmer to somersault more easily. Therefore, the purpose of this study was to use an underwater videography to investigate the interrelationship of various kinematic variables with the swimmers 7.5-m RTT tumble turns. A greater understanding of these relationships will enable identification of good tumble turn strategies.

METHODS: Ten experienced adult male swimmers served as subjects for the study. The swimmers performed six complete freestyle turns and glides at maximum speed, beginning 10 meters from the wall. To analyze the tumble turn, selected kinematic variables of the tumble turn such as; speed in, speed out, time in and time out, rotation and streamlining times were recorded. As we sought in this study to examine features that contributed to the tumble turn process, rather than the sole push-off, a 7.5-m RTT was selected as criterion measure. The fastest 7.5-m RTT for each subject was selected for analysis. The push-off time represented the period from the first forward displacement of the hips after wall contact until the feet left the wall, while the contact time represented the period from the moment first feet touched the wall until the feet left the wall. Video data of swimmers may be collected in various ways provided that the camera is viewing from below the water surface. All data for our kinematic study were collected using fixed camera. A JVC handicam sampling at 50Hz was at 3m from the plane of motion of swimmers.

RESULTS AND DISCUSSION: A limitation when analyzing any performance is that the selected parameters may not be those which contribute most to performance. However, we have chosen the kinematic measures which might be important for the coaches for examination. Table 1 shows the means and the standard deviations of the kinematic values. Final push-off velocities recorded in this study were higher than the peak outgoing velocities reported by Blanksby et al. (1996) but lower than those reported by Takahashi et al. (1982). On Figure 1 the correlations between the kinematic variables are shown. As can be seen, there were no relations between rotation time and speed in (R^2= 0.014) and out (R^2= 0.001), while we were expecting to get reasonable relation between speed-in and rotation time. Because of higher speed-in, the rotation should be performed faster and therefore the lesser time of rotation. This might come from the fact that there was the inherent variation in swimmers' turning techniques. As we had no force plate, therefore we were not able to find out the percentage of push-off time of the total wall contact time. According to Lyttle et al. (1999), the relative push-off time may range from 33 to 94% of the wall contact time.

Table 1: Kinematic variables: Mean ±SD.

Variables	Time-in (s)	Time out (s)	Contact time (s)	Rotation time(s)	Streamline time(s)	Speed in (m/s)	Speed out (m/s)
Mean	5.58	3.95	0.32	1.08	0.20	1.31	2.45
± SD	± 0.87	± 0.57	± 0.08	± 0.11	± 0.04	± 0.25	± 0.31

There was signification correlation between speed-in and wall time contact (R^2= 0.81) and also the relation between speed-out and wall contact time was good (R^2= 0.79). This positive correlation indicated that longer wall push-off times resulted in faster final push-off velocities for the swimmers. A rapid push-off might not allow sufficient time to develop an optimal impulse, thus reducing the potential to effectively increase the acceleration of the CG. According to Lyttle et al. (1999), the longer wall push-off times results in faster final push-off velocities for the swimmers.

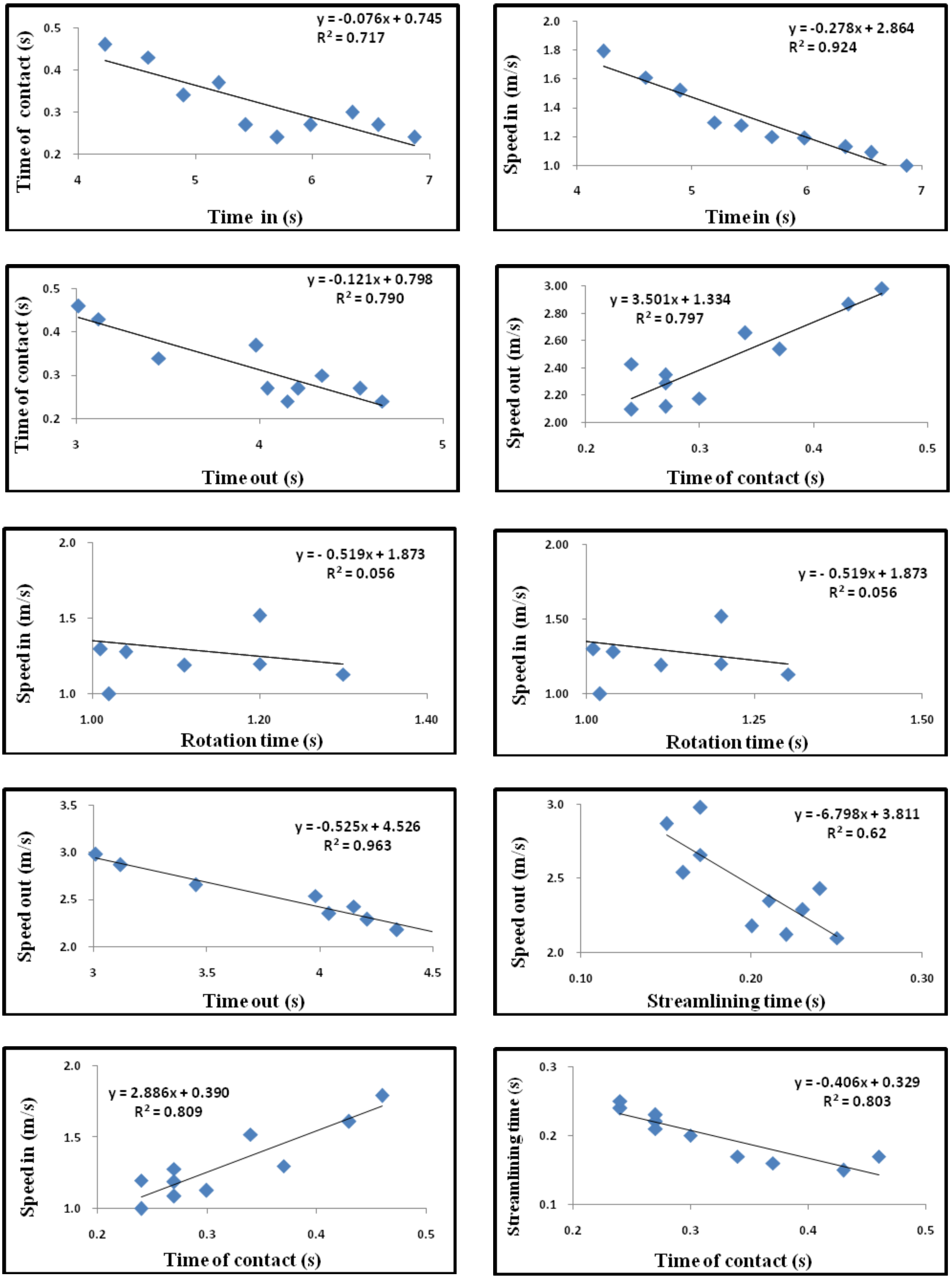

Figure 1. The relations between kinematic variables are depicted.

Good relations were found between Time-in and wall contact time (R^2= 0.705), time-in and speed-in (R^2= 0.925), and time-out and speed-out (R^2= 0.962). There was also a negative correlation between wall contact time and streamlining time showing that the swimmers tried to get faster streamlining by increasing time on the wall for getting a better push-off velocity. A correlation has been observed between streamlining time and speed out. A streamlined transition from a flexed position at the start of push-off to a fully extended position at the end of push-off is necessary also to prevent excess drag from being produced. This could explain previous findings that the larger the tuck index during a flip turns (ie. straighter legs), the faster were the turn times.

CONCLUSION: As little has been written regarding tumble turn mechanism and the correlations between the kinematic variables, therefore the purpose of the present study was to find out the correlations between the kinematic variable measures identified in the coaching literature as being important for examination. Turning technique is an important component in overall swimming performance, with turn times positively correlating with the final event times. The results of this study indicate that an optimal combination of reduced streamlining time and increased wall contact time are conducive to a high push-off velocity for the swimmer.

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