BIOMECHANICAL ANALYSIS OF THE GRAB AND TRACK SWIMMING STARTS

Chueh-Yu Lee[1], Chen-Fu Huang[1] and Ching-Wen Lee[2]

Department of Physical Education, National Taiwan Normal University, Taipei, Taiwan[1]

Division of Physical Education, National Taipei University, Taipei, Taiwan [2]

The aim of this study was to compare the grab and track competitive swimming starts. Twelve male college competitive swimmers (six used the grab start and six the track start) participated in this study. Data were collected from two video cameras (60Hz) above water. The video data were digitized and analysis was performed with the Kwon3D Motion Analysis system. No significant differences existed between the two groups for flight time and distance, time to 12m, takeoff velocity and angle, entry velocity and angle and the center of mass at highest position above water. The track start had the centre of mass on the block more towards the rear and a shorter block time ($p<0.05$). Coaches should consider individual differences when deciding which of the two start techniques should be used by each competitive swimmer.

KEY WORDS: swimming, grab start, track start.

INTRODUCTION: Swimming start technique is an essential part of competitive swimming, particularly in shorter sprint race. Maglischo (2003) stated that starts account for approximately 10% of total time in swimming events of 50m and 5% in those of 100m, and an improved start could reduce race time by at least 0.10s. For this reason, many studies have examined the swimming start. As a faster start technique is important in short race distances.

In recent years, the most common forward flat starts are the grab and track start. Competitive swimmers tend to use one of the two dive techniques. The grab start has both feet at the front of the block and hands grabbing the front edge of the block, inside or outside both feet. The track start has one foot at the front edge of the block and the other foot placed on the back on the block, with similar hand placement. Rutemiller (1995) stated the “slingshot track” start as a track start in which “the swimmer shifts the centre of gravity to the back foot”. According to Rutemiller, the swimmer pulls on the block, and then uses the hands to push off the blocks as the legs power off the block. However, several studies have shown that the track start has a faster block time than the grab start (Shin & Groppel, 1986). Swimmers were able to move their centre of mass more forward over the water in the track start than was possible with the grab start and thus have a shorter distance to travel during the block phase of the start (Blanksby, Nicholson & Elliott, 2002). The purpose of this study was to compare the grab start and the track start (Figure 1 a,b).

(a) (b)

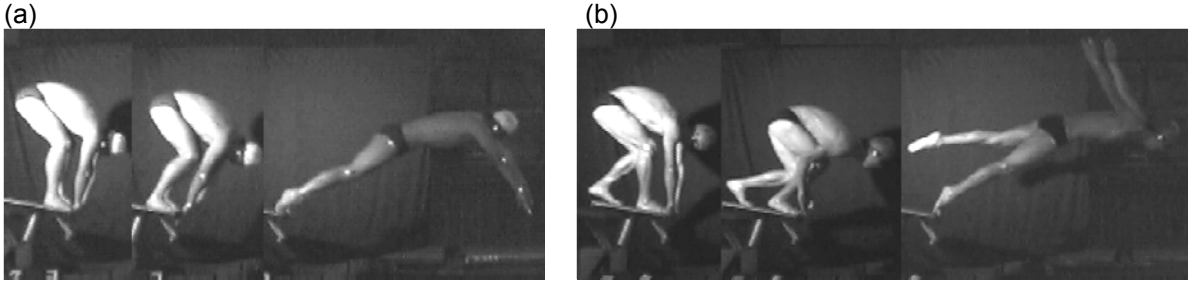


Figure 1: (a) The Grab start: Both feet at the front of the block and hands grabbing the front edge of the block. (b) The track start: One foot at the front edge of the block and the other foot placed toward the back on the block.

METHODS: Twelve male college competitive swimmers, from the National Taiwan Normal University participated in this study. Six used the grab start and the other six the track start. The participants were all swimming athletes and the mean age of the grab start was 23 ±1.9

years, the track start was 21 ±1.3 years; the mean height and mass of the grab start were 1.74 ±0.03 m and 75 ±4 kg, the track start were 1.77 ±0.05 m and 73 ±3 kg. Time to 50-m freestyle of the grab start was 25.1 ±0.6 sec and for the track start was 24.6 ±0.4 s.
After a warm up, swimmers performed a few practice starts. Subjects were filmed above water at 60 Hz by two digital video camera (JVC9800, Japan). One DV camera was placed 12 m lateral from the centre of the starting block and 3 m forward from the starting end of the pool. Another DV camera was placed 12 m forward from the starting end of the pool to provide time to 12m. The two DV cameras and starting horn were synchronizing by a light emitting diode (LED) in the field of view of each digital video camera lens (Figure 2).

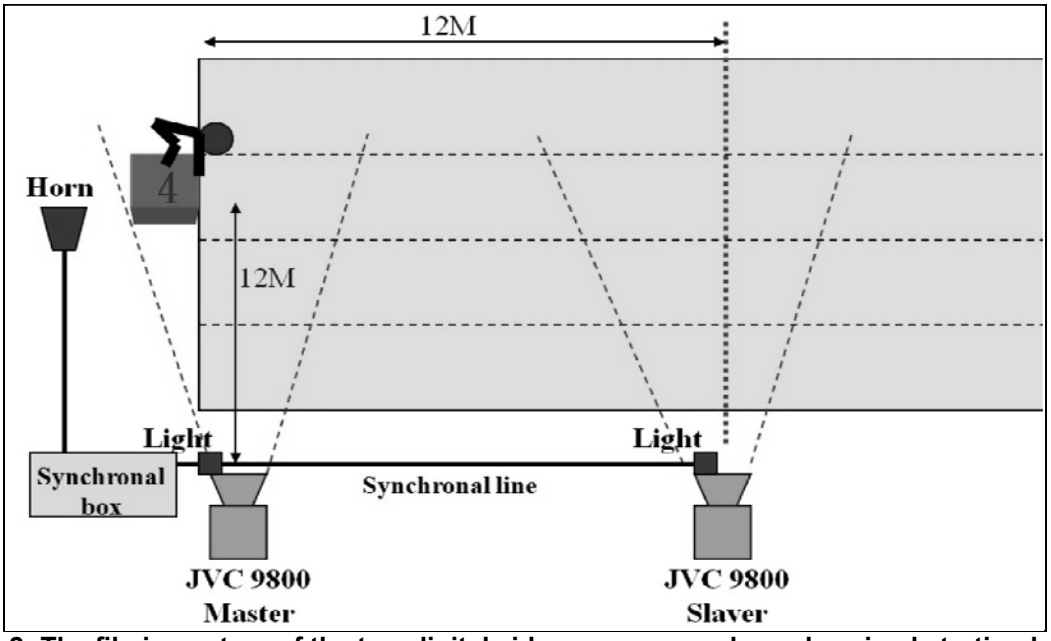


Figure 2: The filming set-up of the two digital video cameras and synchronised starting horn.

The following variables were calculated: block time (the starting signal horn to toe-off), flight time (toe-off to finger tip entry), time to 12m (the starting signal to vertex of head reaching 12m) (Welcher, Hinrichs & George, 2008). Block time was calculated by adding reaction time and movement time. Flight distance was determined by subtracting the horizontal distance from the point where the finger tips touch the water surface to a point on the wall (Blanksby et al.). The variables included the block time, flight time, time to 12m, takeoff angle and velocity (horizontal velocity), entry angle and velocity (horizontal velocity), flight distance, centre of mass at the set position, highest point of centre of mass position above water, velocity to 12m. The video data were digitized and analysis performed with Kwon3D Motion Analysis system. The body land marks were ear, shoulder, elbow, wrist, figer tip, greater trochanter, knee, ankle, toe. The body segments consisted of the head, trunk, upper arms, forearms, hands, thighs, lower legs and feet. Body segment centre of mass parameters were taken from Dempster (1955). Each swimmer performed three of each dive with the faster time to 12m chosen for analysis. Independent t-tests were used to determine whether differences existed between the grab and track start, ($p<0.05$).

RESULTS: The results indicated that the track start had more mass toward the back of the block at the set position, and the track start was faster than the grab start in block time ($p<.05$). There were no difference between two groups for flight time, takeoff angle and velocity, entry angle and velocity, and hightest point of centre of mass position above water. The result found no significant differences in time to 12m between the grab start and track start. Variables of the grab start and track start are presented on Table 1.

Table 1
Variables of the grab and track start (mean ±s)

	Grab start	Track start	p
CM at the set position (cm)	-2.8 ±3.5	-10.5 ±4.5*	0.004
Block time (sec)	0.84 ±0.03	0.79 ±0.05*	0.04
Flight time (sec)	0.34 ±0.04	0.29 ±0.06	0.059
Takeoff angle (deg)	-3.9 ±2.6	-6.4 ±3.4	0.094
Takeoff velocity (m/s)	4.21 ±0.19	4.35 ±0.07	0.066
Takeoff velocity (horizontal) (m/s)	4.2 ±0.2	4.32 ±0.1	0.117
Entry angle (deg)	37.6 ±5.9	40.9 ±3.9	0.141
Entry velocity (m/s)	5.24 ±0.32	5.31 ±0.32	0.361
Entry velocity (horizontal) (m/s)	4.03 ±0.27	4.14 ±0.16	0.203
Flight distance (cm)	325 ±18	307 ±19	0.062
Highest CM position above water (cm)	116.7 ±4.7	119.3 ±7	0.233
velocity to 12m (m/s)	1.83 ±0.07	1.84 ±0.08	0.361
Time to 12m (sec)	5.53 ±0.19	5.45 ±0.17	0.246

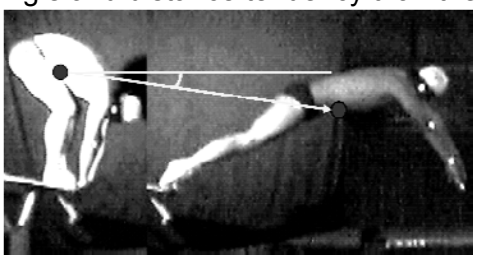
*p<.05

DISCUSSION: In terms of time, the track start swimmers left the block with a slight time advantage compared with the grab start. In this study the track start had a significantly quicker movement time and reaction time. Flight distance is a very important performance variable in swimming start. Although the grab start increased time on the block it did not increase flight distance. The grab start had however a tendency to increase flight distance (no significant). Never the less, by the time the vertex of head reached 12m, any advantage of flight distance from the track start over the grab start had decreased and was no longer significant. This is consistent with previous results reported by Blanksby et al. (2002) and Welcher et al. (2008).

Welcher et al. (2008) compared the grab start, forward weighted and rear weighted track start, and found that there were no significant differences between the three dive technique for time to 5m. However, some studies have found the track start to be superior to the grab start (Breed & McElroy, 2000; LaRue, 1985), and some studies claimed that the grab start was superior to the conventional start (Maglischo, 1982; Lewis, 1980). It was possible that larger difference to the two dive performance may have occurred if the participants had practiced the for starts several years, to adapt the timing of the neuro-muscular system for the increased muscle force. But Breed & McElroy (2000) indicated that training effects for the track start might be greater than the grab start, because the track start uses a different mechanism for starting, with the body bring pulled directly forwards rather than lowering the body's centre of mass.

The centre of mass was further forward during grab start than track start at the set position on the block and significant differences were found. The centre of mass position differences were greater as the swimmer leaned further forward and reduced the time on the block in the grab start. With the track start, the centre of mass was placed further back on the block than the grab start, but this position increased the swimmer's base of support. This enabled the swimmer to exert a longer force in which to create a higher takeoff velocity and impulse (Blanksby et al., 2002).

In this study, no significant results or trends were observed for take velocity and entry velocity between the grab start and track start. The higher takeoff angle could have contributed to an increase flight distance. The grab start in this study demonstrated a higher takeoff angle and distance tendency than the track start (p>.05). (Figure 3).



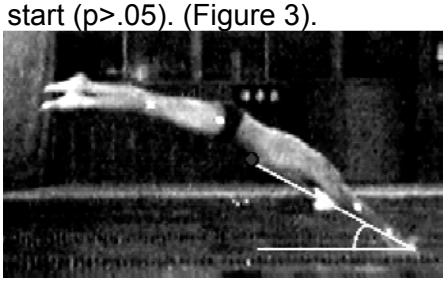


Figure 3: Take off angle and entry angle.

CONCLUSION: In the track start, the centre of mass was centered more toward the rear of the block and this start had a shorter block time ($p<.05$). However, no significant differences were found between the grab and track start in this study. Coaches should consider individul differences in each competitive swimmer to decided upon which of the track and grab technique was most appropriate to use in competition.

REFERENCES:

Blanksby, B.,Nicholson, L., & Elliott, B. (2002). Biomechanical analysis of the grab, track and handles swimming start: an intervention study. *Sports Biomechanics, 1*(1), 11-24.

Breed, R. V. P., & McElroy, G. K. (2000). A biomechanical comparison of the grab, swing and track starts in swimming. *Journal of Human Movement Studies, 39*, 277-293.

Dempster, W. T. (1955). Space Requirements of the Seated Operator. *WADC Technical Report* (TR-55-159). Wright-Patterson Air Force Base, OH.

LaRue, R. J. (1985). Future start. *Swimming Technique, 21*(4), 30-32.

Lewis, S. (1980). Comparison of five swimming techniques. *Swimming Technique*, 16(4), 66-69.

Maglischo, E. W. (1993). *Swimming Faster*: A Comprehensive Guide to the Science of Swimming. Mayfield Publishing Company.

Robert, L. Welcher, Richard N. Hingrichs, & Thomas R. George (2008). Front- or rear-weighted track start or grab start: Which is the best for female swimmers. *Sport Biomechanics*, 7(1), 100-113.

Rutemiller, B. (1995). Taper basic: Fine tuning starts and turns. *Swimming Technique*, February-April, pp 14-18.

Shin, I. S., and Groppel, J. L. (1986). A comparison of the grab start and track start as utilized by competitive swimmers. In D. L. Landers (Ed.), *Sport and elite performers* (pp. 171-175). Champaign: Human Kinetics.