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Differences between the Grab Start and Track Start in Collegiate Swimmers

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ABSTRACT

International Journal of Exercise Science 10(4): 515-521, 2017. The purpose of this investigation was to determine which foot stance, the track start (TS) or the grab start (GS), is most beneficial for competitive swimmers. Seven male and eight female collegiate swimmers participated in this study. The average participant age was 20.1 ± 1.13 years while the average years of competitive swimming experience was 10.8 ± 3.36 years. Participants performed three TS and three GS stances consecutively. Distance markers were placed on the side of the pool to determine where each swimmer entered the water. Video analysis was used to determine the following factors: start phase time, flight phase time, flight distance, horizontal entrance velocity, and entrance angle. Prior to participating in the study, swimmers completed a brief survey regarding age and competitive swimming experience, and researchers measured each participant's height and weight. A paired sample T-test was used to determine significant differences between the GS and TS. The results indicated that the TS foot stance resulted in a shorter start phase time (0.76 ± 0.07 s vs. 0.88 ± 0.10 s; $P < 0.001$), a shorter flight phase time (0.81 ± 0.08 vs. 0.95 ± 0.07; $P < 0.001$), and a greater horizontal entrance velocity (3.56 ± 0.51 m/s vs. 3.10 ± 0.41 m/s; $P < 0.001$). The GS allowed swimmers to travel further in the air (2.96 ± 0.43 m vs. 2.88 ± 0.41 m; $P = 0.013$). The TS entrance angle was significantly shallower than the GS entrance angle (36.98 ± 3.17° vs. 38.53 ± 3.81°; $P = 0.004$). Based on the results, the TS foot stance provides swimmers with the greatest advantage.

KEY WORDS: Kinematic analysis, swimming, performance

INTRODUCTION

In competitive swimming, races are often won by a fraction of a second. As a result, swimmers are constantly trying to find ways to gain a competitive advantage. Many swimmers focus on improving their strength or endurance, but technique is equally important. A great start, turn, or finish may make the difference between first and second place. For example, Michael Phelps edged out Milorad Cavich by 0.01s during the 100m Butterfly final at the 2008 Olympics. Although Phelps' finish was dramatic, his start was likely a crucial component of his success.

The start accounts for approximately 10 percent of the total time during a 50m race and 5 percent of the total time during a 100m race (1). Furthermore, an improved start reduces race times by at least 0.1s (8).

Two starts commonly used by competitive swimmers are the grab start and the track start. The track start has become increasingly popular (3) and is now used almost exclusively during individual races. Athletes, however, commonly use variations of the grab start during relay races. During the grab start, both feet are placed at the front edge of the starting block. The hands are placed inside or outside the feet with the fingers curled over the edge of the block. During the track start, one foot is placed at the front edge of the starting block while the other foot is positioned near the back. The hands are placed at the edge of the block approximately shoulder width apart. Despite the differences between the two techniques, researchers have been unable to determine whether one start offers a competitive advantage.

Analysis of the two starts have shown little difference in flight time, entrance velocity, entrance angle, and time to 12m (1,2) Cheuh-Yu et al (2) and Welcher et al (6) found that athletes leave the block sooner when they perform the track start compared to the grab start. However, Bingul et al. (1), was unable to confirm these findings. Data suggests that swimmers travel further in the air when they perform the grab start, but it is unclear whether this will result in faster start times (1) One study found that the track start may offer an advantage compared to the grab start when athletes start from the Omega® OSB11 block (5) The Omega® OSB11 starting block differs from a traditional block, however, because it features an angled kick plate near the rear (4,6). Many facilities continue to use traditional starting blocks because the Omega® OSB11 starting system is more expensive. Therefore, the results from this study may not be generalizable. Additionally, this study only included four participants. Given the current data, additional research is needed to determine which start technique is the most beneficial. Therefore, the purpose of this investigation was to determine whether the track start or the grab start is more advantageous for competitive swimmers. We hypothesized that flight distance and entrance velocity would be greater in track starts compared to grab starts.

METHODS

Participants

The current study was approved by the Pacific Lutheran University Human Participants Review Board, and complied with the standards of the Helsinki Declaration. Fifteen NCAA Division III athletes, seven males and eight females, participated in this study (mean age 20.1 ± 1.13 years, mean height 176 ± 8.36 cm, mean weight 73.0 ± 10.4 kg, mean competitive experience 10.8 ± 3.36 years). All individuals had at least three years of prior competitive swimming experience. The participants included in this study preferred the track start, however, the athletes were familiar with the grab start. Additionally, many of the swimmers used a stance similar to the grab start during relay races. All athletes were cleared to participate in varsity athletics by the University's medical staff and had no significant musculo-skeletal injuries.

Protocol

Prior to testing, participants completed a brief survey detailing age and years of competitive swimming experience. Additionally, height and weight were recorded by researchers. Participants were given 15 minutes to practice the two starting techniques. The participants were instructed to place both feet on the front edge of the block when performing the grab start technique. The track start technique required placing one foot on the front edge of the block and one foot towards the rear. Standardized instructions were given for both starts even though many of the participants were already familiar with one, or both of the starting techniques. All testing occurred after practice, eliminating the need for a warm-up session. All athletes completed the same practice prior to testing. Participants performed six swimming starts (3 grab starts, 3 track starts). Although the starts were performed consecutively, the participants were allowed to rest in between each start to minimize the effects of fatigue. Starts were performed one after another to prevent the athletes from getting stiff, and to minimize the need for a warm-up prior to each trial. An order effect may have occurred, however, because the swimmers performed the track starts following the grab starts. A starting system (Daktronics Inc., Brookings, SD, USA) was used to replicate the starting signal used during competition.

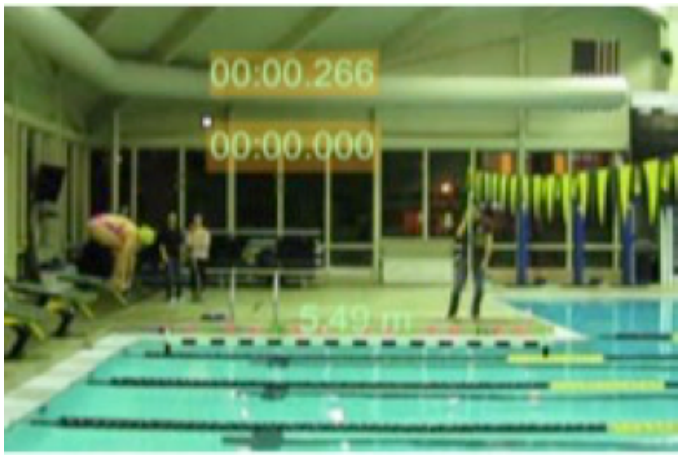

Figure 1. Screenshot from Dartfish 7. Flight movement time was measured from the moment the fingertips left the block to fingertip entry.

Figure 2. Flight distance was measured from the edge of the starting block to the point where the fingertips entered the water.

Each trial was filmed at 30 fps using a digital camera (Canon Inc., Tokyo, Japan). The digital camera was placed above the water perpendicular to the plane of motion. The camera was located approximately 13 meters from the plane of performance. The camera placement minimized potential scaling error and increased the accuracy of measurements. The following variables were calculated using video software (Dartfish 7, Fribourg, Switzerland): start phase time, flight phase time (Figure 1), flight distance (Figure 2), horizontal entrance velocity, and entrance angle (Figure 3). Markers placed on the edge of the pool aided in the calculation of flight distance. The first marker was aligned with the front edge of the starting block. Additional markers were placed at 1 yd. intervals. The start was divided into two phases during video analysis: start phase and flight phase. The start phase time was measured from the first detectable movement to the moment the fingers left the block. The flight phase time

was measured from the moment the fingers left the block to fingertip entry. Flight phase time and flight distance were used to calculate horizontal entrance velocity as the fingertips entered the water.

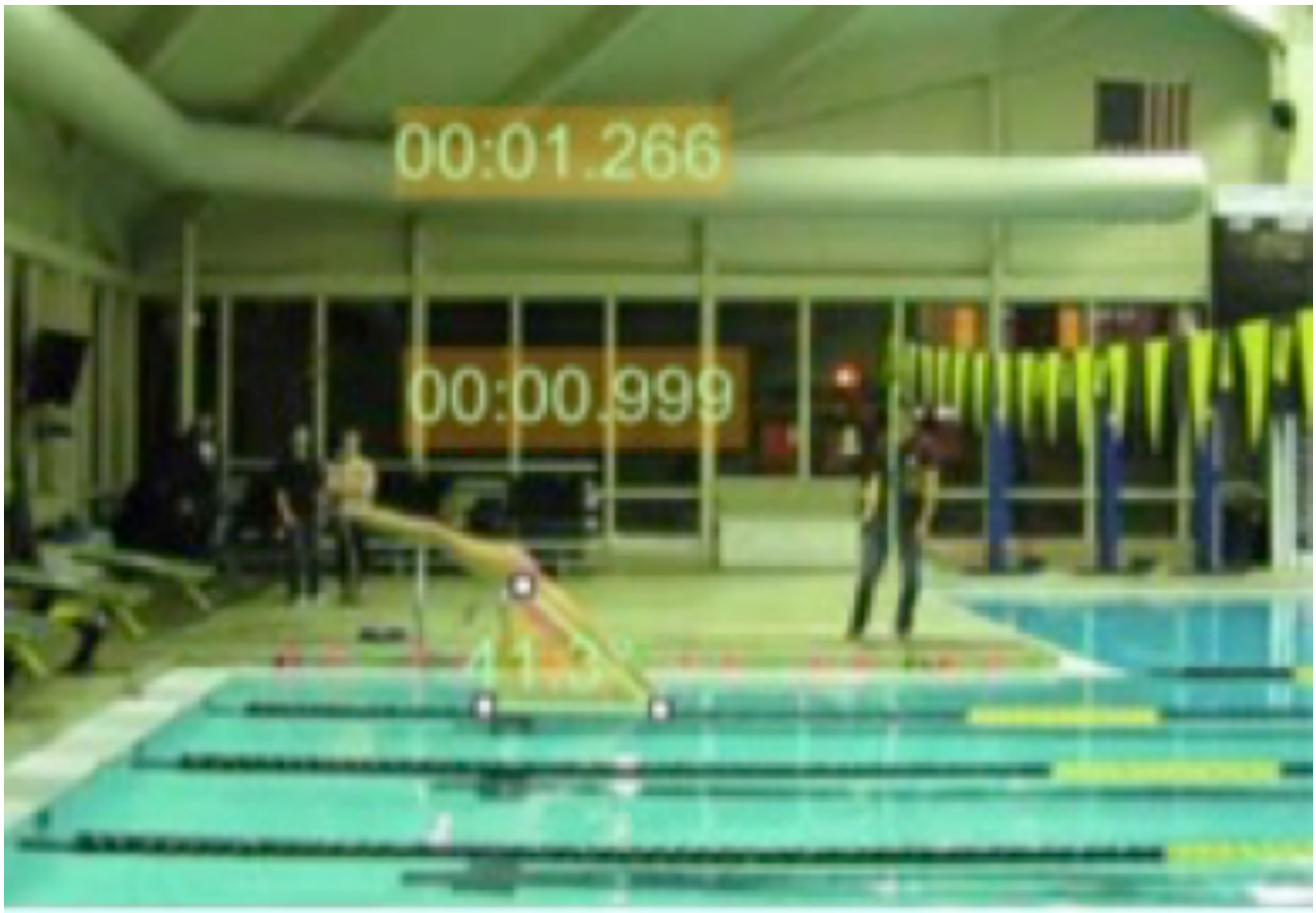

Figure 3. The edge of the pool, the fingertips, and the hip served as landmarks when calculating the entrance angle.

Statistical Analysis

A paired two-tailed T-test (SPSS, IBM, Armonk, NY, USA) was used to determine whether the differences between the track start and the grab start were significant ($P < 0.05$).

RESULTS

The results indicate that the participants traveled significantly further ($P = 0.013$) in the air when the athletes performed the grab start compared to the track start. Start phase time and flight phase time were significantly greater ($P < 0.001$, $P < 0.001$), and horizontal entrance velocity was significantly slower ($P < 0.001$) when the athletes performed the grab start. The athletes entered the water at a significantly shallower angle ($P = 0.004$) when they utilized the track start stance. These results are summarized in Table 1.

Table 1. Comparison of grab start and track start performance variables. (mean ± std. dev.)

Variables	Grab Start	Track Start	Significance Level
Flight Distance (m)	2.96 ± 0.43	2.88 ± 0.41	= 0.013*
Flight Phase Time (s)	0.95 ± 0.07	0.81 ± 0.08	< 0.001*
HorizontalEntrance Velocity (m/s)	3.10 ± 0.41	3.56 ± 0.51	< 0.001*
Entrance Angle (deg)	38.5 ± 3.81	37.0 ± 3.17	= 0.004*
Start Phase Time (s)	0.88 ± 0.10	0.76 ± 0.07	< 0.001*

* Statistically significant difference (P< 0.05) between track start and grab start stance.

DISCUSSION

The data suggests that swimmers travel significantly further in the air when starting from the grab start position. This result is congruent with findings by Binguel et al. (1) Chueh-Yu et al. (2) also noted that the grab start stance resulted in greater flight distances, however, their findings were not significant. Cheuh-Yu et al. (2) found that the track start resulted in a faster time to 12 m even though the grab start resulted in a greater flight distance. Our data indicates that participants only traveled 8 cm further when they performed the grab start compared to the track start. Given our results and the findings by Cheuh-Yu et al. (2), overall performance does not appear to be affected by minor differences in flight distance.

Our results indicate that the track start stance reduces flight phase time and start phase time. It should be noted that many researchers referred to the time on the block and the time in the air as block time and flight time respectively. Block time is measured until the feet leave the block while flight time begins when the toes are no longer in contact with the starting block. Despite the slight difference in our definitions, it is our belief that block time and flight time should be discussed in addition to start phase time and flight phase time as they evaluate similar phases of the start. Bingul et al. (1) found that block time and flight time decreased when the swimmers performed the track start compared to the grab start, however, the results were not significant. Welcher et al. (8) discovered that block time was significantly faster when female participants utilized the front-weighted track start compared to the grab start. The present study did not differentiate between the front-weighted and rear-weighted track start. Consequently, it is difficult to determine whether changes in center of gravity affected track start performance.

The data also demonstrated that the track start results in a significantly greater horizontal velocity and a significantly shallower entrance angle compared to the grab start. Cheuh-Yu et al. (2) measured entrance angle and entrance velocity, but they did not find any significant differences. The findings by Cheuh-Yu et al. (2) may have been affected by extraneous variables, such as strength and experience, because the participants did not perform both starts. Twelve total athletes participated in the study by Cheuh-Yu et al. (2) Six of the athletes performed the track start while the other six performed the grab start. It is unclear whether the sample size selected was large enough to lessen the effects of population variability. The

present study minimized the effects of undesired variables by requiring participants to perform both the track start and the grab start.

During the track start and the grab start, force is primarily generated by the quadriceps, glutes, semimembranosus, semitendinosus, biceps femoris, and gastrocnemius. Additionally, some swimmers use their arms to propel themselves off the starting block. Core activation is an important component of a swimming start, but the core muscles primarily acts as a stabilizers. The primary osteokinematic motions that occur during the track start and grab start are hip extension, knee extension, plantar flexion, and shoulder flexion.

Video observation revealed that the track start stance allowed an increase in knee and hip flexion, which lengthened the quadriceps, glutes, biceps femoris, and hamstrings during the resting position compared to the grab start. We hypothesize that the track start stance resulted in a more optimal force-length relationship, and therefore increased the force generated during the start. A recent study(7) found that maximal voluntary vastus intermedius contraction during knee extension occurred at 90 degrees of knee flexion. A second study (5) found that hamstring torque increased as hamstring length increased. Maximum hamstring torque was generated during 90 degrees of hip flexion (5). The results from these research articles suggest that optimal start position may be 90 degrees of hip and knee flexion. The track start stance may make it easier for swimmers to achieve these angles. Additional research should be conducted to determine average hip and knee angles during the grab start and track start stance.

The following limitations must be considered when interpreting the data. Fatigue may have been a factor because participants completed the trials following a varsity swimming practice. All participants, however, completed the same practice, Therefore, the effects of fatigue were likely similar for each athlete. The participants selected had more experience performing the track start. Consequently, comfort level may have influenced the outcomes. The frame rate selected increased blurring during motion analysis. A frame rate of 60 or 120 fps would increase the accuracy of the measurements. Horizontal entrance velocity may have been underestimated because flight phase time, as defined in this investigation, included the initial acceleration off the block. We do not believe that measuring flight phase time from the moment the fingertips left the block to the moment the fingertips entered the water impacted the results of the investigation. All measurements were consistent for the track start and the grab start.

Future research should examine differences between youth and adult swimmers to determine whether the track start is advantageous for all ages. The participants in this study were all college athletes and had similar abilities levels. The majority of the studies published to date have focused on a similar demographic. It is unclear how start performance is affected by age and experience. Additional research is also needed to determine the impact of gender on performance. Although this study included both male and female participants, there is little literature on the subject.

The current data suggests that the track start offers a competitive advantage over the grab start. Although swimmers traveled further when they performed the grab start, flight phase time, start phase time, entrance angle, and horizontal velocity appear to have a greater impact on overall performance. Swimmers and coaches should recognize that individual start performance may vary. Therefore, athletes should become proficient in both the track start and the grab start before deciding which stance is most advantageous.

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