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THE KINEMATIC ANALYSIS OF THE GRAB, REAR TRACK AND FRONT TRACK START IN SWIMMING

Introduction

In competitive swimming, the fundamental goal is to cover a set distance in the least amount of time. When evaluating a swimmer's performance, several measures such as final time, strategy, and technical components are considered. The latter, important parameters are speed, stroke mechanics, starting, turning, and finishing (Galbraith *et al.*, 2008). The start in swimming, together with the other elements of the race, is very important for achieving better results in competitions. Faster racing start performances can provide a swimmer with a significant advantage over competitors with slower starting performances (Juergens, 1994). Starts account for approximately 10% of total time in swimming events of 50m and for approximately 5% in those of 100m (Blanksby *et al.*, 2002; Maglischo, 2003). Hay (1986) estimated that the start accounted for 11% of the total race time for the 50m freestyle (Thanopoulos *et al.*, 2012). The three main starting techniques currently used by elite swimmers include the track start (both rear and front weighted) and the grab start (Galbraith *et al.*, 2008).

The grab start was introduced and presented by Eric Hanauer in 1960 (Maglischo, 2003) and it has become popular among swimmers. The track start appeared later, and it was presented by Fitzgerald in 1973. The main difference between these two start techniques is the position of the feet on the starting block. In the grab start, both feet are positioned parallel on the front part of the starting block, with the toes curled over the front edge of the starting block. In the track start, the foot of the starting leg is placed forward, on the front part of the starting block, while other foot is behind it (Maglischo, 2003). The main objective of swim-start research has been to identify the most effective start technique in terms of performance (Vantorre *et al.*, 2014). In the literature, the following kinematic parameters have been measured: flight time, block time, start time, start reaction, start time that involves flight time and block time, flight length, angle of take-off, angle of entry, takeoff velocity, the centre of mass velocity (Welcher *et al.*, 2008; Takeda and Nomura, 2006). Thanopoulos *et al.* 2012 determined differences between these two starts technique in terms of gender and Blanksby *et al.*, 2002 have also examined the different start technique. Breed and Young (2003), investigated the effectiveness of a resistance training programme, designed to improve vertical jumping ability, on the grab, swing and rear-weighted track starts in swimming. Vantorre *et al.*, (2014) were analysed comparison of grab start between elite and

trained swimmers. The aim of this study was to examine the differences in the some kinematic parameters between the grab and track starts rear-weighted track and front-weighted track.

Methodology

Participants

Ten elite male swimmers (mean age \pm SD 11.3 \pm 2.3 years, mean height 152.3 \pm 5.6 cm, mean weight 48.2 \pm 3.9 kg), from Yildizlar Swimming Club, Kocaeli, Turkey were participated to this study. The swimming performances of the subjects were measured in the indoor pool, at Kocaeli University. All subjects had no significant musculo-skeletal injury according to their recent medical history.

Procedures

The current study was conducted consistently to comply with the recommendations of the declaration of Helsinki. Before participating to the study, the subjects were informed of the potential risks and benefits of the study. Swimmers performed three trials with three different starts technique (Figure 1-3) in indoor pool after 16.00 pm.



Figure 1. Grab Start **Figure 2. Rear-Track Start** **Figure 3. Front-Track Start**

Subjects had to refrain from using alcohol, caffeine and ergogenic aids the day before the test. All data were recorded directly to computer by using two Basler A602f cameras at 100 hz. and they were analyzed after the test using Simi Motion 8.5.7 program. For field calibration, Direct Linear Transformation technique that was developed by Abdel-Aziz and Karara (1971) and Shapiro (1978) was used. Four calibration points were calculated by using 0.3m x 0.3m x 0.5m calibration cube. Four kinematic parameters; Flight length (FL) - the distance from the swimming pool wall under the starting block to the first contact of the swimmer's fingers with the water (in meters); Flight time (FT) - the time between the last contact of the feet with the starting block and the first hand finger contact with water (in seconds); Entry time (ET)- the time between the start signal and first hand finger contact with water (in seconds); Block time (BT)- the time between the start signal and moment when leaving the foot of the start block were calculated.

Statistical Analysis

SPSS version 11.5 for windows (SPSS, Chicago, IL) was used to analyse the data. The statistical analysis was performed using the Friedman test followed by Wilcoxon test to determine significant differences of kinematic and performance variables. The statistical significance level was set at 0.05.

Results

According to the results, statistically significant difference in the parameter FL ($p=0.024$) was found. The difference between other parameters (FT, BT, ET) is not statistically significant ($p>0.05$). Longer flight length in grab start is obtained rather than front track starts (Table.1), ($p=0.007$).

Table 1. Results of kinematic parameters of three starting positions and statistical differences between each other

Parameters	Grab start Mean±St.D	Front-Track start Mean±St.D	Rear-Track start Mean ± St.D	p
BT (Block time) sec	0.78±0.29	0.76±0.21	0.72±0.35	0.98
FT (Flight time) sec	0.26±0.09	0.20±0.08	0.19±0.09	0.07
ET (Entry time) sec	1.05±0.36	0.95±0.31	0.9 ±0.43	0.48
FL (Flight length) m	2.83±0.25*	2.56±0.23*	2.73±0.31	0.02*

* $p<0.05$

Discussion

The aim of this study was to determine the differences in the kinematic parameters between the grab, front-track and rear-track starts. The start in swimming is very important for achieving better performance. It takes up an increasing proportion of the total duration of the competition, especially if the distance is shorter (Nikodelis and Kollias, 2003). There are a few studies about different starting techniques in the literature and some of these were investigated similar parameters with the current study (Thanopoulos *et al.*, 2012; Kruger *et al.*, 2003; Takeda and Nomura, 2006). Flight distance is a good indicator in swimming start performance and with better flight distance; swimmers can get some choice of strategy to achieve a ‘good start’ at the beginning of the competition. Some studies investigated this parameter. Jorgiæ *et al.*, 2010 were found the flight length (FL) of the grab start is approximately 0, 23m bigger than in the track start in their study, but it had not statistically significant. Thanopoulos *et al.*, (2012) examined the differences in the kinematic parameters between the grab and track starts and the differences between these two starts in terms of gender and they indicated that the males had a statistically longer flight distance (FD) for both start techniques compared with the females ($p = 0.00$), the FD was greater by 0.39 m for the grab start and 0.41 m for the track start. Blanksby *et al.*, (2002) studied the grab, track and handle swimming racing starts by elite level swimmers. Reaction, movement, block and flight times, flight distance and the centre of mass at the set position were measured. No significant differences between dive groups in time to 10 m were

revealed pre or post training. Kruger *et al.*, (2003) investigated the differences in the two starts on a sample of women and concluded that flight time did not differ between the two starts. Takeda and Nomura (2006) determined that there was no statistically significant difference in the flight distance between the grab and track starts, with the flight distance being greater for the grab start than the track start (3.25m vs. 3.15m). Yu Lee *et al.*, (2012) were found no significant differences between the two groups for flight distance. Another research was investigated that grab start has further FD (0,09 m. $p=0,03$), in comparison with track start as statistically significant (Baykal, 2013). Miller *et al.*, (2003) determined a greater ($p<0.001$) flight distance for the grab start compared with the track start, a difference that was statistically significant and measured 0.14m.

In the study of Jorgić *et al.*, (2010) flight time (FT) of the grab start were found approximately 0.10sec bigger than in the track start, but it had not statistically significant. Galbraith *et al.*, (2008) during the 10m swim trial, significant differences were found in time to 10m and total time. Nicholas and Watkins (2006) stated that the flight time recorded for the females in their sample was significantly shorter than the time recorded for the males. In addition to the FD and FT, the males also had a greater compared with the females, but this difference was not statistically significant. Yu Lee *et al.*, (2012) found no significant differences between the two groups for flight time, besides there was found the track start was faster than the grab start in block time. Blanksby *et al.*, (2002) determined that there was no difference in the flight time (FT) between the grab and track starts. Thanopoulos *et al.*, (2012) stated that the males also had a significantly longer flight time for the grab start compared with the females ($p=0.04$). Baykal (2013) was found no significant differences between the two groups for flight time, block time and entry time. Welcher *et al.*, (2008) found significantly sooner using the front-weighted track start (0.80s) than the other two starts (both 0.87s; $p<0.001$) for block time. Juergens (1994), statistical analysis also determined significant difference between the grab start and track start techniques for block time.

In conclusion, it was obtain longer flight length in grab start rather than front track starts. It is recommended that athletes experiment with different start types to find their preferred technique and coaches should consider individual differences to decided which of the track and grab technique will be better for the competition.

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The aim of this study was to determine the differences in the kinematic parameters between the grab and track starts (rear-weighted track and front-weighted track). Ten elite male swimmers (mean age \pm sd 11.3 \pm 2.3 years, mean height 152.3 \pm 5.6 cm, mean weight 48.2 \pm 3.9 kg) participated to this study. Swimmers performed three trials with three different starts technique in indoor pool. Data were recorded directly to the computer by using two basler a602f cameras at 100 hz. and records were analyzed after the test using simi motion 8.5.7 program. The study examined the four kinematic parameters: flight length (FL), flight time (FT) block time (BT), entry time (ET). The kinematic data were compared with friedman test using spss 11.5 program. Based on the comparsion results, it was found statistically significant difference in the parameter FL ($p < 0.05$). Also, the difference between other parameters (FT, ET, BT) is not statistically significant. The flight length during grab start is longer than during front track starts.

Key words: swimming, grab-track starts, kinematic analysis.

„Dan“, 7. februar 2015.

НАЈВЕЋИ НАУЧНИ СКУП ИЗ СПОРТСКИХ НАУКА У РЕГИОНУ
ОДРЖАЋЕ СЕ ОД 2. ДО 5. АПРИЛА У ПОДГОРИЦИ

Рекордан број учесника

За 12. међународну конференцију и 11. Конгрес Црногорске спортске академије, који ће од 2. до 5. априла у Подгорици окупити око 250 учесника из 28 земаља, рецензенти су одабрали 110 научних радова.

– Сви прихваћени радови биће објављени у зборнику сажетак на енглеском језику, а после Конгреса биће штампани у специјализованом часопису Спортмонт. Што се тиче пленарних излагања учешће су потврдили Хенк Ерик Мајер, Зденко Ретули, Вишња Ђорђић и Мартин Звонар, рекао је председник приређивачког одбора Конгреса, проф. др Душко Бјелица. – Специјални гост биће Бранислав Антала, редовни професор



на Коменус Универзитету из Словачке. Он је и председник FIEP Europe, организације чији је циљ да промовише развој широ-

ког спектра дјелатности у области образовања, спорта и физичког васпитања и школског спорта, спорта за све, фитнеса и здравља и рекреације за људе свих узраста и у свим земљама свијета. Планиране су и двије радионице у оквиру Конгреса ЦСА. Нејц Шарабон са Универзитета у Приморској у Словенији приказаће савремени приступ смањењу јаза између истраживања и потреба индустрије, кроз практичне примјере, док ће представници свјетски познате компаније Десис за производњу система за електромиографију представити најновија достигнућа у тој области, рекао је Бјелица.

Т.Б.