

Original empirical article

THE KINEMATIC ANALYSIS OF THE GRAB AND TRACK START IN SWIMMING

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**Bojan Jorgić, Miloš Puletić, Ratko Stanković,
Tomislav Okičić, Saša Bubanj, Radoslav Bubanj**

Faculty of Sport and Physical Education, University of Niš, Serbia

Abstract. *The winner in swimming is often decided by hundredths of a second, and therefore, all the elements of the race must be practiced. The start in swimming, together with the other elements of the race, is very important for achieving better results in competitions. Nowadays, swimmers use two start techniques: the grab and track start. The aim of this study is to determine the statistically significant differences in certain kinematic parameters between the grab and track start among competitive swimmers, cadet selection. The sample consisted of 6 competitive swimmers, 15 years of age \pm SD, who belong to the cadet selection of the swimming club "Argiroupoli Nautical Club" from Athens (Greece). Three swimmers performed the grab start, while the other three performed the track start. This study involved 8 kinematic parameters: flight length (FL), flight time (FT), ascending angle (AA), angle of entry (AE), velocity of the centre of mass at take-off (VCMT), velocity of head movement at takeoff (VHMT), velocity of hand movement at takeoff (VHdMT) and velocity of hip movement at takeoff (VHpMT). In order to determine the statistically significant difference between the grab and track start, we used the *t*-test for each kinematic parameter. According to the results obtained in this research, we can conclude that there is no statistically significant difference between the grab and track start, except in the parameter AA ($p=0.04$). That is why an advantage cannot be given to one of these start techniques. Instead of that, the regular and intensive drill of a chosen start technique should be applied. While doing that, the choice of a start technique must be adapted to the swimmer's abilities and it must increase his competitive efficiency..*

Key words: *the grab start, the track start, competitive swimmers, differences, kinematic parameters*

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Corresponding author: Bojan Jorgić

Dr. Zorana Đindića Blvd 73/7, 18000 Niš, Serbia

• Tel: +00381 62 217 118 • E-mail: jorgicb5@yahoo.com

INTRODUCTION

Sport swimming belongs to the group of mono-structural sports of the cyclical type (Malacko & Rađo, 2004; Volčanšek, 1996). According to the form and manner of the performance, swimming is dominated by rather simple movements, that are same all the time and the winner in swimming is often decided by hundredths of a second, and therefore, all the elements of the race must be practiced. The start in swimming, together with the other elements of race is very important for achieving better competition results. The significance of the start can be seen through the statistically significant correlation between the start time and swimming performances at 50, 100 and 200 meters freestyle, determined at the Olympic Games in Barcelona, 1992. (Arellano et al., 1994). The start time, defined as the time elapsed since the start signal to the moment until the swimmer's head reached the 15-meter mark, represents 0.8 % of the total time in the 1500-meter race, and 26.1 % of the total time in the 50-meter race, depending on the swimming technique (Cossor & Mason, 2001). It also points out to the importance of learning and drilling the start. Nowadays, swimmers use two start techniques: the grab and track start. They represent main start techniques in competitive swimming (Takeda & Nomura, 2006). The grab start was introduced and presented by Eric Hanauer in 1960 (Maglischo, 2003) and soon it became popular among swimmers. The track start appeared after it, and it was presented by Fitzgerald in 1973 (Hong & Bartlett, 2008). 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). There are two variants of the track start. In the first one, the swimmer is on the front part of the pedestal surface, while in the second one, he is on the back part of the pedestal surface (Okičić et al., 2007). Modern testing of high-performance sportsmen requires tests to be not only reliable, objective, valid and technology-friendly but situational-specific as well (Dopsaj et al., 2003). In order to determine the differences, or advantages of one type of start over the other, the analyses of certain kinematic and kinetic parameters have been performed. In the research carried out so far, the following kinematic parameters have been measured: flight time, block time, start time for 5, 7.5, 10 and 15 meters, 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 et al., 2006; Chen & Tang, 2005; Issurin & Verbitsky, 2003; Nikodelis & Kollias, 2003; Kruger et al., 2003; Miller et al., 2003; Blanksby et al., 2002). It is worth mentioning that these studies included a different number of the kinematic parameters mentioned above. The aim of this study was to determine statistically significant differences in certain kinematic parameters between the grab and track start, which can influence competitive efficiency of the cadet selection swimming competitors.

METHOD

This study involved 6 competitive swimmers, with at least 6 years of experience. The average age of the swimmers was 15 (15.4 years \pm 0.2 months) and they belonged to the cadet selection of the swimming club "Argiroupoli Nautical club" from Athens (Greece).

Three swimmers used the technique of the grab start, while the other three used the technique of the track start with the body mass above the forward leg. This study involved the following parameters: 1. 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); 2. Flight time (FT) - the time between the last contact of the feet with the starting block and the first finger contact with water (in seconds); 3. Angle of take-off (AT) - an angle between the horizontal line and the line which connects the body centre of mass with the referential spot on the foot, at the moment of the last contact of the foot with the starting block (in degrees); 4. Angle of entry (AE) - an angle between the horizontal line and the line which connects the body centre of mass with the referential spot on the hand, at the moment of the first contact of the fingers with the water (in degrees); 5. Velocity of the centre of mass at take-off (VCMT) - velocity of the centre of mass at the moment of the last contact of the foot with the starting block (in m/s); 6. Velocity of head movement at takeoff (VHMT) - movement velocity of the referential spot on the head at the moment of the last contact of the foot with the starting block (in m/s); 7. Velocity of hand movement at takeoff (VHdMT) - movement velocity of the referential spot on the hand at the moment of the last contact of the foot with the starting block (in m/s); 8. Velocity of hip movement at takeoff (VHpMT) - movement velocity of the referential spot on the hip at the moment of the last contact of the foot with the starting block (in m/s).

The study was carried out at the swimming pool of the sport centre "Čair" in Niš, during the preparations of the Greek club. Each swimmer performed the start several times, while the best attempt was analyzed. The start was recorded in the sagittal plane, with a high speed camera Casio FX, set at 300 frames per second. The camera lens was positioned vertically towards the swimmer's direction of movement. The obtained data were processed using the software for kinematic analysis "Hu-m-an[™]". Firstly, the digitalization of the referential points was performed, by using a nine-model system, and later, the scale and ratio were defined. After that, the values of the kinematic parameters were calculated. All of the obtained data were processed by using the software "Statistica 6". In order to determine the statistically significant difference between the grab and track start for each kinematic variable, the t-test was used, whereas for the statistically significant difference, the value of the importance level was set up to 0.05 ($p \leq 0.05$). For each variable, descriptive parameters Mean (arithmetic mean) and SD (standard deviation) were calculated.

RESULTS

The descriptive statistics of the calculated kinematic parameters and the results of the t-test are presented in Table 1, while the techniques of the track and grab start can be seen in Figures 1 and 2.

Out of the 8 kinematics parameters, a statistically significant difference between the grab and track start can be found only in the size of the angle of take-off (AT), while the difference between other parameters is not statistically significant. Higher Mean numeric values have been recorded in the grab start, in 6 of the variables (FL, FT, AT, AE, VCMT and VHMT), while higher Mean numeric values were recorded in the track start in the variables of hand movement velocity and hip movement velocity (VHdMT and VHpMT). The flight length (FL) of the grab start is approximately 0, 23 m bigger than in the track

start. The flight time (FT) of the grab start is approximately 0.10 seconds bigger than in the track start. The angle of take-off (AT) is approximately 10.34 degrees bigger in the grab start than in the track start, and that difference is statistically significant ($p=0.04$). In the grab start, the angle of entry (AE) is approximately 4 degrees bigger than in the track start. Also, in the grab start, the velocity of the centre of mass at take-off (VCMT) and velocity of the head movement at take-off (VHMT) are approximately 0.21 m/s and 0.33 m/s (respectively) higher than in the track start. The velocity of the hand movement at take-off (VHdMT) and the velocity of the hip movement at takeoff (VHpMT) are approximately 0.6 m/s and 0.17 m/s (respectively) higher in the track start, than in the grab start.

Table 1. The descriptive statistics of the calculated kinematic parameters and the results of the t-test used to examine the statistically important difference between the grab and track start.

Variables	Mean G	Mean T	SD G	SD T	t-value	df	p
FL	3.21	2.98	0.17	0.13	1.92	4	0.13
FT	0.33	0.23	0.10	0.03	1.76	4	0.15
AT	33.67	23.33	5.69	1.53	3.04	4	0.04
AE	33.33	29.33	5.13	5.51	0.92	4	0.41
VCMT	4.01	3.80	0.01	0.20	1.77	4	0.15
VHMT	4.65	4.32	0.05	0.36	1.58	4	0.19
VHdMT	4.57	5.17	0.08	0.57	-1.81	4	0.14
VHpMT	4.89	5.06	0.21	0.21	-1.00	4	0.37

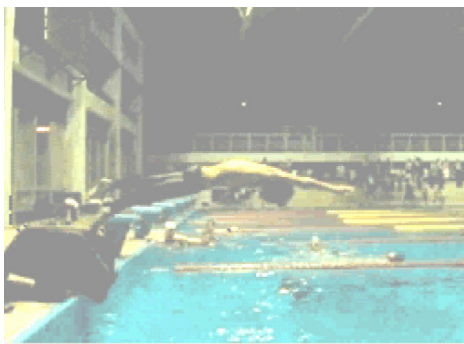


Fig. 1. The track start in the phase of the last contact of the foot with the starting block

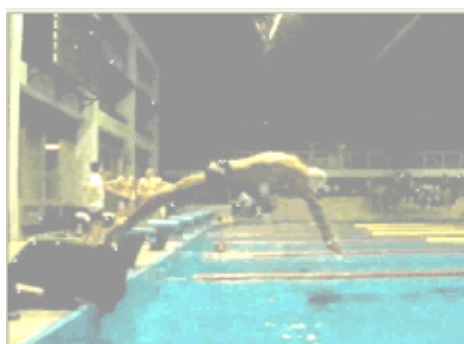


Fig. 2. The grab start in the phase of the last contact of the foot with the starting block

DISCUSSION

Maglischo (2003), on the basis of several studies, considered that in the grab start, the angle of take-off should be at 30-40 degrees, flight length should be 3-4 meters and flight time 0.30-0.40 seconds, which is in accordance with the results of the arithmetic means (Mean) for the parameters of the grab start in Table 1, and which can be found within the

already mentioned limits. It points to the correct performance of the grab start by the examined swimmers. The flight length of the grab start is 0.23 meters longer than in the track start, but not statistically significantly longer, which is in accordance with the results of the research carried out by Takeda et al., (2006); Blanksby et al., (2001). The authors Chen et al. (2005) and Miller et al. (2003) have also noticed a greater flight length in the grab start, in comparison with the track start, which has made this difference statistically significant. There was no statistically significant difference in the flight time between these two starts, which corresponds to the research results obtained by Miller et al., (2003); Kruger et al., (2003); Blanksby et al., (2001). The angle of take-off is statistically significantly bigger ($p=0.04$) in the grab than in the track start. In his paper, Maglischo (2003) claimed that the main difference between the grab and track start, apart from feet position on the starting block, is the angle of take-off (AT) that is smaller in the track start, which has been proved in this study (23.22 degrees in comparison to 33.67 degrees, respectively). There was no statistically significant difference in the size of the angle of the entry ($p=0.41$) between the grab and track start. Also, there was no statistically significant difference in the calculated velocities of the centre of body movements, head movements, hand movements and hip movements ($p=0.15$; $p=0.19$; $p=0.14$; $p=0.37$). Taking into account that a statistically significant difference exists in only one of the 8 kinematic variables (AT, $p=0.04$), we cannot conclude whether the grab start is superior to the track start or vice versa. On the basis of the study conducted by Issurin et al. (2003), there was no statistically significant difference in start time up to 15 m, between the grab and track start in all semi-final and final races in the men's competitions at the Olympic Games in Sydney. Blanksby et al. (2002), also concluded that there was no statistically significant difference in start time up to 10 meters, before and after coaching, between these two start techniques. They also noted that in both start techniques there were improvements in the mentioned and other kinematic parameters, after the coaching process. On the basis of our results and the results of the mentioned studies, we consider regular and intensive training of the chosen start technique, as the most important.

CONCLUSION

According to the results in this study, we can conclude that there is no statistically significant difference between the grab and track start, except in the parameter AT (angle of take-off). Therefore, we cannot give an advantage to one of these techniques over the other. Instead of that, we consider regular and intensive training of the chosen start technique to be the most important thing. The choice of the start technique should, first of all, suit the abilities of the swimmer and his competitive efficiency. In addition, we recommend that the coaches make time in their plans for practising and improving the start technique, and other elements of the race that are important for achieving better competitive results.

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KINEMATIČKA ANALIZA GRAB I TRAK STARTA U PLIVANJU

**Bojan Jorgić, Miloš Puletić, Ratko Stanković,
Tomislav Okičić, Saša Bubanj, Radoslav Bubanj**

Pobednika u plivanju često odlučuje nekoliko stotinki sekunde, zbog toga se svi elementi trke moraju uvežbavati. Start u plivanju je zajedno sa ostalim elementima trke veoma važan za postizanje što boljih takmičarskih rezultata. Danas plivači uglavnom koriste dve tehnike starta: grab i trak start. Cilj ovog istraživanja bio je da se utvrde statistički značajne razlike u određenim kinematičkim parametrima između grab i trak starta, kod plivača takmičara, selekcije kadeta. Uzorak ispitanika je činilo 6 plivača takmičara, starosti 15 ± 0.21 godina (mean \pm stdev), koji pripadaju selekciji kadeta plivačkog kluba "Argiroupoli Nautical Club" iz Atine (Grčka). Trojica plivača su izvodila grab start, a ostala trojica trak start. U istraživanju je mereno 8 kinematičkih parametara: dužina leta (DL), vreme leta (TL), uzlazni ugao (UZU), upadni ugao (UPU), brzina kretanja težišta plivača pri odskoku (VTT), brzina kretanja glave pri odskoku (VG), brzina kretanja šake pri odskoku (VŠ) i brzina kretanja kuka pri odskoku (VK). Da bi se utvrdila statistički značajna razlika između grab i trak starta za svaki kinematički parametar, korišćen je t-test. Na osnovu dobijenih rezultata u ovom istraživanju zaključuje se da između grab i trak starta ne postoji statistički značajna razlika, osim u parametru UZU ($p=0.04$). Zbog toga se ne može dati prednost jednoj tehnici starta u odnosu na drugu. Umesto toga, najvažnije je pravilno i intenzivno uvežbavanje izabrane tehnike starta. Pri tome izbor tehnike starta mora pre svega da odgovara sposobnostima plivača i povećanju njegove takmičarske efikasnosti.

Ključne reči: *grab start, trak start, plivači takmičari, razlike, kinematički parametri*