THE KICK START: KEY OF ITS SUPERIORITY

Sonia Taladriz[1], Blanca de la Fuente[2] and Raúl Arellano[1]

Physical Education and Sport Department, Faculty of Sports Sciences, University of Granada, Granada, Spain[1]
High Performance Training Centre of Sierra Nevada, Granada, Spain[2]

The purposed of this study was to observe the differences between the grab start and the kick start regarding the initial position that determines the aspect that the swimmers must train to improve their start. Results showed some advantages in the times obtained by the kick start in the block phase, keeping them until the hands entry. The kick start was able to reach a similar entry distance, similar than the grab start can do, at 0.18 s less with a small difference in the horizontal velocity in the flight. The rear foot allows the swimmers to reach an acceleration peak of 11.81 ± 2.05 m/s² in 0.37 ± 0.05 s while in the grab start the values were lower and the increase of the acceleration more progressive (8.97 ± 1.02 m/s² in 0.67 ± 0.08 s). With the kick start the swimmers were able to produce a great horizontal force since the moment of the starting signal.

KEYWORDS: performance, block phase, acceleration, swimming, starts.

INTRODUCTION: One of the first experimental studies about the swimming start compared the performance differences between a body wet swimming start and a body dry swimming start (Gentile, 1966). Since that moment, the swimming starts have never stopped to be an object of study.

Throughout years, the start technique more used by the swimmers and more studied by the researchers were the grab start, the track start and nowadays, the kick start.

The grab start and the track start are the more ancient and their main difference lies in the feet position at the starting block. In the grab start, the feet are placed parallel to each other while in the track start the swimmers placed one foot in the front edge of the starting block and the other in the rear part of the starting block.

The kick start appeared in 2009 when a new starting block with back plate was developed. This technique is similar to the track start except because the rear foot is placed in the back plate, providing to the swimmers a stable base where to put their rear foot and allowing them to have their center mass in a most rear and higher position at the ready position (Nomura, Takeda, & Takagi, 2010). This starting block supposed an evolution in the swimming starts. Nowadays the kick start is the starting technique more used by the swimmers at International Competitions.

The studies related to the swimming start aimed to know the differences between them. When comparing the track start and the grab start we find contradictory results. They conclude in many cases that a regular and intense training can make superior one technique over the other (Benjanuvatra, Lyttle, Blanksby, & Larkin, 2004; Lee, Huang, & Lee, 2012; Mason, Alcock, & Fowlie, 2007; Thanopoulos et al., 2012; Welcher, Richard, Hinrichs, & George, 2008). On the contrary, all researches comparing the track start and the kick start showed this last as the better, mainly in the block phase (Nomura et al., 2010; Ozeki, Sakurai, Taguchi, & Takise, 2012). With the kick start, the swimmers got advantages of 0.3s in the starting block (Garcia-Hermoso et al., 2013; Honda, Sinclair, Mason, & Pease, 2010; Ozeki et al., 2012) and advantages of 0.14s in the total start performance (Ozeki et al., 2012).

Regarding the grab start and kick start, we have just found at the moment one study focused on both techniques. Its aim as to know the differences between males and females at the entry phase (Fischer & Kibele, 2014).

The differences in the initial position between the grab start and the kick start as well as the superiority of the KS in the block phase with respect to the track start, made us to propose as aim of study: a) To know the differences between the KS and the GS that are related to the different initial position of these both techniques. In addition, due to the absence of studies

focused in our aim of study we proposed: b) to determine the key point over which the swimmers must train to improve their start.
It was hypothesized that rear foot impulse allows the swimmers to produce a quicker and higher acceleration values of the center of mass.

METHOD: Nine elite swimmers of the Spanish Swimming National Team with an average of 824 FINA Points participated in this study (70.0 ± 7.7 kg; 178 ± 9.4 cm; 24.5 ± 5.3 years).
An informed consent was signed by all subjects and the procedures used for this testing were approved by the ethics committee of the University of Granada.
All swimmers were familiar with the grab start (GS) and kick start (KS) but their preferred technique of starting is the KS. The swimmers used their preferred footrest position for to perform the KS.
Each swimmer performed one GS and one KS from a starting block (OMEGA OSB11) prior to perform the longest glide as possible. Trials were recorded by four cameras high definition Nikon 1 J1 (60Hz). The cameras were placed at both sides of the swimming pool, two on each side at 2.80 meters and 10 meters of the starting block respectively.
A control object (2 m x 1.55 m x 0.81 m) was used to calibrate the plane of motion. After calibrating of the control object dimensions by using 11DLT parameters (3D DLT; Kwon 3D XP, 2009), a calibration error of 0.78% was obtained.
Twenty-one points were digitalized to define the body model of 14 segment proposed by De Leva (1996). The Kwon 3D XP software was used for the digitalization and the subsequent kinematical analysis. All the data were processed by using a Butterworth Low-pass filter with a cutoff frequency of 6Hz.
Descriptive statistic was performed to calculate the mean and the standard deviation for each variable. The t-student test was applied in order to observe the differences between both starts.

RESULTS AND DISCUSSION: The temporal differences between the GS and KS showed that the swimmers achieve a better performance with the KS as showed in the Table 1. The KS obtained shorter time from the hands takeoff to the entry hands. Nevertheless, the main advantages were produced in the block phase. The swimmers were 0.17s faster at the block time with the kick start; this advantage was maintained until the entry hands.

Table 1
Mean, standard deviation and differences in the kinematic variables between the GS and the KS

	GS	KS	p-value
Hands takeoff time (s)	0.51 ± 0.04	0.38 ± 0.07	0.001*
Block Time (s)	0.83 ± 0.07	0.66 ± 0.59	0.000*
Flight time (s)	0.24 ± 0.05	0.22 ± 0.49	0.056
Hands entry time (s)	1.07 ± 0.06	0.89 ± 0.06	0.000*
Entry distance (m)	2.83 ± 0.29	2.79 ± 0.27	0.114
Horizontal Velocity in the Flight (m/s)	4.06 ± 0.21	4.12 ± 0.30	0.004*
Maximum peak of acceleration (m/s²)	8.97 ± 1.02	11.81 ± 2.05	0.001*
Time of maximum peak of acceleration (s)	0.67 ± 0.08	0.37 ± 0.05	0.001*
Takeoff acceleration (m/s²)	3.93 ± 0.73	1.84 ± 0.65	0.001*

Similar results were found in the entry distance. When performing the KS, the swimmers reached the same distance but in a shorter time comparing with the GS. Since the moment the swimmers release the hands from the starting block the KS began to shown lower times to reach the same distance. Moreover, the differences in the flight horizontal velocity were small indicating that the advantages between both techniques had been produced during the block phase. As showed the Figure 1, the advantages started in the takeoff hands moment. This indicated that the KS was faster respect to the GS from the moment of the starting signal to the moment of the takeoff hands.

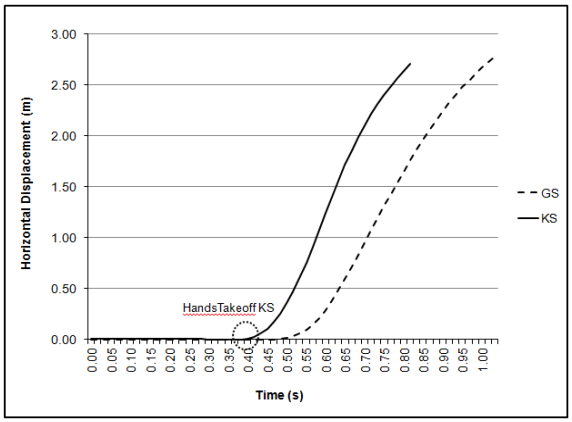

Figure 1: Comparison of the horizontal displacement of the hands respect to the time between GS and KS

As mentioned by Guimaraes & Hay (1985), one of the keys to producing a fast swimming start is to quickly move the center of mass in a forward direction. In this respect, the KS was able to produce a higher acceleration in the first moment of the start and consequently obtained a better performance. The swimmers were able to reach the maximum peak of acceleration previously to the takeoff hands which allowed them to reduce the block time without compromising the entry distance. The KS reached the maximum acceleration peak in 0.37s while the GS had a more progressive acceleration, reaching the maximum peak to 0.67s (see Figure 2). These results were similar to the ones obtained by Nomura et al. (2010) who showed higher horizontal and vertical acceleration in the KS with respect to the track start in the previous 0.3s to the takeoff.

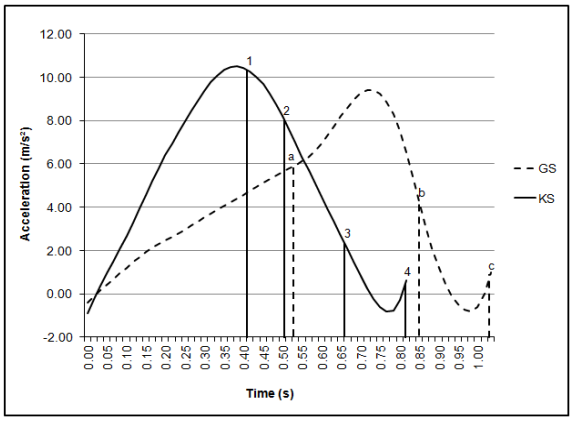

Figure 2: Acceleration generated in the GS and the KS, the numbers correspond to the phases of the KS and the letters to the GS. 1, a (hands takeoff); 2 (rear leg takeoff); 3, b (takeoff block); 4, c (entry hands).

However, it should be mentioned that the KS also produced a higher deceleration respect to the GS what makes the swimmers to get a lower acceleration when the feet leaves the block. Nevertheless, the greater acceleration previously produced was big enough to maintain this advantage during all the flight phase.

Thanks to the back plate, the swimmers are able to produce a great horizontal force since the moment in which the starting signal is given, producing a huge acceleration in short time. Honda et al. (2010) observed this characteristic of the KS when comparing this technique with the track start. They concluded that the KS obtained a higher horizontal force and on consequence a better performance.

On the contrary, the initial position adopted by the swimmers when performing the GS impeded them to quickly produce a great horizontal force.

CONCLUSION: The back plate of the new starting block and the rear foot position allows the swimmers to obtain a better performance than the achieved with the GS. With the KS, a great acceleration peak can be reached in a very short time producing therefore, a great horizontal force. However when this same acceleration peak is reached with the GS, the KS has already achieved a great advantage.
The coach should try to improve the force developed by the swimmers. In addition, the starting position should be trained in order to achieve the highest acceleration before the hands takeoff in the shortest time as possible. Some specific drills focused to increase these values could lead to an improvement of the start, getting a more efficient KS.

REFERENCES:

Benjanuvatra, N., Lyttle, A., Blanksby, B., & Larkin, D. (2004). Force development rofile of the lower limbs in the grab and track start swimming. In M. Lamontagne, D. Gordon, E. Robertson & H. Sveistrup (Eds.), *International Symposium Biomechanics Swimming* (pp. 399-402). Ottawa, Canada International Society of Biomechanics in Sports.

Fischer, S., & Kibele, A. (2014). On the movement behavior of elite swimmers during the entry phase. In B. Mason (Ed.), *XIIth International Symposium on Biomechanics and Medicine in Swimming* (pp. 131-135). Canberra, Australia Australian Institute of Sport.

Garcia-Hermoso, A., Escalante, Y., Arellano, R., Navarro, F., Dominguez, A. M., & Saavedra, J. M. (2013). Relationship between final performance and block times with the traditional and the new starting platforms with a back plate in international swimming championship 50-m and 100-m freestyle events. *J Sports Sci Med, 12*(4), 698-706.

Gentile, A. (1966). Comparison of dry and wet body starts in swimming. *Research Quarterly. American Association for Health, Physical Education and Recreation*, *35*(1), 81-82.

Guimaraes, A. C. S., & Hay, J. G. (1985). A mechanical analysis of the grab starting technique in swimming. *International Journal of Sports Biomechanics, 1*(1), 25-35.

Honda, K. E., Sinclair, P. J., Mason, B. R., & Pease, D. L. (2010). A Biomechanical Comparison of Elite Swimmers Start Performance Using the Traditional Track Start and the New Kick Start. In P. Kjendlie, R. K. Stallman & J. Cabri (Eds.), *XIth International Symposium Biomechanics and Medicine in Swimming* (pp. 94-96). Oslo, Norway Norwegian school of sports sciences.

Lee, C., Huang, C., & Lee, C. (2012). Biomechanical analysis of the grab and track swimming starts. *30th Annual Conference of Biomechanics in Sports*, 369-372.

Mason, B., Alcock, A., & Fowlie, J. (2007). A kinetic analysis and recommendations for elite swimmers performing the sprint start. In H. J. Menzel & M. H. Chagas (Eds.), *XXV ISBS Symposium* (pp. 192-195). Canberra, Australia Australian Institute of Sport.

Nomura, T., Takeda, T., & Takagi, H. (2010). Influences of the back plate on competitive swimming starting motion in particular projection skill. In P. Kjendlie, R. K. Stallman & J. Cabri (Eds.), *XIth International Symposium Biomechanics and Medicine in Swimming* (pp. 135-137). Oslo, Norway Norwegian school of sports sciences.

Ozeki, K., Sakurai, S., Taguchi, M., & Takise, S. (2012). Kicking the back plate of the starting block improves start phase performance in competitive swimming. In E. J. Bradshaw, A. Burnett & P. A. Hume (Eds.), *30th annual conference of the international society of biomechanics in sports* (pp. 373-376). Melbourne, Australia.

Thanopoulos, V., Rozi, G., Okicic, T., Dopsaj, M., Jorgic, B., Madic, D., & Velicković, S. (2012). Differences in the efficiency between the grab and track starts for both genders in greek young swimmers. *Journal of Human Kinetics, 32*(1), 43-51.

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

Acknowledgement

The authors wish to acknowledge the support of the group “Physical Activity and Sport in the Aquatic Environment” (CTS-527), to the Higher Council for Sports in the Sierra Nevada CAR, to the Spanish National Swimming Team and to the professor Jesús Dapena for their help in data processing.