INDIVIDUAL OPTIMIZATION OF THE KICK START POSITION RELATIVE TO TIME PARAMETERS

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Abstract:

The purpose of the present study was to determine how the duration of particular swim start phases differed from the preferred ones when various OSB12 kick plate and starting positions were used, which aimed to optimize the kick start. The sample included 2 non-randomly recruited performance-level swimmers whose average age was 17.0 years. To collect the data about time parameters of the kick start, we used the SwimPro camera system and DartFish software. The results for the sample studied show that the preferred OSB12 kick plate position and the starting position need not be optimal. In terms of individual assessment of the kick start, the results showed that swimmers produced the fastest times when using the neutral-weighted and rear-weighted kick start and adjusting the kick plate to positions 3 and 4. According to these findings, we recommended that performance-level swimmers use the kinematic analysis of the swim start and determine their optimal position of the kick plate and basic starting position on the OSB starting block because performance in sprint races depends on hundredths of a second.

INTRODUCTION

Swim start is an integral part of every swim race. Some studies [Lyttle, Benjamvatra 2005; Slawson 2010; Matúš 2016; Ružbarský, Matúš 2017] show that start is defined as the time from the starting signal until the swimmer's head breaks the water surface at 15 meters. In terms of race length, swim starts show different factor loadings. In sprint races, the resultant time depends at the rate of 30% on the start. However, the contribution of the start to the time in a 1,500 m race is 0.08%. At elite swim events all over the world and in Slovakia as well, swimmers have been using the new Omega OSB starting block with an adjustable rear kick plate since 2009. This footrest may be adjusted in the front-rear direction in the rear section of the starting block (5 kick plate positions). The kick plate is angled at 30° (90° rear knee angle), which facilitates the takeoff from the starting block [Omega 2016]. First studies [Biel et al. 2010; Nomura et al. 2010; Beretic et al. 2012] compared the new OSB11 starting block with the traditional starting block without the rear kick plate. The results of the studies showed that swimmers produced higher takeoff velocity and force impulse, and shorter times

to 5 m, 7.5 m, and 15 m when the start from the new OSB11 starting block was used. Overall, we may conclude that the rear kick plate aids in the takeoff from the starting block, which results in a more efficient takeoff. Some studies [Slawson et al. 2011; Takeda et al. 2012; Honda et al. 2012] dealt with the rear OSB11 kick plate positions, but none of the studies focused on all kick plate positions. The positions studied included the preferred kick plate position, plus minus one position. Other studies [Honda et al., 2012; Barlow et al., 2014; Kibele et al., 2014] looked at the basic starting position on the OSB11 starting block but did not deal with various starting positions across all kick plate positions. Most of the specified studies did not focus on the optimal basic starting position for individuals as such but rather for groups. Therefore, the purpose of the present study was to determine how the duration of particular swim start phases differed from the preferred ones when various OSB12 kick plate and starting positions were used, which aimed to optimize the kick start.

MATERIAL AND METHODOLOGY

Participants

The sample included 2 non-randomly recruited performance-level swimmers whose average age, body height, and body weight was 17.0 years, 182.2±1.4 cm and 81±1.1 kg, respectively. The swimmers participated regularly in the Slovak regional swimming championships and Slovak swimming championship, having competed in particular in sprint races and freestyle races. When tested, all swimmers were healthy and did not report any health problems before the testing. Each tested person read an information leaflet about testing and gave his or her written consent.

Test protocol

The testing session took place in the morning at the swimming pool facilities of the Faculty of Sports, University of Presov, Presov, Slovakia. Each of the swimmers was informed about the testing conditions. Swimmers first had to determine their regularly used starting position on the OSB starting block. This was followed by a standard warm-up protocol and swimming over the course of 400 meters. After the warm-up, eleven waterproof adhesive markers were applied on swimmers' bodies: (1) lateral margin of the left transverse tarsal joint, (2) lateral left and right malleolus, (3) lateral left and right knee condyle, (4) left and right greater trochanter, (5) lateral margin of the left and right scapular spine, (6) lateral left and right elbow epicondyle, (7) ulnar styloid process of the left and right wrist, (8) medial side of the 5th metacarpal–phalanx joint. After that swimmers performed three trial kick starts from the OSB12 starting block to become familiar with the three basic starting positions: front-weighted, neutral-weighted, and rear-weighted.

To determine the starting position, we placed a 2-cm thick bar perpendicularly to the front edge of the starting block. The body position in the basic position on the starting block was determined according to the spot marked on the scapular spine. When this spot was located in front of the bar, the starting position was front-weighted. When the spot overlapped with the bar, the starting position was neutral-weighted. When the spot was located behind the bar, the starting position was rear-weighted. Swimmers took their marks and responded to a sound signal and a LED light signal at the same time. The swimmers started from starting positions and adjusted the kick plate to positions 1 through 5. Each of the swimmers performed 3 starts from all three positions (front-, neutral-, and rear-weighted). The rest period between starts and the change in the OSB12 kick plate position was 30 seconds and 2 minutes, respectively. Each swimmer performed a total of 45 jumps.

To measure the velocity parameters, we used the SwimPro camera system. The first camera was perpendicular to the starting block in the 0 m distance from the edge of the pool

and 1.5 m above the water surface. The second camera was 1.6 m from the edge of the pool and 1.5 m under the water surface. The third camera was 1.6 m from the edge of the pool and 1.7 meters below the water surface. The fourth camera was 5 m away from the edge of the pool and 1.7 m below the water surface. To increase the level of lighting, we used halogen and additional LED lights. The camera system was operating at 60 frames per second and the shutter speed was set at 1/1000s- The video recording was subsequently assessed using the Dartfish© software (Dartfish ProSuite4.0, 2005; Switzerland). This software meets the validity and reliability criteria for the assessment of kinematic parameters using the 2D analysis in swimming [Seifert et al. 2010; Norris, Olson 2011].

The velocity parameters assessed during the start from the OSB12 starting block included:

- start reaction (s) – time between the starting signal and the takeoff from the starting block,
- flight time (s) – time between the water entry and distance to 5 meters,
- time (s) to 2 and 5 meters, which is the time between the start signal and the moment when swimmer's head breaks the water surface at a specified distance,
- velocity (m/s) at 2 and 5 meters.

RESULTS

The parameters of the kick start from the OSB12 starting block showed that the first swimmer's optimal starting position corresponded with his preferred starting position on the OSB12 starting block. The swimmer achieved the shortest time (1.617 s) and highest velocity (3,092 m/s) at 5 meters. Although having reached the fastest time to 5 meters, the fastest reaction (0.733 s) was recorded when the OSB12 kick plate was in position 3 and 4, and the swimmer used the front-weighted and neutral-weighted kick start, respectively.

When the kick plate was adjusted to position 4, the swimmer produced the fastest time (0.933 s) to two meters. Unlike the glide time, which was the shortest (0.466 s) when the rear OSB12 kick plate was in position 3 and the swimmer used the neutral-weighted kick start, the time to 5 meters was found to be average (0.350 s). The second fastest time to 5 meters (1.666 s) was recorded for the kick plate position 3 but for the rear-weighted kick start. The difference between the fastest and second fastest time was 0.049 s, which equals 0.091 m/s (Table 1).

Table 1 Parameters of the kick start: Swimmer 1

	Block time	Time to 2 m		Flight time	Glide time	Time to 5m	
	s	s	m/s	s	s	s	m/s
1F	0.833	1.089	1.837	0.383	0.584	1.800	2.778
1N	0.870	1.110	1.802	0.350	0.540	1.760	2.841
1R	0.851	1.133	1.765	0.350	0.553	1.754	2.851
2F	0.826	0.999	2.002	0.384	0.533	1.743	2.869
2N	0.836	1.100	1.818	0.356	0.540	1.732	2.887
2R	0.840	1.120	1.786	0.316	0.566	1.722	2.904
3F	0.733	0.980	2.041	0.433	0.616	1.783	2.804
3N*	0.800	0.980	2.041	0.350	0.466	**1.617**	3.092
3R	0.833	0.983	2.035	0.333	0.500	**1.666**	3.001
4F	0.766	0.986	2.028	0.400	0.650	1.817	2.752
4N	0.773	0.933	2.144	0.433	0.551	1.757	2.846
4R	0.850	1.053	1.899	0.366	0.483	1.699	2.943
5F	0.850	0.995	2.010	0.350	0.616	1.816	2.753
5N	0.856	0.996	2.008	0.383	0.551	1.790	2.793
5R	0.856	1.050	1.905	0.386	0.535	1.777	2.814

Note. 1-5 kick plate position; F - front; N - neutral; R – rear; * - preferred kick plate position

The shortest time in the kick start from the OSB12 starting block showed that the second swimmer's optimal kick plate position differed from his preferred kick plate position on the OSB12 starting block. The swimmer produced the fastest time (1.734 s) and highest velocity (2.884 m/s) when using the rear-weighted kick start using the position 4 of the kick plate. The difference between the fastest resultant time and the time recorded for the kick start from the preferred OSB12 kick plate position was 0.082 s (0.132 m/s). Despite the shortest time to 5-meter distance, the fastest start reaction (0.816 s) was found when the OSB12 kick plate was adjusted to position 3 and the front-weighted kick start was used. When the kick plate was in position 3 and the swimmer used the front-weighted kick start, the flight time for the fastest kick start to 5 meters was found to be average (0.333 s). Unlike the flight time, the glide time was the shortest (0.483 s) when the swimmer adjusted the OSB12 kick plate to position 4 and used the neutral-weighted kick start. The second fastest time to 5 meters (1.766 s) was recorded for the kick plate position 3 and the neutral-weighted kick start. The differences between the fastest and second fastest time was 0.05 s, which equaled 0.09 m/s (Tab. 2).

Table 2 Parameters of the kick start: Swimmer 2

	Block time	Time to 2 m		Flight time	Glide time	Time to 5m	
	s	s	m/s	s	s	s	m/s
1F	0.912	1.080	1.852	0.350	0.637	1.899	2.633
1N	0.915	1.100	1.818	0.352	0.626	1.893	2.641
1R	0.933	1.116	1.792	0.300	0.633	1.866	2.680
2F	0.912	1.096	1.825	0.366	0.558	1.836	2.723
2N	0.916	1.100	1.818	0.300	0.585	1.801	2.776
2R	0.916	1.090	1.835	0.350	0.533	1.799	2.779
3F	0.816	1.020	1.961	0.383	0.650	1.849	2.704
3N*	0.916	1.083	1.847	0.350	0.550	1.816	2.753
3R	0.950	1.103	1.813	0.333	0.483	**1.766**	2.831
4F	0.820	1.040	1.923	0.460	0.550	1.830	2.732
4N	0.853	1.060	1.887	0.400	0.550	1.803	2.773
4R	0.900	1.083	1.847	0.351	0.483	**1.734**	2.884
5F	0.916	1.050	1.905	0.350	0.616	1.882	2.657
5N	0.900	1.030	1.941	0.346	0.618	1.864	2.682
5R	0.920	1.050	1.905	0.353	0.560	1.833	2.728

Note. 1-5 kick plate position; F - front; N - neutral; R – rear; * - preferred kick plate position

DISCUSSION

Starts in swimming may be decisive in terms of winning in the sprint races because the percentage contribution of the start to 50-meter performance in the short-course pool is 30%. At present, every sprint swimmer should know which OSB12 kick plate and starting position to use. Slawson et al. [2011] studied 3 kick plate positions (3, 4, and 5) on the OSB11 starting block. The results of this study showed that horizontal takeoff velocity was higher in kick plate positions 4 and 5, compared with position 3. The highest rates of peak force were found for the kick plate position 5. Similarly, Honda et al. [2012] studied the plate located one position immediately behind (position +1) and one immediately in front (position -1) of their preferred position on the OSB11 starting platform (positions 3, 4, and 5). After establishing the preferred position, the effect of the kick plate positions (positions +1 and -1) on the horizontal takeoff velocity was determined. The results of the study showed that moving the plate one position backward from the preferred position produced a significantly higher horizontal velocity off the block. Takeda et al. [2012], used their own modified blocks with a kick plate at various distances from the front edge (0.29 m, 0.44 m, and 0.59 m). The results of their study showed that horizontal takeoff velocity was higher for the kick plate 0.44 m from the front edge than for the kick plate 0.29 m from the front edge of the block. There were no significant differences in the horizontal takeoff velocity between the 0.29 m and 0.59 distance of the kick plate form the front edge of the starting block. This means that Takeda et al. [2012] assume that the range (0.44 m from the front edge of the starting block) may be optimal when taking off from the starting block with a kick plate. The results of this study need not be objective because the OSB11 starting block was not used. In our study, we have applied specific methods to perform the kinematic analysis of the kick start from the OSB12. As compared with other studies, our study differed in that the swimmers who participated in our study started from all five kick plate positions of the OSB12 starting block. The individual assessment has shown that swimmer 1 produced the fastest time to 5 meters when starting from the kick plate position identical to that preferred (3). On the contrary, swimmer 2

produced the fastest time to 5 meters when the kick plate was adjusted to one position backward. This means that the results of our study are correspond with the results reported by the above-mentioned authors. In addition to the kick plate position on the OSB12 starting block, we also focused on the basic starting position in which the swimmer could have used the front-weighted, neutral-weighted, or rear-weighted kick start. The studies by Honda et al. [2012] and Kibele et al. [2014] show that when swimmers use the kick start, the center of gravity is over the front section of the starting block, which results in shorter reaction time. On the other hand, when the center of gravity was in the rear section of the starting block, swimmers produced higher takeoff velocity. Barlow et al. [2014] found that swimmers produced shorter time to 15 meters when their center of gravity was positioned in the center of the starting block. Our findings are consistent with the above-mentioned findings showing that swimmers produced shorter reaction time when the front-weighted kick start was used. Despite these findings, swimmers produced shorter time to 5 meters from the rear-weighted starting position.

CONCLUSION

The results for the sample studied show that the preferred OSB12 kick plate position and the starting position need not be optimal. In terms of individual assessment of the kick start, the results showed that swimmers produced the fastest times when using the neutral-weighted and rear-weighted kick start and adjusting the kick plate to positions 3 and 4. According to these findings, we recommended that performance-level swimmers use the kinematic analysis of the swim start and determine their optimal position of the kick plate and basic starting position on the OSB starting block because performance in sprint races depends on hundredths of a second.

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