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A COMPARISION BETWEEN FRONT CRAWL AND BUTTERFLY START

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PRIMERJAVA MED ŠTARTNIM SKOKOM KRAVL IN DELFIN

Abstract

The aim of the present study was to see if a difference in depth of diving between front crawl and butterfly technique is reflected in corresponding differences in a starting action prior the first contact with water. Ten swimmers (age 16.7±1.3 yrs, height 174.2±7.2 cm, mass 64.9±7.8 kg) participated in the study. Each swimmer performed 4 (2 crawl and 2 butterfly) grab swimming starts followed by swimming with maximal velocity for 17 meters. Swimmers were filmed with a 50 Hz video camera. A 2D kinematical model was employed to obtain the joint angles and linear and angular velocities. Statistical differences between both techniques were checked. The results showed that no statistically significant differences at the starting position and at the first water contact between both styles existed. During the last contact on the starting block, the statistically significant differences appeared only in a knee angle (167.2°±6.2° and 161.4° ±6.7°, P<.05, crawl and butterfly, respectively) and in a knee angular velocity (582.1°/s ±161.1°/s and 671°/s ±133.4°/s, P<.05). Obtained results suggest that some differences in a start kinetics were present but had no effect on the flight phase and consecutive diving.

Keywords: swimming, grab start, starting action

Izvleček

Cilj raziskave je bil ugotoviti ali je razlika v globini plavanja pod vodo med kravlovo in delfinovo tehniko posledica razlike v štartni akciji pred prvim stikom z vodo. V raziskavi je sodelovalo deset plavalcev (starost 16.7±1.3 let, telesna višina 174.2±7.2 cm, telesna masa 64.9±7.8 kg). Vsak plavalec je izvedel 4 (2 kravl in 2 delfin) grab štarte, katerim so sledila maksimalna plavanja do 17 metrov. Plavalci so bili posneti z 50 Hz video kamero. Za ugotavljanje kotov v sklepih in linearno in kotno hitrost je bil uporabljen 2D kinematični model. Preverjene so bile statistične razlike med obema tehnikama. Rezultati so pokazali, da ni bilo statističnih razlik v štartnem položaju in med prvim stikom z vodo. Pri zadnjem stiku s štartnim blokom so se pokazale statistično značilne razlike samo v kolenskem kotu (167.2°±6.2° in 161.4° ±6.7°, P<.05, kravl oziroma delfin) in kotni hitrosti v kolenu (582.1°/s ±161.1°/s in 671°/s ±133.4°/s, P<.05). Dobljeni rezultati kažejo, da obstojajo določene razlike v štartni akciji, vendar niso imele učinka na fazo leta in plavanje pod vodo.

Ključne besede: plavanje, grab štart, štartni skok

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Introduction

In swimming, the start plays an important role in final result, particularly in the sprint events. The grab start is the most used starting action on the international competitions in crawl, butterfly and breaststroke. Since Fina rules allowed to the swimmers in butterfly unlimited underwater fly kick, the result is that the butterfly swimmers dive deeper into the water after the starting action than the front crawl swimmers to obtain more efficient propulsion under water (3) and be consequently faster than on the surface. Several studies have been made to compare effectiveness of the grab start to other starting action (1) and to investigate characteristics of the grab starting technique (2). Counsilman et al. compared three starting actions of the grab starts: the scoop start, the flat start and the track start and found differences in the starting actions as well as in diving among the starting techniques (2).

The aim of the present study was to see if a difference in depth of diving between both techniques is reflected in corresponding differences in a starting action prior the first contact with water.

Methods

Four male (age 17.5±1.3 yrs, height 182.3±7.2 cm, mass 74.5±7.8 kg) and six female (16.2±1 yrs, 168.8±7.4 cm, 58.6±5.8 kg) swimmers of national and international level from Slovenia volunteered to participate in the study. Each swimmer performed the grab swimming starts followed by swimming with maximal velocity, either front crawl or butterfly technique for 17 meters. Each technique was performed twice. The start with a better time at 15 m mark from starting block was analysed.

The swimming start was filmed by 50 Hz video camera placed perpendicular to the plane of jumping direction. The movement from the starting signal to the first water contact with the hands was analysed by 2D kinematical model. The model included 7 body segments digitised from the right side of the body: foot, shank, thigh, trunk, head, upper-arm, and lower-arm. For the subjects, an acoustic starting signal was provided, simultaneously a visual marker was displayed for the video camera. The block time was defined by the frame number from the first visual marker to the last contact of the foot with the block. For the kinematical analysis, the APAS (Ariel Dynamics Inc., San Diego, Ca) was used. The following body points were digitised: the toe, the lateral melleolus, the knee, the hip, the shoulder, the apex, the elbow and the wrist. The centre of gravity (CG) was calculated according to the model from Winter (1990) which was modified for 2D. The coordinates of the points were smoothed with 7 Hz digital filter. The joint angles as well as angular velocities for the ankle, knee, hip and shoulder joint were calculated. These values at the instant of the starting signal the end of takeoff and at the first water contact were used for statistical analysis. A takeoff angle of CG and an angle at the water entry were obtained.

The analysis started with a starting signal and ended with a first water contact by the hand. Statistical differences between both styles were tested two-sided with the Wilcoxon test for two related samples.

Results

Table 1 presents comparison between starting position in front crawl and butterfly at the starting signal. No statistically significant differences between both styles were find neither in joints angle and their angular velocities. We can see that the starting position was almost the same in both technique.

Table 1.: Starting position at the starting signal

	Crawl		Butterfly		
Joint	Angle (°)	Ang.veloc (°* sec-1)	Angle (°)	Ang.veloc (°* sec-1)	P
Ankle	97 (8,7)	-22,8 (125,7)	96,4 (9,2)	47,8(181,9)	n.s.
Knee	126,7 (13,6)	-33,4 (61,3)	124,9 (11,1)	11,1 (106,7)	n.s.
Hip	24,7 (6,1)	-58,8 (97,1)	22,3 (4,1)	-13,0 (48,4)	n.s.
Shoulder	107,4 (10,3)	6,2 (38,7)	107,5 (9,0)	17,2 (93)	n.s.

Single cell displays AS and SD (in brackets). * P<0,05 Significant difference.

During the last contact with the starting block, the statistically significant differences appeared only at the knee angle (167.2°±6.2° and 161.4° ±6.7°, P<.05, crawl and butterfly, respectively) and the knee angular velocity (582.1°/s ±161.1°/s and 671°/s ±133.4°/s, P<0.05)(see Table 2.).

The knee angle at the takeoff was slightly smaller in butterfly, but on the other hand a knee angular velocity was noticeable higher.

Table 2.: Last contact of toes with starting block

	Crawl		Butterfly		
Joint	Angle (°)	Ang.veloc (°* sec-1)	Angle (°)	Ang.veloc (°* sec-1)	P
Ankle	138,7 (9,5)	616,6 (116,9)	138,9 (5,9)	568,3 (75,4)	n.s.
Knee	167,3 (6,2)	582,1 (161,1)	161,4 (6,7)*	671,8 (133,4)*	*
Hip	153,4 (13,6)	535,5 (166,4)	147,5 (12,1)	551,0 (110,2)	n.s.
Shoulder	110,4 (52,6)	-310,8 (385,9)	108,5 (53,4)	-299,8 (346,7)	n.s.
CG (x axis)	-0,30 (8,09)		2,31 (9,63)		n.s.

Single cell displays AS and SD (in brackets). * P<0,05 Significant difference.

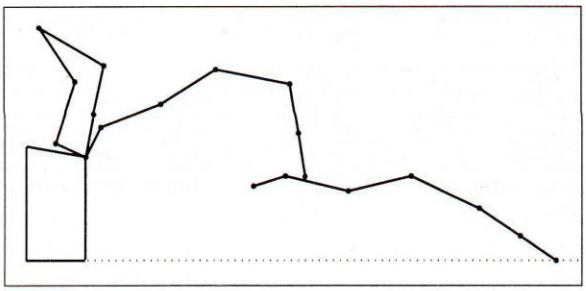
At the first water contact, there were again no statistically significant differences in any of the observed parameters (see Table 3). The medium entry angle of the body to the water was surprisingly almost the same in both technique. The medium distance from the starting block was also very similar. Thus the difference obtained at the take off phase was not reflected at the beginning of water entry.

Table 3.: First water contact with hands

	Crawl		Butterfly		
Joint	Angle (°)	Ang. veloc (°* sec-1)	Angle (°)	Ang. veloc (°* sec-1)	P
Ankle	146,5 (11,6)	-121,7 (183,2)	150,5 (14,5)	-24,1 (183,7)	n.s.
Knee	166,7 (32,4)	34,1 (239,4)	164,1 (40,2)	18,8 (134,3)	n.s.
Hip	141,8 (14,9)	8,2 (228,6)	139,9 (18,8)	12,4 (279,6)	n.s.
Shoulder	171,8 (6,0)	85,8 (212,4)	170,9 (10,2)	150,9 (166,2)	n.s.
CG (x axis)	-47,52 (6,62)		-48,78 (9,80)		n.s.
Distance starting block – wrist	3,19 (,22)		3,22 (,26)		n.s.

All values are in degrees except the distance which is in meters. Single cell displays AS and SD (in brackets). * P<0,05 Significant difference.

All three action phases are shown also in picture 1.



Pic. 1.: Analysed starting actions

From the picture and analysis of the joints angles at the takeoff was also possible to observe that the subjects were not extended maximally at the end of take off. The full body extension first occurred after the end of takeoff, during the air-phase. However, this was noticeable for both technique.

Discussion

Results of this study surprisingly showed that only small differences between starting action in front crawl and butterfly swimming exist.

The only observed differences in our study were connected to the knee action at the end of the block contact (see Table 2). However, it was not possible to observe how these differences were compensated by other joints, especially by hips, which regulate the trunk movement since in the later phases at the first contact with the water these differences disappeared and also the length of the first water contact was very similar(see Table 3). The takeoff angle between 0 to 3 degree with tendency to a higher takeoff angle in butterfly was find. There are different opinions about an optimal takeoff angle. Just to make the longest flight, the angle should be kept around 40 degrees above the horizontal axis. Horizontal velocity of CG is therefore reduced, but not a resultant velocity. A water entry angle would be in that case greater and more adequately for the butterfly than at more shallow trajectory which is probably more adequate for the crawl. Obtained results suggests that some differences in a manner of a starting impulse production were present but had no effect on the flight phase.

Since for the swimmers in the butterfly technique a longer diving phase has been observed, we could expect that during the flight phase some differences in the trajectory of the center of gravity will occur, at least in a different entry angle at the first water contact, which allows to swimmers to enter deeper into the water. It was found that during scoop start (technique that allows the body to enter at the same point at which the hands enter) the angle of entry into the water was among 47 degrees what is in accordance with our results (2). With this starting action was observed the deepest penetration beneath the surface of the water (121 cm). Since in our study we didn't measure the depth of the penetration, we can only speculate that the entry angle was almost optimal for underwater butterfly kick. It may not be advisable for the freestyle where the stroke action starts earlier and should be therefore eliminated. Because of that, the essential differences between styles probably started after the diving into the water.

According to the obtained results, it was possible to conclude that some differences in a manner of a starting impulse production were present but had no effect on the flight phase.

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