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A TEMPORAL INVESTIGATION INTO THE BUTTERFLY KICK PLACEMENT FOLLOWING A BREASTSTROKE START AND TURN.

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The purpose of this study was to determine whether an early or late placement of the butterfly kick during the arm pull-down is more effective in terms of breaststroke start and turn performance between female and male swimmers. Overall the timing of the kick placement does not appear to influence the effectiveness of the underwater phase following a breaststroke start or turn. Therefore the style selected by swimmers may be as a result of individual preference. Females overall start performance was improved by using an early placement.

KEY WORDS: kick placement, underwater phase, breaststroke.

INTRODUCTION: According to FINA's (international governing body of aquatics) rules and regulations it states that: *SW 7.1. After the start and after each turn, the swimmer may take one arm stroke completely back to the legs during which the swimmer may be submerged. A single butterfly kick is permitted during the first arm stroke, followed by a breaststroke kick.* Since FINA stated that the butterfly kick could occur *during* the arm pull-down, it is observed that many swimmers, regardless of skill level and gender, have developed a preference to either execute the butterfly kick relatively early or late within the arm pull-down.
Cossor and Mason (2001) concluded that the underwater phase had the greatest influence on overall breaststroke start performance for Olympic finalist and semi-finalist swimmers. However whether an early or late placement of the butterfly kick during the arm pull-down would offer an enhanced performance throughout the underwater phase following a breaststroke start or turn is unknown. Another consideration is whether the placement of the butterfly kick is 'event specific'. That is, one method may be better utilised in starts, whilst the other method may be more suited following a breaststroke turn. Finally it is unknown whether females prefer one method over males, and vice-versa. Clarification of the above issues is necessary in order to provide coaches and swimmers with detailed guidelines regarding the optimal placement of the butterfly kick during the underwater arm pull-down following a breaststroke start and turn.
Therefore, the purpose of this study was threefold: 1) to determine whether an early or late placement of the butterfly kick during the arm pull-down is more effective; 2) whether an early or late kick placement is more suitable following a breaststroke turn or start, therefore making it event specific; 3) to assess whether differences exist between genders in terms of kick placement during breaststroke turn and start performance.

METHODS: Sixteen swimmers (18.9 ±3.1 y; 72.0 ±11.5 kg; 183.0 ±6.8 cm) comprising of eight females and eight males, volunteered to participate in this study. The criteria for participation were as follows: a) the swimmer specialised in breaststroke events, and b) the swimmer was a successful national age-group or open national/international standard within Australia. Test procedures were approved by the Australian Institute of Sport (AIS) Ethics Committee and all swimmers provided written informed consent.
All swimmers participated in two testing sessions at the AIS Aquatic Testing, Training and Research Unit (ATTRU). During the first testing session each swimmer performed their 'normal' or 'preferred' style of kick placement (early or late) during the underwater breaststroke phase, in addition to their 'non-preferred' or 'alternative' method of butterfly kick (early or late). To minimise ordered effects, each swimmer randomly performed 5 preferred

trials and 5 alternative trials during both the turning and starting conditions. All swimmers were given a 90min rest period between the completion of the turn trials, before commencing the start trials in order to reduce the effects of fatigue. To enhance learning of the non-preferred or alternative method of kick placement, each swimmer was required to complete a two week training protocol at their respective swimming clubs, under the supervision of the investigator and club coaches. This training protocol consisted of 4 sessions per week practicing 20 starts (10 preferred kick, 10 alternative kick) and 20 turns (10 preferred kick, 10 alternative) all in a randomised manner during each session. Following the training period, each swimmer was retested at the ATTRU, implementing the same protocol utilised during the first testing session.

A turn trial was captured as 5m out from the wall, completion of the turn including underwater phase, followed by maximal breaststroke swimming through to the 15m mark. Start trials were captured from a start signal, completion of the underwater phase, and continue maximal breaststroke swimming to the 20m mark.

All trials were recorded by a number of high speed gigabit ethernet cameras operating at a frame rate of 100 Hz. Five cameras were positioned above water to capture hand touch/start-time and times to the 5m, 10m, 15m and 20m marks, based on when the head passed these distances. The 'Wetplate' system (proprietary start and turn analysis system designed by the AIS) was used to acquire the following variables for the start and turn performances: '*maximum depth'*- the maximum depth to which the swimmer descends after pushing off the wall and following a start; '*breakout distance'*- the distance from the time the feet leave the wall or starting block until the swimmer's head breaks the surface; '*breakout time'*- the time from the feet leave the wall or starting block until the time the swimmer's head breaks the surface; '*time to 10m'*- the time from which the feet leave the wall until the head crosses the 10m mark; '*time to 15m'*- the time from which the feet leave the wall and starting block until the head crosses the 15m mark; '*time to 20m'*- the time from which the feet leave the starting block until the head crosses the 20m mark.

Analysing only the post training trials (second testing session data), independent t-tests were used to determine if any significant differences existed between the early and late placement of the butterfly kick following a breaststroke turn/start across all variables and to examine whether the kick placement was event specific. Independent t-tests were also used to assess whether differences existed between genders across all variables. The processed data were analysed using the Statistical Package for Social Sciences (SPSS) version 14.0 and significance was accepted at $p<0.05$ for all statistical tests.

RESULTS AND DISCUSSION: When all the swimmers were grouped together, it was found that there was no significant difference in kick placement and start performance, in terms of time to 15-m and 20-m (Table 1).

When the sample was separated by gender, it was found that despite no difference between kick placement at the 15-m mark, females were faster to the 20-m mark following a breaststroke start using an early kick placement during the underwater phase compared to the late kick placement (Table 1). This finding indicates that the performance of the underwater phase following a breaststroke start is not affected by the timing of the kick placement. However, it is speculated that the transition from the underwater phase to free swimming is most effective for females following a breaststroke start with an early kick placement compared to a late placement kick. This may be due to differences in swimming technique, hydrodynamic characteristics, or fatigue following the underwater phase of a breaststroke start and the timing of the kick placement, which requires further examination.

Although the female group travelled the same relative distance underwater when using the early and late kick placement, it was found that all female swimmers took longer to surface with an early kick placement following a breaststroke start (Table 1). However, because females were faster to the 20m marker with an early kick, this suggests that the longer time to surface may not affect overall start performance in this case. Moreover, the results of this study indicate that all the variables associated with a breaststroke start performance are not influenced by the timing of the kick placement for male swimmers.

When all the swimmers were grouped together, it was also found that there was no significant difference in kick placement and turn performance, in terms of time to 10-m and 15-m (Table 2).

Table 1: Group mean (S), female mean (FS), male mean (MS) and SD for breaststroke start performance with an early and late kick placement. * Significant at p<0.05.

	Max Depth (m)	Breakout Distance (m)	Breakout Time (secs)	Time to 15m (secs)	Time to 20m (secs)
Early (S)	-1.12 ±0.20	11.88 ±0.86	6.26 ±0.48	8.65 ±0.73	12.50 ±1.00
Late (S)	-1.15 ±0.19	11.57 ±0.88	6.06 ±0.45	8.68 ±0.72	12.74 ±1.15
P-value	0.31	0.03*	0.01*	0.79	0.27
Early (FS)	-1.18 ±0.14	11.51 ±0.81	6.33 ±0.44	9.16 ±0.60	13.37 ±0.56
Late (FS)	-1.19 ±0.16	11.19 ±0.80	6.09 ±0.40	9.18 ±0.63	13.73 ±0.68
P-value	0.78	0.07	0.01*	0.92	0.05*
Early (MS)	-1.06 ±0.24	12.25 ±0.74	6.18 ±0.51	8.11 ±0.37	11.61 ±0.31
Late (MS)	-1.13 ±0.22	11.94 ±0.79	6.03 ±0.50	8.20 ±0.43	11.72 ±0.38
P-value	0.28	0.08	0.19	0.34	0.25

Table 2: Group mean (T), female mean (FT), male mean (MT) and SD for breaststroke turn performance with an early and late kick placement. * Significant at p<0.05.

	Max Depth (m)	Breakout Distance (m)	Breakout Time (secs)	Time to 10m (secs)	Time to 15m (secs)
Early (T)	-0.78 ±0.10	8.49 ±0.85	6.14 ±0.50	7.33 ±0.60	11.27 ±0.88
Late (T)	-0.84 ±0.10	8.19 ±0.80	5.92 ±0.43	7.32 ±0.62	11.33 ±1.02
P-value	0.01*	0.02*	0.01*	0.94	0.75
Early (FT)	-0.72 ±0.08	7.85 ±0.68	6.10 ±0.38	7.90 ±0.35	12.34 ±0.35
Late (FT)	-0.78 ±0.08	7.59 ±0.74	5.94 ±0.38	7.94 ±0.31	12.51 ±0.36
P-value	0.01*	0.15	0.09	0.66	0.10
Early (MT)	-0.81 ±0.10	8.96 ±0.63	6.14 ±0.60	6.85 ±0.29	10.60 ±0.35
Late (MT)	-0.88 ±0.09	8.63 ±0.51	5.90 ±0.49	6.82 ±0.27	10.51 ±0.33
P-value	0.01*	0.02*	0.06	0.60	0.26

Swimmers descended deeper during the underwater phase following a breaststroke turn with a late kick placement compared to an early kick placement (Table 2). Although correlation analysis was not performed in this study, Ruschel et al. (2007) reported a high correlation with maximum depth to time to 15m (r=0.515) following a swim start, indicating that the deeper the swimmer travels following a start, the slower the time to 15m. Therefore a late kick placement, which is characterised by a deeper trajectory during the underwater phase, may not necessarily be conducive to optimal turn performance. Further study, which examines the swimmer's velocity profile, is required to substantiate this possibility in addition to correlation analysis following a breaststroke turn.

Common to both breaststroke start and turn performance, it was found that relative to a late kick placement, all swimmers broke the surface significantly further from the wall when implementing the early kick placement (Table 1 & Table 2). However, it was also found that the early kick meant that all swimmers broke the surface significantly later following a start and turn compared to the late kick placement. Because the breakout variables differed between the two kick placements, it appears that these variables do not influence the swimmers overall start and turn performance in terms of time to the 20m and 15m markers respectively. However, it may be worth considering from a physiological viewpoint, implementing the early kick in distance events where energy could be conserved during the turns (due to the further distance travelled), allowing a greater potential of force application during the free swimming sections. Similarly, it may be worth considering implementing the late kick in sprint events, where the necessity to start swimming is more important than energy conservation. It is important to realise that these are suggestions; however the breakout 'distance vs. time trade-off' should be considered by coaches and breaststroke swimmers.

Analysing the female turn performance data, it was found that there was no significant difference in kick placement in terms of time to 10m and 15m (Table 2). All females were observed to travel deeper when performing the late kick compared to the early kick, which is in agreement with the overall group findings. As stated previously, further study is required to investigate the affects of a deeper underwater trajectory following a breaststroke turn. When all the male swimmers were grouped together, it was found that there was no significant difference in kick placement for the turn performance, in terms of time to 10m and 15m (Table 2). Because the male group travelled further underwater after using the early kick placement compared to the late kick placement in the same relative time, and no difference in turn performance, suggests that the breakout distance may not affect overall turn performance in this case. It was also found that all male swimmers descended deeper when performing the late kick compared to the early kick, which is in agreement with the overall group and female results, which requires further study. All males go further with the early kick in the same relative time as the late kick placement. From a physiological viewpoint, it is suggested that the early kick placement may have a greater potential for improved performance, since all males are travelling further underwater within the same relative time after a breaststroke turn compared to a late kick placement.

CONCLUSION: Across the combined sample no difference in start or turn performance was found by implementing either an early or late kick placement. Therefore swimmers should select the kick placement style due to their individual preference, as one style does not appear to be more advantageous over the other. The finding that the early placement kick is characterised by a longer breakout distance over a slightly prolonged period relative to the late placement kick, may have physiological consequences which require further examination. Female swimmers overall start performance appears to be improved by utilising an early placement kick, which may be due to the transition from the underwater to free swimming phase and thus requires further investigation. Examination of the swimmers velocity profile during the underwater phase following a breaststroke start and turn will advance our understanding of the kick placement and start/turn performance.

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