A COMPARISON OF TWO BACKSTROKE STARTS

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This study investigated the effect of a staggered or parallel foot placement on horizontal distance and velocity at which the swimmer moved away from the block to the point that the hands entered the water during a backstroke start. Ten NCAA division II collegiate women swimmers were filmed from above water performing three of each of the two types of starts. An underwater camera was used to capture stability aspects of the feet prior to and during the start. There was no significant difference ($p > 0.05$) seen in average velocity or horizontal distance that the swimmer traveled when comparing both types of starts. The Chi squared analysis found no significant differences in movement of the feet during the two backstroke starts ($p > 0.05$). Further research should be performed with increased practice time of both starts and to compare differences between genders.

KEYWORDS: swimming, kinematics, staggered.

INTRODUCTION: Swimming performance in a short distance swimming event is measured by the sum of the time of four primary components; the start, the swim, the turn and the finish (Blanksby et al. 2002). Each of these components may be mastered using mechanical adaptations to improve specific aspects, thus leading to a more efficient swimming race. Yet, each swimming event must begin with a start, which may involve up to 15 m, or 30%, of a 50 m race. There have been numerous studies completed on the variety of ways that the swimmer may propel themselves off the starting block at the beginning of a freestyle, breaststroke, or butterfly event. These can be classified as standing starts, as the swimmer competing in these events must stand on top of the block to begin the race. In the standing starts, studies have investigated placement of the hands on the block, foot stance and forces generated by the swimmer during the start (Blanksby et al. 2002, Counsilman et al. 1988, Cousins et al. 2004, Gambrel et al. 1991, Holthe et al 2001, Mills and Gehlson 1996, Wilson and Marino 1983). Unfortunately the fourth competitive swimming stroke, the backstroke, has been under examined in all components including the start.

The backstroke start is the only start that begins with the swimmer in the water. Hands grip the starting block handles, while the balls of the feet push against the pool wall. Previous research (Green et al. 1987, Tichy 1981, Scheuchenzuber 1970) investigated starting positions that are no longer deemed legal by two of swimming's governing bodies, the Federation International de Natation and the National Collegiate Athletic Association. Current rules state that the toes must be below the level of the pool water when starting with both hands being placed on the starting block handles (NCAA, 2006) Anecdotal evidence suggests that to accommodate this rule, swimmers often choose to place their feet parallel to one another and at the same level horizontally, with both feet slightly less than shoulder width apart, also known as the standard start in this study.

Most evidence for backstroke swimming starts is either outdated or limited as many of the rules have changed over the years and possibly because nearly ninety percent of all swimming starts begin out of the water. Green et al. (1987) compared the conventional and whip backstroke starts to determine which may lead the swimmer to an overall faster backstroke race. Their data demonstrated that the whip start aided the swimmer to have a faster race time than when using the conventional start. Tichy (1981) investigated ways to optimize the standing and crouch backstroke starts via computer simulation. This research allowed computer simulation of the backstroke start to be used to improve individual start biomechanics. Scheuchenzuber (1970) compared four types of backstroke starts with modifications to the handle height on the starting block; two were crouching starts while the

other two were modified standing starts. Their results most notably demonstrated that the conventional crouch start was significantly less effective than the other starts in regards to the time it took to reach four meters from the starting wall. According to Scheuchenzuber, this may be due to the lack of underwater foot stability. Stratten (1970) investigated differences between three backstroke starts as well. One start was the FINA start which at the time required the swimmers feet to be below the level of the wall. The next start was the NCAA start, which at the time allowed the toes to be in the gutter of the swimming pool. The third start was known as the "Dilley" start or the standing start. This start allowed the swimmer to stand in the gutter while bending over the starting block and upon starting command swinging the arms out to the side while bending the knees and pushing off of the wall. It must be noted that the FINA start in this study is currently used in international and NCAA competitions. Both other starts are now deemed to be illegal.

Stratten (1970) compared thirteen male and female swimmers for this study, and split the swimmers into three groups. One group was made up of competitive backstroke swimmers, the second of competitive swimmers that were not backstrokers, and the third of noncompetitive swimmers who could swim but never competed in an organized swimming event. It should be noted that this is the first study found to investigate teaching a sample group of non-competitive swimmers a start which was not popular at the time. This study investigated time in seconds it took the swimmer to reach the twenty yard marker, and the reaction time it took from the point of signal to the point that the toes left the wall. The investigator found that there was a significant difference in speed between the three starts to the 20 yard marker, with the NCAA start being faster than the FINA and Dilley start. Although there was not a significant difference between the FINA and NCAA start seen when observing reaction time until the toes left the wall, the Dilley start proved to be significantly slower.

Currently swimmers competing in the freestyle, breaststroke, or butterfly events may choose to use the grab or track start. This is not the case for those swimming backstroke events.

With this concept in mind, it was hypothesized that if backstroke swimmers began to use a start with staggered foot position, similar to the standing track start with one foot near the surface of the water and one foot at or below the level of the top foot's heel, horizontal distance may increase along with velocity as compared to the standard backstroke start.

Therefore the purpose of the current paper was to examine if a staggered foot placement during the backstroke start will propel the swimmer further away from the block horizontally and at a faster velocity than the standard backstroke start. Stability of the feet during these two starts will also be examined to determine if one of the two starts provides more stability by preventing the swimmer from slipping down the wall at the beginning of the backstroke start.

METHODS: Ten NCAA Division II college women swimmers from Northern Michigan University, with at least five years of competitive swimming experience (Age = 19.1±1.97 y; Height = 169.3±5.5 cm; Weight = 65.3±7.3 kg) were participants in the study. Each subject provided written consent, with both the study and consent form being approved by the University Human Subjects Research Review Committee (HS05-052).

Subjects were required to participate in two, 30 minute backstroke start familiarization sessions before data were collected. To facilitate data collection subjects were marked with black 7 by 7cm "X's" on the right-lateral styloid process. Subjects were then allowed a 20 minute warm up session before trials were recorded. Each subject was given a card with a random order of the three staggered and three standard starts listed; this would be the subject's start trial order. At the beginning of each trial the subject was instructed to place their feet in the designated position, take their mark (pull into a crouch position) and upon a signal from the starting device, perform the start. There was at least one minute of rest between each of the subject's trials. The same *KDI Paragon* (LaGrangeville, NY) starting block was used for all starts.

Two video cameras were used to capture data during this study. A *Canon Optura 20* digital recording device was set up on the pool deck, so that a 2D view from the starting blocks to

the first backstroke flag could be recorded. The second camera, a *Hitachi 8mm VM-H100LA* underwater camera, was placed in the corner of the swimming pool, with the moveable lens mounted so that the underwater 2D placement of the feet during the start could be viewed. A *Colorado Time Systems Infinity* (Loveland, CO) starting device was used to signal the start of each trial. Both cameras recorded at 60 frames per second, with the shutter speed at 250. A rectangular calibration object 33.5 cm x 25.5 cm, with four black "X's" located in each corner, was used to scale the video for digitizing purposes. This object was held in the same lane that the swimmers performed their starts in, and briefly recorded before the trials began. Each trial was recorded from the point that the swimmer was positioned on the wall to the point at which the swimmer reached the first set of backstroke flags.
Statistical analyses were performed using *SPSS 13.0* for Windows (Chicago, IL USA). A Two-way repeated measures ANOVA was used to compare the horizontal distance and average velocity between the standard and staggered starts and across each of the completed trials. An alpha level was set at 0.05 during statistical analysis.
Non-parametric testing was used to examine the stability of the feet during these trials All starts were viewed to visually determine if movement of the feet was seen while the swimmer pulled into starting position or before the feet left the wall The feet of the starts were classified as moving (1) or not moving (2) and the frequency of occurrence compared during standard and staggered starts using a Chi squared test.

RESULTS: The Two-way repeated measures ANOVA results for each trials average velocity and horizontal distance are listed in Table 1. There was no significant difference found across the three trials in either the standard or the staggered start ($p > 0.05$), nor was any start more significantly different than the other in respect to the average velocity or horizontal distance that the swimmers traveled. There was no interaction found between trials one, two, or three when the staggered and standard starts were compared. The Chi squared test indicated no significant difference between movements of the feet during either the staggered or standard start ($p > 0.05$), although there was movement noted.

Table 1. Means ± SD for the average velocity and horizontal distance traveled by the swimmers over each of the six trials.

Start Type and Trial Number	Average Velocity	Horizontal Distance
Staggered Start Trial 1	3.25 ± .284	1.50 ±.161
Staggered Start Trial 2	4.12 ± 2.30	1.76 ± .809
Staggered Start Trial 3	2.87 ± 1.23	1.61 ± 181
Standard Start Trial 1	3.51 ± .257	1.59 ± .224
Standard Start Trial 2	3.29 ± 1.14	1.55 ± .199
Standard Start Trial 3	3.71 ± 1.86	1.75 ± .557

DISCUSSION: There were no differences found between start type and the average velocity or horizontal distance traveled. This may be due to a number of factors. Based on the frequency of data collection (60 Hz), the precision of measurement for velocity was estimated to be ± 0.2 $m \cdot sec^{-1}$, while the horizontal distance was estimated to be ± 0.05 m. Thus because the variability of the measurements approached the differences between the trials, a lack of difference may have been due to a lack of precision in the measures. This may also have contributed to the increased variability in the criterion measures. It is possible that by using a faster sampling rate the likelihood of finding a difference between the conditions might have improved. In addition, the limited number of subjects in this study (n=10) may have contributed to the lack of significant difference seen between the starts; as was the case in studies by Scheuchenzuber (1970) and Green and colleagues (1987). By examining a larger number of subjects and both genders, differences may be seen between these two starts along with between subject differences. It should also be noted that most swimmers of the current study were not backstroke specialists and did not regularly practice and or

participate in backstroke swimming events. Practicing the newly introduced staggered start may improve other aspects of performance in the swimming event along with an increased average velocity and horizontal distance, leading to an overall decreased race time. Training sessions to examine individual preference and foot placement may also aid the swimming community to determine if one of these starts is more superior to its counterpart in respect to horizontal distance, average velocity, and preference (Mills and Gehlson, 1996, Blanksby et al., 2002).
As stated earlier, anecdotal evidence found that many swimmers have had problems with movement of the feet before the start occurs. Although the Chi Square test found that there was not a strong difference between the two types of starts, the occurrence of foot movement, training and introduction of an alternate foot placement may prevent or decrease the occurrence of this issue for swimmers.

CONCLUSION: In the current study, the variables of average velocity and horizontal distance at which the swimmer moved through the water were measured. Although there was no significant difference found between the two starts nor did one start prevent the swimmer from slipping down the wall more than the other; further research is recommended to determine whether more training will show whether the staggered or standard start may be beneficial to an individual swimmer. It was concluded that the two starts were not different in velocity or distance variables. Based on the results of the current study the use of a staggered start does not impact performance of the backstroke start negatively or positively. Thus its use is left to the swimmers preference.

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