FACTA UNIVERSITATIS
Series: **Physical Education and Sport** Vol. 15, N° 2, 2017, pp. 249 - 259
https://doi.org/10.22190/FUPES1702249L

Original research article

A CASE STUDY OF A BEACH FLAGS START TECHNIQUE VARIATION IN ELITE SPRINTERS

UDC 796.012:612.766

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Abstract. *Beach flags are a surf lifesaving event that involves a 20-meter sprint across sand. Sprinters begin in a prone position, facing the opposite direction to the intended sprint, before rising and turning to sprint and dive to capture a flag positioned in the sand. The typical start involves posterior movement away from the start line during the turn. Anecdotal evidence has suggested that beach flags sprinters can use variations to the start technique documented in the literature. Therefore, this research provided a case study of a start variation termed the pivot start. One male (age = 19 years; height = 1.74 m; mass = 66 kilograms), and one female (age = 23 years; height = 1.68 m; mass = 57 kilograms) elite sprinter were analyzed. A high-speed camera filmed the start. The analyzed data included: start time; hip and shoulder height during the turn; feet spacing; elbow, hip, knee, trunk lean, and trajectory angles at take-off, and descriptive statistics were derived. The analysis showed that the sprinters had no posterior movement behind the start line as they kept one leg on the start line, while the other leg was swung about the body so the sprinter rotated about the pivot leg. The rotatory start movements placed both sprinters into an effective, low body position for acceleration, indicated by trunk lean (~60°) and trajectory angle (~47°). These unique movement patterns should be trained accordingly for beach flags sprinters that use the pivot start.*

Key words: *acceleration, biomechanics, sprinting, sprint start, surf lifesaving.*

Received June 17, 2017/ Accepted November 9, 2017
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INTRODUCTION

The beach flags are a surf lifesaving event comprised of a 20-meter (m) sprint across soft beach sand over a series of elimination rounds. The aim of this event is for the sprinter to attain a flag positioned in the sand ahead of their opponents. Elimination rounds continue until there is one remaining sprinter who is declared the winner. The beach flags feature a unique method by which to start the race. Sprinters begin in a prone position with their feet placed on the start line, facing the opposite direction to where the flags are positioned vertically in the sand a distance of 20 m away. Upon the start command, sprinters turn as quickly as possible to face the flags and begin their run. As for track sprint events, an effective start is needed to enhance the chances of success in the beach flags (MacDonald, 2007). Furthermore, there has been some scientific analysis of the beach flags start in the literature (Lockie & Vickery, 2013; Lockie, Vickery, & Janse de Jonge, 2012c).

Lockie et al. (2012c) analyzed the typical start technique of experienced young adult beach flags sprinters. Following the initiation of the start, sprinters completed an initial posterior movement away from the start line, which helped facilitate the turn. After the turn, the feet were positioned in a manner where the distance was similar to a medium block spacing in the traditional athletic track start (Čoh et al., 2006). Lockie et al. (2012c) found that after the initial movement leading to take-off, the resulting body position adopted by beach flags sprinters was not dissimilar to that of track sprinters following a block start. Some of the kinematic factors of the beach flags sprint start that contributed to a faster sprint performance included greater range of motion of the arms, most likely to assist with balance on the unstable sand surface, and a longer first step following the start (Lockie et al., 2012c).

Lockie and Vickery (2013) extended this research by investigating kinematic differences in the beach flags start between elite and non-elite sprinters. Interestingly, in opposition to track sprint starts (Harland & Steele, 1997; Harland et al., 1995), elite sprinters tended to have a longer start time when compared to their non-elite counterparts (0.95 ± 0.31 seconds [s] vs. 0.60 ± 0.21 s, respectively). Lockie and Vickery (2013) suggested that this was due to the influence of the unstable sand surface, where more time was needed for force production during the start. Elite sprinters also had an angle of trajectory that was significantly ($p = 0.01$) orientated closer to the horizontal when compared to the non-elite sprinters (45.93 ± 4.36° vs. 54.08 ± 1.07°, respectively), and a greater trunk lean (45.93 ± 4.36° vs. 54.08 ± 1.07°, respectively). As for a better track sprint start (Čoh et al., 2006; Schot & Knutzen, 1992), elite beach flags sprinters also had a longer first step following that start, which although non-significant, was 29% greater than the non-elite sprinters. The work by Lockie and Vickery (2013) demonstrate that high level beach flags sprinters will have specific technique variations that contribute to their high level of performance.

In addition to this, certain beach flags sprinters have adopted a different start technique when compared to the typical methods outlined previously (Lockie & Vickery, 2013; Lockie et al., 2012c). Within coaching manuals specific to beach flags (MacDonald, 2007), there is no direction as to what start technique should be used. The only advice that is provided is that the turn should be completed as quickly as possible, with no recommendations as to the method to achieve this (MacDonald, 2007). Observations of the beach flags start have demonstrated that there are variations to the typical start technique previously documented by Lockie et al. (2012c). One such example is a technique whereby sprinters keep one leg in contact with the start line throughout the entirety of the start. The other leg is abducted and used to generate angular momentum, so the sprinter can rotate about the stance leg. However, there has been no scientific analysis of variations to the typical beach flags start technique. Investigation of these variations to the start could allow for beach flags and strength and conditioning coaches to specifically tailor training programs to the movements performed by the sprinter.

Even though there is research that has documented the typical beach flags start (Lockie et al., 2012c), there are variations to this technique. Therefore, this research conducted a case study descriptive analysis of the start technique of two elite, national-level beach flags sprinters, which was different to that described by Lockie et al. (2012c). In accordance with protocols documented by Surf Life Saving Australia (SLSA, 2005), Lockie et al. (2012c), and Lockie and Vickery (2013), the participants completed 20-m sprints using their competition start, and each sprint was timed and the start filmed for analysis. The small sample size (n = 2) precluded statistical analysis. Nonetheless, the kinematics of the start for each participant was defined. This research has value for beach flags and strength coaches, in that it will identify the different types of movement patterns that may be used by a sprinter during the start of a beach flags race. This information can then be used to drive training practices for beach flags sprinters.

METHODS

Participants

Two elite beach flags sprinters volunteered to participate in this study. One male (age = 19 years; height = 1.74 m; body mass = 66 kilograms [kg]), and one female (age = 23 years; height = 1.68 m; body mass = 57 kg), both of whom were part of the SLSA national squad, were identified by their national team coaches as using an atypical start technique. In addition to performing at an elite level and using a start variation, participants were required to be injury-free. Testing was conducted during the surf lifesaving season. The methodology and procedures used in this study were approved by the institutional ethics committee. Both participants received a clear explanation of the study, including the risks and benefits of participation, and written informed consent was obtained prior to testing.

Procedures

Testing was conducted at Narrabeen Beach in Sydney, Australia. A single 30-minute session per participant was used for data collection. Participants wore competition attire, consisting of a swimming costume. Prior to testing, the participant’s age, height, and body mass were recorded in the Narrabeen surf lifesaving club house, and leg dominance was defined for both participants through three standard tests (de Ruiter, de Korte, Schreven, & de Haan, 2010). Height was measured barefoot using a portable stadiometer (Ecomed Trading, Seven Hills, Australia) and recorded to the nearest 0.01 centimeter. Body mass was recorded to the nearest 0.01 kg using digital scales (Tanita Corporation, Tokyo, Japan). The first leg dominance test involved each participant stepping up on a 40-centimeter platform. The leading leg was viewed as dominant. The second test involved the participant standing with their feet parallel before being pushed between the shoulder blades by a researcher. The leg that prevented the fall was defined as dominant. Lastly, participants were asked their preferred kicking leg, and this leg was dominant. The dominant leg was then classified as the leg that was dominant in at least two of three tests (de Ruiter et al., 2010). Sprint tests were then conducted on the beach over level sand. Both participants completed an identical warm-up routine which consisted of jogging, dynamic stretches of the upper- and lower-body, and acceleration runs over the testing distance. Due to time constraints because of their national team training requirements, two successful trials of each sprint were obtained for each participant, with 3 minutes recovery between trials. Two trials for a particular sprint condition have been used in previous research to elicit reliable and valid data (Bushnell & Hunter, 2007; Dupler, Amonette, Coleman, Hoffman, & Wenzel, 2010; Lockie, Jeffriess, Schultz, & Callaghan, 2012a; Lockie, Murphy, Knight, & de Jonge, 2011; Lockie, Schultz, Callaghan, & Jeffriess, 2012b; Spinks, Murphy, Spinks, & Lockie, 2007).

Kinematic analysis

Figure 1 documents the set-up for the assessment of the beach flags start and sprint time, which has been used in previous research (Lockie & Vickery, 2013; Lockie et al., 2012c). Sprint time was measured by timing gates (Fusion Sport, Sumner Park, Australia). Time was recorded for the 0-2 m, 0-5 m, and 0-20 m intervals. As per SLSA protocols, gates were placed at 2 m and 20 m (SLSA, 2005). Another gate was placed at 5 m to measure initial acceleration (Callaghan, Lockie, & Jeffriess, 2014; Callaghan, Lockie, Jeffriess, & Nimphius, 2015; Lockie et al., 2011; Lockie, Murphy, Schultz, Jeffriess, & Callaghan, 2013; Lockie et al., 2015; Lockie & Vickery, 2013; Lockie et al., 2012c). The first gate was positioned next to the starter, who initiated timing by passing their hand through the light beam (Lockie & Vickery, 2013; Lockie et al., 2012c). The reliability of the testing methods used for this research were established by Lockie et al. (2012c). The intra-class correlation coefficients (ICC) and Cronbach's alpha (CA) for the 0-2 m (ICC = 0.77, CA = 0.93); 0-5 m (ICC = 0.81, CA = 0.95); and 0-20 m intervals (ICC = 0.93, CA = 0.98) were all acceptable, and thus this method was used.

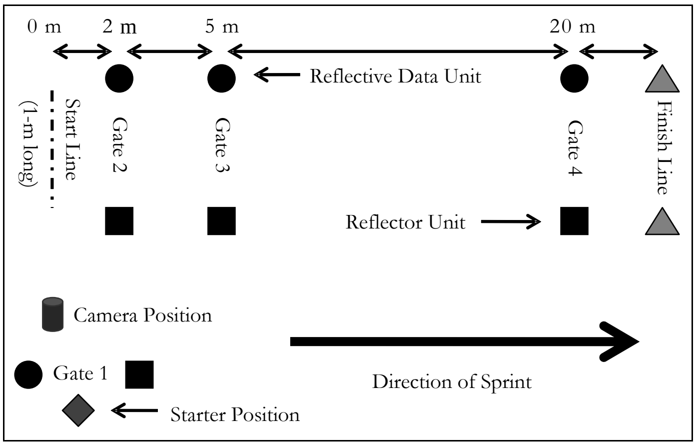

Fig. 1 Equipment set-up for the assessment of the beach flags start and sprint. m = meters.

Participants were instructed to use their competition start technique to initiate each sprint. Participants were given the standard set of commands that are used during beach flags competitions. These were: "you are in the starter's hands"; "heads down"; and the starter then blew a whistle to start the sprint while simultaneously initiating the timing gate system. Participants sprinted past the final timing gate and were instructed not to slow down prior to 20 m. This was achieved by placing a target line 5 m past the last gate. If participants false started, the trial was disregarded and re-attempted.

A high-speed camera (Basler Vision Technologies, Ahrensburg, Germany), recording at 100 Hertz and connected to a laptop computer (Dell Inc., Round Rock, USA) filmed each sprint. A 300-watt portable invertor (Sinergex Technologies, Orem, USA), connected to a deep-cycle battery, supplied power. The camera was placed 5.5 m lateral to the participant, perpendicular to the start line (Figure 1). This position recorded sagittal plane movements, and the camera was positioned on the side the participant turned towards during the start, which was determined during initial warm-up. A meter-long scale was filmed in the capture area prior to testing to ensure appropriate scaling. As per established methods (Lockie & Vickery, 2013; Lockie et al., 2012c), black, hemispherical markers were placed on both sides of the body on the following landmarks: the acromion process (shoulder); lateral epicondyle of the ulna (elbow); midpoint of the styloid process of the radius and ulna (wrist); greater trochanter of the femur (hip); lateral epicondyle of the femur (knee); lateral malleolus of the fibula (ankle); and fifth metatarsal (toe).

Camera recordings were analyzed within motion analysis software (Dartfish Video Software Solutions, North Melbourne, Australia). The leg that was used for rotation during the start was noted. Start time was measured as the duration from the initiation of movement until the foot of the driving leg broke contact with the ground (Bradshaw, Maulder, & Keogh, 2007; Lockie & Vickery, 2013; Lockie et al., 2012c). As beach flags sprinters are in a position where both feet are in contact with the ground following the turn, the maximum distance between the feet at this time was also measured (Lockie & Vickery, 2013; Lockie et al., 2012c). Kinematic variables analyzed at take-off from the start included knee, hip, and elbow joint angles, and trunk segment relative to the vertical angle (Figure 2).

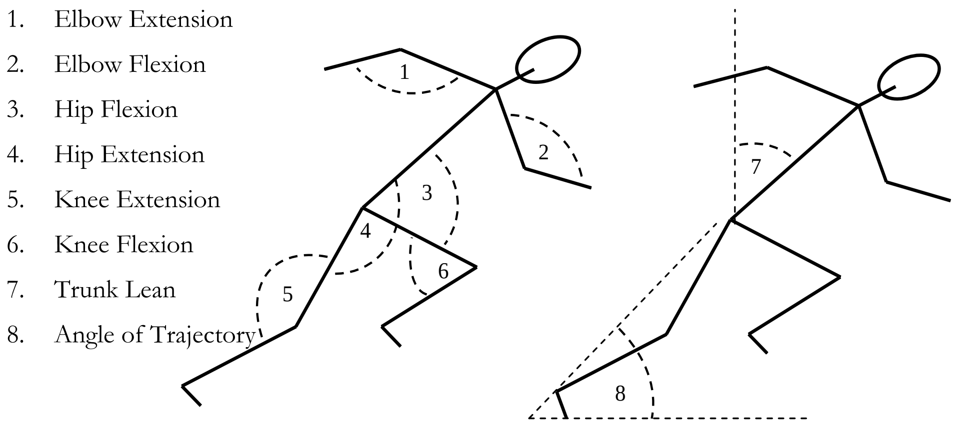

Fig. 2 Joint kinematics measured during the beach flags start.

Statistical analysis

No statistical analysis could be performed during this study due to the nature of the case study (n = 2), which has occurred previously in published literature (Čoh, Peharec, Bačić, & Kampmiller, 2009; Čoh et al., 2006; Gir¢n, McIsaac, & Nilser, 2012; Lovell, Bousson, & McLellan, 2012; Puiu, 2014). However, as per previous sprint start research (Čoh et al., 2009; Čoh et al., 2006), a descriptive analysis of the start for each participant was conducted. Data for each trial were computed, as well as means and standard deviations.

RESULTS

The start technique used by the study participants has been termed the pivot start. This was because the sprinter used one leg as a pivot to turn the rest of the body (Figure 3). This particular leg remained on the start-line, while the non-pivot leg was forcibly abducted and extended, before being swung in an arc to facilitate the turn. For both participants, the right leg was dominant, and this leg was used as the pivot. The kinematic data for the elite male and female are shown in Tables 1 and 2, respectively. For the male sprinter, the maximum distance between the feet was 0.68 m for the first trial, and 0.67 m for the second trial (average = 0.68 ± 0.01 m). The female sprinter had a distance between the feet of 0.62 m for both trials. As would be expected, the male sprinter was faster over all intervals. However, as will be discussed, there were similarities between the sprinters in select kinematic variables (e.g. trunk lean and angle of trajectory). Furthermore, the take-off kinematics was typical of that from sprint start and acceleration research.

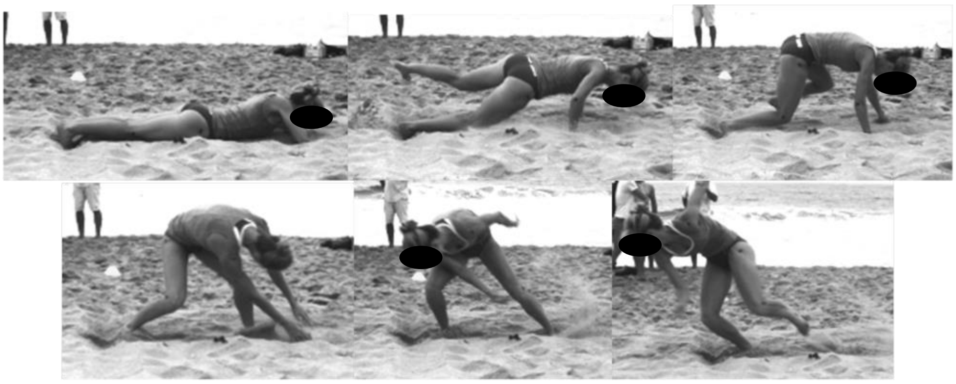

Fig. 3 Sequence of the pivot start.

Table 1 Temporal characteristics and body kinematics (mean ± standard deviation) for the beach flags start for the elite male participant. m = meters.

	Trial 1	Trial 2	Average
***Times* (seconds)**			
Start Time	1.181	1.129	1.155 ± 0.040
0-2 m	1.070	1.051	1.061 ± 0.013
0-5 m	1.675	1.719	1.697 ± 0.031
0-20 m	3.395	3.907	3.921 ± 0.020
Angles (°)			
Rear Arm Extension	128.30	129.80	129.05 ± 1.06
Front Arm Flexion	35.93	39.60	37.77 ± 2.60
Swing Leg Hip Flexion	60.80	56.40	58.60 ± 3.11
Swing Leg Knee Flexion	106.50	101.50	104.00 ± 3.54
Drive Leg Hip Extension	158.80	158.28	158.54 ± 0.37
Drive Leg Knee Extension	167.25	164.60	165.93 ± 1.87
Trunk Lean	61.50	60.70	61.10 ± 0.57
Angle of Trajectory	42.70	44.40	43.55 ± 1.20

Table 2 Temporal characteristics and body kinematics (mean ± standard deviation) for the beach flags start for the elite female participant. m = meters.

	Trial 1	Trial 2	Average
Times (seconds)			
Start Time	1.141	1.118	1.130 ± 0.016
0-2 m	1.130	1.156	1.143 ± 0.018
0-5 m	1.739	1.863	1.801 ± 0.088
0-20 m	4.154	4.234	4.194 ± 0.057
Angles (°)			
Rear Arm Extension	147.20	137.20	142.20 ± 7.07
Front Arm Flexion	59.90	63.55	61.73 ± 2.58
Swing Leg Hip Flexion	72.20	74.10	73.15 ± 1.34
Swing Leg Knee Flexion	89.00	89.40	89.20 ± 0.28
Drive Leg Hip Extension	141.35	139.30	140.33 ± 1.45
Drive Leg Knee Extension	152.50	151.95	152.23 ± 0.39
Trunk Lean	62.21	58.80	60.51 ± 2.41
Angle of Trajectory	48.40	49.10	48.75 ± 0.49

DISCUSSION

Previous research has documented the typical action of the beach flags start, where one of the notable components is an initial posterior movement away from the start line, by approximately 0.18 m (Lockie et al., 2012c). However, observations of the beach flags event have indicated certain sprinters will use a variation of this typical technique. This study analyzed two elite sprinters who used a technique which has been termed the pivot start. This start technique involved no posterior movement. Instead, sprinters kept one leg on the starting line, and used the other leg to initiate the rotation about the pivot leg (Figure 3). The start time for both the male (1.155 ± 0.040 s) and female (1.130 ± 0.016 s) sprinter was longer than that for the typical start recorded for young adult male and female (0.72 ± 0.32 s) (Lockie et al., 2012c), and elite (0.95 ± 0.31 s) (Lockie & Vickery, 2013) beach flags sprinters. Nonetheless, the longer start time did not adversely affect sprint times for the elite male sprinter in this study, as he was faster in each interval when compared to the data recorded by Lockie et al. (2012c). This does provide an indication that for an elite beach flags sprinter, the start technique they are familiar with using can lead to fast sprint times. Furthermore, although this research was a case study on two elite sprinters, there are important implications that can be drawn from this study.

Both participants completed the turn during the start on their dominant leg, which then resulted in this leg being at the front of their stance before take-off (Table 3). By placing the dominant leg in the front position, sprinters who used the pivot start would be more balanced on the unstable sand surface. Ross, Guskiewicz, Prentice, Schneider, & Yu (2004) state that the dominant leg has higher proprioceptive function than the non-dominant leg, and this aids with stability in dynamic actions. Additionally, effective track sprint starts have been obtained when the dominant foot is in the front starting block, as it will spend more time in contact with the blocks to generate force (Vagenas & Hoshizaki, 1986). Beach flags sprinters who use the pivot start must ensure that the dominant leg is strong enough to balance the body while it rotates, before generating force to take-off into the sprint. Exercises that enhance both strength and dynamic stability, such as the Bulgarian split-squat (McCurdy, Langford, Cline, Doscher, & Hoff, 2004) or single-leg squat (Sheppard, 2004), should be a necessary component of training for sprinters who use the pivot start.

The rotation of the body is crucial during the pivot start. If the sprinter does not rotate fast enough, or far enough, the start would lose its effectiveness. Although this study did not report angular velocity of the body during this rotation, and indeed three-dimensional motion analysis of the pivot start would be of benefit, there is still important information that can be drawn from the observation of these movements for beach flags coaches. Sprinters must not only be powerful enough to initiate the rotation such that they face in the correct direction to start the sprint (Lockie & Vickery, 2013; Lockie et al., 2012c), but also have the kinesthetic awareness of how their body is being repositioned during this rotation (Gir¢n et al., 2012; Parsonage et al., 2015). Beach flags sprinters who use the pivot start should incorporate exercises that can improve kinesthetic awareness, in conjunction with capacities such as strength and power, within their training programs. An example of this would be plyometrics that involve body rotations, such as 180° vertical jumps (Myer, Ford, Brent, & Hewett, 2006). Nonetheless, future research should further investigate the angular velocity and momentum generated during a beach flags pivot start, and determine whether a higher magnitude for these variables contributes to a more effective start.

A greater trunk lean can positively influence take-off velocity from a track start by facilitating an angle of trajectory advantageous for sprinting (Atwater, 1982), and this also appears true for the beach flags start (Lockie & Vickery, 2013). Track sprinters have a trunk lean of approximately 66° when leaving the starting blocks (Atwater, 1982; Bradshaw et al., 2007). Both the male (61.10 ± 0.57°) and female (60.51 ± 2.41°) beach flags sprinters had a trunk lean not dissimilar from this value. As stated previously, elite beach flags sprinters have a start angle of trajectory of 45.93 ± 4.36° (Lockie & Vickery, 2013), and both the male (43.55 ± 1.20°) and female (48.75 ± 0.49°) beach flags sprinters were near this value following the pivot start. These findings demonstrate that following a pivot start, high level beach flags sprinters can attain a body position that is advantageous for sprinting.

The spacing between the feet following the turn for both participants (male = 0.68 ± 0.01 m; female = 0.62 ± 0.00 m) was analogous to a medium block spacing for a track start (Čoh et al., 2006). Further documenting similarities with the track sprint start, and as for the typical beach flags start (Lockie et al., 2012c), both participants attained joint angles in the take-off position comparable to other sprint start and acceleration research (Lockie, Murphy, & Spinks, 2003; Mann, 1985; Merni et al., 1992; Murphy, Lockie, & Coutts, 2003). As an example, the elbow angles for both participants was similar to that achieved by elite track sprinters (Mann, 1985). Furthermore, as has been noted in research that has analyzed the track sprint start (Merni et al., 1992), and the initial acceleration of field sport athletes (Murphy et al., 2003), neither participant in this study attained a full extension of the knee at take-off (male sprinter = 165.93 ± 1.87°; female sprinter = 152.23 ± 0.39°). The unstable surface notwithstanding, the case study results demonstrate that elite sprinters can achieve what appears to be a typical gait pattern following the pivot start.

Despite the novel findings from this study, there are limitations that should be noted. The sample size (n = 2) meant that only a case study could be conducted. Future research should use a larger sample, such that the start technique from this study could be compared to that documented by Lockie et al. (2012c). This could then determine whether there is a more effective start that could be used by beach flags sprinters. In addition to this, the practical nature of the research (i.e. conducting data analysis in the competition environment of the beach) precluded the use of three-dimensional motion analysis of technique, or force platforms to measure ground reaction force during the start. Future investigations should attempt to conduct this type of analysis on the beach flags start. Nonetheless, this case study of the pivot start has provided pertinent information for beach flags sprinters, and this information could be used by coaches to program training.

CONCLUSION

This research provided a case study of a variation to the beach flags start in elite sprinters. This start was termed the pivot start, as it involved the sprinter keeping one leg on the start line, while the other leg is swung in an arc to facilitate the turn into the sprint. The notable kinematics of this start included no posterior movement during the start, as one leg was kept on the start line. Furthermore, the two sprinters from this study were able to transition into a beneficial angle of trajectory at take-off from the start, and establish typical running mechanics following the start. The unique movement patterns adopted by beach flags sprinters who use the pivot start should be trained appropriately by beach flags and strength and conditioning coaches.

Acknowledgments: *Thank you to Renee Lavery and Alex Templeton from SLSA for facilitating the testing. I would like to acknowledge our participants for their contribution to the study. This research project was supported by a University of Newcastle New Staff Grant. There is no conflict of interest.*

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STUDIJA SLUČAJA VARIJACIJE BEACH FLAGS START TEHNIKE NA UZORKU ELITNIH SPRINTERA

Beach flags je deo surfovanja koji uključuje sprint od 20 metara preko peska. Sprinteri počinju u ležećem položaju, okrenuti u suprotnom pravcu od cilja, zatim ustanu i počnu da trče kako bi zaronili i dohvatili zastavice postavljene u pesak. Tipičan početak uključuje okretanje zadnjeg dela tela od startne linije tokom okreta. Iskustvo je pokazalo da beach flags sprinteri mogu da koriste varijacije početka tehnike dokumentovane u literaturi. Stoga, ovo istraživanja je uključilo studiju slučaja varijacije startne tehnike nazvane 'okretnim' startom. Analizirani su podaci dobijeni od jednog muškarca (starosti = 19 godina; visina = 1.74 m; težina = 66 kg), i jedne žene (starosti = 23 godine; visina = 1,68 m; težina = 57 kg), elitnih sprintera. Kamerom za snimanje brzih poketa snimljen je početak. U analizirane podatke spadaju: početno vreme; visina kukova i ramenog pojasa tokom skretanja; razmak između stopala; nagib lakta, kukova, kolena, i ugaona putanja pri startu, kao i deskriptivne statističke analize. Analiza je pokazala da sprinteri nisu pomerali zadnji deo tela na startnoj liniji dok su na njoj držali jednu nogu, dok bi zamahnuli drugom nogom oko tela i rotirali se oko jedne noge. Start sa okretom doveo je oba sprintera u efikasan, nizak položaj tela pogodan za ubrzanje, što se može videti iz nagiba gornjeg dela tela (~ 60°) i ugaone putanje (~ 47°). Beach flags sprintere koji koriste 'okretni' start trebalo bi učiti ovim jedinstvenim obrascima kretanja.

Ključne reči: *ubrzanje, biomehanika, sprint, start u sprint, surfovanje.*