COMPARISONS OF GROUND REACTION FORCES BETWEEN TWO DIFFERENT 180-DEGREE TURNING TECHNIQUES IN FEMALE CRICKETERS

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Changing direction (COD) particularly a 180-degree turn is a key skill in cricket. Two different techniques, Side-lunge (SL) and sprinting (SP) are commonly performed by cricketers. The aim of this study was to compare ground reaction forces (GRF) differences before turning between the two techniques. Nine Thai national female cricket players volunteered in this study. Participants executed running and 180-deg turning techniques while holding a bat on a track with embedded force platforms. GRFs and contact time (CT) at the three-foot contact events; antepenultimate (AFC), penultimate (PFC), and final (FFC) were analysed. The results showed that all GRFs of SP at AFC are significantly higher than SL ($p<0.05$). However, GRFs during SL were higher at PFC ($p<0.05$). This finding revealed different GRFs between two techniques particularly at AFC and PFC.

KEYWORDS: change of direction, cricket, ground reaction force.

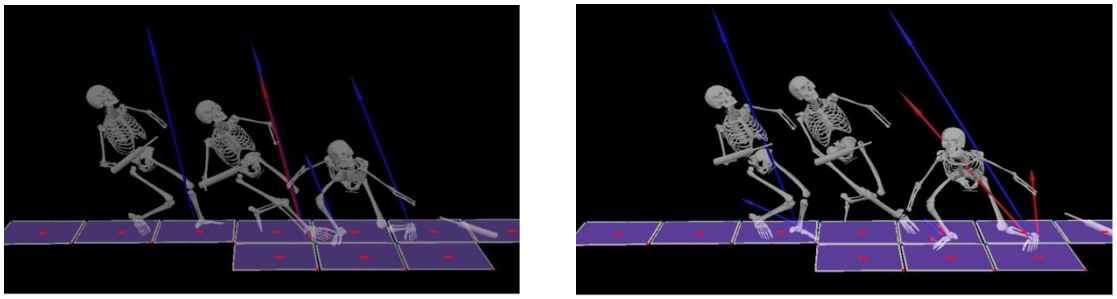
INTRODUCTION: The ability to change direction (COD) is a critical skill for athletes engaged in multidirectional sports, involving the capacity to quickly decelerate (using eccentric action) and then rapidly reaccelerate (through concentric action) into a new direction while running or sprinting (Dos' Santos & Thomas, 2017). The ability to execute a 180° change of direction (COD) is a key skill in various sports, including soccer, basketball, netball, and cricket (Santoro et al, 2021). In cricket, scoring is achieved by batsmen running to the opposite end of the pitch (17.68 meters) and touching the ground behind the batting crease with either their body or bat after hitting the ball, all while holding a bat. They may then choose to stop or attempt additional score by making 180-degree turns and running back to the opposite end, risking an 'out' if the wickets are broken.

Previous studies have focused on the biomechanical characteristics of the penultimate foot contact (PFC) and final foot contact (FFC) during the execution of a 180-degree change of direction (COD), particularly in traditional and modified 505 tests. More recently, research has begun to explore the antepenultimate foot contact (AFC) in these movements. The findings indicate that higher performance athletes typically exhibit increased maximal vertical, horizontal, and resultant ground reaction forces (GRF) in the AFC (Dos' Santos et al, 2021), augmented horizontal GRF during the penultimate foot contact PFC (Dos' Santos & Thomas, 2017), and greater vertical braking and propulsive force in FFC when they performed the 505 tests (Spiteri et al, 2015).

Two turning techniques, side-lunge (SL) and sprinting (SP), are currently used in cricket players. SL turning is a technique used during the initial crossover step to decelerate and has eyesight on sideway (Houghton, 2010). Whereas some cricketers perform a 180-degree turn by incorporating a slight rotating jump before landing in the sprinting position during the turning process (LeDune et al, 2012) to expectedly maximise acceleration with directional eyesight on sprinter-like stance, which is the so-called sprinting technique. For our knowledge, no previous studies have explored differences between both techniques. Therefore, the objective of this study was to compare kinetics parameters including ground reaction forces (GRF), contact

time (CT) and force angle (FA) between the SL and SP techniques while performing a 180-degree turn.

METHODS: Nine Thailand national female cricket athletes (age: 19.9 ± 2.9 years, weight: 55.9 ± 10.2 kg, height: 157.9 ± 6.0 cm) were volunteered in this study. Inclusion criteria were as follows: 1) be able to perform both turning techniques fluently and 2) no lower limb injuries or have any surgery in the past 6 months. All participants were signed a consent form approved by the Institution Review Board (MU-CIRB 2022/059.1403).
Participants performed 6 trials in an alternating order: 3 turning 180-degree with Side-lunge techniques and 3 turning 180-degree with Sprinting techniques while holding a standard cricket bat and wearing their own shoes. After performing a 15-minute standard warm-up, all participants were instructed to maximal sprint to the line marked 17.68 meters from the start, touch the bat behind the line, and ensure some part of their body crossed behind or across the line, simulated as popping or batting crease, with dominant leg. They were then to turn 180 degrees and sprint maximally back to the starting point. Twelve force platforms (FP4060-08-1000, Bertec Corp, USA) embedded into running track were used to collect data at the sampling rate of 1200 Hz. GRF raw data were low-pass filtered and normalized by body weight. GRFs at three events; AFC, PFC, FFC were analysed. APC is defined as the third-last interaction with the ground before transitioning into a new intended direction of movement. PFC is the second-last contact with the ground prior to changing direction. FFC is identified as the moment during a pivot where an individual touches the ground, instigating movement in a new direction (Fig 1).



(A) **(B)**

Figure 1: Demonstrates a comparison of 180-degree turning techniques, showcasing a side-lunge (A) and sprinting (B). It highlights the side lunge executed before turning in technique A, and a rotating jump followed by landing in technique B, specifically after the antepenultimate foot contact (AFC), leading into the penultimate foot contact (PFC) and the final foot contact (FFC) steps.

The CT was determined as the moment following initial ground contact when the vertical GRF exceeded 20 N, while the termination of contact was defined as the point when the vertical GRF dropped below 20 N (Dos' Santos & Thomas, 2017).
The descriptive data were analysed using Jamovi (version 2.3) statistical software. Data normality was assessed using Shapiro-Wilk tests. Since the data were and the paired-t test was employed to compare GRF parameters between the two techniques. The significance level was set at 0.05.

RESULTS: A significant difference was observed in ground reaction force variables between the SL and SP techniques ($p<0.05$) in both AFC and PFC, as shown in Figure 2. The SP technique revealed higher values for vertical GRF (SP; 3.4±0.6 vs SL;2.8±0.9) ($p<0.05$), horizontal GRF (SP; 1.7±0.5vs SL; 1.3±0.5) ($p<0.05$), resultant GRF (SP; 3.8±0.8vs SL; 3.1±1.1) ($p<0.05$) compared with the SL technique during AFC. However, performing the SP technique resulted in a reduction in vertical GRF (SP; 1.3±0.3 vs SL; 1.6±0.3) ($p<0.05$), horizontal GRF (SP; 0.8±0.3vs SL; 1.0±0.3) ($p<0.05$), resultant GRF (SP; 1.5±0.5vs SL; 1.9±0.4) ($p<0.05$), in contrast to the SL technique, during PFC. Furthermore, the results

presented in Table 1 show that no significant differences were observed in ground contact time, angle of force, and H/V ratio between SP and SL techniques in AFC, PFC and FFC.

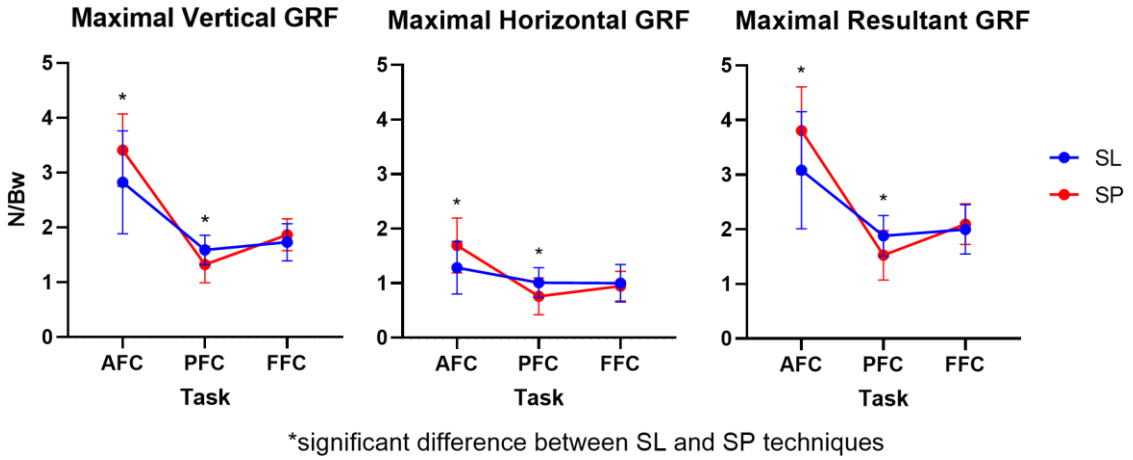


Figure 2: Comparison between two techniques in vertical, horizontal, and resultant GRF characteristics during foot contacts.

Table 1: comparison between SL and SP techniques variables during antepenultimate, penultimate, and final foot contacts.

Variable	SL	SP	P-value
1. Maximum H to V GRF Ratio			
AFC	0.45±0.03	0.49±0.08	0.14
PFC	0.63±0.08	0.56±0.14	0.102
FFC	0.57±0.11	0.50±0.08	0.162
2. Angle of force (degree)			
AFC	65.82±1.39	64.02±3.55	0.142
PFC	57.92±3.38	61.22±5.86	0.096
FFC	60.59±4.65	63.49±3.57	0.168
3. Ground contact time (second)			
AFC	0.15±0.02	0.16±0.02	0.058
PFC	0.47±0.12	0.37±0.09	0.062
FFC	0.17±0.05	0.19±0.05	0.194

Abbreviations; AFC = antepenultimate foot contacts, PFC = penultimate foot contacts, FFC = final foot contacts, SL = Side-lunge technique, and SP = Sprint technique.

DISCUSSION: The purpose of this study was to compare GRFs and the angle of force between the SL and SP turning techniques during the three-foot contact events in cricket athletes executing a 180-degree turn. We identified distinct some GRFs characteristics associated with each turning technique. However, the results did not reveal significant differences in the maximum horizontal to vertical GRF ratio, the angle of force, or ground contact time.

Our study revealed that the trend in GRF results aligns with previous studies, indicating that the AFC has the highest GRF value, followed by the FFC and then the PFC, respectively (Dos' Santos et al, 2021). This study found that a difference between vertical, horizontal, and resultant GRF value were demonstrated in AFC and PFC. All GRFs of SP were higher in AFC than SL but lower in PFC. Higher GRF at the AFC and PFC are advantageous for decelerating the body in preparation for a directional change (Dos' Santos et al, 2021; Dos' Santos et al, 2020). These differences in GRF between the techniques suggest the employment of varied procedural methods, emphasized by the unique characteristics of each turning technique. For instance, the SL technique involves executing a side lunge during the PFC step for stabilization, in contrast to the SP technique, which focuses on decelerating the body at the AFC step, followed by a slight jump during the turn and then landing in a sprinting position.

This indicates that while the SP technique, with its higher GRF during AFC, may lead to more significant changes in momentum and a greater reduction in horizontal velocity (Dos' Santos et al, 2021), the SL technique might offer more stability during turns due to its effective posture for weight acceptance (Dos' Santos et al, 2019), facilitated by greater ground reaction force during the penultimate foot contact.
Although there is no significant difference in ground contact time, data trends suggest that the SP generally involves a longer ground contact time during the AFC step. In contrast, the SL typically exhibits a longer duration during the PFC step. This variation in ground contact patterns may be a contributing factor to the increased ground reaction force observed in each technique.

CONCLUSION: In conclusion, the observed differences in kinetic variables during the antepenultimate foot contact (AFC) and penultimate foot contact (PFC) steps can be attributed to the distinct turning procedures employed in the SL and SP techniques. This highlights the importance of technique-specific training to optimize performance in these critical movements.

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