INSTEP KICK TECHNIQUE DOES NOT ALTER FOLLOWING A SELF-PACED FATIGUE PROTOCOL IN AMATEUR SOCCER PLAYERS

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The purpose of this study was to determine whether amateur soccer players alter their dominant-instep (D-instep) and non-dominant instep (ND-instep) kick technique in response to self-paced fatigue protocol. Twelve male amateur soccer players performed 10 consecutive trials D-instep and ND-instep, prior to and following the completion of a 30-minute self-paced treadmill running protocol. 3D ground reaction forces and kinematic data were recorded during each trials and assessed using a repeated measures factorial analysis of variance. Numerous D-instep and ND-instep differences were observed. The fatigue protocol did not alter D-instep technique, and only minimal changes in the ND-instep technique were demonstrated, suggesting that players were more sensitive to fatigue effects during ND-instep due to their lower skill proficiency compared to D-instep.

KEYWORDS: soccer, fatigue, injury.

INTRODUCTION: Hamstring strain injuries (HSIs) and groin injuries are the two top recurrent injuries in elite soccer players, and the 2nd and 4th recurrent injuries in amateur players (Hägglund, Waldén, & Ekstrand, 2016). The injury mechanism of HSI (Gabbe, Finch, Bennell, & Wajswelner, 2005) and acute groin injury commonly occurs during kicking (Serner, et al., 2015). Previous research have reported asymmetries in the instep kick technique (Dörge, Andersen, SØrensen, & Simonsen, 2002; Nunome, Ikegami, Kozakai, Apriantono, & Sano, 2006) and muscular strength imbalances in HSI (Croisier, Ganteaume, Binet, Genty, & Ferret, 2008) and groin injuries (Thorborg, et al., 2011). While kicking dominance (asymmetries) has not previously been associated with HSI (Ekstrand, Waldén, & Hägglund, 2016), 81% of acute groin injuries are in the kicking limb (Serner, et al., 2015).
A higher tendency of injuries have been reported in soccer to occur towards the end of the first and second halves (Ekstrand, Hagglund, & Walden, 2011). Not only is fatigue associated as an injury risk, it has also shown to reduce ball velocity during an instep kick and technique (Apriantono, Nunome, Ikegami, & Sano, 2006). Investigations of the effects of fatigue on instep kicking performance have only utilised a constant load protocol (Apriantono, et al., 2006). Nevertheless, the findings of this previous research may be limited as a constant load protocol in soccer does not reflect game performance that is not maintained at a constant level of intensity throughout a game. Furthermore, making between-study comparisons is inappropriate due to the task-dependent effects of fatigue (Enoka & Duchateau, 2008). Therefore, this study aimed to whether amateur soccer players alter their dominant-instep (D-instep) and non-dominant instep (ND-instep) kick technique in response to self-paced exercise. It is hypothesised that the players instep kick technique with alter between limbs and more changes in response to fatigue will be shown in the ND-instep than D-instep kick.

METHODS: Twelve male amateur soccer players performed 10 consecutive trials of instep kicking on a synthetic grass surface for both lower limbs, prior to and following the completion of a 30-minute self-paced treadmill running fatigue protocol. The instep kick was performed for accuracy and power to a 0.4 m^2 target 10 m away on a wall, with a three-step approach prior to initiation of the kicking action. Participants were instructed to cover the greatest distance possible during the 30-minute self-paced running protocol in which they ran at a self-selected pace, except for 1-min sprint efforts at 5, 10, 15, 20, 25 and 30 mins when they were required to run at 70% of their peak treadmill running velocity (PTV) (Marino, Lambert, & Noakes, 2004). To establish PTV, the participant started at 8 km/h at a 1%

gradient and the running speed was increased by increments of 1 km/h every minute until the participant could no longer maintain the required speed.

Ten trials were recoded to minimise the typical error in the instep kick (Lees & Rahnama, 2013). For each trial, 3D ground reaction forces (Kistler force platforms; 1000 Hz) and kinematic (Qualisys Oqus 300+; 250 Hz) data were recorded. Passive reflective markers were placed in accordance with Schaefer, O'Dwyer, Ferdinands, and Edwards (2018) and five markers were placed on the ball. 3D kinematic analysis of the instep kick trials was performed by examining the flight, support and deceleration phases (Figure 1).

To minimise experiment-wise error in this study that involved the assessment of multiple dependent variables, a repeated measured factorial analysis of variance (ANOVA) was used to identify any significant changes (p<0.05). Repeated measures factors were fatigue, dominance (D-instep, dominant defined as the preferred kicking leg as the swing limb; ND-instep, non-dominant), events (Figure 1) and joint angles. When main effects or interactions were found, Tukey *post hoc* tests were completed.

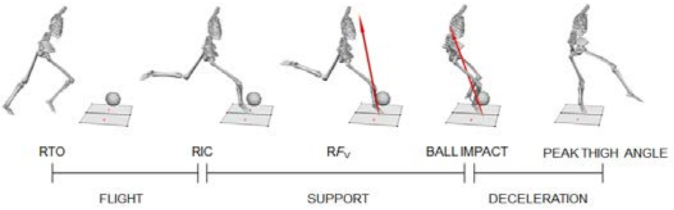

Figure 1. Temporal events and phases of the instep kick.

RESULTS: 30-minute self-paced protocol: Participants ran at 9.53±2 km/h and covered 4.76±0.74 km. Main effects of time and sprint effort was observed for heart rate (HR) Time p<0.001; Sprint p<0.025) and rate of perceived exertion (RPE) (Time p<0.001; Sprint p=0.006), that increased throughout the protocol and following each sprint. A significant time*sprint interaction for HR (p<0.025), not RPE (p=0.18), revealed with *post hoc* testing that post-sprint HR increased at minutes 4-5, 14-15 and 19-20 mins versus pre-sprint. Maximal handgrip strength showed a main effect of repeats (p<0.001), yet not fatigue (p=0.24) or fatigue*repeats interaction (p=0.84).

Ball speed: Peak ball speed was greater than initial ball speed (p<0.0001). No main effect of fatigue was present (p=0.25), so that ball speed was maintained post-fatigue. A main effect of dominance was observed (p=0.003) with higher initial and peak speed for the D-instep.

Joint angles: No main effects for joint angles were observed for fatigue (p=0.61) or dominance (p=0.27), nor any significant interactions between dominance*fatigue (p=0.08), fatigue*event (p=0.62), dominance*fatigue*event (p=0.77), fatigue*event*angle (p=0.15) or dominance*fatigue*event*angles (p=0.08; Figure 1). Yet the dominance*event (p<0.0001) and dominance*angles (p<0.0001) interactions revealed on *post hoc* analysis higher hip external rotation of the swing leg during D-instep and the stance leg during ND-instep, this difference being averaged across the four events and pre- and post-fatigue. *Post hoc* analyses to the significant interactions observed between fatigue*dominance*angles (p<0.01)

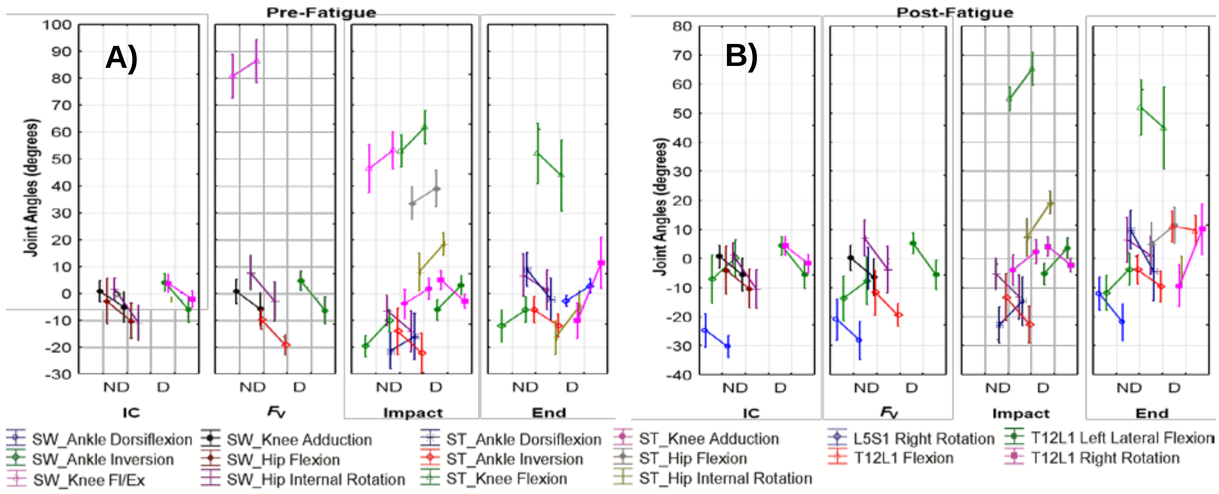

Figure 1: Mean (± SE) for the significant joint angles between the D-instep and ND- instep kicks across A) pre- and B) post-fatigue conditions. Swing leg (SW), stance leg (ST), initial contact (IC), peak vertical ground reaction force (F_V). Legend denotes positive direction of joint angles.

and dominance*event*angles ($p<0.001$), and the fatigue*dominance*event *angles approaching significance ($p=0.079$), *post hoc* analyses revealed only two pre- vs post-fatigue differences in ND-instep only but a large number of ND-instep vs D-instep differences.

DISCUSSION: The findings from the present study are difficult to compare to the existing literature for either of the soccer-specific tasks as the effects of fatigue are task-dependent (Enoka & Duchateau, 2008). Completion of the self-paced fatigue protocol differentially affected D-instep and ND-instep task execution, with changes in movement mechanics with fatigue were more prominent for ND-instep kick. This finding is in line with previous research outlining that a decline in skilled performance under fatigue is greater in novice compared to expert participants (Lyons, Al-Nakeeb, & Nevill, 2006), indicating that when individuals are more highly skilled in a task, they are better able to manage fatigue effects. In the present study, ND-instep task execution was more sensitive to fatigue effects, likely due to lower skill expertise compared to the D-instep, and likely affected by the conditioning of the players.
The presence of only minor between-fatigue differences and greater changes in the more fatigue sensitive ND-instep may be partly explained by the type of fatigue protocol implemented. Commonly, exercise protocols may vary in terms of whether performance is self-regulated by the participant or completed at a predetermined constant load. The nature of the self-paced fatigue protocol implemented in the present study allows for the input of feedforward and feedback processes, and is more closely aligned with human performance – including soccer where performance is not maintained at a constant intensity level for the entirety of a match. Yet, this study's participants demonstrated an 'endspurt' in performance (Kay, et al., 2001), whereby they apparently decreased their work rate by choosing a lower self-selected running speed in the self-paced fatigue protocol, until the final minutes of exercise when running speed was increased. This 'endspurt' potentially restricted the effects of fatigue and was reflected in concurrent changes in HR and RPE. Therefore, it is possible that completion of a constant-load exercise protocol in which total effort and workload is fixed, may be necessary to elicit fatigue effects in both D-instep as well as ND-instep.
The numerous differences between the D-instep and ND-instep technique were observed in this study, the supporting previous research (Sinclair, et al., 2014). Nevertheless, the differences in technique between limbs observed in this study differs to that seen in professional soccer players (Sinclair, et al., 2014), likely due to between-study differences in skill level of participants and their ability to achieve accuracy and power to a 0.4 m2 target 10 m away. In amateur soccer players, this study observed greater hip external rotation of the stance leg during ND-instep and greater hip external rotation of swing leg during D-instep kick suggests an inferior kicking performance ability with the ND-instep, in which participants reverted to a kicking action more reflective of an inside-foot pass rather than an instep kick. Differences in kicking technique contributed towards the greater ball speed for the D-instep compared to ND-instep. When kicking with the dominant limb, faster ball speed is reported to be due to superior intersegmental coordination (Dörge, et al., 2002), higher shank angular velocity (Nunome, et al., 2006), higher foot speed and better transfer of velocity from foot to ball (Dörge, et al., 2002).

CONCLUSION: No changes in D-instep and minimal alterations in ND-instep technique in response to a self-paced exercise protocol suggest that healthy amateur soccer players were able to maintain their performance and thus alter their risk of sustaining a HSI or groin injury. It is likely that greater fatigue effects would be observed during soccer-specific tasks with a fixed-load compared to the self-paced fatigue protocol used in this study. The minimal changes observed after the self-paced exercise during the ND-instep-kick suggest that players more sensitive to fatigue effects during ND-instep compared to D-instep due to their lower skill proficiency for the performance of ND-instep.

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