Footwear induced changes in ankle biomechanics during unanticipated side-step cutting in female soccer players

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Introduction

Sex-specific soccer cleats have recently been supported in part due to the overall popularity of soccer and growth of female players worldwide (Althoff et al. 2014). Additionally, sex differences in foot morphology exist, warranting the development of female-specific shoe lasts rather than a scaled down male shoe, as inappropriate fit may lead to higher injury risk (Krauss et al., 2008; Kulessa et al., 2017). Footwear should balance performance enhancement and reduction of injury risk. The most commonly injured body site in soccer is the ankle followed by the knee (Fong et al. 2007). 85% of ankle sprains are considered lateral ankle sprains with most common mechanism of injury involving ankle inversion (Ferran et al. 2006). In addition, a specifically debilitating injury in female soccer is a ruptured anterior cruciate ligament (ACL). We have previously shown that high-risk biomechanics, specifically larger knee abduction loads, predict future ACL injury in young female athletes (Hewett et al. 2005). Therefore, in order to decrease the risk of injury without compromising performance, research of female-specific soccer cleats during dynamic movements is necessary.

Purpose of the study

The purpose of this study was to determine the effects of sex-specific footwear on the biomechanics soccer players during unanticipated side-step cutting.

Methods

24 high school and collegiate female soccer players (height 165.2 ± 6.4cm; mass 61.3 ± 9.5kg; age 17.6 ± 2.9yrs) were fitted with two pairs of soccer specific cleats (adidas X 15.1 (control, CT) and female-specific prototype adidas ACE 17.1 (prototype, PT)). Unanticipated side-step cuts (Figure 1) with each cleat were performed on an artificial turf surface with data collected from 3D motion analysis cameras (Motion Analysis Corp), force platforms (AMTI), and in-cleat pressure distribution (Novel). Statistical comparisons between cleats were made using a repeated measures ANOVA ($p < 0.05$).

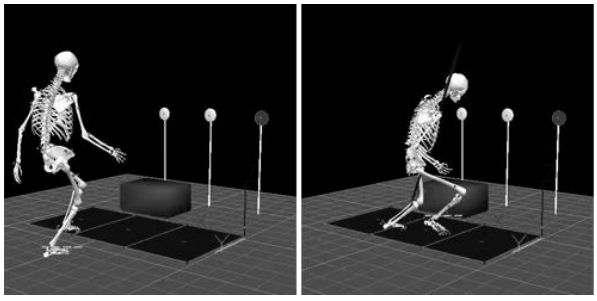

Figure 1. Side step cut with light stimulus that provided a cue to either plant and back pedal or cut at a 90-degree angle.

Results

Knee abduction moment was not statistically different between cleats during the deceleration phase of the side-step cut (CT: -61 ± 29.6Nm; PT: -57.7 ± 27Nm; p=0.53). However,

maximum ankle inversion moment (Figure 2) was significantly reduced in the PT compared to CT cleat (CT: 42.9 ± 18.2Nm; PT 32.8 ± 14.7Nm; $p<0.001$). Higher peak pressure was found in the lateral forefoot in the CT compared to PT cleat ($p=0.017$). In contrast, higher peak pressure existed in the PT cleat compared to CT cleat in the medial midfoot ($p=0.007$), lateral midfoot ($p=0.01$), and central forefoot ($p<0.001$). There were no differences in stance time ($p=0.6$) or approach velocity ($p=0.5$) between cleats.

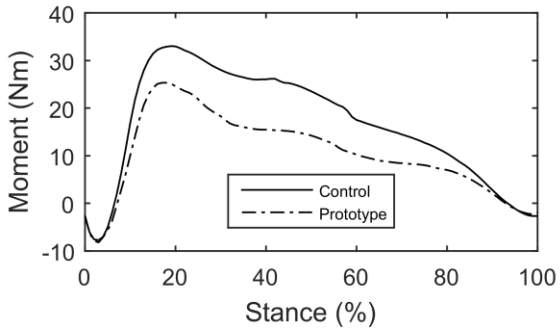

Figure 2. External ankle inversion (+) moment during stance phase of side step cut.

Discussion and conclusion

The findings of this study indicate that while wearing the PT cleat, biomechanical differences exist during side-step cutting without increasing risk of knee injury (as evidenced by no change in knee abduction moment between cleats) and without sacrificing performance (as stance time and approach velocity were not different between cleats). The most salient and promising finding was decreased ankle inversion while wearing the new PT compared to standard footwear. This may indicate that risk for ankle sprains could be reduced and may relate to the female-specific last and stiffness properties used in the PT design (i.e. the last was narrower in the heel of the PT compared to CT condition). There was also a design change to the stud configuration between cleats, a property that can influence the contact area and traction between the cleat and surface (Kulessa et al., 2017). Within the central forefoot, the PT cleat had a more prominent stud which likely relates to greater peak plantar pressure, a measure that is widely used to evaluate comfort in shoes (Henning et al. 2010). Modification of the length or position of central forefoot stud should be considered. Overall, the findings of this study show potential, and encourage the continued research and design of sex-specific footwear for female soccer players. We acknowledge funding support from adidas International, Inc.

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