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Original article

Effect of turf on the cutting movement of female football players

Gerda Strutzenberger [a,b,*], Hue-Man Cao [a,c], Janina Koussev [a,c], Wolfgang Potthast [c], Gareth Irwin [a,c]

[a] School of Sport, Cardiff Metropolitan University, Cardiff CF236XD, UK
[b] Department of Sport and Sport Science and Kinesiology, University of Salzburg, Hallein-Rif 5400, Austria
[c] Institute of Biomechanics and Orthopaedics, German Sport University Cologne, Cologne 50933, Germany

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Abstract

Purpose: The globalisation of artificial turf and the increase in player participation has driven the need to examine injury risk in the sport of football. The purpose of this study was to investigate the surface–player interaction in female football players between natural and artificial turf.
Methods: Eight university level female football players performed an unanticipated cutting manoeuvre at an angle of 30° and 60°, on a regulation natural grass pitch (NT) and a 3G artificial turf pitch (AT). An automated active maker system (CodaSport CXS System, 200 Hz) quantified 3D joint angles at the ankle and knee during the early deceleration phase of the cutting, defined from foot strike to weight acceptance at 20% of the stance phase. Differences were statistically examined using a two-way (cutting angle, surface) ANOVA, with an α level of $p < 0.05$ and Cohen's d effect size reported.
Results: A trend was observed on the AT, with a reduction in knee valgus and internal rotation, suggesting a reduced risk of knee injury. This findings highlight that AT is no worse than NT and may have the potential to reduce the risk of knee injury. The ankle joint during foot strike showed large effects for an increase dorsiflexion and inversion on AT. A large effect for an increase during weight acceptance was observed for ankle inversion and external rotation on AT.
Conclusion: These findings provide some support for the use of AT in female football, with no evidence to suggests that there is an increased risk of injury when performing on an artificial turf. The ankle response was less clear and further research is warranted. This initial study provides a platform for more detailed analysis, and highlights the importance of exploring the biomechanical changes in performance and injury risk with the introduction of AT.

Keywords: Artificial turf; Football-specific movement; Gender; Injury risk; Kinematics

1. Introduction

Over the last decade artificial turf (AT) has been promoted as a viable alternative to natural turf (NT) by the major sporting international governing bodies, which utilise these playing surfaces (e.g., Fédération Internationale de Football Association (FIFA), International Rugby Board (IRB), Rugby League (RL), National Football League (NFL), International Hockey Federation (FIH)). The rationale behind this promotion is based on, firstly economic reasons: AT reduces the cost of maintaining a grass-based surface, which is particularly challenging across diverse environmental and climatic conditions. Secondly, consistency of playing surface will provide a more congruent playing surface globally. Finally, providing longer playing hours, as well as a multi-purpose application support the global health agenda.

These surfaces have been particularly promoted and installed in professional football communities, with the 3rd generation (3G) AT being the most common system.[1] A 3G

* Corresponding author. School of Sport, Cardiff Metropolitan University, Cardiff CF236XD, UK.
E-mail address: Gerda.Strutzenberger@sbg.ac.at (G. Strutzenberger)
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AT system is typically installed on a rigid base layer and consists of an elastic layer, an artificial grass carpet and infill material between the grass fibres.[2] Against the benefits stands the generally negative perception of male players on playing on AT with a subjective feeling of poorer ball control and greater physical effort[3] and greater difficulties in cutting.[4] Female football players in this Swedish study demonstrated a different response pattern. Both regular AT and NT players reported, no general influence of AT on the game but felt that running with the ball and passing was easier on AT.

Independent of gender, the players psychological perceptions identified a perceived higher injury risk when playing on AT.[5] These psychological observations were partly supported by epidemiological research[6] exploring football injuries on 3rd and 4th generation AT, which suggested an increased risk of ankle injury on AT. However, a recent epidemiological meta-analysis of football injuries, summarised the risk of injury by playing on different surfaces (AT−NT) from eight published studies[7] drawing the conclusion that competing or training on AT generally reduces the risk of injury compared to NT. Another recent study identified generally no differences in acute injury rates when playing on AT compared with NT, but demonstrated, that clubs with AT at their home venue had higher rates of acute training injury and overuse injury compared with clubs that play home matches on NT.[8]

Additionally the role of gender and the surface effects are inconsistently reported in the literature. Generally, knee and ankle injuries are the most common injuries for female football players.[9,10] Additionally they sustain a 2−3 times higher risk of ACL-rupture than their male counterparts.[10,11] While Fuller et al.[10] and Meyers[12] identified a lower injury risk for women on AT, Steffen et al.[13] found a trend towards higher risk of ankle sprains for female football players below the age of 17. Additionally, young female football players were very likely to sustain severe injuries on AT.[6] During training Fuller et al.[9] reported a higher risk of ankle sprains in men on AT, but no differences for women. Over a 5-year period, Soligard et al.[14] reported no difference in overall injury risk between AT and NT for male and female players.

These epidemiological studies provide useful information about the frequency and trends in injury occurrence. However, there is still a gap between these descriptions and the aetiology of injury risk, with considerations for gender, age, and turf still under represented. Some evidence exists that surface changes lead to alterations in football-specific movement patterns[2,15,16] of male football players, but to date no research was found by the authors, which investigates surface-induced effects on the movement of female football players. Playing on AT includes, for example, increased peak torque and different rotational stiffness properties of shoe−surface interaction, decreased impact attenuation properties of surfaces and differing foot loading patterns.[6] While the approach velocity remained constant, the last step to a kick was decreased on a rubber and sand filled artificial surface leading to a "more cautious braking behavior".[16] Since female football players respond differently to football injury and perception of the AT than their male counterparts, investigating the female specific movements on different surfaces could enhance the understanding of injury risk and improve the quality of these surfaces. As approximately 50% of all season ending injuries during match play in female football are ACL-tears,[10] it seems worthwhile investigating a movement task that is commonly representative for this injury. Female athletes tend to demonstrate less knee flexion, more knee valgus angles, greater quadriceps activation, and lower hamstring activation in cutting and running tasks than male athletes.[17] In non-contact situations an extended knee position (up to 30°)[18−21] as well as an anterior tibial draw combined with valgus and internal rotation moments[22−24] could induce excessive loads on the ACL causing it to rupture. Thirty-seven percent of the non-contact ACL injuries occur during cutting manoeuvres, followed by 32% in landings, 16% land and steps, 10% stopping/slowing, and 5% crossover-cut manoeuvres.[18] Further, unanticipated cuttings are more likely to represent the movements during a game situation and are described with an increased risk of injury compared to anticipated cuttings.[25]

Therefore, the purpose of this study was to investigate the lower limb kinematics on different surfaces in female football players during an unanticipated cutting manoeuvre. This could lead to a more comprehensive knowledge of player−surface interaction and provide further understanding of the mechanism of injury risk and enhancement of artificial surfaces in football. It was hypothesised that AT would lead to increased contact times, no alterations in knee positions but higher ankle dorsiflexion, inversion, and rotational angles.

2. Materials and methods

2.1. Participants and surfaces

Eight female university level football players (age: 21.5 ± 2.1 years; height: 162.8 ± 7.1 cm; weight: 66.0 ± 8.5 kg; football experience: 13.3 ± 4.1 years) participated in the study. The institutional ethical review board approved the study and additionally a written consent form prior to participating was signed by all athletes. Athletes were free from injury over a 6-month period prior to testing. Leg dominance was determined by the leg instantaneously used for a single-legged forward jump and only right-leg dominant players were included in the study. Participants used their individual football shoes, which they would use on both AT and NT.

The data collection was performed on two neighbouring pitches: the natural surface pitch (NT) was a natural grass pitch approved for national competition, and the AT pitch was a 2-star FIFA approved 3G AT pitch. As this was an outdoor testing, each participant underwent data collection for both surfaces in one session to keep the influence of weather and temperature change at a minimum.

2.2. Data collection

A testing session consisted of an individual warm-up, habituation phase and data collection on surface A followed