Evaluation of the effects of traction on ankle kinematics during a side cut using bfPCA (abstract only)

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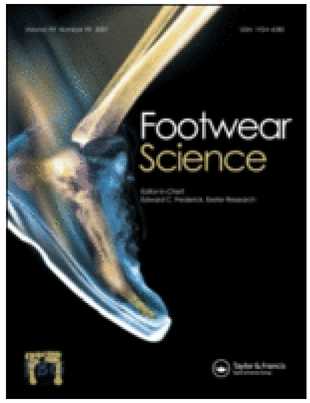

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Introduction

High intensity movements and sudden changes of direction in football are known to contribute to the occurrence of non-contact injuries (Jain *et al*. 2014). Studies of ankle injury pathways have shown that these occur when one or more loading mechanisms follow a defined sequence (Funk, 2011). Under this principle an increased risk due to inadequate traction can be identified, such as excess grip between the foot and the playing surface or insufficient traction due to a slippery surface. The present study uses bivariate functional Principal Component Analysis (bfPCA) to identify the variability in ankle kinematics caused by traction during a side cut. This approach analyses two angle variables relative to each other, identifying relationships that could lead to injury.

Purpose of the study

The purpose of this study was to demonstrate how variability in ankle kinematics aids to identify injury mechanisms during a side cut.

Methods

Data were collected from 20 recreational male football players (age 24.2 ± 4.67 years, mass 73.0 ± 6.97 kg, height 1.77 ± 0.06 m). Participants performed 3 trials of a side-cut using futsal shoes (Kipsta Agility 100 Sala, Decathlon). Two different conditions on carpeted floor were used: Rubber outsole without modification (High traction) and Rubber outsole covered with a pattern of 1cm PVC tape stripes (Low traction). The coefficient of traction (μ) of each outsole was 1.24 and 0.49 in the high and low traction conditions, respectively. Lower leg kinematics were collected using a Motion Capture (MAC, Motion Analysis Corporation) at 200Hz. Data were then evaluated using open source bfPCA code (Matlab, MathWorks), evaluating coupled joint mechanisms. Positive/negative scores were identified as participant trials related to angle deviations, due to addition or subtraction of the effect of a bivariate functional Principal Component (bfPC). Three couplings were analysed: PD-IE: plantar/dorsiflexion-in/eversion, IE-ROT: in/eversion-in/external rotation, PD-ROT: plantar/dorsiflexion-in/external rotation. The first 3 bfPC were extracted for all combinations accounting for >85% of total variation.

Results

Results of the present study show changes in angle couplings between traction conditions. Non-trivial effect sizes (Cohen's d >0.2) were observed for 3 of the bfPCs (Table 1).

(Here Table 1)

For PD-IE, bfPC2 and bfPC3 described variations in inversion and plantarflexion angles during the first 20% of the movement. The largest effect size (d=0.55) was observed for bfPC3, depicting increased plantarflexion, attributed to low traction outsoles during landing.

For bfPC2 of PD-ROT, negative bfPC2 scorers showed an increase in plantarflexion and internal rotation during 50-80% of the movement (Figure 1). Mean scores of the high traction trials scored negatively on this bfPC.

(Here figure 1)

Discussion and conclusion

bfPCA weights variations in multivariate movement signatures and highlights where and how injuries might occur.

For the PD-IE, insufficient traction leaded to increased inversion coupled with plantarflexion changes, due to instability during the landing stage of the side cut. Both angles individually or combined are known to cause Anterior Talofibular ligament (ATFL) and Calcaneofibular ligament (CFL) injuries. For bfPC2 of PD-ROT, high traction outsoles generated a simultaneous increase in plantarflexion and internal rotation. Both mechanisms are known to lead to ATFL injury, which is the most common in football and often occurs simultaneously with CFL injury. Inadequate traction during fast, high intensity movements bring increased loading, increasing the likelihood of complex injuries rupturing one or two lateral ligaments (Ekstrand, 2016). Using bfPCA, footwear can be evaluated in order to avoid designs increasing the identified mechanisms.

References

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	Var	High traction M±SD	Low traction M±SD	Cohen's *d*
PD-IE: Plantar/dorsiflexion-in/eversion				
bfPC1	52.2%	2.93±78.3	-2.93±70.1	0.08
bfPC2	28.1%	-5.98±53.3	5.98±55.1	**0.21**
bfPC3	6.2%	7.04±24.2	-7.04±25.1	**0.55**
IE-ROT: in/eversion-in/external rotation				
bfPC1	46.7%	2.44±77.1	-2.44±74.4	0.06
bfPC2	38.5%	0.69±64.5	-0.69±72.9	0.02
bfPC3	5.1%	-1.40±25.3	1.40±25.0	0.11
PD-ROT: plantar/dorsiflexion-in/external rotation				
bfPC1	60.2%	2.42±79.0	-2.42±100.5	0.05
bfPC2	18.5%	-7.48±55.1	7.48±43.3	**0.29**
bfPC3	7.6%	2.71±31.4	-2.71±32.9	0.16

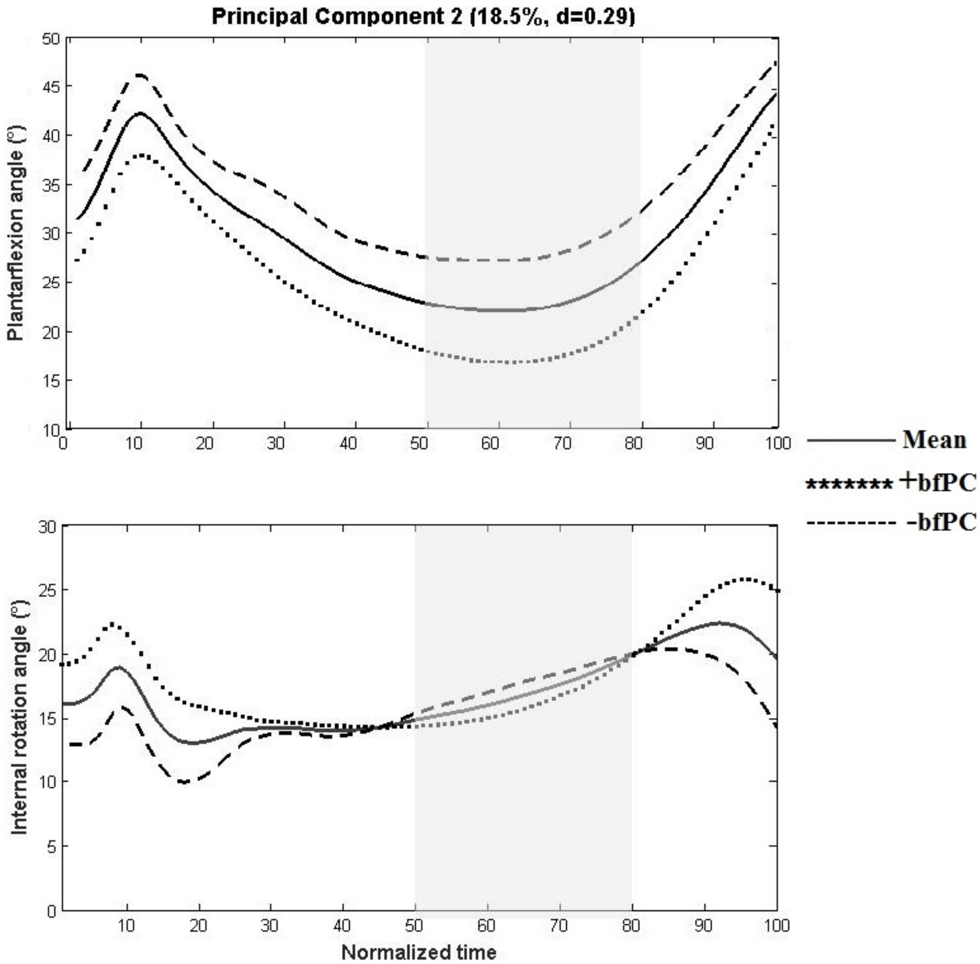

Figure 1. bfPC2 of the plantarflexion and internal rotation angles.

208x204mm (96 x 96 DPI)