SHOE-SURFACE TRACTION OF CONVENTIONAL AND IN-FILLED SYNTHETIC TURF FOOTBALL SURFACES

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INTRODUCTION

The higher risk of injury reported among American footballers playing on synthetic turf (e.g. Zemper,1989) has been attributed to higher levels of resistance to shoe rotation (e.g. Bonstingl *et al*, 1975; Clarke & Miller, 1997; Heidt *et al*, 1996). Football shoes with greater resistance to shoe-surface rotation have also been associated with higher injury rates (Torg *et al* ,1974; Lambson *et al* ,1999).

In recent years, in-filled surfaces with long grass-like fibers and a top dressing or "in-fill" of sand and/or rubber granules have replaced conventional foam-backed, short-fiber turf systems as the synthetic surface of choice in new football field installations. While the structure of in-filled surfaces suggests the possibility of very different shoe-surface interaction, their traction characteristics have not been previously reported. Therefore, the purpose of this study was to compare the traction properties of natural turf, conventional synthetic turf and in-filled synthetic turf. A further goal was the development of guidelines for selecting footwear for a particular surface that would provide adequate traction while minimizing resistance to rotation.

METHODS

The traction required to perform high-effort cutting maneuvers was determined by analysis of ground reaction forces. Ten High School football players performed five cuts at angles of 45º, 90º and 180º under non-slip surface conditions. The traction requirement was defined as the peak value of the ratio of the horizontal and vertical force vector magnitudes.

The traction and resistance to rotation produced by each combination of six shoes and four dry surfaces were measured using an Exeter Research traction device (Exeter Research Inc., Exeter, NH). (Fz = 529 N; $^{dx}/_{dt} \approx 0.30$ m s^{-1}; $^{d\theta}/_{dt} \approx 3$ s^{-1}). The shoes represented the variety of outsole designs used by football players, ranging from a basketball shoe to an aggressively cleated "turf" shoe, The surfaces were a conventional synthetic turf (Astroturf, [AT]), two in-filled synthetic systems (AstroPlay [AP] and Fieldturf [FT]) and a natural turf [NT] test site. Shoe-surface combinations were characterized by the average value of the traction coefficient during linear sliding motion ($\mathbf{T_T}$) and the peak value of the moment resisting rotation ($\mathbf{T_R}$), each averaged over five trials.

RESULTS

The peak traction coefficient during cutting movements averaged 0.74 ± 0.20 sd with a ± 95th percentile range of 0.41 to 1.07. ANOVA found significant surface, shoe and interaction effects ($p<0.01$) on both traction and resistance to rotation. In *post-hoc* analysis, AT had significantly lower translational traction and significantly higher resistance to rotation ($p<0.5$) than the other surfaces. The resistance to rotation of the in-filled surfaces (AP, NT) was not significantly different from that of NT.

Table 1: Surface Traction and Resistance to Rotation (Mean ± standard deviation of 6 shoe conditions).

		NT	AT	AP	FT
$\mathbf{T_T}$		0.97 ± 0.19	0.85 ± 0.21	1.09 ± 0.21	1.30 ± 0.15
$\mathbf{T_R}$	Nm	29 ± 11	41 ± 15	32 ± 7	27 ± 12

DISCUSSION

The finding that AT has less traction and greater resistance to rotation ($p<0.5$) than NT is consistent with previous research and the subjective reports of coaches and athletes. However, surfaces with granular in-fills appear to function differently showing significantly higher translational traction, and lower resistance to rotation, similar to that of natural turf. In contrast to NT and AT, the traction made available by in-filled surfaces (AP and FT) exceeded the 95th percentile requirements of football players in this study, reducing the probability of slipping during aggressive changes of direction.

The higher resistance to rotation of AT has been linked with non-contact and ACL injuries among football players. Since in-filled surfaces have more natural turf-like properties in this regard, epidemiological studies linking synthetic turf to higher injury rates may not apply to them. Whether the different traction properties result in different injury patterns remains for new epidemiological studies to determine.

The significant interaction of shoe and surface effects on traction suggests that appropriate shoe selection is an important element in risk reduction. Aggressively cleated shoes cannot be recommended because of their high resistance to rotation. Each of the six shoe types demonstrated adequate slip resistance on dry, in-filled surfaces, so shoe selection should be based on minimizing resistance to rotation by reducing the number and length of cleats.

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ACKNOWLEDGEMENTS

This study was supported by Fieldturf, Inc. and NIKE, Inc.