FOOTBALL PLAYING SURFACE COMPONENTS MAY AFFECT LOWER EXTREMITY INJURY RISK

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INTRODUCTION

Injuries to the lower extremity are among the most frequent injuries in all levels of sports and often account for more than 50% of reported injuries (Fernandez et al., 2007). While translational friction is necessary for high-level performance during any athletic contest, it is generally accepted that excessive rotational friction results in high forces being transmitted to vulnerable anatomic structures which may then precipitate ankle and knee injuries.

Although the torsional friction of shoe-surface interfaces has been documented, it has been limited by non-portable testing equipment (Cawley et al., 2006), forefoot only cleat engagement with the surface and small compressive loads (Lambson et al., 1996; Livesay et al., 2006), and an inadequate representation of modern day artificial turfs used in football (Cawley et al., 2003; Torg et al., 1974).

In the current study a mobile testing apparatus was developed to measure the torque produced at the shoe/surface interface on sixteen surface systems. It was hypothesized that the size and structure of the infill would affect the rotational resistance of cleated shoes.

METHODS

The testing method conformed to the ASTM standard method for traction characteristics of an athletic shoe-surface interface (F2333). A static compressive load of 1000N and a dynamic 90° external rotation were applied to shoes mounted on a rigid footform. Additionally, a compliant ankle joint was developed to better represent the *in vivo* loading at the shoe-surface interface.

Ten cleated football shoes were tested across 16 surfaces (Figure 1). Five trials were conducted on fresh sections of turf resulting in a total n=50 for each surface. Peak torques were compared for various shoe-surface interfaces with an ANOVA and SNK post-hoc tests, when appropriate. An additional two-way ANOVA of the GameDay surfaces was performed to determine the effect of infill and surface fiber structure.

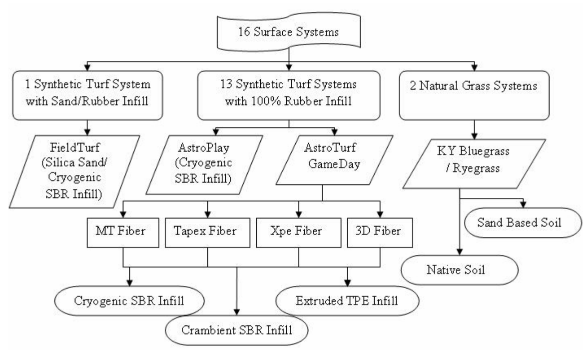

Figure 1: Description of the test matrix.

RESULTS AND DISCUSSION

Peak torques were significantly affected by playing surface (Figure 2). FieldTurf and the native soil natural grass system produced significantly different torques than all other surfaces. This was in agreement with the trend in a comparable study performed by Livesay et al (2006). In the GameDay analyses, all three infills were found to be significantly different from one another. The highest torques were associated with the cryogenic SBR infill. This infill consisted of fine crumb rubber particles capable of packing into a dense structure thought to increase a cleated shoe's resistance to rotation. The lowest torques were associated with the extruded infill, a larger rounded cylindrical particle made of TPE, incapable of packing as tight as the cryogenically processed infill. The open structure of the extruded infill layer was thought to reduce the frictional resistance.

The GameDay analyses also indicated significant differences in peak torque for fiber structure in the GameDay 3D surface. This was the only fiber structure which consisted of a nylon root zone. The nylon root zone leads to a reduction in the amount of infill required for a stable system, which may lower the compactness of the infill layer. This may limit cleat contact with the infill, thereby lowering the peak torque.

Similarly, the highest mean torque, seen in the FieldTurf system, may be due to the cryogenically processed rubber embedded in a fiber layout constructed with a gauge length of 3/4". The gauge length is the distance between rows of fiber on the artificial surface, and it was 3/8" on all other tested synthetic surfaces. A greater gauge length may lead to more cleat penetration into the infill and in the case of a densely compacted infill, higher torques.

SUMMARY/CONCLUSIONS

Generation of excessive torque at the shoe-surface interface was a factor of both the infill particle size and fiber spacing. The peak torques measured in the current study exceed injury levels based on cadaveric studies (Hirsch and Lewis, 1965). However, muscle stiffness has been shown to protect the lower extremity at similar torques (Shoemaker, 1988). Future studies using a more biofidelic ankle may help establish relationships between shoe-surface interfaces and the potential for ankle injury. Additionally, epidemiological studies of shoe and surface injury rates will be important for validating the injury risk potential of various shoe-surface interfaces.

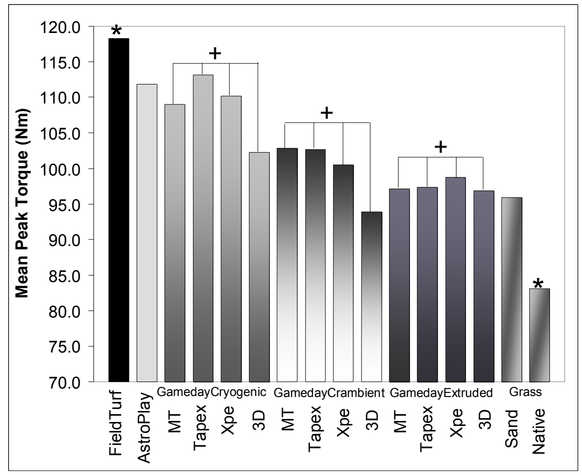

Figure 2: Mean peak torques
* significantly different from all systems.
+ significantly different from other infills.
(+ from GameDay analyses)

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