Effects of Playing Surface and Shoe Type on ACL Tears in Soccer Players

Melissa Mansfield
Advisor: Professor Bucinell

Introduction and Background

The knee is one of the most frequently injured joints in the body. Studies have shown there are over 150,000 anterior cruciate ligament (ACL) tears in the United States each year [1]. Approximately 70% of these injuries occur in non-contact situations where there are high compression forces and the knee is slightly rotated [2]. The ACL is a primary stabilizer of the knee during this motion and experiences high levels of torque. It is believed that ACL tears in soccer players are influenced by the type of shoe worn and the surface being played on.

Experimental Procedures

Testing was carried out on a MTS servo-hydraulic tension-torsion machine. A prosthetic lower limb fitted with various soccer cleats was mounted to a load cell. A metal fixture was designed to apply the load across the forefoot of the shoe and to keep the heel raised off the playing surface to comply with ASTM standards [3]. Playing surface samples were secured to a fixture allowing for precise and reproducible rotation as seen in Figure 1. A 225 lbs (1000 N) normal load and a 45° rotation at a rate of 45°/s were applied. Four types of soccer cleats were tested as seen in Figure 2. Five playing surfaces were tested: soil, thatched artificial turf with 1/2” blades and foam backing (Gym Turf), ten year old slit film artificial turf with rubber infill (Old Turf), and a new slit film artificial turf surface with 1” deep rubber infill (New Turf 1”) and 1.5” deep rubber infill (New Turf 1.5”). The artificial turf surfaces are shown in Figure 3. Five trials were conducted for each combination and the order in which the various shoe-playing surface combinations were tested was randomized to insure that factors that were not included in the study did not confound the data.

Results

It was determined that the playing surface had a greater influence of the measured torque than the shoe type. In addition, some artificial turf samples produced less torque and some produced more torque than the natural grass samples. Generally, the torque increased with playing surface in the following order: Gym Turf, Old Turf, Grass, New Turf 1.5” and New Turf 1.0”. The torque also increased when the shoe type was varied as follows: Round Studded, Turf Shoe, Bladed Studded and Soft Grounds. A summary of these results is represented by the plot in Figure 4.

Discussion

Although our experimental set-up fails to reproduce the complex forces that occur during an injury to the ACL, we assume that an increased amount of tension would be created in the ACL proportional to the increased torque between various shoe-playing surface combinations. The Grass samples stabilized the torque at approximately 550 in-lbs for all shoe types tested on it. This could have resulted from the grass surface’s ability to deform when it experiences torque greater than 550 in-lbs. Gym Turf and Old Turf experienced less torque than Grass which was due to the shoes ability to slip; however, this is not desirable when playing. The New Turf 1.0” samples experienced significantly more torque than Grass, but when the sample was filled with more rubber infill to make New Turf 1.5”, the resulting torque values were very similar to that of Grass. This shows that there are playing surfaces that have comparable torque to that produced on Grass; however, artificial surfaces do not have the ability to continuously deform.

References


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