FOOTWEAR TRACTION AND JOINT LOADING

John W. Wannop, Jay Worobets and Darren Stefanyshyn
Human Performance Lab, Faculty of Kinesiology, University of Calgary, Calgary, Canada, bwannop@kin.ucalgary.ca

INTRODUCTION

The knee and ankle joint are two of the most frequently injured joints in the body, with most of these being non-contact injuries. There have been several studies that have linked lower extremity injuries to the interaction between shoe and surface. Higher injury rates occurred on football and tennis surfaces with high coefficients of friction [1]. Also two-thirds of all non-contact soccer injuries may be due to excessive shoe-surface friction [2]. Increased loading due to high joint moments are thought to lead to joint injury [3]. However, few studies have looked at comparing frictional properties at the shoe surface interface with actual forces and moments occurring in the joints. Therefore the purpose of this study was to investigate how court shoes of different sole designs and traction properties influence knee and ankle joint loading**.**

METHODS

Two adidas court shoes of varying sole designs (Fig. 1) had their translational and rotational traction properties measured using a six degree of freedom robotic testing machine. All testing was conducted on a 60x90cm piece of sample track surface that was bolted to the robot.

Figure 1: Photographs of the smooth shoe (left) and the cleated shoe (right) soles.

Kinematic and Kinetic data were collected on 13 recreational athletes performing running v-cuts in the two different shoe conditions. Five trials per condition were collected with reflective markers placed on the right shank and shoe of each subject. Eight high speed cameras (240Hz) were used to record kinematic data, and a Kistler force plate (2400Hz) was used to record the kinetic data. The same sample surface that was attached to the robot was attached to the force plate for data collection. Joint moments were calculated with inverse dynamics and a paired t-test was used to compare the conditions (α=0.05).

RESULTS AND DISCUSSION

The coefficient of translational friction and the peak moment of rotation were both significantly higher in the cleated shoe compared to the smooth shoe (1.00 compared 0.87 and 23.87Nm compared to 16.12Nm respectively).

The cleated shoe had significantly higher peak ankle external rotation moments, peak knee external rotation moments, peak knee adduction moments and knee adduction angular impulse compared to the smooth shoe (Fig. 2). No other significant differences were seen between conditions.

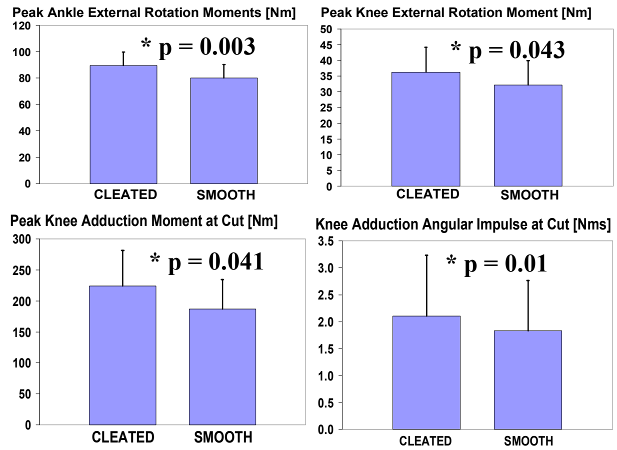

Figure 2: Ankle and knee joint moments compared between shoes (mean and standard deviation).

It has been shown that 90% of all ligamentous injuries to the ankle are caused by internal rotation [4] and the higher ankle joint loading in the cleated shoe may lead to increased ankle joint injury. It has been proposed that increased transverse and frontal plane knee moments are associated with running injuries such as patellofemoral pain syndrome [3], as well previous studies have shown that loads of 35-80Nm in the transverse plane, and 125-210Nm in the frontal plane can damage and rupture knee ligaments [5]. The cleated shoe increased these loads closer to the danger zone in the transverse plane, and above this danger zone in the frontal plane. These increases in knee loading may enhance the risk for ACL or other ligamentous injury.

As the traction of the footwear increased, the joint moments in the frontal and transverse plane of the ankle and knee also increased. Since there were only two footwear conditions tested, the exact nature of this relationship could not be determined. Future studies may attempt to determine if the relationship between shoe-surface traction and joint loading is linear. The cleated shoe had an increase in both translational and rotational traction; therefore it could not be determined which aspect of traction impacted joint loading. Future studies may investigate which aspect of traction have the largest influence on joint loading.

CONCLUSIONS

Increased shoe traction increases ankle and knee joint loading during a modified v-cut. These changes could have an affect on ankle and knee joint injury.

REFERENCES

1. Luethi S, & Nigg N, *Biomechanics IX-B*,149-153, 1985.
2. Ekstrand J, & Nigg B, *Sports Medicine*, **8**:56-62, 1989.
3. Stefanyshyn et al., *Proc. 4th Foot Biom. Symp.,* 89-87, 1999.
4. Stacoff et al., *Med Sci Sports Exerc*, **28**:350-358, 1996.
5. Seering W, et al., *J. Biomech*. 13, 785-794, 1980.