ISAKOS

International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine

9th Biennial ISAKOS Congress • May 12-16, 2013 • Toronto, Canada

Paper #122

Landing Leg Alignment Alters Tibial Slope Creating High-Risk for Non-Contact ACL Injury

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Summary:
This study demonstrates that limb alignment and the tibial slope in relation to the femur are critical components of the non-contact ACL injury.

Abstract:
Background:
Noncontact anterior cruciate ligament injuries (NC-ACLI) are typically sports related, involve expensive intervention with long recoveries, and result in many athletes losing knee function and quality of life. Recently, the importance of the intrinsic slope of the lateral tibial plateau (relative to the long axis of the tibia) has been debated as a risk factor for NC-ACLI (4). Yet, the average difference between control and NC-ACLI cohorts has been reported to be only 1.5°. We hypothesize that limb alignment and relative slope of the lateral tibial plateau (relative to the long axis of the femur) are key components of NC-ACLI and play a much larger role in NC-ACLI than the intrinsic tibial slope. Thus, the purpose of this study was to determine if these two factors during one-legged landing could be a contributing factor in NC-ACLI.

Methods:
For the first arm of the study 25 videotapes captured during an athletic event in which the athlete had a NC-ACLI, along with 25 control videotapes (matched for gender, sport, and activity prior to ground contact) were evaluated. The hip, knee, and ankle angle were measured along with the distance from the athlete's center of mass to their base of support (COM_BOS). Using these measures a safe (not resulting in a NC-ACLI) and provocative (resulting in a NC-ACLI) landing position was established. Following this initial arm of the study, 3D sagittal plane magnetic resonance (MR) images were acquired for a single knee in twenty-five non-injured athletes while the subject stood with the leg in one of three positions (safe, provocative, and exaggerated provocative). From the MR images the relative lateral tibial plateau slope (the angle between the lateral tibial plateau and the long axis of the femoral shaft) was measured. For both arms of the study the data were analyzed using a two-way repeated measures analysis of variance followed by a Tukey posthoc analysis. Significance was set at $p = 0.05$.

Results:
For the initial arm of the study, athletes experiencing a NC-ACLI (provocative position) landed flat-footed, with the hip flexed, knee extended, and the COM far posterior to their BOS (1, 5). In the safe position, athletes landed on their forefoot with the hip in a neutral position, the knee slightly more flexed, and the COM close to the BOS. For the MRI-arm of the study, it was found that the relative tibial slope was significantly greater in the provocative (85.6° ± 10.9°) and exaggerated positions (94.9° ± 9.2°) than in the safe landing position (72.8° ± 8.4°) (2,3).

Conclusion:
As the limb moves toward the provocative landing position, anatomic alignment contact characteristics places the knee at significant risk for NC-ACLI (3). The overall limb alignment, particularly the dorsiflexed foot, results in poor shock absorption, increasing the axial compressive force at the knee. This provocative position creates a situation

where the relative slope of the lateral tibial plateau is increased by an average of 12.8°, which favors sliding of the condyle on the tibial plateau instead of rolling and normal knee flexion. Not only is this difference in relative slope eight times greater than that reported for the intrinsic slope of patients with an ACL injury, it is a risk that athletes may be able to reduce through training. Future studies are needed to determine if neuromuscular interventions that focus on improving core stability and landing position can help reduce the incidence of NC-ACLI

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