Introduction: Residual anterior static laxity can be presented even with satisfying functional result after anterior cruciate ligament (ACL) reconstruction. Little is known about the variation of three-dimensional behavior of the ACL reconstructed knee of different residual static laxities during dynamic, functional loading. More recently, dynamic stereo X-ray (DSX) analysis has been suggested as a more accurate method of measuring knee joint motion during functional activities.

Methods: We retrospectively recruited subjects between the ages of 16 and 50 years undergoing unilateral, primary arthroscopic single bundle ACL reconstruction. Exclusion criteria included any prior substantial injury to the contralateral limb, substantial damage to other knee structures in the ACL-injured limb (eg. >50% partial meniscectomy) and a value of residual static anterior laxity higher than 5mm (indicative of possible graft failure).

Twenty-two subjects (37.1±11.2 years old; 8 women, 14 men) with 1-year follow-up data available were included in this analysis. Knee kinematics were assessed during downhill running 12 months after ACL reconstruction (bone-patellar tendon-bone or quadrupled hamstring tendon with interference screw fixation) using a 250 frame per second stereo radiographic system. Tibiofemoral translations/rotations and dynamic functional graft elongation were calculated as previously described. Residual static laxities of ACL reconstructed knees were measured using a KT-1000 arthrometer (MEDmetric Corp, San Diego, CA, USA), using manual maximum force. The patients were divided into 2 groups according to the side-to-side difference (SSD) in knee laxity. The “low-laxity” group (n=11) consisted of subjects with SSD laxity less than 3mm. The “high-laxity” group (n=11) had SSD laxity of 3 mm or more.

Results: No significant differences were found between limbs of the low-laxity group for any of the kinematic measures (Table 1). In the high-laxity group, reconstructed knees were significantly more externally rotated (mean difference 3.7°) across all subjects and time points (p=.023; Figure 1). No significant differences were found for the remaining kinematic variables (Table 1). The percentage of graft elongation was significantly smaller in the low-laxity group than in the high-laxity group (p=.038; Figure 2). However, there were no significant correlations between absolute knee laxities and kinematics data (p-value range 0.19-0.99; Table 2).

Discussion: Several studies have reported that ACL reconstructed knees were more externally rotated than normal contralateral knees during downhill running or under simulated muscle loads. The present study found this relationship was more likely to occur in subjects with side-to-side differences in knee laxity of greater than 3 mm. However, static testing of knee laxity, which assesses only passive response of the knee to a unidirectional load, cannot predict the dynamic behavior of the knee during functional tasks combining high-magnitude, complex loads.

Significance: Static laxity measures (such as the KT-1000) may have some value as a screening tool for identifying subjects more likely to have abnormal kinematics, which might place them at risk for degenerative joint changes. Static laxity, however, should not be considered as a surrogate measure for dynamic joint stability.

Acknowledgments: Data collection performed at the Bone & Joint Center, Henry Ford Hospital, Detroit, MI.

FIGURE LEGENDS
Figure 1: Increased external tibial rotation after ACL reconstruction for subjects in the high-laxity group (side-to-side difference of anterior laxity greater than 3 mm). ER, External Rotation; SSD, side-to-side difference (reconstructed side-contralateral side); round symbols, reconstructed side; square symbols, contralateral side. Asterisks indicate significant differences (p<0.05).

Figure 2: The percentage of graft elongation after heel strike for the high-laxity group (round symbols) and the low-laxity group (square symbols). Asterisks indicate significant differences (p<0.05).
TABLE LEGENDS

Table 1. Mean knee kinematics for subjects were calculated for the period from early to mid-stance phase of downhill running. Rigid-body motions of the tibia relative to the femur were determined for each limb for each of six kinematic variables: flexion/extension, internal/external rotation, abduction/adduction (valgus/varus), mediolateral translation, anteroposterior translation. SSD, side to side difference - value of reconstructed side minus that of contralateral side; KT-MM, the value tested from KT-1000 by anterior manual maximum.

Table 2. Absolute KT value of reconstructed side, Absolute KT value of contralateral side.

ORS 2014 Annual Meeting
Poster No: 0168