ISAKOS

International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine

10th Biennial ISAKOS Congress • June 7-11, 2015 • Lyon, France

Paper #98

Gait is a Poor Task Choice for Identifying Kinematic Deficits After ACL Reconstruction

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Summary:
When evaluating dynamic function of the ACL-reconstructed knee, tasks more biomechanically challenging than gait, such as downhill running, are necessary to reliably identify kinematic abnormalities.

Abstract:
INTRODUCTION: Abnormal kinematics after ACL injury and subsequent reconstruction may be associated with the development of osteoarthritis, even in a clinically stable knee. Clinical examinations (e.g. laxity, pivot shift) evaluate only passive structures under sub-physiological loading, and cannot predict dynamic function. While gait is the most common task for assessing knee function, the forces generated are well below those encountered during common sports activities. The goal of this study was to compare gait with a more demanding task, downhill running, for assessing knee kinematics after ACL reconstruction.

METHODS: 50 individuals (age 22±7.5 years, 31% female) were prospectively enrolled in an ongoing ACL reconstruction clinical trial. ACL reconstruction was performed using quadriceps tendon autografts and anatomical tunnel placement. Kinematic testing was performed 7±1.9 months after surgery using dynamic stereo x-ray (DSX) imaging. Biplane radiographic images were acquired for both reconstructed (RECON) and contralateral, uninjured (CONTRA) knees during level walking (1.3 m/s, 100 frames/s) and downhill running (3 m/s, 10% slope, 150 frames/s) on an instrumented treadmill. Tibio-femoral kinematics were determined using a model-based tracking algorithm that matched bone models (from subject-specific CT scans) to the radiographic images, with 0.6o/0.5mm precision. Differences between RECON and CONTRA knees and effects of task selection were assessed for anterior and medial-lateral translation, flexion, internal/external rotation and ab/adduction using a 3-factor repeated-measures ANOVA (limb*activity*time), with alpha=0.05.

RESULTS: The effect of activity was significant for A/P translation ($p=0.044$), M/L translation ($p<0.001$), flexion ($p<0.001$), and internal/external rotation ($p<0.001$). Significant interactions between activity and other factors (limb and/or time) were found for all five kinematic variables. During downhill running, RECON knees exhibited significantly greater medial translation, extension, external rotation and adduction than CONTRA limbs (all $p<0.01$). During gait, significant differences were found only for internal rotation (remaining p-values ranged from 0.14 to 0.70).

DISCUSSION: While the trends in limb-to-limb differences were somewhat similar between walking and downhill running, the changes were consistently larger across subjects during the more challenging task. Of particular note is the clearly increased adduction during running, which was not evident during gait. A study including only gait data

would have concluded that only internal/external rotation differed between the reconstructed and contralateral limbs, whereas during running all kinematic measures were abnormal.

Knee forces and torques during gait are dramatically less than those encountered during sports with high risk of ACL injury (e.g. soccer, basketball, volleyball). These findings suggest that higher-demand activities are necessary to reveal comprehensive differences in dynamic knee function that may be relevant to re-injury and/or development of osteoarthritis. Studies using gait to compare treatment methods may fail to identify meaningful differences, and a knee judged to be “normal” based on gait data may still exhibit significant and potentially damaging mechanics during more demanding activities. This raises significant doubts about the clinical impact of studies reporting no differences in gait kinematics between reconstruction techniques. Use of more demanding tasks is recommended, especially as advanced ACL reconstruction techniques are developed and our abilities for accurately measuring dynamic knee function continue to improve.