ACL Reconstruction Appears to Restore Patello-femoral Kinematics During Stair Ascent

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Introduction

Background

- ACL reconstruction (ACL-R) is the 6th most common orthopedic procedure in the United States, with more than 100,000 ACL reconstructions performed annually[1].
- The reported prevalence of patello-femoral (PF) osteoarthritis (OA) in patients following ACL injury and surgical reconstruction ranges from 16% to 36%[2].
- The etiology of PF OA following ACL injury is unclear.
- In order to assess the effects of ACL injury and repair on PF tracking, it is necessary to evaluate PF kinematics during dynamic functional loading.

Aim

- To evaluate the effects of ACL injury and reconstruction on PF kinematics.

Hypotheses

- PF motion during stair ascent is different between ACL-injured and uninjured contralateral knees and that ACL-R restores PF kinematics to match the uninjured contralateral knee.

Methods

Subjects

- Six subjects (include 2M, 4F, average age 29±11; range 21-42 years) signed informed consent and agreed to participant in this IRB approved study.
- All ACL-reconstructions were performed anatomically with either patellar tendon (n=3) or four strand hamstring auto graft (n=3). Fixation was achieved with aperture (patellar) or suspensory (hamstring) fixation.

Data Collection

- Participants were tested prior to and 3 months after surgery.
- CT scans (0.68x0.68x1.25mm) were obtained for each participant's knee.
- Three stair ascent trials were imaged using biplane radiographs collected at 100 frames/s for one second, two cameras were placed in a dual horizontal oblique configuration with an angle of 55° between them (Figure 1).

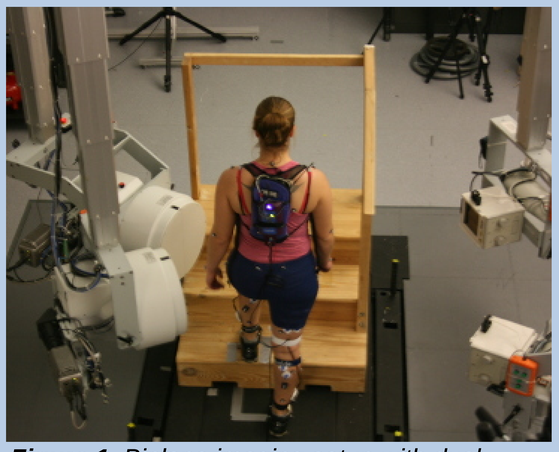


Figure 1. *Biplane imaging setup with dual horizontal oblique views.*

Data Processing

- Three-dimensional PF motion during stair ascent was determined with sub-millimeter accuracy using a volumetric model-based tracking process that matched subject-specific bone models obtained from CT to the biplane radiographs[3].

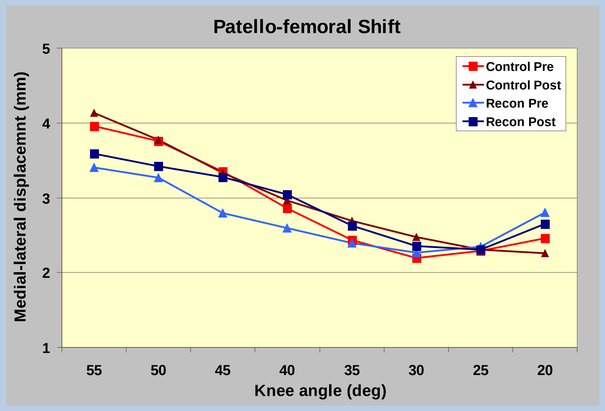
Figure 2. *Edge enhanced biplane radiographs showing step up activity.*

Data Analysis

- PF kinematics were determined as a function of knee (tibio-femoral) flexion angle and analyzed at 5 degree intervals (Figure 3 and Figure 4).
- The primary kinematic outcome variables were patellar shift and tilt (Figure 5).
- Repeated measures ANOVA was used to identify differences between ACL-injured and contralateral healthy knees prior to and after surgery, and within ACL-R knees pre to post-surgery.

Results

- Surgical repair of the ACL resulted in patello-femoral kinematics that were more similar to the contralateral knee.
- The ANOVA identified significant differences in shift between the injured and contralateral knee prior to surgery (p=.009) (Figure 3).
    - Post hoc testing did not identify significant differences at any particular knee flexion angle all (p >.510).
- Patellar tilt in the repaired knee looks more similar to that of the contralateral knee in comparison to the ACL deficient knee, however no significant main effects or interactions were identified (all p > .153) (Figure 4).



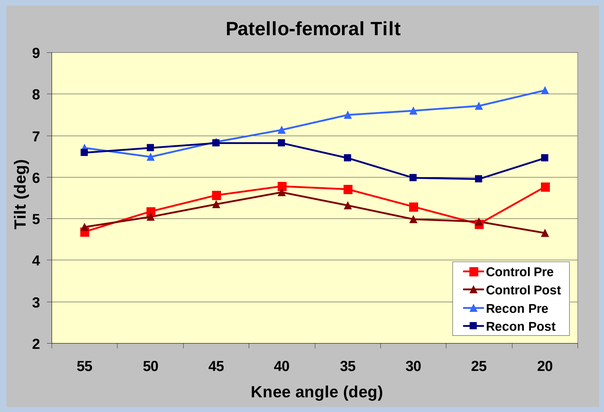


Figure 3 (left) & Figure 4 (right)*: Mean PF kinematics for control and reconstructed legs prior to (pre) and following (post) surgery.*

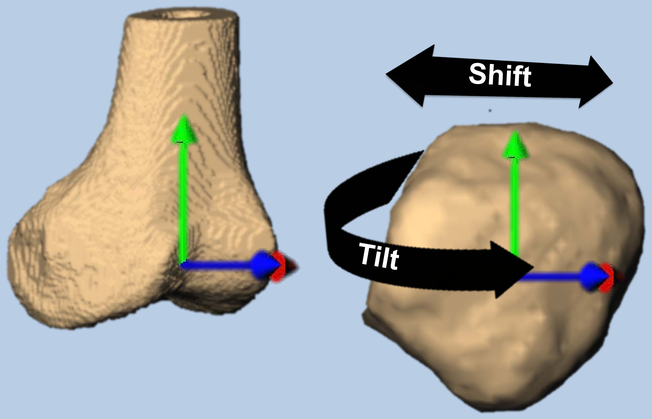


Figure 5*: Subject specific bone models created from CT scan showing the anatomic axis: X (red),Y (green), Z (blue), Patellar shift (medial-lateral translation) and tilt (defined as rotation about the patella's long axis)[4] was calculated using the patellar anatomic axis relative to the femur.*

Discussion

- This study was unable to detect any effect of ACL-injury and reconstruction on PF tilt or shift, however, PF kinematics were more similar to the contralateral side after surgery than they were before surgery.
    - This failure to detect statistically significant differences was likely due to the small sample size.
- Ongoing recruitment will allow comparisons between patellar tendon and hamstring graft patients.
- Long-term follow-up will be necessary to determine if these sort-term effects of surgery are maintained or amplified over time.

Significance

- PF kinematics during stair ascent appears to be partially restored 3 months after ACL-R.

References and Acknowledgement

1) Spindler and Wright, N Engl J Med, 2008. 2) Culvenor et al., Br J Sports Med, 2013. 3) Pitcairn et al., ASB Annual Meeting, 2017. 4) Bull AM et al. KSSTA, 2002.

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