Deformation behavior on the native and reconstructed ACLs in response to external knee loading is different

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Introduction

The primary function of the native anterior cruciate ligament (ACL) is transmitting tensile forces between the femur and tibia for stabilizing the knee. Within the ACL, location-dependent stress generated in response to the tensile force plays a role in providing joint stability. A one-to-one relation between stress and strain generally exists. For assessment of graft function in ACL reconstruction, comparison of the strain in the native and reconstructed ACLs is required.

Objective

Compare strain distribution in native and reconstructed ACLs in response to external knee loadings for assessment of ACL reconstruction procedure.

Materials & Methods

- Subjects: 16 fresh-frozen cadaveric knee joints (70.3 ± 10.5 years)
  (Intact: 10 knees, Reconstructed: 6 knees)

1. Biomechanical tests
   - 6-DOF robotic testing system
     - ➢ Loading conditions
       - ✓ 100 N of anterior tibial load
       - ✓ 5 Nm/10 Nm of internal/valgus torque (simulated pivot shift)
     - ➢ Measured strain in native ACL or reconstructed ACL at full extension and 30 degrees of flexion

2. Strain measurement
   - Rotational stereoscopic image method (Figure 1, [3])
     - ➢ Fiber strains measured in 20 regions (Figure 2)

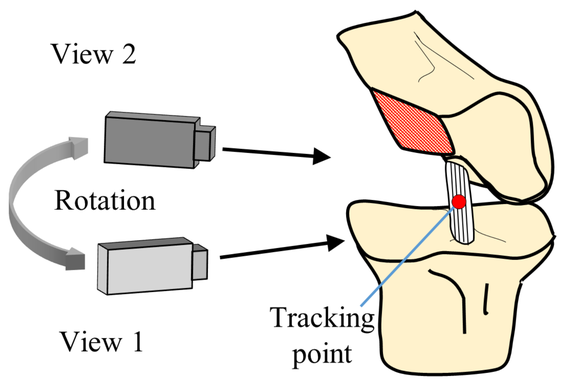

Figure 1: Schematic drawing of the rotational stereoscopic image method

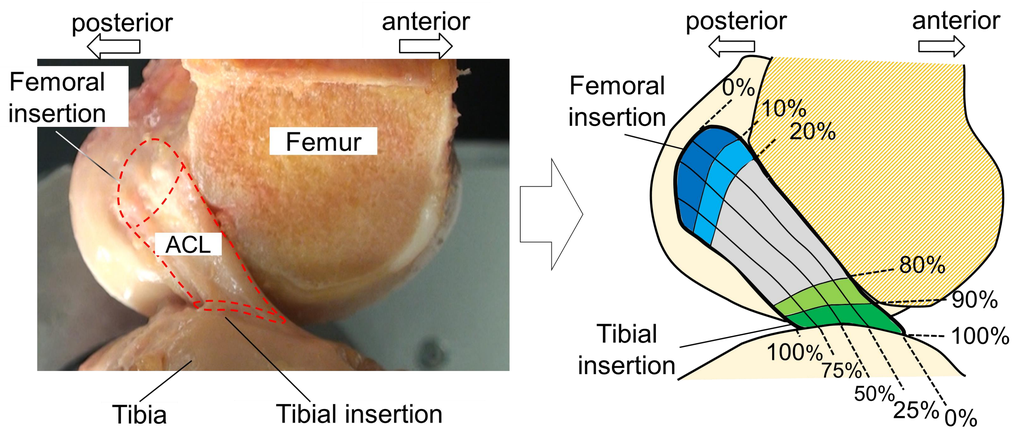

Figure 2: 20 portions on the ACL surface layer for the strain distribution (blue regions: femoral insertion area, green regions: tibial insertion area)

Statistics

- Willcoxon signed-rank test to compare the strain values in each region between loading conditions. P-values < 0.05 were considered statistically significant.

Results

Strain distribution in both native and reconstructed ACLs in response to external knee loading was

1. Similar at full extension
2. Different at 30 degrees of flexion especially in posterior fibers

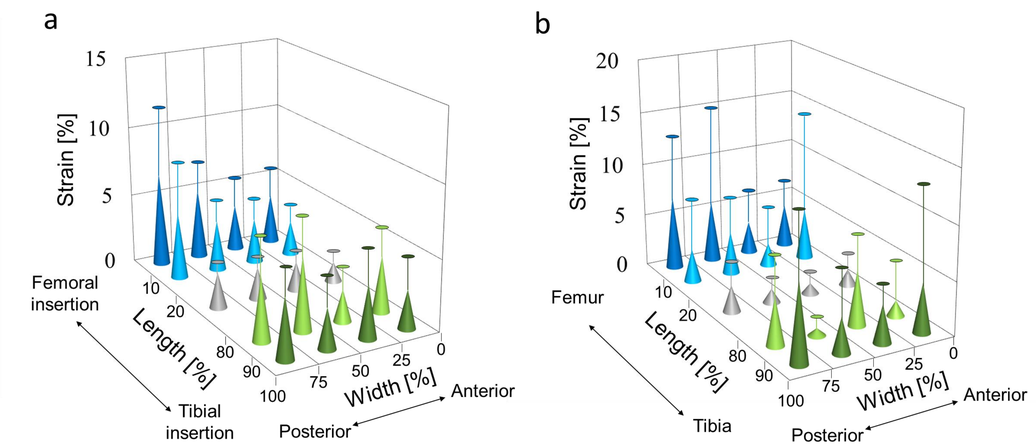

Figure 3 Strain distribution in native ACL (a) and reconstructed ACL (b) in response to 100 N of anterior tibial load at full extension (mean ± SD)

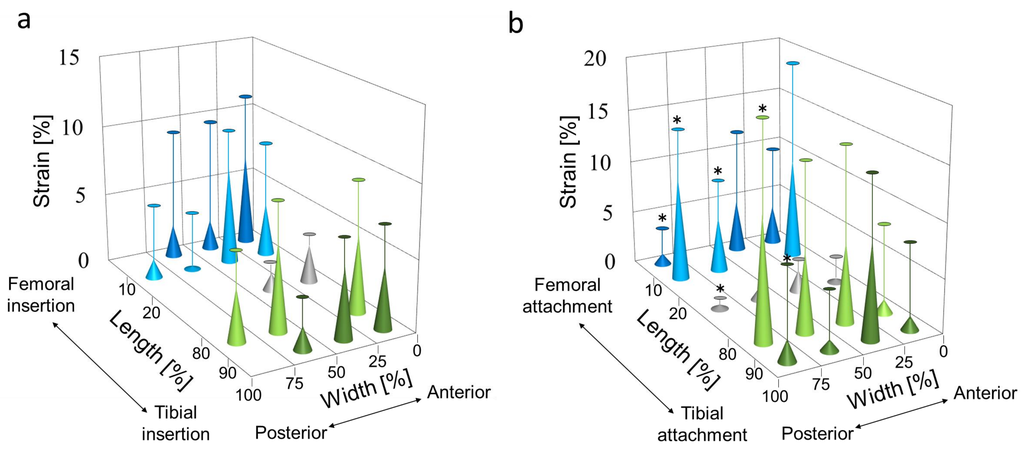

Figure 4 Strain distribution in native ACL (a) and reconstructed ACL (b) in response to 100 N of anterior tibial load at 30 degrees of flexion (mean ± SD, * p<0.05 vs native ACL)

Discussion

- Reconstructed ACL has different strain pattern compared to native ACL especially in posterior fibers in flexed knee.

Significance

- Reconstructed ACL mimicking more closely strain behavior of native ACL in posterior fiber may be beneficial for restoring native ACL function.

Acknowledgements
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References
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