Four-dimensional computed tomographic analysis of screw home movement in patients with anterior cruciate ligament deficient knee - a 3D-3D registration technique -

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Introduction

- The tibia externally rotates to the femur during the last stage of the knee extension motion, and it is called the screw home movement (SHM) [1].

- The Anterior cruciate ligament (ACL) contributes to SHM [2, 3].

However, little attention has been paid to difference between ACLD knee and intact (ACLI) knee in SHM.

To clarify the SHM in ACLD during dynamic knee motion using four-dimensional computed tomography (4DCT).
Methods

6 patients with a unilateral ACLD knee (5 females and 1 male, average age 28.3 yrs)

- Acquisition of Static CT scans
  In the static position, CT scan of the both limbs including whole length of the femur and tibia were performed.

- Acquisition of Static 4DCT
  Patients performed active knee extension within 10 seconds on each Limb.

320-detector CT scanner
(Aquilion ONE, Canon Medical Systems)
3D Surface Matching

From the static CT and 4DCT DICOM data, surface data of femur and tibia were reconstructed using Aviso®.

The partial femur surface in 4DCT was matched into the whole femur data in static CT using 3D-3D registration technique [4].
Femur

The coordinate system of the femur defined by the method of proposed by Sato et al [5].
The line connecting the center of the most medial point on the border of the medial tibial condyle (MC) and the most lateral point on the border of the lateral tibial condyle (LC) and the center of the tibia plafond and pointing to the upward was defined as the Y axis.

The line connecting the MC and LC was defined as the T axis.

The Z axis was the line perpendicular to both the Y axis and the T axis and pointing to the lateral. The X axis was defined as the line perpendicular to both the Y and Z axis pointing anteriorly.
Analysis of 3D Knee Kinematics

In each frame, knee flexion, knee abduction and knee external rotation angle were defined as the tibia angle with respect to the femur were calculated.

- As a statistical analysis, Wilcoxon signed rank-test was used to evaluate the relationship ACLD knee and ACLI knee.
- Values of $P < 0.05$ were considered significant.
No significant difference was found.
Results - Knee External rotation angle -

External rotation angle was significantly smaller on the ACLD side than on the ACLI side in 0-15 degrees of knee flexion angle.
Discussion

- According to previous study, the loss of SHM was observed in ACLD knee under static condition [6].

- The SHM may be influenced by muscle activation in knee joints of living subjects [7].

In vitro biomechanical studies might be difficult to accurately simulate the effects of both gravity and muscle contraction on the knee joint motion.

Dynamic knee motion can be analyzed using 4DCT in this study.
Conclusion

● SHM was significantly different between ACLD and ACLI.

● The dynamic knee motion was assessed using 4DCT with 3D-3D image registration technique.
References


