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A Simulation of the Optimal Femoral Insertion Site in Medial Patellofemoral Ligament Reconstruction

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Summary:
The study was undertaken to validate a new simulation system that could predict optimal femoral insertion of MPFL using preprogrammed conditions of graft length change in healthy twenty knees. The mean optimal insertion site determined by our system was close to the anatomical insertion site while the length change pattern at the anatomical insertion site was sufficient for our defined conditions.

Abstract:
Background:
To accomplish good clinical outcomes after Medial Patellofemoral Ligament (MPFL) reconstruction, the optimal femoral graft fixation site which shows a proper graft length change is important.

Purpose:
The study was undertaken to validate a new simulation system that could predict optimal femoral insertion of MPFL using preprogrammed conditions of graft length change.

Methods:
Twenty knees of ten healthy volunteers were assigned for this study (mean age 33y.o.). A CT scan was performed at knee extension for creating a bone surface model of the patella and the femur. Lateral radiographs of the knee and axial radiographs of patellofemoral joint at 30, 60, 90 and 120°of the knee flexion were used for creating three dimensional patellofemoral joint model by 3D-2D image matching at each knee flexion angle. A distance along femoral bone surface was measured between medial upper two third of patella to any points of medial bone surface of femur. To calculate optimal femoral insertion, following three conditions were programmed; (1) MPFL behaves near isometric (<5% strain) from 0°to 60°, (2) MPFL is most taut at full extension and (3) MPFL is slack more than 60° of the knee flexion. Every condition was projected in the femoral bone surface model and the area which fulfills all conditions was defined as optimal femoral insertion of MPFL. The positions of simulated femoral insertion were evaluated by proximal-distal ratio and anterior-posterior ratio which were measured anterior-posterior diameter of the medial femoral condyle as a standard. The mean simulated femoral insertion site was compared to anatomical femoral insertion site that was determined as 1cm distal to adductor tubercle. To verify validity of the preprogrammed conditions, length change of MPFL at anatomical femoral insertion was examined.

Results:
The mean proximal-distal and anterior-posterior position of simulated femoral insertion was located at 53.6 ± 5.4% and 37.7 ± 3.4%. The mean proximal-distal and anterior-posterior position of anatomical femoral insertion was

located at 54.4 ± 3.1% and 38.9 ± 3.7%. The Simulated femoral insertion site was almost identical to the previously reported anatomical insertion site. The length change of the simulated MPFL at anatomical femoral insertion site was sufficient for our three conditions.

Discussions:
In normal knees, the mean optimal insertion site determined by our system with the programmed conditions was close to the anatomical insertion site while the length change pattern at the anatomical insertion site was sufficient for our defined conditions, indicating the validity of our system. The simulation could be applied to patients with patellar instability as a preoperative planning for MPFL reconstruction.