Biomechanical Evaluation of the Isometry of Medial Patellofemoral Ligament Reconstruction Grafts Fixed at Non-Anatomic Femoral Insertion Points

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INTRODUCTION:

In MPFL reconstruction surgery, achieving perfect placement of the femoral tunnel intraoperatively is difficult. An understanding of the effects femoral tunnel malpositioning has on graft isometry is crucial to minimizing instability or overconstraint which leads to anterior knee pain, increased patellofemoral contact pressures, or graft failure. The purpose of this study was to identify differences in MPFL reconstruction graft isometry with femoral tunnel malpositioning, specifically evaluating isometry differences as the femoral position is moved anterior, posterior, proximal, and distal relative to the femoral radiographic landmark of the MPFL, Schottle's point.

METHODS: A biomechanical study evaluating 11 fresh frozen cadaveric knees was conducted. Non-elastic suture, used as an MPFL graft analogue, was anchored at Schottle's point with the knee at 30° of flexion, and at 5 mm and 10 mm anterior, posterior, superior, and distal to Schottle's point. A draw wire displacement sensor was used to evaluate length changes of the MPFL graft analogue through 0-120° of knee flexion. Knee flexion position was continuously measured using a motion tracking system. Pairwise t-tests with Bonferroni corrections were used to compare isometry between Schottle's point and non-anatomic femoral insertion points.

RESULTS:

Grafts placed at Schottle's point demonstrated mild anisometry with tightening in extension and loosening in flexion. Similarly, grafts placed distally and posteriorly also demonstrated tightening in extension and loosening in flexion. Grafts placed anteriorly and proximally demonstrated tightening in flexion. Mean and range of total draw wire excursion over full ROM across specimens is shown in Figure 1. The mean draw wire length was found to be greater with further displacement from Schottle's point in all directions but posterior. Pairwise comparisons relative to Schottle's point found grafts placed in the proximal or distal direction demonstrated significant differences in MPFL excursion, while grafts placed in the anterior or posterior direction did not (10 mm proximal: 0.36 (p=0.028), 5 mm distal: 0.14 (p=0.012), 10 mm distal: 0.22 (p<0.001)) (Table 1).

DISCUSSION AND CONCLUSION: In order to minimize the risk of graft tightening during knee flexion, if deviating from Schottle's point, it is safest to err posterior or distal in femoral tunnel position. Travel away from Schottle's point in the proximal or distal direction has the greatest effects on graft isometry. The greatest risk of overconstraint and graft tightening in flexion is seen with proximal placement of the femoral insertion point.

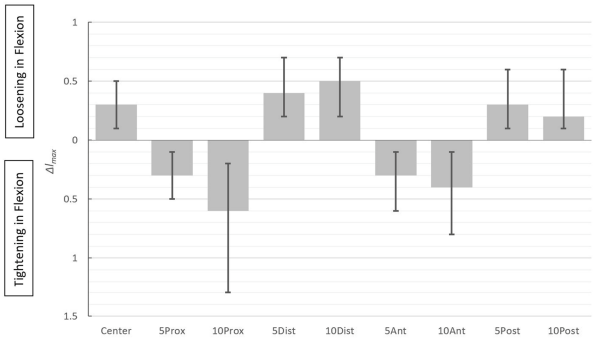

***Figure 1**:* Mean and range of total graft excursion, Δl_{max}, across the 9 experimental femoral insertion locations as a fraction of average graft length at 30°. Bars below the X axis indicate experimental insertion points with undesirable clinical flexion angle – tension relationships which result in graft tightening with knee flexion. Bars above the X axis indicate experimental insertion points with desirable clinical flexion angle – tension relationships which result in graft loosening with knee flexion.

MPFL Excursion of the 8 Off-Center Locations Relative to Schottle's Point

Location (mm)	Difference (95% CI)	Unadjusted p-value	Bonferroni p-value
5 Proximal	0.01 (-0.08, 0.09)	0.8849	1.000
10 Proximal	0.36 (0.15, 0.58)	0.0035	0.028
5 Distal	0.14 (0.07, 0.21)	0.0015	0.012
10 Distal	0.22 (0.15, 0.30)	<.0001	<.001
5 Anterior	0.02 (-0.04, 0.09)	0.4102	1.000
10 Anterior	0.16 (0.03, 0.28)	0.0189	0.151
5 Posterior	0.00 (-0.09, 0.09)	0.9406	1.000
10 Posterior	-0.01 (-0.10, 0.09)	0.8971	1.000

***Table 1**:* Pair-wise comparisons of Δl_{max} of MPFL excursion for the 8 off-center locations relative to Schottle's Point. Difference = $\Delta l_{max,\ location} - \Delta l_{max,\ center}$.