MPFL GRAFT TENSIONING TO TREAT PATELLAR INSTABILITY RELATED TO PATELLA ALTA: DYNAMIC SIMULATION

Travis Jones, MD¹, Kerwyn C. Jones, MD², John J. Elias, PhD¹

¹Cleveland Clinic Akron General, OH, USA, ²Akron Children’s Hospital, OH, USA

Background: Medial patellofemoral ligament (MPFL) reconstruction is a popular treatment for lateral patellar instability. For knees with patella alta, however, tibial tuberosity distalization is the most common approach due to concerns about graft tensioning. A MPFL graft is tensioned intra-operatively to prevent lateral subluxation without over-constraining the patella by allowing some translation.

Purpose: To analyze the effects of MPFL reconstruction on lateral tracking and cartilage pressure for knees with patella alta using dynamic simulation of knee function.

Methods: Knee function was simulated with 8 multibody dynamic simulation models (RecurDyn) constructed from 3.0 T MRI scans of subjects being treated for recurrent patellar instability. The models were validated in previous studies and included ligaments, tendons, and retinacular structures represented by tension-only springs (Fig1). Four models displayed patella alta; the remaining 4 models were made to reflect patella alta by lengthening the springs. Forces were applied to simulate a dual limb squat from 0° to 90°. Motion was simulated in a pre-operative condition and for three MPFL graft tensioning techniques (1.0, 0.5, and 0 patellar quadrants of lateral translation). The maximum bisect offset index during flexion was used as a measure of patellar instability and the maximum pressures applied to patellar cartilage (lateral, medial) as measures of the risk of overloading cartilage. Statistics were used to compare the parameters with significance set at p < 0.05. Post- and pre-operative maximum bisect offset index were also correlated.

Results: MPFL reconstruction with 0.5 and 0 quadrants of allowed lateral translation significantly decreased the maximum bisect offset index compared to the pre-operative condition, but not for 1.0 quadrants (Table 1). MPFL reconstruction did not significantly influence the maximum pressure applied to medial or lateral cartilage. The maximum post-operative bisect offset index was significantly correlated with the pre-operative bisect offset index for 1.0 and 0.5 quadrants of lateral translation allowed ($r^2 = 0.80$, 0.65, and 0.48 for grafts allowing 1, 0.5 and 0 quadrants of translation, respectively).

Conclusion: For knees with patella alta, the influence of MPFL reconstruction on patellar tracking varied with the allowed patellar translation during graft tensioning. None of the graft tensioning conditions significantly decreased the maximum lateral pressure or increased the medial cartilage pressure. Significance: The graft tensioning process for MPFL reconstruction typically allows some lateral patellar translation to avoid overconstraining the knee. For knees with patella alta, reducing the allowed lateral translation seems to limit maltracking without overconstraining the knee.
### Table 1: Average (± standard deviation) output parameters (*p<0.05 compared to pre-op)

| Parameter                    | Pre-op   | MPFL 1.0 | MPFL 0.5 | MPFL 0  |
|------------------------------|----------|----------|----------|---------|
| Maximum bisect offset        | 0.92±0.18| 0.86±0.17| 0.81±0.14*| 0.74±0.13*|
| Maximum lateral pressure     | 4.2±0.9  | 3.9±0.9  | 3.7±0.9  | 3.8±1.0 |
| Maximum medial pressure      | 3.0±1.7  | 3.4±1.2  | 3.4±1.4  | 3.7±1.2 |

Fig1: Dynamic simulation of knee flexion and the patellofemoral pressure distribution.