

## THE EFFECT OF TIBIOFEMORAL LOADING ON PROXIMAL TIBIOFIBULAR JOINT MOTION

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### INTRODUCTION

The posterolateral part of the knee joint has been largely ignored in past biomechanical studies. Specifically, little is known about the proximal tibiofibular joint (PTFJ) and its relationship to overall knee joint mechanics.

The proximal fibula serves as the insertion for several anatomic structures integral to knee stability – the lateral collateral ligament (LCL), arcuate ligament, posterolateral capsular complex, and biceps tendon all insert onto the proximal fibula. A recent study has shown that the force in the lateral-collateral ligament is greatest during external tibial rotation loading conditions [1].

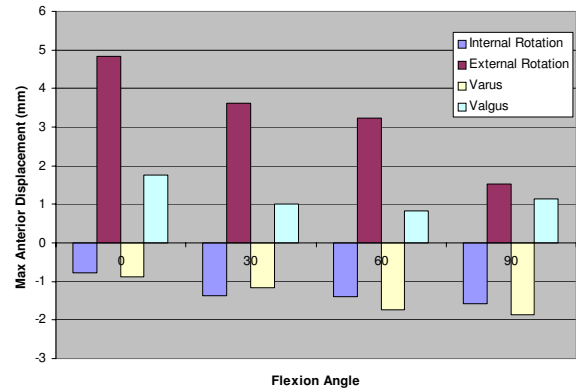
We hypothesize that these same loading conditions could cause motion in the PTFJ. Excessive motion in this joint may contribute to the development of posterior-lateral knee pain..

### METHODS

Fresh-frozen cadaveric knee specimens were tested with the knee joint fully intact. The tibia was mounted vertically on a six degree of freedom force/torque sensor (SI-2500-400, ATI Industrial Automation, Apex NC) mounted to the floor. The distal fibular connections to the tibia and talus were undisturbed during dissection and subsequent testing. Two reflective markers were mounted on pins driven into the tibial plateau and the head of the fibula at the proximal tibiofibular joint, respectively. Motion was recorded by a video camera (DALSA model #CL-C3 running Epix FrameGrabber software) at 10 frames per second. Load cell data was synchronized to the video data and recorded at 10 Hz.

The knee joint is then subjected to manual loading conditions in each of four flexion angles (0, 30, 60, 90 degrees as established by a manual goniometer). Varying loads were applied manually to a “handlebar” on the femur, in combination with a static compressive load of 40 lbs of compressive load to simulate weight bearing [2]. At each flexion angle, four discrete loading conditions were generated by the operator: varus, valgus, internal tibial rotation, and external tibial rotation. Peak moments were 20 Nm for internal-external rotation and 50 Nm for varus-valgus. To ensure standardized loading conditions, there is real time visual feedback of force/torque data.

Video images were digitized using custom Matlab software. The tibia marker was used as a reference and the displacement of the fibula marker, relative to its initial position, was computed to quantify PTFJ motion. Results from one typical specimen are presented.



**Figure 1:** Maximal anterior-posterior joint motion for the sixteen knee joint loading conditions. Positive values represent an anterior translation of the fibular head relative to the tibia.

### RESULTS AND DISCUSSION

Initial results indicate that there is significant tibiofibular joint motion. The greatest motion was seen in external rotation near full extension when we see the fibular head displacing more than 4 mm anteriorly relative to the tibia, at an external rotation moment of about 20 Nm. Results for all loading conditions are summarized in Figure 1.

The tibiofibular joint is a robustly encapsulated synovial joint that has very flat and smooth articular surfaces which do not mechanically resist translation. Considering the size of the joint itself (~7mm across), a translation of 4mm is substantial, and in the paradigm of any other joint would have to be considered traumatic.

While the applied rotation torques were much larger than typically seen during gait, the load-displacement relationship was nonlinear such that 2 mm displacement was already seen at 10 Nm external rotation torque which is more representative of in vivo loading. Frontal and transverse plane torques were only applied in isolation, and not combined. Because of the LCL, we would expect the PTFJ to be especially sensitive to external rotation in combination with varus loading. Further studies will investigate these interactions.

### REFERENCES

1. LaPrade, *Am J Sports Med*, Vol 32, No. 7, 2004.
2. Mizuno et al., (2004) Orthopaedic Research Society 50th Annual Meeting, Paper #240.

### ACKNOWLEDGEMENTS

We acknowledge Stryker Corporation and NIH (1P30AR050953) for financial support.