**The Effect of Torsional Moment on the Posterolateral Rotatory Instability of a Lateral Ligament Deficient Elbow: A Novel Biomechanical Modeling and *In Vitro* Investigation**

## Purpose

Previous biomechanical studies of lateral collateral ligament (LCL) injuries and their surgical repair, reconstruction and rehabilitation have primarily relied on gravity effects with the arm in the varus position. The application of torsional moments to the forearm manually in the laboratory is not reproducible; hence studies to date likely do not represent forces encountered clinically.

The aim of this investigation was to develop a new biomechanical testing model to quantify posterolateral stability of the elbow using an *in vitro* elbow motion simulator.

## Method

Six cadaveric upper extremities were mounted in an elbow motion simulator in the varus position. A threaded screw was then inserted on the dorsal aspect of the proximal ulna and a weight hanger was used to suspend 400g, 600g, and 800g of weight from the screw head to allow torsional moments to be applied to the ulna. An LCL injured (LCLI) model was created by sectioning of the common extensor origin, and the LCL.

Ulnohumeral rotation was recorded using an electromagnetic tracking system during simulated active and passive elbow flexion with the forearm pronated and supinated. A repeated measures analysis of variance was performed to compare elbow states (intact; LCLI; and LCLI with 400g, 600g, and 800g of weight).

## Results

During active motion, the LCLI state with or without weight resulted in a significant increase in external rotation (ER) of the ulnohumeral articulation compared to the intact state (pronation: LCLI P=.021, 400 g P=.018, 600 g P=.015, 800 g P=.013; supination: LCLI P=.015, 400 g P=.001, 600 g P=.001, 800 g P=.001). Comparing different injured states, we found that increasing torsional moments increased elbow instability with the forearm both pronated and supinated (pronation: P=.013; supination: P=.004).

During passive motion, there was no significant difference in ER of the ulnohumeral articulation between the LCLI without weight and the intact state (pronation: P=.265; supination: P=1.000). However, addition of weights resulted in a significant increase in ER of the ulnohumeral articulation compared to the intact state (pronation: 400 g P=.036, 600 g P=.001, 800 g P=.0001; supination: 400 g P=.005, 600 g P=.003, 800 g P=.001). Comparing different injured states, we found that increasing torsional moments increased elbow instability with the forearm both pronated and supinated (pronation: P=.000; supination: P=.000).

## Conclusion

This investigation demonstrates that the application of even small amounts of torsional moment on the forearm with the arm in the varus position exacerbates the posterolateral rotatory instability of an LCL deficient elbow. During clinical examinations for PLRI and when performing biomechanical studies of LCL injury, repair and rehabilitation, the application of an external torsional moment to the forearm should be considered to detect more subtle instability than are detectable with varus gravitational effects alone. Moreover, our results suggest that the weight of splints, braces and casts used in the management of patients with LCL deficiency may exert torsional moments on the unstable elbow and exacerbate their instability.