MEDIAL ULNAR COLLATERAL LIGAMENT INJURIES OF THE ELBOW: A COMPARISON ON STRETCHING AND CUTTING MODELS

Fitzpatrick, M J; Udall, J H; McGarry, M H; Leba, T; +Lee T Q
Orthopaedic Biomechanics Laboratory, Long Beach VA Healthcare System, University of California, Irvine
tqlee@med.va.gov

INTRODUCTION:

The elbow of the throwing athlete is subjected to repetitive forces that are responsible for injuries to the medial ulnar collateral ligament (MUCL) among other structures. Modeling of this injury in the past has been through sectioning studies in which the medial structures of the elbow are sequentially cut. Since this is often a repetitive stress injury, we believe a more accurate model of this injury is a stretch of the medial structures. The hypothesis of this study is that an elbow model that stretches the medial structures more accurately simulates the injuries that occur in the thrower's elbow. Therefore, the objective of this study was to develop a thrower's elbow model for MUCL stretch injuries then biomechanically evaluate and compare this model.

METHODS:

Six cadaveric elbows were prepared and tested using a custom device that allowed varying positions of forearm rotation and elbow flexion. The forearm skin and subcutaneous tissue were removed, leaving the musculature and ligamentous structures intact. A Tekscan (Tekscan Inc, South Boston, MA) was used to measure the contact pressures in the radiocapitellar joint. The elbows were tested in the following positions: flexion angles of 30, 60, 90, 120 degrees, and forearm rotation of neutral and 70 and 30 degrees of supination and pronation. Three different valgus torques were applied to the forearm: forearm weight, forearm weight plus 0.75Nm, and forearm weight plus 1.5Nm. The medial ulnar collateral ligament was tested in the intact, stretched, and cut states. To create the stretched medial structure condition, the elbow was stretched until the valgus angle increased 50% to that of the initial varus-valgus angle. The stretching was done at both 30 and 90 degrees elbow flexion with valgus loads applied to the forearm.

Valgus angulation, radiocapitellar pressures, and ligament length were compared between the models with the intact, stretched, and cut MUCLs. Statistical analysis was performed using repeated measures ANOVA with a tukey post-hoc test and $p < 0.05$.

RESULTS:

Both the stretching and cutting models demonstrate increased valgus laxity compared to the intact elbow [intact 7.4 ± 1.6 degrees, stretched 8.7 ± 1.1degrees ($p < 0.06$) , cut 17.3 ± 2.1 degrees ($p < 0.004$)] (Figure 1). Both the stretching and cutting models demonstrate increased radiocapitellar pressures compared to the intact ligament [intact 0.02 ± 0.03 MPa, stretched 0.25 ± 0.05 MPa ($p < 0.22$), cut 0.45 ± 0.08 MPa ($p < 0.001$)] (Figure 2). The cutting model demonstrates higher valgus angles and radiocapitellar pressures than the stretching model at all positions of flexion/extension and pronation/supination. The intact, stretch, and cut ligament models demonstrate increasing valgus angulation as the forearm is positioned from pronation to supination (valgus angle in the intact ligament increases from 5.3 degrees to 9.5 degrees, compared to increases from 6.5 to 10.6 degrees in the stretched ligament, and 15.6 to 18.7 degrees in the cut ligament states). In the model with the intact ligament, radiocapitellar pressures were highest at 70 degrees pronation (0.22 MPa) and 70 degrees supination (0.20 MPa) versus the stretched and cut models where the highest radiocapitellar pressures were seen at 30 degrees pronation and neutral. While the stretching and intact models showed decreased radiocapitellar pressures when going from extension to flexion (0.3 MPa and 0.24 Mpa at 30 degrees flexion versus 0.18 MPa and 0.14 MPa at 120 degrees flexion), the cutting model showed the opposite trend with increasing radiocapitellar pressures with increased flexion of the forearm (0.37 MPa and 0.45 Mpa at 30 and 120 degrees of flexion). Both the cut and stretched models demonstrated increased valgus angle as the elbow was positioned from flexion to extension (stretch 10.6 and 6.9 degrees at 30 and 120 degrees flexion respectively, verses the cut, 18.4 and 14.4 degrees at 30 and 120 degrees flexion).

CONCLUSIONS:

Both the stretching model developed in this study and the cutting model simulates an increase in valgus laxity and radiocapitellar pressures during valgus loading. The magnitude of the changes in valgus angle and radiocapitellar pressure are less in the stretching model compared to the cutting model. Valgus angle in the thrower's elbow model is dependent on the position of the elbow in flexion and extension as well as pronation and supination. The two models behave differently with regards to patterns and magnitude of radiocapitellar pressure and magnitude of valgus angulation.

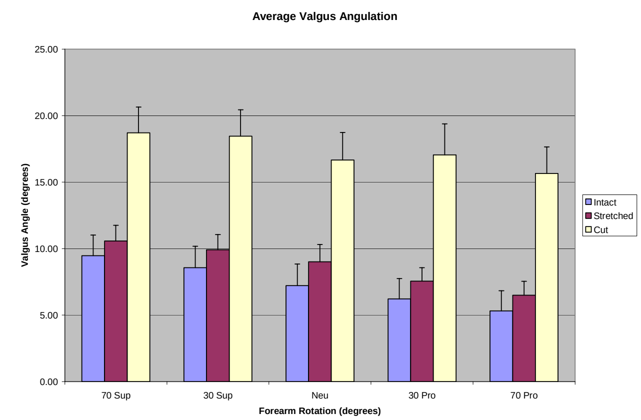

Figure 1: Average valgus angulation for each forearm rotation position.

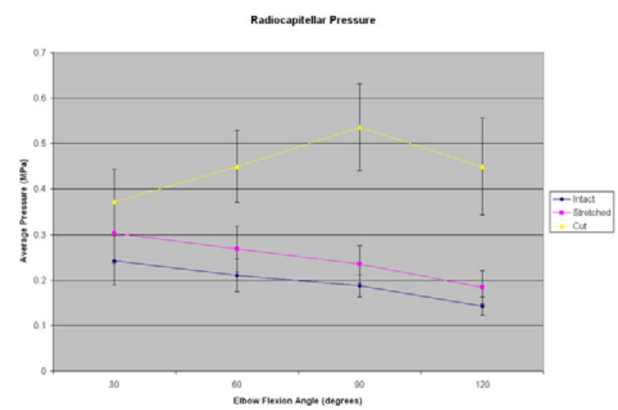

Figure 2: Average radiocapitellar pressures for each flexion angle.

REFERENCES:

1) Pomianowski S, O'Driscoll SW, Neale PG, et al. The effects of forearm rotation on laxity and stability of the elbow. Clin Biomech 2001; 16:401-407.
2) Morrey BF, An KN. Articular and ligamentous contributions to the stability of the elbow joint. Am J Sports Med. 1983; 11:315-9.

Acknowledgements: VA Rehab R&D and Medical Research