

How Does Capsule Disorganization Correlate To The Range Of Motion In Contracted Elbows

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Introduction:

Stiffness is a common sequelae of trauma to the elbow joint. Previously, it has been demonstrated that contracted elbow capsules are thicker than cadaveric controls and lack normal collagen organization. Currently, there is little data on the degree of disorganization observed in these contracted capsules. In this study, we use a semi-quantitative grading system, previously validated in tendinopathies, to grade the level of disorganization and correlate this with elbow motion loss. We hypothesized that a more disorganized collagen structure would lead to increased range of motion.

Methods:

Twenty-three whole anterior elbow capsules from patients with elbow contractures that required surgical intervention were collected via an open elbow release surgery and were stored in 10% formalin. Measurements of each specimen's length, width and thickness were recorded. Each specimen was divided into four portions, two from the lateral side and two from the medial side. The medial and lateral portions were oriented at 90 degrees to each other, embedded in paraffin, sectioned and H&E stained. The tissue sections were graded using the modified Movin scale. Range of motion data was collected at three time points: pre-operative, immediately postoperatively, and at the final follow-up appointment and this data was correlated with the modified Movin scale. Pearson's correlation, a two-tailed student's t-test, and an ANOVA were utilized via Excel (Microsoft Excel 2013) and SPSS (IBM SPSS Statistics 22). Our study received IRB approval and informed consent was obtained.

Results:

Each of the 23 specimens was assigned a modified Movin scale score equal to the average of the medial and lateral scores. There was no significant difference between the two scores based on laterality (12.9 vs. 13.1, $p=0.69$). All capsules were scored as either abnormal or markedly abnormal. The average thickness (5.2cm) was comparable to previously published work (4.0cm, $p=0.47$) and was significantly greater than cadaveric controls of normal capsules (0.6cm, $p=0.01$) [1]. Average follow up was 6.9 months. Patients showed significantly increased extension at both postoperative measurements when compared to the preoperative measurement after the capsulectomy ($p=0.001$ and $p=0.00002$). When the preoperative flexion-extension range of motion was correlated to the modified Movin subscore for collagen arrangement, a strong positive correlation was observed (Figure 1, $r=0.6$). ANOVA analysis of the pre-operative extension deficit and the structure score was significant ($p=0.0138$). The pre-operative pronation-supination range of motion was also positively correlated with modified Movin subscore score (Figure 2, $r=0.54$) and ANOVA analysis confirmed the significance of this finding ($p=0.034$).

Discussion:

Our data demonstrated that the elbow capsule becomes thicker and abnormally arranged in elbow contracture. Moreover, there was a significant positive correlation between a modified Movin scale score and elbow range of motion in both the flexion-extension and pronation-supination arcs, implying that a more disorganized collagen structure (i.e., higher modified Movin scale score) correlated with more motion. Conversely, a loss of extension and pronation-supination range of motion was correlated with a more normal (linear) collagen fiber arrangement (i.e., lower modified Movin scale score). One interpretation of these results is that a more disorganized capsular structure conveys a more favorable motion arc in the early stages following injury. As the newly laid collagen becomes more disorganized and the modified Movin score increases, it becomes more beneficial for that collagen to be more wavy and deformable as a means of counteracting the fact that bundles are being laid down haphazardly. Thus, patients with a higher modified Movin score would be expected to have greater elbow motion in the early collagen maturation stage where crosslinking is at minimum. Our study is limited by a smaller sample size and that we only assessed the anterior capsule from our specimens.

Significance/Clinical Relevance:

Our data is useful in furthering the understanding of the molecular and cellular level of elbow contraction and how it affects range of motion clinically.

References:

- [1] Cohen MS, Schimmel DR, Masuda K, et al. Structural and biochemical evaluation of the elbow capsule after trauma. J Shoulder Elbow Surg 16 (2007): 484-90.

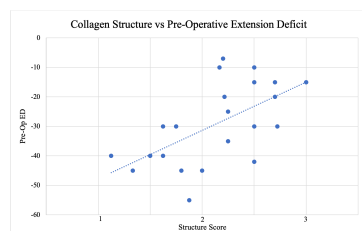


Figure 1: Pre-operative extension deficit (ED) vs. Movin sub-score of structure, which demonstrates that the more organized a sample was in terms of structure, the larger extension deficit that patient had ($r=0.6$).

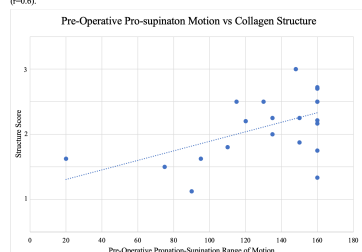


Figure 2: Pronation-supination arc of motion vs. Structure score, which demonstrates that as the structure score becomes more abnormal (has a higher Movin score), the more motion the patient has in the pre-supination arc ($r=0.54$).