Introduction: Rotator cuff tears are a common cause of pain and disability in the adult shoulder (1). While operative management has previously demonstrated good clinical results, the ability of rotator cuff tears to heal to bone has been questioned due to the presence of persistent rotator cuff defects on follow-up imaging. For example, Harryman et al. (2) have reported that when repairing rotator cuff tears involving the supraspinatus and infraspinatus tendons, up to 50% of rotator cuff repairs demonstrated persistent rotator cuff defects on follow-up ultrasound and the presence of a defect correlated with a poorer clinical result.

The purpose of this study was to determine at an mRNA level the response following tearing of the human rotator cuff. We evaluated a subset of extracellular matrix molecules, which have previously been identified in other models of healing as potential players in soft tissue healing (3).

Methods: Tissue was obtained from 10 patients undergoing rotator cuff repair for full thickness rotator cuff tears. The mean age of the patients was 59.2 +/- 4.4 years. Two patients had medium sized tears (1-3 cms), five patients had large tears (3-5 cms) and three patients had massive tears (>5 cms). The mean time from the onset of symptoms to surgery was 14.6 months (range: 2 – 60 months). Nine of ten patients had a traumatic onset to their symptoms. All patients had failed conservative management of their shoulder.

During surgery, rotator cuff tissue was harvested from the tear margins and bursal tissue was harvested by sharply dissecting the bursa immediately adjacent to the tear site. Care was taken to ensure that there was no cross-contamination of tissue from either structure. In addition, tissue was obtained post-mortem from donors with no evidence of shoulder surgery or rotator cuff disease on gross examination. The mean age of the cadaveric tissue was 74 +/- 7 years.

Reverse transcriptase polymerase chain reaction (RT-PCR) was performed as previously described (3) for type I collagen, type II collagen, type III collagen, biglycan, decorin and aggrecan and normalized to the housekeeping gene GAPDH using human-specific primer sets. The ethics review board from our institution approved the study. Statistics were performed using one way ANOVA with a post-hoc Tukey test to determine significant differences between groups.

Essential Results: All of our no RT controls were negative. The mRNA results for the collagens and proteoglycans are summarized in Figure 1 respectively.

Figure 1: Type I, II, and III Collagen mRNA Levels In The Bursa and Rotator Cuff Margin Of Normal And Torn Rotator Cuffs.

Results demonstrated that there was a significant increase in type I collagen mRNA levels in the bursa and rotator cuff of patients with rotator cuff tears when compared to normal controls (p<0.02). There was no significant difference in the proteoglycan mRNA levels in the bursa.

Discussion: This study demonstrated that both the bursa and rotator cuff margin of patients with full-thickness rotator cuff tears have significant changes in mRNA levels for the matrix molecules evaluated. Furthermore, the changes are both molecule and tissue dependent. While, both tissues demonstrated significant increases in type I and type III collagen mRNA levels, only the rotator cuff demonstrated changes in proteoglycan mRNA levels (increased biglycan and aggrecan mRNA levels, decreased decorin mRNA levels). Interestingly, the pattern of mRNA changes demonstrated in the rotator cuff is strikingly similar to mRNA changes demonstrated in animal models of ACL (4) and MCL (3,4) healing and in the stumps of torn human ACLs (5,6). Thus there appears to be a generalized “healing” response following injury to dense connective tissues with respect to mRNA levels.

Importantly, our results are in contrast to reports by Uthoff et al. (7,8), which have stressed the importance of the bursa as the major contributor to rotator cuff healing. While our results do demonstrate that the bursa can contribute to rotator cuff healing, it does appear that the intrinsic capacity of the rotator cuff tendon to heal is preserved and that this is maintained even in chronic rotator cuff tears more than 60 months following injury. Thus, while it is unclear what the relative contribution of each tissue is to rotator cuff healing, it does appear that both the bursa and rotator cuff tendon can contribute to rotator cuff healing following repair.

Interestingly, there was also an increase in aggrecan mRNA levels in the rotator cuff margin of patients with torn rotator cuffs. While aggrecan has been identified in rotator cuff tendon tissue (9), it is more typical of tissues under compressive rather than tensile loads. During tearing of the rotator cuff, there is a disruption of the normal force couples about the shoulder, which can lead to proximal migration of the humerus and obligate compression of the torn rotator cuff (10). Thus, the increased aggrecan mRNA levels may be secondary to an increase in compressive loads on the rotator cuff margin (11).

In conclusion, this study demonstrated specific changes in mRNA levels for the matrix molecules evaluated. While our results do demonstrate that both the bursa and rotator cuff margin can contribute to rotator cuff healing following repair, both tissues demonstrated a response following injury and may potentially contribute to healing of the rotator cuff following repair.