Introduction: Rotator cuff pathology is a significant cause of morbidity and disability, particularly in the middle-aged and elderly population. The etiology of cuff pathology remains poorly understood due largely to an incomplete understanding of the structure and functional anatomy of the normal supraspinatus tendon. A recent investigation noted increased proteoglycan (PG) content and localized acian blue stained ‘sheets’ within the supraspinatus tendon. It was hypothesized that PG functioned to separate and lubricate collagen bundles minimizing shear stress as fascicles moved relative to each other. The present investigation employed stereomicroscopic dissection and 3D computer reconstruction to test the hypothesis that supraspinatus tendon collagen fascicles are structurally independent units, separated by a lubricating PG rich matrix, and thus capable of movement relative to one another.

Methods: Structural subdivisions within the supraspinatus tendon were defined based on stereomicroscopic observations. Supraspinatus tendons from nine grossly normal fresh (5) and fresh frozen (4) human shoulders (mean age 68 yrs., range 44-89 yrs.) were embalmed, longitudinally and transversely sectioned (2-4 mm in thickness), stained with acian blue (pH 2.5), and examined under a dissection stereomicroscope (7.5X). Collagen architecture and endotenon location were examined and fascicles were manually manipulated with microsurgical instruments.

A 3-dimensional computer montage technique was used to examine the course and relationship of individual collagen fascicles from muscle to tendon in the event of a tear in the attachment fibrocartilage (consistent with the findings of Burkhart et. al.)2. The alternating fiber orientation within the tendon proper (A), attachment fibrocartilage (B), rotator cable (C), and the humeral head (H) (capsule is not well visualized). In this particular specimen the space progressing from muscle to tendon may be a factor. The attachment fibrocartilage is of particular interest because of its extended length (compared to other tendons) and its involvement in pathology (it encompasses the ‘critical zone’ where tears commonly originate). Its fibrocartilaginous composition may function to dampen and disperse loads at the tendon – bone transition where stresses are known to be high. Fibrocartilage in this zone may also be an adaptation to compressive load (impingement). The thick fascicles of the rotator cable spanned the attachment fibrocartilage, potentially enabling transfer of a tensional load from the supraspinatus muscle to the humerus in the event of a tear in the attachment fibrocartilage (consistent with the findings of Burkhart et. al.)2. The alternating fiber orientation within the capsule may allow it to resist stress from multiple axes. Further investigations are required to test these hypotheses and determine if the described structural characteristics of this mosaic tendon contribute to its ability (while healthy) to transmit tension and withstand shear and compression.

Discussion: A few prior studies have focused on rotator cuff anatomy1,3,4; however, the present one is unique in its mapping of collagen fascicles. Although this investigation is limited to a descriptive analysis, the functional significance of its findings may be hypothesized based on existing knowledge. The parallel independent collagen fascicles of the tendon proper may allow for differential excursion between fascicles during glenohumeral motion. The role of convergence is presently uncertain; however, reduction in available space progressing from muscle to tendon may be a factor. The attachment fibrocartilage is of particular interest because of its extended length (compared to other tendons) and its involvement in pathology (it encompasses the ‘critical zone’ where tears commonly originate). Its fibrocartilaginous composition may function to dampen and disperse loads at the tendon – bone transition where stresses are known to be high. Fibrocartilage in this zone may also be an adaptation to compressive load (impingement). The thick fascicles of the rotator cable spanned the attachment fibrocartilage, potentially enabling transfer of a tensional load from the supraspinatus muscle to the humerus in the event of a tear in the attachment fibrocartilage (consistent with the findings of Burkhart et. al.)2. The alternating fiber orientation within the capsule may allow it to resist stress from multiple axes. Further investigations are required to test these hypotheses and determine if the described structural characteristics of this mosaic tendon contribute to its ability (while healthy) to transmit tension and withstand shear and compression.

Results: Four distinct structural subunits were observed within the supraspinatus tendon: the tendon proper, the attachment fibrocartilage, the rotator cable, and the capsule (Fig.1). The tendon proper extended from the muscle to the attachment fibrocartilage, an average length of 1.69±0.4 cm. Its internal organization consisted of collagen bundles, grouped as fibers and fascicles, running parallel to its longitudinal (longitudinal) axis. A thick endotenon region that stained prominently with acian blue separated fascicles. Gentle manipulation demonstrated that the fascicles easily slid past one another and that acian blue staining endotenon was situated in the region of motion between fascicles. The attachment fibrocartilage extended from the tendon proper to the bone, averaging 1.8±0.5 cm in length. Its collagenous structure approximated a basket weave pattern staining diffusely with acian blue. Thick parallel collagen fascicles of the rotator cable (originally described by Burkhart et al.2) extended posteriorly from the rotator cuff and from the UNM Orthopaedics department, George E. Omer Jr., M.D. endowment.

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References:

** UNM SOM, Department of Cell Biology and Physiology, Albuquerque, New Mexico
*** University of New Mexico, Biology Department, Albuquerque, New Mexico

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