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Characteristics of small to medium-sized rotator cuff tears with and without disruption of the anterior supraspinatus tendon

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Background: The purpose of this study was to examine the baseline function and results of arthroscopic cuff repair in shoulders with small and medium-sized full-thickness cuff tears with complete supraspinatus disruption compared with those with an intact anterior supraspinatus tendon.
Methods: The study evaluated 112 subjects with small and medium-sized cuff tears. Subjects were grouped according to anterior supraspinatus integrity (83 shoulders intact, group 1; and 29 shoulders with anterior supraspinatus tendon disruption, group 2). Functional assessments included visual analogue scale for pain, American Shoulder and Elbow Surgeons (ASES) score, Simple Shoulder Test score, and Constant score. Repair integrity was assessed by ultrasound examination.
Results: Group 2 shoulders had greater mean tear width, length, and area ($P < .0001$) and greater supraspinatus muscle degenerative changes ($P < .0001$) compared with shoulders with an intact anterior supraspinatus tendon. There were no differences in demographics or baseline function (ASES score: 45 group 1 vs 46 group 2, $P = .79$; Constant score: 56 group 1 vs 52 group 2, $P = .29$) before surgery. There were no differences in any functional parameter (ASES score: 92 group 1 vs 93 group 2, $P = .71$; Constant score: 84 group 1 vs 85 group 2, $P = .84$) after surgery. There was no difference in tendon healing rates (93% group 1 vs 86% group 2; $P = .26$).
Conclusions: In the setting of painful small and medium-sized rotator cuff tears, disruption of the anterior supraspinatus tendon was associated with greater tear size and more advanced supraspinatus muscle degeneration. However, anterior supraspinatus tendon integrity had no influence on the clinical presentation or the functional and structural results of cuff repair surgery.
Level of evidence: Level III, Retrospective Cohort, Treatment Study.

Keywords: Rotator cuff; rotator cable; supraspinatus tear; arthroscopy

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Integrity of the anterior supraspinatus tendon in rotator cuff-deficient shoulders may be an important predictor of functional disability and affect the outcome of surgical management. Traditionally, degenerative rotator cuff tears were believed to begin as articular-sided, partial-thickness cuff tears located adjacent to the biceps tendon and near the front edge of the supraspinatus tendon.[5,6,16,19,24]

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Kim et al[21] had challenged this conventional thinking, noting that the majority of asymptomatic degenerative tears were centered in a region 13 to 17 mm posterior to the biceps tendon by ultrasound examination, thereby preserving the anterior supraspinatus attachment in most shoulders. In a separate study, Kim et al[20] noted that the location of the tear had important effects on the pattern and severity of rotator cuff muscle atrophy. This study highlighted the importance of the integrity of the anterior supraspinatus tendon to development of supraspinatus muscle atrophy and noted a strong correlation between disruption of the front edge of the tendon and the development of supraspinatus atrophy. These findings correlated with more recent anatomical descriptions of the supraspinatus tendon,[26] suggesting that the supraspinatus footprint was much smaller than previously defined, triangle shaped, and anteriorly positioned near the biceps tendon. Therefore, the supraspinatus tendon may not be fully compromised unless the tear involves the most anterior aspect of the tendon.

Whereas it was shown that the presence of an asymptomatic rotator cuff tear, regardless of size, had little effect on shoulder function,[17] it was well recognized that painful rotator cuff tears result in significant measurable loss of function. The loss of shoulder function and degree of disability seen in the presence of a painful rotator cuff tear do not necessarily correlate with the size of the rotator cuff tear.[15,25] Tear-related biomechanical factors and the effect of pain may play a significant yet poorly defined role in the loss of shoulder function with symptomatic rotator cuff tears. Disruption of the traditional rotator cuff force couple seen with tears of the infraspinatus tendon has been correlated with proximal humeral migration in both experimental[14,30,31] and clinical studies[2,18]; however, to our knowledge, no studies have examined the correlation between integrity of the anterior supraspinatus tendon and the clinical presentation of painful rotator cuff tears or the outcomes of surgical treatment. In theory, complete supraspinatus disruption may be associated with greater loss of elevation strength and range of motion as well as greater pain through partial disruption of the anterior cable attachment. Likewise, the more advanced muscle degenerative changes associated with this tear pattern may influence the results of rotator cuff repair. The purpose of this study was to examine the baseline shoulder function and the subsequent results of arthroscopic rotator cuff repair in patients with painful small and medium-sized posterosuperior full-thickness rotator cuff tears in shoulders with complete disruption of the supraspinatus tendon compared with those with an intact anterior supraspinatus tendon. Secondary goals included determination of the differences in patient demographics, incidence of biceps disease, and supraspinatus atrophy in patients with and without an intact anterior supraspinatus tendon.

Materials and methods

Subjects for this study were enrolled in a prospective randomized trial examining the effect of postoperative rehabilitation on the outcomes of arthroscopic rotator cuff repair surgery. Specifically, the original study was performed to examine the potential effects of immobilization compared with early passive range of motion of the shoulder after arthroscopic repair of small and medium-sized rotator cuff tears. Data for this study included the preoperative and postoperative functional scores and shoulder ultrasound findings. All subjects were indicated for surgery after failure of conservative treatment. Inclusion criteria for this study were (1) full-thickness tears of the posterosuperior rotator cuff $\leq$30 mm in size (sagittal plane measurement), (2) age $\leq$65 years, and (3) complete preoperative ultrasound and clinical examination data. Exclusion criteria were (1) presence of a full-thickness subscapularis tear, (2) radiographic glenohumeral arthritis, (3) labral tear requiring surgical repair, (4) preoperative shoulder stiffness (defined as loss of passive elevation $>$100 degrees or $>$50% loss of passive external rotation compared with the opposite shoulder), and (5) recurrent rotator cuff tear. Subjects with biceps pain or disease were retained in the study.

Ultrasound examinations

All ultrasonography examinations were performed in real time with use of a Siemens Antares scanner (Siemens Medical Systems, Issaquah, WA, USA) or a Logiq E9 scanner (GE Medical Systems, Milwaukee, WI, USA). High-frequency linear-array transducers (ranging from 7.5 to 10 MHz) were used by 1 of 3 radiologists who had more than 10 years of experience in musculoskeletal ultrasonography. The utility of ultrasound examination in our institution has been validated for both the diagnosis of tendon tear and fatty degeneration characterization.[32,33] Ultrasound examinations included the following data parameters: (1) assessment for fatty degeneration of both the supraspinatus and infraspinatus muscles, (2) tear width (sagittal plane) and length (retraction in the coronal plane), and (3) tear location. For evaluation of fatty degeneration, the echogenicity and echotexture of each muscle were examined with use of a 3-point scale,[36] modified from that described by Strobel et al[29] (Table I). In brief, the echogenicity of the supraspinatus was determined in comparison with the echogenicity of the overlying trapezius. The echogenicity of the infraspinatus was determined in comparison with the overlying deltoid. The architecture was determined on the basis of the visibility of the intramuscular tendons and of the normal muscle pennate pattern. The mean of the grades for echogenicity and architecture was calculated to determine a single grade (0 to 2) for the extent of fatty degeneration of each rotator cuff muscle as described by Wall et al.[36] Tear area (mm^2) was calculated from the tear width (mm) and length (mm). Tear location was assessed by measuring with digital software the anteroposterior distance (mm) from the posterior margin of the biceps tendon (or the lateral edge of the biceps groove when the biceps was absent) to the anterior extent of the tear in transverse views. Patients were divided into 2 groups on the basis of the tear location. Patients in whom the most anterior aspect of the tear initiated $>$3 mm posterior to the biceps were considered to have an intact anterior supraspinatus tendon