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Patterns of tear progression for asymptomatic degenerative rotator cuff tears

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Background: The purpose of this study was to examine patterns of rotator cuff tear size progression in degenerative rotator cuff tears and to compare tear progression risks for tears with and without anterior supraspinatus tendon disruption.
Methods: Asymptomatic full-thickness rotator cuff tears with minimum 2-year follow-up were examined with annual shoulder ultrasound examinations. Integrity of the anterior 3 mm of the supraspinatus tendon determined classification of cable-intact vs. cable-disrupted tears. Tear enlargement was defined as an increase of 5 mm or more in width. Tear propagation direction was calculated from measured changes in tear width in reference to the biceps tendon on serial ultrasound examinations.
Results: The cohort included 139 full-thickness tears with a mean subject age of 63.3 years and follow-up duration of 6.0 years. Ninety-six (69.1%) of the tears were considered cable intact. Cable-disrupted tears were larger at baseline (median, 19.0 mm vs. 10.0 mm; $P < .0001$) than cable-intact tears. There was no difference in the risk of enlargement (52.1% vs. 67.4%; $P = .09$) or time to enlargement (3.2 vs. 2.2 years; $P = .37$) for cable-intact compared with cable-disrupted tears. There was no difference in the magnitude of enlargement for cable-intact and cable-disrupted tears (median, 7.0 mm vs.9.0 mm; $P = .18$). Cable-intact tears propagated a median of 5 mm anteriorly and 4 mm posteriorly, whereas cable-disrupted tears propagated posteriorly.
Conclusions: The majority of degenerative rotator cuff tears spare the anterior supraspinatus tendon. Although tears classified as cable disrupted are larger at baseline than cable-intact tears, tear enlargement risks are similar for each tear type.
Level of evidence: Level I, Prognosis Study.

Keywords: Rotator cuff tear; progression; rotator cable; ultrasound

Identification of at-risk rotator cuff tears will better refine surgical indications for rotator cuff disease. Recent research has better illustrated the general risks of tear enlargement of degenerative rotator cuff tears through the monitoring of asymptomatic tears.[9,15,17] Although the time-dependent risks of tear progression have been better

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defined, longitudinal analysis of the common patterns of tear enlargement has not been performed to our knowledge. Descriptive analysis of tear propagation patterns is fundamental for further defining the natural history of rotator cuff disease and may also help refine surgical indications. This is particularly clinically relevant given the high prevalence of degenerative rotator cuff tears in association with age[23,25] and the lack of consensus about appropriate surgical indications for symptomatic tears.[3]

Traditionally, most degenerative rotator cuff tears have been thought to begin as partial-thickness tendon defects occurring at the undersurface of the anterior supraspinatus tendon.[2,6,10,14] Others have suggested that these tears are most likely to initiate within the rotator crescent, with the majority of tears sparing the anterior cable insertion of the tendon.[12,18] Recent data have suggested that these degenerative tears may enlarge within the crescent, propagating in both the anterior and posterior directions[12]; however, there are few data defining these patterns of tear propagation in a prospective, longitudinal fashion. Furthermore, little is known about the risks of tear progression for tears isolated to the rotator crescent compared with those involving the anterior aspect of the tendon. Loss of the anterior supraspinatus origin of the rotator cable is associated with an increased risk of fatty muscle degeneration,[13] but to date, little information exists about associated progression risks. A better understanding of the patterns of tear progression is fundamental in defining the natural history of rotator cuff disease, and the clinical relevance is magnified given the influence of tear location on rotator cuff muscle degeneration.

The purpose of this study was to examine the temporal-based patterns of rotator cuff tear size progression in full-thickness, degenerative rotator cuff tears. In addition, we sought to compare the risks and patterns of tear progression in shoulders with and without disruption of the anterior rotator cable origin.

Methods

Subjects for this study belong to a cohort of individuals with asymptomatic rotator cuff tears that have been observed longitudinally for the purpose of defining the risks of tear enlargement and pain development over time. Subjects presented to the physician with shoulder pain secondary to rotator cuff disease and were found to have an asymptomatic rotator cuff tear in the contralateral shoulder with shoulder ultrasonography. After tear identification, subjects were confirmed to be asymptomatic at baseline on the study side and were observed annually with a repeated clinical examination, shoulder ultrasonography, and shoulder radiographs according to a previously published protocol.[9,16] Exclusion criteria included the presence of shoulder pain as previously defined, history of shoulder trauma or injury, isolated subscapularis tears, pre-existing glenohumeral arthritis, history of inflammatory arthritis, and prior surgery on the study shoulder.

Shoulder ultrasonography

Shoulder ultrasonography was performed according to a previously described protocol[21,22] in real time with a Siemens Elegra or Antares (Siemens Medical Solutions, Mountain View, CA, USA) or GE E8 or E9 (General Electric, Madison, WI, USA) scanner and a variable high-frequency linear array transducer (7.5-13 MHz) by one of 3 radiologists with extensive experience in musculoskeletal ultrasonography. The accuracy of this modality in our institution has been well documented.[20-22,24] The maximum anteroposterior dimension of the tear was measured in transverse views (perpendicular to the long axis of the cuff) and designated the width of the tear. This is analogous to the sagittal plane size of the tear. The maximum degree of retraction was measured in longitudinal views (parallel to the long axis of the cuff) and designated the length of the tear. This is analogous to the amount of tear retraction in the coronal plane. The distance of the anterior aspect of the supraspinatus tear to the biceps tendon or the lateral aspect of the biceps groove if the tendon was absent was measured to determine the integrity of the anterior aspect of the supraspinatus tendon.

Tear propagation analysis

For this analysis, we studied only full-thickness tears, either classified as full thickness at baseline or later converted to a full-thickness tear during follow-up. We chose to analyze full-thickness tears as shoulder ultrasonography is more accurate in defining the tear size of full-thickness compared with partial-thickness tears. All full-thickness tears with a minimum of 2 years of follow-up without tear enlargement and any full-thickness tear with width enlargement on consecutive ultrasound examinations regardless of the length of follow-up were included. A tear was considered enlarged only if the width was increased by 5 mm or more compared to baseline ultrasound dimensions. Serial ultrasound reports were analyzed, referencing the dimensions of the tear and the distance of the anterior aspect of the tear to the long head of the biceps tendon. We categorized tears as cable intact if the anterior supraspinatus footprint (immediately posterior to the biceps tendon/groove) was intact for more than 3 mm posterior to the biceps. Cable-disrupted tears were defined as tears that involved the anterior 3 mm of the supraspinatus tendon footprint. Based on the width of the tear and the location of the anterior edge of the tear to the biceps, the location of each tear within the supraspinatus and infraspinatus footprint can be mapped. By comparing the change in width of the tear and the change in location of anterior aspect of the tear in reference to the