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Operative Techniques in
Orthopaedics

Operative Technique on Arthroscopic Partial-Thickness Articular Rotator Cuff Repairs

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Since its first description in 1931, there has been an evolution in the understanding of partial articular tears of the supraspinatus. Partial articular supraspinatus tendon avulsion represents a Southern California Orthopaedic Institute type 3 or 4 tear classification with a traumatic etiology. Partial-thickness tears have little active healing response and may progress to a full-thickness tear. These tears are painful for patients and are particularly debilitating for overhead activities. A tear that involves more than 50% of the tendon may require surgical intervention after extensive conservative management. Arthroscopic repair of these lesions have proven to be successful. There are various techniques of repairing the tear, which can involve a transtendinous or conversion approach. The goal of our technique is to anatomically reduce the delaminated layer to the greater tuberosity under direct visualization, thereby maximizing the biomechanical advantage of fixation while minimizing iatrogenic injury to the remaining fibers. This article outlines the historical and current literature, outcomes, techniques, and our preferred approach with pearls to this type of rotator cuff tear.
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Literature Review and Outcomes

History

In 1931, Codman and Akerson[1] first described partial articular tears or rim rents of the supraspinatus. Codman believed that these tears typically occur as a gradual process, except in occasions of acute trauma. As the tear progressed from medial to lateral on the supraspinatus footprint, the defect was noted to increase in size.[2] These types of tears also tend to increase with age. In 1950, DePalma[3] demonstrated that the incidence of asymptomatic partial articular tears was 37% and was most common in patients older than 60 years. This type of partial tear was also shown to be more common than bursal-sided tears[4] and is caused primarily by intrinsic factors.[5]

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In 1990, Ellman[6] subclassified partial articular supraspinatus tears into 3 different grades (Table 1). This was a modification of Neer's[7] stage III rotator cuff tear from 1983. Grades were separated by 3 mm intervals with grade 3 representing a defect greater than 6 mm.[6] A grade 3 equates to at least a 50% tear of the supraspinatus tendon, as demonstrated by Ruotolo et al[8] in an anatomical study of 17 specimens.

Another classification system used is the Southern California Orthopaedic Institute (SCOI) rotator cuff classification.[9] The articular surface classification is divided into 4 subcategories based on severity of the tear (Table 2): 0—normal cuff; 1—minimal irritation of synovial lining or localized fraying (<1 cm); 2—failure of rotator cuff fibers with synovial or capsular injury (<2 cm); 3, more severe injury of cuff with fragmentation of the tendon fibers, typically involving the entire surface of the tendon (<3 cm); and 4—very severe injury to the tendon with a flap tear involving one or more tendons. The partial articular supraspinatus tendon avulsion (PASTA), was coined from the SCOI classification.[10] It represents a type 3 or 4 tear with a traumatic etiology without requiring a certain size or location of the tear. Many have used the term PASTA to describe any articular surface cuff tear, but this is not the actual original descriptive purpose of the acronym.

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Table 1 Subclassification of Stage III Rotator Cuff Tears

Location	Grade	Area of Defect
Partial-thickness tear		
(A) Articular surface	1: <3-mm deep	Base of tear × maximum retraction = mm^2
(B) Bursal surface	2: 3-6-mm deep	
(C) Interstitial	3: >6-mm deep	
Full-thickness tear (F)		
(A) Supraspinatus	1: Small, <2 cm	Base of tear × maximum retraction = cm^2
(B) Infraspinatus	2: Large, 2-4 cm	
(C) Teres minor	3: Massive, >5 cm	
(D) Subscapularis	4: Cuff arthropathy	

Adapted from Ellman.[6]

Natural History

There has been an evolution in the understanding of the natural history of articular surface tears. Early on, Codman and Akerson[1] believed these lesions may heal; however, this has not been the experience of others.[6,11,12] Bey et al[13] demonstrated that the occurrence of an articular-sided tear significantly alters the strain of the supraspinatus tendon at abduction angles of 30° or greater. Additionally, Reilly et al[14] showed the propagation of a tear from the articular to bursal side during abduction. In a cadaveric study, Mazzocca et al[15] found a significant difference in tendon strain once an articular surface tear reached 50% of the tendon footprint, and showed that strain returned close to normal after repair. Furthermore, histologic studies have reaffirmed that there is little active healing response after partial-thickness tears.[5,16] Many feel that full-thickness tears may result from progression of partial-thickness tears.[17-22] Yamanaka and Matsumoto[22] reimaged patients at slightly more than a year from initial diagnosis and demonstrated tear enlargement in 53% and progression to full-thickness in 28% of patients. Tashjian,[23] in a natural history study, demonstrated that partial-thickness tears progress in tear size slower than full-thickness tears. More importantly, tear progression was correlated with pain.

Presentation

Similar to full-thickness rotator cuff tears (FTRCT), partial-thickness rotator cuff tears (PTRCT) are painful for patients; sleeping and overhead activities are bothersome. Neer and Hawkins impingement signs are typically present. However, as the tendon is only partially torn, weakness may or may not be present. Pain is typically worse in PTRCT than FTRCT.[17] Fukuda et al[17] showed that nocturnal pain existed in 50% of FTRCT vs 73% of PTRCT. Inflammatory markers, especially substance P, were found at higher local concentrations in PTRCT as well.[24] Levels of substance P directly correlated with higher levels of pain.

Overhead athletes also develop PTRCT and may present differently. Complaints include pain with rest, loss of velocity, and mechanical symptoms when throwing.[5] Unlike typical PTRCT, where the injured tendon is the anterior supraspinatus, overhead athletes commonly injure the posterior supraspinatus, anterior infraspinatus, or both.[25]

Imaging

Historically, arthrography and bursography were used to evaluate PTRCT. Unfortunately, these methods involved significant variation with accuracy ranging from 15%-83% and 25%-67%, correspondingly.[20,26,27] Currently, ultrasonography (US) and magnetic resonance imaging (MRI) are the mainstay of diagnostic methods. US sensitivity and specificity range from 41%-94% and 91%-94%, respectively, when confirmed with arthroscopic evaluation.[28,29] Although early studies with nonenhanced MRI reported false-negative rates of 83%[20] with a sensitivity of 56%[30]; arthrography has significantly improved proper diagnosis. Meister et al demonstrated a sensitivity of 84% and a specificity of 96% with gadolinium-based contrast agent on T1-weighted fat-suppressed images.[31] When directly compared, Iannotti et al found the accuracy of MRI to be 73% and US to be 70%.[32] It is well known that US is less expensive than an MRI or MRI arthogram. However, the MRI provides the clinician with a better overall picture of possible shoulder pathology. Both modalities must be used with caution and in combination with clinical evaluation, as asymptomatic PTRCT may be present.

When imaging an overhead athlete, an MRI arthrogram with abduction and external rotation sequence is recommended to help identify an undersurface tear with an intratendinous plane of delamination.[25] This variant has been termed "PAINT" for partial articular tear with intratendinous extension.[33]

Treatment Options

The treatment of symptomatic PTRCT is not clearly defined. As technology and understanding have changed, so have treatment algorithms. Typically, PTRCTs are initially treated

Table 2 SCOI Rotator Cuff Classification: Subclassification of Articular Surface Tears

Articular Surface Classification	Severity of Lesion	Size of Tear
0	Normal cuff	0 cm
1	Minimal irritation of synovial lining or localized fraying	<1 cm
2	Failure of rotator cuff fibers with synovial or capsular injury	1 cm <2 cm
3	More severe injury of cuff with fragmentation of the tendon fibers, typically involving the entire surface of the tendon	2 cm <3 cm
4	Very severe injury to the tendon with a flap tear involving one or more tendons	>3 cm

Adapted from Snyder.[10]