A PASTA lesion is a partial articular supraspinatus tendon avulsion. There is no consensus on the ideal treatment of partial-thickness tears. This article will help in the decision-making process and outline the surgical steps in arthroscopic transtendon repair of a partial-thickness articular-sided rotator-cuff tear.

KEY WORDS: PASTA lesion, articular supraspinatus tendon, partial thickness, repair, rotator cuff, arthroscopic

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A PASTA lesion is a partial articular supraspinatus tendon avulsion. Steve Snyder, MD, is responsible for the term "PASTA" lesion. Codman's was one of the first to describe in detail a partial-thickness rotator-cuff tear. He referred to them as "rim rents" and said "(they) are the cause of the majority of sore shoulders." The ideal treatment of partial-thickness rotator-cuff tears has yet to be determined. Partial-thickness articular-sided tears are 2-3 times more frequent than bursal-sided tears and more common than complete tears of the rotator cuff in cadaveric studies. In a cadaveric study, Ogata et al. found 47% of the specimens had partial thickness tears with 94% located on the articular side. Payne et al. studied partial-thickness tears in athletes and found 91% were on the articular side.

HISTORY/PHYSICAL EXAMINATION

Often the patients are younger than a typical middle-aged patient with a rotator-cuff tear. The patient may recall an acute event. Pain at night is less common than with a full-thickness rotator-cuff tear, but pain with activities is a frequent complaint. A thorough examination of the shoulder is always performed. The range of motion is often within normal limits. Supraspinatus weakness is usually present and is probably secondary to pain. Impingement tests are not consistently positive.

IMAGING

Radiographs are obtained consisting of a true anteroposterior, scapular Y view, and axillary view. These are usually normal. A magnetic resonance imaging (MRI) scan can be helpful in making the diagnosis because a small articular-sided defect in the supraspinatus can be visualized. However, the sensitivity in detecting partial-thickness tears varies from 56% to 89%.

DECISION-MAKING PROCESS/INDICATIONS

Making the definitive diagnosis of a partial-thickness tear can be challenging due to the similarities in examination and imaging when differentiating the wide spectrum of rotator-cuff disease. Once the diagnosis is made, one should start with conservative treatment including rehabilitation, activity modification, NSAIDs, and possibly corticosteroid injections. If the patient continues to have pain with no improvement after 3 months of conservative treatment, then one may consider surgical treatment.

At the time of surgery, the depth of the defect plays an important role in choosing the surgical options, which include no treatment, debridement, debridement with acromioplasty, completing the tear and repairing it open or arthroscopically, or performing a transtendon arthroscopic repair with or without an acromioplasty. A common recommendation found in the literature is to repair a partial-thickness tear that is greater than 50% of the tendon’s thickness.

One way of determining the percentage of supraspinatus tear was developed by Nottage et al. in an anatomic study evaluating the exposed bone between the rotator cuff and the articular margin. They found that the normal space is 1.7 mm. If this interval is greater than 7 mm, it most likely represents a tear involving more than half the tendon (the footprint of the supraspinatus is 12-15 mm thick).

At the time of surgery, it is paramount to carefully evaluate the shoulder for additional primary pathology, including instability and posterior-superior labral pathology. If found, these also must be repaired at the time of treatment. In our opinion, when treating a young overhead athlete with a partial-thickness articular-sided tear, a subacromial decompression should not be performed. Instead, one should think of internal impingement and associated instability patterns that may require definitive treatment.
Table 1. Eillman's Subclassification of Partial-Thickness Stage III Rotator-Cuff Tears

<table>
<thead>
<tr>
<th>Grade</th>
<th>Thickness</th>
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<tbody>
<tr>
<td>Grade I</td>
<td>0-3 mm</td>
</tr>
<tr>
<td>Grade II</td>
<td>3-6 mm</td>
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<tr>
<td>Grade III</td>
<td>&gt;6 mm</td>
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</tbody>
</table>

Classification

Eillman's classification is frequently used for partial-thickness tears (Table 1). The normal cuff is considered to be 10-12 mm thick by Eillman. This classification has been modified to less than 50% of the tendon and greater than 50%.

TECHNIQUE OF THE REPAIR

A thorough physical examination of the shoulder under anesthesia is performed before patient positioning. Documentation of preoperative shoulder crepitation, range of motion, and stability is recorded and compared with the patient's contralateral shoulder. Assessing instability in young overhead throwers is essential. Our preferred method of anesthesia is the combination of an interscalene block and general endotracheal anesthesia. A long-acting interscalene block reduces the required inhalation agents and narcotics necessary for effective general anesthesia, as well as providing postoperative pain relief throughout the day of their surgery. Using this method, more than 95% of our patients are discharged from the surgical facility within a few hours after the completion of the arthroscopic repair.

Patient Positioning

We prefer the beach-chair position for arthroscopic repairs of the rotator cuff. The beach-chair position makes it simple for ancillary staff to set up the patient; the shoulder is oriented in a position familiar to the surgeon, and the ability to easily move the arm and therefore the supraspinatus insertion site during the procedure facilitates the surgical repair.

Portal Placement

The bony landmarks of the shoulder are drawn on the skin to identify the acromion, clavicle, acromioclavicular articulation, spine of the scapula, coracoid process, and coracoacromial ligament. A standard 30° arthroscope is used throughout the procedure. The standard posterior portal is placed in the "soft spot" of the posterior shoulder, which is approximately 2 cm inferior and 1-2 cm medial to the posterior lateral corner of the acromion with the patient in the beach-chair position. The anterior portal is immediately lateral to the coracoid process and below the coracoacromial ligament. A lateral portal will be made 2-3 cm inferior to the lateral edge of the acromion and just anterior to a line that would bisect the anterior to posterior distance of the acromion. The portal sites are injected with 0.25% bupivacaine and epinephrine before making incisions. The posterior cannula is introduced into the glenohumeral joint by using a blunt trochar to avoid damage to the articular cartilage. The arthroscope is then placed through this cannula. The standard anterior portal is established by using an inside-out technique. This technique is performed by advancing the arthroscope inferior to the biceps tendon and into the rotator interval. The arthroscope is then withdrawn from its sheath, and a Wissinger rod is advanced through the cannula. The rod is passed through the anterior capsule of the rotator interval, below the coracoacromial ligament, and into the subcutaneous tissue lateral to the coracoid process. The skin is infiltrated with bupivacaine and epinephrine, and a skin incision is made over the Wissinger rod. An anterior cannula with an outflow attachment (5.7 mm, Arthrex, Naples, FL) is then advanced over the rod and into the glenohumeral joint. This establishes the portal within the lateral aspect of the rotator interval and below the biceps tendon. A systematic evaluation of the glenohumeral joint is performed. Evaluation of the articular surfaces and documentation of associated pathologies is important. Arthroscopic evidence of abnormalities related to the glenoid rim, the biceps tendon, or the subscapularis tendon may alter the preoperative plan in 10-15% of patients undergoing rotator-cuff surgery.

A meticulous evaluation of the articular side of the rotator cuff is essential. Dynamic examination of the insertions of the subscapularis, supraspinatus, and infraspinatus can all be performed when viewing from the posterior portal. The superior labrum anteriorly and posteriorly should be probed, with an eye to detachment.

Once the avulsion of the supraspinatus is identified (Fig 1), it should be probed to assess the degree of the tear. If the tear is less than 50% of the thickness of the cuff, debridement can be considered (see indications). This region should be marked to help identify the specific region on the bursal side. An 18-gauge needle is placed through the lateral skin of the shoulder to pierce the center of the

Fig 1. Partial thickness tear of supraspinatus illustrating the increased space between the articular cartilage margin and intact cuff.
lesion. Then a #1 PDS suture is passed through the needle into the glenohumeral joint. An arthroscopic grasper is used to grasp the end of the PDS and pull it out the anterior cannula (Fig 2). The 2 ends of PDS are clamped with a hemostat outside the shoulder.

The arthroscope is then removed from the glenohumeral joint. The blunt trochar is placed in the cannula. The cannula is then slid into the subacromial space through the posterior portal. It is then passed anteriorly underneath the coracoacromial ligament and through the anterior portal. The anterior cannula is placed over the blunt trochar and pulled into the subacromial space. The arthroscope is inserted to the anterolateral region of the subacromial space and into the “room with a view,” under the anterolateral edge of the acromion. An 18-gauge needle is inserted through the site of the tentative lateral portal in order to confirm that the angle is sufficient for use of the instruments and lateral cannula during the procedure. The portal is created and a 4.5-mm shaver is placed into the subacromial space and the bursa is debrided (Fig 3). A radiofrequency device is also used to clear the bursa. This is a crucial step to ensuring adequate visualization of the rotator cuff. The arthroscope is then moved to the lateral portal and the shaver is placed posteriorly. The bursectomy continues until the majority of the bursa is gone and the entire supraspinatus tendon insertion is easily visible with the PDS suture through the tendon. Arm position is critical during this step. It is important to have an assistant abduct and externally rotate the arm. The tendon is probed to get a tactile sense of the thickness of the tear and to see if the tear is also present on the bursal side. If this is the case and the tear is essentially full-thickness, then the tear is completed from the bursal side with a shaver. If the bursal side is intact, then the arthroscope is returned into the glenohumeral joint via the posterior portal. A shaver or 5.0-mm burr is introduced through the anterior cannula and the exposed footprint of the supraspinatus is debrided to bleeding bone (Fig 4).

Fig 2. An 18-gauge spinal needle is placed through the skin into the glenohumeral joint piercing the center of the tear. A 0 PDS is passed through the spinal needle into the glenohumeral joint, then grasped with an arthroscopic grasper, and pulled out the anterior cannula.

Fig 3. A complete bursectomy is completed in the subacromial space, the suture placed in the rotator cuff to localize the tear on the bursal side is present.

Fig 4. A shaver (seen here) or burr can be used to prepare the bed if the greater tuberosity for repair of the torn tendon.
Fig 5. Localize the trajectory of the suture anchor with an 18-gauge needle before percutaneous insertion of the first anchor.

Placement of Suture Anchors

An 18-gauge spinal needle is passed through the skin of the lateral shoulder and into the glenohumeral joint to localize the insertion site of the first suture anchor. A percutaneous technique is used to insert the anchors. The anchors are inserted at a 45° angle to the bone, the so-called “deadman’s angle.” The metal corkscrew anchor is placed through the skin and the subacromial space, and screwed through the supraspinatus tendon and into the bone (Fig 5). The second anchor is placed in a similar fashion, and then a third or fourth, if necessary. The anchors should be placed 5 mm apart to ensure that the continuity of the bone is not interrupted.

Passing the Suture

A crochet hook is passed through the anterior cannula and one suture limb from the first suture is pulled out the anterior cannula (Fig 6). A 30° Suture Lasso (Arthrex, Naples, FL) is passed through the lateral cannula and the supraspinatus tendon. Its entry point should be medial to the retracted edge of tendon. This will allow the tendon to be placed back to its anatomic position. The lasso is advanced into the glenohumeral joint and the loop is pulled out the anterior cannula with a crochet hook. The first limb of the suture is then passed through the lasso loop and shuttled back through the tendon (Fig 7). Then, second limb of the first suture is pulled out the anterior cannula in the same fashion as the first limb. The lasso is then passed through the supraspinatus tendon medial to the avulsion to create a horizontal suture. The lasso loop is pulled out the anterior cannula and the second limb of the suture is passed through the loop and shuttled through the tendon.

Fig 6. A crochet hook is passed through the anterior cannula to retrieve one limb of suture that will be the first limb shuttled through the tendon.

Fig 7. (clockwise) Place the Suture Lasso through the tendon and then pull the lasso loop out the cannula. Next pass the suture limb outside the cannula through the open loop. The lasso is pulled out of the glenohumeral joint to shuttle the suture limb through the tendon.
The two limbs of the first suture anchor are now out the lateral cannula. A switching stick is placed through the lateral cannula and the cannula is removed. The two limbs of suture are then pulled out of the cannula and the cannula is then reinserted with no suture through it. These two limbs are then clamped together outside the shoulder with a hemostat. This step is important to aid in suture management. The two limbs of the second suture are then passed in a similar fashion. (Figs 8 and 9). If additional anchors are needed, then they can be inserted and their sutures passed in a similar fashion before tying any of the sutures.

Fig 8. Shuttling the second limb of the second suture. All 4 limbs of suture through the cuff.

Fig 10. Tie the horizontal mattress sutures in the subacromial space.

Tying the Sutures

The sutures will be tied in the subacromial space. The arthroscope is placed into the subacromial space through the posterior portal for viewing. A 6.0-mm clear cannula is placed in the lateral portal and will be the working cannula because of the ease of post-pointing suture limbs, which improves knot security. The anterior cannula is also placed in the subacromial space and all sutures are pulled out the anterior cannula. They are pulled anteriorly in pairs with a crochet hook and kept clamped together in pairs to aid in suture management. Two limbs of the most posterior suture are pulled out the lateral cannula with the crochet hook. The arm is rotated so that the suture, anchor, and cannula are in alignment before tying the knot. When tying knots, the arm is externally rotated and abducted to improve visualization of the knot. If tension is then placed on one suture limb, while holding the other limb steady, the tendon is reduced to the tuberosity repair site (Fig 10). Multiple alternating half hitches with alternating posts are used to secure the suture knot; then, the suture is cut. After the first suture is tied, the next two suture limbs from the same suture anchor are retrieved from the anterior cannula out the lateral clear cannula with the crochet hook and are tied. A simple suture pattern is routinely used because this technique is adequate for maximal loading conditions of the tendon repair. All knots are tied with a single-hole knot pusher. Each throw includes post-pointing the suture limbs in order to maximize loop security by reducing slack between loops. A minimum of 3 alternating half hitches on alternating post limbs are included with every knot after a slip knot or 2 half hitches are initially placed. The sutures are cut at the end of the knot with a suture-cutting tool. The arm is then rotated to determine the security of the rotator-cuff repair. In order
In young throwing athletes the surgeon must look for instability and internal impingement as part of the pathology involving the partial-thickness tear, and a subacromial decompression should not be performed.

There are many options for treating a partial-thickness supraspinatus tear. One technique is a transtendon repair, which can be completed by an experienced shoulder arthroscopist and is effective at repairing the tear to the greater tuberosity.

REFERENCES