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The arthroscopic "subdeltoid approach" to the anterior shoulder

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Surgical management of shoulder pathologies has evolved tremendously during the past 3 decades, such that many lesions previously treated with open techniques are now addressed arthroscopically. Despite this movement, many surgeons and outcome studies continue to prefer open repairs as the gold standard, criticizing—with good reason—the reliability, reproducibility, and extended operative time of arthroscopic repairs, particularly with respect to anterior stabilizations and subscapularis repairs. With this in mind, we present the arthroscopic ''subdeltoid approach,'' a novel standardized exposure technique for extracompartmental anterior shoulder arthroscopy. We define the subdeltoid space as the fascial plane bound superiorly by the acromion and coracoacromial ligament, medially by the coracoid and the conjoint tendon, inferiorly by the musculotendinous insertion of the pectoralis major to the humerus, and laterally by the lateral border of the humerus. When coupled with existing arthroscopic tools, this space dramatically enhances our ability to apply open techniques to some of the more challenging anterior shoulder pathoanatomy and expand the indications and efficacy of arthroscopy. This exposure technique has been used in more than 300 cases during the past decade to treat a myriad of shoulder pathologies, without any longstanding postoperative complications.

Level of evidence: Technique Article.

Keywords: Shoulder; arthroscopy; subdeltoid space; subdeltoid arthroscopy; long head of the biceps tendon; biceps transfer

Orthopedic surgery is moving away from traditional open shoulder operations in favor of less invasive arthroscopic modalities. Green and Christensen[7] compared operative time, blood loss, and postoperative narcotic use in patients with anterior shoulder instability who underwent arthroscopic or open stabilization. Significant reductions of 1.8-fold in time, 10-fold in blood loss, and 2.5-fold in postoperative narcotic use were noted in the arthroscopically treated cohort.[7] Further, patient perception of arthroscopy is that it is safer and less invasive. Sperling et al[18] surveyed 202 patients about their impressions of open vs arthroscopic surgery. More than 90% of patients reported that they would prefer arthroscopy, and up to 25% would avoid surgery altogether if an open procedure were their only option.

Despite advances in shoulder arthroscopy, open surgery remains the gold standard for many procedures, largely

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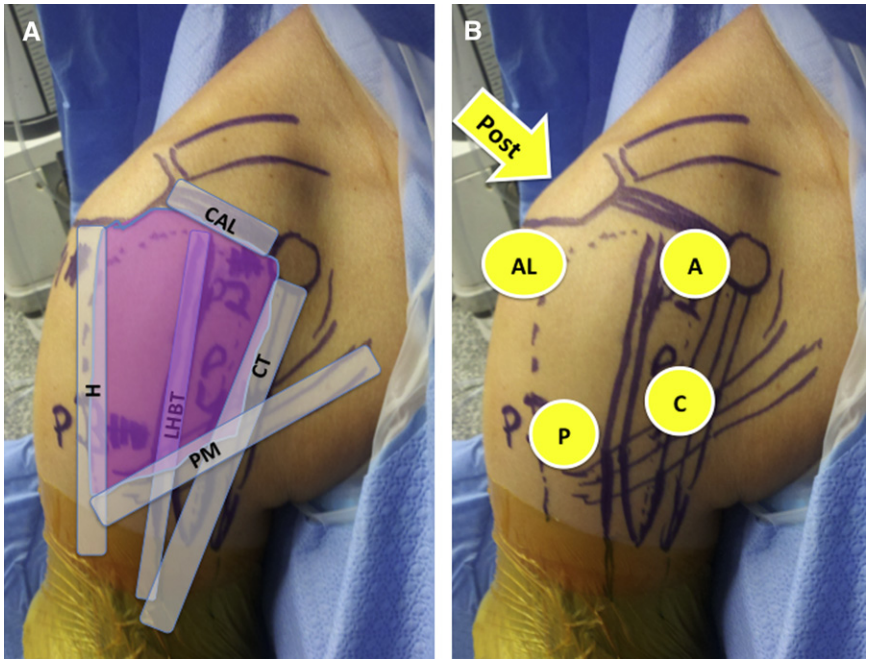


Figure 1 (**A**) The subdeltoid space (*purple*) is defined superiorly by the coracoacromial ligament (*CAL*), medially by the coracoid and conjoint tendon (*CT*), inferiorly by the pectoralis major (*PM*), and laterally by the lateral border of the humerus (*H*). The long head of the biceps tendon (*LHBT*) exists in the floor of the subdeltoid space. (**B**) Five portals are used during subdeltoid arthroscopy: the standard posterior (*post*) portal, anterolateral portal (*AL*), an anterior portal (*A*), a conjoint portal (*C*), and the pectoralis (*P*) major portal.

due to arthroscopy's inability to provide comparable visualization and manipulation of requisite anatomic structures. The purpose of this study is to present a formalized, safe, and efficient arthroscopic exposure technique that can be achieved in less than 20 minutes.

The subdeltoid space is extra-articular and defined superiorly by the acromion and coracoacromial ligament, medially by the coracoid and the conjoint tendon, inferiorly by the musculotendinous insertion of the pectoralis major to the humerus, and laterally by the lateral border of the humerus (Fig. 1, *A*). When insufflated with saline, it provides reliable, versatile, reproducible, and unprecedented arthroscopic access to the anterior shoulder.

Technique

With the patient in the beach chair position, diagnostic arthroscopy is performed in the standard fashion. Intra-articular pathology is addressed primarily, followed by redirection of the arthroscope into the subacromial space from the posterior portal. Subacromial decompression is only performed when clinically indicated.

The first step (Fig. 2) is to reposition the ipsilateral arm into the "90-90-15 position."[17] Shoulder forward flexion of 70° to 90°, elbow flexion to 90°, and arm abduction to 15° to 30° allows the humeral head to fall posteriorly, which facilitates exposure of the subdeltoid space anteriorly.

The second step is entry into the space. With the arthroscope in the posterior portal, an anterolateral working portal is established under spinal needle localization such that the bony edge of the acromion does not impede the working vector (Fig. 1, *B*). For most patients, this is approximately 1 to 2 cm distal to and 1 to 2 cm posterior to the anterolateral edge of the acromion. This working portal is later converted into a viewing portal.

The third step is the clockwise sequential exposure of the subdeltoid space (Fig. 3, *A*). We prefer radiofrequency ablation of the subdeltoid bursa. This minimizes bleeding and heeds warning (stimulates contraction) if a nervous structure is approached inadvertently. To safely expose the space, the surgeon sequentially identifies a "safe" structure and then follows it to the next "safe" structure. Stepwise exposure of the subdeltoid space can be view in an instruction video available online at www.jshoulderelbow.org.

1. The coracoacromial ligament is exposed at its acromial attachment and followed medially to the coracoid. The coracoid marks the medial boundary of dissection (Fig. 3, *C*).
2. The conjoint tendon is exposed at its attachment to the coracoid process. Dissection proceeds inferiorly to its musculotendinous junction (Fig. 3, *D*).
3. The pectoralis major tendon is identified next. It is traced as it runs inferiorly and laterally toward the humeral insertion, lateral to the tendon of the long head of the biceps (Fig. 3, *E*).
4. The humeral shaft is then tracked proximally to the anterolateral border of the acromion.

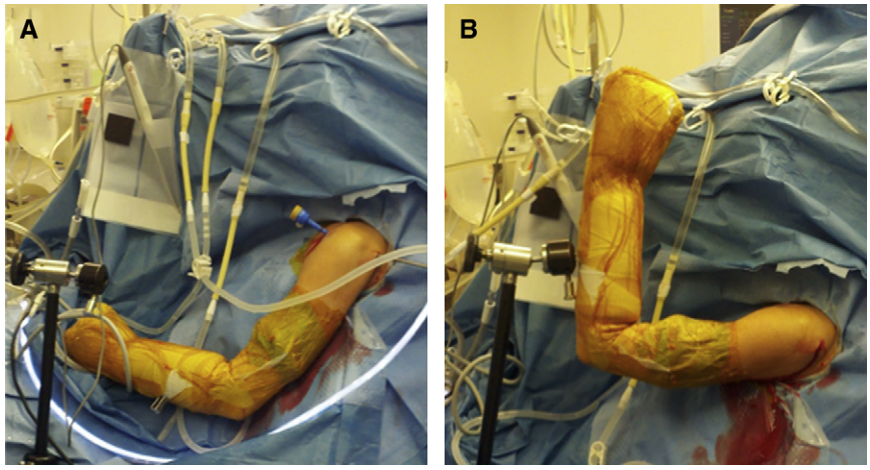


Figure 2 (**A**) Standard arthroscopy in the beach chair position precedes exposure of the subdeltoid space. (**B**) Next, the ipsilateral arm is placed in the "90-90-15 position," such that the shoulder is forward flexed to 90°, the elbow is flexed to 90°, and the arm is abducted 15° from the sagittal plane. This position allows the humerus to fall posteriorly, facilitating subdeltoid exposure.

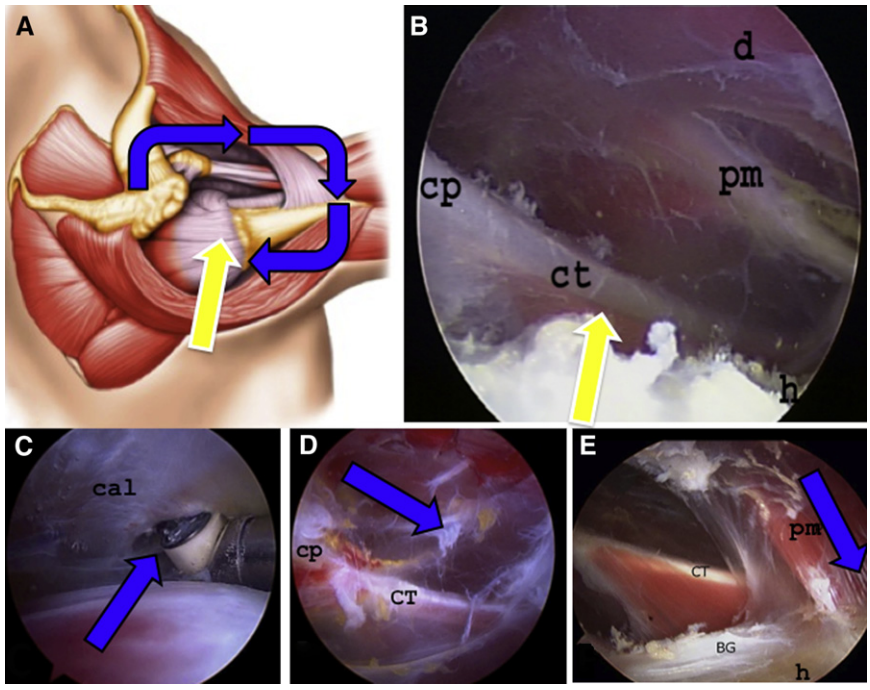


Figure 3 (**A**) The subdeltoid space is exposed by using the posterior portal for viewing and an anterolateral portal (*yellow arrow*) for working and instrumentation. Exposure is accomplished in a sequential clockwise manner (*blue arrows*) in which a safe structure is identified and followed to the next safe structure. (**C**) First, the coracoacromial (*cal*) ligament is identified and traced medially (*blue arrow*). (**D**) Next, the coracoid process (*cp*) is identified, and the conjoint tendon (*ct*) is traced distally (*blue arrow*) to its intersection with (**E**) the pectoralis major tendon (*pm*). (**B**) A panoramic view of the subdeltoid space is seen from the anterolateral portal (*yellow arrow*). *BG,* bicipital groove; *d*, deltoid; *h*, humerus.

5. Radiofrequency ablation of the subdeltoid bursa within the exposed boundaries can then be completed safely.

An inferolateral "pec-portal" is typically established at this time to permit visualization in inferior-to-superior and medial-to-lateral directions. This portal is optimally positioned at the inferolateral corner of the subdeltoid space, the junction of the superior margin of the pectoralis major tendon, and the long head of the biceps tendon.

After the subdeltoid space is fully exposed and insufflated with saline, additional portals may be placed to improve functional access as needed. Spinal needle localization guarantees functional angles. Incision is "skin-deep only," followed by blunt transdeltoid passage of a switching stick and passage of a cannulated trochar.

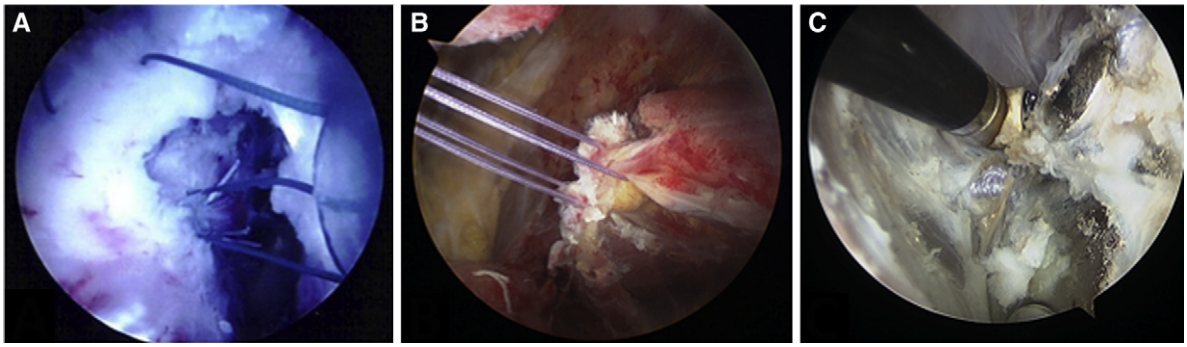


Figure 4 The subdeltoid space has already been used for (**A**) anterior stabilization, (**B**) pectoralis major repairs, and (**C**) arthroscopic-assisted removal of proximal humerus plates.

A steady state of inflow and outflow avoids excessive swelling. We prefer gravity inflow and outflow, but pump insufflation can maintain the space with relatively low inflow pressures comparable to those used in the subacromial space. This exposure technique should not be performed in the lateral decubitus position due to (1) an inability to achieve necessary exposure of the subdeltoid space with the 90-90-15 positioning of the arm, and (2) the possibility of medial fluid extravasation due to gravity.

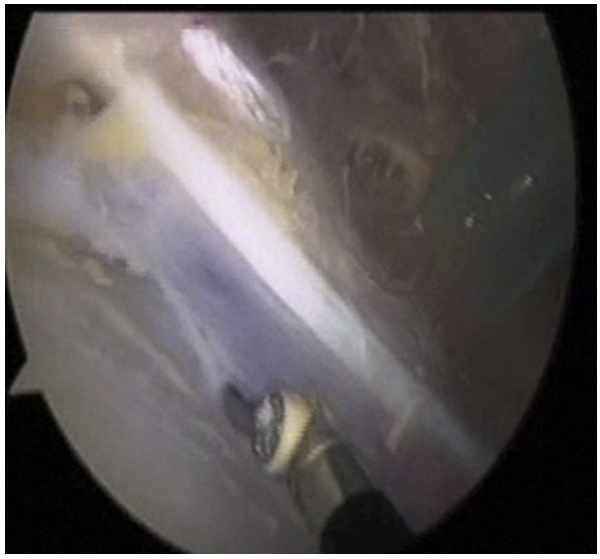
Discussion

Open subdeltoid approaches to the posterior shoulder have been described.[9,13,19] Others have addressed subdeltoid pathologies with arthroscopic techniques such as coracoplasty,[10,11] capsular plication,[3] and rotator interval imbrication.[4] In each technique, however, a tunneling approach was used, without direct, extra-articular visualization of the target. The subdeltoid space enables broader visualization, making such procedures safer, easier, and more efficient.

The subdeltoid space offers a "room with a view," in contrast with conventional tunneled approaches (Fig. 3, *B*). Unlike open techniques, anatomic relationships are maintained in a relatively bloodless field, without retractor distortion.

The arthroscopic subdeltoid approach to the anterior shoulder was to facilitate transfer of the long head of the biceps tendon to the conjoint tendon.[5,17] We have used this approach for more than 300 cases, including stabilization procedures (Fig. 4, *A*), pectoralis major tendon repairs (Fig. 4, *B*), and subscapularis tendon repairs. Another surgeon at our institution, Dr Joshua S. Dines, is using the subdeltoid space for arthroscopic-assisted removal of symptomatic proximal humerus plates (Fig. 4, *C*). To date, there have been no neurovascular complications, compartment syndrome, or longstanding asymmetry. One woman noted temporary breast asymmetry (2 months) after surgery.

Risk to neurovascular structures occurs at two levels: portal placement and manipulation of structures within the subdeltoid space itself. Unlike traditional shoulder arthroscopy, we enjoy great flexibility in portal placement within the subdeltoid space because only one layer (deltoid)



Video still. View of the conjoint tendon in a right shoulder within the subdeltoid space, during exposure. The arthroscopic view is from the anterolateral portal. The radiofrequency ablation device is in the pectoralis portal.

is traversed.[12,14-16] Two neurovascular structures are at risk during portal placement, the cephalic vein and the axillary neurovascular bundle. Iatrogenic cephalic vein laceration can be avoided by staying lateral to the deltopectoral interval and using the aforementioned technique of blunt portal placement. The axillary neurovascular bundle can be found within the roof of the subdeltoid space, along the undersurface of the deltoid, 3.5 cm distal to the greater tuberosity and 6 cm distal to the anterolateral edge of the acromion.[6] It is generally not encountered.

More frequently encountered, however, are the anterior humeral circumflex artery and its 2 vena communicantes, also known as the "three sisters." Along the floor of the subdeltoid space, they transverse deep to the musculotendinous junction of the coracobrachialis and short head of the biceps, typically just medial to the bicipital groove. The ascending branch of the anterior humeral circumflex artery may be encountered along the lateral border of the bicipital groove and can be

coagulated safely if bleeding is encountered. The percentage of the contribution of the anterior humeral circumflex artery to humeral head perfusion remains a controversial topic.[8] If possible, ligation of the anterior humeral circumflex artery should be avoided to prevent postoperative avascular necrosis of the humeral head. To date, none of our patients have presented with avascular necrosis.

The brachial plexus runs in concert with the subclavian/axillary artery medial to the conjoint tendon. These structures remain protected as long as the dissection remains lateral to the conjoint tendon.

The musculocutaneous nerve, however, pierces the coracobrachialis muscle and then runs distally within its belly. It enters the conjoint tendon from the medial side at an average of 49 mm from the tip of the coracoid, but this can be less than 25 mm in 5% of patients.[2] The relationship of the musculocutaneous nerve to the coracoid is dynamic. With the shoulder in 90° abduction and internal rotation, it moves to within 20 mm of the coracoid process.[1] During subdeltoid arthroscopy, the upper extremity is maintained in the 90-90-15 position, and thus, the musculocutaneous nerve remains medial and well protected.

Conclusion

The subdeltoid space can be easily and safely exposed. This technique enables unprecedented arthroscopic access to anatomic structures such as the coracoid process, conjoint tendon, pectoralis major and pectoralis minor, anterior capsule, subscapularis tendon, supraspinatus tendon, and rotator interval. We believe that subdeltoid arthroscopy can provide a safe and efficient addition to evaluating and treating anterior shoulder pathology.

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Disclaimer

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