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Sports Tips & Tricks: Arthroscopic Repair of Massive Rotator Cuff Tear

Cody Hansen, MD
John D Kelly IV, MD

Department of Orthopaedic Surgery
University of Pennsylvania

The treatment of massive, retracted rotator cuff tears presents a challenge to the shoulder surgeon. However, when certain principles are adhered to, most large tears can be restored to at least near anatomic position. The preponderance of tears possess at least one mobile limb and require a side to side reduction. In fact the width of the supraspinatus insertion has been shown to be only 1.3mm.[1] indicating that tears retract posteriorly or anteriorly. The infraspinatus tendon to inserts anteriorly on the greater tuberosity as it blends with the supraspinatus footprint. (Figure 1) and will predictably retract posteriorly in time. Tears with an exposed lateral footprint greater than 1.3mm require some mobilization to allow excursion infraspinatus tissue anteriorly, or coracohumeral ligament tissue posteriorly in order to effect a tear reduction. So called 'crescent' (Figure 2) tears that are repaired directly laterally with double row constructs are predictably repaired under excessive tension and are more likely to fail.(Figure 3) Tension is the 'bane' of rotator cuff repair[11], and it is the senior author's contention that in an effort to obtain a 'double row' construct, the art of tear reduction has been abandoned.

Clearly a double row construct affords greater footprint compression. However biomechanical studies comparing double row to single row are inherently flawed since that are performed in cadaveric specimens where acute tears are created surgically.[23] Clinically, the preponderance of rotator cuff tears are chronic and retract in line of muscle pull.

The repair of massive rotator cuff tears have yielded unpredictable results with a high reported rate of re-tear noted,[7] highlighting the importance of honoring the biology of tendon healing. This paper will delineate an approach for arthroscopic repair of massive rotator cuff tears emphasizing the importance of tear reduction and minimizing tension. We would also like to introduce the term 'oblique reduction' to more precisely characterize surgical restoration of anatomy.

Reducing the Tear

Anatomic reduction of the torn cuff to the greater tuberosity should be the surgeon's chief goal in order restore to restore cuff function and minimize rotator strain at the repair site. Two principle factors that may affect the surgeon's ability to achieve anatomic reduction include the amount of

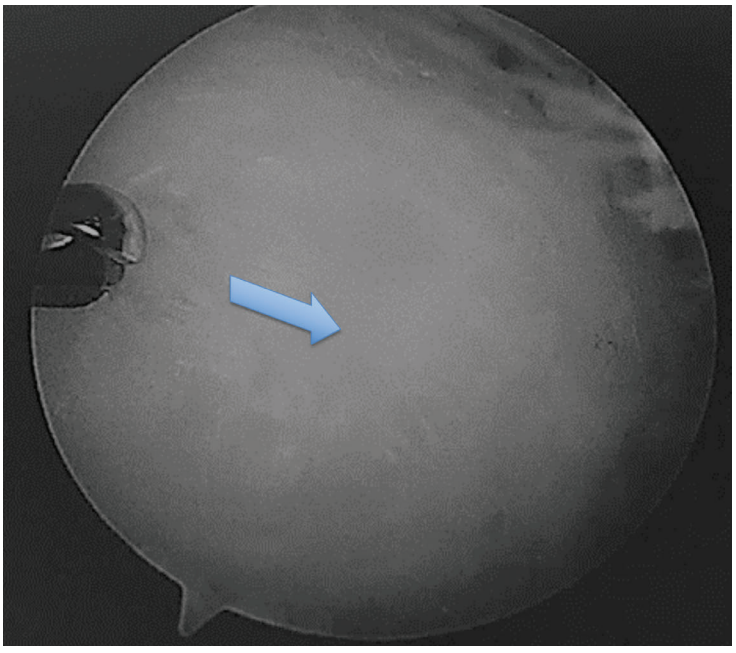

Figure 1. Infraspinatus fibers inserting anteriorly on greater tuberosity.

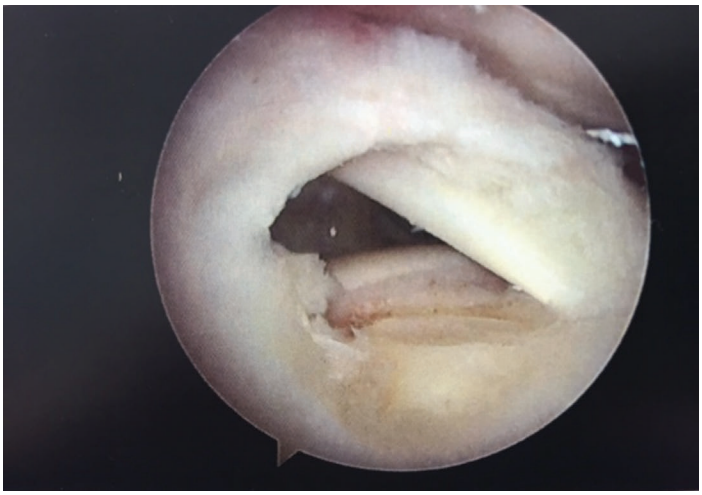

Figure 2. "Crescent tear."

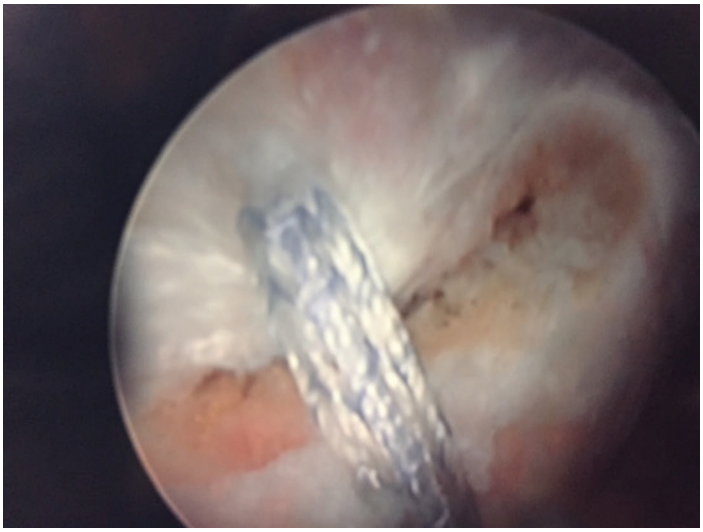

Figure 3. 'Oblique Reduction' of mobile posterior limb.

tendon retraction or scarring, and tissue quality. However, once the direction of cuff displacement is recognized, it is the senior author's experience that at least a near complete tear reduction is usually possible.

The location of the 'mobile limb' in the retracted tear will dictate the strategy of side to side suturing. When grasping the edges of the tendon with an arthroscopic grasper and pulling the posterior limb anteriorly and the anterior limb posteriorly a more mobile limb will be appreciated. Tendon excursion can be apprised from various portal locations, but is usually best visulaized while viewing from the '50 yard line' view—a portal directed lateral to the tear apex. Cuff mobilization can be improved with debridement of scar and bursal tissue, as well as extra- and intra-capsular releases of adhesions. An anterior interval slide can be performed (technique discussed below) which not only frees the subscapularis (often torn) but also releases the coracohumeral ligament (CHL). The senior author does not recommend posterior interval slides as this may introduce excessive tissue trauma to already compromised tissue.[3] Furthermore, as stated previously, the infraspinatus insertion on the tuberosity curves anterolaterally[1], and a straight posterior interval slide conceivably may violate the native infrapsinatus tendon.

It is paramount to recognize that subscapularis tears are far more common than generally realized.[22] With subscapularis repair and advancement, the adjacent 'comma tissue' is lateralized, allowing tissue for suitable fixation for the posterior cuff. Thus, subscapularis repair lessens cuff defect size as well as providing tissue to be approximated to the posterior cuff (oblique reduction).

The term "margin convergence" was introduced by Burkhart et al. to describe the side-to-side repair of massive, longitudinal-type tears, converting them into smaller 'crescent-shaped' tears.[2,3] This technique effectively shifts adjacent tissue laterally to decrease the medial to lateral dimension of the tear. Using margin convergence, the free edge of the tear "converges" toward the rotator cuff footprint, allowing for decreased strain and tension. [3] Burkhart et al illustrated the power of this technique when he compared those who underwent direct tendon to bone repair for smaller crescent-shaped tears versus patients with larger U-shaped tears treated with margin convergence, and found no significant difference at 3.5 years post operatively.[4] Additionally these authors used elegant biomechanical principles to illustrate how margin convergence confers significant strain reduction at tear edges.[5] By virtue of the rotator cuff footprint[1] and the anterolateral insertion of the infrapsinatus, most side to side suturing will involve an apical suture posteriorly with anterior tissue bites usually taken more laterally ('L shaped' tear) in an effort to execute the 'oblique reduction' (Figure 4).

Although the goal is to achieve anatomical reduction of the rotator cuff, medialization of the repair may be necessary since excessive tension is to be avoided (Fig 5). Several biomechanical and anatomic studies combined with clinical data have asserted that insertion medialization less than 10 millimeters yields favorable outcomes without

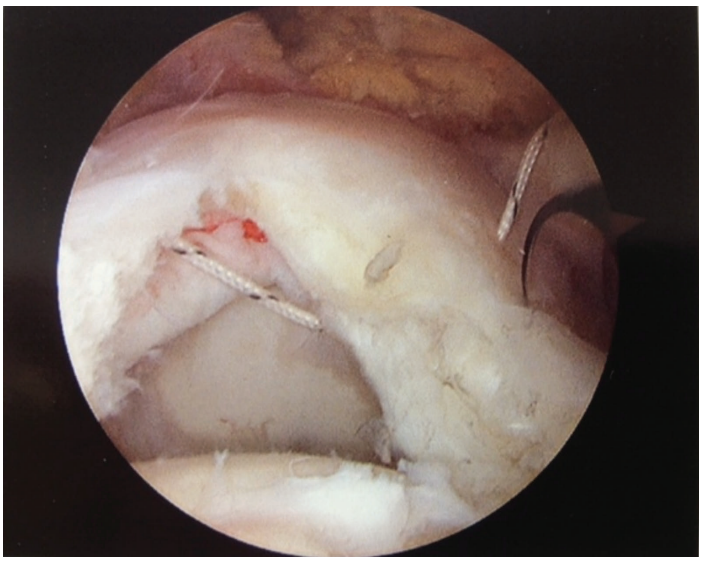

Figure 4. Oblique suture pattern for Margin Convergence.

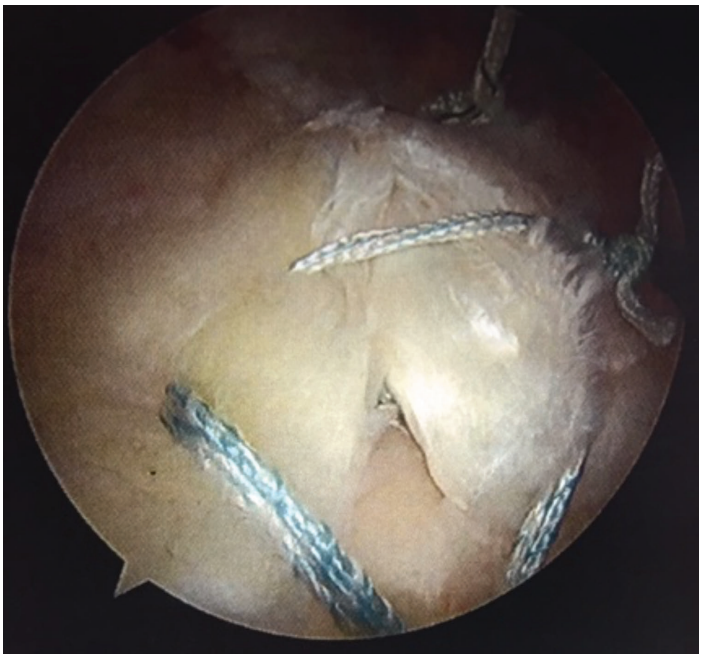

Figure 5. Medialized repair.

appreciable effects on range of motion strength[6,8].

Tension

Cuff tears repaired under tension have been shown in animal studies to be at higher risk of failure with a decrease in material properties within the repaired tissues. [10] Additionally, patients who underwent rotator cuff repair under increased tension were noted to have decreased perceived improvement post operatively, decreased strength measures, and increased post-operative pain.[11] More recently the description of 'type 2' failure (Figure 6) a result of excessive medial tension in double row constructs, reinforces the perils of tension on biology.

As mentioned above, margin convergence (oblique reduction) is a technique that approximates tendon edges and creates a relatively tension free repair. Using a cadaveric model, Burkhart et al.[5] described the improvement in tear gap size and strain with margin convergence with singular successive side-to-side suture placement. The index suture decreased the gap size by 50%, followed by 60% with the second suture, 67% with the third suture, and 75% with the fourth and final suture. In addition, there was an average reduction in the strain in both the subscapularis and infraspinatus tendons of 58%[5]

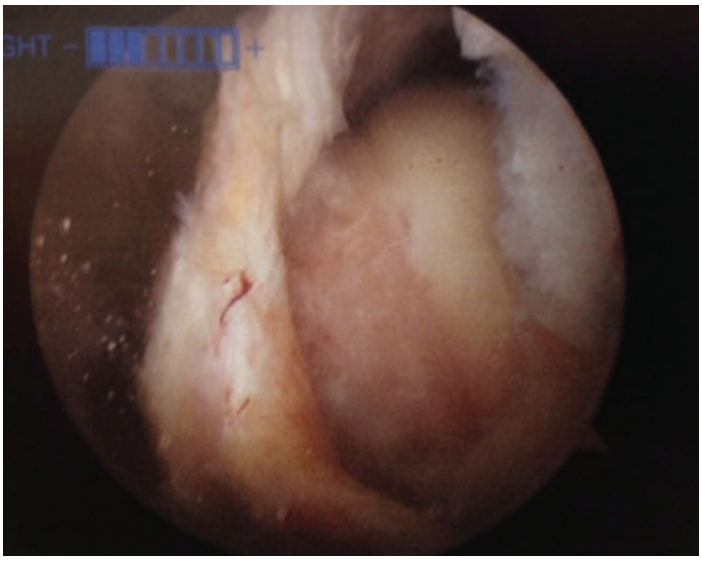

Figure 6. 'Type 2" (medial) failure.

Technique

Arthroscopic repair of the massive rotator cuff tear demands appropriate pre-operative planning, positioning of the patient, optimal portal placement, and thorough arthroscopic evaluation of the glenohumeral joint and subacromial space. Once the cuff tear has been defined and the tissue appropriately debrided, excursion of the cuff tendon is assessed using an arthroscopic grasper. As stated above, the tendon is grasped on either side of the apex to assess which limb is mobile (usually posterior). Oblique reduction suturing can then be planned in order to effect reduction.

It is critical to release all bursal adhesions medially to the scapular spine in an effort to increase excursion of the infraspinatus. The senior author maintains that an inferior capsular release is an essential element of reducing humeral head elevation. (Figure 12) since most chronic tears are associated with anterior superior humeral head excursion. In addition, a thorough CHL release will similarly allow the humeral head to descend inferiorly and facilitate humeral head coverage. An electrothermal device is delivered down to the base of the coracoid process while the lateral soft tissues linking the supraspinatus and infraspinatus are left intact. (Figure 13) An important structure, termed 'comma sign' by Burkhart, must be preserved as it houses a connection of the subscapularis to the supraspinatus. In fact, some investigators posit that the 'comma tissue', once thought to consist of the superior glenohumeral ligament and coracohumeral ligament, may actually contain anterior fibers of the supraspinatus.[3] Often the senior author finds that the placement of traction sutures in both anterior and posterior limbs facilitates reduction. (Figure 7)

Again, oblique reduction suturing proceeds medially to laterally with an apical suture placed into the mobile (usually posterior) limb with the subsequent bite in the opposing limb directed more laterally in order to effect a tear reduction. The absence of a 'dog ear' indicates that the tear is anatomically reduced. (Figure 8) The surgeon is to continue to place oblique side-to-side sutures until the tendon reduction tension becomes noticeable. After oblique reduction suturing is completed, the lateral free margin can be repaired to the prepared bony footprint on the humerus with decreased tension using a variety of techniques. The senior author prefers to incorporate tape type suture to secure tendon edges to bone. The

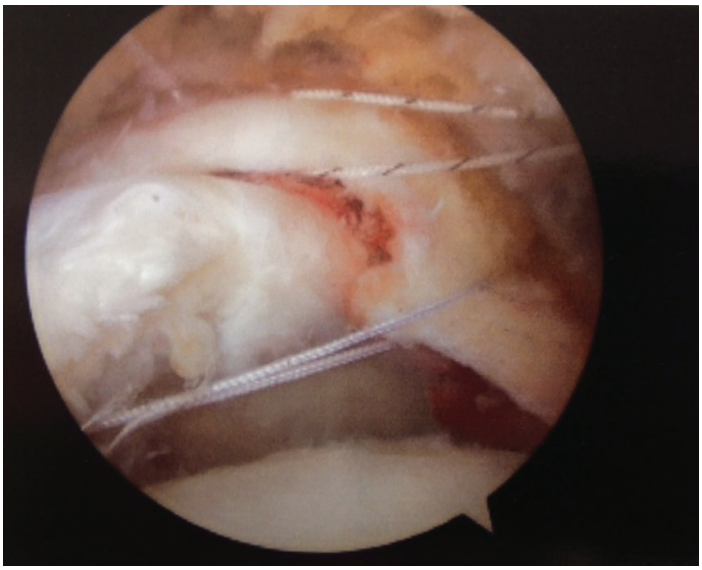

Figure 7. Traction sutures placed anteriorly and posteriorly.

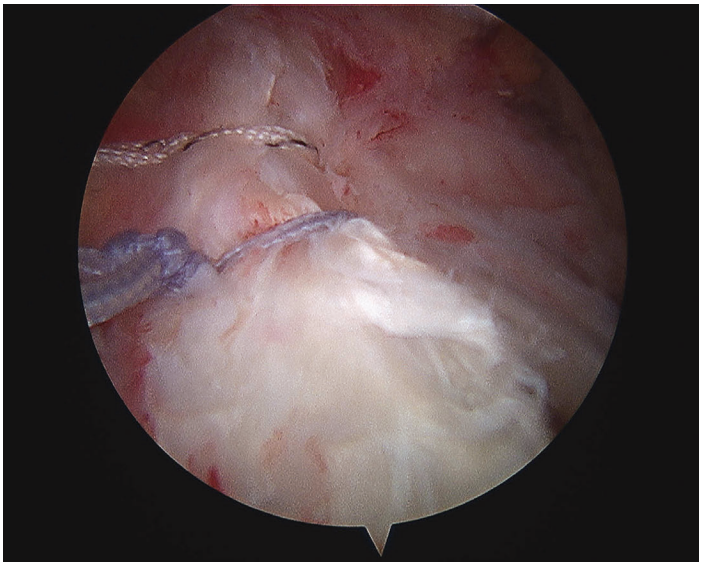

Figure 8. Absence of 'dog ear' in anatomic reduction.

Figure 9. Usage of Tape Suture to reduce tear.

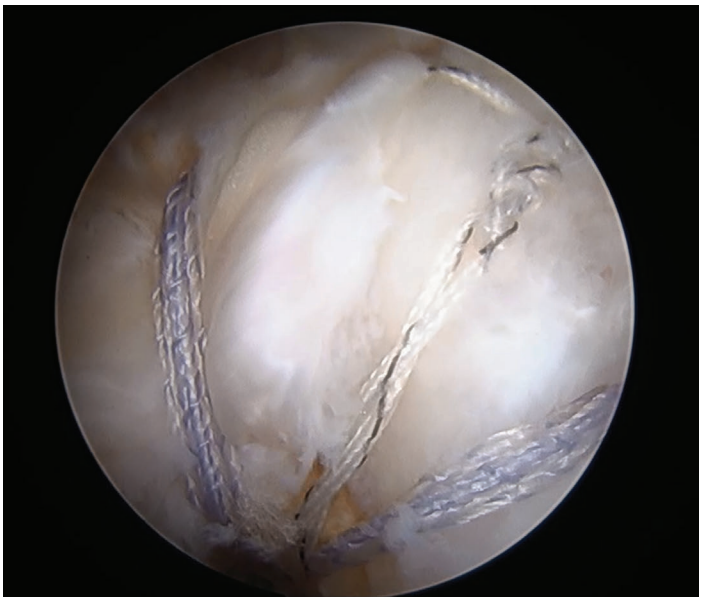

Figure 10. Using margin convergence suture and tape to reduce tear.

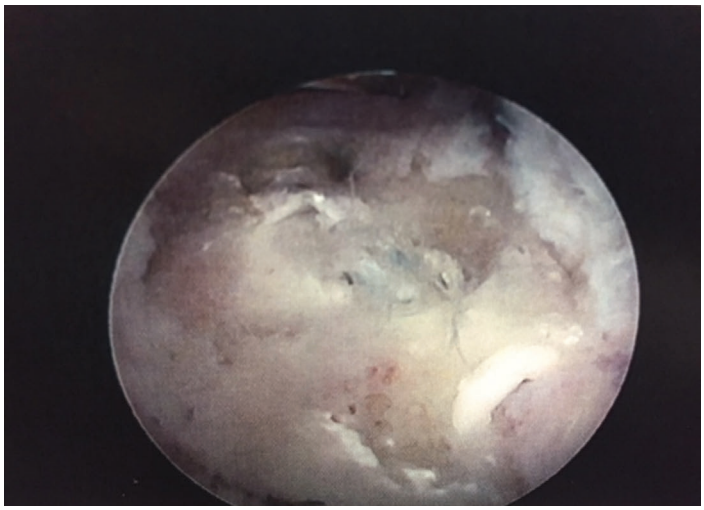

Figure 11. 'Anchor Fest' on tuberosity eliminating bone surface area for healing.

tape suture bites are taken in an effort to continue tear reduction—that is, the tape sutures help to converge the margin to bone when tensioned (Figure 9). Occasionally the senior author will incorporate the free ends of the margin convergence sutures into the lateral anchor in an effort to enhance fixation security. (Figure 10)

Anchors

Suture anchors are costly[6] and when double row fixation is implemented precious 'footprint' is occupied by non-biologic tissue (Figure 11). The senior author regards the footprint area as 'sacred' and should be revered as a repository of receptive, healing bone rather than a 'graveyard' of anchors. In order to enhance biology, the senior author routinely performs a 'tuberoplasty' in an effort to help joint congruence and generate a bleeding

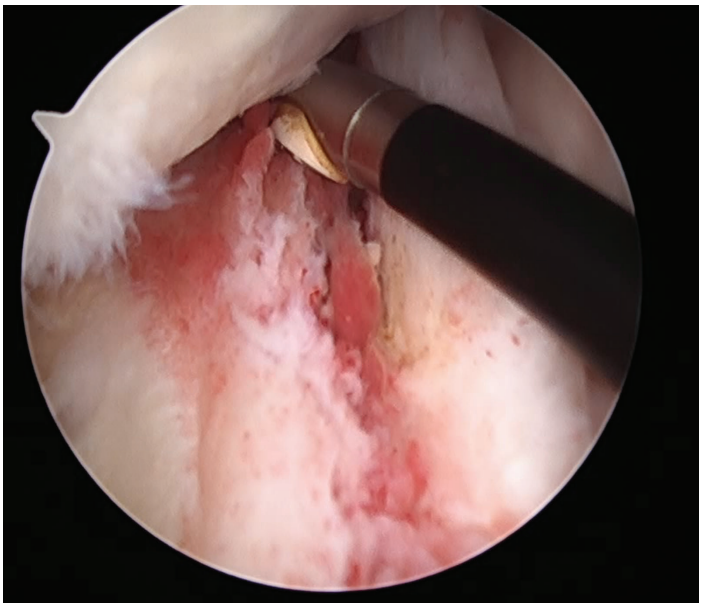

Figure 12. Posterior inferior capsular release.

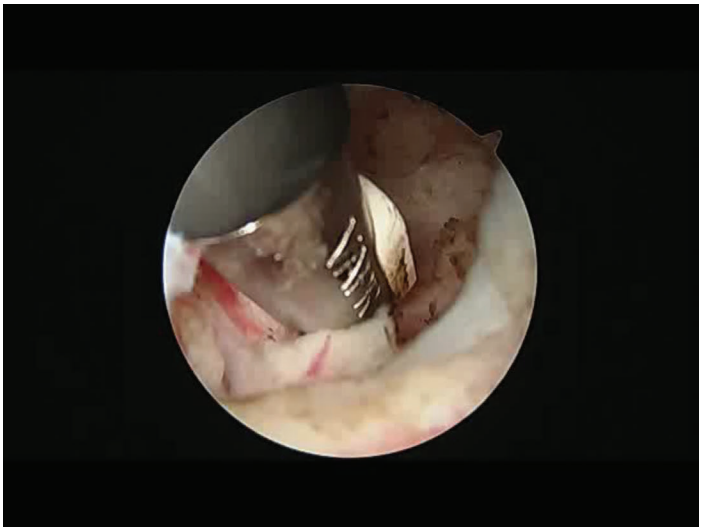

Figure 13. Release of CHL off Coracoid Neck. 70 degree scope may be helpful.

bone bed.[8]

Summary

Oblique reduction is essential to effect anatomic restoration in the preponderance of rotator cuff tears. The very narrow lateral insertion of the supraspinatus dictates that essentially all tears will have an oblique reduction pattern. The impetus of industry to promote more anchor usage and regard most tears as 'crescent' shape leads to improper reduction with non-physiologic tension and excessive costs. Reduction of humeral head elevation and near coverage of a depressed humeral head are tantamount to success. The senior author's experience with these aforementioned techniques has been favorable with attainment of Penn Shoulder score of 84 when full coverage is attained.[24]

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