

회전근개 질환의 외과적 치료

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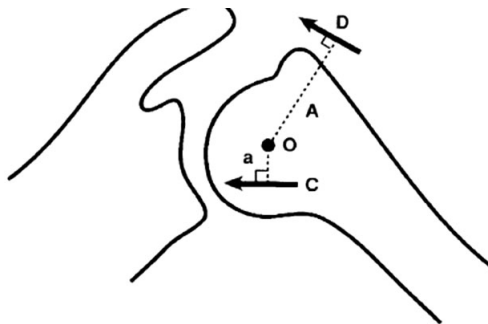
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A. PRINCIPLES^{5,15)}:

1. Maintain Force Couple:

1) CORONAL PLANE FORCE COUPLE:

This force couple is a result of the balance of moments created by the deltoid muscle and opposed by those created by the intact portions of the inferior rotator cuff (that is, the infraspinatus, teres minor, and subscapularis muscles).



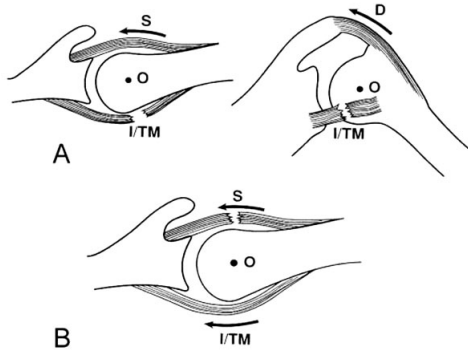
$$\begin{aligned} \Sigma M_o = 0 &= C \times a - D \times A \\ D \times A &= C \times a \end{aligned}$$

CORONAL PLANE FORCE COUPLE

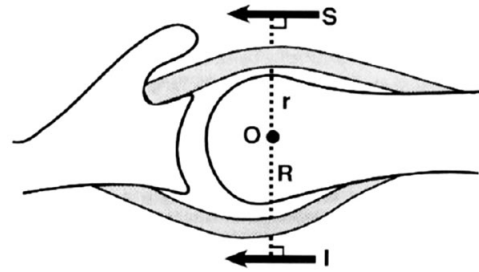
At the initiation of abduction, the coronal plane force couple will only be balanced if the line of action of the rotator cuff force(C) is below the center of rotation (o) of the humeral head so that it may oppose the moment created by the deltoid muscle (D) to maintain stable fulcrum of glenohumeral joint.

2) TRANSVERSE PLANE FORCE COUPLE:

This force couple consists of the subscapularis muscle anteriorly balanced against the posterior rotator cuff (the infraspinatus and teres minor muscles). This force couple is particularly relevant in cases of massive rotator cuff tears that extend more posteriorly, in which there is only a remnant of posterior cuff, as well as in cases involving significant portions of the subscapularis tendon.



UNBALANCED TRANSVERSE PLANE
FORCE COUPLE



$$\Sigma M_O = 0 = I \times R - S \times r$$

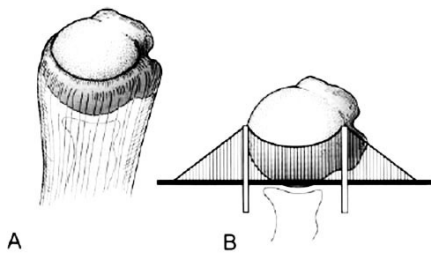
$$\therefore I \times R = S \times r$$

BALANCED TRANSVERSE PLANE
FORCE COUPLE

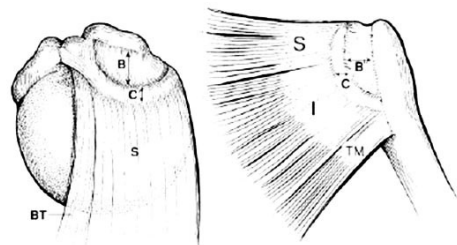
Therefore, when faced with a rotator cuff tear, the primary goal of surgery is to balance the force couples in the transverse and coronal planes and not necessarily to cover the hole.

2. Rotator Cable–Crescent Complex

This “rotator cable” extends from its anterior attachment just posterior to the biceps tendon to its posterior attachment near the inferior border of the infraspinatus tendon. Although the function of the rotator cable is unclear, it appears that the rotator cable may function in a way that is analogous to a load-bearing suspension bridge. By this model, stress is transferred along the rotator cable as a distributed load, thereby stress-shielding the thinner, avascular crescent tissue. Such a model would predict that, despite a tear in the avascular zone of the supraspinatus tendon, the supraspinatus muscle can still exert its compressive effect on the shoulder joint by means of its distributed load along the span of the suspension bridge configuration

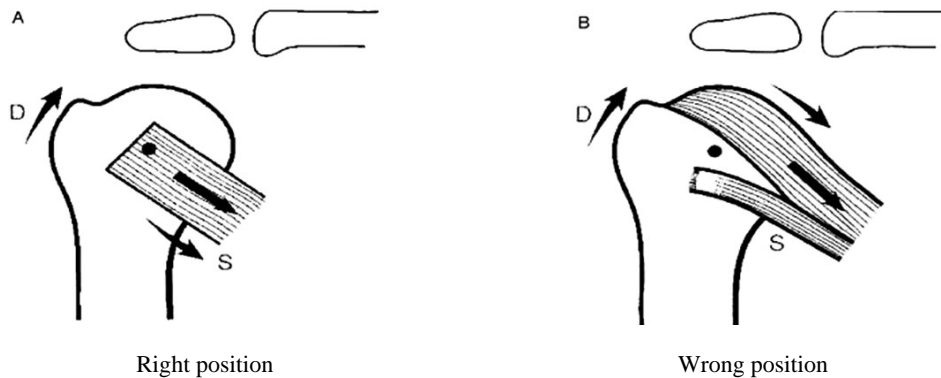


(A) SUSPENSION (B) BRIDGE



(A) POSTERO- SUPERIOR (B) CUFF

3. Anatomic Foot Print Insertion



A. the centroid (line of action) of the subscapularis tendon lies inferior to the center of rotation, forming a force couple with the deltoid muscle. These two muscles have moments that are opposite in direction.

B. the subscapularis tendon in its transferred position now has its centroid above the center of rotation and its moment are in the same direction as the deltoid moment. This muscle transfer destroys the important coronal plane force couple.

D, deltoid moment; S, subscapularis.

B. INDICATIONS OF SURGERY:

Nonsurgical treatment remains the standard initial care for rotator cuff tear. Surgery is indicated for those patients who fail to respond to nonoperative measures. Although some have attempted to define a specific period of time to try treatment without surgery, it seems more reasonable to rely on the patient's response to nonoperative management and functional demands of the shoulder as the basis for determining future treatment. Many patients have had several months of nonsurgical care before they are seen by an orthopaedist. In such cases, especially if there has been no improvement, an additional lengthy period of nonoperative treatment is unnecessary before surgery. For active patients, once a torn rotator cuff is diagnosed, surgical repair is recommended. In less-active patients who do not rely on the shoulder for work or sports, employ a trial of nonoperative measures similar to the program used for impingement. If there is no significant improvement in pain and function within 2 to 3 months, surgical repair is recommended.

1. Pain: > 3 months of conservative treatment
Good Strength
2. Sudden Loss Of Strength: RC Repair as soon as possible

3. Gradual Loss OF Strength : RC Repair before it becomes Irreparable

C. RESULTS OF ROTATOR CUFF SURGERY

The results of open or arthroscopic subacromial decompression are essentially equivalent, with approximately 75% to 90% of patients having a good or excellent result. Advocates of the arthroscopic approach note diminished perioperative pain, faster return of motion and earlier return to activity. The arthroscopic procedure is technically demanding, and other than error in diagnosis, an inadequate or poorly performed acromioplasty is the major reason for failure of the procedure.

Following direct tendon repair, satisfactory results can be expected in 75% to 90% of patients. Relief of pain rates highest, followed by lower scores for ROM and return of function. The following are useful guidelines to predict success when treating patients with rotator cuff tear:

1. In general, small and moderate tears have better overall results (pain relief, motion and function) than large and massive tears
2. Duration of symptoms and preoperative weakness correlate with size of the cuff tear
3. Cuff integrity at follow-up correlates with improved strength, motion, and function but does not affect pain scores; large tears with involvement of the supraspinatus and infraspinatus have a retear rate greater than 50%
4. Return to previous activity level for the high-level competitive athlete is approximately 50%, whereas more than 80% of recreational athletes can return to activity
5. Rehabilitation time is prolonged by 25% when distal clavicle excision for AC joint arthritis is performed concomitantly with rotator cuff repair
6. Persistent mechanical impingement and large or massive tears of the cuff are the two major reasons for surgical failure
7. Although a good outcome for pain relief, motion and strength can be obtained in full-thickness tears treated by decompression only, improvement in pain only is most likely, and repair offers the best results.

D. PROGNOSTIC FACTORS²⁵⁾:

1. Size of tear: small and medium sized tear have excellent results compare to large and massive size.
2. Chronicity of the tear: more chronic tear more failure
3. Grade of fatty infiltration: more the Goutalliar fatty index more chances of failure
4. Occupation ratio: >50% indicates supraspinatus atrophy resulting in more failure
5. Tangent sign : indicates supraspinatus atrophy resulting in more failure
6. Age & Sex : Female and higher age people generally have poor results

E. BASIC TEAR PATTERNS AND REPAIR TECHNIQUES:

Rotator cuff tears are either single or multiple tendon tear. Generally single tendon tear are small to

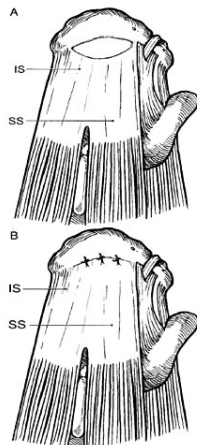
medium size(1~3cm) and multiple tendon tear are large to massive size(3-5cm & > 5cm). Other classification can be anterosuperior tear (subscapularis/biceps lesion/ supraspinatus mainly anterior) and posterosuperior tear (supraspinatus and infraspinatus, \pm biceps, teres minor)

Various steps in surgical repair either open or arthroscopic are:

1. Identify which tendon is involved and size of the tear.
2. Subacromial decompression (acromioplasty & bursal removal)
3. Check for the mobility of the tendon.
4. Release Adhesions (subacromial & subdeltoid) if the torn tendon is still retracted
5. Identify the footprint and prepare the bone bed for tendon insertion and healing
6. Repair the tendon to bone bed with transosseous suture or suture anchors with either single row or double row technique.

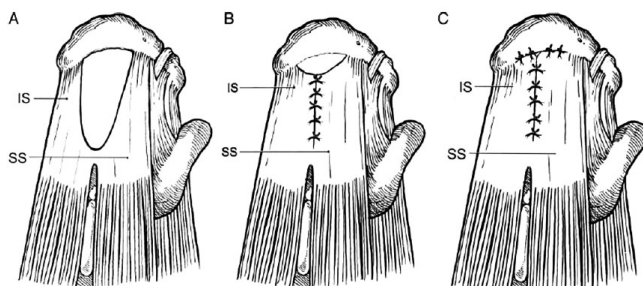
Below few surgical steps and technique are mentioned on how to identify tear pattern and repair them^(6,8,24,25):

POSTERIO-SUPERIOR TEAR



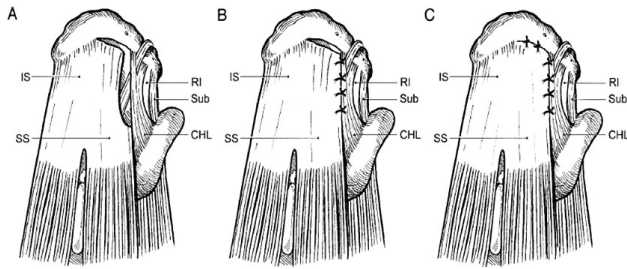
A. Crescent Shape Tear:

1. Excellent Mobility
2. Simplest of all Tears
3. Minimal Tension
4. Type 1 Repair
5. Good Tendon to Bone Healing



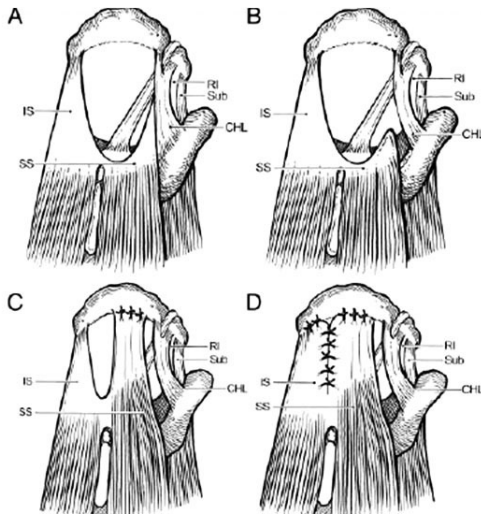
B.U Shape Tears:

1. Excellent mobility ant-posteriorely
2. Side to Side Repair
(Margin Convergence)
3. Tension free tendon to bone Healing
4. Type one repair
5. Non Anatomical



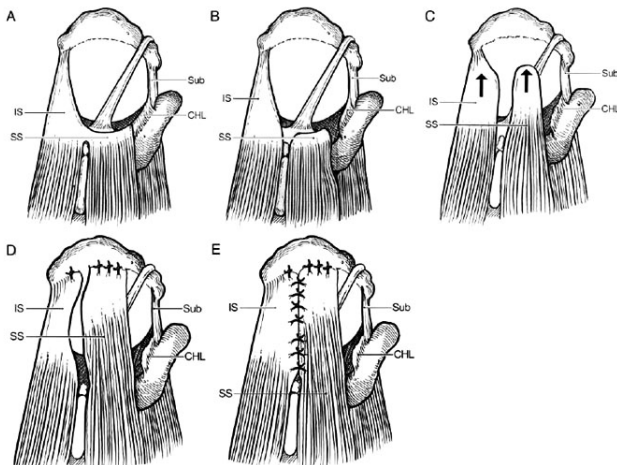
C. L Shape Tear:

1. Side to Side repair for longitudinal split
2. Usually posterior leaf more mobile
3. Tension Free tendon to bone healing
4. Type one repair



D. Massive, Contracted, Immobile Tears:

1. Generally L Shape or Crescent Shape
2. Mobilization techniques:
 - Subacromial/subcoracoid decompression & adhesion release
 - Subdeltoid adhesion release
 - Capsular release
 - Anterior interval Slide
 - Both Anterior & Posterior Interval Slide
3. Partial Repair
4. High retear rates
5. Good functional recovery inspite of poor anatomical healing



Chronic Massive, Contracted, Immobile Longitudinal (L) Tear

Chronic Massive, Contracted, Immobile Crescent shape tear

SUBSCAPULARIS TEAR:

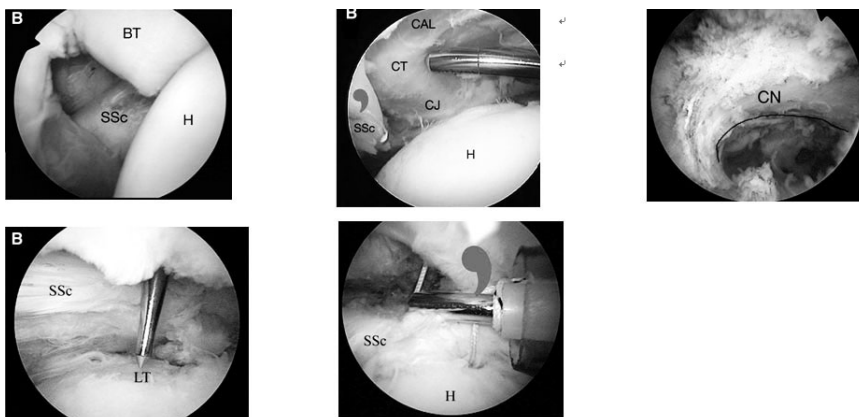
Subscapularis tears have become an increasingly recognized cause of shoulder pain and dysfunction. Although the overall incidence of subscapularis injuries has been traditionally reported to be small when compared to disorders of the superior rotator cuff, there is evidence to suggest that subscapularis tears had been probably under-recognized before MRI and arthroscopy. In one study, abnormalities of the subscapularis were reported in 27% of patients during arthroscopic evaluation of patients with other intraarticular pathology.

A useful classification divides subscapularis tears into three types:

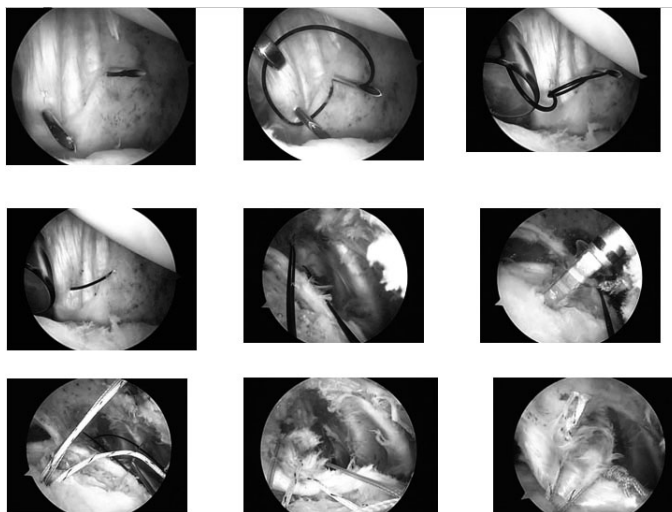
- Partial tears, which can involve the superior third or the superior and middle portions
- Complete, nonretracted tears
- Retracted tears

Subscapularis tears more commonly occurs in combination with other rotator cuff tears, rather than in isolation and partial tears are more common than complete tears. Its main functions are maintenance of force couple, anterior stabilization of glenohumeral joint and internal rotation. Arthroscopic repair of subscapularis tears has developed significantly since the early 21st century. Most partial tears are amenable to arthroscopic mobilization and repair; complete tears that are significantly retracted are often difficult to safely and effectively mobilize laterally without an open approach. Arthroscopic debridement is an option in selected patients with limited demands in the setting of substantial, chronic subscapularis tears. A few reports document outcomes after arthroscopic subscapularis repair. Burkhart and associates reported 92% good to excellent outcomes after arthroscopic suture anchor repair in 25 patients. In a prospective series of isolated arthroscopic subscapularis repairs, Bennet reported significantly improvement in pain and function at 2 to 4 years of follow-up. However, still no consensus exists on treatment algorithms for debridement compared with repair of partial-thickness or full thickness tears of subscapularis tendon^{1,11)}. Two types of repair technique are shown below one by Dr. Burkhart SS⁷⁾ and other articular side mattress suture²⁶⁾

a. Intraarticular Repair for Complete Tear



b. Double Mattress Repair Technique for Incomplete Tear



F. REPAIR APPROACH

- * Open/
- * Miniopen +/- Arthroscopic assisted.
- * All Arthroscopic

OPEN REPAIR²⁰⁾

Traditional open technique though produced good results is decreasing in popularity because of improved instrumentation, technique and understanding of arthroscopy⁴⁾. It uses transosseous tunnel technique for fixation. Complications associated with open repairs majorly like deltoid dehiscence or detachment, deep infections, postoperative pain, stiffness have been avoided by arthroscopic repair with equivalent results

MINI OPEN REPAIR

Advantage¹⁷⁾

- * Small to medium size tear can be repaired
- * One or One-n-Half tear (SP OR SP/IF)
- * Less morbid compared to open technique
- * Deltoid Splitting procedure
- * Day care procedure
- * Requires less specialized equipment

- * Transosseous fixation or suture anchor fixation both are possible
- * 90% excellent to good results

Disadvantage^{3,17)}

- * Subscapularis Tear cannot be repaired
- * Revision RC Repair not possible
- * Massive Tear, BT Pathology difficult to manage
- * Limited exposure
- * Significant trauma to deltoid
- * Arthroscopic assisted is sometimes required.
- * Recurrent Tear
- * Complications like stiffness, postoperative pain, reduced ROM, infection are more compared to arthroscopic repair

ARTHROSCOPIC REPAIR

Advantages¹⁷⁾

- * Minimally invasive
- * Deltoid sparing
- * All types (small to massive) RCT can be managed
- * Better understanding of tear Geometry, Extent of medial retraction, mobility and repair techniques
- * Less post operative pain, better cosmesis
- * Early Rehabilitation is possible
- * Concurrent glenohumeral joint pathology can be addressed
- * Results are similar to traditional open or mini open technique with fewer complications^{2,10,17}

Disadvantage:

- * Long learning curve
- * Technically demanding
- * Costly equipments
- * Retear or Recurrence
- * Complications associated with suture anchor ? eyelet fracture, anchor breakage, cyst formation around anchor,

G. REPAIR TECHNIQUES

As our understanding of arthroscopic techniques and its instrumentation continue to improve, arthroscopic rotator cuff repair has become increasingly more popular. High rate of recurrent tear was reported after using arthroscopic single row repair in large and massive rotator cuff tears as it did not adequately restore the footprint contact area^{2,13)}. So to have more foot print coverage, better tendon to

bone (biological) healing and to improve initial strength and stiffness, to decrease gap formation and strain over footprint and to have a biomechanically more stable construct a double-row repair technique was introduced^{12,16,23}.

SINGLE ROW

1. Technically Easy
2. Less Time Consuming
3. Cheap
4. Time Tested

DOUBLE ROW

1. Biomechanically more Superior²²
2. Better footprint coverage.
3. Time consuming, ? Cuff strangulation, Greater tuberosity fracture
4. Technically demanding and costly

RECENT REPORTS STATES THAT THERE IS NO CLINICAL OR MRI DIFFERENCE IN SINGLE AND DOUBLE ROW^{15,19,21}

H. CHRONIC IRREPAIRABLE CUFF TEARS:

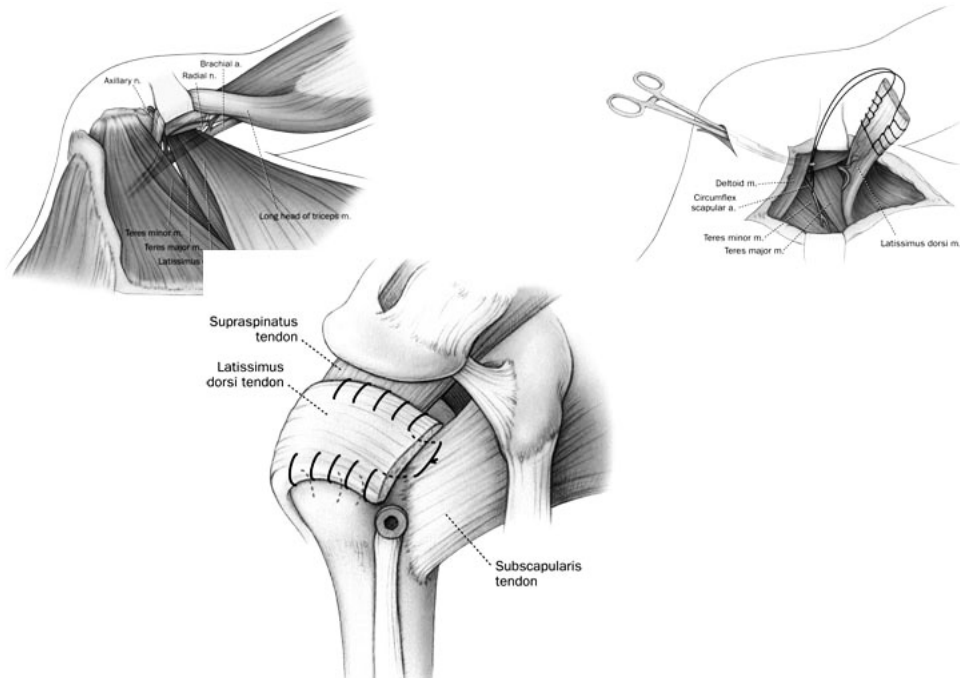
Options available:¹⁸⁾

1. Debridement with or without acromioplasty/biceps treatment for functionally low demand patient with good pain relief
2. Partial repair: improves pain and function/biomechanics of shoulder by maintaining force couple.
3. Tendon transfer: for relatively young patient whose chief complaint is weakness, produce stable shoulder kinematics by maintaining force couple
4. Reverse total shoulder arthroplasty

Ideal management for this type of tear is still debatable

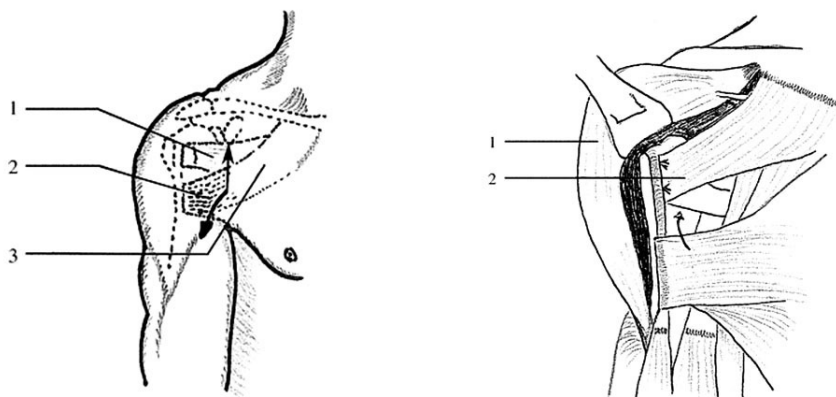
A. Latissimus Tendon Transfer⁹⁾:

Indicated for irreparable postero-superior cuff tear with loss of shoulder elevation and external rotation. It needs substantial period of rehabilitation, so person who is will to undergo such process is ideal. Also subscapularis should be intact. Contraindicated in case of, substantial subscapularis tear, gleno-humeral arthritis, axillary nerve injury, irreparable deltoid detachment, uncooperative patient.



B. Pectoralis Major Transfer¹⁴⁾:

Indicated for chronic irreparable antero-superior tear. Complications are brachial plexus or musculocutaneous nerve injury, infection, haematoma formation, arthropathy, etc. Good results with regards to pain relief, function and stability of glenohumeral joint



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