Aus dem Johanna-Etienne Krankenhaus
Klinik und Poliklinik für Orthopädie und Unfallchirurgie
Chefarzt: Prof. Dr.med. Dr. h.c. Jörg Jerosch

EVALUATION OF THE RESULTS OF ARTHROSCOPIC REPAIR OF ROTATOR CUFF TEARS

INAUGURAL - DISSERTATION

Zur

Erlangung des doctor medicinae

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der Westfälischen Wilhelms-Universität Münster

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Morsy, Mohamed

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1. Berichterstatter: Prof. Dr.med. Dr. h.c. Jörg Jerosch
2. Berichterstatter: Prof. Dr. med. Timm J. Filler

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Aus dem Johanna-Etienne Krankenhaus
Klinik und Poliklinik für Orthopädie und Unfallchirurgie
Chefarzt: Prof. Dr.med. Dr. h.c. Jörg Jerosch
Referent: Prof. Dr.med. Jörg Jerosch
Koreferent: Prof. Dr. med. Timm J. Filler

Zusammenfassung

Titel der Dissertation

EVALUATION OF THE RESULTS OF ARTHROSCOPIC REPAIR OF ROTATOR CUFF TEARS

Morsy, Mohamed

Rotatorenmanschettenruprturen gehören zu den häufigsten Beschwerdebildern der Schulter. Von jeher werden sie als stark limitierende Erkrankung der oberen Extremität eingestuft. Klinisch werden sie durch Provokations- und Funktionstests nachgewiesen. Die bildgebende Diagnostik besteht aus initialen nativen Röntgenaufnahmen und setzt sich mit sonographischen Untersuchungen, sowie mit MRT und MR-Angiographie fort. Die Klassifikation der Rotatorenmanschettenrupturen erfolgt nach ihrer Form, Ausmaß und nach dem Verletzungsmuster.Bei persistierende Beschwerden und dem Versagen der konservativen Therapiemaßnahmen ist eine operative Rotatorenmanschettenrekonstruktion indiziert.Zahlreiche Publikationen berichten über die Ergebnisse der offenen Rotatoren- manschettenrekonstruktionen und über diverse Opertationstechniken.Seit kurzem werden nun auch arthroskopische Rekonstruktionsmethoden angewandt, die viel versprechende Ergebnisse zeigen.

Ziel: Ziel dieser Studie war die Ergebnisse der arthroskopischen Rotatorenmanschetten-rekonstruktion zu bewerten und ihre Einflußfaktoren zu ermitteln.

Patienten und Methode

Die Studiengruppe besteht aus 40 Patienten(19m, 21f) zwischen 37-78Jr. (Median 61,15 Jr.).Spezielle Ein- und Ausschlusskriterien wurden angewandt. Die Symptome bestanden im Median seit 0,83Jr. (0,25-5Jr.). Der Nachuntersuchungszeitraum variierte zwischen 10-15 Monaten (Median 13,83 M.).

Methode

Diagnostik: Alle Patienten unterzogen sich klinischen und radiologischen Untersuchungen.

Bewertung: Ein Modifikation des Schulterscore der University of California at Los Angeles (UCLA) wurde den Bewertungskriterien zugrunde gelegt.

Therapie: Arthoskopische Rotatorenmanschettenrekonstruktion wurde mittels Knochenankertechnik in Kombination mit einer subacromialen Dekompression durchgeführt.

Ergebnisse

In der klinischen Nachuntersuchung stellten wir eine signifikante Verbesserung des Beschwerdebildes bei 35 Patienten (87,5%) fest, wohin gegen nur 5 Patienten (12,5%) mit dem Ergebnis unzufrieden waren.

Radiologiosch zeigte sich eine signifikante Zunahme des Subacromialraumes von präoperativen 8,15 mm (Median) auf post operative 14,525mm (Median).

Arthroskopische Rotatorenmaschettenrekonstruktionen haben somit ein gutes Ergebnis und ermöglichen die Rekonstruktion der Rotatorenmanschette ähnlich der offenen Operationstechniken mit Vermeidung deren Komplikationen.

Tag der mündlichen Prüfung: 10.03.2007

LIST OF CONTENTS

INTRODUCTION

The rotator cuff (musculotendinous) is the structural integration and functional coordination of the four short scapulohumeral muscles that insert onto the humeral tuberosities (Fig1). It is made up of the subscapularis in the front, the supraspinatus above and the infraspinatus and teres minor behind.[19,29]

The collagenous tissues of the supraspinatus, infraspinatus, and teres minor tendons are structurally integrated with each other and with the underlying capsule, consolidating at their tendinous insertion onto the greater tuberosity.[19,29]

The collagenous fibres of this portion of the rotator cuff form a complex woven pattern rather than a parallel arrangement. Therefore, the normal rotator cuff cannot be incised "in line with its fibres" but only "in line with muscle pull". The complex woven pattern of the collagen bundles offers an advantage over a parallel arrangement, because it provides better purchase for suture materials during repair.[46]

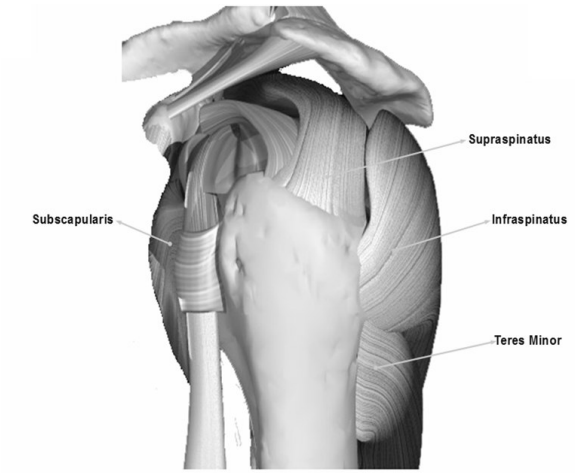


Figure 1: Rotator cuff muscles[1]

Vascular Anatomy

The vascular anatomy of the rotator cuff is of significant interest because of its suggested role in the pathogenesis of rotator cuff tears. Six arteries supply the rotator cuff. The posterior humeral circumflex and suprascapular arteries supply primarily the posterior and superior portions of the cuff, while the anterior humeral circumflex artery supplies primarily the anterior and superior portions. In most cases, the acromial branch of the thoracoacromial artery supplies the supraspinatous. In some cases, there is a small vascular contribution from the subscapular and suprahumeral branches of the lower portion of the axillary artery and, occasionally, from the bone of the greater tuberosity.[54]

Microinjection studies of normal shoulders in cadaveric specimens have shown an area of decreased vascularity("hypovascular zone") within the tendinous portion of the supraspinatous. This area of hypovascularity corresponds to what Codman termed the "critical portion" of the cuff (Fig2).[18] It is in this zone that most degenerative rotator cuff tears occur, suggesting that hypovasularity of the supraspinatous tendon may play a role in the pathogenesis of cuff tears.

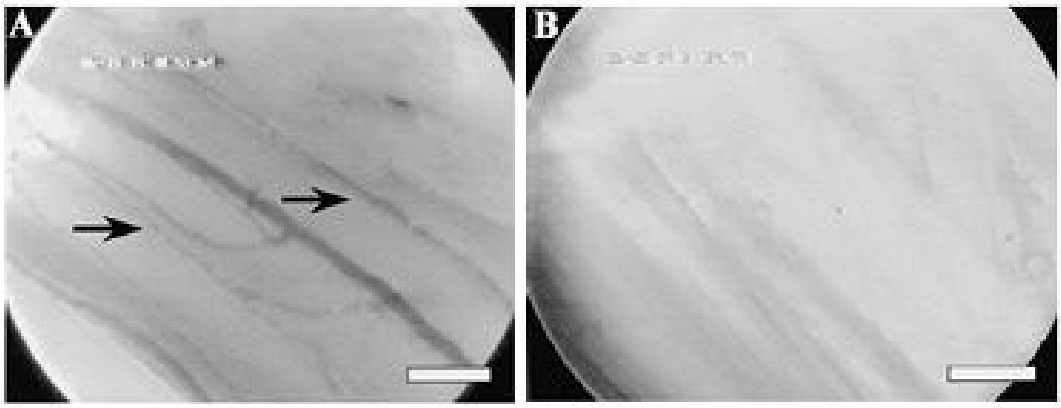


Figure 2:A – capillaries within normal supraspinatus tendon. B – absent capillaries in the edges of a supraspinatus cuff tear.[8]

Functional Biomechanics

The supraspinatous provides approximately 50% of torque output in shoulder abduction in the plane of the scapula and 50% of the total torque of forward elevation in the sagittal plane.[21,43]

A normal and intact rotator cuff helps maintain healthy articular cartilage. When chronic cuff tears are massive, it has been suggested; the rotator cuff fails to perform its nutritional function and may, therefore, contribute to glenohumeral arthropathy.

Rotator cuff produces the following important functions:

- Counterbalance the upward pull of the deltoid on the humerus (Fig 3)
- Hold the head of the humerus secure in the glenoid (Fig 4).
- Externally rotate the shoulder which is important during arm elevation.
- Provide a stable base for the major movements of the shoulder.

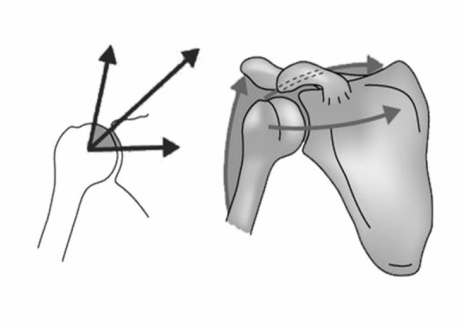


Figure 3: Direction of pull of the rotator cuff [37]

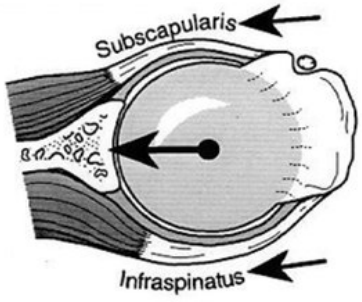


Figure 4: Rotator cuff holding the head of the humerus [38]

Etiology of Rotator Cuff Tears

The important role played by the rotator cuff in the stability and mobility of the glenohumeral joint makes it susceptible to damage and injuries. The etiology of rotator cuff injury is probably multifactorial

Some of the many factors associated with damage to or irritation of the rotator cuff mechanism are intrinsic to the rotator cuff or its overlying coracoacromial arch and some are extrinsic. [46]

The etiological factors in the rotator cuff syndromes can be classified as follows:

I. Traumatic factors

Rotator cuff

- Acute high velocity trauma (acute partial- or full-thickness tears)
- Repetitive low velocity microtrauma (overuse, athletic or work related syndromes)

Supraspinatus outlet

- Acromiocalvicular separation
- Coracoid non-union or malunion
- Greater tuberosity malunion
- Acromial malunion or non-union

II. Degenerative factors

- Proliferative and degenerative changes of the acromion, coracoacromial ligament, acromioclavicular ligament, acromioclavicular joint or greater tuberosity.
- Intrinsic degenerative changes of the rotator cuff.
- Calcific tendinitis.

III. Developmental factors

- Os acromiale
- Coracoid malformation

- Type II or III acromial morphology
- Low-lying acromioscapular angle

IV. Capsuloligamentous factors

Instability

Traumatic, unidirectional

Atraumatic, multidirectional

Capsular contracture

Tight posterior capsule

V. Scapulothoracic neuromusclular dysfunction

- Chronic cervical spondylosis
- Serratus anterior palsy (long thoracic nerve injury)
- Trapezius nerve palsy (spinal accessory nerve injury)
- Scapulofascial muscular dystrophy

VI. Scapulohumeral neuromuscular dysfunction

Entrapment syndromes

Axillary nerve

Suprascapular nerve

VII. Inflammatory disease

- Calcific tendinitis or bursitis
- Rheumatoid arthritis
- Crystal-induced arthropathy

VIII. Iatrogenic or acquired disorders

- Hardware placement
- Foreign material
- Inferior placement of the humeral prosthesis
- Corticosteroid-induced tendinopathy

Impingement Syndrome

Definition:

Subacromial impingement is defined as the encroachment of the acromion, coracoacromial ligament, coracoid process and/or acromioclavicular joint on the rotator cuff mechanism that passes beneath them as the glenohumeral joint is moved particularly in flexion and rotation.[64,56]

Types:

There are four (4) main types of "***shoulder impingement syndrome***" that have been identified today:

1) Primary Impingement
2) Secondary Impingement
3) Subcoracoid Impingement/Stenosis
   TUFF's (Tensile Under-Surface Fiber Failure) Lesion
4) Internal (Glenoid) Impingement
   Posterior-Superior Glenoid Impingement (PSGI)

It is imperative that the shoulder diagnosis be as specific as possible. Each specific type of impingement syndrome requires its own type of treatment, rehabilitations and/or surgical procedure.

Primary impingement

By definition "*shoulder impingement syndrome*" was considered, subacromial outlet obstruction resulting in irritation of the supraspinatus tendon(Fig 5). The concept was attributed to *Charles Neer* in 1972. Neer Classified and named the disorder of shoulder impingement. He also gave structure to the diagnostic process. However, the process itself was first described but not named by Meyer as early as 1931.

Neer described three different stages of the impingement syndrome: (Fig 6)

Stage I: Reversible oedema and hemorrhage usually present in a patient less than 25 years.

Stage II: Fibrosis and tendinitis affecting the rotator cuff of a patient typically in the 25 to 40 years.

Stage III: Bone spurs and tendon ruptures present in individual over 40 years of age.

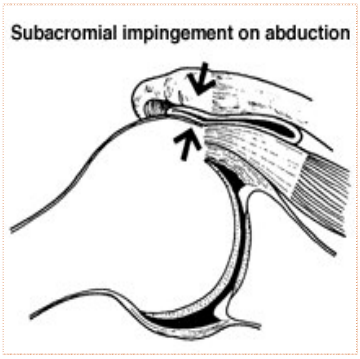


Figure 5: Subacromial Impingement[3]

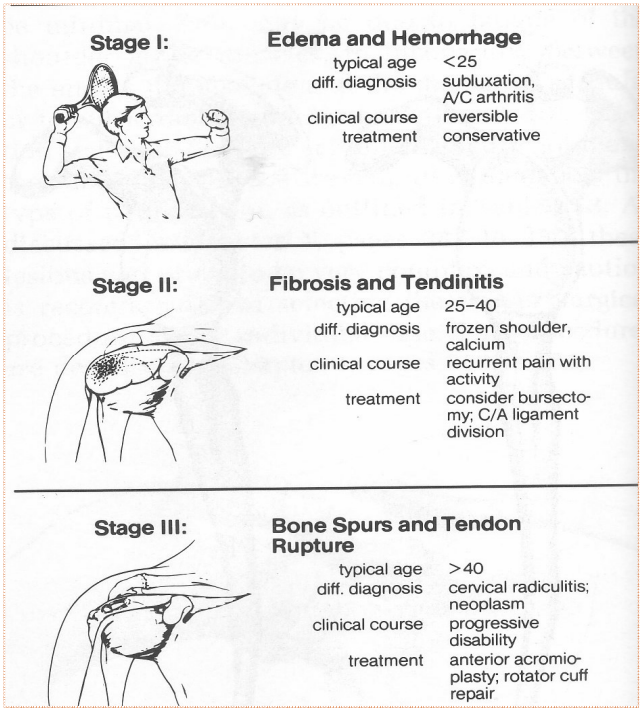


Figure 6: Neer Impingement stages.[56]

Secondary Impingement

Secondary Impingement by definition implies that there is a problem with keeping the humeral head centered in the glenoid fossa during movement of the arm. Generally is caused by weakness in the rotator cuff muscles (functional instability) combined with a glenohumeral joint capsule and ligaments that are to loose (micro-instability).

The impingement generally occurs at the coracoacromial space secondary to anterior translation of the humeral head .Tearing of the rotator cuff is again Extra-articular however intra-articular tearing is also seen in these patients.

Patients are typically younger and the pain is located in the anterior or anterolateral aspect of the shoulder. The symptoms are usually activity specific and involve overhand activities. It is important to treat the underlying "micro-instability" in patients with secondary impingement. [4]

Internal Glenoid Impingement

Internal Glenoid Impingement is probably the most common cause of posterior shoulder pain (pain in the back of the shoulder) in the throwing or overhead athlete. It is commonly misdiagnosed as rotator cuff tendonitis.

It is also called posterior-superior glenoid impingement (PSGI). [49]

PSGI is caused by the impingement of the articular surface (intra-articular) of the rotator cuff (posterior edge of the supraspinatus and the anterior edge of the infraspinatus) against the posterior-superior-glenoid and glenoid labrum (Fig7). The mechanism of injury is shoulder extension, abduction and external rotation mechanism. [24]

Subcoracoid Impingement and Subcoracoid stenosis

Subcoracoid space: Interval between the tip of the coracoid and the humeral head (the coracohumeral interval). Normal coracohumeral interval: **8.4-11.0mm**

Subcoracoid stenosis: Narrowing of the Subcoracoid space with a coracohumeral interval of less than **6mm**. Subcoracoid stenosis *may not be pathologic or symptomatic.*

Subcoracoid Impingement: Impingement of the coracoid process against the humerus (usually the lesser tuberosity) in a coracoid impingement position (humerus is flexed, adducted and internally rotated).

Subcoracoid impingement may cause tears of the undersurface of the Subscapularis via the **"Roller-Wringer Effect".** This is caused by the bowstringing of the Subscapularis across the prominent coracoid process (Fig 8).

The Coracoid process causes an indenting of the superficial surface of the upper Subscapularis tendon while stretching (tensile loading) of the deep surface of the Subscapularis. This leads to a **Tuff's** (Tensile under –surface fiber failure) lesion or an articular side tearing (inside the joint) of the Subscapularis tendon.

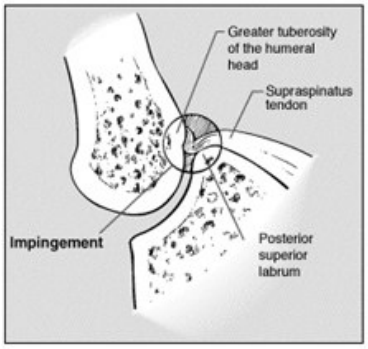


Figure 7: Internal glenoid impingement.[24]

Figure 8: MRI shoulder with Coracoid Impingement.[57]

Classification of Rotator Cuff Tears

Rotator cuff tears can be classified as follows:[40]

- **According to mechanism of injury:**
  - *Traumatic*
  - *Impingement*
- **According to the thickness:**
  - ***Partial thickness*: (Fig 9)**

Bursal **Articular** **Midsubstance**

- *Grade I : <25% of the cuff thickness*
- *Grade II: 25-50%*
- *Grade III: >50%*

  - ***Full thickness*:**

***According to the size:**

- *Small <1 cm*
- *Moderate 1-3 cm*
- *Large >3 cm*
- *Massive >5 cm*

* **According to the muscle involved:** [48]

- *Grade I :complete rupture only of the supraspinatus*
- *Grade II: rupture of the supraspinatus and part of the infraspinatus*
- *Grade III: rupture of the three main muscles (Supra-,Infraspinatus and subscapularis)*
- *Grade IV: rotator cuff arthropathy.*

According to the shape: [17] **(Fig 10)**

Crescent-shaped

U-shaped

L-shaped

Massive, contracted, immobile

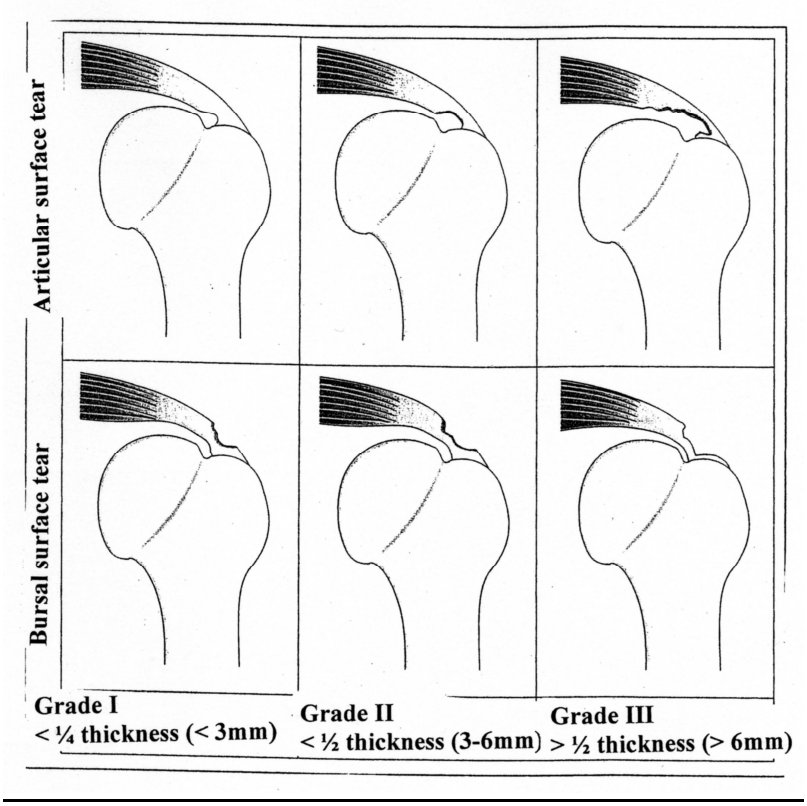


Figure 9: Types of partial thickness cuff tears[48]

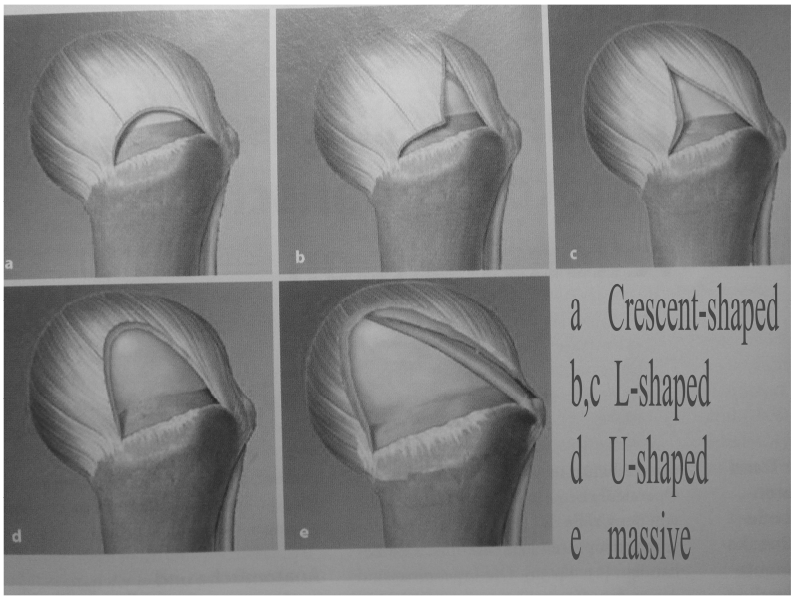


Figure 10: Types of cuff tears according to the shape.[6]

DIAGNOSIS OF ROTATOR CUFF TEARS

The history

Symptoms associated with primary intrinsic rotator cuff disease include pain, weakness, and limitation of motion.

Physical examination

Many patients with primary rotator cuff disease have mild to moderate tenderness to palpation over the anterior acromion, the anterior aspect of the greater tuberosity, and occasionally, over the long head of the biceps or the acromioclavicular joint.

Abnormal active elevation of the arm can be associated with cuff weakness. Abnormal elevation of the scapula during active elevation of the arm is termed the "shrug sign". Weakness of external rotation of grade 3 or less particularly when the arm is at 0 degrees of abduction, is generally associated with larger rotator cuff tears extending into the posterior aspect of the cuff. [59,69]

Two impingement signs, that of Neer [65] (Fig11) and that described by Hawkins and Kennedy [72] (Fig12) accentuate the pain by mechanical irritation of the rotator cuff and biceps tendon beneath the coracoacromial arch.

Subacromial crepitus is often palpable and audible when the shoulder is rotated in the abducted position. This is more common in chronic impingement syndrome associated with degenerative spur formation and full thickness rotator cuff tears.

Impingement and injection tests

Of the many diagnostic tests available, the most clinically useful is the selective injection of a local anesthetic. [65] The classic impingement test is performed by injecting 8 to 10 ml of a local anesthetic into the subacromial space.

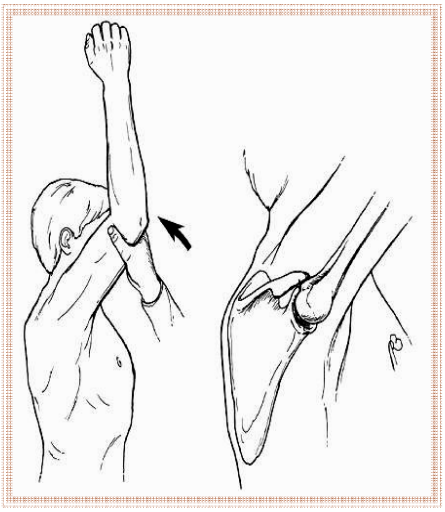


Figure 11: Neer Impingement sign.[65]

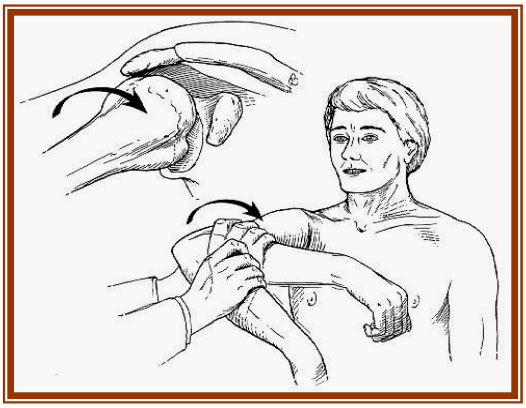


Figure 12: Hawkins impingement sign.[72]

In general, the pain should decrease by at least 50% after injection. If it does not, another source of pain should be sought. [35]

Diagnostic imaging

Plain radiographs

Standard and specialized tilt views are useful in the evaluation of symptomatic rotator cuff disease. Proliferative degenerative spur formation at the anterior or inferior margin of the acromion and undersurface of the acromioclavicular joint is often associated with supraspinatus outlet impingement. [39] Degenerative changes in the greater tuberosity, including

cyst formation, sclerosis, and occasionally, spur formation, can be seen. Proliferative changes of the acromion and acromioclavicular joint are best evaluated on the supraspinatus outlet (Fig13). An os acromiale is best seen on an axillary view (Fig14). Calcific deposits in the subacromial space are particularly evident on rotational anteroposterior views of the shoulder.

An acromiohumeral interval of less than 7 mm is helpful in the diagnosis of chronic rotator cuff tears (Fig15).[70,74] Cuff arthropathy is demonstrated radiographically as marked cephalad migration of the humeral head, humeral osteopenia, cyst formation, and humeral head collapse.[84]

Arthrography

Arthrography is considered the traditional gold standard by which the imaging diagnosis of full-thickness rotator cuff tears is made (Fig 16). [70] A full-thickness tear is diagnosed when there is extravasation of contrast material into the subacromial space. Extravasation of contrast material into the acromioclavicular joint-called a Geyser sign-is correlated with massive chronic cuff tears.[23]Digital arthrography and computed tomography also aid in the assessment of tear size. [88] Contrast injection followed by active range of motion of the shoulder and spot anteroposterior radiographs taken in internal and external rotation is the technique preferred by most.

Ultrasonography

Ultrasonography of both shoulders has been reported by some investigators to be highly accurate in the diagnosis of full-thickness rotator cuff tears. [26,81] Others disagree.[2]

Ultrasonography is noninvasive and offers advantages over other diagnostic means, but it has the disadvantages of significant dependence on the radiologist performing the study and its unproven effectiveness in partial-thickness lesions, capsule-labral abnormalities, and subacromial impingement.

Figure 13: Acromial spur

Figure 14: Axillary view with os acromial

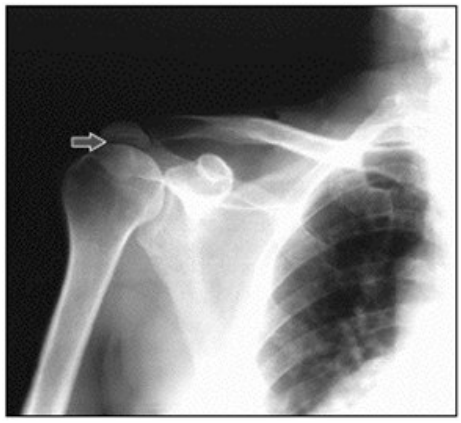


Figure 15: Acromiohumeral interval.

Figure 16: Arthrography of the shoulder with cuff tear [70]

Magnetic resonance imaging

The diagnosis is usually based on a discontinuity of the tendon on T_1-weighted images that is consistent with fluid signal on T_2-weighted images. Secondary findings include fluid in the subacromial space (on T_2-weighted images), loss of the subacromial fat plane (on T_1-weighted images), and proliferative spur formation of the acromion and/or acromioclavicular joint (Fig17). [45]

Magnetic resonance arthrography

More recently, magnetic resonance (MR) arthrography has virtually replaced conventional arthrography in the assessment of internal derangements of the shoulder. MR arthrography has been proved to have higher sensitivity and specificity compared with routine MR imaging for the detection of shoulder joint abnormalities.

A full-thickness tear will appear as gadolinium solution extending through a defect in the cuff and into the subacromial-subdeltoid bursa (Fig18). [12,30]

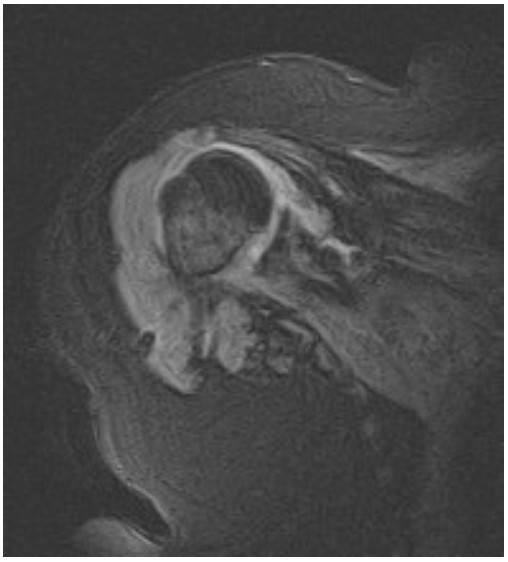


Figure 17: MRI shoulder with cuff tear

Figure 18: MRI Arthrography with cuff tear and the dye in the subacromial space

TREATMENT OF ROTATOR CUFF TEARS

Non-surgical management

McLaughlin recommended initial non-surgical treatment for all patients with rotator cuff tears except young, active patients with acute, massive avulsions of the cuff or grossly displaced greater tuberosity fractures. [63] Neer also recommended initial non-surgical management in all cases except the "occasional patient who was suspected of having a massive cuff avulsion". [65]

Medication

Corticosteroid injection
Sodium hyaluronate injection[79]
Nonsteroidal Anti-inflammatory medication

Ultrasound

The biologic effects of ultrasonic energy can be divided into thermal and nonthermal phenomena. The major beneficial effect of increased tissue temperature is hyperemia, which has the potential to increase healing. Reported nonthermal effects of ultrasound include increased membrane permeability and increased protein synthesis by fibroblasts. [53]

Exercise

Exercise therapy is the mainstay of non-surgical management of impingement syndrome and symptomatic rotator cuff tears.

Failure of therapy

Surgical repair is recommended if the patient showed no improvement after six to eight weeks of conservative treatment. It seems reasonable to continue with non-surgical management for as long as three months provided that there is continued improvement. [60]

Surgical treatment

Indications for surgery

There has been considerable confusion surrounding the indications for rotator cuff and biceps surgery, with many factors influencing the decision to operate. It is important to understand, as fully as possible, the type and extent of abnormality before embarking on any surgical program.

In the absence of a rotator cuff defect, pain is the primary justification for surgical intervention. When a rotator cuff defect is present, the functional deficit that is manifested by limited motion and weakness is an additional consideration. [46]

Treatment options

The majority of cuff tears are outlet impingement tears which are expected to persist or advance unless decompressed and repaired.

There are four major objectives in repairing impingement tears of the rotator cuff: (1) closure of the cuff defect, (2) eliminating impingement, (3) preserving the origin of the deltoid muscle, and (4) preventing adhesions post-operatively without disturbing the repair by a careful exercise program.[65]

Open Rotator Cuff Repair

The procedure consists of a decompressive anterior acromioplasty (Fig 19) and restoration of cuff anatomy (Fig 20). The technique of reconstruction depends on the size of the cuff tear, the tissues available for reconstruction, and the presence of associated abnormalities.

In a large cuff defect with deficiency of the supraspinatus tendon, a tendon transposition flap can be created by separating the outer portion of the subscapularis and detaching it from the lesser tuberosity, leaving the underlying capsular portion intact. [22] The detached tendinous portion of the subscapularis is mobilized superiorly to help cover the humeral head (Fig21).

Complete absence of infraspinatus and supraspinatus tendons can be treated by latissmus dorsi transfer.

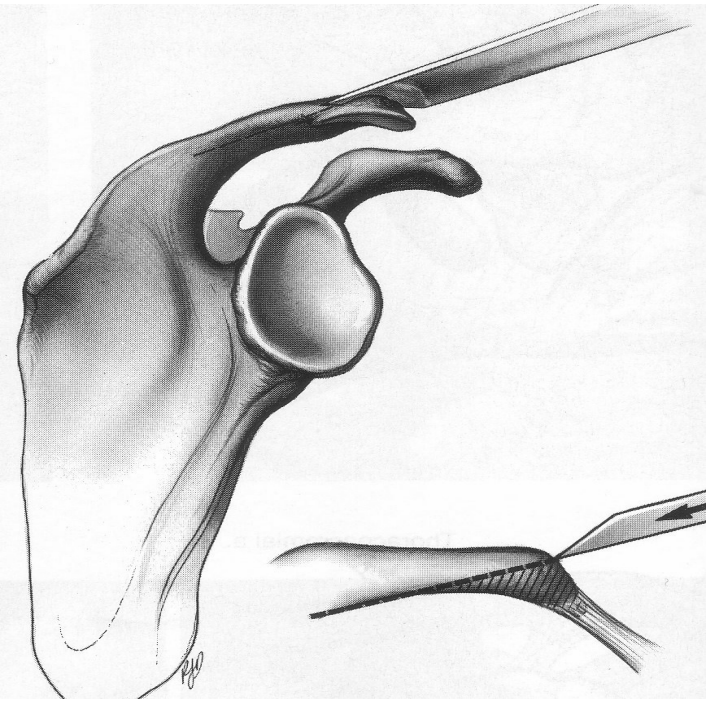


Figure 19: Acromioplasty.[61]

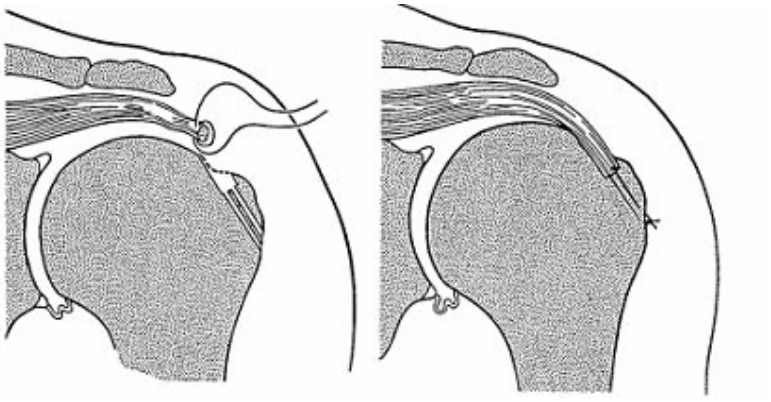


Figure 20: Bone trough created to repair the cuff tear.[40]

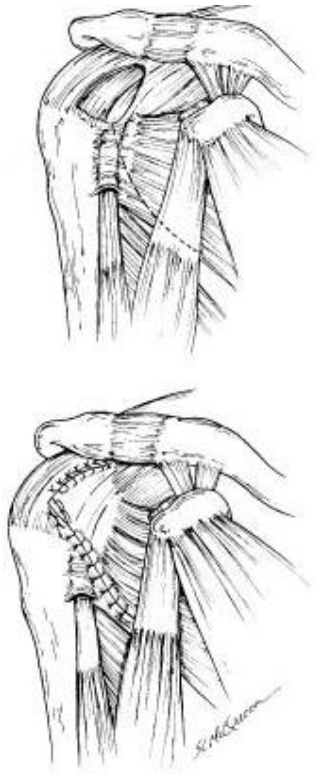


Figure 21: Subscapularis flap transfer to close a large cuff defect.[22]

Arthroscopic Surgical Interventions

Shoulder arthroscopy has proved to be a useful surgical technique for the arthroscopic surgeon. Arthroscopically assisted procedures are now commonly performed in the glenohumeral joint, subacromial space, and the acromioclavicular joint. The arthroscope has improved and refined the understanding of shoulder anatomy.

ARTHROSCOPIC SUBACROMIAL DECOMPRESSION

The goals of the procedure are to decompress the subacromial space and perform an anterior acromioplasty.

The procedure starts with intra-articular examination of the glenohumeral joint. The undersurface of the rotator cuff is examined and any frayed edges are debrided. Pathologies of the labrum should be verified.

Decompression is accomplished by the resection of the subacromial bursa and sectioning the acromial attachment of the coraco-acromial ligament. The anterior acromioplasty changes a type II or III acromion to type I by removing the anterior 7 to 10 mm of the acromion, thinning the inferior acromion an additional 15 to 20 mm posteriorly, and removing the acromion's anterior hook. (Fig 22)

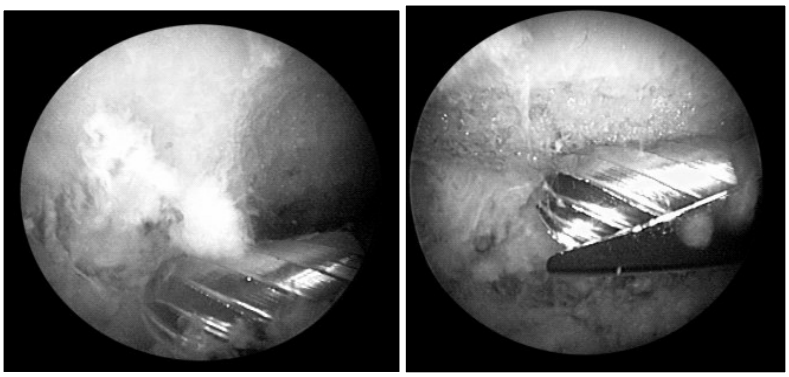


Figure 22: Arthroscopic subacromial decompression

ARTHROSCOPIC ROTATOR CUFF REPAIR

Introduction:

With the advent of arthroscopic surgery, rotator cuff repair has evolved from an all-open technique to a combined arthroscopic and mini-open technique and, recently, to an all-arthroscopic technique. Arthroscopically assisted mini-open rotator cuff repair has been shown to provide predictable excellent results in the management of rotator cuff repairs. Advantages of a mini-open technique compared with an all-open technique include preservation of the deltoid origin, less pain and morbidity, and quicker recovery.

The all-arthroscopic rotator cuff repair has increased in popularity over the past several years, paralleling improvements in arthroscopic instrumentation and technique. [92]

Indications:

Ideally, the choice between mini-open and arthroscopic tendon repair should depend on the preoperative surgical expectations of the patient (e.g., how much he or she values a minimally invasive approach), the mechanical properties of the torn cuff (e.g., where simple sutures will hold the tendon edge), the surgical experience of the surgeon (currently perhaps a dominant factor), and the reported outcomes obtained with the various types of procedures (still preliminary).

Technique:

I- Mini-open Repair:

With mini-open repair the patient is placed in the beach-chair position. Examination under anaesthesia for passive range of motion and translation of the humeral head should be done. A standard shoulder arthroscopy was then performed. After completion of the diagnostic intaarticular arthroscopy, the arthroscope is inserted into the subacromial space and a complete bursectomy

and acromioplasty are performed by use of an arthroscopic shaver through a lateral portal. At this point, the rotator cuff tear is once again assessed for size, location, mobility, and reparability. A tear is considered repairable if the tendon edge could be mobilized and positioned without significant tension just lateral to the articular cartilage margin.

The arthroscope is then removed, and the lateral portal is extended longitudinally toward the acromion. The deltoid fascia is incised in line with the skin incision, and the deltoid muscle is split in line with its fibres. After mobilisation of the rotator cuff, the greater tuberosity is debrided just lateral to the articular margin, and a shallow trough is created. Transosseous sutures or bone anchors can be used for repair (Fig 23). The incision is then closed and the arm is immobilized in a sling or brace according to the adequacy of the repair and the quality of the tissues. [60,92]

Figure 23: Mini open rotator cuff repair

II- All arthroscopic Repair:

With all arthroscopic technique a standard subacromial bursectomy and acromioplasty is performed through the posterior and lateral portals as described before. The rotator cuff is evaluated for the size. With the use of a grasper through the lateral portal, a trial reduction of the cuff tear is performed. If necessary, an arthroscopic elevator is used to mobilise the cuff. Once it is determined that the cuff could be repaired, the tendon edge is debrided with a shaver to a stable rim, and the tuberosity is debrided of all soft tissue. Repair of the cuff is then done using bone anchor or transosseous Giant needle (Fig 24). [31]

Advantages of Arthroscopic repair:

Although the best method for repair of full-thickness rotator cuff tears has been controversial, complete arthroscopic rotator cuff repair techniques have been evolving as a future alternative to traditional open and mini-open repairs [33]. Early reported experience has been promising, and the technique has become increasingly popular among experienced shoulder surgeons as a preferred means to obtain repair of the rotator cuff. In experienced hands, the technique appears to offer less pain and morbidity as well as quicker recovery than do alternative techniques such as open or mini-open repair.Arthroscopic repair offers the advantage of the deltoid muscle preservation as well as the arthroscopic evaluation and treatment of any glenohumeral pathology.

Disadvantage of Arthroscopic repair:

Complete arthroscopic rotator cuff repair is widely considered to be a technically difficult procedure. It may be necessary to perform a relatively large number of these procedures to obtain the experience required to carry them out in a reliable fashion.

However, although complete arthroscopic rotator cuff repair may be a more technically difficult procedure than a mini-open repair, it should not preclude a surgeon from eventually transitioning to this method if it is deemed

to be superior. With a proper transition strategy, those with less experience with arthroscopic surgery can still achieve the skills necessary to do a complete arthroscopic repair [91].

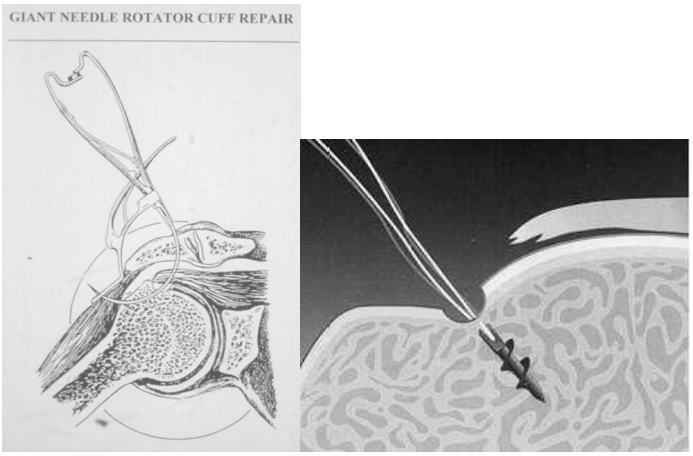


Figure 24: Transosseus Giant needle and Bone anchor.[31]

Complications associated with Arthroscopic shoulder surgery

The last decade has seen an exponential increase in the volume of arthroscopic shoulder surgery performed. As the complexity of the procedures has increased, a corresponding increase in the number and type of complications has also occurred.

Complications Of Shoulder Arthroscopy: [25]

1. General surgical complications
    a. Infection
    b. Anaesthetic complications
2. Shoulder arthroscopy complications
    a. Vascular injury
    b. Neurological injury
    c. Fluid extravasation

d. Stiffness

e. Iatrogenic tendon injury

f. Complications related to specific procedures:

* *Subacromial surgery:*

- Inadequate resection
- Fracture
- Acromioclavicular symptoms
- Heteropic ossification

* *Arthroscopic rotator cuff repair:*

- Failed repair
- Hardware problems
- Captured shoulder.

* *Instability surgery*

- Recurrence

* *Thermal:*

- Nerve injury
- Capsular necrosis.

COMPLICATIONS RELATED TO ROTATOR CUFF SURGERY

Complications have been rarely reported after arthroscopic rotator cuff repair, and some believe that the rate of complications is lower than that after open repair after these procedures.

Fortunately, most operations for symptomatic rotator cuff tears are successful because of the surgical techniques developed in the last few decades. However, complications do occur and can lead to failure of a repair. Often these are complex problems with multiple reasons for failure. Subsequent repairs are difficult and the results are not as good as those for primary surgery.

The major reasons for failure of repair of the rotator cuff are an incomplete or incorrect diagnosis; postoperative complications; errors in operative technique; and errors in or poor performance of postoperative rehabilitation, or both. A combination of these factors may be responsible for a poor result in a given patient. The clinical evaluation of these parameters must be extremely thorough in order to avoid failure of treatment. [51]

Errors in Diagnosis:

Physical examination and injection tests help to define the patient's current problems. Care must be taken to specifically identify referred pain due to thoracic outlet syndrome and lesions of the cervical spine.

Neuropathies of the suprascapular and axillary nerves also may mimic disease of the rotator cuff and cause misdiagnoses. The suprascapular nerve, a branch of the superior trunk of the brachial plexus, may be compressed beneath the suprascapular ligament in the suprascapular notch [51] or by a ganglion in the spinoglenoid notch[68].

Arthropathy of the acromioclavicular joint also may complicate the clinical presentation of disorders of the rotator cuff and may lead to failures in diagnosis and treatment.

An unrecognized os acromiale may lead to persistent pain after subacromial decompression and repair of the rotator cuff. Lesions of the biceps tendon and the superior aspect of the glenoid labrum often are found in patients who have impingement syndrome and a tear of the rotator cuff.

Errors in Operative Technique:

Errors in the operative technique of acromioplasty and repair of the rotator cuff can undermine the results of treatment of even the most accurately diagnosed lesions of the cuff. These errors include inadequate operations and intraoperative complications. Inadequate operations include those in which a lesion of the biceps tendon or the labrum, or both, is missed; those in which arthropathy of the acromioclavicular joint is missed, as discussed previously; and inadequate acromioplasty. Intraoperative complications include fracture of the

acromion, detachment or denervation of the deltoid, and failure to preserve the coracoacromial arch in patients who have an irreparable tear of the cuff.

Frank acromial fractures can occur either intraoperatively or postoperatively.[62] Careful visualization and palpation of the thickness of the acromion is necessary to avoid this complication (Fig 25).

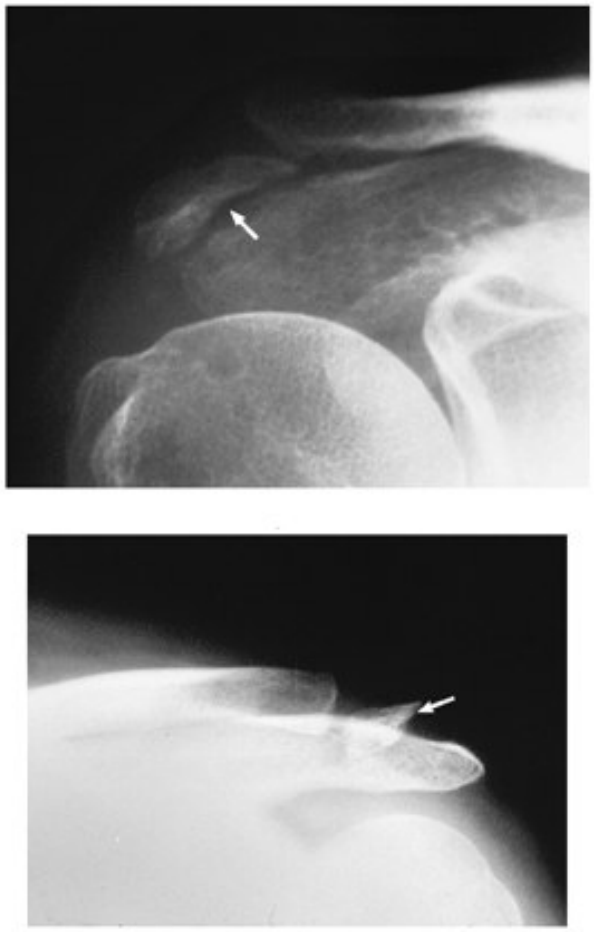


Figure 25: Acromial fracture following arthroscopic subacromial decompression.[62]

Arthroscopic acromioplasty and mini-open repair of the rotator cuff theoretically should decrease the prevalence of detachment of the deltoid.

Reattachment of the deltoid to the acromion after repair of a tear of the rotator cuff is crucial.

Examination of the shoulder of a patient who has detachment of the deltoid reveals a defect at the origin of the deltoid from the acromion and a prominence of the deltoid distal to the defect that is accentuated by active elevation of the arm (Fig 26). A magnetic resonance image may be helpful for confirming this diagnosis (Fig27). Operative repair of a retracted deltoid should proceed as soon as possible. Prolonged retraction leads to scarring and subsequent stiffness, pain, and loss of shoulder function. [51]

Figure 26: Postoperative detachment of the deltoid. Clinical photograph revealing a defect that is accentuated by attempted active elevation of the arm.[51]

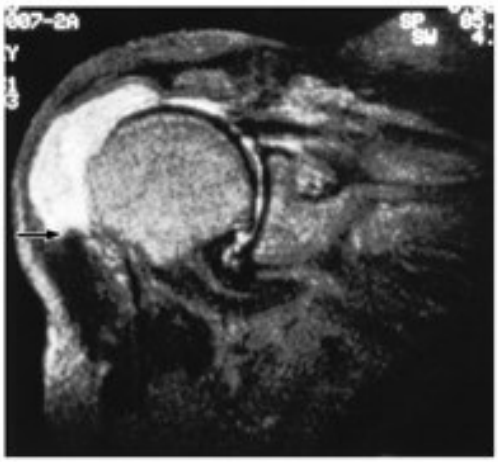


Figure 27: Weighted magnetic resonance image demonstrating detachment and retraction of the origin of the deltoid.[51]

Postoperative Complications: [51]

Complications of repair of the rotator cuff include infection, heterotopic ossification, frozen shoulder, and recurrent tearing. These complications can be related both to the operative technique and to the postoperative rehabilitation.

Heterotopic ossification is uncommon after acromioplasty and repair of the rotator cuff. It occurs in approximately 3 to 5 per cent of patients but not all of these patients are symptomatic. Copious irrigation to remove all bone fragments after acromioplasty reduces the chance of heterotopic bone formation. When ossification occurs in the subacromial space or in the space created by resection of the lateral portion of the clavicle, it can be a source of pain (Fig28).

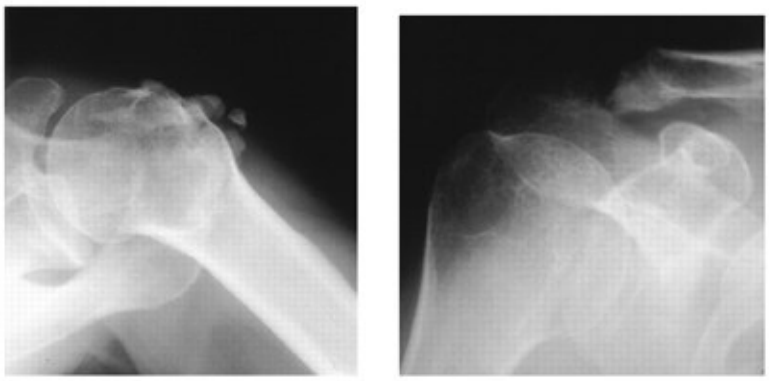


Figure 28: Postoperative radiographs showing heterotopic ossification. Left: Axillary radiograph demonstrating heterotopic bone in the vicinity of an anterior acromioplasty. Right: Zanca (acromioclavicular joint) radiograph demonstrating heterotopic bone formation in the space created by resection of the lateral portion of the clavicle.[51]

Postoperative stiffness after repair of the rotator cuff can lead to severe functional limitations. Bigliani et al. reported on five patients who had frozen shoulder after the procedure. Those authors attributed the failures to inadequate rehabilitation in the postoperative period and they recommended gentle pendulum exercises and passive elevation in the scapular plane, beginning on the first or second postoperative day, as preventive measures [67].

Persistent Defects of the Rotator Cuff:

Persistent defects of previously repaired rotator cuff tendons may be related to an inadequate initial repair of the cuff, poor-quality tendon or bone, persistent impingement, or improper physical therapy. [67]

Overly intensive physical therapy during the early postoperative period may lead to avulsion of the tendon before healing. In addition, Neviaser and Neviaser found that early use of weights was a factor leading to failure of repair of rotator cuff tears[66]. Rehabilitation must be tailored individually to intraoperative observations of the repair in each patient.

In conclusion, there are many potential causes of failure of rotator cuff repair. The categories of incomplete and incorrect diagnosis, errors of operative technique or postoperative rehabilitation, and postoperative complications are convenient for classification, but it must be remembered that there may be several causes of failure in any given patient. Clinical evaluation is most dependent on a careful history, a review of the medical record and the preoperative imaging studies, and a physical examination with use of injection tests as indicated. On the basis of this evaluation, a definitive diagnosis or a limited differential diagnosis often can be established. The selective use of additional imaging studies and diagnostic arthroscopy will define the anatomical abnormalities. These lesions must be correlated carefully with the clinical findings in order to determine their relative importance and to choose the appropriate treatment.

AIM OF THE WORK

The aim of this work was to describe our own surgical technique of arthroscopic repair of rotator cuff tears and to evaluate the clinical and radiological results of arthroscopic repair of full thickness as well as partial thickness rotator cuff tears.

Moreover, we would like to study a variety of factors that may influence the outcome of rotator cuff repairs. These factors including the age and the sex of the patient, side affected, preoperative complaint of the patient regarding the pain and functional abilities, dominant shoulder, timing of the surgical intervention (time lag before presentation), size of the tear, and the duration of the follow up.

PATIENTS

The study was conducted on forty patients, (19) men and (21) women.

The inclusion criteria include:

1. Patients suffering from symptomatic chronic rotator cuff tears.
2. Patients who failed to improve on conservative methods of treatment (local corticosteroids and/or physiotherapy).
3. No age discrimination.
4. No sex discrimination.

The exclusion criteria include:

1. Patients with instability problems.
2. Patients with acute rotator cuff tears.
3. Patients with associated symptomatic acromioclavicular arthritis.
4. Patients with associated biceps brachii tendon pathology.
5. Patients with previous surgery on the rotator cuff.
6. Patients with cuff tear arthropathy.

1. Age:

The youngest patient was 37 and the oldest patient was 78 with mean age of 61.15 years. (SD + 8.40).

2. Sex:

Of the 40 patients, there were 19 males and 21 females.

Table (I) shows the demographic data of the studied group.

Table (I): Demographic data of the studied group.

	Frequency	
	No.	**%**
Age		
<50	3	7.5
50 – <60	11	27.5
60 - < 70	22	55.0
More than 70	4	10.0
Range	37 – 78	
Mean	61.15	
S.D.	8.40	
Sex		
Male	19	47.5
Female	21	52.5

3. Dominant Hand:

Thirty nine patients were right handed (97.5%) while only one patient was left handed (2.5%).

The left handed patient suffered from left sided cuff tear while 25 of the right handed patients suffered from right sided cuff tear and the rest suffered from left sided cuff tear.

4. Time lag before presentation:

The time lag before presentation varied between 0.25-5 years with a mean of 0.83 year. (SD + 0.76)

Table (II) shows the distribution of the studied group regarding the dominant hand, site affected and time lag before presentation.

Table (II): Distribution of the studied group regarding dominant hand, site affected and time lag.

	Frequency	
	No.	%
Dominant hand		
Right	39	97.5
Left	1	2.5
Site		
Right	25	62.5
Left	15	37.5
Lag time		
< 1 year	24	60.0
≥ 1 year	16	40.0
Range	0.25 – 5.0	
Mean	0.83	
S.D.	0.76	

5. Occupation:

Of the forty patients, twenty were manual workers, thirteen were office workers, six were housewives and one patient was Golf's player. The right handed Golf's player suffered from left sided cuff tear. All of the patients were indulged in excessive overhead arm activity.

6. Associated conditions:

- Three patients suffered from cardiac problems.
- Two patients suffered from cervical spondylosis.
- One patient had rheumatoid arthritis involving her ipsilateral hip.
-None of the patients suffered from elbow problems.
- None of the patients were diabetic.

METHODS

All patients included in the study underwent the following system for evaluation (clinical and radiological) as well as the treatment:

(I) Clinical assessment:

All patients were clinically assessed as regards:

History:

- ***Pain:***

  - Nocturnal pain.

  - Pain during daily activity.

- ***Weakness during elevation or external rotation.***

- ***Previous trauma.***

Physical Examination:

- ***Range of shoulder motion: (ROM)***

  - Passive and Active ROM:

The range of passive and active movements of the shoulder as regards the forward flexion, abduction and external rotation were recorded which was used to calculate the assessment's score (described later).

- Strength of motions:

The strength of the forward flexion, abduction and external rotation were recorded. The muscle strength was divided into five grades (described later).

- **Impingement sign:**

The scapula is depressed with one hand as the arm is raised with the other hand, forcing the greater tuberosity against the anterior acromion.

The sign was considered positive if the patient experienced pain with this maneuver.

- **Impingement test (subacromial local anaesthetic injection):**

After good disinfection 10 ml of local anaesthetic was injected in the subacromial space through the posterolateral portal (1cm below and lateral to the posterolateral acromial angle). After 10 minutes the patients were reevaluated. The test was considered positive if there was complete relief of pain on forced forward elevation of the humerus against the anterior acromion as the examiner's opposite hand depressed the scapula (Fig 29).

- **Subacromial crepitus:**

The subacromial crepitus may be associated with degenerative spur formation and full thickness cuff rotator cuff tears

- **Examination to exclude any shoulder instability.**
- **Examination of the Acromioclavicular joint to exclude symptomatic arthritis.**
- **Examination of the biceps tendon to exclude any pathology.**

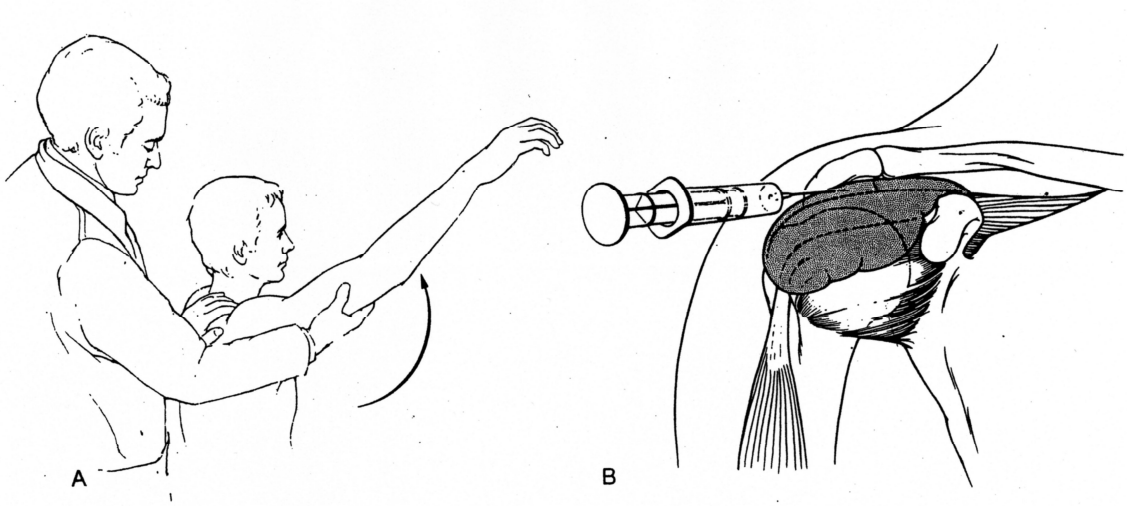


Figure 29 : Impingement injection test: Complete relief of pain on forced forward elevation of the humerus against the acromion as the examiner's opposite hand depresses the scapula [A] (the impingement sign) after the subacromial injection of 10 cc. of local anaesthetic into the subacromial space [B].[65]

(II) Diagnostic imaging:

The following imaging modalities were done for confirmation of the clinical diagnosis:

1. Plain X-Ray:

Plain radiography was requested for all patients and three views were obtained:

- ***Anteroposterior view (AP):***

  The acromiohumeral distance was measured from the AP view in all cases. Also the secondary signs of rotator cuff tears including the square sign (flattening and squaring of the greater tuberosity) as well as the sourcil sign (sclerosis of the under surface of the acromion) were looked for.

- ***Supraspinatus outlet view:***

  To detect any narrowing of the subacromial space or acromial spurs.

- ***Axillary view:***

  To show the congruity of the articular surface of the shoulder to exclude cuff arthropathy cases.

2.Ultrasonographic evaluation:

All patients underwent ultrasonographic examination of both shoulders.

3. Magnetic resonance imaging(MRI) and MRI arthrography:

MRI was done for ten cases and MRI arthrography for three cases where the results obtained from the plain radiography and U/S were not conclusive.

(III)Methods of Treatment:

Indication:

Surgery was decided in the cases suffering from chronic rotator cuff tears (impingement tears) after failure of conservative treatment (subacromial steroid injection and/or physiotherapy) for at least three months.

Technique:

Arthroscopic rotator cuff repair was performed using the suture anchor technique of repair with subacromial decompression.

The technique performed in our study was as follows:

Anaesthesia: General anaesthesia

Position: Semi sitting position (Fig 30).

Procedure:

1. The bony landmarks of the shoulder joint (acromion, scapular spine, clavicle, acromioclavicular joint and coracoid) were identified and marked (Fig 31).
2. Portals were created by making small skin incisions of their sites and then inserting a blunt obturator.
3. The posterior portal was created first through which the intra articular portion of the joint was examined systematically, noting the state of the articular cartilage, the glenoid, biceps tendon, synovium and the humeral head (Fig 32).
4. Synovitis within the joint may be debrided using a 3.5mm soft tissue resector introduced through the anterior portal.

Figure 30: Semi sitting position for shoulder arthroscopy.

Figure 31: Bony landmarks and sites of arthroscopic portals.

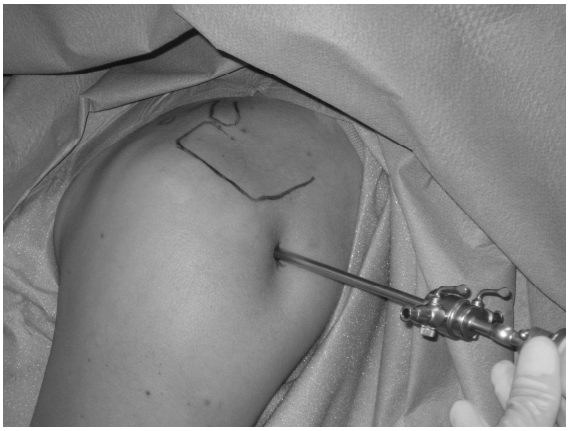


Figure 32 : Posterior portal

5. The condition of the biceps tendon and the undersurface of the rotator cuff were checked out.
6. The scope was then transferred and directed upwards under the acromion outside the rotator cuff towards the subacromial space.
7. Through a lateral portal the soft tissue resector was introduced into the subacromial space. Making sure that it was in place under the acromion by moving it around the bursa until it touched the sheath of the scope introduced through the posterior portal (Fig 33).
8. All the bursal tissues were removed until the anteroinferior surface of the acromion as well as the coracoacromial ligament were identified.
9. The periosteal tissues of the undersurface of the acromion were removed with the soft tissue resector until the cancellous bone appeared.
10. The coracoacromial ligament was resected using the arthroscopic tissue ablation system which provides excellent hemostasis, especially due to the fact that a small branch of the thoraco-acromial artery is usually cut during removal of the coracoacromial ligament, and this might impair proper visualization.

Figure 33 : The scope and the soft tissue resector in the subacromial space

11. The soft tissue resector was then replaced by using a 4mm bony burr which was used to remove 7-10mm of the antero-inferior border of the acromion and any present osteophytes. Bone resection was continued until the under surface of the acromion was flat.

12. After adequate subacromial decompression inspection and probing of the rotator cuff tear took place.

13. The type of cuff repair depended on the type and size of the cuff tear:

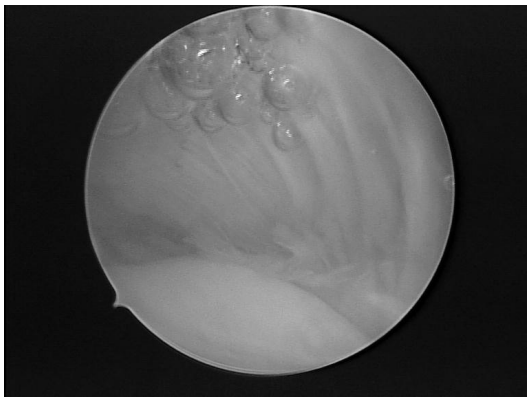
I- Partial thickness rotator cuff tears:

In cases with partial thickness cuff tears (bursal or articular) involving more than 50% of the thickness of the tendon the edges of the tear was freshened with the shaver. If the partial thickness tear involved an area less than 1cm (in an anterior-to-posterior direction), then only one bone suture anchor (5mm Smith&Nephew) double loaded with No.2 Ultrabraid suture threads was used. The anchor was inserted through the substance of the tendon into the foot-print area of the rotator cuff. Using a suture passing instrument (Arthro-pierce suture passer; Smith&Nephew), the rotator cuff is then penetrated and one limb of each suture thread is retrieved and withdrawn through a healthy part of the rotator cuff. Then both suture threads were

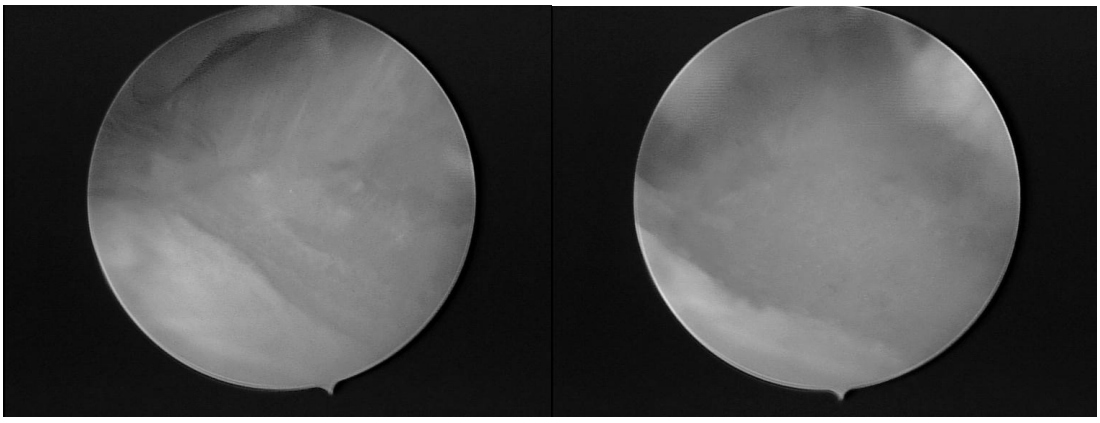
pulled to exit through the lateral portal. Arthroscopic knot was then tied outside and pushed inside with the knot pusher to close the defect and bring a healthy part of the cuff into the foot-print Fig (34 A-I).

On the other hand, if the partial thickness tear involved an area more than 1cm, two suture anchors were used. Both were inserted through the rotator cuff into the foot-print area, one placed anteriorly and one placed posteriorly on the footprint. Then we returned to the subacromial space, and the suture limbs were located Fig (35). One limb of suture of the same color from each anchor was grasped (1 green limb from the anterior anchor and 1 green limb from the posterior anchor) and retrieved through the lateral portal. These sutures were then tied together. By pulling the opposite limbs of the same sutures (the green limbs), the tied knot will be drawn over the rotator cuff. In this manner, the eyelets of the 2 anchors were used as pulleys to draw the tied knot inside over the rotator cuff that compresses it against the prepared bone bed. To secure this construct, the free limbs of the suture pair that were previously tied were retrieved through the lateral portal for tying and pushed inside in a mattress fashion over a tendon bridge Fig (36). The other sutures (white sutures) were dealt with similarly.

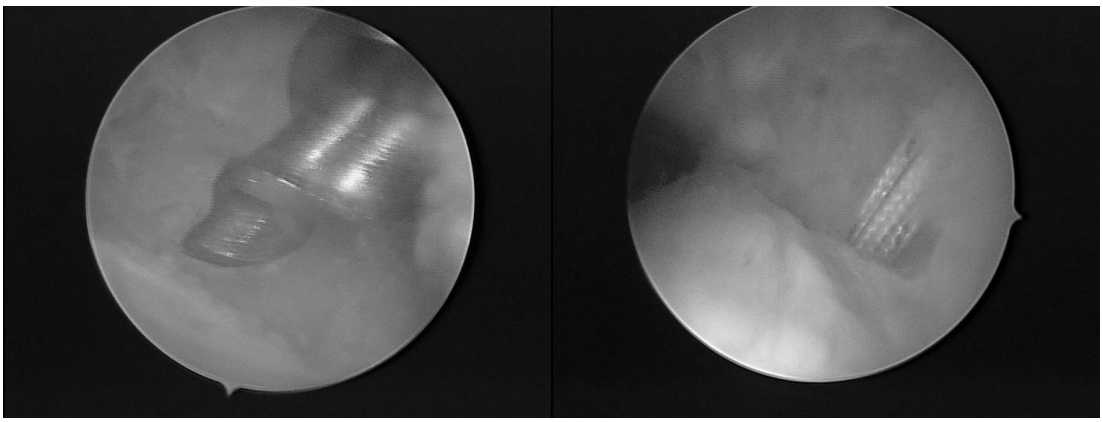
Figure 34 (A-I): Steps of arthroscopic repair of partial thickness rotator cuff tear



A: Partial thickness tear of the articular surface of the rotator cuff

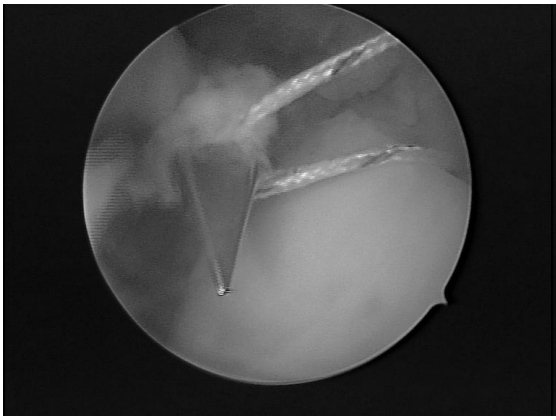


B: Footprint preparation for the reattachment of the rotator cuff

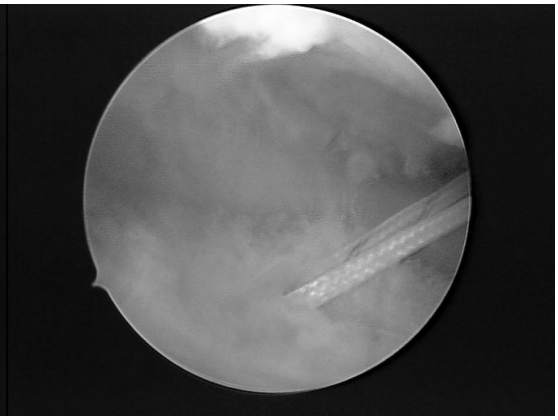


C: Anchor insertion through the tendon into the foot print

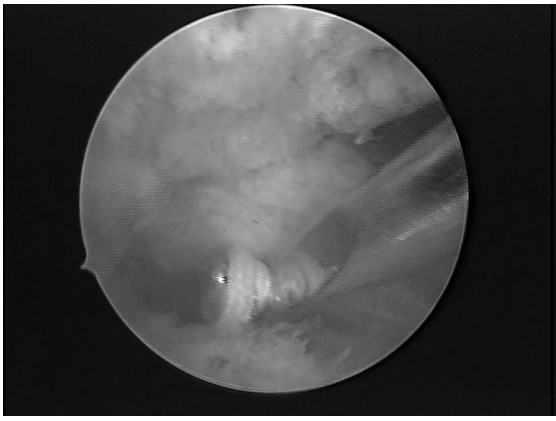
D: Sutures of the anchor passing through the tendon



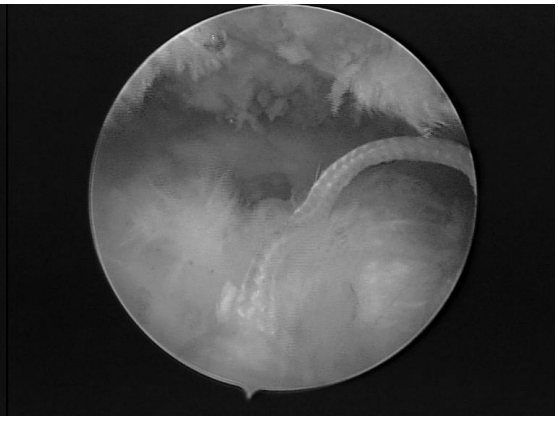
E: One of the suture limbs pulled through a healthy part of the rotator cuff



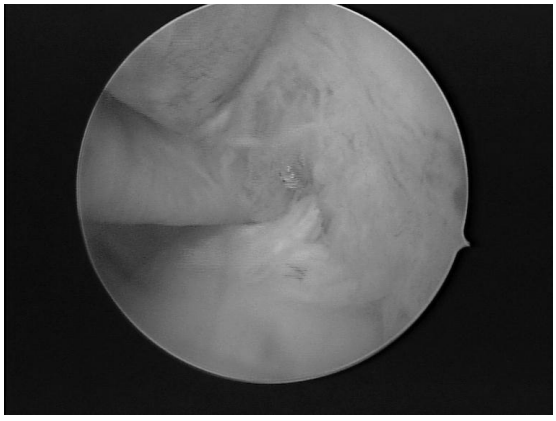
F: Subacromial view showing the sutures passing through the tendon



G: Other 2 suture limbs were pulled to exit through the lateral portal



H: Subacromial view after completion of the knot tying



I: Glenohumeral view showing rotator cuff repair and reconstruction of the footprint up to the articular surface of the humeral head

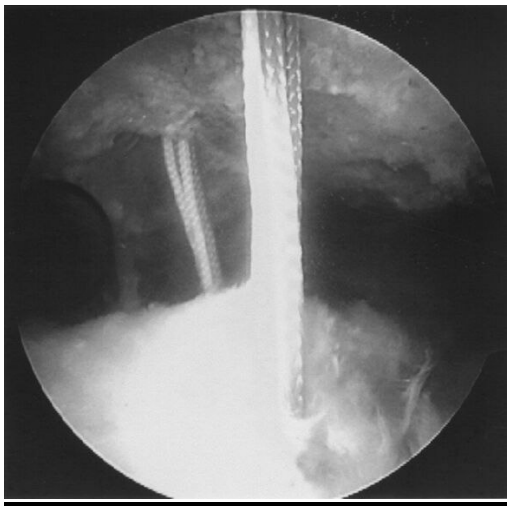


Figure 35: **The suture limbs of both anchors passing through the tendon and the subacromial space**

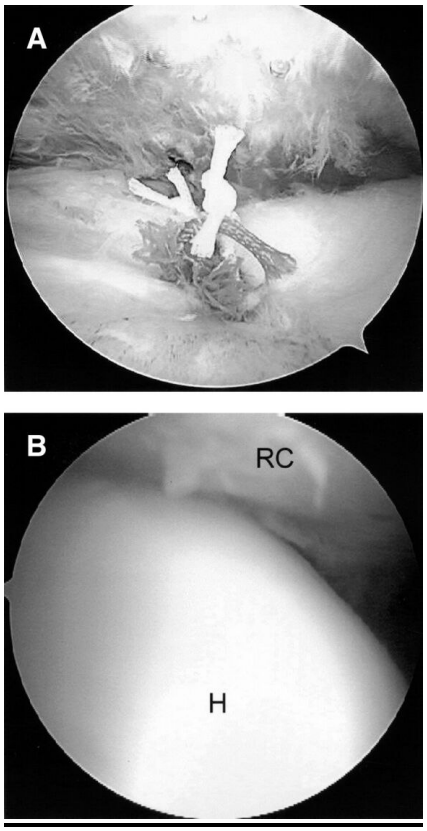


Figure 36: **Final repair. (A) Posterior subacromial view showing the repair. (b) Posterior glenohumeral view showing rotator cuff repair and restoration of the foot-print up to the articular surface of the humeral head. H, humeral head.RC, rotator cuff.**

II-Full thickness rotator cuff tears:

After adequate inspection of a full thickness tear to detect its size and extension a bone trough in the foot-print area of the rotator cuff insertion was made using firstly the shaver and then the bony burr (Fig 37). One or more bone anchors (5mm Smith&Nephew) depending on the size and extent of the cuff tear was inserted at the foot-print area and placed at a deadman's angle of approximately 45°. [15] An anterograde suture passing instrument, such as Elite Pass arthroscopic suture shuttle instrument (Smith&Nephew) (Fig 38), was used to pass one limb of each suture thread through the margins of the rotator cuff tear and back again through the lateral portal. Arthroscopic knot was then tied outside and pushed inside to close the defect Fig (39 A-G).

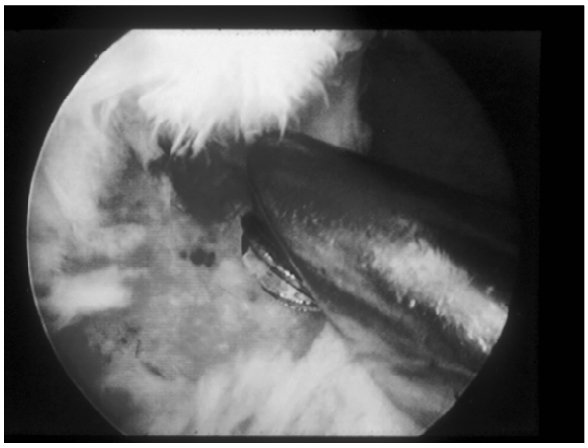


Figure 37: The burr was used to prepare the foot-print area for repair of the rotator cuff.

Figure 38: Elite Pass arthroscopic suture shuttle instrument

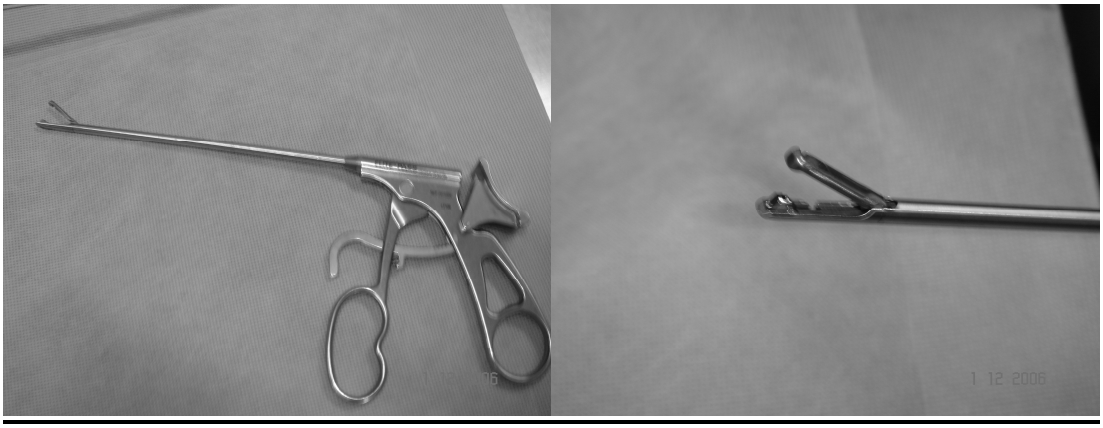
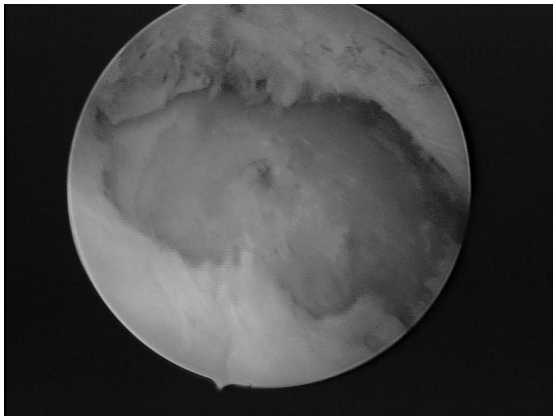
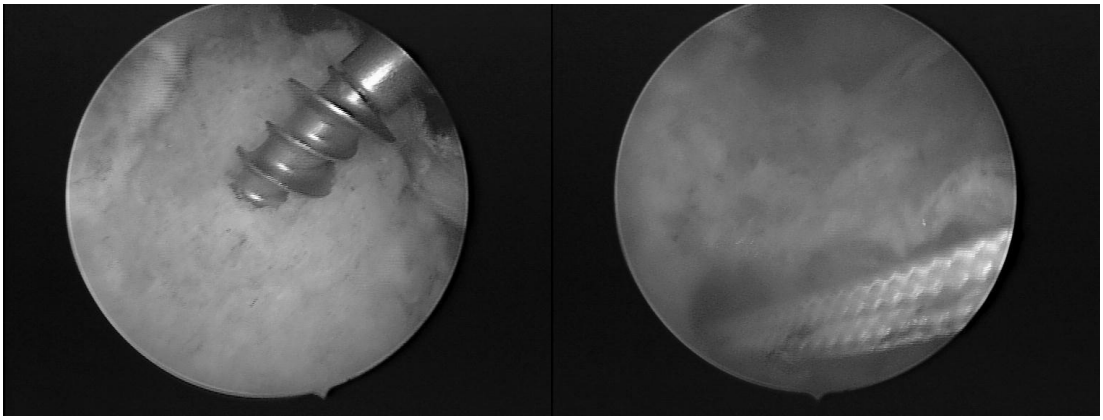


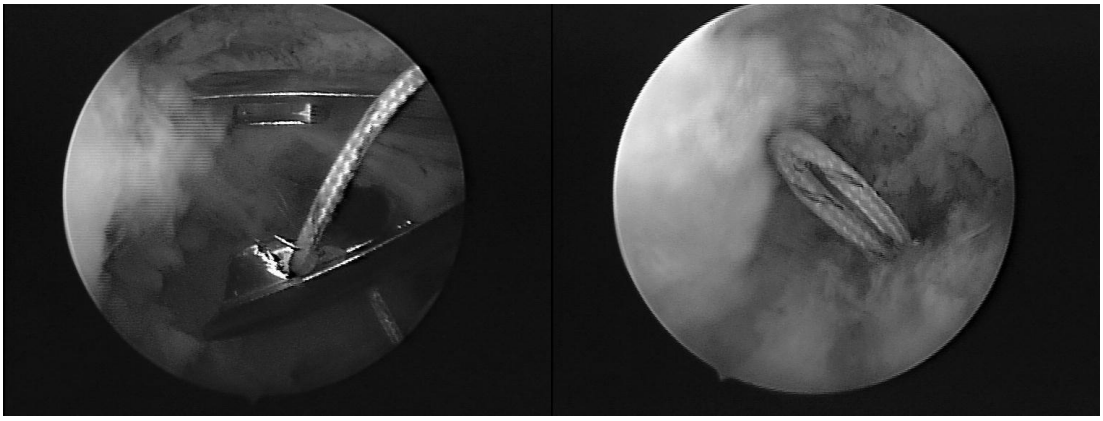
Figure 39 (A-G): Steps of arthroscopic repair of full thickness rotator cuff tear



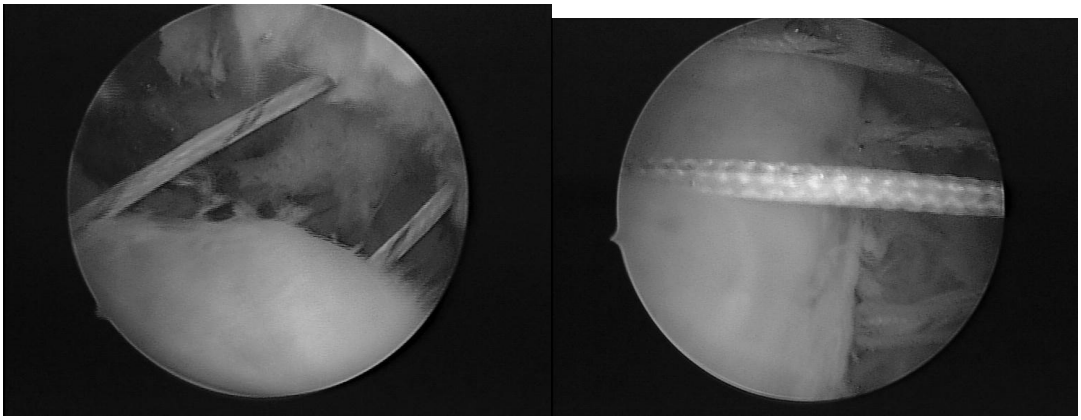
A: Subacromial view showing full thickness rotator cuff tear



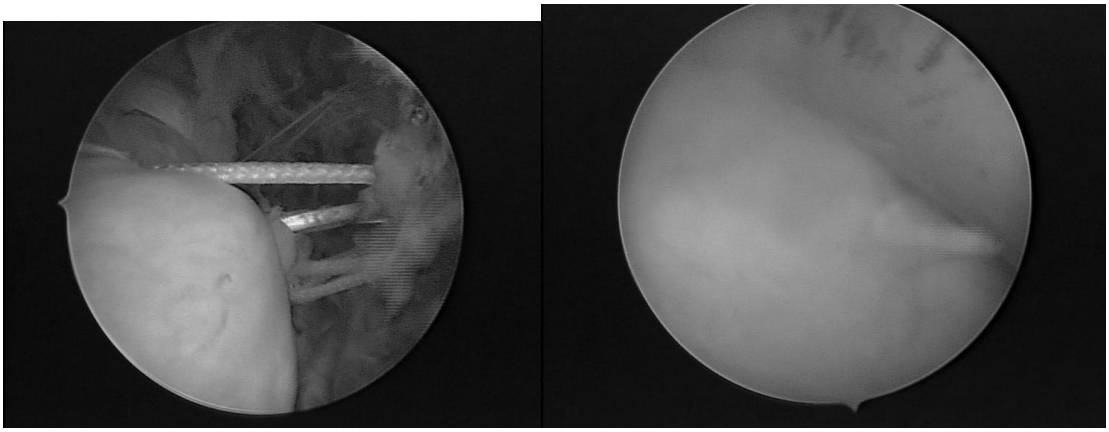
B: 2 Anchors were inserted into the prepared foot print area of the rotator cuff



C: **Elite Pass loaded with suture thread** **D:** **Suture thread passed through the cuff**



E: **One limb of each suture thread of each anchor was passed through the rotator cuff and pulled back through the lateral portal**



F: **Arthroscopic knot tying and closure of the defect** **G:** **Intra articular view showing fixation of the cuff to the foot print area**

(IV) Postoperative Management:

A sling immobilization or abduction brace was applied to all patients depending on the extent of the tear and the quality of the tissues. Then a special self-assisted rehabilitation program was started. This program is based on the cooperation between the therapist and the surgeon. The exercises were done step by step by the patients themselves several times a day. These exercises were practical, as they could be done anywhere.

The program consisted of three phases:

Phase I:(6weeks) consisted of passive and isometric exercises aiming at improvement of the range of shoulder movements.

Phase II:(6weeks) consisted of active exercises aiming at strengthening of the shoulder muscles and preservation and improvement of the movements of the shoulder.

Phase III: (4weeks) consisted of muscle strengthening exercises aiming at regaining the normal shoulder muscle power.

(V) Method of assessment:

A special shoulder rating scale was used in this study. This is a modification of the **University Of California at Los Angeles (UCLA) score system** to monitor the shoulder state before and after at least 6 months from the operative intervention. [28]

In our study the shoulder –rating system of the University of California at Los Angeles was modified. This scoring system evaluates only the range and the strength of forward flexion. As the rotator cuff plays also an important role in abduction (supraspinatus) and external rotation (infraspinatus and teres minor), the score in our study was modified to evaluate also the range and the strength of the shoulder abduction and external rotation.

Modified University of California at Los Angeles (UCLA) scale:

	Score
Pain:	
•Present all of the time and unbearable; strong medication frequently.	1
•Present all of the time but bearable; strong medication occasionally.	2
•None or little at rest, present during light activities, salicylates frequently.	4
•Present during heavy or particular activities only; salicylates occasionally.	6
•Occasional and slight	8
•None	10
Function:	
•Unable to use limb	1
•Only light activities possible	2
•Able to do light housework or most activities of daily living	4
•Most housework, shopping, and driving possible; able to comb hair and dress and undress, including fastening brassiere	6
•Slight restriction only; able to work above shoulder level	8
•Normal activities	10
Active forward flexion:	
•150º or more	5
•120º-150º	4
•90º-120º	3
•45º-90º	2
•30º-45º	1
•<30º	0
Strength of forward flexion:	
•Grade 5 (normal)	5
•Grade 4 (good)	4
•Grade 3 (fair)	3
•Grade 2 (poor)	2
•Grade 1 (muscle contraction)	1
•Grade 0 (nothing)	0

Active Abduction:	
•140° or more	5
•120°-139°	4
•90°-119°	3
•45°-89°	2
•30°-44°	1
•<30°	0
Strength of abduction:	
•Grade 5 (normal)	5
•Grade 4 (good)	4
•Grade 3 (fair)	3
•Grade 2 (poor)	2
•Grade 1 (muscle contraction)	1
•Grade 0 (nothing)	0
Active external rotation:	
•80°- 90°	5
•55°-79°	4
•40°-54°	3
•25°-39°	2
•<25°	1
•Ankylosed	0
Strength of external rotation:	
•Grade 5 (normal)	5
•Grade 4 (good)	4
•Grade 3 (fair)	3
•Grade 2 (poor)	2
•Grade 1 (muscle contraction)	1
•Grade 0 (nothing)	0
Satisfaction of the patient:	
•Satisfied and better	5
•Not satisfied and worse	0
Total score =	**55 points**

The overall score is then classified as:

Excellent: 43 to 55 points

Good : 31 to 42 points

Fair : 21 to 30 points

Poor : 20 or less points

Excellent and good will be considered satisfactory results, while fair and poor will be considered unsatisfactory results.

(VI) Methods of Statistical assessment:

Statistics of the results were carried out according to the following formulae:

1. Arithmetic mean ($\overline{X}$):

Was calculated as follows:

$$\bar{x} = \frac{\sum x}{n}$$

Where:

$\bar{x}$ = arithmetic mean
Σx = Sum of observations
n = number of observations

2. Standard deviation (SD):

Was calculated as follows:

$$SD = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}}$$

Where:

Σx^2 = sum of squared observations.

$(\Sigma x)^2$ = square of the sum of observations.

n = number of observations.

3. "t" test:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{S_P^2 (\frac{1}{n_1} + \frac{1}{n_2})}}$$

$$S_P^2 = \frac{S_1^2 (n_1 - 1) + S_2^2 (n_2 - 1)}{n_1 + n_2 - 2}$$

Where: S_P^2 = Pooled variance.

S_1^2 = Variance of sample (1).

S_2^2 = Variance of sample (2).

n_1 = Size of sample (1).

n_2 = Size of sample (2).

X_1 = Mean of sample (1).

X_2 = Mean of sample (2).

S_1 = Standard deviation of sample (1).

S_2 = Standard deviation of sample (2).

4. Chi-square (X^2):

For comparison between distribution of patients according to different items of study and use this formula for calculation:

$$X^2 = \sum \frac{(O-E)^2}{E}$$

O = Observed results E = Expected results

$(O-E)^2$ = Difference squared

Where E = $\frac{\text{Total row x total column}}{\text{Grand total}}$

RESULTS

The study was conducted on forty patients; all suffered from chronic rotator cuff tears (impingement tears). In all cases arthroscopic rotator cuff repair was performed. All patients were followed up clinically (using the modified University of California at Los Angeles score) and radiologically.

The follow up period ranged from 10 to 15 months with a mean of 13.83 months.

I- Clinical results:

All patients were subjected to preoperative clinical assessment as regards the presence of pain during overhead activities as well as during sleep, subjective feeling of weakness, impingement sign and impingement test.

The following clinical data were obtained:

Of the forty patients thirty five (87.5%) complained of pain during overhead daily activities, whereas; thirty nine patients (97.5%) complained of nocturnal pain accentuated with sleeping on the affected shoulder.

Subjective feeling of weakness of the affected shoulder during the daily activities was recorded in thirty six patients (90%), while the other four patients (10%) complained only of pain. Those patients were found to have partial thickness rotator cuff tears.

Regarding the impingement sign, it was positive in the forty patients (100%).

Impingement test was performed in all patients, thirty three (82.5%) showed complete relief of pain with overhead elevation of the arm following the subacromial local anaesthetic injection and therefore, the test in them was considered positive. In seven patients (17.5%) the test was considered negative as the patients still complained of pain following the injection.

Table (III) shows the distribution of the studied group regarding the preoperative clinical assessment.

The modified University of California at Los Angeles score (UCLA) (presented before in the methods' section) was improved from a mean of 24.85 points preoperatively (range from 16-38 points) to a mean of 43.83 points postoperatively (range from 16- 55 points). This improvement was statistically significant.

Table (IV) and Figure (40) show the comparison between the pre and post operative total scores.

Of the forty patients thirty five patients (87.5%) showed postoperative satisfactory results, whereas; only five patients (12.5%) showed unsatisfactory results. The difference between the pre and post operative satisfactory results was statistically significant.

Table (V) shows the comparison between the pre and postoperative net results.

It is to be noted that five patients (12.5%) showed preoperative satisfactory scores. Their main complain was pain and they had fair and in two of them good strength and range of motions. Although their preoperative overall scores (between 31-33 points) were satisfactory the patients were not satisfied with their conditions and asked for further intervention. During arthroscopic intervention those patients were found to have subacromial impingement with partial thickness cuff tears.

Table (III): Distribution of the studied group regarding pre-operative clinical assessment.

	Frequency	
	No.	%
Pain activity		
Yes	35	87.5
No	5	12.5
Night Pain		
Yes	39	97.5
No	1	2.5
Weakness		
Yes	36	90.0
No	4	10.0
Imping Sign		
Positive	40	100.0
Negative	0	0.0
Imping Test		
Positive	33	82.5
Negative	7	17.5

Table (IV): Comparison between pre and post operative total score.

Total score	Pre-operative	Post-operative
Range	16 – 38	16 – 55
Mean	24.85	43.83
S.D.	5.60	9.91
t	7.25	
p	0.0001*	

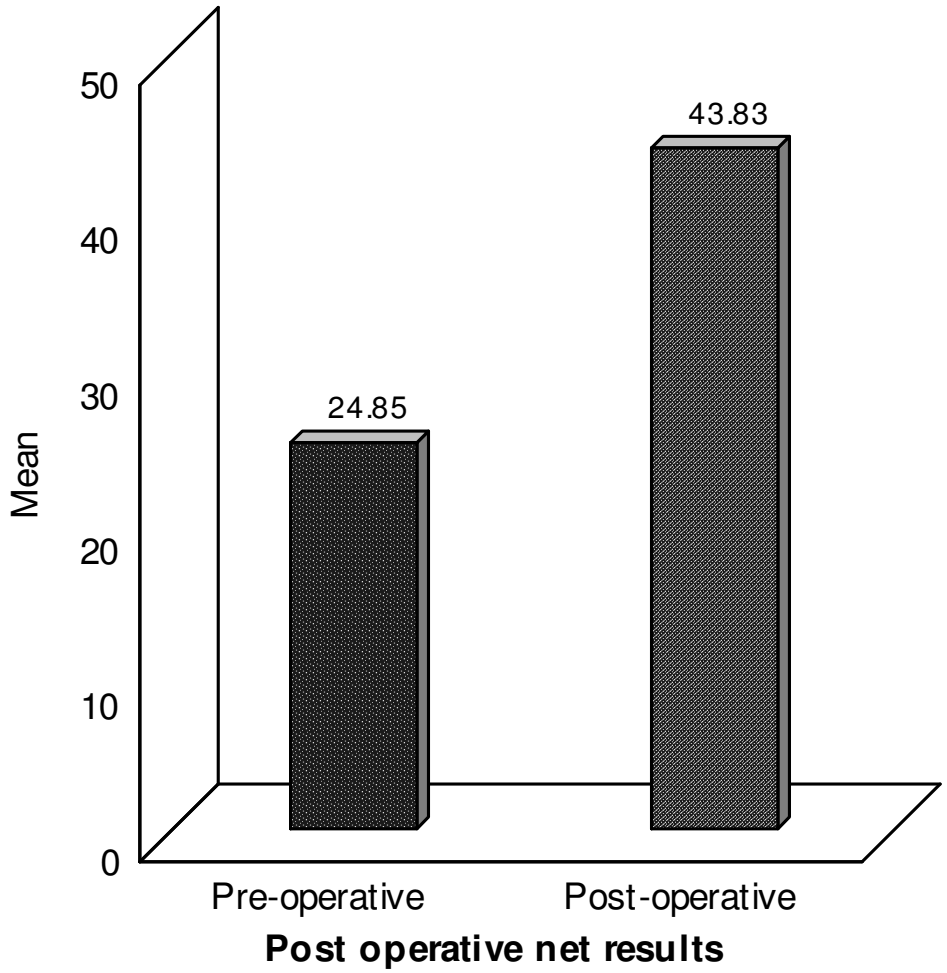


Figure 40: Comparison between pre and post operative total score.

Table (V): Satisfaction pre and post operative.

Net results	**Pre-operative**		**Post-operative**	
	No.	%	No.	%
Satisfactory	**5**	**12.5**	**35**	**87.5**
Excellent	0	0.0	24	68.6
Good	5	100.0	11	31.4
Unsatisfactory	**35**	**87.5**	**5**	**12.5**
Fair	26	74.3	4	75.0
poor	9	25.7	1	25.0
X^2	25.68			
p	0.0001*			

Analysis of the different items of the assessment's score:

The pain score was improved significantly from a mean of 2.95 points preoperatively (range 1-6 points) to a mean of 8.11 points postoperatively (range 4-10 points). The period of complete disappearance of pain varied between 2 and 8 weeks postoperatively (mean time 4.8 weeks).

The function score improved from a mean of 3.675 points preoperatively (range 1-8 points) to a mean of 7.85 points postoperatively (range 2-10 points). The difference between the pre and post operative points was statistically significant.

Table (VI) shows the comparison between the pre and post -operative pain and function scores.

Regarding the range and the strength of shoulder movements (Flexion, Abduction and External rotation) there were evident improvements in the postoperative follow up scores. These improvements were statistically significant.

Tables (VII, VIII) show the comparison between the pre and post operative range and strength of movements.

Table (VI): Comparison between pre and post operative pain and function scores.

	Pre-operative	**Post-operative**
Pain score		
Range	1-6	4-10
Mean	2.95	8.11
S.D	1.12	2.95
t	12.87	
p	0.0001*	
Function score		
Range	1-8	2-10
Mean	3.675	7.85
S.D.	1.89	2.19
t	12.3	
p	0.0001*	

Table (VII): Comparison between pre and post operative range of movements.

	Pre-operative	**Post-operative**
Flexion score		
Range	2-5	1-5
Mean	3.375	4.425
S.D.	0.81	0.96
t	2.65	
p	0.032*	
Abduction		
Range	1-5	1-5
Mean	3.025	4.275
S.D.	0.86	0.96
t	2.03	
p	0.01*	
Ext. rotation		
Range	1-5	1-5
Mean	2.85	3.675
S.D.	0.74	0.80
t	2.11	
p	0.031*	

Table (VIII): Comparison between pre and post operative strength of movements.

	Pre-operative	**Post-operative**
Str. Flextion		
Range	2-4	2-5
Mean	3.0	4.15
S.D.	0.68	0.89
t	4.23	
p	0.001*	
Str. Abduction		
Range	2-4	3-5
Mean	3.025	4.225
S.D.	0.66	0.86
t	1.99	
p	0.041*	
Str. Ext rotation.		
Range	2-4	2-5
Mean	2.85	4.075
S.D.	0.66	0.92
t	4.65	
p	0.0021*	

Factors that might affect the postoperative results:

Certain factors among the studied group of patients were evaluated to show their relations to the postoperative net results.

1. ***Age:***

There was no statistically significant relation between the age of the patient and the postoperative net result. Three of the five patients with unsatisfactory net results were between 60-70 years. However, nineteen patients in the same age group showed satisfactory outcome.

2. ***Sex:***

Although the female patients constituted the majority of the studied cases (21 patients), only two of them showed unsatisfactory results. On the other hand, three of the nineteen male patients showed unsatisfactory net results.

Statistically there was no significant relation between the sex of the patient and the postoperative net result.

Table (IX) and Figure (41) show the relation between the postoperative results and the demographic data of the patients (Age & Sex).

3. ***Dominant shoulder:***

There was no significant difference in the postoperative results for the dominant and non dominant arms.

4. ***Side affected:***

Although three of the five unsatisfactory shoulders were left, however, there was no statistical significant relation between the site affected and the postoperative results.

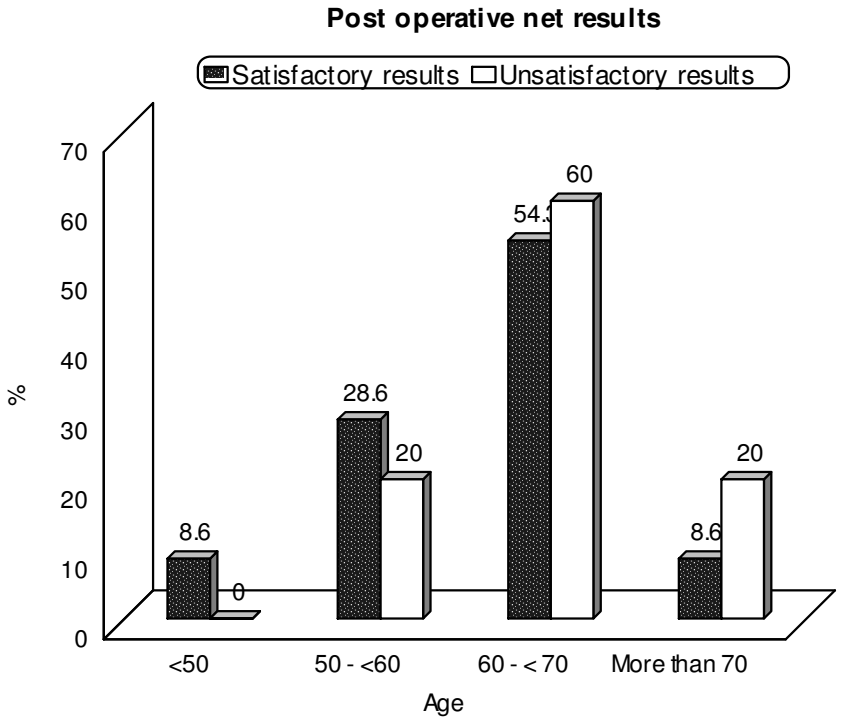
Table (X) and Figures (42, 43) show the relation between the dominant shoulder and the side affected with the postoperative results.

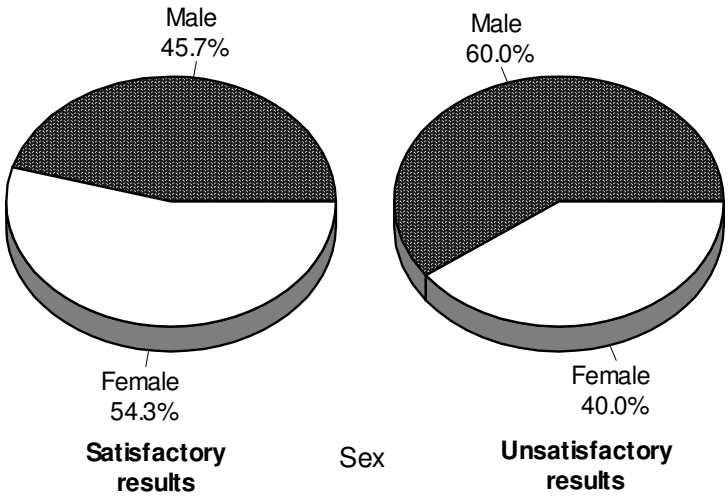
Table (IX): Relation between the post operative results and the demographic data.

	Post operative net results				X^2	p
	Satisfactory results		Unsatisfactory results			
	No.	%	No.	%		
Age						
<50	3	8.6	0	0.0		
50 – <60	10	28.6	1	20.0	0.65	0.42
60 - < 70	19	54.3	3	60.0		
more than 70	3	8.6	1	20.0		
Sex						
Male	16	45.7	3	60.0	0.73	0.34
Female	19	54.3	2	40.0		
Total	35	100.0	5	100.0		

Table (X): Relation between the dominant shoulder and side affected with post operative result.

	Post operative results				X^2	p
	Satisfactory results		Unsatisfactory results			
	No.	%	No.	%		
Dominant arm						
Right	34	97.1	5	100.0	0.41	0.48
Left	1	2.9	0	0.0		
Side						
Right	23	65.7	2	40.0	0.98	0.23
Left	12	34.3	3	60.0		





Figures 41: Relation between post operative results and demographic data (Age & sex) .

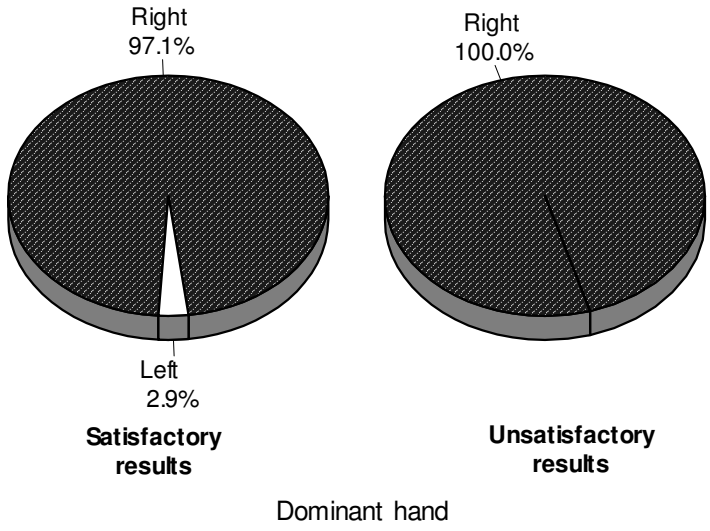


Figure 42: Relation between the dominant hand and the postoperative results.

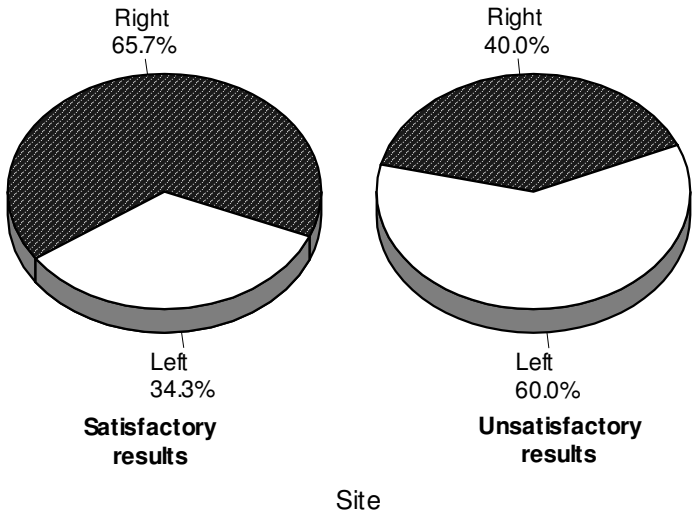


Figure 43: Relation between dominant hand and side affected with the post operative results

5. ***Preoperative complaint (Pain&Weakness):***

There was no statistical significance between the preoperative pain (whether during activity or nocturnal) and the weakness with the postoperative results. Table (XI)

6. ***Timing of repair:(Time lag before presentation):***

The mean time lag before presentation was 0.55 year (6.6 months) in patients with satisfactory results, whereas; it was 0.87 year (10.44 months) in patients with unsatisfactory outcomes. The difference between both groups was statistically significant. In other words, the earlier the timing of repair, the better was the postoperative results.

Table (XII) and Figure (44) show the relation between the postoperative results and the time lag before presentation.

7. ***Duration of follow up:***

The mean follow up period was 13.83 months in patients with satisfactory results, whereas; it was 14.4 months in patients with unsatisfactory results. There was no statistical significant relation between the duration of follow up and the postoperative results. Table (XIII) and Fig. (45)

8. ***Type of the tear:***

Of the forty patients, twenty eight (70%) were found to have full thickness cuff tears whereas; twelve patients (30%) had partial thickness cuff tears. Table (IX) and Fig. (45)

Although all the patients with partial thickness cuff tears showed satisfactory results whereas five of the twenty eight patients with full thickness cuff tears showed unsatisfactory results, however, there was no statistical significant difference between the type of the tear and the postoperative result. Table (XV) and Fig. (47)

Table (XI): Relation between pain & weakness with the post operative result.

	Post operative results				X^2	p
	Satisfactory results		Unsatisfactory results			
	No.	%	No.	%		
Pain activity						
Yes	30	85.7	5	100.0	0.82	0.336
No	5	14.3	0	0.0		
Night pain						
Yes	34	97.1	5	100.0	0.41	0.48
No	1	2.9	0	0.0		
Weakness						
Yes	31	88.6	5	100.0	0.98	0.38
No	4	11.4	0	0.0		

Table (XII): Relation between the post operative results and the time lag before presentation.

Time before Present	Post operative results	
	Unsatisfactory results	**Satisfactory results**
Range	0.25 - 5.0	0.5 - 0.75
Mean	0.87	0.55
S.D.	0.81	0.11
t	2.06	
p	0.0164*	

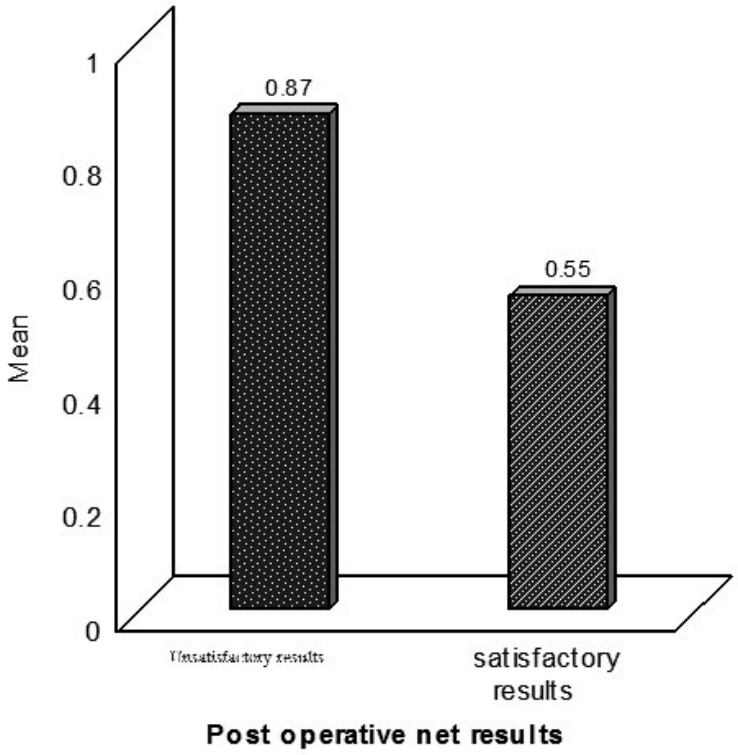


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Figure 44: Relation between post operative results and time before presentation

Table (XIII): Relation between post operative results and duration of follow up.

Duration of follow up	Post operative results	
	Satisfactory results	Unsatisfactory results
Range	10-15	12-15
Mean	13.83	14.4
S.D.	3.29	1.34
t	1.22	
p	0.24	

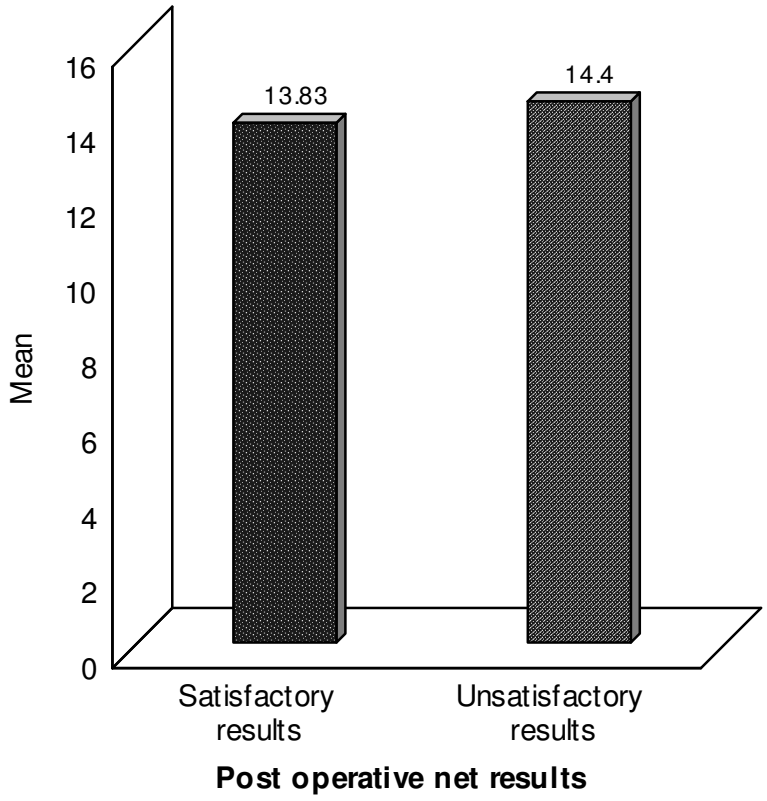

Figure 45: Relation between post operative results and duration of follow up

Table (XIV): Distribution of the studied group regarding type of tear.

Type of tear	Frequency	
	No.	**%**
FTRCT	28	70.0
PTRCT	12	30.0
Total	40	100.0

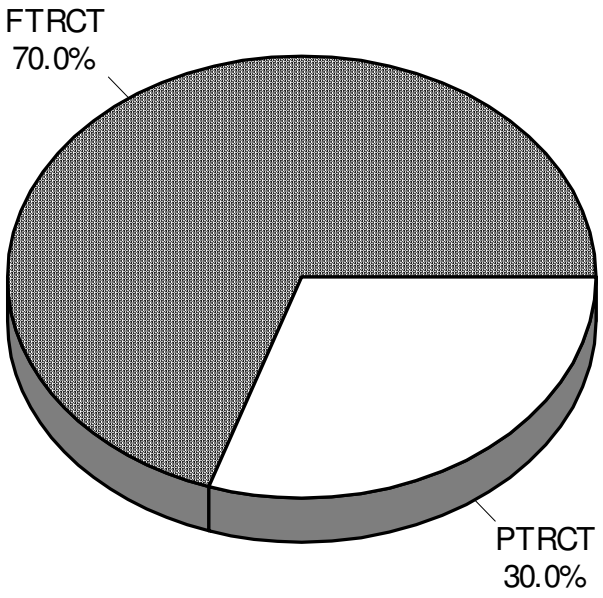

Figure 46 : Distribution of the studied group regarding type of tear.

Table (XV): Relation between the post operative results and the type of tear.

	Post operative results				X^2	p
	Satisfactory results		Unsatisfactory results			
	No.	%	No.	%		
FTRCT PTRCT	23 12	65.7 34.3	5 0	100.0 0.0	2.45	0.117
Total	35		5			

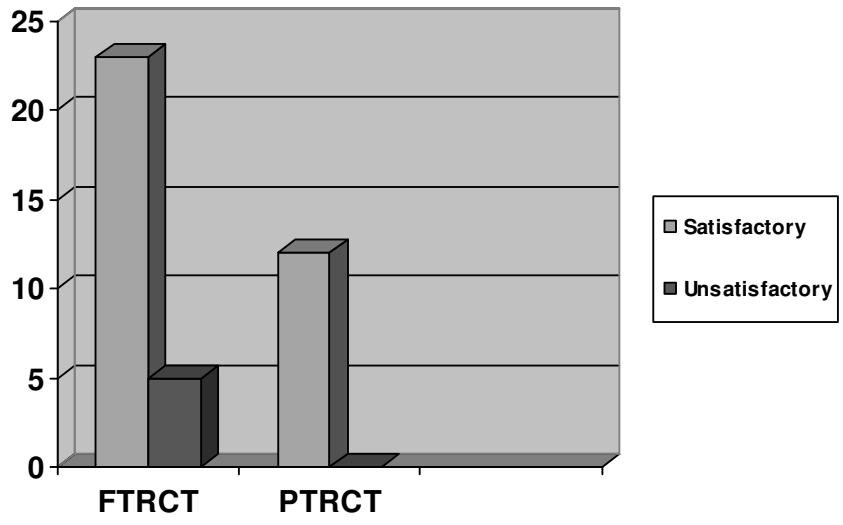

Figure 47: Relation between the post operative results and the type of tear.

II- Radiological results:

A] Plain X-ray:

The acromiohumeral distance was increased from a mean of 8.15mm preoperatively (range 5-11mm) to a mean of 14.525 mm postoperatively (range 12-18mm). This improvement was statistically significant. Table (XVI) and Fig. (48)

The square sign was detected in fourteen patients (35%), eight of them had full thickness cuff tears and the other six had large cuff tears.

The sourcil sign was detected in seven cases (17.5%), all of them were found to have large cuff tears.

B] Ultrasonography:

Ultrasonographic examination was performed in all cases. In thirteen patients (32.5%) the results obtained from the U/S were not conclusive.

C] MRI and MRI arthrography:

MRI was done in ten cases. Eight of them showed partial thickness cuff tears and two showed full thickness cuff tears. Figures (49,50,51)

MRI arthrography was performed for three cases, two showed partial thickness tears and one showed full thickness tear in which the dye was detected in the subacromial space. The arthroscopic findings were similar to the results obtained by both radiological maneuvers.

Table (XVI): Comparison between pre and post operative AHD.

	Pre-operative	Post-operative
AHD		
Range	5-11	12-18
Mean	8.15	14.525
S.D.	1.53	1.50
t	5.32	
p	0.001*	

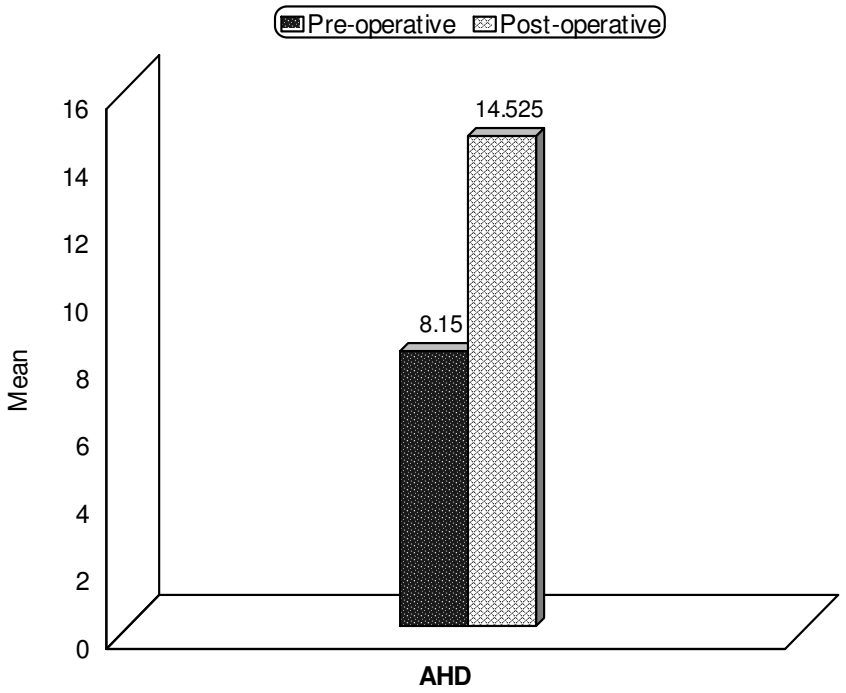

Figure 48: Comparison between pre and post operative AHD.

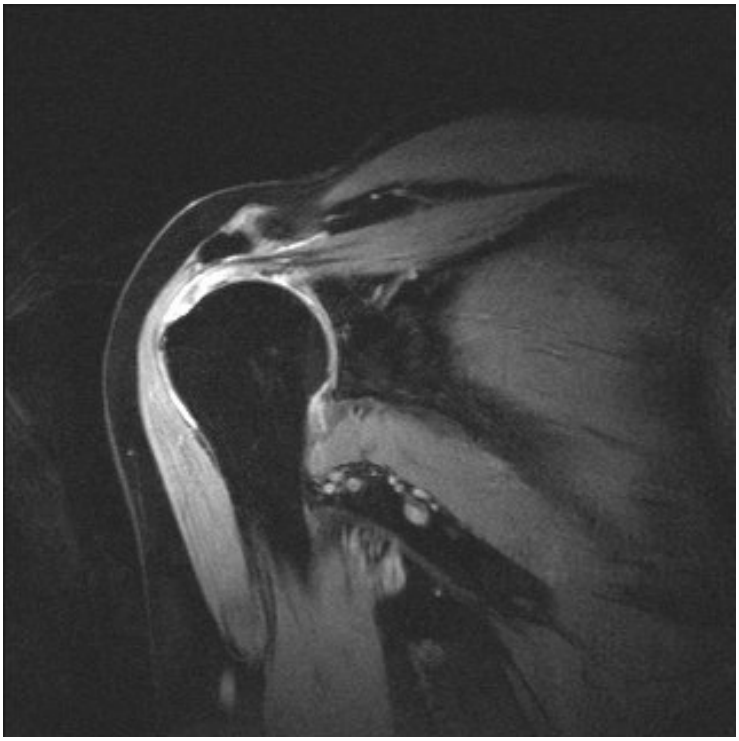

Figure 49 : Preoperative MRI picture showing full thickness cuff tear

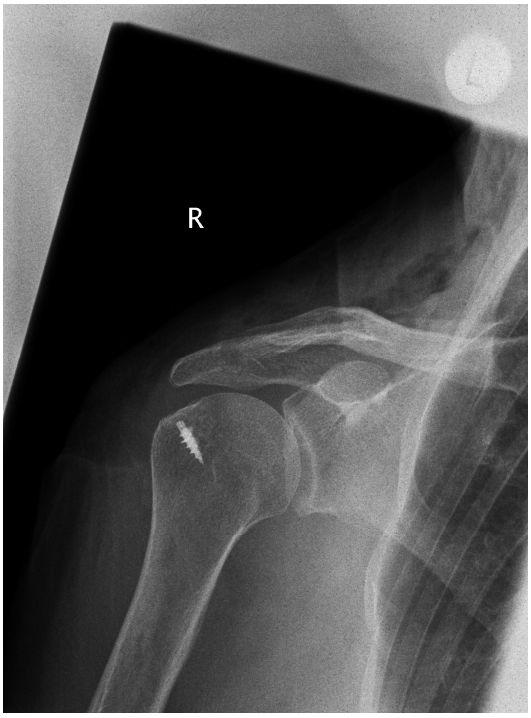

Figure 50 : Postoperative X-ray following the repair of the full thickness tear

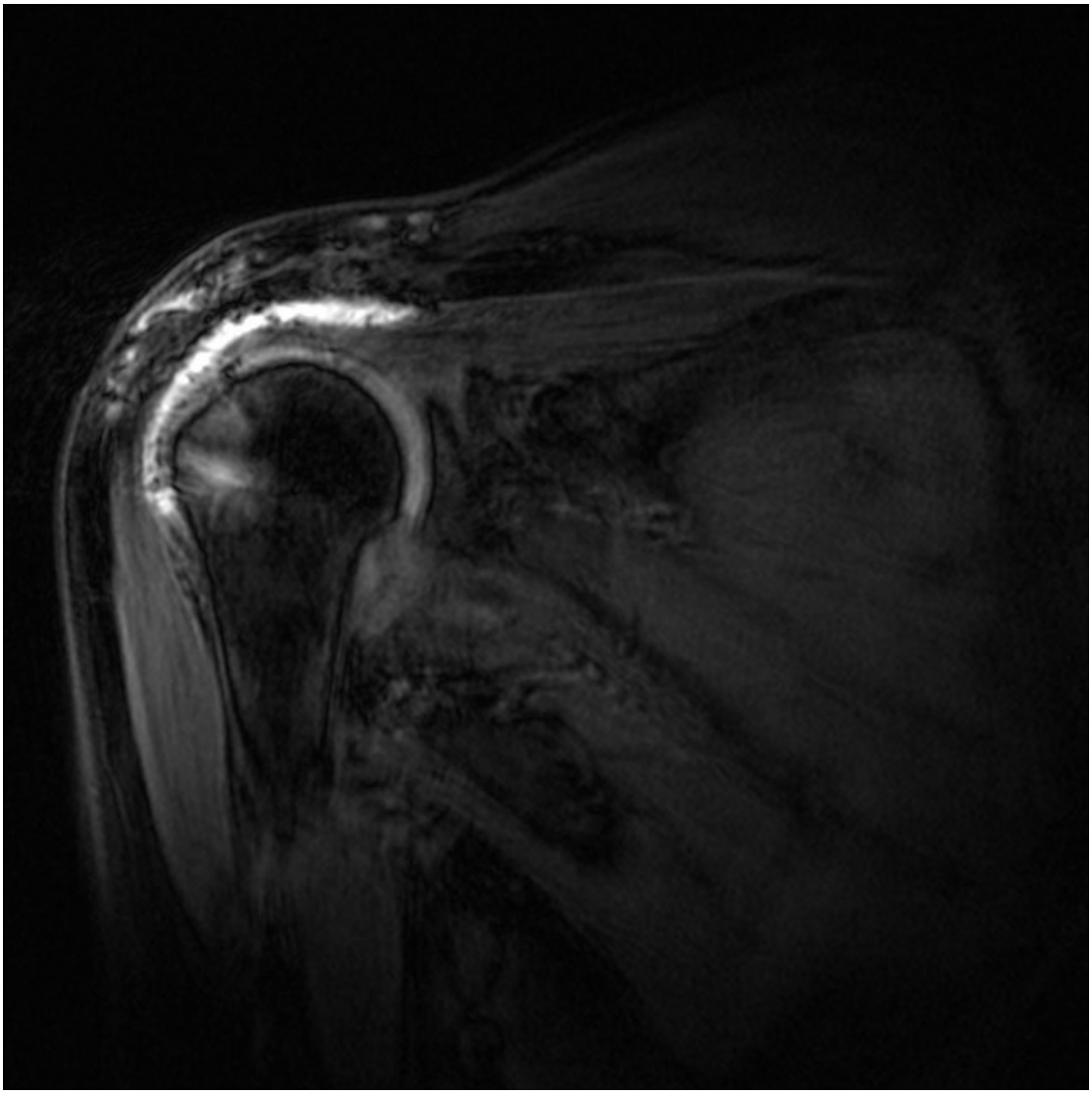

Figure 51 : Follow-up MRI picture (11 months postoperative) showing continuity and healing of the cuff tendon to the site of insertion

Complications:

Superficial infection:

Superficial infection in the lateral portal was encountered in one patient. The infection was resolved with frequent dressings and local antibiotics. The patient showed satisfactory result at the time of the follow up.

Persistent pain:

The five unsatisfactory results showed persistent pain during activity and at night. However, the pain was not strong compared with the preoperative pain.

Failure of repair:

One of the five unsatisfactory patients who had repair of a large cuff tear sustained trauma to the operated shoulder “falling down” two months after the surgery. After that the patient experienced pain and weakness. However, the patient refused any surgical intervention.

DISCUSSION

Rotator cuff tears are among the most common conditions affecting the shoulder. Despite their ubiquity, however, there is substantial debate concerning their management.

Arthroscopic repair of rotator cuff tears is technically demanding and is still in the developmental phase, with only short and intermediate-term studies available. The results of arthroscopic repair have not been as thoroughly studied as those after open repair. [89]

Despite its prior reputation as an impractical operative technique, recent reports of arthroscopic rotator cuff repair have shown promising results that appear to be as good as, if not superior to, the results of open rotator cuff repair. [58]

I- Clinical results:

The clinical success rate in patients included in our study was 87.5%. It is more or less comparable to the other similar published studies. Rebuzzi et al. showed satisfactory results of 81.4 %; [75] whereas, Boileau et al. showed satisfactory results of 92 %.[11]

The clinical results reported in our study are similar to those of previously published reports on open [42,78] and mini-open techniques [73,86]. Outcome studies after open repair of the rotator cuff showed an 88% to 90% success rate [28]. In 1990, Levy et al. reported a preliminary one-year follow-up study of twenty five patients with rotator cuff tears who had been treated with an arthroscopic subacromial decompression and then a mini-open lateral deltoid-splitting repair. Twenty of the patients (80%) had a good or excellent result according to the shoulder-rating system of the University of California at Los Angeles. [55]

Youm et al. performed a comparison of clinical outcomes and patient satisfaction following arthroscopic and mini-open rotator cuff repair. They found that, at greater than two years of follow-up, arthroscopic and mini-open rotator cuff repairs produced similar results for small, medium, and large rotator cuff tears with equivalent patient satisfaction rates.[92] Similarly Ide et al. performed a comparison between arthroscopic and open rotator cuff repairs in 100 cases. They concluded that the arthroscopic repair of small-to-massive tears had outcomes equivalent to those of open repair. [47]

In the study published by Boileau et al, they concluded that the results of arthroscopic repairs were comparable with those obtained with open or mini-open techniques, and they have given them the confidence to continue performing arthroscopic cuff repair.[11] In a long-term follow-up study (2-14 years) of rotator cuff tears repaired arthroscopically, Wilson et al. concluded that the arthroscopic techniques for rotator cuff repair achieve results comparable to the results of traditional open repair. [87] Similarly Jones and Savoie showed success rate of 88% in cases with arthroscopic repair of large and massive cuff tears. They concluded that the arthroscopic management of such tears could obtain results comparable to the reported outcomes following open repairs.[50] Moreover, Buess et al. performed a comparative study between open versus arthroscopic repair of rotator cuff tears in 96 cases. The authors reported that the arthroscopic repair had yielded equal or better results than open repair, even at the beginning of the learning curve. They found that the patients with an arthroscopic repair had a significantly better decrease in pain and a better functional result concerning mobility. The authors concluded that the arthroscopic repair is successful for large and small tears and biomechanically, large tears might even benefit more than small ones. [14]

Indications for surgical intervention:

In the present study, pain during overhead daily activities (87.5%), nocturnal pain (97.5%), and/or weakness of the affected shoulder during the daily activities (90%) were considered indications for surgical treatment after failure of conservative treatment (subacromial steroid injection and physiotherapy) for at least three months. Watson et al. considered pain as the most common indication for surgery and alleviating it was clearly an important goal.[85] In the study published by Gartsman et al, the primary indication for the arthroscopic repair of rotator cuff tears was persistent pain in the shoulder not responding to a minimum of six months of conservative treatment.[33] Pain and functional disability refractory to conservative care were also the indications for arthroscopic surgical repair in the study reported by Boileau et al. [11]

Pain:

Several authors have noted that the rotator cuff surgery appears to be more effective for pain relief than for improvement in strength and function.[9,10,71] The pain score in our study was improved significantly from a mean of 2.95 points preoperatively to a mean of 8.11 points postoperatively. The improvement of the pain score in our study was nearly similar to that reported by Boileau et al, where the pain was also improved significantly from a mean of 2.1 points preoperatively to a mean of 9.1 points postoperatively.[11] Similar report was published by Gartsman et al. who performed arthroscopic repair of full thickness rotator cuff tears in 73 patients. [33]

Function:

The function score in our study was improved significantly from a mean of 3.67 points preoperatively to a mean of 7.85 points postoperatively. Similar reports of significant functional improvement following arthroscopic repair of cuff tears were published by Boileau et al [(11)] and Gartsman et al.[(33)]

Range and strength of movements:

The range of forward flexion was significantly increased from a mean of 3.375 points preoperatively to a mean of 4.425 points postoperatively. Similarly Gartsman et al. reported significant improvement in the forward flexion which improved from a mean of 3.7 points preoperatively to a mean of 4.9 points postoperatively. [(33)] On the other hand, although Boileau et al. reported improvement in the forward flexion; however, this improvement was not statistically significant. [(11)]

The range and the strength of abduction and external rotation of the shoulder were also significantly improved. Similar arthroscopic studies did not include these measurements in their scores; therefore, it was difficult to compare our results with them. However, in a study published by Cofield et al, they did open surgical repair in 105 patients suffered from chronic rotator cuff tears. They reported significant improvements in the range and the strength of the active abduction and external rotation. [(20)]

Patient satisfaction:

In the present study 87.5% of the patients were satisfied at the time of the follow-up. The patient's satisfaction published by Tauro [(83)], Gartsman[(33)], Nottage and Servud, and Weber were 92%, 90%, 91%, and 92% respectively.[(91)]

Factors affecting the results of surgery

The outcome of rotator cuff repairs may be influenced by a variety of factors.

1. Age:

The average age of the patients in our study was 61.15 years. Although in this study there was no limitation concerning the age, we found no statistical significant relation between the age of the patient and the postoperative net results. Similarly, Bennet reported no difference in the outcome based upon the age as a variable.[7] Stollsteimer and Savoie showed also no difference in the outcome noted among patients of different ages, suggesting that the arthroscopic repair is equally effective in all age groups.[82]

On the other hand, Boileau et al. reported that the age was clearly a factor influencing tendon healing. They found that the patients who had a healed tendon were, on the average, ten years younger than those in whom the tendon did not heal. They concluded that the chance of tendon healing decreased to 43% when the patient was more than sixty five years old. However, they stated that the absence of tendon healing (or only partial healing) did not necessarily compromise pain relief and patient satisfaction.[11]

2. Sex:

There is little commentary in the literature with respect to sex for outcomes of rotator cuff disease.

This study included 19 males and 21 females. The almost equal sex distribution was also shared between this study and other studies carried out by Kim [52], Boileau[11] , and Galatz.[32] They also shared that there was no significant relation between the sex of the patient and the postoperative net results.

On the other hand, in the study performed by Watson et al, they identified a small, but statistically significant difference between male and female patients with regard to overall satisfaction, improvement in the functions of activity of daily livings (ADLs), and performance of usual work. However they stated that "what does exist does not support a sex difference".[85] Harryman et al evaluated patient satisfaction, functional outcome, and ultrasonographic cuff integrity after 105 rotator cuff repairs and found no significant correlation of patient sex with the outcomes. [41]

3. *Dominant shoulder:*

In the present study we found no significant relation between the dominant shoulder and the postoperative outcome. Cofield et al reported similar result. [20]

4. *Timing of repair:*

Our study showed that the earlier the timing of the rotator cuff repair was, the better was the postoperative net results. Clinical data from studies by Goutallier et al. also supported the concept that the longer a patient had symptoms of a rotator cuff tear, the more extensive the fatty degeneration of the torn rotator cuff muscle. The authors also reported that surgical intervention when there is minimal fatty degeneration of the muscle reduces the rate of retears.[36] These data suggest that early operative intervention would facilitate improved outcomes for patients. Additional support for this statement was reported in the study done by Harryman et al. [41]

In contrast, Cofield et al. reported that the time from the beginning of symptoms to surgery did not have a significant effect on the outcome.[20] Similarly, Burkhart et al reported that the delay from injury to surgery, even of several years, did not adversely affect the surgical outcome and was not a contraindication to arthroscopic rotator cuff repair. [16]

5. Size of the tear:

This study included 70% full thickness and 30% partial thickness cuff tears. There was no statistical significant difference between the size of the tear and the postoperative net results.

Various authors have reported a relation between the size of the cuff tear and the results of repair, suggesting that the functional outcome is better for small and medium tears than for large and massive tears. [5,10,,77] Others have suggested otherwise. [27,66] Harryman et al. [41] and Gazielly et al.[34] concluded that the patients with smaller tears had a higher rate of healing. Basset and Cofield found that the strength on the abduction and external rotation after repair of small and medium sized tears was consistently better than that after repair of large tears.[5] Hawkins et al. found a direct relationship (although not a significant one) between the size of the tear and the strength as determined with the postoperative manual muscle-testing. [42]

In a long-term follow-up study using ultrasound, Harryman et al found a much higher prevalence of recurrent defects in the cuff in the patients who had had a larger tear. [41] Rokito et al performed repair of rotator cuff tears in forty-two patients, they found a trend between the size of the tear and the recovery of strength. [76] Iannotti et al, in a prospective study of forty patients who had repair of the rotator cuff, found a significant association between the functional outcome and the size of the tear at the time of the operation. [44]

On the other hand, Burkhart et al reported the long-term functional results of arthroscopic rotator cuff repair (average, 3.5 years) and analyzed the results by tear size and repair technique. They found that the large and massive tears did as well as the small and medium sized tears. They concluded that the results of arthroscopic repair of rotator cuff tears are independent of tear size. [16]

6. Duration of follow-up:

The average follow-up period in our study was 13.83 months. There was no statistical significant relationship between the duration of follow-up and the postoperative net results. Wolf et al reported 4-to 10 year results of arthroscopic repair of full thickness rotator cuff tears. Their study showed that the patients had maintained excellent clinical outcomes 4 to 10 years after surgery. [(90)] In another long-term study performed by Wilson et al, in which 2-to 14 year follow-up for cases who underwent arthroscopic repair of full thickness rotator cuff tears took place, they concluded that the arthroscopic technique for rotator cuff repair achieve results comparable to the results of traditional open repair.[(87)] On the other hand, in the study performed by Galatz et al. where the arthroscopic repair of large and massive rotator cuff tears was evaluated. They found that, with the minimum twelve-month of evaluation, excellent pain relief and improvement in the ability to perform activities of daily living; whereas, at a minimum follow-up of two years, the results deteriorated. However, they reported that their study had some inherent limitations. The number of patients was relatively small and the study was conducted on large and massive tears only.[(32)]

II- Radiological results:

The presence and the size of rotator cuff tears are important in planning the treatment and advising the patients regarding the prognosis and outcome following repair. [(13)]

In the present study the acromiohumeral distance was significantly increased from a mean of 8.15mm preoperatively to a mean of 14.525mm postoperatively. Similar report was presented by Boileau et al. [(11)] However, their study could not demonstrate a clear benefit of performing an acromioplasty during the steps of arthroscopic repair of rotator cuff tears. In

another study published by Gartsman et al, they performed a prospective, randomized study to determine whether arthroscopic subacromial decompression (ASD) changes the outcome of rotator cuff repair. They concluded that the ASD does not appear to change the functional outcome after arthroscopic repair of rotator cuff tears. [33]

Other radiological findings obtained from the plain radiography in our study included square sign (sclerosis or rarefaction in the greater tuberosity) in 35% of patients, sourcil sign (sclerosis of the undersurface of the anterior portion of the acromion) in 17.5%. Similar findings were reported by Cofield et al. [20]

III- Complications:

Complications have been rarely reported after arthroscopic rotator cuff repair, and some believe that the rate of complications is lower than that after open repair. [91]

The complications reported in our study were superficial infection in one patient, failure of repair following trauma in one patient and persistence of pain in five patients. No intraoperative complications were reported.

We did not encounter the complication of anchor loosening that led to reoperation. [91] None of the cases included in our study suffered from postoperative stiffness. Nottage and Servud reported postoperative stiffness that required surgical manipulation or release. [91] Sperling et al. reported persistence of pain in nine shoulders included in their study. [80]

CONCLUSIONS

1. Arthroscopic rotator cuff repair offered good results and enabled the same reconstruction as with open technique and avoided its complications.

2. Arthroscopic rotator cuff repair is technically demanding procedure that needs prerequisite skills as diagnostic shoulder arthroscopy, arthroscopic subacromial decompression, and arthroscopic knot tying.

3. Advantages of arthroscopic rotator cuff repair include, a small cosmetic scar, the ability to perform the procedure on an outpatient basis, reduced early postoperative pain, availability to diagnose any intraarticular pathology that can affect the end results, and deltoid muscle preservation that allows early and easier postoperative rehabilitation.

4. Every cuff tear is unique and requires individual planning.

5. Diagnosis of rotator cuff tears is made mainly by history, clinical examination, and confirmed by ultrasonography or magnetic resonance imaging.

6. Patients with rotator cuff tears can respond to conservative treatment. Therefore, the operative intervention is indicated only after failure of conservative treatment for 3-6 months.

7. The potential for structural failure should not be considered to be a formal contraindication to an attempt of rotator cuff repair if optimal functional recovery is the goal of treatment.

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