# 17 Subacromial Impingement

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**Abstract**

Subacromial impingement is classified into two main groups; primary and secondary. Primary subacromial impingement is a structural problem and can be further subdivided into outlet and non-outlet types. Physical examination is the key to diagnose impingement syndrome. The indication of endoscopic acromioplasty includes structural problems causing impingement, such as type 2 or 3 acromion, hypertrophic coracoacromial ligament, an inferior spur from acromioclavicular joint or hypertrophic subacromial bursa. This is also indicated as a concomitant procedure for rotator cuff or superior labrum anterior–posterior (SLAP) repair. In this chapter, the details of subacromial impingement are discussed.

**Keywords**

Shoulder · Arthroscopy · Impingement · Subacromial · Decompression

## 17.1 Introduction

In 1949, Armstrong introduced the term supraspinatus syndrome [1]; which was named the impingement syndrome later by Neer in 1972. The syndrome was defined as rotator cuff impinging beneath the acromion and coracoacromial arch and causing chronic pain in the shoulder [2]. The impingement was later coined as subacromial impingement as there were other forms of shoulder impingement ranging as internal/posterosuperior impingement, anterior impingement, and subcoracoid impingement [3–5]. Internal impingement, also known as posterosuperior impingement, is reported in throwing athletes, where patients' arms are in the abduction and external rotation position, the articular surface of the supraspinatus and infraspinatus tendon come into contact with the posterosuperior glenoid, resulting in articular partial-thickness cuff tear. Anterior impingement is impingement between the anterosuperior glenoid and the subscapularis, and the long head of the biceps. Lastly, subcoracoid impingement is impingement between subscapularis and the coracoid process.

## 17.2 Classification

Subacromial impingement is classified into two main groups; primary and secondary. Primary subacromial impingement is a structural problem and can be further subdivided into outlet and non-outlet types. Outlet type is bony narrowing involving acromion and greater tuberosity, such as bony spur growth from the inferior surface of the acromion, malunion of acromion, or greater tuberosity. Non-outlet types are increased soft tissue volume within the bony boundaries and involve tendons and bursa, such as bursitis, tendinosis, or tendinitis (calcified deposit).

Subacromial impingement can lead to rotator cuff tendinopathy, resulting in partial or even full-thickness rotator cuff tears. Furthermore, it can cause calcific tendinitis and subacromial bursitis.

## 17.3 Anatomy/Pathoanatomy

The subacromial space is bound superiorly by the undersurface of the anterior one third of acromion, medially by acromioclavicular joint and anteriorly by coracoacromial ligament. The inferior margin is the humeral head and greater tuberosity. The content inside this space is the rotator cuff

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tendon, subacromial bursa, and the long head of the biceps tendon. The acromion-humeral distance is measured between the inferior surface of the acromion and the head of the humerus on an anteroposterior radiograph and is about 1–1.5 cm [6, 7].

Acromion has three growth centers known as meta-acromion, meso acromion, and pre acromion. They fuse during growth and around 15% of the population, one or more of these centers do not fuse together and become os acromiale. When the growth plate fails to close, the unfused segment becomes mobile and impinges on the bursa and rotator cuff tendon. Os acromiale can increase the risk of subacromial impingement syndrome [8].

Bigliani et al. classified acromion morphology into three types. Type 1 is a flat acromion, type 2 is a curved acromion, and type 3 is a hook acromion. Hook acromion is associated with a higher incidence of rotator cuff tears [9].

The subacromial bursa lies between the acromion and the rotator cuff and bursitis can reduce the subacromial space and cause pain during overhead movement. Hypertrophy of the coracoacromial ligament also decreases the space. Existing subacromial pathology can alter scaphulothoracic kinematic during shoulder elevation, which includes upward rotation or posterior tilting of the scapula, leading to functional subacromial impingement [10]. Supraspinatus tendinosis increases the thickness of the tendon with greater tendon occupation ratios, which may also cause impingement.

## 17.4 Biomechanics

The functional range of motion of the shoulder can alter the volume of the subacromial space and lead to impingement, especially during abduction and external rotation. As the glenohumeral joint moves from 30° to 120° of abduction, the acromiohumeral distance decreases by around 50% [11, 12]. With the arm in 90° external rotation, the acromiohumeral distance is the shortest [13]. Supraspinatus tendon is closest to the anteroinferior border of the acromion when the arm is in 90° abduction and 45° of internal rotation [11]. On the other hand, adduction muscle forces increase the acromiohumeral distance. Biomechanics studies support the strengthening of the adductors, including latissimus dorsi, subscapularis, and teres major and minor to be the important components in both conservative and postoperative rehabilitation programs to improve the symptoms of subacromial impingement syndrome [14, 15]. Patients with subacromial impingement syndrome have decreased muscle output force, muscle balance, electromyographical activity of trapezius and serratus anterior muscles, which are important stabilizers of the scapula and motor units of scapulothoracic motion. Scapular dyskinesis and scapular winging on overhead activity may contribute to symptoms of impingement. Rotator cuff weakness can lead to abnormal scapulothoracic and glenohumeral kinematics and decreased volume of the subacromial space [16]. Patients with full-thickness rotator cuff tears have a shorter acromiohumeral distance than those without rotator cuff pathology or subacromial impingement [17]. More than 30% of patients with clinical signs of subacromial impingement syndrome also have degeneration in the acromioclavicular joint, with bone spur growing inferiorly and projecting into the subacromial space [18]. Superior labrum anterior–posterior (SLAP) is associated with subacromial impingement, in which 21% of patients with clinical signs of SLAP have concomitant subacromial impingement. Subacromial decompression together with SLAP repair showed improved functional outcomes as compared to SLAP repair alone [19, 20].

## 17.5 History and Physical Examination

Patients with subacromial impingement syndrome complain of gradual and progressive shoulder pain that worsens with overhead activities or placing their arm behind the back, such as putting on a lady's bra or grabbing a wallet from their back pocket. A patient may also complain of decreased shoulder movement and weakness due to pain. The pain can occur suddenly after a traumatic event. The pain is usually localized in the anterolateral aspect of the acromion, though not specific. The patient complains of pain that wakes them up and patient cannot sleep on the affected side. Workers and athletes that work with repeated overhead motion may complain of overhead shoulder pain due to impingement. Trauma-related impingement can be due to direct injury to a superolateral aspect of the shoulder or axial load on an outstretched hand, compressing the humeral head onto the acromion, which leads to inflammation of the subacromial bursa or injury to the underlying rotator cuff and finally lead to impingement syndrome.

Physical examination is the key to diagnose impingement syndrome. A good physical examination requires adequate exposure with male removing their shirt and female wearing appropriate shoulder gowns. Good exposure requires exposing the patient's neck, shoulder, and periscapular region. The exam begins with an evaluation of the cervical spine and shoulder girdle. We need to rule out cervical pathology from shoulder pathology. Shoulder examination starts with an inspection of shoulder contour and muscle bulk, which must be compared to the contralateral side, with particular attention to muscle atrophy and shoulder squaring. Changes in resting position and abnormal contours of shoulder musculature may point to neurological cause, which may be the cause of secondary impingement. Tenderness is usually localized around the acromion, non-specifically, mainly over the anterior and lateral aspect, around the subacromial bursa and rotator cuff, and along the coracoacromial ligament. Active shoulder range is usually limited, especially active forward flexion and abduction. The painful arc of motion between 60° and 120° in the scapula plane suggests impingement. This test has a sensitivity and specificity of 73.5% and 81.1%, respectively [21]. The patient's passive range of motion must be tested to rule out adhesive capsulitis. Power is usually limited by pain. Neer test is used to differentiate impingement syndrome from rotator cuff pathology. Local anesthetic, lignocaine is injected into the subacromial space to increase the accuracy of diagnosis of impingement. The procedure is done with 10 mL 1% lignocaine using a 25 gauge 1.5-in. needle into the subacromial space via an anterior approach; ultrasound (USG) can be used to improve the accuracy—improvement of symptoms after lidocaine injection highly suggestive of subacromial impingement syndrome. There are several special tests to help diagnose the syndrome. Hawkins described the impingement test, which elicits pain when the arm is placed at 90° of forward flexion and internal rotation; the test is 71.5% sensitive and 66.3% specific. The Neer sign is pain over the anterolateral edge of the acromion when the arm is passively forward flexed over 120° with humerus internally rotated and scapula stabilized. The sign has a 68% sensitivity and 68.7% specificity. The infraspinatus test is 42.6% sensitivity and 90.1% specificity. The test sensitivity increases when the patient does not have any rotator cuff pathology. All these tests put the greater tuberosity of the humerus and rotator cuff against the undersurface of the acromion or coracoacromial ligament, leading to pain. A combination of these tests (Hawkin, painful arc, and infraspinatus test) increase the likelihood of diagnosis up to >95%; when all test is negative, the likelihood of impingement is <24%.

## 17.6 Investigation

The specificity of the special physical test is low. Plain radiograph such as scapular outlet view is used for routine radiographic evaluation and surgical planning; and it is best to see the anteroinferior acromion. It is taken in a true scapular lateral with an X-ray tube angled 10° caudally; it is used to evaluate the concavity of the acromion and to look for any subacromial spurs, presence of any degenerative change involving the acromioclavicular joint, sclerotic change of the greater tuberosity and anterolateral acromion. An anteroposterior view of the shoulder is also mandatory. It was taken with the X-ray tube 30 caudally to evaluate the anteroinferior acromion and to rule out any calcified coracoacromial ligament, with the highest interobserver reliability [22]. A radiograph is helpful for surgical planning to determine the amount of acromion that needs to be removed to establish a flat acromion (Figs. 17.1 and 17.2). The distance from the acromial cortex to the end of the acromial spur on the X-ray significantly correlated with intraoperative spur length. Acromial slope, a line drawn on the undersurface of the acromion and another line connecting the posteroinferior border of the acromion with the inferior border of the coracoid measured in the supraspinatus outlet view, is shown to correlate with intraoperative acromial resection thickness [23, 24].

MRI is used to rule out other concomitant shoulder pathology such as rotator cuff pathology and to assess subacromial subdeltoid bursa. It can also be used to assess the bony acromial shape and evaluate bony spurs in the coronal and sagittal oblique cut. Small spurs appear black on T2 images, whereas large spurs appear hyperintense because they contain marrow. MRI can also evaluate the acromioclavicular joint to assess whether the joint capsule has hypertrophy. Ultrasound (USG), CT, and MRI are reliable methods for measuring acromion-humeral distance. USG can also provide a dynamic assessment of the active impingement and the severity, such as whether the bursa, the rotator cuff, or the tuberosity is impinged.


**Fig. 17.1** Pre-operative supraspinatus outlet view, showing inferior bone spur


**Fig. 17.2** Supraspinatus outlet view after acromioplasty, showing inferior bone spur removed, and converted to the flat acromion

## 17.7 Treatment

Conservative treatment is the first line of treatment. The goal is to reduce inflammation while at the same time preserving the range of motion. Painful overhead shoulder motion should be limited. Non-steroidal anti-inflammatory medication and modalities such as ice, heat, iontophoresis, and ultrasound are used to reduce inflammation. Strengthening exercise can start once symptoms begin to improve [25–27]. Injecting subacromial space with corticosteroid and local anesthetic can be therapeutic and reduce inflammation [28]. Patient with concomitant pathology is unlikely to respond to conservative treatment.

Operative treatment is indicated when conservative treatment fails or there is a recurrence of symptoms. Patients without symptoms of improvement after injection require further workup before proceeding to surgery. The indication includes structural problems causing impingement, such as type 2 or 3 acromion, hypertrophic coracoacromial ligament, an inferior spur from acromioclavicular joint or hypertrophic subacromial bursa. Patients also indicated surgery when failed a minimal 3 months of conservative treatment but have previously responded to subacromial injection. Other indications include patients undergoing debridement for bursal side partial rotator cuff tears and patients having rotator cuff repair. Subacromial decompression is performed in concomitant rotator cuff repair in order to enhance visualization. However, most studies suggest that decompression offers no clinical benefit over repair alone [29, 30]. Some studies indicated that bursal side partial supraspinatus tear and primary impingement demonstrate good results with decompression alone, without repair if tear size is <50% thickness [31, 32]. Subacromial decompression is also indicated in conjunction with primary superior labral repair.

Acromioplasty and release of the coracoacromial ligament are contraindicated in patients with shoulder instability and irreparable rotator cuff tear. After releasing the ligament, there will be an increase anterior and superior glenohumeral translation and increased demand on the remaining rotator cuff to maintain glenohumeral biomechanics [33]. Acromioplasty in conjuncture with adhesive capsulitis is controversial. Subacromial decompression is contraindicated in patients with internal impingement, as this could lead to further destabilization and worsening of symptoms. Subacromial decompression alone is typically contraindicated in patients with superior migration of the humeral head on AP radiographs due to insufficient force couples and anterosuperior escape.

Diagnostic bursoscopy can be done in either beach chair or lateral position with the cannula placed into the posterior portal, aiming at the posterolateral border of the acromion and advancing to the anterior acromial edge toward the coracoacromial ligament. The arthroscope is inserted and slowly withdrawn until the bursa is reached; a radiofrequency device can be used to debride and remove bursal adhesions via the lateral portal (Fig. 17.3). The acromion's anterior and lateral borders should be defined (Fig. 17.4), and the undersurface of the acromion is debrided (Fig. 17.5). Caution should be taken when debriding medial bursal tissue as it is very vascular. We can improve visualization for the acromial morphology; by viewing from the posterior portal, a burr is placed through the lateral portal and oriented along the anterior border of the acromion [34]. Burring with the burr till the depth of resection is similar to the diameter of the burr (6.0 mm) (Fig. 17.6); resection is begun just lateral to the acromiocla-

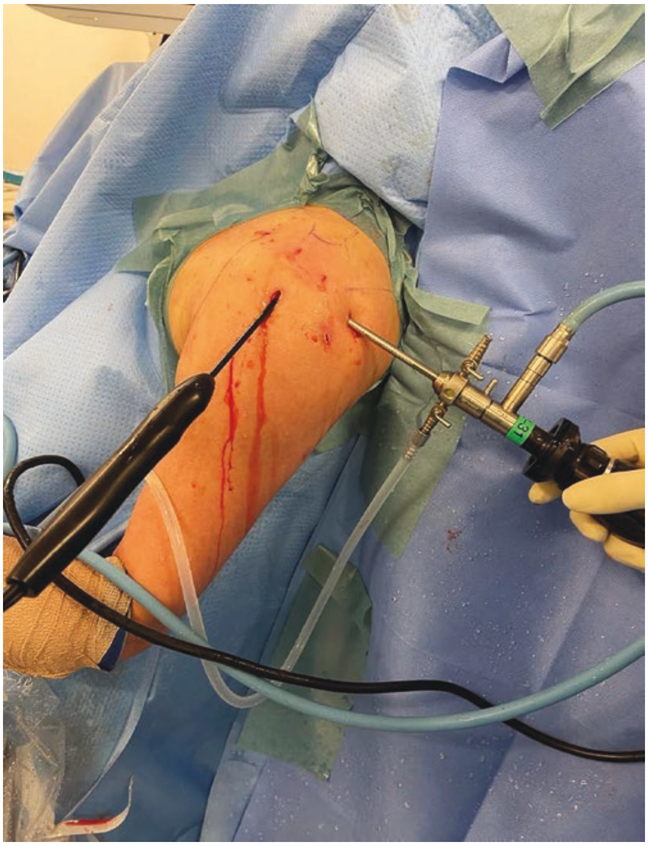

**Fig. 17.3** Arthroscopic bursectomy. A 4.0 mm arthroscope was inserted via the posterior shoulder portal, and a radiofrequency device was inserted through the lateral portal

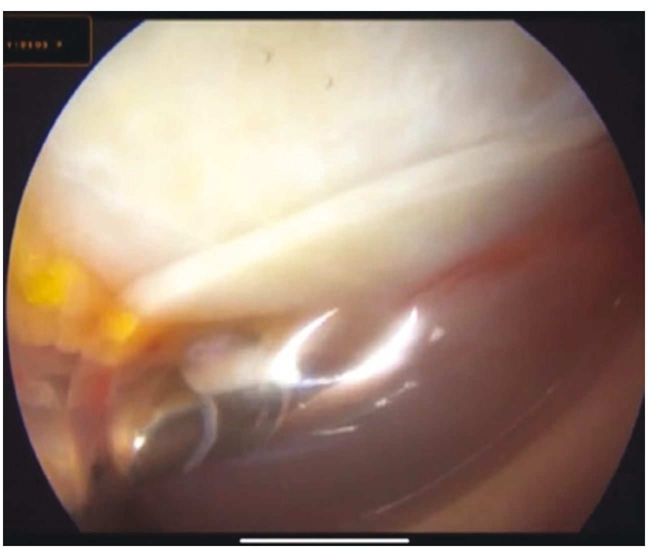

**Fig. 17.4** Posterior portal is the viewing portal. The subacromial space is examined. The anterolateral portal can be seen. The white surface at 12 o'clock is the inferior surface of acromion covered by bursal tissue. An air bubble is observed at 6 o'clock

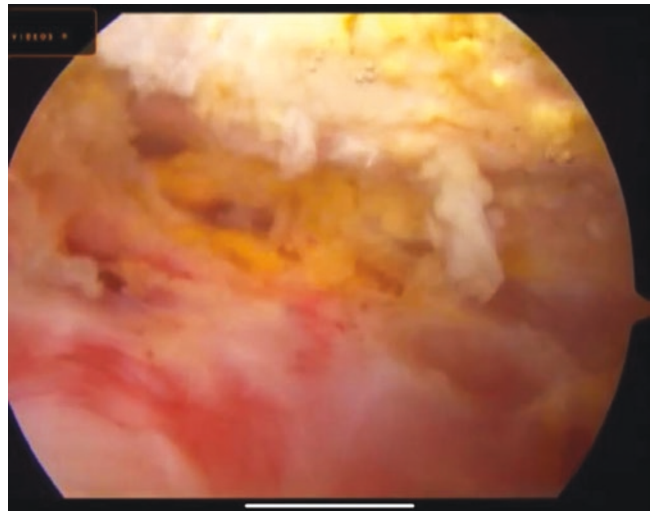

**Fig. 17.5** The posterior portal is the viewing portal and the subacromial space after bursectomy is examined. A large inferior acromial bone spur is observed at 12 o'clock

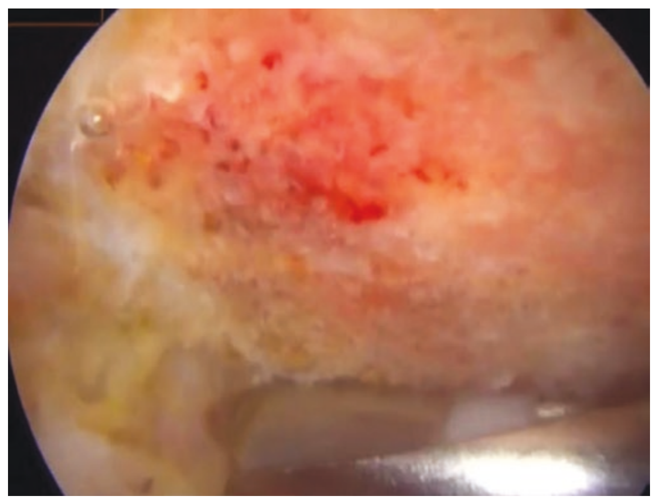

**Fig. 17.6** The posterior portal is the viewing portal and the lateral portal is the working portal. The inferior acromial bone spur is removed by acromionizer

vicular joint and avoids violation of the acromioclavicular joint capsule. An alternative method is the cutting block approach [18]. The posterior portal is created 1–2 cm superior and lateral to the classical posterior portal. The arthroscope is placed at the lateral portal for visualization (Fig. 17.7). Burr is advanced from the posterior portal to the anterior border of the acromion using the undersurface of the posterior acromion as the cutting block (Fig. 17.8); each pass of burr serves as a guide for the subsequent pass. Each pass

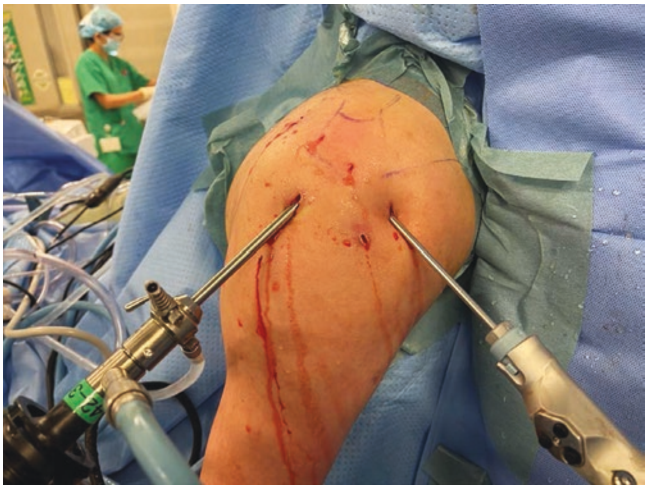

**Fig. 17.7** Cutting block technique. The arthroscope is inserted through lateral portal and the acromionizer is inserted through the posterior portal

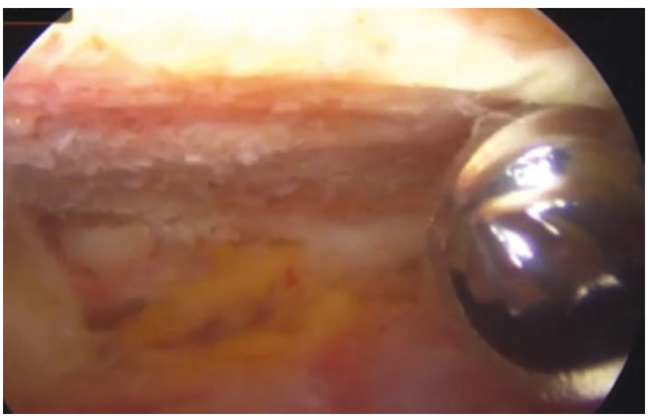

**Fig. 17.8** The lateral portal is the viewing portal. Acromioplasty is performed using the cutting block method with acromionizer from the posterior portal

begins at the medial acromion and moves to the lateral border.

## 17.8 Postoperative Rehabilitation

The operated arm is rested in a shoulder sling, and early motion and physical therapy are encouraged. On day 1, all dressings are changed, and the patient is encouraged to begin pendulum exercise and gentle active and passive range of motion exercises. The sling is weaned by the end of first week. The patient is encouraged to return to daily activities. Progressive strengthening of the shoulder girdle and scapular stabilization is encouraged. Return of full activities once the patient is pain-free and regains 90% strengthening when compared to the contralateral shoulder.

## 17.9 Complications

Performing subacromial decompression in a patient with shoulder instability will fail and result in persistent symptoms. Proper posterior portal placement is needed to avoid under or over-resection when using the cutting block method. The complication is limited if appropriate patient selection and careful preoperative planning.

## 17.10 Outcome

The satisfactory result is around 67–88% which is comparable to Neer's open approach [35, 36]. Long-term outcomes are still rather rare in studies, requiring a high-quality randomized controlled trial.

## 17.11 Summary

Endoscopic subacromial decompression is an effective operative option for subacromial impingement recalcitrant to conservative treatment.

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