Original Research Article

Subacromial impingement and extrinsic mechanisms: MR imaging

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Abstract

Introduction: Shoulder pain is the most common musculoskeletal complaint in the middle and old age population. Shoulder pain is frequently caused by rotator cuff tendon pathology. Rotator cuff disease is multi-factorial, both extrinsic and intrinsic mechanisms are attributed and subacromial impingement is the common most underlying extrinsic factor. MRI (Magnetic Resonance Imaging) is an excellent modality for imaging soft tissues of the shoulder joint, structural causes leading to impingement and rotator cuff disease is well depicted. Diagnosis specific sequences, special positions and ultra-high field magnets contribute to accurate diagnosis.

Methods and materials: This was a prospective study conducted at our institute during the period 2019-2021 on 100 shoulder pain patients, clinically suspected of subacromial impingement. MRI was performed on a 1.5 Tesla electromagnet (GE Company) using dedicated shoulder coil.

Results: Acromio clavicular joint degenerative changes and subacromial subdeltoid bursitis were the most frequently reported findings, with a minor contribution from type 2 and type 3 acromion. Subacromial impingement commonly involved supraspinatus tendon, and supraspinatus tear was the most commonly identified pathology.

Conclusion: Extrinsic mechanisms are found to be commonly causing subacromial impingement. Predominant findings made, causing impingement and rotator cuff tears were, acromio clavicular joint osteoarthritis, subacromial subdeltoid bursitis and type of acromion.

Key words

Sub acromial impingement, Rotator cuff disease, Acromioclavicular joint degeneration, Sub acromial sub deltoid bursitis, Type of acromion.

Introduction

Shoulder pain is the most common musculoskeletal disorder resulting in loss of functional stability of the shoulder joint, more commonly seen in people of more than 40 years age. Rotator cuff disorders are considered to be the main cause of chronic shoulder pain with impingement of rotator cuff often playing an important role and sub acromial impingement is the most common causating factor [1].

The glenohumeral joint is a load bearing joint with a wide range of motion. Rotator cuff centers the head of the humerus in the glenoid cavity and coraco acromial arch limits the anterior and superior migration of humerus head and overlying rotator cuff tendons. Neer and his associates proposed that impingement generates bursitis and subacromial inflammation, secondary rotator cuff tendon alteration, progressing to tendon tears. He proposed 96% rotator cuff disorders are due to subacromial impingement [2].

Pathophysiology of rotator cuff disease is still not clearly understood and multiple factors both extrinsic and intrinsic to the tendons are attributed. Intrinsic mechanisms causing rotator cuff tendinopathy are, age related degenerative and vascular changes, alterations in tendon matrix and tensile tissue overload [3].

Extrinsic factors encroach upon the sub acromial space and contribute to bursal side of rotator cuff tendon compression. Primary sub acromial impingement is due to mechanical narrowing of subacromial space. Acromian configuration abnormalities related with impingement are type 2 and type 3 acromion, low lying acromion, down sloping lateral acromion. And degenerative etiologies contributing for primary sub acromial impingement include inferior acromial spurs, acromioclavicular joint degeneration, coracoacromial ligament thickness or ossification. Secondary extrinsic impingement is related to glenohumeral or scapulothoracic instability with underlying labral and capsular abnormalities rather than corocoacromial arch structure causes [4, 5].

Sub acromial impingement due to primary extrinsic factors is the most common factor for shoulder pain and supraspinatus tendon is the most commonly affected rotator cuff tendon. Abnormalities from subacromial impingement affecting the supraspinatus and surrounding structures range from edema to full thickness tendon tears and these are better studied on conventional MRI. Study objective was to assess the extrinsic mechanism of sub acromial impingement, its causes, association and MRI appearances.

Materials and methods

It was a prospective study undertaken at our institute Osmania Medical College and Hospital, Hyderabad. Study was conducted on 100 shoulder pain patients with clinical suspicion of sub acromial impingement, referred to MRI examination of shoulder joint. Data consisted of 100 patients with shoulder pain for more than 3 months period and with no history of previous trauma. MRI was performed on a 1.5 Tesla electromagnet (GE company) using dedicated shoulder coil.

Inclusion criteria

Patients with shoulder pain, clinically suspected subacromial impingement referred to our Radiology department for MRI shoulder examination during the study period.

Exclusion criteria

Patients with previous trauma history, recent surgery on the affected shoulder, known case of rotator cuff lesion on treatment, instability, rheumatoid arthritis, cervical radiculopathy and infections were excluded from the study.

Technique

MRI performed on patient in supine position with arm at the side of the body and in the neutral position. Dedicated surface coil (Helmholtz pair) for shoulder was used. Additional imaging in the abduction and external

rotation (ABER) position increases diagnostic accuracy for under surfacepartial thickness tears of supraspinatus tendon [6].

After obtaining localizer in all three orthogonal planes, following sequences are obtained.
Axial T1, T2 and PD Fat Sat, STIR and GRE.
Oblique coronal T1, T2 and PD Fat Sat.
Oblique Sagittal T2, PD Fat Sat and GRE.

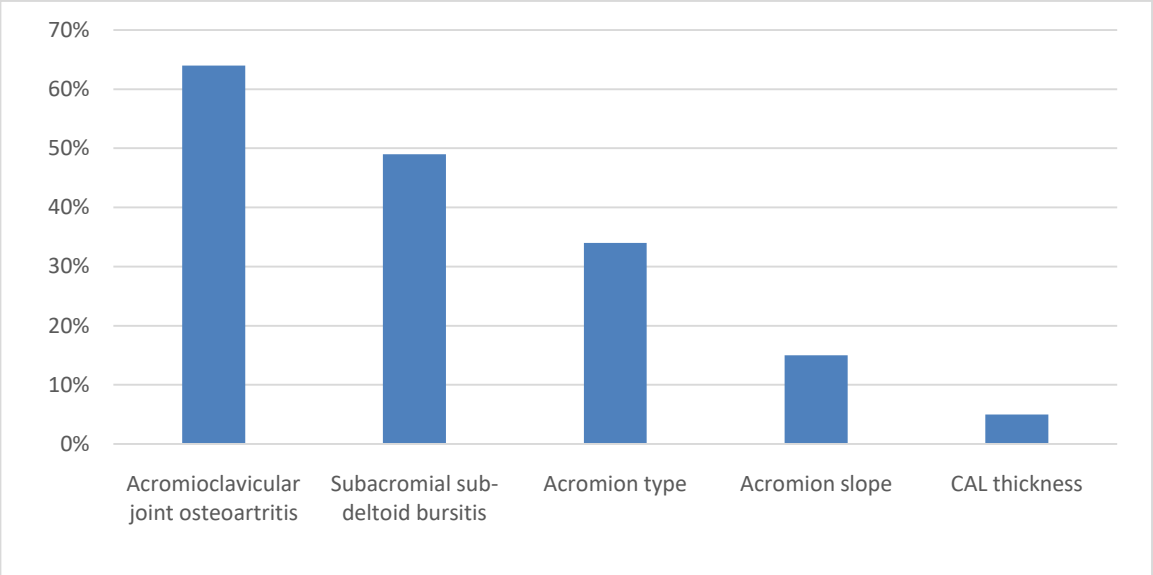
Results

Distribution of Rotator cuff pathology in subacromial impingement was as per **Table – 1.** Extrinsic factors implied in subacromial impingement were as per **Figure – 1**. MRI findings were as per **Figure – 2a, 2b, 2c, 2d, 2e, 2f**.

Table - 1: Distribution of Rotator cuff pathology in subacromial impingement.

Muscle tendon	Tendinosis	Partial thickness tears	Full thickness tears
Supraspinatus	36%	44%	10%
Subscapularis	25%	11%	3%
Infraspinatus	3%	10%	2%
Teres minor	-	-	-

Figure - 1: Extrinsic factors implied in subacromial impingement.



Discussion

Shoulder pain is the most common musculoskeletal disorder and is the common indication for MR imaging of shoulder joint, other than for trauma. Rotator cuff disease is a common etiology for shoulder pain, with impingement of the cuff playing an important role.

Rotator cuff disease includes impingement causing tendinosis and partial and full thickness rotator cuff tears, calcific tendinitis, and coracoid impingement involving the subscapularis which indirectly involves the supraspinatus [6].

Patients with shoulder impingement suffer from painful entrapment of soft tissue whenever they elevate the arm with abnormal contact between the rotator cuff and the humeral head, the resulting mechanism is a structural narrowing of the subacromial space. Abnormalities from impingement that affect the supraspinatus tendon and surrounding structures range from edema to full thickness tendon tears. All of these abnormalities are associated with symptoms of

pain and collectively are referred to as the impingement syndrome [7].

Figure - 2a: Coronal oblique proton density fat saturation image showing, subscapularis tendon low grade partial thickness tear, acromioclavicular degeneration and subacromial subdeltoid bursitis.

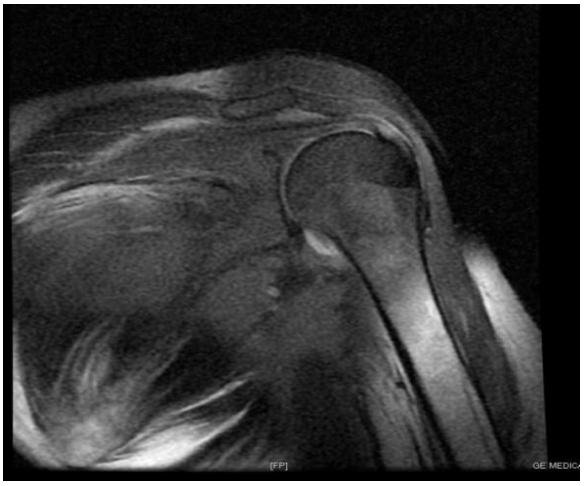


Figure - 2b: Coronal oblique proton density fat saturation image showing, high grade partial tear at supraspinatus critical zone, acromioclavicular degeneration, subacromial subdeltoid bursitis.

Neer proposed rotator cuff impingement by the subacromial arch structures was the principal cause of shoulder pain. He and his associates proposed that impingement generates bursitis and subacromial space inflammation and then secondary rotator cuff tendon attrition, intrasubstance microtrauma and tendinosis progressing to tendon stretching and tear [2].

Figure - 2e: Sagittal oblique proton density fat saturation image showing, inferiorly projecting anterior hook of acromion with supraspinatus tendinopathy.

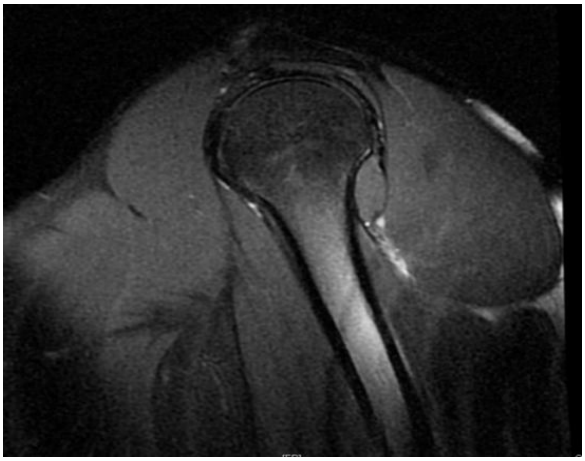
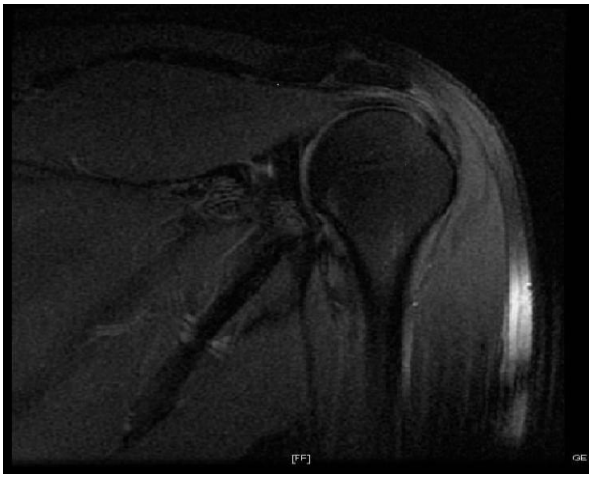


Figure - 2f: Anterior coronal oblique proton density fat saturation image showing, anterior down slope of lateral acromion causing supraspinatus tendinopathy.



The pathophysiologic mechanisms of rotator cuff degeneration remain controversial, multiple factors are attributed and the two main theories are extrinsic compression of the cuff and intrinsic tendon degeneration.

Advanced SAI is associated with rotator cuff defects. The relation between these two entities is a controversial debate. Extrinsic compression theory postulates pressure damage due to pathological contact of the shoulder roof with the supraspinatus tendon and soft tissues of the subacromial space, whereas intrinsic compression theory postulates degenerative

processes within the supraspinatus tendon itself, secondarily leading to subacromial space narrowing and impingement [8].

Primary extrinsic mechanisms are the most common factors in causing subacromial impingement and this results from depression of one or more components of the coracoacromial arch or roughening of its under surface. Rarely, a downward sloping coracoid process causes impingement of the subscapularis tendon, indirectly resulting in supraspinatus impingement by depressing the coracoacromial ligament. Rarely by post traumatic calcification or ossification of the coracoacromial ligament [9].

Present study was intended towards extrinsic causes for sub acromial impingement. Study included 100 patients of shoulder pain with clinically suspected subacromial impingement and MR imaging characteristics of causating pathology and its effects on rotator cuff and soft tissues of sub acromial space were studied.

Primary Extrinsic factors and their MR appearances

Acromion configuration: Morphological abnormalities of the acromion lead to subacromial impingement [10]. Bigliani classified acromion into 3 types, basing on scapular Y-view. Type-1 acromion has a flat under surface, type 2 is with more concave under surface, type 3 acromion has inferiorly projecting anterior hook, type 4 acromion has recently been described having convex under surface. The most common type is type 2, while type 3 is the one most commonly associated with rotator cuff tear when its anterior hook causes injury to the anterior fibers of the supraspinatus tendon. Acromion morphology is better studied in oblique sagittal views on MRI.

Abnormally lowlying acromion and a lateral or anterior down sloping acromion contribute to impingement. Excessively low lying acromion is diagnosed in relation to the distal end of the clavicle at acromioclavicular joint level on the anterior coronal oblique images. An inferolateral slope is detected by measuring the angle between the acromion and the clavicle, an angle>10 is abnormal. Anterior down slope is diagnosed on sagittal oblique images where the anterior part of the acromion is closer to the related part of the humeral convexity than its posterior part [11].

Osacromiale: An unfused osacromiale is a rare cause of impingement .By reducing the size of the coracoacromial arch and by its mobility, causes repeated trauma to the rotator cuff tendons. This is best identified on axial images [12].

Acromioclavicular joint degeneration: Acromioclavicular joint degenerative changes cause narrowing of subacromial space, peri articular sclerosis or bone marrow edema, subchondral cyst formation, marginal osteophytes, joint effusion and capsular distension. These changes are better studied in coronal oblique proton density fatsat and T2- wt images.

Studies suggested that acromioclavicular joint degeneration, spurs, osteophytosis, acromian configuration abnormalities all increase with age [13].

Calcific tendinitis: Calcific tendinitis of rotator cuff is known to cause subacromial impingement. Exact pathogenesis is not known, likely related to degeneration,reactive changes, predisposing medical conditions and genetics. Appear as a focal intra tendinous focus of signal void in MR imaging. Usually associated with acromioclavicular hypertrophy. Studies suggest, percentage of affection of the right and left side shoulder was 68 and 32, respectively, signifying the role of degeneration [14].

Subacromial subdeltoid bursitis: Subacromial subdeltoid bursal inflammatory changes are observed more commonly in cases scanned for subacromial impingement. The bursa is a highly innervated structure and distortion of bursa primarily or secondarily by impingement from coracoacromial arch may elicit pain in the

shoulder joint. The bursa usually doesn't exceed 2 mm in thickness, not in communication with joint space and usually located posteriorly. On coronal MR images features suggesting bursitis are, abnormal thickness of fluid signal more than 3 mm, seen as low signal intensity on T1- and increased signal intensity on T2- and PD weighted images and presence of fluid signal medial to the level of the acromioclavicular joint and in the anterior part of the bursa. The findings of fluid in the subacromial bursa is nonspecific and may be a co incidental finding in a patient with shoulder pain. In a patient with a clinical history of subacromial impingement, however, this finding is more likely to be significant [15].

MR imaging appearances of Rotator cuff defects

Tendinopathy: Tendinopathy represents mucoid degeneration without macroscopic fiberdisruption.Appear as thickening and increased signal within the tendon on proton density weighted images and less than that of fluid on T2-weighted images [16].

Partial thickness tear: Partial thickness tears are diagnosed by fluid-like signal on fat suppressed T2-weighted images in the tendon, not involving the entire bulk of the tendon [17]. Ellman classified partial thickness tears according to the depth of involvement into grade 1; with < 3mm or < ¼ of tendon thickness, grade 2; 3 to 6 mm or more than ¼ and less than half of the tendon thickness torn and grade 3; when more than half of the tendon thickness is torn. According to the site of the tear, partial thickness tears are classified into bursal; articular surface and intratendinous tears. Articular surface tears being more common as this surface is hypovascular compared to bursal surface. The sensitivity of MRI for detection of partial thickness tears is limited. It can be increased by imaging in the ABER position or with MR arthrography.

Full thickness tear: These are characterized by fluid-like signal within the tendon, extending from the articular to the bursal surface. Appears as a focal well defined area of increased signal intensity in both T1-and T2-weighted images [18]. DeOrio and Cofield classified full thickness tears based on their greatest dimension as, small (<1 cm), medium (1 to 3 cm), large (3 to 5 cm), or massive (>5 cm).

Distribution of rotator cuff pathologies – study Observations

In our study the most commonly affected tendon being supraspinatus followed by subscapularis and infraspinatus. This is consistent with the study conducted by Jerosch, et al. [19].

Supraspinatus tendon isolated injurymore common thanits association with the remaining rotator cuff muscles. But no tear occurred without involvement of the supraspinatus tendon. Supra humeral portion of long head of biceps involvement seen along with subscapularis tears.

Present study suggests, partial tears are being more common than full thickness tears and among partial thickness tears, articular surface tears are more common than bursal surface tears this is consistent with the study conducted by Lohr, et al. [20].

Subacromial subdeltoid bursitis seen more commonly in subacromial impingement. This is observed independently or along with cuff defects and frequently in association with acromioclavicular joint arthropathy.

Acromioclavicular joint degenerative changes are observed more frequently, causing subacromial subdeltoid bursitis and rotator cuff defects.

Type 2 and 3 acromion and anterior down sloping acromion are associated with abnormal rotator cuff tendons.

Atrophy, Fatty degeneration of supraspinatus muscle can be demonstrated well on MRI. Degenerative cystic bone lesions of greater tuberosity of humerus are associated with rotator cuff disease are well demonstrated on MRI.

Thusconventional MRI is found to be very useful in depicting rotator cuff pathology along with predisposing factors.

Limitations

This study includes only symptomatic patients with shoulder pain. As some studies suggest higher prevalence of degenerative findings also in the asymptomatic population being reported for the shoulder along with the other musculoskeletal locations, Further cross-sectional studies are required to understand the mechanisms of impingement.

Conclusion

Shoulder pain is the most common musculoskeletal disorder with underlying rotator cuff pathology. Subacromial impingement by extrinsic factors is the commonest mechanism involved. In this study commonly found extrinsic factors are, acromioclavicular joint degeneration, subacromial subdeltoid bursitis and abnormal acromian configuration. MRI is found to be an excellent modality in delineating subacromial pathologies.

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