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Spectrum of Shoulder Pathologies:Retrospective Analysis ofMRI Shoulder ofIndustrial Workers Presenting With Shoulder Pain

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Abstract:*Shoulder pain is a significant cause of morbidity in manual labourers. Shoulder pain increases the financial burden towards health care expenses. Our aim was to study the spectrum of shoulder pathologies in manual labourers presenting with shoulder pain. It is a retrospective analysis of MRI shoulder study performed on 51 patients working as manual labourers in industries.In our study, Rotator cuff injuries are a major cause of shoulder pain, in about 78% of our patients, biceps avulsion in 2%, Shoulder dislocation in 5%, degenerative joint disease in 3%, labro-ligamentous pathologies in 8%, cervical rib/ clavicle fracture in 2% and metastasis in 2%.MR imaging of shoulder in manual labourers with shoulder pain is essential to make early diagnosis of the cause. After identification of cause of shoulder pain, appropriate early management can be instituted; so that the morbidity is decreased and there is early return to work. Plain radiograph can act as a useful screening modality in patients with shoulder pain.*

Keywords:*Manual labour, MRI shoulder, Radiograph,Rotator cuff, Shoulder pain*
Abbreviations – MRI – Magnetic resonance imaging

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I. Aim & Introduction

Shoulder disease is multifactorial with genetics, age and bodyweight as predisposing factors (1). There is increased occurrence of shoulder injuries in manual labourers working in various industries. Overhead work has a several-fold increased risk for shoulder disorders. The factors like highly repetitive work alone or in combination with other factors such as very high job structural constraints, forceful exertions and forceful pinch also contribute to earlier onset of shoulder diseases(2). Shoulder pain is a significant cause of morbidity. It results in poor work performance, absenteeism, frequent change of work and poor work quality. Our aim was to study the spectrum of shoulder pathologies in manual labourers presenting with shoulder pain.

II. Materials And Methods

2.1 Materials

It is a retrospective analysis of MRI shoulder study performed on 51 patients working as manual labourers in industries. The subjects included in the study are between 25 and 55 years, both male and female manual labourers with shoulder pain were included in the study. Acute and chronic pain was taken into consideration. The patients with history of trauma or fracture (that are not related to work / work-place), previous surgery, arthroscopy, already diagnosed or treated case of rotator cuff injuries were excluded from the study. The MR images obtained for manual labourers' with shoulder pain in past two years [2016, 2017] was analysed. The image analysis and study was done between December 2017 and January 2018. Image analysis was done by two radiologists in SyngoDICOMworkstation. Statistical analysis was done using Microsoft excel SPSS software.

2.2 Methods

Plain anteroposterior radiograph of the shoulder was done in Allengers 500 mA High frequency x-ray unit. Radiograph was taken with affected shoulder against the cassette and 15 degrees rotation so that shoulder is close to the cassette and acromioclavicular joint is parallel to the central beam. Images were viewed in work station and used to assess the bones of the shoulder (glenoid, coracoid, acromion, scapula, humeral head, greater and lesser tuberosity) for fracture, degenerative changes, lytic or sclerotic lesion; Presence of soft tissue calcification and joint congruity. Acromioclavicular joint was assessed to look for arthritis or degenerative changes like osteophytes, subcortical cysts. Acromio-humeral distance was measured between cortical bone of inferior aspect of acromion and apex of the humeral head [3]. Visualised cervical spine was assessed for presence of cervical rib or degenerative changes.

MRI shoulder was done using Siemens (Germany) 1.5 Tesla unit, 8 channel head coil. Standard protocol for MR shoulder was performed in supine position with arm by the side of the patient, in neutral position. Images were obtained in axial, oblique coronal and oblique sagittal planes. Fat saturated Proton density(PD) and fat saturated T2 weighted image was obtained in three planes. T1 weighted image without fat suppression (TR- 15 ms, TE- 5 ms, slice thickness- 3 mm, field of view - 160 × 160 mm; matrix size - 256 × 512). PD weighted image with fat suppression (TR-4700 ms, TE-14 ms, slice thickness- 3 mm, field of view - 160 × 160 mm; matrix size - 256 × 512). T2 weighted image without fat suppression (TR- 8880 ms, TE- 103 ms, slice thickness- 3 mm, averages- 2, field of view - 160 × 160 mm; matrix size - 256 × 512). MR arthrogram was done by intraarticular injection 10-12 ml of diluted gadolinium based contrast media. T1 weighted fat-saturated images were acquired in all three planes after intra-articular injection. Contrast enhanced T1 weighted MRI was performed in selected few patients. T1 weighted images were used to assess the bone for fractures, osteophytes, marrow abnormalities and muscles.

2.3 Image Analysis

1.3.1 Rotator Cuff

T1, T2 and Proton density fat saturated images were used to assess the status of tendon, myotendinous junction and tears of rotator cuff. Tendinosis and tendinitis appear as focal areas of increased signal intensity on PD and T2, but intensity less than adjacent fluid. In chronic cases there is thickening of the tendon (tendinosis). Tears are identified as fluid signal intensity in the fat saturated T2 / PD images. Depending on the location, depth and width of the tear, it is classified as partial tear –articular surface, intrasubstance or bursal surface and complete tear - full thickness partial width, full thickness complete width with or without tendon retraction[4]. Post Contrast enhancement images were used to assess the chronicity of the tear.

The grading of muscle fatty degeneration was performed according to Goutallier et al [4], in T1 weighted oblique sagittal images. Grade 0- No fatty degeneration, Grade 1-Few fatty streaks, Grade 2 -Fat less than muscle – Mild fatty infiltration, Grade 3- Equal amount of fat and muscle – Moderate fatty infiltration, Grade 4 -Fat more than muscle - Severe fatty infiltration. If the fatty degeneration is found variable in different parts of the muscle, highest grade was considered[4].Atrophy of the supraspinatus muscle bulk was assessed by two methods – Using tangent sign. Tangent sign was used to evaluate the presence of atrophy of supraspinatus muscle. A line is drawn through the superior border of scapular spine and coracoid process. Tangent sign is present when the muscle does not cross the tangent, and indicated atrophy.

Calcific tendinopathy is diagnosed by hypointense signal in tendon in all spin echo sequences [5]. Plain radiograph correlation was done to identify the presence of calcification in the tendon.

2.3.2 Rotator Interval

Adhesive capsulitis: There is thickening of the rotator interval capsule, thickening of the ligaments of the rotator interval, Superior glenohumeral ligament, and coracohumeral ligament, thickening of the joint capsule alongthe axillary pouch and increased width of the axillary recess[6].Capsular thickening more than 3 mm is considered significant.

Long head of biceps tendon: Intra-articular segment of this tendon is depicted better seen optimally in the oblique coronal and sagittal images, extra-articular segment is evaluated in axial image. High signal areas and thickening in the tendon with fluid around the tendon is diagnostic of tendinosis. Fluid signal intensity with in the tendon is diagnostic of tear [5]. Dislocation of the biceps tendon, may be associated with subscapularis tear and rotator interval tears. Avulsion is diagnosed by noting the absence of the intra-articular segment of the tendon with no signs of dislocation.

2.3.3 Acromion

The acromion process is of four types, based on the inferior surface of acromion. Type I (flat), Type II (curved downward), Type III (hooked downward anteriorly) and Type IV (curved upward) [7]. It assessed in the oblique sagittal plane images lateral toacromioclavicular joint. The anterior down-sloping acromion is diagnosed in the oblique sagittal plane, when anterior part of the acromion is closer to the related part of humeral convexity than its posterior part [5]. The lateral down-sloping of the acromion is diagnosed in the oblique coronal images at the level of acromioclavicular joint, by measuring the angle between acromion axis and the clavicle [5], angle more than 10 degrees is abnormal.Os acromiale is diagnosed in the coronal oblique images, by ‘double AC joint’ sign, first being the acromioclavicular joint next being the pseudo-articulation of the os acromiale[7].Acromio-humeral distance was measured in T1 weighted oblique coronal image at the level of apex of humeral head. The distance between T1 hypointense inferior margin of the acromion and subchondral humeral head under it was measured [3].

2.3.4 SubacromialSubdeltoid Bursa

The normal bursa usually does not exceed 2 mm in thickness and is usually located posteriorly. Abnormal fluid in the SASD bursa is diagnosed by thickness of fluid signal more than 3mm, fluid signal medial to the level of the AC joint and fluid in the anterior part of bursa. SASD bursa communicates with the joint space in case of full thickness supraspinatus tear(5).

2.3.5 Glenohumeral Joint

Congruence of the joint was assessed. Anterior dislocation of the shoulder was identified by the sub-coracoid position of the humeral head. The primary finding of a Bankart lesion on axial MRIs is a zone or band of abnormal signal intensity. This zone separates the anteroinferiorcapsulolabral complex from the osseous glenoid margin. Flattening of the posterosuperior aspect of the humeral head seen in the first two axial sections, were considered as hill sach's lesion.If the dislocation is recent, an effusion is often present, and detachment of the labroligamentous complex may be visualized. Subchondral bone changes may be seen as low signal intensity on T1W and high signal intensity on T2W. Small separations, called partial Bankart lesions, may appear to involve the glenoid labrum alone on axial images. These are more likely to be associated with subluxational instabilities. In chronic recurrent instability, the labrum degenerates and is likely to be markedly diminished in size or to be totally absent. In long-standing lesions, in which the labrum is reapproximated in its normal position and granulation tissue forms, a zone of intermediate intensity is observed separating the capsulolabral complex from the glenoid on PD images. When seen on MRI, this pattern is a highly accurate indicator of a healed Bankart lesion. Degenerative changes were observed. Subchondral cyst seen in the head of the humerus.

2.**3.6 Labroligamentous Complex**

High signal areas in the labrum and glenohumeral ligaments were identified. The labral tears were diagnosed based on the location and after excluding the normal variants. The ligaments include: superior, middle and inferior glenohumeral ligaments. The glenoid labrum is seen attached to the margins of the glenoid articular surface.TheHumeral Avulsion of inferior glenohumeral ligament [HAGL] lesion refers to avulsion of the IGHL from the humerus, without accompanying tear of the subscapularis. This lesion has not been shown to demonstrate an age predilection. The HAGL lesion may exist in patients with anterior instability with or without an anterior labral tear and still cause instability. The anterior labrum with stripped periosteum is seen to be displaced medially and rotated inferiorly on the neck of the glenoid in Anterior Labroligamentous Periosteal sleeve avulsion [ALPSA].

III. Results

51 patients from age group of 25 to 55 years were included in the study. 8 patients were between the age of 25 to 30 years, 10 patients were between the 31 to 40 years, 27 patients were between the 41 to 50 years, 6 patients were between the 51 to 55 years. 35 patients were male, and 16 patients were female. Right side involvement was predominantly involved in 46 patients, left side involvement was seen in 5 patients.

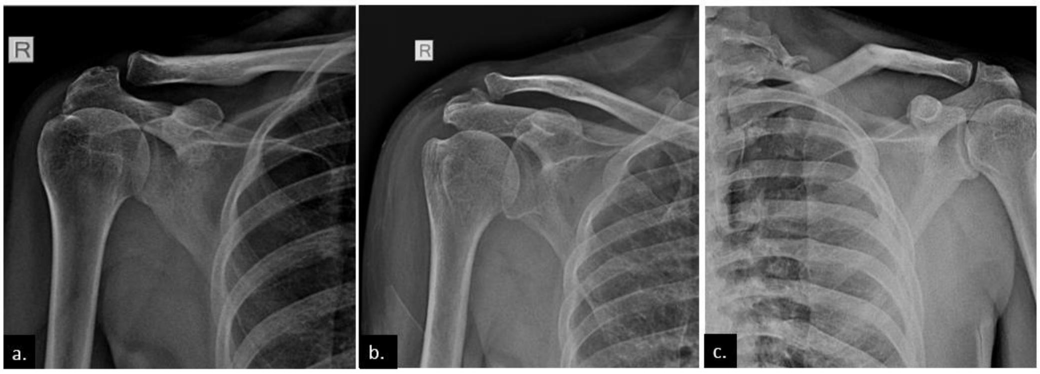

Figure 1: a. Calcific opacity seen in the supraspinatous tendon – calcific tendinitis, b. Soft tissue swelling seen acromioclavicular joint- arthritis, c. Left cervical rib in a patient with clavicle fracture..

The plain radiograph of shoulder was analysed as discussed above. The findings in the humeral head included the following: Degenerative changes like subchondral cyst and sclerosis (n=11), Greater tuberosity avulsion (n=2), Hill Sach's lesion (n=2), Reverse Hill Sach's lesion (n=1) and Bankart with Hill Sach's lesion (n=1). Bankart lesion (n=2) was identified seen. Acromio-clavicular joint showed degenerative changes (n=11), Os acromiale (n=1), arthritis (n=2) and lytic lesion likely metastasis (n=1). Left Cervical rib was detected in a patient with clavicle fracture was seen in one patient.(Figure 1&2)

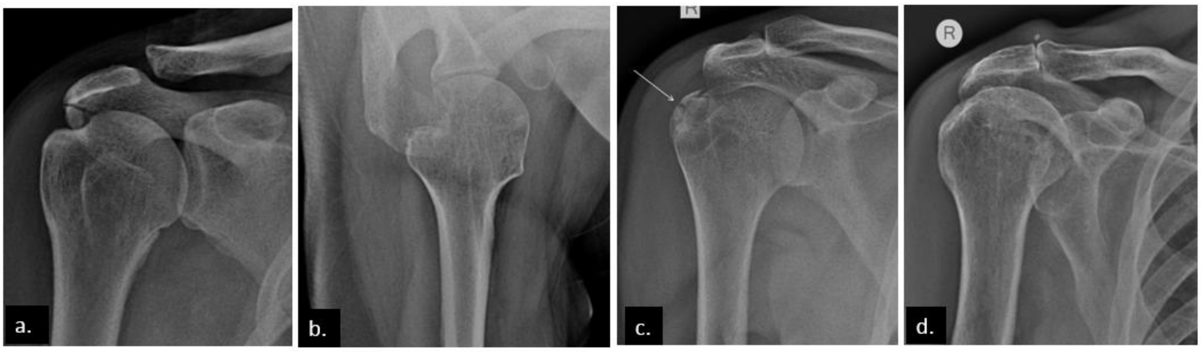

Figure 2: a. Os acromiale, b. Hill Sach's lesion, c. Greater tuberosity, d. Acromioclavicular arthritis, decrease in acromio-humeral distance.

On MRI, rotator cuff was analysed. Signal changes seen in supraspinatus muscle and tendon were seen in 35 patients. The following were diagnosed: Avulsion from greater tuberosity (n=1), Calcific tendinosis (n=1), Supraspinatus tendinosis (n=8), Delamination tear (n=7), Partial thickness tear (n=13), Complete tear with retraction (n=4) (Figure 3,4). Signal changes seen in infraspinatus muscle and tendon were seen in 11 patients. The following were diagnosed: Muscle edema (n=3), partial tear (n=1), Complete tear (n=2) and fatty atrophy (n=4) (Figure 4).

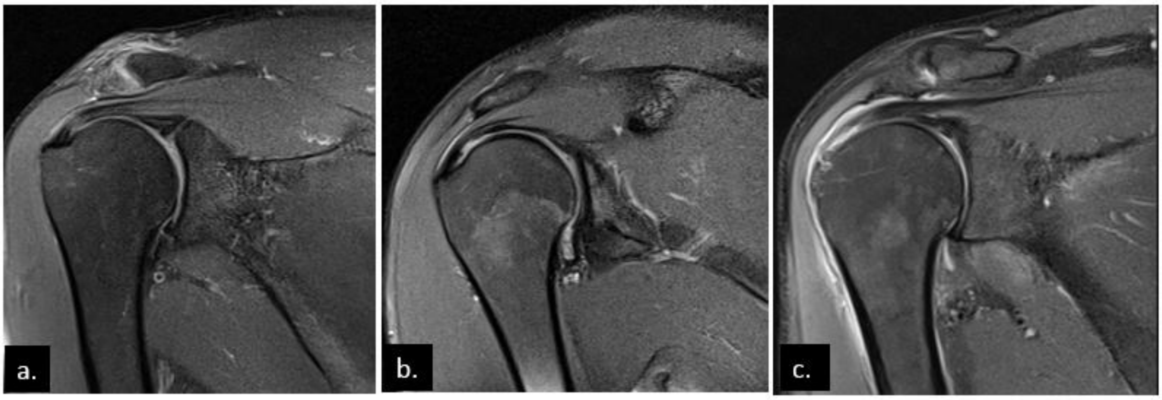

Figure 3: a. Supraspinatus tendinosis, with acromio-clavicular joint arthritis, b. Articular surface partial thickness tear in supraspinatus tendon, with lateral downsloping acromion, c. Delamination tear of the supraspinatus tendon

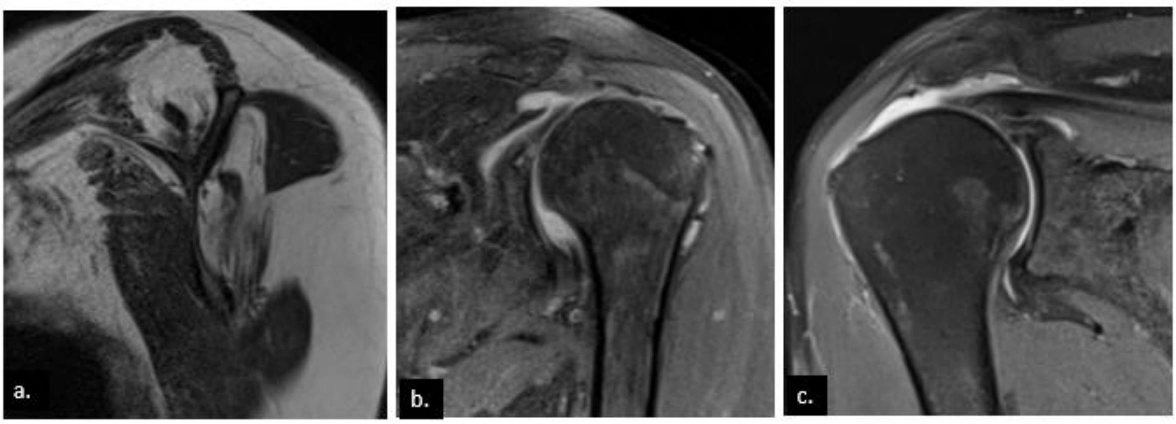

Figure 4: a.Grade IV – severe fatty atrophy of the supraspinatus, infraspinatus and teres minor; b & c.Complete tear of the supraspinatus tendon with retraction.

Signal changes seen in teres minor muscle and tendon were seen in 6 patients. The following were diagnosed: Muscle edema (n=1), strain (n=1), partial tear (n=1) and fatty atrophy (n=3). Signal changes seen in subscapularis muscle and tendon were seen in 6 patients. The following were diagnosed: Muscle edema (n=4), tendinosis (n=5), partial tear (n=5) and fatty atrophy (n=2). (Figure 5)

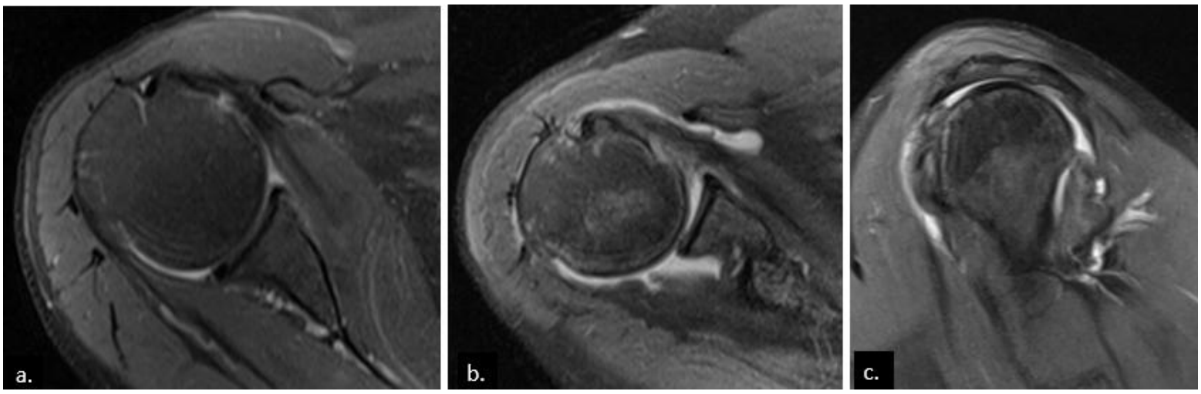

Figure 5: a. Partial tear of the subscapularis tendon; b&c. complete tear of the supraspinatus tendon, infraspinatus with retraction and partial tear of teres minor; c. Decrease in acromio-humeral distance.

Signal changes seen in coraco-acromion ligament, with edema (n=3), strain (n=2) and tear (n=4). Signal changes seen in Biceps tendon, with tendinosis (n=2), strain (n=1) and tear (n=2) (Figure 6). Fluid signal seen in the SASD bursa (n=24) and subcoracoid bursa (n=14). Fluid signal seen around the biceps tendon (n=21).

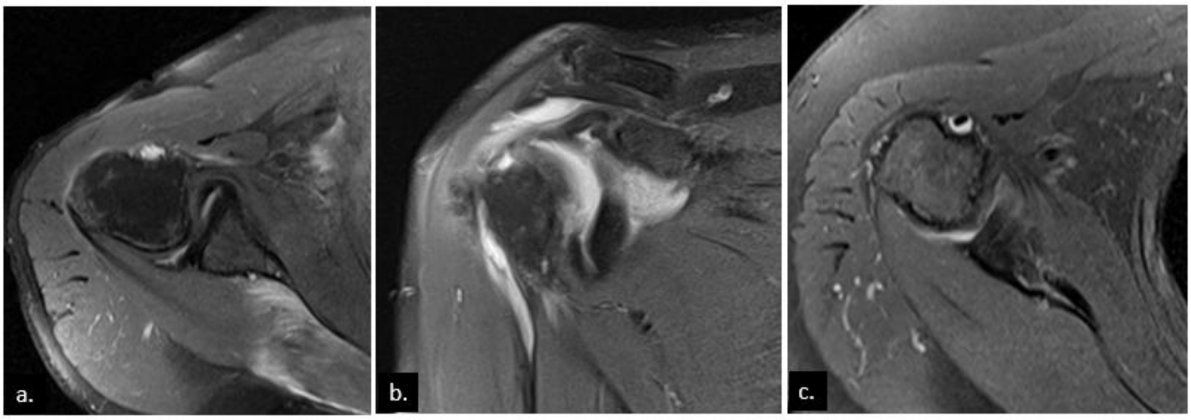

Figure 6: a. & b. Complete tear of the long head of biceps tendon with retraction, partial tear of the subscaplaris. c. Fluid around the biceps tendon related to joint effusion.

High signal areas are seen in the labrum were seen. Normal variants of high signal areas in the labrum were identified and not included in the diagnosis. Labral tears seen include Bony bankart (n=2), Reverse bankart (n= 1), Anterior Labroligamentous Periosteal sleeve avulsion [ALPSA] (n= 2), SLAP (n= 4) and Posterior labral tear (n=2). (Figure 7)

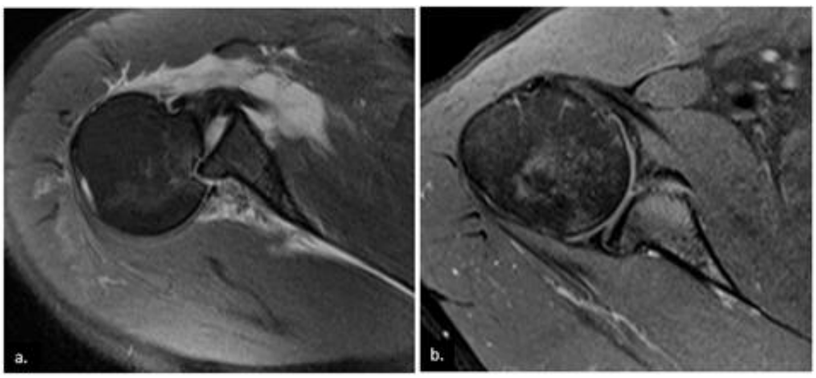

Figure 7: a. Posterior dislocation of the shoulder with Reverse Bankart's lesion and Hill Sach's lesion, Joint effusion seen. b. Bony bankart lesion seen.

High signal areas seen in the glenohumeral ligaments also. The SLAP tear extended to the superior glenohumeral ligament, in two patients. The inferior glenohumeral ligament shows edema (n=1), strain (n=8), Humeral Avulsion of inferior glenohumeral ligament [HAGL] (n=1) and adhesive capsulitis (n=1). (Figure 8)

Figure 8: a. Adhesive capsulitis; thickening of Inferior Glenohumeral ligament, b. Humeral Avulsion of inferior glenohumeral ligament

Humeral head showed sub cortical cyst (n= 7), focal lesion (n= 2) suggestive of metastasis in one patient a case of carcinoma breast and other with carcinoma lung, contusion (n= 1), degenerative changes (n= 3) with sub-cortical cysts and sclerosis, Hill sach's lesion (n= 2) and reverse hill sach's lesion (n= 1). There was edema (n= 6), avulsion fracture (n= 2) in greater tuberosity. The glenohumeral joint showed joint effusion (n= 11), anterior sub coracoid dislocation (n=1).

The type of acromion was assessed on the classification described above. On oblique coronal images, lateral down-sloping acromion was seen in 13 patients. On sagittal images, anterior down-sloping acromion was seen in 2 patients. Based on inferior surface of acromion; 27 patients had Type I, 12 patients had type II, 10 patients has type III, 1 patient had type IV, Os acromiale was seen in 1 patient. Acromioclavicular joint shows degenerative changes in 9 patients and arthritis with synovial thickening in 3 patients.

From the findings discussed above there is increased incidence of rotator cuff abnormalities among all the pathologies of the shoulder joint. The rotator cuff tears were seen in 39 of 51 patients. Rest of the labroligamentous pathologies and bony abnormalities were seen in 8 of 51 patients.

There is considerable decrease in the acromio-humeral distance in the plain radiograph and MRI in patients with rotator cuff pathologies in the MRI. The readings ae shown in Table

The most commonly involved muscle in the rotator cuff is supraspinatus, 32 of 39 patients. Isolated involvement of supraspinatus alone as seen in 23 of 32 patients. Other patients showed infraspinatus, teres minor and subscapularis muscle/tendons involvement. Isolated involvement of subscapularis was seen in 5 of 39 patients with rotator cuff involvement.

The predominant involvement of supraspinatus muscle was identified on MRI. There was evidence of decrease in acromiohumeral distance in patients with supraspinatus involvement in both MRI and Radiograph. The decrease in this distance correlated well with severity of the tear.

Supraspinatus Tear	Mean MR Acromio-humeral distance (mm)	No Of Patients	P value - 0.006
Complete tear	3.95	4	ANOVA Significant
Delamination tear	6.43	7	
Partial tear	6.62	13	
Tendinosis	8.36	8	

Table 1: The relation of acromio-humeral distance with Grade of supraspinatus tendon tear

IV. Discussion

In our retrospective analysis, Rotator cuff injuries are a major cause of shoulder pain, in about 78% of our patients, biceps tendon tear 2%, Shoulder dislocation 5%, degenerative joint disease with intact rotator cuff in 3%, labro-ligamentous pathologies in 8%, cervical rib with clavicle fracture 2% and metastasis 2%.

There is increased incidence of rotator cuff abnormalities in the manual labourers. There are various aetiologies attributed to the rotator cuff involvement. First being, compression of the rotator cuff tendons against the underlying structures, usually by the coraco-acromial arch. Second being, squeezing of the subacromial tendon structures during abduction movement. Third being, impaired microcirculation due to high intramuscular pressure, as in tendinitis. The overuse theme is common in workers in industrial workers. Work over exposure can result in shoulder tendinopathy, which causes pain and loss of function. Repetitive stress by performing flexion and overhead abduction rest in deformation of tendons. Large supraspinatus contraction forces increase the chance of tendon avascularity [1,2,8,9]. The rotator cuff muscles generate torque forces to move the humerus while acting in concord to produce balanced compressive forces to stabilize the glenohumeral joint. Thus, rotator cuff tears are often associated with loss of shoulder strength and stability, which are crucial for optimal shoulder function.

The dimensions and extent of rotator cuff tears, the condition of the involved tendon, tear morphologic features, involvement of the subscapularis and infraspinatus tendons or of contiguous structures like, rotator interval, long head of the biceps brachii tendon, specific cuff tendons, and evidence of muscle atrophy may all have implications for rotator cuff treatment and prognosis [5,6,10]. The treatment modalities include conservative, medical and surgical repair. Lifestyle, work modifications, physiotherapy are advised depending on the severity of disease. Medical managements includes intraarticular injection of medications like corticosteroids, hyaluronic acid. The subacromial corticosteroid injections for the rotator cuff disease and intra-articular steroid injection for adhesive capsulitis are found to be beneficial. Surgical management is based on the type of tear or injury.

Linaker et al[1], in his study described, ergonomic adjustments introduced in many workplaces as an attempt to reduce the physical exposure of a worker in order to prevent or alleviate musculoskeletal pain. However, ergonomic interventions alone may not be sufficient to address this issue and more recently, alternative strategies have been developed with the aim of increasing a worker's physical capacity. Such physical conditioning programmes in the workplace have been developed and investigated, with promising results in terms of reducing chronic pain and disability in the upper limb among workers in a variety of occupational settings, including those performing forceful and repetitive manual tasks. Such interventions focus on physical resistance-training and have been found to reduce pain intensity and disability, and improve muscle strength.[1]

Intra-articular glenohumeral joint injection is done for osteoarthritis, adhesive capsulitis. For the acromioclavicular joint, injection may be used for diagnosis and treatment of osteoarthritis and distal clavicular osteolysis. Subacromial injections are useful in cases of adhesive capsulitis, sub-deltoid bursitis, impingement syndrome, and rotator cuff tendinosis. Scapulothoracic injections are reserved for inflammation of the involved bursa. Persistent pain related to inflammatory conditions of the long head of the biceps responds well to injection in the region.[11]MRI also acts as a guidance for selecting the appropriate site for intra-articular injection.

In a study by L. Nové-Josserand et al[12], regarding return to work after surgery in patients with rotator cuff tear due to a work-related injury; there is return to work in the same or a modified position in almost 60% of cases. In almost one-quarter of the cases, the patient did not return to work because of a factor unrelated to the operated shoulder. Overall, 16% of the population studied did not return to work because of the shoulder injury itself. In our current study, though lack of post treatment follow up was a limitation; early diagnosis and treatment of the rotator cuff tears can cause early return to work[12].

Hence, there is a need for early diagnosis of cause of shoulder pain in manual labourers. In our study, all the patients with shoulder pain had underwent plain radiograph of shoulder. We found that, the patients with rotator cuff abnormalities, the acromio-humeral distance was decreased in MRI and corresponding decrease in distance was found in plain radiograph also. The decrease in the acromio-humeral distance correlated well with the type of tear. Higher grades of tear was associated with small acromio-humeral distance. Table 1 clearly depicts this observation of small acromio-humeral distance in higher grade of rotator cuff tear. Post contrast enhancement images show chronicity of the tear, presence of granulation tissue, synovial thickening and enhancement. MR imaging helps in early identification of the soft tissue changes. This aids in early institution of appropriate management. The type of treatment depends on grade of the disease. It may be medical management, intraarticular injections, arthroscopic repair or open surgical procedure like tendon repair.

Many other abnormalities like calcific tendinitis, avulsion fracture, shoulder dislocation, hillsach's lesion were also identified on radiograph. MRI is the imaging modality of choice for detailed assessment of pathological changes in soft tissues. Plain radiograph can act as a useful screening modality in patients with shoulder pain.

V. Conclusion

Magnetic resonance imaging can demonstrate the extent and configuration of rotator cuff abnormalities, suggest mechanical imbalance within the cuff and document abnormalities of the cuff muscles and adjacent structures. Thus, MR imaging of shoulder in manual labourers with shoulder pain is essential to make early diagnosis of the cause. After identification of cause of shoulder pain, appropriate early management can be instituted; so that the morbidity is decreased and there is early return to work. Plain radiograph can act as a useful screening modality in patients with shoulder pain.

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