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RESEARCH ARTICLE
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ULTRASOUND OF THE SHOULDER IN EVALUATION OF ROTATOR CUFF INJURIES

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Abstract:
Shoulder pain affects approximately 18 million Americans a year, most of which are a result of rotator cuff tears. Tears can occur from a mix of trauma, overuse, or age-related degeneration and can be asymptomatic or cause severe pain and decreased mobility. Research has shown that smoking, hypercholesterolemia, and family history all predispose to tears. Rotator cuff injury runs the full spectrum from injury to tendinopathy to partial tears, and finally complete tears. Informed consent was obtained from each patient prior to their enrolment in the study. Brief case history was obtained. Depth of US beam adjusted to accommodate for differences in soft-tissue injuries among patients ranged from 3 to 5 cm. The US examinations were performed with both the patient and examiner seated on backless stool facing each other. US gel was liberally applied to the shoulder. USG showed that most commonly affected tendon by rotator cuff pathology was Supraspinatus (62%), followed by Subscapularis (4%), Infraspinatus (2%), Teres Minor (2%), and Biceps tendon (2%).

Keywords: Ultrasound, Evaluation, Rotator Cuff Injuries

Introduction:

Rotator cuff pathology stands as the leading cause of shoulder pain and disability. These pathologies encompass a spectrum from tendinosis to complete tears. The shoulder joint's axis of rotation isn't fixed; it's an incongruous ball and socket joint with motion occurring across multiple planes, resulting in a broad range of motion. This increased mobility comes at the expense of reduced stability. Several structures contribute to shoulder stability, including the glenohumeral ligaments, joint capsule, osseous glenoid, fibrous labrum, and notably, the rotator cuff, comprised of four tendons.[1] Shoulder pain affects approximately 18 million Americans a year, most of which are a result of rotator cuff tears. Tears can occur from a mix of trauma, overuse, or age-related degeneration and can be asymptomatic or cause severe pain and decreased mobility. Research has shown that smoking, hypercholesterolemia, and family history all predispose to tears. Rotator cuff injury runs the full spectrum from injury to tendinopathy to partial tears, and finally complete tears. Age plays a significant role. Injuries ranged from 9.7% in those 20 years and younger increasing to

62% in patients 80years and older (whether or not symptoms were present). Increasing age and those with unilateral pain are also at risk for a tear in the rotator cuff of the opposite shoulder. In a study comparing patients with unilateral shoulder pain, the average age for a patient having no cuff tear was 48.7 years. After age 66, there is a 50% likelihood of bilateral tears. Additionally, age was linked to the presence and type of tear but did not correlate with tear size.[2]

Age stands out as the primary factor in the development of rotator cuff disease, representing a degenerative and progressive process. Smoking is identified as a significant risk factor, with research demonstrating increased rates and sizes of degenerative tears in smokers, potentially leading to higher rates of surgeries. Family history also plays a role, as evidenced by a study showing a significant correlation between individuals with rotator cuff disease up to third cousins, particularly in those under 40 years of age. Poor posture has emerged as an interesting predictor, with tears being more prevalent in patients with kyphotic-lordotic, flat-back, or sway-back postures compared to those with ideal alignment. Additionally, trauma, hypercholesterolemia, and occupations involving significant overhead activity contribute to the risk.[3]

Partial tears pose a risk for further propagation, influenced by factors such as tear size, symptoms, location, and age. Small tears may remain dormant, while larger tears are more likely to undergo structural deterioration, although the critical size for tear progression remains undefined. Actively enlarging tears are five times more likely to develop symptoms compared to stable tears. The tear's location also influences its progression, with anterior tears more prone to degeneration. Moreover, age plays a role, with patients over 60 being more susceptible to tear progression, while younger patients with full-thickness tears appear more adaptable to stress and tear propagation.[4]

Methodology:

Study Population: Data for the study was collected from both outpatients and inpatients referred for high resolution ultrasound (US) and MRI scans of shoulder to the department of radio-diagnosis, with suspected rotator cuff injuries

Study Design: Prospective Cross-sectional study

Sample size: 50

Exclusion Criteria:

- General contraindication of MRI scan like cardiac pacemaker, ferromagnetic aneurysm clips, cochlear implants and metallic foreign bodies
- Claustrophobia
- Post operative cases
- Age below 18 years

Informed consent was obtained from each patient prior to their enrolment in the study. Brief case history was obtained. Depth of US beam adjusted to accommodate for differences in soft-tissue injuries among patients ranged from 3 to 5 cm. The US examinations were performed with both the patient and examiner seated on backless stool facing each other. US gel was liberally applied to the shoulder. Patient positioned the arm at the side with the elbow bent to 90°. By positioning the transducer around the curvature of humeral head in oblique transverse plane, the biceps muscle was viewed in its osseous groove. Once located, the biceps was followed longitudinally, parallel to its fibres. Dynamic images of the subscapularis tendon were recorded while the patient actively rotated the shoulder from internal to external rotation. The transducer was oriented transverse to arm to allow longitudinal extent of subscapularis tendon to be seen as the tendon inserts on the lesser tuberosity. The subscapularis tendon was viewed longitudinally, parallel to its primary fiber orientation. On transverse images the individual tendon slips were seen. Dynamic images of the supraspinatus tendon were recorded with the arm in extension and internal rotation, as the patient placed his or her hand on the buttock or lower lumbar spine[1].The US transducer was placed anterior to the acromioclavicular joint and oriented 45° to demonstrate the longitudinal course of the supraspinatus tendon. The course of the spine of the scapula was a useful reference plane. The transducer was then rotated 90° to

demonstrate the tendon in the transverse plane. The infraspinatus was also viewed longitudinally with the arm at the side of the body, and dynamic images were recorded with internal and external rotation of the shoulder. The transducer was positioned just inferior and parallel to the spine of the scapula. The Infraspinatus muscle was then followed laterally as it crossed the posterior glenohumeral joint and became the tendon[1].

Results:

In this study, USG showed that most commonly affected tendon by rotator cuff pathology was Supraspinatus, which was observed in 31 study patients (62%), followed by Subscapularis in two patients (4%), Infraspinatus in 1 patient (2%), Teres Minor in 1 patient (2%), and Biceps tendon in 1 patient (2%). Thus, among the affected tendons, majority of the findings were abnormal for Supraspinatus which was significantly higher (38.0%) ($Z=3.39$;$p<0.0001$). Among the pathologies affecting Supraspinatus, most common was partial tear, observed in 12 patients (24%), followed by tendinosis in 10 patients (20%), full thickness tear in 8 patients (16%), while one patient showed both tendinosis and partial tears. Among the two patients with Subscapularis tendon pathology, both showed partial tear (4%) on USG, one patient with Infraspinatus pathology showed Tendinosis (2%), one patient with Teres Minor pathology showed Partial tear (2%), and one patients with Biceps Tendon pathology showed Tendinosis (2%).

Table 1: USG Findings of Rotator Cuff Tendons Pathology in Study Patients

Affected Tendon	Supraspinatus	Infraspinatus	Teres Minor	Subscapularis	Biceps Tendon
	N(%)	N(%)	N(%)	N(%)	N(%)
Full Thickness Tear	8 (16%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Partial Tear	12 (24%)	0 (0%)	1 (2%)	2 (4%)	0 (0%)
Tendinosis	10 (20%)	1 (2%)	0 (0%)	0 (0%)	1 (2%)
T/P (Tendinosis/ Partial Tear)	1 (2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Normal	19 (38%)	49 (98%)	49 (98%)	48 (96%)	49 (98%)
Total	50 (100%)	50 (100%)	50 (100%)	50 (100%)	50 (100%)

In this study, USG findings showed subacromial-subdeltoid bursitis in 15 patients (30%), while in 35 patients (70%), it was absent. This difference was statistically significant ($Z=5.65$; $p<0.0001$).

Table 2: USG Detection of SA-SD Bursitis in Study Patients

SA-SD	Number	%
Absent	35	70.0%
Present	15	30.0%
Total	50	100.0%

USG showed Subacromial (SC) bursitis in 5 patients (10%), while it was absent in 45 patients (90%). This difference was statistiacally significant ($Z=11.31$; $p<0.0001$).

Table 3: USG detection of SC Bursitis in Study Patients

Bursal Fluid SC	Number	%
Absent	45	90.0%
Present	5	10.0%
Total	50	100.0%

USG findings showed presence of Peribicipital Tendon Fluid in 26 study patients (52%), while in 24 patients it was absent (48%). This difference was not statistically significant (Z=0.56; p=0.56).

Table 4: USG Detection of Peribicipital Tendon Fluid in Study Patients

Peri-bicipital Tendon Fluid	Number	%
Absent	24	48.0%
Present	26	52.0%
Total	50	100.0%

In this study, ACJ pathology was not detected in 41 patients (82%), while in 9 patients (18%), it was not assessed. Thus, among the 82.0% of the cases assessed for ACJ pathology, it was found absent in all the patients, which was significant. (Z=14.14; p<0.0001). (Table 10, Figure 42)

Table 5: USG Detection of ACJ Pathology in Study Patients

ACJ pathology	Number	%
Absent	41	82.0%
NA	9	18.0%
Total	50	100.0%

Discussion:

In our study, USG showed that most commonly affected tendon by rotator cuff pathology was Supraspinatus (62%), followed by Subscapularis (4%), Infraspinatus (2%), Teres Minor (2%), and Biceps tendon (2%) (p<0.0001). Similarly, Supraspinatus (90%) was the most commonly affected tendon, followed by Subscapularis (6%), and Infraspinatus (3%) in the study by Lohith K et al[5]. These results are in accordance with the study by Maravi P et al[1]. Supraspinatus was the most commonly affected tendon by rotator cuff pathology in the studies by Vijayan D et al[4], Aminzadeh B et al[6].

We observed that, among the pathologies affecting Supraspinatus in our study, most common was partial thickness tear (24%), followed by tendinosis (20%), full thickness tear (16%), and both tendinosis and partial thickness tear in 2% of patients. Similar observations were made by Lohith K et al[5], in their study, who observed that USG detected partial thickness tear in supraspinatus tendon in 30% of patients, and full thickness tear in 13.3% of patients. Murugan J et al[7] observed that USG was able to detect partial thickness tear in Supraspinatus tendon in 55.55% of patients, and full thickness tear in 5.55% of their study patients. In the studies by Maravi P et al[1] and Selvaraj S et al[8], USG detected partial thickness tear in Supraspinatus tendon in 28% and 42% of patient, and full thickness tear in 8% and 18% of their study patients, respectively.

In our study, USG detected pathology in infraspinatus tendon in only 2% of patients, which was tendinosis, while in 98% of patients, the tendon appeared normal. Murugan J et al[7] have observed that tendon pathology detected by USG in Infraspinatus tendon were partial thickness tear in 4.44% of patients and full thickness tear in 1.11% of their study patients. Among the two patients with tendon pathology in Subscapularis detected by USG in our study, both showed partial thickness tear (4%), one patient with Teres Minor pathology showed partial thickness tear (2%), and one patient with Biceps Tendon pathology showed tendinosis (2%). In a similar study by Gupta A et al[9], USG detected partial tear in 12% of study patients and tendinosis in 12% of patients in Subscapularis tendon. On the other hand, in the study by Selvaraj S et al[8], USG detected partial thickness tear in Infraspinatus in 10% and in Subscapularis in 6% of study

patients, whereas full thickness tear in Infraspinatus and in Subscapularis was detected in 6% and 2% of their study patients, respectively.

In our study, USG detected subacromial-subdeltoid (SA-SD) bursitis in 30% of patients (30%), Subacromial (SC) bursitis in 10% of patients, and presence of Peribicipital Tendon Fluid in 52% of patients.) In the study by Lohith K et al[5], USG detected Peribicipital Tendon Fluid in 63% of patients. In the study by Murugan J et al[7] USG detected SA-SD bursitis, SC bursitis, and Peribicipital Tendon Fluid in 22.22%, 32.22%, and 22.22% of patients, respectively. ACJ pathology was not detected by USG in any of our study patients.[10] However, USG detected ACJ pathology in 11.11% of patients in the study by Murugan J et al[7].

Conclusion:

- USG showed that most commonly affected tendon by rotator cuff pathology was Supraspinatus (62%), followed by Subscapularis (4%), Infraspinatus (2%), Teres Minor (2%), and Biceps tendon (2%).
- USG detected Supraspinatus pathology in 62% of patients, Infraspinatus pathology in 2% patients, Teres Minor pathology in 2% of patients, Subscapularis pathology in 2% of patients, and Biceps Tendon pathology in 2% of patients.

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