International Research Journal of Pharmacy and Medical Sciences
ISSN (Online): 2581-3277

Can USG Replace the MRI- in Rotator cuff? A Prospective Study

Dr. Mohamed Rafi Kathar Hussain
Assistant Professor, Department of Radio Diagnosis, Sri Manukula Vinyagar Medical College, Puducherry, India
Email: radiologistrafi1984 @ gmail.com

Abstract— Background*: The shoulder joint is an elegant anatomic structure; its range of motion exceeds all other joints, it relies on a variety of structures for its stability including rotator cuff tendons. Both ultrasound and magnetic resonance imaging (MRI) was used as an investigation tool for rotator cuff pathologies. There is a difference in consensus, which is more accurate and cost-effective study in evaluating the rotator cuff diseases. This prospective study is done to evaluate the findings of both MRI and USG.* ***Results****: USG examination had an excellent specificity (88 to 100%), PPV (84 to 100 %), better NPV (87 to 96 %), and fair sensitivity (66 to 95%) in comparison to MRI for diagnosing complete rotator cuff tear than partial tear or tendinosis.* ***Conclusion****: MRI can be used in difficult or unsure cases where the diagnosis is doubtful on USG. Although USG was operator-dependent, a well-performed USG can effectively serve as a primary diagnostic method and screening of all painful shoulder joints because it is cheap, fast, and widely available. USG imaging can be considered relatively effective as MRI in the initial evaluation of rotator cuff pathologies.*

Keywords— *USG, MRI, rotator cuff, complete tear, partial tear*.

I. BACKGROUND

The shoulder joint is an elegant anatomic structure; its range of motion exceeds all other joints, it relies on a variety of structures for stability including rotor cuff tendons (1). Both diagnostic ultrasound and magnetic resonance imaging (MRI) are used as an investigation for rotator cuff lesions. There is a difference in consensus as to which is the more accurate and cost- effective study in evaluating the rotator cuff tendon (2). Hence, this prospective study was done to correlate USG findings with MRI findings in rotator cuff injury.

II. METHODS

The source of data for the study was from the tertiary medical college hospital from July 2014 to January 2015. The study is a prospective study, done in those patients who had been referred for shoulder MRI with clinical suspicion of rotator cuff pathology was selected and additional USG of the shoulder joint was done on the same day. Findings of both MRI and USG were compared and evaluated. Both USG and MRI were done and reported by an expert consultant radiologist in their field for more than 5 years.

III. TECHNIQUE

Imaging was done with 3 Tesla Philips Achieva using shoulder coil. The following sequences are done; PDW Axial SPAIR sequence, PDW –FAT/SAT coronal sequence, STIR TSE coronal sequence, PDW FAT/SAT sagittal sequence, and T2W TSE coronal sequence. USG machine used was TOSHIBA XARIO and shoulder USG was done with 6 to 7.5 MHZ linear probe. Both static and dynamic USG examination of the affected shoulder was done.

Inclusion Criteria used in the study are; those patients who had been referred for MRI shoulder with a history of shoulder pain and clinically suspected to have rotator cuff pathology. Exclusion criteria are patients contraindicated to MRI, and those not willing or uncooperative or any previous history of shoulder surgery.

IV. STATISTICAL METHODS

Qualitative data were represented in form of frequency and percentage. Association between qualitative variables will be assessed by chi-Square test with continuity correction for all in 2 X 2 tables and with or without continuity correction in rest. Fisher's exact test for all 2 X 2 tables, where p-value of Chi-Square test is not valid due to small counts.

Adjacent row data of more than 2X2 tables were pooled and the Chi-Square test reapplied in case more than 20.0% cells. Quantitative data were represented using to mean ± SD and Median & IQR (Interquartile range). Diagnostic efficacy will be calculated through sensitivity, specificity, PPV, NPV, positive Likelihood measurements. Cohen's k (kappa) was run to determine if there was an agreement between USG & MRI findings.

V. RESULTS

The age of the patients ranged from 10 to 75 years, with a mean of 43.10 +/_ 2.08. While 14 (43%) cases are from 21 to 40 years of age, and 10 (33%) of the cases are from 41 to 60 years of age. One patient is below 20 years and 5 patients are above 60 years. Of the 30 patients studied, nine (30%) were females and 21(70%) were males. The mean age among females was 45.1 years and the mean age among males was 42.2. Out of 30 patients, 22 (74%) had derangements of the right shoulder while eight (26%) had left-sided derangements.

In MRI, 13 patients (43%) had abnormal subscapularis tendon, in which articular surface tendinosis and articular surface partial tear constituted six cases (20%) (Table 1). While in USG, 13 (43%) patients had abnormal subscapularis tendon, in which insertion site tendinosis and articular surface partial tear constituted 26% (8) of the cases (Table 2). In MRI, 23 patients (67%) had abnormal supraspinatus tendon, in which articular surface partial tear constituted 20% of the

Dr. Mohamed Rafi Kathar Hussain, "Can USG Replace the MRI- in Rotator cuff? A Prospective Study," *International Research Journal of Pharmacy and Medical Sciences (IRJPMS)*, Volume 4, Issue 2, pp. 20-24, 2021.

cases (Table 3). While in USG, 22 patients had abnormal subscapularis tendon (63%), in which articular and bursal surface partial tear constituted 10 cases (34%).

TABLE 1. MRI findings in subscapularis tendon

MRI findings-Subscapularis	No.	Percentage
Articular Surface tendinosis	3	10%
Bursal surface tendinosis	1	3%
Insertion site tendinosis	2	7%
Complete Tear	2	7%
Articular surface partial tear	3	10%
Bursal surface partial tear	1	3%
Insertion site partial tear	1	3%
Normal	17	57%
Total	30	100%

TABLE 2. USG findings in subscapularis

USG findings Subscapularis	No.	Percentage
Bursal surface tendinosis	1	3%
Insertion site tendinosis	4	13%
Complete Tear	2	7%
Articular surface partial tear	4	13%
Bursal surface partial tear	1	3%
Interstial partial tear	1	3%
Normal	17	57%
Total	30	100.0%

TABLE 3. MRI findings in supraspinatus

MRI findings-Supraspinatus	No	Percentage
Bursal surface tendinosis	3	10%
Insertion site tendinosis	4	13%
Insertion site tendinosis + complete Tear	1	3%
Complete Tear	2	7%
Articular surface partial tear	6	20%
Bursal surface partial tear	4	13%
Interstial partial tear	3	10%
Normal	7	23%
Total	30	100%

MR detected three cases (10%) of abnormal Infraspinatus tendon, in which two of them were complete tears (Table 4) (6.7%) seen in USG, while one of the patients had interstitial partial tear which was not detected in USG (Table 6). In this study, no teres minor pathology was found. Of 13 abnormal cases of the subscapularis tendon in MRI, USG had detected 11 cases. Among 17 normal cases in MRI, 2 cases were diagnosed as abnormal by USG. Sensitivity, specificity, PPV, NPV, LLR for negative test, LLR for positive test measures 84%, 88%,84%,88%,7.1,0.7 respectively. Youden's index and odd's ratio measures 0.7 and 47.2 respectively. Kappa agreement between USG and MRI was 0.729, which is significant. Pearson Chi-Square test and Continuity correction test were significant. Of 23 abnormal cases of the supraspinatus tendon in MRI, USG had detected 22 cases. Among 7 normal cases in MRI, all cases were diagnosed as normal by USG. Sensitivity, specificity, PPV, NPV, and LLR for negative test measures 95%, 100%, 100%, 87%, 0.043 respectively. Youden's index measures 0.95. Kappa agreement between USG and MRI was 0.911, which is near 100 percent significant. Pearson Chi-Square test, Continuity correction test, and Fisher Exact Test were significant.

Of three abnormal cases of Infraspinatus tendon in MRI, USG had detected two cases. Among 27 normal cases in MRI, all cases were diagnosed as normal in USG. Sensitivity, specificity,

TABLE 4. USG findings in supraspinatus

USG findings Supraspinatus	No.	Percentage
Articular Surface tendinosis	2	7%
Bursal surface tendinosis	1	3%
Insertion site tendinosis	4	13%
Complete Tear	3	10%
Articular surface partial tear	5	17%
Bursal surface partial tear	5	17%
Interstial partial tear	2	7%
Normal	8	27%
Total	30	100.0%

TABLE 5. MRI findings in Infraspinatus

MRI findings-Infraspinatus	No.	Percentage
Complete Tear	2	6.7%
Interstial partial tear	1	3.3%
Normal	27	90.0%
Total	30	100.0%

TABLE 6. USG findings in Infraspinatus.

USG findings -Infraspinatus	No.	Percentage
Complete Tear	2	6.7%
Normal	28	93.3%
Total	30	100.0%

PPV, NPV and LLR for negative test measures 66%, 100%, 100%, 96%, and 0.33 respectively. Youden's index measures 0.667 respectively. Kappa agreement between USG and MRI was 0.783, which is significant. Pearson Chi-Square test and Continuity correction test were significant. In five cases of subscapularis tendinosis, one case of bursal surface tendinosis and insertion site tendinosis was detected by USG. Of 3 cases of articular surface tendinosis seen in MRI, one case was diagnosed as insertion site tendinosis, 2 cases were missed in USG. Pearson

Chi-Square test and Fischer Exact test were significant, sensitivity, specificity, PPV, NPV, LLR for Positive test, and LLR for negative test measures 60.00%, 93.75%, 75.00%, 88.24%, 9.600, 0.427 respectively. Youden's index and odds ratio measure 0.538 and 22.500 respectively.

Kappa agreement between USG and MRI was 0.577, which is significant.

In six cases of supraspinatus tendinosis, two cases were bursal surface tendinosis and four cases were insertion site tendinosis. Among 2 cases of bursal surface tendinosis, one was detected by USG. Of four cases of insertion site tendinosis seen in MRI, three cases were diagnosed as insertion site tendinosis, one case was missed in USG. Sensitivity, specificity, PPV, NPV, LLR for negative test measures 100.00%, 100.00%, 100.00%, 100.00%, 100.00% respectively. Youden's index measures 1.000. Kappa agreement between USG and MRI was one, which is significant. Pearson Chi-Square test and Fischer Exact test were significant.

Among six cases of subscapularis tear, two cases were complete tears, three cases were articular surface partial tears and one case was a bursal surface partial tear. All the cases were detected by USG. However, one normal case on MRI was misdiagnosed as an interstitial partial tear on USG.

Dr. Mohamed Rafi Kathar Hussain, "Can USG Replace the MRI- in Rotator cuff? A Prospective Study," *International Research Journal of Pharmacy and Medical Sciences (IRJPMS)*, Volume 4, Issue 2, pp. 20-24, 2021.

Sensitivity, specificity, PPV, NPV t measures 100.00%, 93.75%, 85.71%, 100.00%, 16.000 respectively. Youden's index measures 0.938. Kappa agreement between USG and MRI was 0.891, which is significant. Pearson Chi-Square test and Fischer Exact test were significant.

Among 14 cases of supraspinatus tear, three cases of the complete tear and two cases of interstitial partial tear were detected by USG. Among four cases of a bursal surface partial tear, one case was missed by USG. Sensitivity, specificity, PPV, NPV, and LLR for negative test measures 92.86%, 100.00%, 100.00%, 87.50%, 0.071respectively. Youden's index measures 0.929. Kappa agreement between USG and MRI was 0.897, which is significant. Pearson Chi- Square test and Fischer Exact test were significant.

Among three cases of Infraspinatus tear, two cases were a complete tear, which was detected by USG. One case was interstitial partial tear was missed by USG. Sensitivity, specificity, PPV, NPV, and LLR for negative test measures 66.67%, 100.00%, 100.00%, 96.43%, 0.333 respectively. Youden's index measures 0.667. Kappa agreement between USG and MRI was 0.783, which is significant. Pearson Chi-Square test and Fischer Exact test were significant.

VI. Discussion

Pathology of the rotator cuff is the most common problems of the shoulder joint and accurate diagnosis is essential for appropriate management (3). Ultrasonography and MRI are imaging modalities for rotator cuff disorders.

When compared to the study conducted by Pavic et al, of the total of 200 cases, the mean age of patients was 39 (range from 15 to 83), which is similar to this study (4). The incidence of rotator cuff tendon degeneration and injury increases with the age (5). Rotator cuff diseases are multi factorial both extrinsic and intrinsic factors have been implicated. Intrinsic factors like poor vascularity, alteration in the material composition with aging have been studied (6, 7,

8). Ozaki et al believe that the pathogenesis of rotator cuff disorders is an intrinsic process and the risk of rotator cuff disorder increases with aging. Micro vascular studies have shown diminished vascularity in the cuff tissue with increased age which appears consistent with the pattern of degeneration observed in age-related degenerative tendinopathies (9). In a study conducted by Needell et al. in 100 asymptomatic shoulders, a higher incidence of tendinosis was found among the younger population against more tears in the older age group in the fifth and sixth decade of life. There is no such difference was found in this study (10).

In a study done by Zhang et.al female patients are fewer when compared to male patients, comparable to this study (11). This may be related to occupation and physical activity which varies with gender leading to shoulder pathology. There is no statistically significant difference in the incidence of rotator-cuff lesions related to gender in our study. This is correlating with a study done among 90 patients by Milgrom et al. which showed no statistically significant differences in the incidence of rotator-cuff lesions related to gender. Equivocal distribution of rotator cuff disease has also been described in the literature (13).

In a study conducted by Zhang et al, the sensitivity of ultrasound diagnosis was 93.4% and specificity is 75.0 % and concluded that high-frequency ultrasound in the diagnosis of rotator cuff tears injuries has high sensitivity and specificity (11). High-frequency ultrasound can be used as a routine method to diagnose rotator cuff tears injuries. The study shows sensitivity equal to the study done by Zhang et al. (11).

In a study of 70 patients conducted by Nabetani Y., et al., the diagnostic accuracy, sensitivity, and specificity of US is 94.3% and 94.3%, 95.8% when the intraoperative finding was regarded as a gold standard (12). Meta-analysis study conducted by Ottenheijm R. P., et al for tendinopathies, sensitivity ranged from 0.67 to 0.93, specificity from 0.88 to 1.00., (13). In which sensitivity is lower in compared to our study, specificity is same as our study.

In a study conducted by Ok J.H. et al. in 51 patients, the sensitivity of ultrasonography for detecting partial-thickness tears is 45.5%, and that for full-thickness tears was 80.0 %. The specificity of ultrasonography for detecting partial-thickness tears is 45.1% and for full-thickness tears was 82.4%, and the Kappa coefficient is 0.47 (14). This is less in compared to our study, however sensitivity and specificity of the complete tear detection by USG is more in compared to a partial tear.

Cochrane database systemic review (15) done on 20 studies of people with suspected rotator cuff tears (1147 shoulders), of which six evaluated MRI and US (252 shoulders), or MRA and US (127 shoulders) in the same people show that for any rotator cuff tears, the summary sensitivity and specificity 91% (95% CI 83% to 95%) and 85% (95% CI 74% to 92%) respectively for US (13 studies, 854 shoulders). For full-thickness tears, the sensitivity and specificity 92% (95% CI 82% to 96%), 93% (95% CI 81% to 97%) respectively for US (10 studies, 729 shoulders) which is near close to our results in our study.

In a prospective study conducted by Siopla et al. in 77 patients, sensitivity, specificity, positive predictive and negative predictive values of USG are 92%, 45%, 91%, and 50%, respectively(16). In a retrospective study conducted by Rutten M.J. et al ,in 5,216 patients for the past 4 years, the US correctly depicted 22 (100%) of the 22 full-thickness tears, 6 (67%) of the 9 partial-thickness tears, Detection of complete tear by USG in good in comparison to partial- thickness tears which is similar to our study(17). In a meta-analysis study conducted by Ottenheijm R. P., et al.. For full-thickness tears, pooled sensitivity of ultrasound was 0.95 (95% confidence interval, .90-.97), and specificity0.96 (.93-.98). For partial-thickness tears, pooled sensitivity was 0.72 (.58-.83), and specificity0.93 (.89-.96) (13). Which is similar to this study.

Teres minor is an important external rotator of the shoulder, contributing up to 45% of the power of external rotation. An intact or even hypertrophied, teres minor can provide enough power to external rotation and can maintain the ability to perform the activities of daily living, such as eating and drinking and reduce the symptoms of the other cuff tendon tear. In a study (18) conducted on 2,436 shoulders MRI examinations for a period of 67 months from September 1996 to April 2002. MRI findings of teres minor abnormality were

seen in very less in only, 0.8% of the study population. No teres minor pathology was found in this study.

Limitations of this study include small sample size and further intra-operative follow-up or MR arthrogram was not done in all patients.

VII. Conclusion

The most common tendon involved in rotator cuff pathology is the supraspinatus tendon. The commonest pathology in rotator cuff tendons is a partial tear, followed by tendinosis and next is full-thickness tears Ultrasound has a high specificity and good sensitivity compared to MRI, for full-thickness tears. MRI can be used in difficult or unsure cases where the diagnosis is doubtful on USG. Although USG is an operator-dependent, a well performed USG can effectively serve as a primary diagnostic method and screening of all painful shoulder joints because it is cheap, fast, and widely available. USG imaging can be considered relatively effective as MRI, in the initial evaluation of rotator cuff pathologies.

MRI has lesser artifacts, good soft tissue resolution but has limitations of being time-consuming, costly, static, and not widely available. In our study, USG examination had an excellent specificity (88 to 100%), PPV (84 to 100 %), better NPV (87 to 96 %), and fair sensitivity (66 to 95%) in comparison to MRI for diagnosing complete rotator cuff tear. USG can be used as a first-line screening investigation for a case of shoulder joint pain to rule out rotator cuff pathologies. USG cannot completely replace MRI in the evaluation of rotator cuff pathology but it will essential initial screening diagnostic tool in countries like India.

List of Abbreviation Used

USG: Ultrasonogram
MRI: Magnetic resonance imaging PDW: Proton density weighted FAT/SAT: Fat saturation
MHZ: Megahertz TSE: Turbo spin echo
STIR: Short Tau inversion recovery PPV: Positive predictive value NPV: Negative predictive value SD: Standard deviation
LLR: Log Likelihood ratio

Acknowledgements

I take this opportunity to acknowledge my deepest sense of gratitude and regards to my respected teacher and guide Dr Ashwini Sankhe, for her constant guidance and supervision in every step of this study.

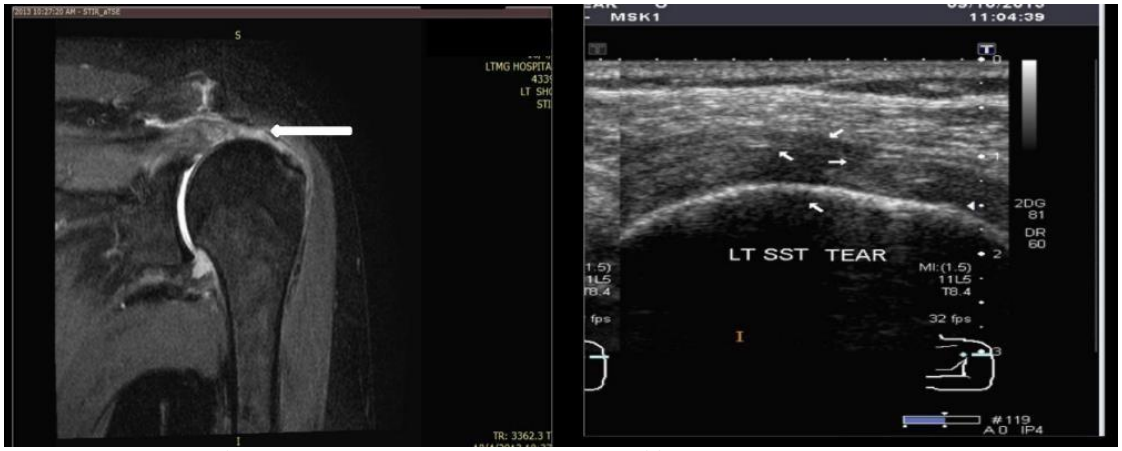

Figure 1. STIR Coronal sequence shows full thickness supraspinatus tear with retraction of fibers up to the AC joint along with corresponding USG image shows USG longitudinal view supraspinatus full thickness tear with retraction of fibers. Retracted fiber end is marked with arrow

Figure 2. PD SPAIR Coronal sequence shows bursal surface partial tear near the insertion site of the supraspinatus tendon with corresponding USG images.

Dr. Mohamed Rafi Kathar Hussain, "Can USG Replace the MRI- in Rotator cuff? A Prospective Study," *International Research Journal of Pharmacy and Medical Sciences (IRJPMS)*, Volume 4, Issue 2, pp. 20-24, 2021.

REFERENCES

[1] Wiener SN, Seitz WH, Jr. Sonography of the shoulder in patients with tears of the rotator cuff: accuracy and value for selecting surgical options. AJR American journal of roentgenology. 1993;160(1):103-7; discussion 9-10.
[2] Cullen DM, Breidahl WH, Janes GC. Diagnostic accuracy of shoulder ultrasound performed by a single operator. Australasian radiology. 2007;51(3):226-9.
[3] Greenberg DL. Evaluation and treatment of shoulder pain. The Medical clinics of North America. 2014;98(3):487-504.
[4] Pavic R, Margetic P, Bensic M, Brnadic RL. Diagnostic value of US, MR and MR arthrography in shoulder instability. Injury. 2013;44 Suppl 3:S26-32.
[5] Tempelhof S, Rupp S, Seil R. Age-related prevalence of rotator cuff tears in asymptomatic shoulders. Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al]. 1999;8(4):296-9
[6] Iannotti JP. Full-Thickness Rotator Cuff Tears: Factors Affecting Surgical Outcome. The Journal of the American Academy of Orthopaedic Surgeons. 1994;2(2):87-95.-
[7] Uhthoff HK, Sano H. Pathology of failure of the rotator cuff tendon. The Orthopedic clinics of North America. 1997;28(1):31-41.
[8] Ozaki J, Fujimoto S, Nakagawa Y, Masuhara K, Tamai S. Tears of the rotator cuff of the shoulder associated with pathological changes in the acromion. A study in cadavera. The Journal of bone and joint surgery American volume. 1988;70(8):1224-30.
[9] Rothman RH, Parke WW. The vascular anatomy of the rotator cuff. Clinical orthopaedics and related research. 1965;41:176-86.
[10] Needell SD, Zlatkin MB, Sher JS, Murphy BJ, Uribe JW. MR imaging of the rotator cuff: peritendinous and bone abnormalities in an asymptomatic population. AJR American journal of roentgenology. 1996;166(4):863-7.
[11] Zhang C, Guo L, An N, Liu GH, Zhu YT, Fan LJ. [Application value of high- frequency ultrasound on the diagnosis of rotator cuff tears]. Zhongguo gu shang = China journal of orthopaedics and traumatology. 2013;26(9):784-6.
[12] Nabetani Y, Watanabe T, Terabayashi N, Hirose A, Nohisa Y, Shinoda K, et al. [Diagnostic ability of ultrasonography for the rotator cuff tear: comparison with ultrasonography and MRI findings]. Rinsho byori The Japanese journal of clinical pathology. 2014;62(1):31-7.
[13] Milgrom C, Schaffler M, Gilbert S, van Holsbeeck M. Rotator-cuff changes in asymptomatic adults. The effect of age, hand dominance and gender. The Journal of bone and joint surgery British volume. 1995;77(2):296-8.
[14] Ok JH, Kim YS, Kim JM, Yoo TW. Learning curve of office-based ultrasonography for rotator cuff tendons tears. Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA. 2013;21(7):1593-7
[15] Lenza M, Buchbinder R, Takwoingi Y, Johnston RV, Hanchard NC, Faloppa F. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. The Cochrane database of systematic reviews. 2013;9:CD009020.
[16] Sipola P, Niemitukia L, Kroger H, Hofling I, Vaatainen U. Detection and quantification of rotator cuff tears with ultrasonography and magnetic resonance imaging - a prospective study in 77 consecutive patients with a surgical reference. Ultrasound in medicine & biology. 2010;36(12):1981-9
[17] Rutten MJ, Spaargaren GJ, van Loon T, de Waal Malefijt MC, Kiemeney LA, Jager GJ. Detection of rotator cuff tears: the value of MRI following ultrasound. European radiology. 2010;20(2):450-7.
[18] Walch G, Boulahia A, Calderone S, Robinson AH. The 'dropping' and 'hornblower's' signs in evaluation of rotator-cuff tears. The Journal of bone and joint surgery British volume. 1998;80(4):624-8.

Dr. Mohamed Rafi Kathar Hussain, "Can USG Replace the MRI- in Rotator cuff? A Prospective Study," *International Research Journal of Pharmacy and Medical Sciences (IRJPMS)*, Volume 4, Issue 2, pp. 20-24, 2021.