



RESEARCH ARTICLE

RE-EVALUATION OF THE DIAGNOSTIC ACCURACY OF MRI IN DETECTION OF ROTATOR CUFF TEAR IN CORRELATION WITH SURGERY.

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Manuscript Info

Abstract

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Introduction:-

Rotator cuff tear (RCT) is one of the most common causes of shoulder pain. Almost thirty to seventy percent of a patient presenting to the clinics with complain of shoulder pain is most probably due to the rotator cuff tear. The accurate identification of types of tear, including its location and muscles involved is a detrimental factor in the selection of its appropriate management (operative or non-operative therapy), as well as it is also of utmost importance that an orthopedic surgeon acquires a good information regarding the status of the tear prior to the surgery. Usually surgical management is reserved for bursal side tear >3mm in depth, articular side Supraspinatus tear with >7mm exposed bone between the articular surface and intact tendon that has failed conservative therapy and any partial or full thickness tear that has failed the non-operative managements.

MRI is a noninvasive technique and due to its excellent soft tissue contrast and multiplanar acquisition which provide optimal assessment of muscles, tendons, hyaline and fibrous cartilage, joint capsule, fat, bursa and bone marrow has gained a popularity as a first choice of investigation for the detection of rotator cuff tear (partial and full-thickness rotator cuff tears). But the accuracy of MRI in detecting the types of tear especially the partial tear is controversial as its interpretation greatly depends on the experience of doctor and the strength of the MRI machines. Reinus et al suggested that MRI was not adequately sensitive or specific for the detection of partial thickness tear. Rutten et al also suggested high accuracy(94%) of MRI in the detection of full thickness tear but comparatively low accuracy(84%) in the detection of partial thickness tear and the overall accuracy of 81% in detection of RCT. In the same study the sensitivity/specificity of MRI in detection of FTT and PTT was shown to be 100%/91% and 67%/86% respectively. Meta analysis of 44 studies in which 2571 shoulder under MRI evaluation of PTT demonstrated a pool sensitivity and specificity of 80%and 95% respectively. But due to several limitations like selection bias, small groups, the strength of MRI less than 3.0 T and consideration of limited parameters have warranted further studies on this topic.

The objective of this study is to re-evaluate the diagnostic efficacy of MRI for the detection of PTT and FTT using surgical finding as the 'gold standard' by improving the limitations of previous studies.

Materials and methods:-

The study was performed under the supervision and guidance of the professor retrospectively and approved by the institutional review board of Zhong Da Hospital affiliated with South East University, Nanjing. The requirement for informed patient consent was waived by the board of Zhong Da Hospital as it was a retrospective study.

Materials:-

The Radiology and Surgical records of Zhong Da Hospital were searched for the term Rotator Cuff Tear between January 2012 to January 2017. All patients were preoperatively evaluated by means of complete orthopedic history, physical examination and MRI of the affected shoulder. All the patient had a pain over shoulder, which was exacerbated by the use of arm at or above the shoulder level. The initial inspection of all the data only included 110 patients who had both MRI of the affected shoulder joints and subsequent surgery. Among them 13 patients were excluded as they did not undergo either arthroscopic or open surgery. In addition to that 4 more patients were excluded because of a time interval between MRI and surgery exceeded 2 months. The final study group consisted of 93 shoulders from 93 cases (63 female and 30 male) with the mean age of 56.85 years and range of 19 to 83 years.

The inclusion criteria were: (1) Patients with shoulder discomfort or pain who underwent MRI (3.0T) at this institute with a normal contralateral shoulder. (2) Patients who underwent surgery (arthroscopic or open surgery) following the MRI of shoulder at this institute. (3) No previous history of a shoulder surgery. The indications to perform MRI was clinical suspicion of having a rotator cuff tear and to determine the cause responsible for restriction of normal shoulder movement or as a request for more diagnostic certainty in a patient who were previously suspected of rotator cuff injury in other centers.

The exclusion criteria were: (1) Patient who refused to consent for arthroscopic surgery or open surgery of the shoulder. (2) Patients who were absconded after the MRI examination. (3) Poor quality MRI image and inadequate data. (3) Time interval between MRI and surgery exceeded more than 2 months. (4) When both MRI and surgery results were negative.

Magnetic Resonance Imaging (MRI):-

MRI examination were performed with 3.0 Tesla(T) MR system (Siemens, Philips). All the patients underwent routine MRI. The routine MRI protocol for rotator cuff evaluation involves T1W, T2W fast echo sequence in axial, sagittal oblique and coronal oblique planes, as well as fat saturation proton density in three planes. A field view of 200 mm was used, the slice thickness was 3mm, the imaging matrix was 320mm×320mm and overall imaging time was 4 minutes.

MRI of all the cases were assessed for the presence of rotator cuff tear. A rotator cuff tear, full thickness or partial was diagnosed when a cuff defect was recognized, based primarily on the anatomic configuration and the signal intensity of the tendon on T2 weighted image. Secondary signs (i.e, fluid in Subacromial Subdeltoid bursa or retraction of musculotendinous junction etc) were looked for as helpful but not essential criteria for diagnosis of the rotator cuff tear.

1. Full thickness tear (FTT) is diagnosed when a focal or diffuse high signal intensity on T2 weighted image is seen extending from bursal to the joint surface of tendon or when tendinous portion of the cuff is not visualized.
2. Partial thickness (PTT) tear is diagnosed when high signal intensity is visualized on either bursal or articular surface of the tendon.

The MRI findings and surgical findings of all the cases were extracted directly from the original preoperative and operative reports respectively. MRI findings of all the cases were correlated to the surgical findings. The surgery either arthroscopy or open surgery was performed by an experienced orthopedic surgeon having a detail information about patient's MRI findings. During surgery, the presence or absence of a partial-thickness or full-thickness rotator cuff tears and all the other associated findings for all the cases were recorded in surgical reports.



Figure 1:-Coronal T2 weighted fat-suppression: MRI appearance of partial thickness tear (arrow) at the insertion of supraspinatus tendon .Also humeral head edema (curved arrow) and shoulder joint effusion can be seen.



Figure 2:-Coronal T2 weighted fat-suppression: MRI appearance of full thickness tear at the insertion of supraspinatus tendon. Also humeral head edema and shoulder joint effusion can be seen.

Statistical analysis:-

Microsoft excel was used to input the data and statistical analysis was performed using SPSS version 18.0. The Chi-square test was used to assess the significance of association between the variables and Kappa coefficient test was used to calculate the agreement between the MRI and surgical findings. A P-value less than 0.05 was considered statistically significant. Sensitivity, specificity, accuracy, the positive predictive value and the negative predictive value were calculated based on the tables.

Results:-

At surgery 88 patients were found to have RCT of which 59 were female(67%) and 29 were male(33%). Right-sided dominance was seen with 55 patients(62.5%) involving the right shoulder and 33(37.5%) involving the left shoulder. But no statistically significant association was seen between gender and tear, and side and tear.

On MRI, 9 patients had full thickness tear, 76 patients had partial thickness tear and 8 patients showed no tear. The surgery confirmed full thickness tear in 10 patients, partial thickness tear in 78 patients and no tear in 5 patients. MRI was able to correctly identify full thickness tear in 9 out of 10 patients with sensitivity, specificity, positive predictive value and negative predictive value of 90.0%, 100%, 100%, 98.9% and partial thickness tear in 70 out of 78 cases with sensitivity, specificity, positive predictive value and negative predictive value of 89.7%, 60%, 92.1%, 52.9% respectively. The accuracy for detection of FTT was 98.9% and PTT was 84.9% and the p value for both tears (FTT and PTT) was less than 0.05.

The overall kappa value was calculated to be 0.497 and kappa value for full thickness tear and partial thickness tear was found to be 0.94 and 0.472 respectively which were all statistically significant with p -value <0.05 . The overall kappa value and kappa value for partial thickness tear suggested a moderate agreement between MRI and surgery for the detection of RCT, where as kappa value for full thickness tear suggested an excellent agreement.

Supraspinatus(82.8%) muscle was most the commonly involved muscle followed by Infraspinatus(6.5%) and Subscapularis(5.4%). In addition to these findings, other findings encountered were Joint effusion in 91(97.8%) patients, Bicep tendon effusion in 44(47.3%) patients, Bicep tendon injury in 34(36.6%) patients of which 5(5.4%) had a Bicep tendon tear, the fluid in Subcoracoid bursa in 4(4.3%) and Subacromial bursa in 1(1.1%), Labrum injury in 13(14%) patients, Fracture in 11(11.8%) patients, Tendinitis and Calcification in 5(5%) patients and Bankart's lesion and Hill-Sach lesion in 1 patient each.

	Full Thickness Tear	Partial Thickness Tear	No Tear	Total
MRI	9	76	8	93
Arthroscopy	10	78	5	93

Table 1:- Distribution of patients with Full and Partial Tendon Tear in MRI and Arthroscopy.

Types of Tear	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Accuracy	P Value	K Vaue
Full Thickness Tear	90.0%	100%	100%	98.9%	98.9%	<0.05	0.94
Partial Thickness Tear	89.7%	60.0%	92.0%	52.9%	84.9%	<0.05	0.472

Table 2:- Correlation of MRI findings with Arthroscopy findings.

Discussion:-

The patients included in our study were all symptomatic with the complain of either pain or limitation of shoulder movement or both. Our study found that RCT was more common on right side, the reason being most of the people were right sided dominant. The majority of patient with RCT involved the people from the age group greater than 40 years and were female. G.Sharma et al in his study reported the risk factor for RCT to be male gender, advancing age and dominant side which was consistent with Yamamoto A et al. But in our study the female outnumbered the male by 2:1 ratio.

Our study contained more partial thickness tear (78) compare to full thickness tear(10). The accuracy, sensitivity and specificity for detection of FTT and PTT was calculated to be 98.9%, 90%, 100% and 84.9%, 89.7%, 60% respectively which was consistent with the studies reporting sensitivity, specificity to be between 80% to 100%(Rutten et al, Reinus et al, De Jesus JO et al , G. Sharma et al). Kappa value for full thickness tear and partial thickness tear was found to be 0.94 and 0.472 respectively which were statistically significant with p -value <0.05 . There was a moderate agreement for partial thickness tear between MRI and surgery for the detection of RCT, where as the agreement for full thickness tear excellent. G. Sharma et al in his study reported an excellent agreement for both partial and full tendon tear.

MRI diagnosis of the rotator cuff tear, full thickness or partial, was done when a cuff defect was recognized, based primarily on the anatomic configuration and the signal intensity of the tendon on T2 weighted image. Waldt et.al stated that the diagnosis of PTT was hindered by presence of other associated factors like tendinitis, tendinopathy, synovial changes and superficial fraying. Same was the case with our study where there occurred a limitation to clearly detect the obvious focal discontinuity or defect relying only on the presence of high signal intensity, which lead to the underestimation of true PTT. Some false negative cases in our study were diagnosed as a result of high signal intensity due to tendinitis and calcification. The introduction of high-field MRI scanner has shown an

improvement in the detection of the shoulder pathology but the challenge of differentiating small PTT from other compounding factors still persists.

MRI is not only effective in detecting the types of tear but also very helpful in detecting the size, shape and site of tear and muscles involved and the other associated findings. As mentioned in many literature, our study also found Supraspinatus muscle was most commonly involved followed by Infraspinatus and Subscapularis. J.Y.Kim et al described that MRI (including Goutallier classification, the tangent sign and Patte classification) was not very useful to predict the reparability of massive RCT. J.F.James Davidson et al reported the preoperative use of MRI to predict the pattern to tear and method of surgical repair of the tear. Similarly, preoperative information are vital since patients with partial thickness tears involving less than 50% of the tendon thickness may be given an initial trial of conservative management, while surgery will be opted in partial thickness tear involving more than 50% of tendon thickness. In addition to above mentioned findings MRI also provides an information about associated findings such as Joint effusion, Bicep tendon effusion and injury, the fluid in Subcoracoid bursa and Subacromial bursa, Labrum injury, Fracture, Bone marrow edema, Bankart's lesion and Hill-Sach lesion.

Our study has some limitations. Since the selection process was not random and excluded all the true negative cases, it was prone to selection bias. There may be an inter observer variance since all the MRI was reported by different Radiologists and all the surgeries were not performed by the same surgeons. Since all the operating orthopedic surgeons were all aware of the preoperative MRI diagnosis, it might have influenced the surgical diagnosis and leading to bias influencing the gold standard. Thus the reference standard, the so-called gold standard possesses an imperfect standard bias.

Conclusion:-

The result of our study was consistent with other studies which demonstrated a high accuracy, sensitivity and specificity for the MRI diagnosis of both partial and full thickness rotator cuff tears. It also showed a good correlation with arthroscopic findings for the detection of tear. Arthroscopy is the gold standard for the diagnosis of rotator cuff injuries but it may not be implicated in all the patients due to its high costs and associated risks. Moreover, the factors like expertise of doctor, strength of MRI, patient preference and cost effectiveness also influence the selection of investigation for diagnosis. MRI is a non-invasive technique which not only gives a detailed information about tear size and its extent, but also provides an additional information about tendon, muscle and labrum, all of which plays a crucial role in better management of tear and improving the prognosis.

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