CORRELATION OF MAGNETIC RESONANCE IMAGING FINDINGS WITH ARTHROSCOPY IN THE EVALUATION OF ROTATOR CUFF PATHOLOGY

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ABSTRACT

Objective: The purpose of this study was to compare the accuracy of magnetic resonance imaging in clinically diagnosed rotator cuff disease based upon the radiologist's interpretation with actual intra-operative arthroscopic findings being used as the reference standard in a Kenyan outpatient practice.
Design: This was a retrospective cohort study.
Setting: The study was carried out at Plaza Advanced Imaging Centre over a period of one year from December 2011 to November 2012.
Methods: Using the University of Nairobi and Kenyatta National Hospital Ethics Committee approved protocol medical records of thirty four randomly selected consecutive patients with shoulder pain were evaluated. The records of these patients were reviewed to determine the demographics, radiologists MRI interpretations, and the surgeon's operative findings.
Results: Thirty four (79%) patients out of the targeted sample size of 43 were successfully evaluated with an aim of establishing the accuracy and sensitivity of MRI in the diagnosis of rotator cuff pathology in relation to arthroscopic findings. Twenty one (62%) of the patients were male, while the female patients s were 13 (38%).
Conclusions: In the present study the sensitivity of MRI in diagnosing of rotator cuff pathology was low but the specificity was high. This means that MRI missed a number of lesions, but of those that were picked the specificity was high. Given the relatively low sensitivity findings of the study compared to previous studies done elsewhere there is need to have a trained dedicated musculoskeletal radiologist. However, there exists a significant correlation between the diagnoses made under MRI and arthroscopy.

Results from this study will serve as a useful guide to orthopaedic surgeons in planning the management pathway for patients with rotator cuff pathology and will also highlight areas in need of improving interpretation skills and imaging protocols for radiologists in the country.

INTRODUCTION

Shoulder pain is a common complaint by patients during general practitioners or orthopaedic visits, and it can be due to a variety of causes. The major cause of shoulder pain in patients older than 40 years is rotator cuff impingement and tears (1).

Various imaging modalities can be used to evaluate a painful shoulder and this includes unenhanced MRI, MR arthrography and ultrasound. Varied sensitivities and specificities have been reported for each of these techniques even though each technique has its inherent strengths and weaknesses (2).

MRI plays an important role as a triage tool in rotator cuff pathology due to its ability to non-invasively display high definition anatomy images with un-paralleled soft tissue contrast (3). However, it remains relatively expensive for the local population. Numerous studies have shown a good radiological-surgical correlation (4) enough to guide on the treatment pathway for the patient.

With the development of new arthroscopic techniques like double row repair (5) for treating shoulder pathology, MRI has played an increasingly important role as a non-invasive test for determining which patients may benefit from surgery and which ones will be managed conservatively.

Therapeutic arthroscopy is "the reference standard" for diagnosis of shoulder pathology. However, arthroscopy is an invasive intervention that requires hospitalization and anaesthesia, thus presenting all the potential complications of a surgical procedure such as brachial plexus paresthesiaes and nerve palsies, infection risks, anaesthesia-related complications or thromboembolic risks and huge financial costs to the patient.

MRI diagnosis can determine the treatment approaches for the surgeon. Rotator cuff disease can be treated through conservative or surgical approach. Symptoms severity, patient's functional needs, existence of other co-morbid factors complicating treatment, and costs affordability are factors determining the treatment

pathway (8). Surgical repair is only recommended in patients with complete rotator cuff tears, repeated dislocation of unstable joint and significant pain with dysfunction despite conservative treatment.

MATERIALS AND METHODS

Study design: This was a retrospective cohort study.
Sample size determination: The sample size was calculated using a formula based on the local prevalence of rotator cuff disease. Findings of a local study on the patterns of MRI findings in patients with shoulder pain by Onyambu and M'Arithi (7) done in Nairobi, found a 13% prevalence of rotator cuff disease. Multiple studies have assessed the prevalence of rotator cuff pathology. The general prevalence varies from 7% to 40%. According to a study by Tashjian *et al* (9), asymptomatic full thickness tears have been found in 13% of the population aged between 50 and 59 years, and in over 50% of people older than 80 years.

The contact point with the patients was the orthopaedic surgeon/ arthroscopist practice where subsequent follow-up of the recruited cases was done. Forty three consecutive patients with shoulder pain clinically suspected to be due to rotator cuff disease were identified and recruited. The pre-operative magnetic resonance imaging findings were evaluated.

The MRIs were obtained prior to our evaluation using a 1.5T Philips magnet and the images were directly interpreted by a general radiologist using a customized PACS system. The researcher independently reviewed the images together with a radiologist with musculo-skeletal bias directly from the films and/or using a computer based PACS system. The researcher and the radiologist with musculo-skeletal bias were blinded to the findings by the primary radiologist. This was important to eliminate observer bias and false negatives.

Indications for arthroscopy included complete tears, functional disability or persistent pain despite conservative management. The arthroscopy was done depending on patient financial affordability. On average this took about 3 – 6 months before it was done. Subsequent intra-operative arthroscopic findings were recorded by the surgeon. Arthroscopy was done by a single surgeon using a standardized arthroscopic procedure.

The findings of MRI and arthroscopy were then compared for each parameter. A data collection sheet was used to record radiological as well as intra-operative arthroscopic findings. Collected data was analyzed using Statistical Package for Social Sciences (SPSS) computer software and results presented in form of tables, charts and graphs. Diagnostic accuracy of the radiologists' MRI interpretations was evaluated by calculating the sensitivity, specificity, and positive and negative predictive values compared to the gold standard of direct examination during intra-operative arthroscopy.

Study area: The study was carried out at Plaza Advanced Imaging Centre using a 1.5 Tesla Philips MRI machine and at a private orthopaedic surgeon's clinic.
Study population: This consisted of patients seen by orthopaedic surgeon/ arthroscopist at his practice with clinical diagnosis of shoulder pain possibly due to rotator cuff disease, who underwent MRI examination at Plaza Advanced Imaging Centre and will have had a subsequent diagnostic or therapeutic arthroscopy done.
Sampling procedure: The researcher had to liaise with the orthopaedic surgeon/ arthroscopist for patient identification. A questionnaire was used to identify each recruited patient for demographic data, and also record clinical, radiologic and surgical data. Systematic sampling was used.

All the shoulder MRI scans from Plaza Advanced Imaging Centre and the subsequent orthopaedic surgeons' arthroscopy reports done for the same patients with shoulder pain suggesting rotator cuff pathology were included in the study. A total of 34 patients out of the 43 initially determined from the sample size computation were recruited.
Inclusion criteria: Patients were included in this study if;

(i) There was a clinical diagnosis of rotator cuff impingement
(ii) An MRI was done prior to an arthroscopic intervention
(iii) An arthroscopic procedure was performed.

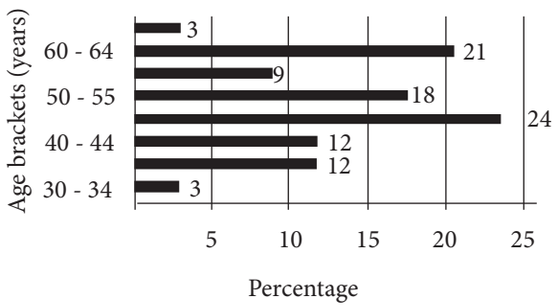
The records of these patients were reviewed to determine the demographics, radiologists MRI interpretations, and the surgeon's operative findings. All the arthroscopic procedures were performed by a single surgeon who documented specific intra-operative findings.

RESULTS

Thirty four (79%) patients out of the targeted sample size of 43 were successfully recruited into the study with an aim of establishing the accuracy and sensitivity of MRI in the diagnosis of rotator cuff pathology in relation to arthroscopic findings. The MRI diagnosis and arthroscopic findings were compared for evaluation of MRI sensitivity and correlation between MRI diagnoses to arthroscopy findings. MRI diagnosis made by the primary radiologist at the outpatient centre were blindly compared with the diagnosis made by the researcher together with a radiologist with a musculo-skeletal bias independent of the initial diagnosis; the initial primary working diagnosis was then correlated with the arthroscopic diagnosis.
Demographic findings: Twenty one (62%) of the patients were male, while the female patients were 13 (38%).

Majority of patients were aged between 45 and 49 (24%) years and between 60 to 64 years (21%). Those aged 35 to 39 years and between 40 to 44 years were equal in number with each constituting 12% of the total (Figure 1).

Figure 1
Age distribution



A cross tabulation of the age brackets and respondents' gender revealed that generally more males were found within the various age brackets except for age bracket 50-59 whereby there were more females than males.

The findings on respondents' occupations are as shown in Table 2. Majority were professionals or office managers. Others were farmers, drivers, and businesspersons as shown in Table 1. However, sporting activities were noted to be a common recreation among most of the professionals.

Generally, the number of patients diagnosed with rotator cuff tendinitis with MRI tends to reduce significantly when the definitive diagnosis is made during arthroscopy (See 'difference' in Table 2). This could be explained partly by MRI diagnosis of magic angle artifact as tendinitis or arthroscopy diagnosis of partial rotator cuff tears as tendinosis. Alternatively this may be because arthroscopy cannot diagnose intra-substance partial tendon tears.

Table 1
Occupations

	Occupation	No.
1	Office manager	2
2	Golfer	4
3	Farmer	2
4	Driver	2
5	Businesspersons	2
6	Banker	2
7	Teacher	2
8	Retired/ golfer	2
9	Lawyer	2
10	Housewife	2
11	Tennis player	1
12	Shop keeper	1
13	Secretary	1
14	Rugby player	1
15	Private security guard	1
16	Pilot	1
17	Office technician	1
18	Market researcher	1
19	Hotelier-housekeeper	1
20	Engineer	1
21	Clerical work	1
22	Athlete (Runner)	1
	Total	34

MRI findings of various aetiologies of rotator cuff pathology: This section presents the findings of Magnetic Resonance Imaging (MRI) on the various aetiologies of rotator cuff pathology. From the findings as shown in Table 2, it is evident that a significant number of patients are diagnosed with osteophytosis (AC joint osteoarthritis), partial thickness rotator cuff tear and subacromial bursitis. However, after arthroscopy, significant majority of the respondents are diagnosed with osteophytosis, partial thickness rotator cuff tear and biceps tendinitis (rather than subacromial bursitis). The least common diagnosis is acromion Type 3 and synovitis in both MRI radiological and arthroscopic diagnoses.

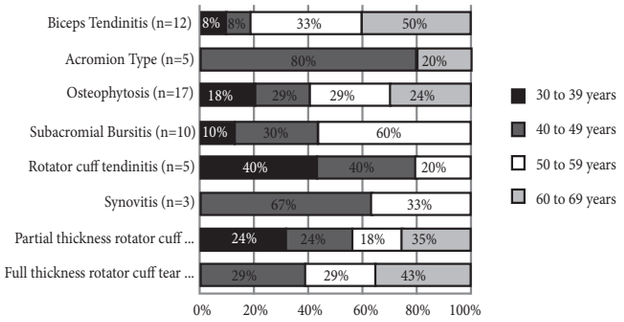
Table 2
MRI diagnosis

		Frequency		
		MRI Diagnosis (n)	Arthroscopic findings (n)	Diff
1	Osteophytosis	23	17	-6
2	Partial thickness rotator cuff tear	16	17	1
3	Subacromial bursitis	14	10	-4
4	Rotator cuff tendinitis	11	5	-6
5	Full thickness rotator cuff tear	9	7	-2
6	Biceps tendinitis	8	12	4
7	Acromion type 3	5	5	0
8	Synovitis	0	3	3

It should also be observed that rotator cuff pathology is generally common among those aged 40 to 59 years (See red and green bars in Figure 2). Majority of those aged 60 to 69 years suffer from biceps tendinitis (50%) and full thickness rotator cuff tear (43%), likely degenerative; while those aged 30 to 39 years are most likely to suffer from rotator cuff tendinitis and partial rotator cuff tears (40%), likely traumatic.

Figure 2

Arthroscopic findings across various age brackets



Relationship between arthroscopy findings and (1) MRI diagnosis, and (2) Gender: There is some degree of trend relating to radiological diagnosis by MRI and the definitive diagnosis made after arthroscopy. However, to determine whether this relationship is significant enough to be relied upon, Pearson Correlation has been used to test significance at 95% level. As shown in the findings in Table 3, the most significant relationship is between MRI radiological diagnosis and arthroscopic findings for the following variables;

- Full thickness Rotator Cuff Tear (0.519^{**} correlation)
- Partial thickness Rotator Cuff Tear (0.825^{**} correlation)
- Osteophytosis (0.440^{**} correlation)
- Subacromial Bursitis (0.378^{*} correlation)
- Acromion Type 3 (0.531^{**} correlation)
- Biceps Tendinitis (0.461^{**} correlation)

It should be noted that all the correlations are positive.

Table 3

Correlation between MRI diagnoses to arthroscopy findings

Full thickness rotator cuff tear	Pearson Correlation	0.519^{**}
	Sig. (2-tailed)	0.002
	N	34
Partial thickness rotator cuff tear	Pearson Correlation	0.825^{**}
	Sig. (2-tailed)	0.000
	N	34
Synovitis	Pearson Correlation	.[a]
	Sig. (2-tailed)	.
	N	34
Rotator cuff tendinitis	Pearson Correlation	0.245
	Sig. (2-tailed)	0.162
	N	34
Subacromial bursitis	Pearson Correlation	0.378^{*}
	Sig. (2-tailed)	0.027
	N	34
Osteophytosis	Pearson Correlation	0.440^{**}
	Sig. (2-tailed)	0.009
	N	34
Acromion Type 3	Pearson Correlation	0.531^{**}
	Sig. (2-tailed)	0.001
	N	34
Biceps tendinitis	Pearson Correlation	0.461^{**}
	Sig. (2-tailed)	0.006
	N	34

NB: 1 Correlation with significance is flagged (*)

Likewise, correlation between gender and arthroscopy findings was carried out and the results are as shown in Table 4. From the correlation figures, it is evident that there was no rotator cuff pathology that is specific to a particular gender since no correlation was significant enough to prove that.

Table 4

Correlation between gender and arthroscopy findings

		Full thickness Rotator Cuff Tear	Partial thickness Rotator Cuff Tear	Synovitis	Rotator Cuff Tendinitis	Subacromial Bursitis	Osteophytosis	Acromion Type 3	Biceps Tendinitis
Sex	Pearson Correlation	0.251	-0.182	-0.182	0.156	-0.289	0.061	0.156	-0.052
	Sig. (2-tailed)	0.152	0.304	0.303	0.379	0.097	0.734	0.379	0.770
	N	34	34	34	34	34	34	34	34

NB: 2 Correlations with significance are flagged (*)

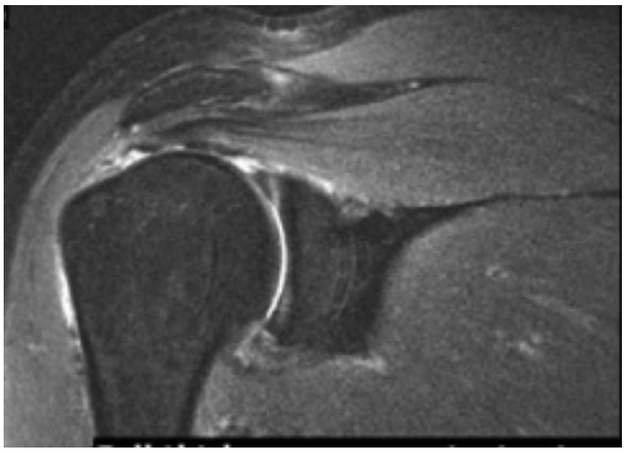
The Sensitivity, Specificity, PPV and NPV of MRI were also tested based on the number of positive and negative results under MRI and arthroscopy. It should be noted once again that these 4 were tested based on number of positives and negatives and not based on the number of subjects (i.e. sample size). The following were the findings:
True Positives (TP) = 54, False Negatives (FN) = 63, False Positives (FP) = 22, True Negatives (TN) = 64. Sensitivity = 46%, Specificity = 88%, Positive Predictive Value (PPV) = 71% and Negative Predictive Value (NPV) = 72%

Illustrations of examples of cases collected during the study are outlined below;

Figure 3
Supraspinatis bursal side partial tear

A 54 year old female with history of left shoulder pain. MRI diagnosis: Partial thickness RCT/ subacromial bursitis/ Biceps tendinitis/ AC joint OA; Arthroscopic diagnosis: Partial thickness RCT/ Subacromial bursitis/ Biceps tendon tear

Figure 4
Full thickness supraspinatas tear



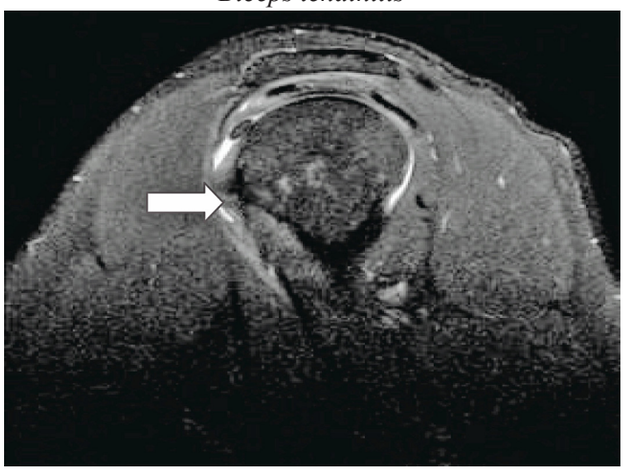
A 61 year old male with complaint of left shoulder pain. MRI diagnosis: Full thickness RCT/ Subacromial bursitis/ AC joint OA; Arthroscopic diagnosis: Full thickness RCT/ Osteophytosis.

Figure 5
Rotator cuff tendinitis

A 37 year male with chronic right shoulder pains. MRI diagnosis: Partial thickness RCT/ RCT tendinitis/ Osteophytosis; Arthroscopic diagnosis: Partial thickness RCT

Figure 6

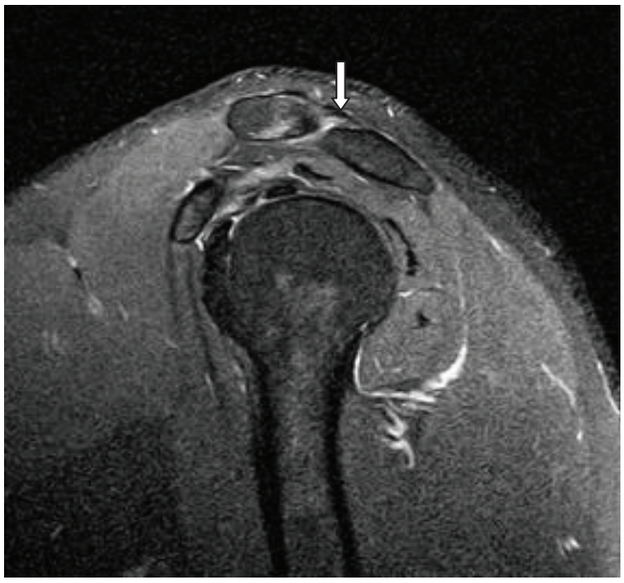
Biceps tendinitis



A 60 year old female with left shoulder pains. MRI diagnosis: Full thickness RCT/ AC joint OA / Bursitis Arthroscopic diagnosis: Biceps tendinitis/ partial thickness RCT/ Acromion type III.

Figure 7

AC joint osteoarthritis



A 68 year old female with chronic right shoulder pains. MRI diagnosis: Partial thickness RCT/ Subacromial bursitis/ AC joint OA; Arthroscopic diagnosis: AC joint OA/ Partial thickness RCT.

DISCUSSION

Gender and age are some of the pre-disposing factors of rotator cuff disease. Among the thirty four patients successfully evaluated, 24% were aged between 45 and 49 years while 21% were between 60 to 64 years. These two groups comprised the majority. This shows that rotator cuff disease is most common in middle aged and elderly populations.

Some of the occupations that were most frequently encountered included office managers, golfers, farmers, drivers, business persons, bankers, teachers, lawyers and housewives. This confirms what has been seen in research done elsewhere that has shown that people who undertake occupations that involve manual and overhead work are at risk of developing symptomatic rotator cuff disease. This would also seem to be the case in people who undertake shoulder intensive recreational activities such as swimming, golf and weight training even though they may be office workers.

On MRI findings of various aetiologies of rotator cuff pathology, it was established that more patients were diagnosed with osteophytosis (10,23), subacromial bursitis (11,18), rotator cuff tendinitis (12,16), and full thickness rotator cuff tear (13,15) under MRI than under arthroscopy (2,12,14,15). On the other hand fewer patients were diagnosed with partial thickness rotator cuff tear (16,20), biceps tendinitis (10,17) and synovitis under MRI than under arthroscopy (2,6,15).

Some degree of trend relating to radiological diagnosis by MRI and the definitive diagnosis made after arthroscopy were realized. However, to determine whether this relationship is significant enough to be relied upon, Pearson correlation was used to test significance at 95% level. The most significant relationship was seen between MRI radiological diagnosis and arthroscopic findings .

It should be noted that all the correlations are positive. These findings indicate that for the listed six diseases, MRI makes similar diagnoses as those made under arthroscopy. However MRI is less likely to make right diagnoses for the rest of the diseases which included synovitis and rotator cuff tendinitis. These findings are comparable to those by Zlakin *et al* (4) who compared shoulder MRI imaging and surgical findings in 160 patients and concluded that there was a good correlation between MRI imaging and arthroscopic findings. No significant correlation was established between rotator cuff pathology and either gender (male or female).

The Sensitivity, Specificity, PPV and NPV of MRI were also tested based on the number of positive and negative results under MRI and arthroscopy. The study findings demonstrate a low sensitivity of MRI in diagnosing rotator cuff pathology of 46%. This sensitivity finding is less comparable to previous studies done elsewhere that reveals significantly higher sensitivity index. However, the specificity is consistent with the other previous studies. This could partly be due to the long interval between the MRI diagnosis and the timing of arthroscopy which is dictated by patient financial constraints in this population. Loeffler *et al* (11) from numerous studies demonstrated the efficacy of MRI with sensitivities and specificities ranging from 85% to 100% for both partial- and full-thickness tears. These studies found the positive predictive value to have been 100% for the detection of rotator cuff pathology. It should be noted that the current study

established a PPV of 71% which has an insignificant difference to the one by Loeffler *et al* (11) .

A study by Motamedi *et al* (18) found sensitivity for MRI of 91% after rotator cuff repair by correlating radiologists MRI interpretation with surgical findings. Elsewhere, Iannotti *et al* (13) showed that MRI was 100% sensitive and 95% specific in the diagnosis of complete rotator cuff tears, and in differentiating tendinitis from degenerative changes, it was 82% sensitive and 85% specific. The same study showed that MRI had 93% sensitivity and 87% specificity in demonstrating a normal from a pathologic tendon. It should be noted that the specificity that was obtained for the study is quite consistent and comparable to all the other previous studies. However, the sensitivity obtained for this study had a significant difference to the previous study findings. These variations in sensitivity compared with other studies done elsewhere could be explained by possibly lack of specialized skills in shoulder MRI interpretation due to lack of dedicated musculoskeletal radiologists. Other reasons could be lack of dedication of adequate time to proper evaluation of the details needed in shoulder MRI interpretation because the radiologist has a lot of work load in general radiology, or the remote possibility of the use of low Tesla (1.5T) magnet at the study center compared to use of higher Tesla MRI (3.0T) commonly used for shoulder joint imaging used in most of the dedicated musculoskeletal imaging centers. MRI over-diagnosis of rotator cuff tendinitis could be because of magic angle phenomenon or even inability of arthroscopy to detect tears within the tendon substance or tendon articular surface. The levels of sensitivity achieved from this study however compare favorably with the levels of 55% reported with community radiologists' interpretation according to the study by Wnorowski *et al* (15).

CONCLUSIONS

(i) Demographic findings reveal that more males than females are affected, and degenerative rotator cuff pathology tend to occur in the older patients whereas traumatic pathology occurs in the younger population. This compares favorably with findings from other studies done elsewhere.

(ii) Occupation could not be directly correlated as a pre-disposing factor for rotator cuff pathology. This could be due to the small sample size.

(iii) The study findings reveal low sensitivity levels of MRI diagnosis in rotator cuff pathology compared with arthroscopy findings in the Kenyan outpatient set up. The study sensitivity findings do not compare favorably with sensitivity levels found with the other multiple studies done elsewhere. Specificity is however comparable. This could partly be due to delay from MRI diagnosis to arthroscopy occasioned by financial constraints. But it also highlights the need for sub specialization for the radiologists as happens in other regions so as to further enhance the diagnostic yield.

RECOMMENDATIONS

(i) There is need for investment in training of radiologists in musculoskeletal imaging to improve accuracy of diagnosis of shoulder joint pathologies in this country.

(ii) We would recommend use contrast studies (MRI arthrography), investment in higher magnetic field (3T) MRI's and dedicated shoulder coils to improve the accuracy MRI in diagnosing rotator cuff pathology.

(iii) Subsequent studies using a larger sample size and dedicated musculoskeletal radiologists' interpretation would be recommended to better evaluate accuracy of using MRI as a reliable tool in the diagnosis of rotator cuff pathology.

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