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Correlation between clinical, MRI and arthroscopic findings in various shoulder joint disorders

Ayush Gupta[1], Atul Agrawal[1]*, Sanad Kumar[1], Shailendra Raghuvanshi[2], Faiz Akbar Siddiqui[1]

[1]Department of Orthopaedics, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Jolly Grant, Dehradun, Uttarakhand, India
[2]Department of Radio-diagnosis, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Jolly Grant, Dehradun, Uttarakhand, India

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***Correspondence:**
Dr. Atul Agrawal,
E-mail: atulscastle@gmail.com

ABSTRACT

Background: Shoulder joint is the most freely moveable, but a relatively unstable joint in the body. The most commonly used currently prevalent diagnostic tools for shoulder joint disorders are clinical examination, Magnetic Resonant Imaging (MRI) and the gold standard arthroscopy. All have their inherent advantages and disadvantages and none is an all-inclusive tool. Furthermore, the current literature lacks studies comparing all the three diagnostic tools together or has just included one or two of the wide array of shoulder joint disorders. Therefore, this study was undertaken to identify correlation between all three diagnostic methods in arriving at a diagnosis in various shoulder disorders taking arthroscopy as a gold standard.
Methods: The study was a prospective descriptive study carried out at a tertiary care hospital over period of 2 years. 33 symptomatic shoulder patients underwent standardized history, physical examination and MRI prior to diagnostic/therapeutic arthroscopy procedure. Shoulder arthroscopy considered as the gold standard, was used as a benchmark for comparing and confirming the results of clinical and radiological findings using the standard statistical data analysis.
Results: Amongst clinical and radiological (MRI) findings; clinical examination was found to be superior to MRI in diagnosing adhesive capsulitis and bicipital tendinitis; MRI was found to be superior to clinical examination for diagnosing rotator cuff tears and Gleno-Humeral (GH) arthritis; both were equivocal in diagnosing Sub-Acromial Impingement Syndrome (SAIS), GH instability and Superior Labrum Anterior Posterior (SLAP) lesions.
Conclusions: No modality in isolation is accurate and a combination of various available diagnostic tools gives the best precision in diagnosing shoulder joint disorders.

Keywords: Arthroscopy, Clinical examination, MRI, Shoulder joint

INTRODUCTION

Shoulder joint is considered to be the most freely moveable joint in the human body; but, this wide range of motion comes at the cost of instability.[1]

This instability is compensated by the presence of tendons, ligaments, glenoid labrum and rotator cuff muscles. A relatively large humeral head articulating against a shallow glenoid cavity, the presence of a loose joint capsule and the absence of any protection inferiorly contribute to this mobile, but an unstable joint. The constant tussle between stability and mobility puts the shoulder joint at risk of various injuries.

Daily wear and tear, age related degenerative diseases and aggressive use of shoulder in sports leads to a gamut of shoulder injuries and disorders. The initial evaluation of a

shoulder disorder usually starts with taking a detailed history and performing a comprehensive clinical examination, which involves various manipulative and provocative tests.

But many patients present with joint pain and limited mobility, making a thorough physical examination challenging. In such cases, MRI is commonly utilized as the imaging method of choice for the assessment of various shoulder conditions. It has replaced other imaging modalities by virtue of being able to detect soft tissue damage early and being a non-invasive procedure.[2]

The drawbacks of MRI include its in-applicability for patients with cardiac pacemakers, ferromagnetic foreign objects and orthopedic implants that are not compatible. Additionally, the cost of the procedure can be high and some patients may experience claustrophobia in high-field strength MRI machines.[2]

Arthroscopy is considered the current gold standard in confirming the diagnosis of shoulder joint disorders. In spite of being the gold standard investigation in identifying a shoulder disorder, arthroscopy does have some disadvantages like being an invasive procedure.

The laxity of the joint is altered by the arthroscopic examination itself thus making it difficult to determine the flaccidity of the capsule.[3] All three currently prevalent diagnostic tools for shoulder joint disorders have their inherent advantages and disadvantages and none is an all-inclusive tool.

A review of the current literature shows that there are many studies which focused on comparing only one or two of the three widely used diagnostic methods (physical examination, MRI and arthroscopy). Furthermore, they included only one or two shoulder joint disorders in their study.

Therefore, this study was undertaken to identify correlation of all three diagnostic methods in arriving at a diagnosis in various shoulder joint disorders. The aim was to obtain diagnostic accuracy of the three diagnostic tools in identifying shoulder joint dysfunction taking arthroscopy as a gold standard.

METHODS

The study was a prospective cross-sectional analytical study carried out in the department of Orthopaedics at a tertiary care hospital, Himalayan Institute of Medical Sciences, Dehradun over a period of two years from January 2020 to January 2022.

33 patients presenting in OPD and emergency with complaints of shoulder pain, loss of function or weakness, decreased range of motion, instability or stiffness in shoulder joint were included in this study. An ethical committee clearance and a written informed consent from the patient were obtained for their participation in the study.

The inclusion criteria used for selection of subjects in this study was as follows: Age more than 12 years patients presenting with symptoms of shoulder pain, loss of function or weakness, decreased range of motion, instability or stiffness in shoulder joint; No contra-indications for MRI and/or arthroscopy.

Subjects with any neuro-muscular disorders involving the upper limbs, multiple joint involvements (Hyper laxity disorder) and having neck and elbow disorders were excluded from this study. All patients underwent a standardized history and physical examination. The history included details about the chief complaints, average duration of symptoms, mode of injury, severity of progression of symptoms, past history of any chronic disease and personal history.

The physical examination included standardized components of shoulder joint examination. Careful inspection followed by palpation of the shoulder joint complex. The shoulder joint was put through its active and passive range of motions. Muscle power of the muscles surrounding the shoulder joint was tested. Finally, a battery of OST to diagnose various shoulder disorders were performed specific for each shoulder disorder as depicted in Table 1.

Patients were evaluated with routine blood and radiological investigations for the concerned shoulder joint. The results of detailed clinical history, clinical examination and MRI findings were recorded in a case recording form.

Intra-operative arthroscopic findings were recorded in the 15-point SCOI arthroscopic exam proforma. Shoulder arthroscopy considered as the gold standard in diagnosing various shoulder disorders, was used as a benchmark for comparing and confirming the results of clinical and radiological findings using the standard statistical analysis.

RESULTS

33 patients were included in the study, ranging from 15-70 years. 75% of the patient population was above 35 years, 46-55 years being the most common age group involved with a slight male predominance. Fall on floor was the most common mode of injury.

Pain followed by stiffness and instability respectively, were the most common symptoms encountered. The results of diagnostic accuracy of clinical examination and MRI findings (taking arthroscopy as gold standard) is depicted in Table 2. In many patients, more than one condition, often co-existed, thus making an isolated clear-cut primary diagnosis tough.

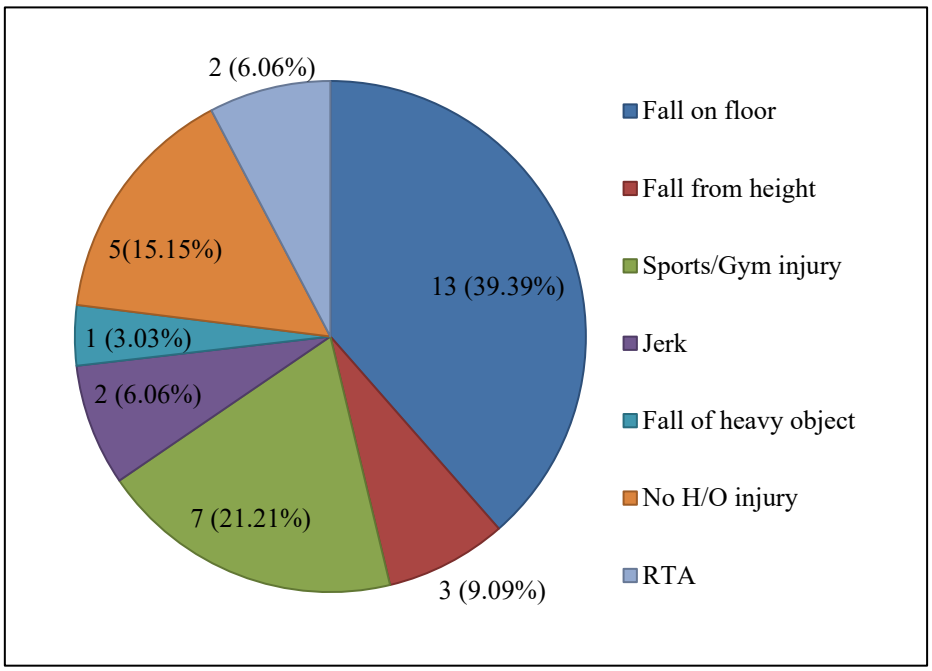

Figure 1: Mode of injury.

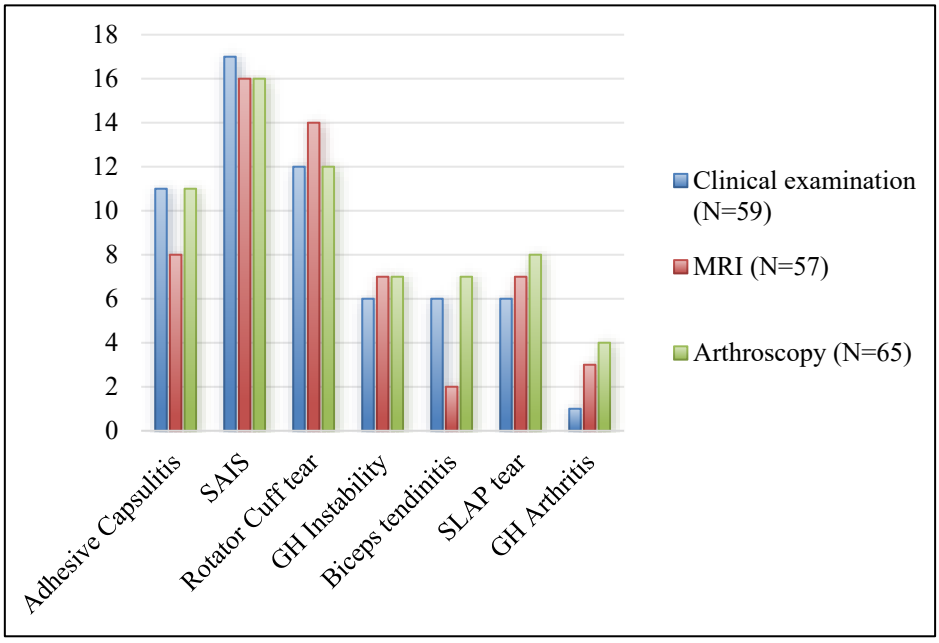

Figure 2: Shoulder joint disorders.

*N is more than 33 as more than one condition, often co-existed, in a single patient.

Table 1: Demographic data of patients.

Characteristics	No. of patients	%
Age wise distribution (in years)		
15-25	4	12.12
26-35	5	15.15
36-45	9	27.27
46-55	10	30.30
56-65	3	9.09
>65	2	6.06

Continued.

Characteristics	No. of patients	%
Gender distribution		
Male	17	51.51
Female	16	48.48
Side of affected shoulder		
Left	12	36.36
Right	21	63.63
Dominance of affected shoulder		
Dominant	23	69.69
Non-dominant	10	30.30
Occupation of patients		
Housewife	12	36.36
Desk-job	14	42.42
Student	4	12.12
Labourer	3	9.09

Table 2: Diagnostic accuracy of clinical examination and MRI findings (taking arthroscopy as gold standard).

Shoulder disorders	Study	*SN	*SP	*PPV	*NPV	*ACC
Rotator cuff tear	Clinical vs arthroscopy	81.80%	86.40%	75.00%	90.50%	84.33%
	MRI vs arthroscopy	92.31%	90.24%	85.71%	94.74%	91.11%
Sub acromial impingement	Clinical vs arthroscopy	92.75%	88.24%	88.28%	93.80%	90.17%
	MRI vs arthroscopy	93.85%	94.22%	93.68%	94.62%	94.04%
GH instability	Clinical vs arthroscopy	86.20%	96.44%	86.26%	96.64%	94.42%
	MRI vs arthroscopy	87.50%	100%	100%	96.30%	97.10%
Biceps tendinitis	Clinical vs arthroscopy	85.71%	100%	100%	97.78%	98.04%
	MRI vs arthroscopy	28.57%	97.73%	66.7%	89.58%	88.24%
SLAP tear	Clinical vs arthroscopy	78.46%	95.86%	83.46%	93.28%	91.28%
	MRI vs arthroscopy	85.70%	96.20%	85.70%	96.24%	93.90%
Adhesive capsulitis	Clinical vs arthroscopy	90.91%	95.45%	90.91%	95.45%	95.00%
	MRI vs arthroscopy	63.64%	95.40%	87.50%	84.00%	84.62%
GH arthritis	Clinical vs arthroscopy	25%	75%	-	92.16%	92.16%
	MRI vs arthroscopy	75%	100.0%	100.0%	94.0%	94.12%

*PPV-Positive predictive value, *NPV-Negative predictive value, *SN-Sensitivity, *SP-Specificity, *ACC-Accuracy, *SAIS-Sub acromial impingement syndrome *GH-Gleno humeral *SLAP-Superior labrum anterior posterior.

DISCUSSION

Rotator cuff tear

The literature has reported varied results for the validity of special tests used in diagnosing rotator cuff tears.[4,5] Somerville et al in 2014 noted that there were no highly sensitive tests for diagnosing rotator cuff tears.[5]

Empty can test had a poor specificity as it was also found to be positive in many cases diagnosed with SAIS in this study.

In a prospective study, Bhatnagar et al compared the diagnostic accuracy and reliability of a cluster of special clinical tests for SAIS and demonstrated 50% sensitivity and 87% specificity for the empty can test.[13]

Table 3: Comparison of diagnostic accuracy of clinical tests in diagnosing various Shoulder disorders with Literature (taking arthroscopy as a gold standard).

Rotator cuff tear	Empty can/Jobes test	Hornblower's test	Drop arm test	Belly press test
Kiebler et al[4]	SN 88.00%	SN 93.00%	SN 53.85%	SN 25.00%
	SP 77.00%	SP 72.00%	SP 73.68%	SP 97.90%
Somerville et al[5]	SN 82.00%	SN 85.00%	SN 63.45%	SN 35.00%
	SP 79.00%	SP 67.00%	SP 69.68%	SP 90.[illegible]
Present study	SN 95.42%	SN 22.22%	SN 55.56%	SN 1[illegible]
	SP 19.02%	SP 97.62%	SP 85.71%	SP 100%
SAIS	**Neer's test**	**Hawkins-Kennedy test**		**Painful arc test**
MacDonald et al[6]	SN 75.00%			
	SP 47.00 %			
Hegedus et al[7]	SN 72.00%	SN 80.00%		SN 62.00%
	SP 60.00%	SP 67.00%		SP 76.00%
Lesniak et al[8]				SN 57.00%
				SP 80.00%
Present study	SN 92.31%	SN 72.54%		SN 53.85%
	SP 39.47%	SP 57.89%		SP 73.68%
GH instability	**Apprehension test**			**Relocation test**
Joshi et al[9]	SN 85.71%			SN 87.34%
	SP 100.00%			SP 98.78%
Farber et al[10]	SN 98.30%			SN 96.70%
	SP 96.00%			SP 92.00%
Present study	SN 93.68%			SN 94.80%
	SP 97.78%			SP 97.78%
Biceps tendinitis	**Speed's test**			**Yergason's test**
Kibler et al[4]	SN 54.71%			SN 41.00%
	SP 81.00%			SP 79.78%
Present study	SN 85.71%			SN77.27%
	SP 97.78%			SP 97.78%
SLAP tear	**O'Brien's test**			**Crank test**
Templin et al[11]	SN 67.00%			SN 57.00%
	SP 41.00%			SP 69.00%
Hegedus et al[7]	SN 67.00%			SN 34.00%
	SP 37.00%			SP 75.00%
Present study	SN 75.00%			SN 64.00%
	SP 85.71%			SP 89.80%

Continued.

*SN-Sensitivity, *SP-Specificity, *SAIS-Sub acromial impingement syndrome, *SLAP-Superior labrum, Anterior-posterior tear.

Table 4: Comparison of diagnostic accuracy of MRI in diagnosing various shoulder disorders with literature (taking arthroscopy as a gold standard).

Rotator cuff tear	SN	SP	PPV	NPV	ACC
Momenzadeh et al[12]	0.91	0.92	0.93	0.89	-
Bhatnagar et al.[13]	0.91	1	1	0.63	0.9
Ringshawl et al[14]	0.92	0.81	0.88	0.87	0.88
Present study	0.92	0.9	0.85	0.94	0.9
SAIS					
Ringshawl et al[14]	0.73	0.81	0.86	0.65	0.76
Malhi et al[15]	0.84	0.76	0.83	0.78	-
Sabharwal et al[16]	1	0.98	0.75	1	0.98
Present study	0.93	0.94	0.93	0.94	0.94

Continued.

Rotator cuff tear	SN	SP	PPV	NPV	ACC
GH instability					
Momenzadeh et al[12]	0.5	0.84	0.77	0.6	-
Bhatnagar et al[13]	0.8	1	1	0.89	0.9
Ringshawl et al[14]	0.88	0.94	0.8	0.96	0.92
Present study	0.87	1	1	0.96	0.97
Biceps tendinitis					
Carr et al[17]	0.27	0.84	0.81	0.32	-
Present study	0.28	0.97	0.66	0.89	0.88
SLAP tear					
Momenzadeh et al[12]	0.74	0.8	0.78	0.76	-
Bhatnagar et al[13]	0.15	0.96	0.67	0.69	0.7
Ringshawl et al[14]	0.28	0.94	0.5	0.86	0.83
Iqbal et al[18]	0.95	0.85	0.84	0.96	-
Present study	0.86	0.96	0.86	0.96	0.94

*PPV-Positive predictive value, *NPV-Negative predictive value *SN-Sensitivity, *SP-Specificity, *ACC-Accuracy *SAIS-Sub acromial impingement syndrome *GH-Gleno humeral, *SLAP-Superior labrum anterior posterior.

Clinical diagnosis

The present study would also like to recommend to include Empty can/Jobs test in the cluster of examination tests for diagnosing SAIS alongside rotator cuff tears. Drop arm test was found to be effective in identifying a full-thickness tear involving both the supraspinatus and infraspinatus, hence the reason for a low sensitivity, as most of the rotator cuff tear cases encountered were isolated partial or full thickness tear of supraspinatus. In the present study, both Hornblower's and belly press tests showed a poor sensitivity for diagnosing rotator cuff tear due to supraspinatus muscle being involved in majority of cases. After assessing the results, it is recommended that on basis of clinical examination, no test in isolation is sufficient to diagnose a patient with rotator cuff damage. A combination of multiple tests is more effective in improving the accuracy of the diagnosis. Secondly, one should quantify the degree/stage of tear and also specify which rotator cuff muscle was torn while diagnosing a rotator cuff tear as these special tests have different validities for different stages/degrees of tear. For e.g., Hornblower's test and Belly press test would show an excellent sensitivity if infraspinatus/teres minor and subscapularis muscles were involved in the rotator cuff tear respectively.

Radiological diagnosis

Similar to findings in the existing literature, the present study also reflects a high level of sensitivity and specificity of MRI in the diagnosing rotator cuff tears.[12-14]

Clinical vs radiological

Clinical examination was not found to be specific enough in diagnosing rotator cuff tears. The diagnostic reliability and accuracy of MRI in identifying rotator cuff lesions was found to be more as compared to clinical examination. Moreover, MRI was better able to label and demarcate the degree/stage of the rotator cuff tear, guiding the surgeon for better plan of management when doing surgical intervention.

Sub-acromial impingement syndrome

Clinical diagnosis

Pain and/or stiffness with decreased active but normal passive range of motion were found in most of the patients of SAIS in this study. Malhi et al too reported similar findings that presence of pain and stiffness along with decreased range of motion, both active and passive, may indicate adhesive capsulitis, while decreased active range of motion but preserved passive range of motion is suggestive of shoulder impingement or rotator cuff injury.[15] The results of this study were in accordance with the studies of current literature showing Neers's Impingement and Hawkins Kennedy test to have good sensitivity, but a moderate to poor specificity for diagnosing SAIS.[6-8] In contrast, the painful arc test was found to have a relatively good specificity as compared to the Neer's sign and the Hawkins-Kennedy test.

Radiological diagnosis

The current literature reports a high sensitivity and specificity for MRI in diagnosing impingement syndromes, the present study echoes the same results.[14-16]

Clinical vs radiological

Impingement syndrome has a multifactorial pathogenesis and often co-exists with other pathologies in shoulder, both clinical and MRI have their own importance in its management. Clinical examination can accurately

diagnose SAIS and is adequate for a conservatively managed patient. MRI on the other hand gives important details like the extent and location of the fluid accumulation/adhesions for the surgeon to plan his arthroscopic intervention in an informative way ahead.

Gleno-humeral instability

Clinical diagnosis

Clinical examination has shown to be accurate for diagnosis of instability cases both in literature and this study too.[9,10] Clinical examination should be employed as the initial diagnostic method to raise suspicion of anterior gleno-humeral instability in a case of shoulder joint pathology.

Radiological diagnosis

The findings of the present study align with previous research, reinforcing the notion that MRI demonstrates high sensitivity and specificity in the diagnosis of shoulder instability.[12-14] This consistency across studies underscores the reliability of MRI as an effective diagnostic tool for identifying instability.

Clinical vs radiological

Clinical examination does not provide an adequate identification of the underlying structural abnormality, therefore radiological evaluation like MRI is required to further evaluate the presence of Bankart's and or Hill Sach's lesion for further surgical management.

Biceps tendinitis

Clinical diagnosis

Most cases of biceps tendinitis co-existed with other shoulder pathologies like impingement syndrome, SLAP/labral tears or Rotator cuff tears; the clinical picture is often suggestive of other pathologies with the exception of few special tests which are helpful in delineating a biceps tendinopathy. Fraying of the fibers of the biceps tendon is a result of the repetitive impingement by its adjoining structures and was observed on arthroscopy for most of the biceps tendinitis cases in this study. The speed test caused the frayed biceps tendon to further impinge upon adjoining structures by reducing the sub-acromial space on flexion of the shoulder, thus causing pain and highlighting its high sensitivity in the present study. Yergason's test was found to be positive in relatively larger biceps tendon tear or biceps rupture.

Radiological diagnosis

MRI was found to have poor sensitivity but good specificity as a tool to detect biceps tendinitis in both this study as well as the review of literature. Carr et al reported MRI had more accuracy in identifying complete tears of biceps tendon.[17] Tendinopathy or incomplete tears were more likely to be misdiagnosed or missed. The present study also reports similar findings and finds MRI not to be a very reliable method in diagnosing, biceps tendinitis.

Clinical vs radiological

Any pathology involving the biceps tendon causes pain on the antero-lateral aspect of shoulder. Symptoms of biceps tendon tears and tendinopathy can overlap, with those caused by tendinopathy harder to distinguish.

As a result, accurate diagnosis requires a clinician to rely heavily on the patient's medical history and physical examination to form a strong clinical suspicion. MRI should be only used as an adjunct to discern the presence of any obvious tear in the biceps tendon.

Superior labrum anterior posterior/labral tears

Clinical diagnosis

The initial clinical examination was unremarkable with normal active, passive range of motion and normal muscle strength. Individual special tests described in literature have shown moderate sensitivity and specificity, using them in combination for diagnosis increases their efficiency and the present study echos the same results.[7,11]

Radiological diagnosis

MRI as a tool for detection of SLAP/labral tears was not found to be sensitive or specific in the review of literature except for one study by Iqbal et al.[18] Differing from results of current literature, the present study showed good sensitivity and specificity for MRI as a diagnostic tool for the detection SLAP/labral tears.

Clinical vs radiological

Both clinical and radiological methods have shown to have comparable results of good sensitivity and specificity in diagnosing SLAP / labral tear cases in this study. Clinical examination can serve as the primary diagnostic tool for suspecting SLAP tear in cases of shoulder joint pathology.

However, it may not provide a comprehensive diagnosis of the underlying condition, necessitating further radiological evaluation through imaging methods like MRI to further evaluate the extent and location of the labral tear for further surgical management.

Adhesive capsulitis

Clinical diagnosis

Adhesive capsulitis is often a diagnosis of exclusion and no orthopaedic special tests are described in literature for its diagnosis.

Radiological diagnosis

MRI had a low sensitivity, in diagnosing Adhesive Capsulitis.

Clinical vs radiological

According to Mankse et al early in the disease process, adhesive capsulitis may appear clinically similar to other shoulder conditions such as rotator cuff tear, soft tissue injury, labral tear, sub-acromial bursitis.[19] The present study observed a very high sensitivity and specificity for clinical examination, but a low sensitivity for MRI in diagnosing adhesive capsulitis. This is most probably because adhesive capsulitis is generally considered a clinical diagnosis of exclusion and radiological investigations like MRI are seldom needed to further evaluate such cases. There is no study in our knowledge to have compared the diagnostic accuracy of clinical and radiological findings for adhesive capsulitis.

Gleno-humeral osteo-arthritis

Gleno-humeral arthritis is a clinical diagnosis of exclusion which resembles adhesive capsulitis clinically. Depending upon the stage of osteo-arthritis, restriction of active followed by passive ROM is found in patients. No weakness is found in any of the rotator cuff muscles and no special tests are defined in literature for its diagnosis. The present study reported similar observations for its clinical diagnosis.

As depicted in Table 1, this study reported clinical diagnosis of having poor sensitivity as compared to MRI in diagnosing gleno-humeral arthritis. MRI was found to have moderate sensitivity and excellent specificity for the same. The present study concludes that clinical examination is of little help when diagnosing gleno-humeral arthritis and it is a diagnosis of exclusion. One should rely on MRI and/or X-ray to rule out other differential diagnosis to arrive at a diagnosis of Gleno-humeral arthritis. No study could be found comparing the validity of MRI findings in osteo-arthritis to arthroscopy in literature.

One of the strengths of this study was involvement of different individuals in the clinical, radiological and arthroscopic diagnosis of various shoulder pathologies thus eliminating bias. The present study co-related clinical, radiological as well as arthroscopic findings thus taking into account the most common tools available for diagnosing various shoulder joint disorders, for a better comparison. The present study had a few limitations such as a small sample size for some of the differential pathologies of the shoulder joint like SLAP/labral tear and Gleno-humeral osteo-arthritis; thus, decreasing the power of these results on analysis. Only one examiner was involved in the clinical diagnosis and hence inter-test reliability could not be assessed.

CONCLUSION

Individual clinical tests are insufficient for obtaining an accurate diagnosis. Utilizing a combination of special tests may enhance the validity and diagnostic accuracy of the physical examination of the shoulder joint. Amongst clinical and radiological MRI findings clinical examination was found to be superior to MRI in diagnosing adhesive capsulitis and bicipital tendinitis; MRI was found to be superior to clinical examination for diagnosing rotator cuff tears and GH arthritis both were equivocal in diagnosing SAIS, GH instability and SLAP lesions. No modality in isolation is accurate and a combination of various available tools gives the best precision in diagnosing shoulder disorders.

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