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Physical examination, magnetic resonance imaging and the arthroscopy of the shoulder: a correlation of diagnostic tests

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ABSTRACT

Background: Shoulder pathology is the third cause of consultation for musculoskeletal disorders; it is a cause of disability and economic losses. The gold standard for its diagnosis and treatment is arthroscopy. However, arthroscopy is an invasive diagnostic technique. Therefore, clinical and imaging methods may be useful as diagnostic techniques before considering arthroscopy. Nevertheless, these non-surgical diagnostic methods may present a poor correlation in diagnostic accuracy when compared to the arthroscopic diagnostic method in the context of shoulder pathology.
Methods: A retrospective study including 123 patients who presented shoulder complains, underwent physical examination and a shoulder magnetic resonance imaging (MRI) study prior to a shoulder arthroscopy. A clinical correlation was made using the kappa index, sensitivity and specificity of the clinical and imaging tests were also calculated.
Results: The correlation between arthroscopy and the clinical assessment showed a kappa index of 0.25 for rotator cuff injuries, 0.41 biceps pathology, 0.51 sub acromial impingement, 0.51 acromioclavicular arthrosis, 0.28 for SLAP injury. MRI diagnostic method showed a kappa correlation of 0.24 for rotator cuff injuries, 0.59 biceps pathology, 0.39 sub acromial impingement, 0.46 acromioclavicular arthrosis and 0.34 for superior labral anterior posterior (SLAP) injury.
Conclusions: After comparing arthroscopy with clinical assessment and the MRI diagnostic method we found that clinical assessment is useful to diagnose biceps pathologies, subacromial impingement, and acromioclavicular arthrosis. On the other hand, MRI studies and diagnosis made by a radiologist showed to be a valuable tool for the diagnosis of biceps pathology and acromioclavicular arthrosis.

Keywords: Shoulder pathology, Arthroscopy, MRI, Clinical correlation, Clinical examination

INTRODUCTION

Shoulder pain is the third leading cause of consultation for musculoskeletal disorders.[1] In a meta-analysis published in 2022, it was estimated that the prevalence of shoulder pain was 10.8-55.2% in the general population.[2] In Mexico, the prevalence of shoulder pain is estimated at 5.28%-15.2%.[3,4]

Shoulder pain is a pathology that impacts greatly on the quality of life and mental health of the affected population. There is a straight connection between shoulder pain and decreased shoulder function and quality of life decreases and stress increases.[5] The annual economic impact of a patient unable to work secondary to shoulder pain is on average $14,356 US dollars.[6]

A clinical algorithm to perform a better clinical evaluation of patients is recommended to be used, evaluation of possible trauma, discard referred pain, evaluate extra articular pathology, and evaluate intra articular pathology.[7] To achieve a better orientation and a better diagnosis, is. recommended starting the physical examination with the exploration of normal arcs of mobility, evaluation of pain in active and passive movement and then evaluation of the shoulder by means of specific tests.[8] A meta-analysis performed in 2017 concluded that using more than one clinical test in the evaluation of the shoulder increased the sensitivity and specificity of the diagnosis.[9]

the usefulness of ultrasonography (USG) and MRI for shoulder pathology has been evaluated, describing a diagnostic accuracy of 73% and 83%, respectively.[10] MRI had a diagnostic capability of 93% in sports injuries of the shoulder.[11] studies had evaluated the inter observer difference in the evaluation of the same MRI study and found a difference between the diagnoses of the radiologist and the orthopedic surgeon.[12] On the other hand, is reported that 90% of shoulder surgeons do not perform shoulder surgery without having evaluated the MRI and prefer to personally evaluate the study and not the radiologist's result.[13]

Arthroscopy has become the gold standard for shoulder surgeries, since it presents a minimally invasive surgery, lower risk of deltoid injury, less postoperative pain, and faster recovery.[14] However, it is a highly complex technique and, as described it can present complications in up to 10.6% of patients.[15]

Objective were to compare the efficacy of the MRI diagnosis made by a radiologist and the physical examination performed by an orthopedic surgeon specialized in joint surgery, using arthroscopy as a method of diagnostic confirmation.

METHODS

A retrospective study was conducted after authorization by the ethics committee from hospital de ortopedia, Cruz Roja Mexicana, located in Mérida, Yucatán, México.

The records of patients who attended the outpatient clinic for shoulder pain were reviewed. In total, 10,628 records were obtained. Then, patients with shoulder pathology who underwent a detailed physical examination, who had a shoulder MRI radiology report and who also had an arthroscopy performed during the period from January 2013 to December 2022 were selected. A total of 198 clinical records were obtained.

Inclusion criteria included patients above 18 years old with a detailed clinical assessment performed by a staff surgeon, a written report of the affected shoulder MRI made by a radiologist, and who underwent arthroscopy of affected shoulder. All patients underwent clinical maneuvers described in Table 1, reported as positive or negative.

Table 1: Maneuvers used for diagnostic of shoulder pathology.

Variables	Diagnostic parameters
Biceps brachialis injuries	Speed, Yergason
Rotator cuff injuries	Drop-arm, Apley, belly press, lift off and Jobe
Subacromial impingement	Yokum, Hawkins-Kenneddy, Neer
Acromioclavicular osteoarthritis	Scarf test and pain of the joint
SLAP lesion	O'brien and speed.

All the postoperative diagnosis as well as operative findings were collected.

Patients with incomplete data in the medical record and in the database were excluded, as well as patients with previous shoulder surgeries and a history of any shoulder fracture in the affected limb. For greater homogeneity of the study, only surgeries performed by the same shoulder surgeon were considered.

The physical examination and MRI results were divided into 4 categories.

True positive: Positive physical examination or MRI and confirmed at arthroscopy.

True negative: Physical examination or MRI without lesion and confirmed at arthroscopy.

False positive: Positive physical examination or MRI but no lesion was found on arthroscopy.

False negative: Physical examination or MRI without lesion, lesion was found at the time of arthroscopy.

For their evaluation and statistical analysis, they were divided into 5 groups, according to the findings on physical examination and MRI. Patients with rotator cuff pathology; biceps pathology; subacromial impingement, acromioclavicular arthrosis, and SLAP lesions.

We evaluated the correlation between the arthroscopic findings with the clinical tests and the diagnosis of the MRI by the radiologist, respectively.

A statistical analysis was performed, evaluating the sensitivity, specificity, negative and positive predictive values (PPVs), and kappa index.

Results of kappa index were categorized as follows: less than 0.4-no agreement between test and diagnosis, result between 0.4 and 0.75-intermediate agreement (considered as an acceptable test), and >0.75-excellent agreement.

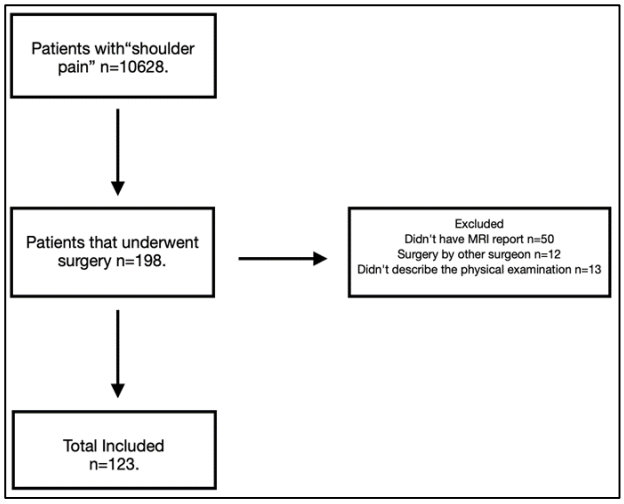

Figure 1: Patients selection.

RESULTS

During the period from January 2013 to December 2022, 198 patients underwent shoulder arthroscopy, we did not include patients without an MRI report (n=50), patients who were intervened by a different surgeon (n=12) and patients without a complete description of the physical examination, for a total of 123 included.

Table 2: Demographics.

Gender	Feminine	Masculine
N	73	85
%	40.65	59.35
Affected side	**Left**	**Right**
%	37.4	62.6

Table 3: Shoulder pathologies according to arthroscopic diagnosis.

Pathology	Frequency*
Rotator cuff injuries	102
Biceps pathology	78
Subacromial impingement	29
Acromio-clavicular arthrosis	17
SLAP injury	12

*More than one pathology may occur in a patient.

The majority of patients were male and the most common affected shoulder was the right side, most frequent pathology among the patients was rotator cuff injury (57.86%), followed by biceps pathology (39.59%), subacromial impingement (14.72%), acromioclavicular arthrosis (8.62%), and SLAP injury (6.1%). We identify at least one lesion per patient on the arthroscopic intervention.

Table 4: Statistical analysis of the clinical examination findings compared to the arthroscopic findings (n=123).

Variables	TP	FN	TN	FP	Sensitivity	Specificity	PPV	NPV
Rotator cuff injuries	99	3	5	16	97%	24%	86%	62%
Biceps pathology	55	23	33	12	71%	73%	82%	59%
Subacromial impingement	16	13	87	7	55%	93%	70%	87%
Acromioclavicular arthrosis	8	9	103	3	47%	97%	73%	92%
SLAP injury	3	9	108	3	25%	97%	50%	92%

*TP: True positive, *FN: False negative, *TN: True negative, *FP: False positive, PPV: Positive predictive value, NPV: Negative predictive value.

Table 5: Statistical analysis of the MRI findings in the report made by a radiologist compared to the arthroscopic findings (n=123).

Variables	TP	FN	TN	FP	Sensitivity	Specificity	PPV	NPV
Rotator cuff injuries	98	4	5	16	96%	24%	86%	56%
Biceps pathology	52	26	28	17	67%	62%	75%	52%
Subacromial impingement	11	18	90	4	38%	96%	73%	83%
Acromioclavicular arthrosis	11	6	94	12	65%	89%	48%	94%
SLAP injury	4	8	107	4	33%	96%	50%	93%

*TP: True positive, *FN: False negative, *TN: True negative, *FP: False positive, PPV: Positive predictive value, NPV: Negative predictive value.

Rotator cuff

Clinical versus arthroscopy

In the clinical evaluation of the 123 patients, 115 presented positive clinical signs for rotator cuff injury, of which 102 cases were confirmed as positive in the arthroscopy. The clinical evaluation presents a sensitivity of 97%, specificity of 24%, PPV of 86% and negative predictive value (NPV) of 62%. It can be observed that in our clinical practice pathology rotator cuff injury is being over diagnosed.

MRI versus arthroscopy

In the MRI reports of the 123 patients, 114 presented a positive report for rotator cuff injury, of which 102 cases were confirmed as positive in the arthroscopy. MRI

presents a sensitivity of 96%, specificity of 24%, PPV of 86% and NPV of 56%. There is an overdiagnosis of rotator cuff lesions by radiologists;14% of the radiological diagnosis did not present a lesion at the time of arthroscopy.

Biceps pathology

Clinical versus arthroscopy

When performing clinical tests to evaluate the biceps, 67 presented positive clinical signs for biceps pathology; however, 78 patients were confirmed as positive in the arthroscopy. The biceps pathology clinical examination presents a sensitivity of 71%, specificity of 73%, PPV of 82% and NPV of 59%. Our data show again that the pathology failed to be diagnosed in 18.7% of the patients; however, when compared with the MRI reports, the clinical practice proved to be a better diagnostic tool.

MRI versus arthroscopy

In the case of the MRI findings, 69 patients had a positive report for biceps pathology; nonetheless, only 52 of these patients were confirmed positive in the arthroscopy and 26 more patients were diagnosed during the arthroscopy in which the MRI had been reported as negative. It was observed that the MRI failed to diagnose biceps pathology in 21.14% of the cases. The MRI presents a sensitivity of 67%, specificity of 62%, PPV of 75% and NPV of 52%.

Subacromial impingement

Clinical versus arthroscopy

The 123 patients underwent the Yokum, Hawkins-Kennedy, Neer and painful mobility arc tests. During this evaluation, 23 patients were diagnosed as positive for subacromial impingement, of which only 16 cases were confirmed in the arthroscopy; still, other 13 patients were diagnosed with subacromial impingement during the arthroscopy that had resulted in a negative clinical evaluation. The clinical diagnosis for subacromial impingement had a sensitivity of 55%, specificity of 93%, PPV of 70% and NPV of 87%. We observed an under-diagnosis of this pathology, failing to make the diagnosis in 10.6% of the patients.

MRI versus arthroscopy

On the MRI reports, 15 patients were diagnosed with subacromial impingement; of which, only 11 were confirmed as positive in the arthroscopy; however, 18 more patients were diagnosed with subacromial impingement during the arthroscopy in which their MRI reports had been negative. The MRI shows a sensitivity of 38%, specificity of 96%, PPV of 73%, and NPV of 83%. The reports given by the radiologists show an under-diagnosis of the pathology in 14.63% of the patients.

Acromioclavicular arthrosis

Clinical versus arthroscopy

In the clinical evaluation 11 patients were diagnosed with acromioclavicular arthrosis; however, only 8 were confirmed as positive in the arthroscopy and another 9 patients were diagnosed during the surgical procedure that weren't diagnosed during the physical exam. The clinical examination presents 47% of sensitivity, 97% of specificity, a PPV of 73% and a NPV of 92%. It is a highly specific test with a low margin of error at the time of diagnosis.

MRI versus arthroscopy

MRI reports found 23 patients with acromioclavicular arthrosis; of which, only 11 had the pathology during the arthroscopy and it failed to diagnose 6 patients who were found positive in the arthroscopy. The MRI shows a sensitivity of 65%, specificity of 89%, PPV of 48% and NPV of 94%. The acromioclavicular pathology is being over diagnosed in the MRI.

SLAP lesion

Clinical versus arthroscopy

Of the 123 patients who underwent arthroscopy, 12 were diagnosed with SLAP lesions, of whom only 3 patients were correctly detected in the clinical evaluation. The clinical evaluation showed 25% sensitivity, 97% specificity, PPV of 50% and NPV of 92%. There is an underdiagnosis of pathology; since, physical examination failed to diagnose 6 patients who had SLAP lesions.

MRI versus arthroscopy

Radiological reports diagnosed 8 patients with SLAP lesions; of which, only 4 patients were diagnosed during the arthroscopy and another 8 patients with negative MRI reports were diagnosed as positive during the arthroscopy. MRI showed a sensitivity of 33%, specificity of 96%, PPV of 50% and NPV of 93%. Half of the patients reported as a SLAP lesion were misdiagnosed.

Table 6: Correlation analysis of both diagnostic methods in comparison to the arthroscopy.

Diagnosis	KAPA clinic	KAPA RNM
Rotator cuff injuries	O.26	0.24
Biceps pathology	0.41	0.60
Subacromial impingement	0.51	0.39
Acromio-clavicular arthrosis	0.52	0.46
SLAP injury	0.28	0.35

The correlation analysis (kappa) of clinical examination and MRI reports was performed and evaluated separately. As described by Fleiss, the kappa correlation is a tool to

evaluate the usefulness of a clinical or imaging test, it measures the agreement between two tests taking one of them as a reference, in our case reference is arthroscopy.

According to the kappa index, clinical evaluation in biceps pathologies, sub acromial impingement and sub acromial arthrosis, presents an intermediate agreement. As for MRI reports, there is an intermediate concordance in diagnosis of biceps pathology and acromioclavicular arthrosis.

Rotator cuff injuries do not present clinical or radiological agreement between both tests and the diagnosis made during the arthroscopy.

DISCUSSION

In the clinical evaluation of rotator cuff injury, a study made by Oliveira et al reported a sensitivity of 84.9% and a specificity of 45.4%, the PPV of 95% and NPV of 24.3%; on the other hand, our study found a higher sensitivity (97%) and a lower specificity (24%), when correlated against arthroscopy.[17,20]

The correlation between MRI reports and arthroscopy in the diagnosis of rotator cuff injury, we found a sensitivity of 96% and specificity of 24%. In a study presented by Abhinav et al they reported a similar sensitivity (98%); yet a much higher specificity (100%). In that study the evaluation of the MRI scans was performed by two single radiologists which gives the study greater homogeneity in terms of results.[18] This could explain the difference in specificity we obtained compared to Abhinav's study; since, in our study, the MRI reports were performed by different radiologists from different imaging centers.

The speed test, for the diagnosis of biceps pathology, has a sensitivity of 54% and specificity of 81%; and the Yergason test, also for biceps pathology, has a sensitivity of 41% and specificity of 79%, as published by Seoyon Yang and cols.[19] In our study, the combination of both tests showed a sensitivity of 71%, specificity of 73%, PPV of 82% and NPV of 59%, demonstrating that the combination of both tests improves the sensitivity and slightly reduces the specificity for the diagnosis of biceps pathology. In a clinical environment, the combination of these tests results in a more efficient way to diagnose this pathology.

Regarding biceps pathology diagnosed by MRI compared to arthroscopy, the results of our study presented a diagnostic sensitivity of 67%, specificity of 62%, PPV of 75% and NPV of 52%. In a study performed in Iran by Omid et al on the diagnosis of bicipital pathology by MRI report, they described a sensitivity of 80%, specificity of 96%, PPV of 85% and NPV of 95%, all values being higher than those obtained in this study, probably because all the images were reported by the same radiologist.[20]

In a study by Malhi et al when clinically evaluating patients with subacromial impingement, they bestowed to the physical examination a sensitivity of 84%, specificity of 76%, PPV of 83% and NPV of 78%.[21] In our study this type of evaluation presented a sensitivity of 55%, specificity of 93%, PPV of 70% and NPV of 87%, which means a higher diagnostic certainty in identified patients.

When using MRI to identify subacromial impingement in a study by Nicholas et al in Canada, he found a sensitivity of 66.7%, specificity 86.4%, PPV 76.0% and NPV 85.7%.[22] In our study, the MRI reports presented a sensitivity of 38% specificity of 96%, PPV of 73% and NPV of 83%, it shows better specificity but again it fails to diagnose the positive cases.

Thiagarajan et al analyzed the clinical and MRI correlation of SLAP lesions and found that the physical examination made by shoulder surgeons had a sensitivity of 90%, specificity of 95%, PPV of 90% and NPV of 95%.[23] In our study, the clinical evaluation we obtained a 25% sensitivity, 97% specificity, PPV of 50% and NPV of 92%. Here we can notice a lower sensitivity in the clinical.

In the same study by Thiagarajan et al the MRI scans in SLAP lesions showed a sensitivity of 60%, specificity of 92.5%, PPV of 80% and NPV of 82.2%.[23] In their study all images were performed by the same resonator and evaluated by the same radiologist. However, in our study the reports were made with different MRI machines by several radiologists, which resulted in lesser values regarding sensitivity (33%) and PPV (50%), and similar values for the specificity (96%) and NPV (93%).

Statistical analysis of the diagnostic accuracy of MRI compared to arthroscopy was performed using the kappa test to determine the level of agreement between the two diagnostic methods. Groarke et al performed a similar analysis in Australia in 2021 at the Brisbane hand and upper limb research institute. The comparison between the results of the two studies is shown in the table below.[24]

Table 7: Correlation index between MRI and arthroscopy results in two different clinical centers: "hospital de ortopedia" in Mexico and the Brisbane hand and upper limb research institute in Australia.

Diagnosis	HO*	Brisbane
Rotator cuff injuries	0.24	0.61
Biceps pathology	0.60	0.54
Subacromial impingement	0.39	0.61
Acromio-clavicular arthrosis	0.46	0.77
SLAP injury	0.35	0.38

*HO=Hospital de ortopedia, Mérida, México.

When comparing both studies, a similar level of concordance is observed in the pathology of the biceps and SLAP injury. As for the other diagnoses, the concordance was better in the study performed in Brisbane. This could be explained by the fact that 3 tesla resonators were used in the Brisbane study, which are superior to those used in this region of America, in addition to the fact that all the images were reviewed by the same team of radiologists.

We did not find any study that analyzed the kappa index to determine agreement between clinical assessment and arthroscopy.

Limitations

The evaluation of the patients was not made by the same examiner, the MRI were made in different centers and evaluated by several radiologists, the quality of the images was different in each center.

CONCLUSION

The present study supports that the clinical evaluation is a useful test for the diagnosis of pathology of biceps, sub acromial impingement and acromioclavicular osteoarthritis, the MRI seems to be a useful test for the diagnosis of biceps pathology and acromioclavicular osteoarthritis, but none of them compare to the accuracy of the arthroscopy. Therefore, both MRI and clinical examination have complementary roles in the diagnosis of shoulder pathology, in order to achieve an accurate diagnosis before the arthroscopic intervention.

Recommendations

The study reinforces the importance of improving the physical examination of patients for more accurate diagnoses, surgeons are advised to evaluate the MRI and not rely solely on its report.

All the patients diagnosed and taken to the operating room presented some damage to the shoulder structures, so it is recommended that in the presence of an MRI with findings of injury and clinical pain in patients that do not improve with conservative treatment should undergo arthroscopy.

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