A Comparative Analysis of the Diagnostic Value of Shoulder MRI Plain Scan and MR Shoulder Arthrography for Rotator Cuff Injury

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Abstract: Objective: To analyze the diagnostic value of MRI plain scan and MR shoulder arthrography on rotator cuff injury. Methods: Sixty patients with suspected rotator cuff injury admitted to Yunnan South Central Hospital in Yunnan Province from October 2022 to March 2023 were selected, and all patients were scanned with MR conventional serial scan and MR arthrography, and the arthroscopic findings were used as the gold standard to compare the diagnostic results of the two methods on rotator cuff injury, the diagnostic value, the diagnostic value of different tear types, and the diagnostic value in oblique sagittal position for different parts of the display rate. Results: Arthroscopic findings were positive in 45 cases and negative in 15 cases; MR arthrography scans were positive in 42 cases and negative in 18 cases; MR conventional serial scans were positive in 39 cases and negative in 21 cases ; MR arthrography sensitivity was 88.89%, specificity 86.67%, accuracy 70.00%, positive predictive value 95.24% and 72.22% negative predictive value, while MR conventional serial scan was 84.44%, 93.33% specificity, 65.00% accuracy, 97.44% positive predictive value and 66.67% negative predictive value, with no statistically significant difference between the two methods (all $P > 0.05$); arthroscopy diagnosed 5 outer layer tears, 32 inner layer tears and 8 tendon MR arthrography diagnosed 6 outer layer tears, 33 inner layer tears and 6 intra-tendon tears, with an accuracy rate of 88.89% (40/45); MR conventional serial scan diagnosed 6 outer layer tears, 33 inner layer tears and 6 intra-tendon tears, with an accuracy rate of 84.44% (38/45). The difference in accuracy between the two groups was not statistically significant ($\chi^2 = 0.857$, $P = 0.355$); in the oblique sagittal position, MR arthrography showed a higher rate of biceps longissimus tendon, rostro-humeral ligament and superior glenohumeral ligament than did MR conventional serial scans ($P < 0.05$). Conclusion: Both MRI plain scan and MR shoulder arthrography have good diagnostic value for rotator cuff injuries, but MR shoulder arthrography is more effective in diagnosing medial tears in patients with rotator cuff injuries and can show more areas in the oblique sagittal position, which is more worthy of clinical use.

Keywords: Shoulder Joint; MRI Plain Scan; MR Shoulder Arthrography; Rotator Cuff Injury; Diagnostic Value

1. Introduction

Rotator cuff injury is one of the more common shoulder pathologies, accounting for 17-41% of all shoulder disorders and up to 50% of those over 80 years of age.[1] Causes include tendon changes, acute trauma and instability of the shoulder joint[2]. It is a major contributor to shoulder pain and dysfunction, but it occurs in patients with no typical symptoms and is easily missed or misdiagnosed.[3] Arthroscopy is the gold standard for the diagnosis of rotator cuff injuries, but although this technique is widely used, it is expensive, demanding and traumatic for the examiner, so its use is limited.[4] Magnetic resonance imaging (MRI) is a non-invasive test with excellent soft tissue resolution, multi-sequence and multi-directional imaging, and is therefore widely used in the diagnosis of rotator cuff injuries.[5]. However, conventional MRI still has its limitations in the diagnosis of rotator cuff injuries, as there are many suspicious points that cannot be accurately diagnosed.[6].

In recent years, MR arthrography has been increasingly used in the diagnosis of rotator cuff injuries, but direct imaging is more diagnostic, but can be more difficult for patients to accept. Indirect imaging involves the intravenous injection of contrast into the patient's joint cavity. The contrast agent penetrates and diffuses into the joint cavity, distending the joint capsule in order to facilitate the visualisation of the anatomical structures within the joint, with better results[7]. The study therefore compared the diagnostic value of MRI scan and MR shoulder arthrography for rotator cuff injuries to further improve the understanding and diagnosis of the rotator cuff in patients, as reported below.

1.1 Materials and methods

Sixty patients with suspected rotator cuff injury admitted to Yunnan South Central Hospital in Yunnan Province from October 2022 to March 2023 were selected. Among them, 35 were male and 25 were female; their ages ranged from 15 to 80 years, with a mean age of (55.39±3.45) years; the duration of the disease ranged from 3d to 3 years, with a mean duration of (0.86±0.40) years; inclusion criteria: ① patients and their families were informed and had signed the consent form; ② all presented with symptoms such as limitation of shoulder joint movement, shoulder pain and dysfunction; ③ no patients with hearing, intellectual or expression impairment; ④All patients agreed to undergo MR conventional serial scanning, MR arthrography and arthroscopy. Exclusion criteria: ① those with combined tumours; ② those with combined respiratory failure or severe organ dysfunction; ③ those with a history of shoulder surgery; ④ those who did not complete the experiment for various reasons.

1.2 Methodology

1.2.1 Conventional MR sequence scan examination

A magnetic resonance scanner (Instrument model: GE 3.0T MRI) was used to perform a routine MR examination on all patients, which was equipped with an 8-channel shoulder phasic coil. The patient was placed in a supine position with the shoulder joint close to the midline of the scanning bed, and the hands were placed on either side of the body to ensure that the patient's shoulder was relaxed on both sides. The centre of the coil is aligned with the humeral head and the centre of the scan, and the patient is scanned in transverse axial, oblique coronal and oblique sagittal fat suppression weighted sequences, starting with the shoulder joint under the field of view, followed by the humeral head, the glenoid and finally the lateral clavicle and the acromion. The scanning field of view is 18cm x 18cm with a matrix of 320 x 256. After the images are acquired, the final imaging diagnosis is made by two diagnostically experienced orthopaedic muscle diagnosticians.

1.2.2 MRI arthrography

MRI arthrography involves the injection of the contrast agent gadopentetate (conventional dosage 0.1 mmol/kg) into the patient's joint capsule under X-ray fluoroscopy, followed by movement of the affected shoulder joint. The MR T1WI sequence was performed in the transverse axial, oblique coronal and oblique sagittal fat suppression planes, with the same field of view, layer spacing and thickness as the conventional MRI scan.

1.2.3 Shoulder arthroscopy

Arthroscopy was performed on all patients using a shoulder arthroscope (instrument model: SY- SHREK-HD801). The arthroscope was inserted after puncturing the patient's shoulder joint to examine the rotator cuff and glenoid labrum to see if there was any rotator cuff or glenoid labrum injury.

1.3 Observation indicators and assessment criteria

(1) To analyse the results of MR conventional serial scans and MR arthrography for the diagnosis of rotator cuff injury, using shoulder arthroscopy findings as the gold standard. Criteria for the diagnosis of rotator cuff injury: A double-blind method was used to complete a D review of the patient's MR images, and when disagreement arose, it was referred to a superior physician for judgement. Conventional MRI: T2WI and PDWI sequences bleed abnormally high signal and

morphological changes occur as the main presentation; MR arthrography is a high signal contrast into the joint tendon rupture.

(2) The diagnostic value of different MR conventional sequence scans and MR arthrography for rotator cuff injuries, with indicators including sensitivity, specificity and positive and negative predictive values.

(3) MR conventional serial scans and MR arthrography were recorded and compared to diagnose the type of tear in patients with rotator cuff injuries, which included inner, outer and intra-tendon tears. The diagnosis of a tear: a high signal causes varying degrees of damage to the surface of the supraspinatus tendon, without involvement of the whole layer, for a localised rotator cuff tear; for a high signal, when the whole layer of the supraspinatus tendon is involved to varying degrees and contracture of the supraspinatus occurs, a total tear is diagnosed.

(4) Comparison of MR conventional serial scans with MR arthrography in the oblique sagittal view of the patient's long head of biceps tendon, rostro-humeral ligament and superior glenohumeral ligament.

1.4 Statistical methods

SPSS 22.0 was applied to process the data of this experiment, and the measurement data were expressed as mean ± standard deviation ($\bar{x}$ ±The t-test was used for the measurement data, and the χ^2 test was used for the count data.

2. Results

2.1 Diagnostic results of MR conventional serial scans and MR arthrography

Arthroscopy results showed 45 positive and 15 negative cases; MR arthrography scans detected a total of 42 positive and 18 negative cases; and MR conventional serial scans detected a total of 39 positive and 21 negative cases. See Table 1.

Table 1 Comparison of the diagnostic results of MR conventional serial scans and MR arthrography [$\bar{x}$ ±s, cases (%)]

Inspection methods		Shoulder arthroscopy diagnosis		
		Positive	Negative	Total
MR arthrography	Positive	40	2	42
	Negative	5	13	18
MR routine sequence scan	Positive	38	1	39
	Negative	7	14	21
Total		45	15	60

2.2 Comparison of the diagnostic value of MR conventional serial scans and MR arthrography for rotator cuff injuries

MR arthrography had a sensitivity of 88.89%, specificity of 86.67% , accuracy of 70.00%, positive predictive value of 95.24% and negative predictive value of 72.22%, and MR conventional sequence scan was 84.44%, specificity of 93.33%, accuracy of 65.00%, positive predictive value of 97.44% and negative predictive value of 66.67%. The differences between the two methods were not statistically significant (all P > 0.05) (Table 2).

Table 2 Comparison of the diagnostic value of MR conventional serial scans and MR arthrography [cases (%)]

Group	Sensitivity (%)	Specificity (%)	Accuracy (%)	Positive predictive value (%)	Negative predictive value (%)
MR arthrography	88.89 (40/45)	86.67 (13/15)	70.00 (42/60)	95.24 (40/42)	72.22 (13/18)
MR routine sequence	84.44 (38/45)	93.33 (14/15)	65.00	97.44 (38/39)	66.67

scan			(39/60)		(14/21)
χ^2	0.857	2.464	0.342	0.686	0.726
P	0.355	0.116	0.559	0.407	0.394

2.3 Comparison of the two groups for the diagnosis of the type of tear

Arthroscopy diagnosed 5 outer layer tears, 32 inner layer tears and 8 intra-tendon tears, a total of 45 cases; MR arthrography diagnosed 6 outer layer tears, 33 inner layer tears and 6 intra-tendon tears, with an accuracy rate of 88.89% (40/45); MR conventional serial scans diagnosed 6 outer layer tears, 33 inner layer tears and 6 intra-tendon tears, with an accuracy rate of 84.44% (38/45). 38/45). The difference in accuracy between the two groups was not statistically significant (χ^2 =0.857, P=0.355). See Table 3.

Table 3 Diagnosis of tear type by MR conventional serial scan versus MR arthrography (cases, n)

Inspection methods	Type of tear	Arthroscopic diagnosis		
		Outer layer	Inner layer	Intertendinous
MR arthrography	Outer layer	4	2	0
	Inner layer	1	30	2
	Intertendinous	0	0	6
	Total	5	32	8
MR routine sequence scan	Outer layer	4	2	0
	Inner layer	1	29	3
	Intertendinous	0	1	5
	Total	5	32	8

2.4 Display rates of different parts

In the oblique sagittal position, MR arthrography showed a higher rate of the long head of the biceps tendon, rostro-humeral ligament and superior glenohumeral ligament than did MR conventional serial scans ($p < 0.05$) (Table 4, Fig. 1, Fig. 2).

Table 4 Display rates of the two methods for different sites (%)

Group	Long head of biceps tendon	rostro-humeral ligament	Upper glenohumeral ligament
MR arthrography	44.44 (20/45)	33.33 (15/45)	40.00 (18/45)
MR routine sequence scan	84.44 (38/45)	57.78 (26/45)	73.33 (33/45)
χ^2	5.092	4.066	7.636
P	0.024	0.044	0.006

3. Discussion

The shoulder joint is the most mobile joint in the body and is often damaged by trauma and impact. Rotator cuff injuries are a common type of shoulder disorder and statistics show that the incidence of this condition is 30% of shoulder disorders[8-9]. Rotator cuff injuries are a common cause of shoulder pain and dysfunction, and the diagnosis of this condition is complex and often misdiagnosed as frozen shoulder[10]. There are two types of rotator cuff injuries, partial tears and complete tears, which are difficult to repair and can develop into complete tears when partial tears are not repaired in time or are not repaired properly[11]. Therefore, there is a need for timely and effective diagnosis of rotator cuff injuries and early treatment and intervention.[12] In recent years, with the development of diagnostic techniques, MRI has become a common method of examining the soft tissues of the shoulder joint[13]. Magnetic resonance indirect shoulder arthrography is also being used in the diagnosis of shoulder disorders, with significant advantages in lesions of the rotator cuff and glenoid

labrum.[14] Some studies have shown that MRI indirect shoulder arthrography is effective in improving the accuracy of diagnosis of rotator cuff injuries.[15]

The results of this study showed that MR arthrography had a sensitivity of 88.89%, specificity of 86.67%, accuracy of 70.00%, positive predictive value of 95.24% and negative predictive value of 72.22%, while MR conventional serial scan had a sensitivity of 84.44%, specificity of 93.33%, accuracy of 65.00%, positive predictive value of 97.44% and negative predictive value of 66.67%. was 66.67%, $P > 0.05$ for both methods, indicating that the two methods had more consistent sensitivity and specificity for rotator cuff injuries; arthroscopic diagnosis diagnosed 32 cases of inner layer tears, 5 cases of outer layer tears and 8 cases of intra-tendon tears; 14 cases of inner layer tears, 16 cases of outer layer tears and 15 cases of intra-tendon tears; MR arthrography diagnosed 23 cases of inner layer tears, 15 cases of outer layer tears and 15 cases of intra-tendon tears. 15 tears and 7 intra-tendon tears. In the oblique sagittal position, MR arthrography showed a higher rate of the long head of biceps tendon, rostro-humeral ligament and superior glenohumeral ligament than MR conventional serial scans ($p < 0.05$). This indicates that MR arthrography was more effective in diagnosing the patient's medial tears with more locations compared to arthroscopic diagnosis as a control. The reason for the above results is that the injection of contrast into the joint cavity during MR arthrography improves the contrast of the tissue in the joint cavity and clearly shows the glenoid lip within the joint capsule[16] ; compared to MR conventional sequences, MR arthrography shows the fine structures within the joint capsule more clearly to, shows images with a lesser degree of damage and can involve the tendon articular facet side - bursal facet side, with a wider range of monitoring, due to from It is more effective in diagnosing the patient's internal tears and more areas.

In conclusion, both MRI scan and MR arthrography of the rotator cuff have good diagnostic value for rotator cuff injuries, but MR arthrography is more effective in diagnosing internal tears in patients with rotator cuff injuries and can show more structures in the oblique sagittal position, which is more worthy of clinical use.

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