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Original Article

Evaluation of the acromiohumeral distance by means of magnetic resonance imaging umerus☆

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ABSTRACT

Objective: To demonstrate the relationship between the size, degree of retraction and topography of rotator cuff injuries and the degree of rise of the humeral head, and to evaluate the influence of gravity, using magnetic resonance imaging (MRI).

Methods: We evaluated 181 shoulder MRIs from 160 patients aged over 45 years, between November 2013 and July 2014. The patients were divided into two groups: one control (no lesion or partial damage to the rotator cuff); and the other with complete tears of the rotator cuff. We measured the acromiohumeral distance in the sagittal plane, and established the shortest distance between the apex of the head and the acromion.

Results: In this study, 96 examinations on female patients (53.04%) and 58 on male patients (46.96%) were evaluated. The mean age was 63.27 years: in the control group, 61.46; and in the group with injuries, 65.19. From analysis on the measurements of the subacromial space, we observed significantly higher values in the control group (7.71 mm) than in the group with injuries (6.99). In comparing the control group with some specific subgroup, i.e. posterosuperior (6.77), anteroposterior-superior (4.16) and retraction Patte III (5.01), we confirmed the importance of topography and degree of retraction in relation to the rise of the humeral head.

Conclusion: The rise of the humeral head was directly related to the size, degree of retraction and topography of the rotator cuff injuries, with greater degrees of rise in cases of superior and posterior lesions and anteroposterior-superior (massive) lesions. The assessment using MRI was not influenced by the force of gravity.

☆ Work performed in the Shoulder Group, Hospital Ortopédico BH, Belo Horizonte, MG, Brazil.

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Avaliação da distância úmero-acromial por meio da ressonância magnética

Palavras-chave:
Bainha rotadora
Imagem de ressonância magnética
Acrômio
Úmero

RESUMO

Objetivo: Demonstrar a relação entre o tamanho, grau de retração e topografia das lesões do manguito rotador com o grau de ascensão da cabeça umeral e avaliar a influência da força da gravidade na ressonância magnética.

Métodos: Avaliamos 181 ressonâncias magnéticas de ombro de 160 pacientes com mais de 45 anos, entre novembro de 2013 e julho de 2014. Os pacientes eram divididos em dois grupos, um de controle (sem lesão ou com lesão parcial do MR) e outro com lesão completa do MR. Fizemos a mensuração da distância acrômio-umeral nos cortes sagitais e foi estabelecida a menor distância entre o ápice da cabeça e o acrômio.

Resultados: Foram avaliados neste estudo 96 (53,04%) exames de pacientes do sexo feminino e 58 de pacientes do sexo masculino (46,96%). A idade média foi 63,27 anos, a do grupo controle 61,46 e a do grupo com lesão 65,19. Ao analisar as medidas do espaço subacromial, observamos valores significativamente maiores no grupo controle (7,71 mm) do que no grupo com lesão (6,99). Quando comparamos o grupo controle com alguns subgrupos específicos, posterossuperior (6,77), anteroposterossuperior (4,16) e retração Patte III (5,01), confirmamos a importância da topografia e grau de retração para ascensão da cabeça umeral.

Conclusão: A ascensão da cabeça umeral tem relação direta com o tamanho, grau de retração e a topografia das lesões do manguito rotador, com graus maiores de ascensão nas lesões posterossuperiores e anteroposterossuperiores (extensas). A avaliação feita pela ressonância magnética não sofre influência da força da gravidade.

Introduction

The rotator cuff acts as a compressor of the head of the humerus against the glenoid, thus enabling shoulder movements in different spatial planes. Disease of the rotator cuff may cause this equilibrium to be broken and may culminate in more advanced stages of injury with consequent ascension of the humeral head.[1–4] This phenomenon can be quantified by measuring the distance from the humerus to the acromion.[5]

The mechanism for ascension of the humeral head is still not completely clear. It is believed that the traction exerted by the deltoid muscle without the stabilizing action of the rotator cuff might explain these findings.[5] In this regard, failure of the infraspinatus and the depressor function of the humeral head would allow ascension by means of an injured supraspinatus that would not occupy the subacromial space.[6–9]

Clinically, this measurement can be used to evaluate the function of the rotator cuff and aid in choosing the type of therapy to be used.[10,11] A distance from the humerus to the acromion of less than or equal to 7 mm measured on radiographs in anteroposterior view suggests that the rotator cuff injury is large, which diminishes the likelihood of successful surgical treatment.[10,12] It has also been shown that the ascension of the humeral head is related to fatty degeneration of the rotator cuff.[11–13]

Use of magnetic resonance imaging (MRI) for estimating the ascension of the humeral head is currently under great discussion. One of the main issues involved is the fact that MRI is performed in dorsal decubitus. It is believed that the reduction of the force of gravity on the limb during the examination might overestimate this radiological finding.

The objectives of this study were: (1) to demonstrate that the degree of ascension of the humeral head is related to the size of the rotator cuff injury and its degree of retraction; (2) to evaluate whether the ascension of the humeral head on MRI has any relationship with gravity; and (3) to ascertain whether the location of the injury influences this ascension of the humeral head.

Materials and methods

This study was approved by the Research Ethics Committee of our institution. Prospective evaluations were conducted on 181 MRIs of the shoulder, from 160 patients who underwent this examination between November 2013 and July 2014. These evaluations were performed in a radiology clinic.

For inclusion in this study, the patients needed to be more than 45 years of age and to have undergone MRI for investigation of non-traumatic pathological conditions of the shoulder. Patients with histories of fractures or previous surgery on the shoulder that was now undergoing examination, cases involving magnetic resonance arthrography and patients with glenohumeral arthrosis that had already become established were excluded.

The patients were divided into two groups. The first group did not present rotator cuff tears or only presented partial tears (control group). The second group, called the injury group, presented complete tears of the rotator cuff and was

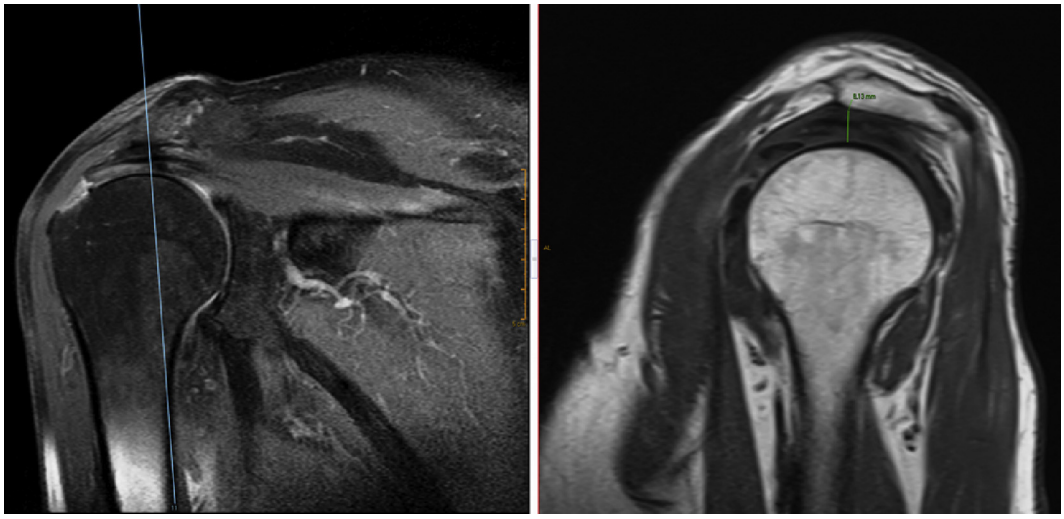

Fig. 1 – Apex of the humeral head, seen on a coronal slice (image on left). Measurement of the shortest distance between the apex of the humeral head and the acromion, seen on a sagittal slice (image on right).

subdivided according to the location of the injury (anterosuperior, superior, posterosuperior or anteroposterosuperior) and the degree of tendon retraction according to the classification of Patte.[14]

All the examinations were performed in MRI machines of 1.5 T. The examinations were evaluated and the measurements were made by two physicians undergoing specialist training in the shoulder surgery service, with assistance from a radiologist who was a specialist in osteomuscular MRI. The measurements on the distance from the humerus to the acromion were made on sagittal slices and the shortest distance between the apex of the head and the acromion was established (Fig. 1: how the measurement was made). Through this measurement, the aim was to make the examination as reproducible as possible in consultation offices.

The statistical analysis relating to the size of the lesion was done using the ANOVA parametric test.

To evaluate the differences between the groups of lesion size and the variable of subacromial space, which comprised more than three groups, either the ANOVA parametric test or Student's *t* test for independent samples was used to compare the means between the groups. This analysis was also performed for the subacromial space in relation to the degree of tendon retraction according to the classification of Patte (I, II or III).

The data of this study were processed using the Predictive Analytics Software (PASW 18). In all the statistical tests, the significance level was taken to be 5%.

Results

Among the 181 shoulders evaluated (160 patients), 88 (48.6%) presented complete rotator cuff tears and formed the injury group, while 93 (51.3%) formed the control group.

Injury group

The patients' mean age was 65 years, and the age range was from 45 to 89 years. There were 43 males (48.8%) and 45 females (51.1%); 55 right shoulders were affected (62.5%) and seven patients were affected bilaterally (7.95%).

Regarding the locations of the injuries, 40 shoulders (45.45%) were injured in a superior location, eight (9.09%) anterosuperior, 27 (30.68%) posterosuperior and 13 (14.77%) anteroposterosuperior. The mean ages in these subgroups were 63, 66, 65 and 70 years, respectively (Table 1).

In analyzing the injuries regarding their degree of retraction, based on the classification of Patte,[14] there were 29 shoulders (32.95%) with grade I, 32 (36.36%) with grade II and 27 (30.68%) with grade III. The mean ages in the subgroups were, respectively, 62, 64 and 69 years (Table 2).

Control group

The patients' mean age was 61 years and the age range was from 45 to 79. There were 42 males (45.1%) and 51 females

Table 1 – Demographics of the injury group.

	n (%)	Mean age (range)	Mean subacromial space (range)
Injury group	88 (100)	65.19 (36–89)	6.97 (1.81–13.5)
Superior	40 (45.45)	63.47 (36–89)	7.78 (4.15–11.58)
Anterosuperior	8 (9.09)	66.25 (51–85)	8.28 (5.73–13.5)
Posterosuperior	27 (30.68)	65.03 (51–88)	6.77 (5.04–9.91)
Anteroposterosuperior	13 (14.77)	70.15 (55–87)	4.15 (1.81–10.11)

Table 2 – Demographics in relation to Patte's classification.

	n (%)	Mean age (range)	Mean subacromial space (range)
Injury group	88 (100)	65.19 (36–89)	6.97 (1.81–13.5)
Patte I	29 (32.95)	62.31 (36–78)	8.56 (4.22–13.5)
Patte II	32 (36.36)	64.28 (51–89)	7.23 (4.19–11.73)
Patte III	27 (30.68)	69.37 (51–88)	5.01 (1.81–10.11)

Table 3 – Correlation of subacromial space between the control and injury groups.

Group	*N*	Mean subacromial space	SD	*t* test	*p*-Value
Control	93	7.71	1.58	2.418	0.017[a]
Injury	88	6.99	2.37		

[a] The probabilities of significance (*p*-values) refer to Student's *t* test for independent samples.

Table 4 – Comparison between mean subacromial space measurements in the injury subgroups and in the control group.

Group	N	Mean subacromial space	SD	*t* test	*p*-Value
Control group	93	7.71	1.57		
Superior	40	7.8	1.75	−0.298	0.766
Anterosuperior	8	8.29	2.82	−0.92	0.36
Posterosuperior	27	6.77	1.85	2.622	0.010[a]
Anteroposterosuperior	13	4.16	2.57	6.97	0.000[a]

[a] The probabilities of significance (*p*-values) refer to Student's *t* test for independent samples.

(54.8%). The right shoulder was evaluated in 49 cases (52.6%) and both shoulders were used in the evaluation in 13 cases (13.9%).

In comparing the mean subacromial space between the injury and control groups, it was found to be significantly larger in the control group (7.71) than in the injury group (6.99), with $p < 0.05$ (Table 3).

Among the subgroups of patients with injuries (superior, anterosuperior, posterosuperior and anteroposterosuperior), it was seen that the mean subacromial space was different between the four subgroups. It was possible to make comparisons between pairs of subgroups in order to identify the real difference between them.

In analyzing the difference in mean subacromial space measurements between these subgroups and the control group, no statistical differences between the control group and the patients with either superior or anterosuperior lesions were observed ($p > 0.05$). On the other hand, in relation to the individuals with posterosuperior and anteroposterosuperior, it was noted that the subacromial space was statistically smaller than in the individuals in the control group or in the subgroups with superior and anterosuperior injuries. In comparing the differences in mean measurements of the subacromial space between the subgroups of posterosuperior and anteroposterosuperior injuries, which showed lower means than the other subgroups, we observed that the subgroup of anteroposterosuperior injuries presented a significantly lower mean (4.16) ($p < 0.05$), in relation to the subgroup of posterosuperior injuries (6.77) (Table 4).

In relation to the analysis on the mean measurements on the subacromial space between the injury subgroups classified in accordance with Patte and the control group, there was a statistical difference ($p < 0.05$) in relation to Patte subgroup I, which presented a larger subacromial space (8.57) than the control group (7.71); and in relation to Patte subgroup III, in which the mean sub acromial space measurement was smaller (5.01) than in the control group (7.71). The patients with injuries classified as Patte II presented a mean subacromial space measurement of 7.23, which was not statistically different from the control group (Table 5).

In evaluating these subgroups in relation to each other, it was observed that the individuals with Patte III injuries presented mean subacromial space measurements that were smaller than those of individuals with Patte I and Patte II injuries. Likewise, the subacromial space in individuals in Patte subgroup II was smaller than the space in individuals

Table 5 – Comparison between mean subacromial space measurements in the Patte subgroups and in the control group.

Group	N	Mean subacromial space	SD	*t* test	*p*-Value
Control group	93	7.71	1.58		
Patte I	29	8.57	1.91	−2.425	0.017[a]
Patte II	32	7.23	1.55	1.484	0.14
Patte III	27	5.01	2.25	7.063	0.000[a]

[a] The probabilities of significance (*p*-values) refer to Student's *t* test for independent samples.

Table 6 – Pair-by-pair comparison of mean subacromial space measurements in relation to the Patte classification.

Group	N	Mean subacromial space	SD	t test	p-Value
I	29	8.57	1.91	3.009	0.004[a]
II	32	7.23	1.55		
I	29	8.57	1.91	6.386	0.000[a]
III	27	5.01	2.25		
II	32	7.23	1.55	−4.472	0.000[a]
III	27	5.01	2.25		

[a] The probabilities of significance (*p*-values) refer to Student's *t* test for independent samples.

with Patte I injuries. Both of these comparisons presented statistically significant differences ($p < 0.05$) (Table 6).

In evaluating the subacromial space of individuals with posterosuperior injuries and comparing them in relation to the Patte classification, it was observed that those with posterosuperior injuries classified as Patte III presented a mean subacromial space measurement of 5.74, which was significantly smaller than the space in individuals with posterosuperior injuries classified as Patte I and II (7.48).

Discussion

Evaluation of the subacromial space by means of MRI may provide information on the biomechanics of the shoulder and the prognosis for rotator cuff injuries. In a study in which subacromial space measurements from conventional X-rays and magnetic resonance arthrography were compared, Saupe et al.[5] concluded that the reduction in distance was associated with rotator cuff injuries and fatty degeneration of the tendons. The same authors concluded that involvement of the infraspinatus tendon caused greater variation in the subacromial space. In our study, patients with rotator cuff injuries presented decreased distances from the humerus to the acromion, in comparison with the control group patients, with a statistically significant difference. In comparing the subacromial space in patients with rotator cuff injuries in different locations with patients in the control group, we found that the subacromial space was smaller in patients with injuries in the posterosuperior and anteroposterosuperior regions, with a statistically significant difference. These findings showed the importance of the tendon of the infraspinatus in maintaining the subacromial space.

In the studies by Patte[14] and Gerber et al.,[15] the biomechanical function of torn, retracted and degenerated tendons may be impaired, thereby enabling ascension of the humeral head.[15,16] Through comparing the variation of the subacromial space with the extent of the rotator cuff injury according to Patte's classification, it was concluded from the present study that Patte III injuries evolved with greater ascension of the humeral head. The association between Patte's classification and fatty degeneration is well known.

The prognostic value of the distance between the humerus and the acromion is well known and can be used to aid in therapeutic decision-making. Weiner and Macnab[17] were the first to describe an association between reduction of the subacromial space and rotator cuff injuries. They observed that if the distance was ≤7 mm on conventional radiographs, a complete tendon tear would be present. Subsequently, it was observed that this measurement of the subacromial space might also be associated with a lower success rate in surgical treatment.[18,19] Werner et al.[20] believed that the cutoff point for evaluating the ascension of the humeral head on MRI should be ≤6 mm, i.e. lower than on conventional radiographs. They attributed this to geometrical attributes and to the patient's position during the examination, which could cause alterations to muscle tonus.[21] The present study found a mean subacromial space measurement of 7.71 mm in the control group, which does not corroborate the findings of Werner et al.,[20] and 6.97 mm in patients with rotator cuff injuries. IN evaluating the tendon groups affected, we observed that only the patients who presented anteroposterosuperior injuries had subacromial spaces ≤6 mm (mean of 4.15 mm).

Conclusions

Ascension of the humeral head (reduction of the subacromial space) is directly related to the location and extent of the injuries. Thus, extensive injuries or those in a posterosuperior location present ascension of the humeral head, and this worsens when it is associated with advanced degrees of tendon retraction.

The ascension of the humeral head assessed through MRI does not influence the severity but, rather, the location and extent of rotator cuff injuries.

Posterosuperior and anteroposterosuperior injuries (extensive injuries) present ascension of the humeral head on MRI. The greater the degree of tendon retraction associated with these injuries is, the greater the ascension will be.

Conflicts of interest

The authors declare no conflicts of interest.

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