



Histologic and magnetic resonance image evaluation in acromioclavicular joint osteoarthritis



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Introduction: Little is known about the development of specific acromioclavicular joint osteoarthritis. Its histologic alterations are controversial, and radiologic alterations are seen in asymptomatic people. The objective of this study was to evaluate histologically the distal clavicle subchondral bone and to analyze magnetic resonance images in patients with painful and nonpainful acromioclavicular joint osteoarthritis.

Methods: An observational, analytical, and cross-sectional study with a control group was conducted. Between August 2018 and June 2019, we analyzed a total of 41 patients. Group 1 consisted of patients with pain in the acromioclavicular joint (symptomatic osteoarthritis), and group 2 consisted of patients without pain in the acromioclavicular joint (asymptomatic osteoarthritis).

Results: Twelve of the 15 patients with acromioclavicular joint pain (group 1) were female, 13 presented distal clavicle edema on magnetic resonance imaging, and 9 had subchondral bone edema on histologic examination. Patients with acromioclavicular joint pain had longer shoulder pain duration than patients without pain. Women were more likely to have acromioclavicular joint pain compared with men. Patients with edema on magnetic resonance imaging showed a greater chance of presenting pain in the acromioclavicular joint in comparison with patients without edema.

Conclusion: Women had a higher chance of presenting with acromioclavicular joint pain than men. Patients with edema on magnetic resonance imaging were more likely to present with pain than patients without edema. Patients with acromioclavicular joint pain had longer shoulder pain duration than patients without pain, and subchondral bone edema on histologic examination was more frequent in patients with pain.

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Osteoarthritis (OA) is the most common osteoarticular system disease and can affect one or several joints.¹¹ In the United States, it is estimated that 36% of the individuals older than 60 years have OA of the knees, but there is little data available on acromioclavicular joint (ACJ) osteoarthritis. The importance of evaluating this joint is due to the frequent association of distal clavicle osteolysis with supraspinatus tendon damage, joint osteophytes, and contribution to the subacromial impingement, exacerbating or producing shoulder pain.³

The causes of ACJ osteoarthritis development are the same as any other joint in the human body. Mechanical overload is

considered a key etiologic factor and can lead to subchondral fatigue fractures, hypervascularization (causing bone resorption), demineralization, osteopenia, cyst formation, and distal clavicle erosion.⁹

Histologic changes are still controversial, but subchondral bone sclerosis is believed to occur along with progressive cartilage degradation, which is widely considered as a hallmark of OA. Despite the increase in bone volume fraction, the subchondral bone becomes hypomineralized because of abnormal bone remodeling. Some histopathologic changes in the subchondral bone have also been detected, including microdamage, bone marrow edema-like lesions, and bone cysts.⁶ However, these analyses were performed in patients with OA of other joints, and no study specifically focused on the ACJ.

Changes in magnetic resonance imaging (MRI) are commonly found¹⁵ and indicate ACJ osteoarthritis; however, the correlation of these images with the patients' clinical evaluation is low. Bone

This study was approved by the Ethics Committee of the Hospital de Base do Distrito Federal, Brasília, DF, Brazil.

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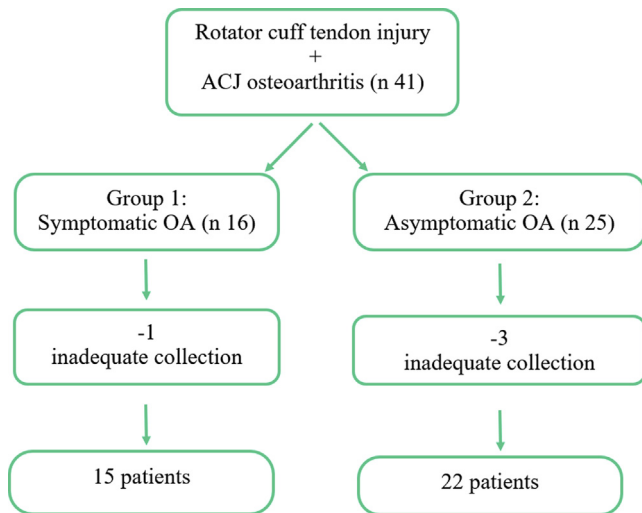


Figure 1 Flowchart of patients included in the study. ACJ, acromioclavicular joint; OA, osteoarthritis.

marrow edema imaging may predict the increased risk of osteoarthritis¹⁶ but are also observed among the asymptomatic and healthy population.

There is a controversy regarding the need for distal clavicle resection in patients with OA because some authors¹⁰ did not find clinical differences between patients who underwent distal clavicle resection and those who were not subjected to such procedure.

This study aimed to perform a histologic examination of the distal clavicle subchondral bone and MRI changes in patients with painful and nonpainful ACJ osteoarthritis.

Methods

An observational, analytical, and cross-sectional study with a control group was conducted.

Between August 2018 and June 2019, a total of 41 patients presenting injury in 1 or more rotator cuff tendons and ACJ osteoarthritis were successively analyzed. These patients underwent a videoarthroscopy for tendon injury repair and a distal clavicle resection according to the standard and usual internationally recognized technique.⁵ However, before the distal clavicle resection, a biopsy was performed, and photographs of the MRI were taken. Then, these patients were divided into 2 groups: group 1 consisted of patients with ACJ pain (symptomatic group), and group 2 consisted of patients without pain in the ACJ (asymptomatic group). All patients signed the free and informed consent form.

Of 41 patients, 16 were allocated in group 1 and 25 were allocated in group 2. One patient of group 1 and 3 of group 2 were excluded from the study because of an inadequate collection of biopsy material. Thus, in the final sample, there were 15 patients in group 1 and 22 patients in group 2 (Fig. 1).

To divide the patients into 2 groups, the pain was evaluated immediately before anesthetic induction through active compression test in the ACJ and cross-body adduction stress test, which can be performed actively by the patient or passively by the examiner, consisting in the upper limb horizontal flexion and adduction. The test is considered positive if the patient presents pain in the ACJ.^{1,2}

Therefore, inclusion criteria were defined as patients with ACJ osteoarthritis previously diagnosed by MRI, with or without pain on physical examination, and the decision was made by the type of the rotator cuff tendon injury. An exclusion criterion adopted was the biopsy sample quality, which was considered to be inadequate

when smaller than 2 cm and adequate between 2 and 3 cm (Fig. 2, B). Another exclusion criterion was the refusal by patients to sign the free and informed consent form. Noninclusion criteria were previous shoulder surgeries, fractures, neurologic sequelae, and rotator cuff injuries greater than 5 cm.

During the surgical procedure, before repairing the rotator cuff tendon injuries, an anterolateral portal was made initially using a 40×1.2-mm needle directed to the ACJ. In every case, when the optimal angulation was found, the needle was replaced with a biopsy needle (bone marrow and bone tissue biopsy needle), and a fragment of the distal clavicle was removed (Fig. 2). A diagonal direction to the joint surface was stipulated because that angle could enable the collection of layers needed for the histologic analysis. Then, resection of the standard distal clavicle was performed in all patients using the endoscopic resection tip.

Samples of the clavicle acromial border collected during the procedure were formalin-fixed and sent to the pathology laboratory of our hospital. The samples were submitted to standard histologic processing, stained using the hematoxylin-eosin method. The institution's pathologist then analyzed the slides.

A single radiologist analyzed all MRIs. The radiologist did not know whether the patient had ACJ pain or not. Based on previous research, these examinations were evaluated for 5 variables:

- distal clavicle inferior osteophyte (in coronal plane images [Fig. 3], a horizontal line in the inferior clavicle surface was used to measure the osteophytes),
- supraspinatus impingement by the ACJ (in coronal plane images, we evaluated whether there was supraspinatus joint compression),
- inferior capsular distension (in coronal plane images, the inferior capsule was measured as of the same horizontal line mentioned above),
- distal clavicle subchondral edema (hyperintensity on T2-weighted images with or without fat saturation, and hyperintensity on T1-weighted images), and
- joint space narrowing (in axial plane images, the shortest distance between the clavicle and the acromion was measured).

A descriptive and an association analysis were performed. Data analyses were performed using the software IBM Statistical Package for Social Sciences, version 23 (IBM, Armonk, NY, USA). The significance level used in the entire study was 5%.

Results

Qualitative variables are presented by frequency and percentage in Tables I and II. Most patients in this study underwent a right-side surgery (75.7%), were female (54.1%), and presented right-side dominance (91.9%). Regarding MRI changes, it was possible to note that 23 patients (62.2%) did not show significant ACJ impingement changes of the supraspinatus tendon or muscle, whereas 22 patients (59.5%) presented distal clavicle edema. Regarding histologic changes (Table II), 16 patients (53.3%) had mild cartilage degeneration. Most patients presented no edema (58.3%), and 25 (69.4%) presented osteoclasts (Fig. 4) in samples. Cartilage thickness was considered thin in 26 patients (83.9%), whereas in 21 patients (75.0%), the plate thickness was also small. In all analyzed specimens, a partial fragmentation of the bone trabeculae was observed. Osteocyte necrosis was present in all specimens, and no bone marrow hemorrhage was found in any of the examined fragments.

Quantitative variables are presented by the median, interquartile range (IQ), minimum, and maximum measurements in Table III. The patients' median age was 60 years, median shoulder

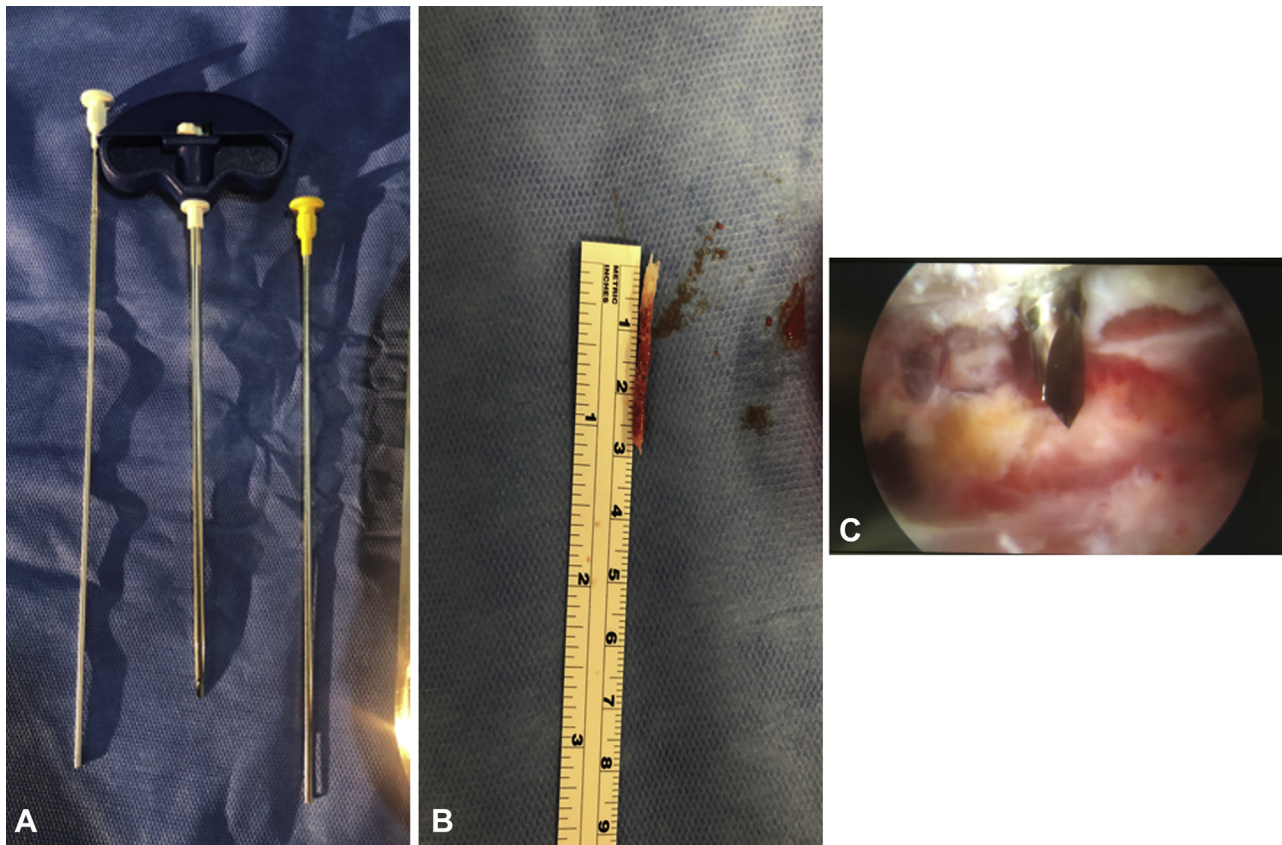


Figure 2 (A) Biopsy needle image. (B) Example of a collected fragment. (C) Needle entry image on a videoarthroscopy.

pain duration was 0.92 years, median osteophyte size on MRI was 2.0 mm, median joint capsule size on MRI was 3.5 mm, and median joint space was 3.0 mm. On measuring the joint capsule size, 2 patients presented inferior capsule rupture and were included as absent in [Table III](#). For qualitative variables, Pearson χ^2 statistical test was used.

[Table IV](#) shows a statistically significant difference between patients with and without pain concerning sex ($P = .009$). Twelve of the 15 patients who presented with ACJ pain (group 1) were female. Therefore, women were 7 times more likely to report ACJ pain than men. The variable edema on MRI was also statistically significant ($P = .005$), patients with edema were 9.4 times more likely to report ACJ pain than patients without edema. For histologic edema ($P = .028$), patients with edema were 4.800 times more likely to present ACJ pain than patients without edema on histologic examination. ACJ changes that cause supraspinatus impingement was more frequent in patients presenting pain but were not statistically relevant.

Regarding the quantitative variables' distribution, to compare the 2 groups (with and without pain), the Kolmogorov-Smirnov test was used. For most variables, the null hypothesis of data normality was rejected and, therefore, a nonparametric test was used to evaluate the independent samples (Mann-Whitney test). Using such quantitative variables' test for independent samples, only the variable shoulder pain duration (years) was statistically significant ($P < .001$). [Table V](#) shows that patients with ACJ pain had longer shoulder pain duration than patients without ACJ pain ([Fig. 5](#)).

Discussion

According to a 2008 study carried out by the National Collaborating Center for Chronic Conditions of the United Kingdom,¹⁴ in

patients older than 40 years, OA is more prevalent in women; thus, more female symptomatic OA patients were expected because of its higher incidence. This finding was an important point in the present study. Women were 7 times more likely to have symptomatic ACJ osteoarthritis than men. Our specific group of patients was nonathletic. Therefore, differences were expected to be found concerning the groups studied by Munford, where the prevalence was in men. Hence, as it is known, pain is subjective and may be linked to local factors, neuroplasticity, and general factors that vary from patient to patient.¹³

The association between shoulder pain duration and ACJ pain was identified as statistically significant ($P < .001$). It was not possible to evaluate the ACJ pain duration exclusively because patients could not discern shoulder pain from ACJ pain and also because it is a cross-sectional study, where patients were analyzed on the operating table at the immediate preoperative moment.

Similarly to Zanetti et al,¹⁷ it was difficult to obtain additional histologic data on the bone marrow edema pattern, as surgical treatment or biopsy usually is not performed in situations that may be associated with similar aspects of MRI. In this study, it was only possible to histologically analyze a small portion of the entire area of the distal clavicle presenting edema in MRI. Zanetti et al¹⁷ evaluated pieces of resected tibial plateaus of patients with gonarthrosis who underwent total arthroplasty, correlating the MRIs that presented edema with histologic findings. They concluded that the bone marrow edema—like pattern in osteoarthritic knees represents histologically noncharacteristic abnormalities that include bone marrow necrosis, bone marrow fibrosis, and trabecular abnormalities but only presents a small amount of bone marrow edema. The same findings were reached in the present study. There is edema in histology; however, it does not correspond to the entire area of edema in MRI. Such bone marrow

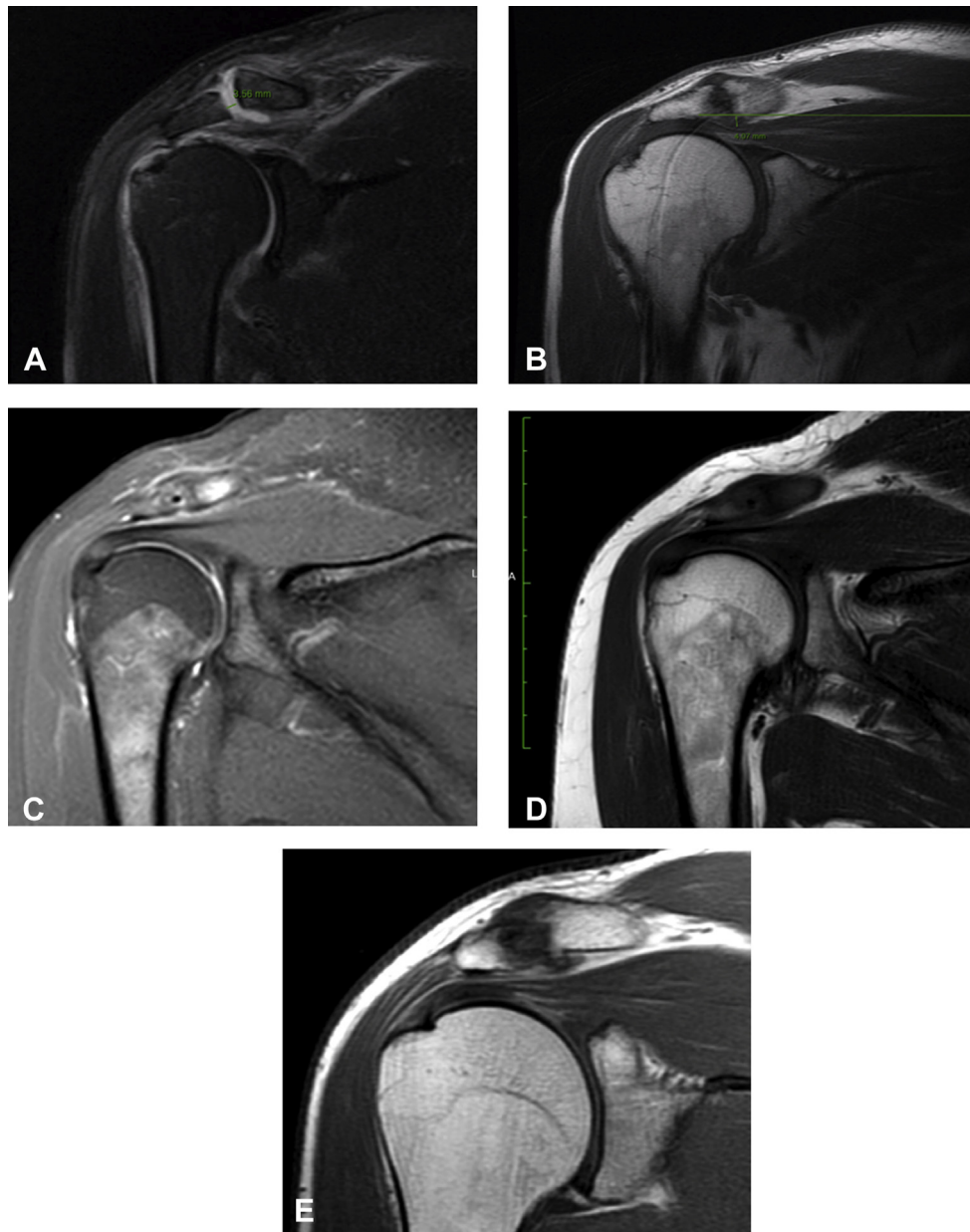


Figure 3 Magnetic resonance images. (A) Joint space. (B) Inferior osteophyte. (C and D) Distal clavicle edema. (E) Supraspinatus tendon impingement.

edema patterns described on MRI probably are not the most appropriate, but there is no better term that can be used by radiologists and orthopedists in a consensual manner yet.

The present study did not intend to compare the edema area in MRI with the histologic findings because it was not possible to resect the entire distal clavicle for analysis and comparison, and only a fragment was analyzed. However, the employed material collection method enabled sending the appropriate layers of cartilage and subchondral bone for analysis. In the study by Montenegro,⁸ the author states that the edema on MRI does not correspond to the edema area in histology and that the same area had several histologic changes, not only edema, which was also found in the present study. However, the biopsy collection technique was different from the one performed in this study, as the cartilage region was not resected. Patients with histologic edema were 4.8 times more likely to present with pain.

It was further found that patients with edema in MRI were 9.4 times more likely to present ACJ pain, showing the importance of this factor in preoperative analyses of patients. Just as in Veen et al,¹⁵ the bone marrow edema was significant on MRI.

It was possible to notice that both the subchondral plate and cartilage were considered thin, with no difference between the 2 groups. In their hypothetical model of OA pathogenesis, Li et al⁶ stated that there would be a progressive thinning of plate and cartilage because of the degenerative character of the disease. Considering this information, it is possible to conclude that the patients in the present study were at a more advanced OA stage.

Kim et al⁴ and Park et al¹⁰ evaluated patients divided into 2 groups. The first group had symptomatic ACJ osteoarthritis, and the second group consisted of asymptomatic patients, both with

Table I
Descriptive analysis of patients with painful and nonpainful acromioclavicular joint osteoarthritis treated at our hospital, 2018-2019

	Frequency	Percentage
Side that underwent surgery		
Right	28	75.7
Left	9	24.3
Sex		
Male	17	45.9
Female	20	54.1
Dominance		
Right	34	91.9
Left	3	8.1
Relation of the ACJ with the supraspinatus		
Does not touch the supraspinatus	23	62.2
Touches the supraspinatus	14	27.8
Resonance edema		
Without edema	15	40.5
With edema	22	59.5

ACJ, acromioclavicular joint.

Table II
Descriptive analysis of histologic changes in patients with painful and nonpainful acromioclavicular joint osteoarthritis treated at our hospital, 2018-2019

	Frequency	Percentage
Cartilage degeneration		
Mild	16	53.3
Intense	14	46.7
Unable to evaluate	7	
Histologic edema		
Without edema	21	58.3
With edema	15	41.7
Unable to evaluate	1	
Cartilage thickness		
Thin	26	83.9
Thick	5	16.1
Unable to evaluate	6	
Plate thickness		
Thin	21	75.0
Thick	7	25.0
Unable to evaluate	9	
Osteoclasts		
No	11	30.6
Yes	25	69.4
Unable to evaluate	1	

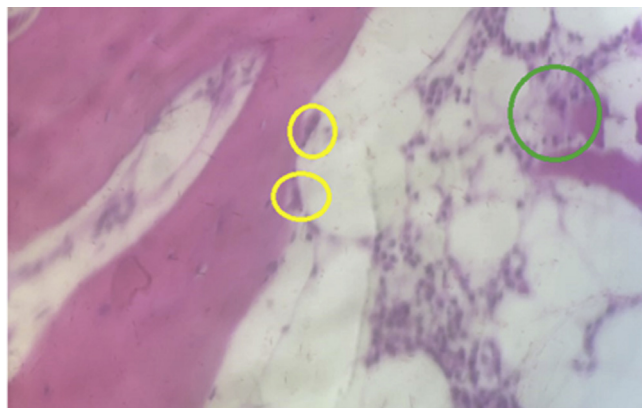


Figure 4 Osteoclasts (○) and edema region (○).

rotator cuff tendon injury. However, there were conflicting results regarding the ACJ resection in patients with OA, showing the need for understanding whether or not resection is indicated in the case of patients with cuff injuries.

Table III
Descriptive analysis of quantitative variables in patients with painful and nonpainful acromioclavicular joint osteoarthritis treated at our hospital, 2018-2019

	n	Absent	Median	IQR	Minimum	Maximum
Age, yr	37	0	60.00	12.00	41.00	79.00
Pain duration, yr	37	0	0.92	2.79	0.04	20.00
Osteophyte resonance, mm	37	0	2.00	3.00	0.00	5.00
Joint capsule resonance, mm	35	2	3.50	3.00	1.00	6.00
Joint space resonance, mm	37	0	3.00	1.00	1.00	6.00

IQR, interquartile range.

Table IV
Association analysis of qualitative variables with painful and nonpainful acromioclavicular joint osteoarthritis in patients treated at our hospital, 2018-2019

	Without ACJ pain, n (%)	With ACJ pain, n (%)	P value	OR	95% CI
Sex			.009	7.000	1.509, 32.478
Male	14 (36.6)	3 (20.0)			
Female	8 (36.4)	12 (80.0)			
Relation of ACJ with the supraspinatus			.109	3.048	0.765, 12.135
Does not touch the supraspinatus	16 (72.7)	7 (46.7)			
Touches the supraspinatus	6 (27.3)	8 (53.3)			
Resonance edema			.005	9.389	1.691, 52.130
Without edema	13 (59.1)	2 (13.3)			
With edema	9 (40.9)	13 (86.7)			
Histologic edema			.028	4.800	1.137, 20.272
Without edema	16 (72.7)	5 (35.7)			
With edema	6 (27.3)	9 (64.3)			
Unable to evaluate	0	1			
Total	22 (100.0)	15 (100.0)			

ACJ, acromioclavicular joint; OR, odds ratio; CI, confidence interval.

Table V
Association analysis of qualitative variables with painful and nonpainful acromioclavicular joint osteoarthritis in patients treated at our hospital, 2018-2019

	n	Absent	Without ACJ pain		With ACJ pain		P value
			Median	IQR	Median	IQR	
Age, yr	37	0	59.00	14.00	61.00	8.00	.843
Shoulder pain duration, yr	37	0	0.29	1.88	3.00	7.08	<.001
Osteophyte resonance, mm	37	0	2.00	3.00	2.50	2.00	.249
Joint capsule resonance, mm	35	2	3.25	2.50	4.00	3.30	.210
Joint space resonance, mm	37	0	3.00	1.40	3.00	1.00	.511

ACJ, acromioclavicular joint; IQR, interquartile range.

As in Singh et al,¹² it is possible to conclude that background and physical examination are indispensable for the diagnosis of ACJ osteoarthritis; however, there are reasons to believe that other factors may be useful in the surgical decision-making process—and MRI may be of greater value. The distal clavicle resection should be performed in some cases of ACJ osteoarthritis, but should not be performed routinely, as evidenced by Livingstone et al.⁷ More data should be gathered to aid in the indication of this procedure with a lower margin of error.

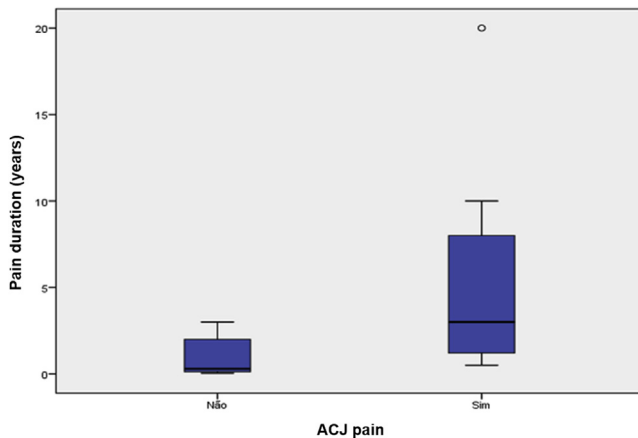


Figure 5 Pain duration (years) box plot of patients with and without pain in acromioclavicular joint osteoarthritis seen at our hospital, 2018-2019.

In the present study, it was possible to observe a certain tendency of patients with painful ACJ osteoarthritis to present, on MRI, osteophytes that caused an impingement (or compression) on the supraspinatus tendon or muscle, but it was not statistically significant ($P = .109$). It is the opposite of Veen et al.¹⁵ who stated that inferior osteophytes have a positive predictive value for ACJ osteoarthritis. Perhaps this association may be significant with a larger sample. Kim et al.⁴ questioned the need for distal clavicle resection in patients with inferior osteophytes, even where asymptomatic, but there is insufficient data to support such conduct.

One strength of the present study was the multiprofessional feature of the analyses, in which various medical specialties were involved, such as orthopedics, pathology, and radiology. Another strength was the sample collection: being diagonal, it was possible to collect all joint layers for analysis. The sample number was further considered significant.

Nevertheless, some weaknesses were further identified, perhaps because of the ACJ pain assessment. As recommended by Chronopoulos et al.¹ to improve the specificity and sensitivity of the ACJ pain assessment, a combination of tests was used: cross-body adduction and active compression test. It is known that pain is subjective, and there was an attempt to minimize the error by assigning only 1 evaluator to this data collection.

Conclusion

Women had a higher chance of presenting with ACJ pain than men. Patients with edema on MRI were more likely to present pain than patients without edema. Patients presenting with ACJ pain had longer shoulder pain duration than patients without ACJ pain, and subchondral bone edema on histologic examination was more frequent in patients with pain.

Disclaimer

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