VIA MEDICA

ORIGINAL ARTICLE

Folia Morphol.
Vol. 81, No. 4, pp. 991–997
DOI: 10.5603/FM.a2021.0087
Copyright © 2022 Via Medica
ISSN 0015–5659
eISSN 1644–3284
journals.viamedica.pl

Acromion types and morphometric evaluation of painful shoulders

R. Koca[1], Z. Fazlıogulları[2], B.K. Aydın[3], M.S. Durmaz[4], A.K. Karabulut[2], N. Unver Dogan[2]

[1]*Department of Physical Therapy and Rehabilitation, Faculty of Health Sciences, Afyonkarahisar Health Sciences University, Afyonkarahisar, Turkey*
[2]*Department of Anatomy, Faculty of Medicine, Selcuk University, Konya, Turkey*
[3]*Department of Orthopaedics and Traumatology, Selcuk University, Konya, Turkey*
[4]*Department of Radiology, Faculty of Medicine, Selcuk University, Konya, Turkey*

[Received: 9 June 2021; Accepted: 30 August 2021; Early publication date: 15 September 2021]

Background: *Due to its many variations, the scapula is among the most frequently examined bones. Especially the acromion can be of different shapes and sizes. Measurements of the morphometric structures in the shoulder joint make it easier to explain the cause of the various shoulder problems. The objective of this study is putting emphasis on the importance of acromion types, os acromiale presence and acromial morphometric measurements in the aetiology and diagnosis of shoulder pain.*
Materials and methods: *A retrospective study, based on 100 patients of both genders who presented with the complaints of shoulder pain and underwent magnetic resonance imaging, was conducted. Within this scope, types of acromion, slope of acromion, length of acromion, length of coracoid process, the distance between acromion and coracoid process, lateral acromial angle (LAA), critical shoulder angle (CSA), acromial index (AI) and acromiohumeral distance were measured. The data were analysed considering the gender and acromion types and the presence of os acromiale is investigated.*
Results: *The most common acromion was type II (curved) (frequency rate 62%) while the rate of type I (flat) and type III (hooked) acromions were 21% and 17%, respectively. The length of acromion and coracoid process were found to be significantly longer in males, while no significant difference between genders in terms of the distance between acromion and coracoid process were observed. Furthermore, while negative correlation between LAA and AI as well as LAA and CSA were observed; positive correlation between AI and CSA was found. In addition, there was negative correlation between slope of acromion and acromiohumeral distance. Besides, acromiohumeral distance was significantly higher in males. Regarding the presence of os acromiale, it was observed in 3 women out of 59 and 2 men out of 41, which indicated no significant difference between genders.*
Conclusions: *It is evaluated that the morphometric measurement is of importance in contributing clinically in distinguishing the problems that may occur according to gender and acromion types.* (Folia Morphol 2022; 81, 4: 991–997)

Key words: acromion, morphometric measurement, shoulder joint, subacromial impingement syndrome

Address for correspondence: Dr. R. Koca, Department of Physical Therapy and Rehabilitation, Faculty of Health Sciences, Afyonkarahisar Health Sciences University, Turkey, tel: +90 506 337 43 70, e-mail: rinerkoca@gmail.com

INTRODUCTION

Acromion types are classified with respect to their shapes. Acromions is named "type I" (flat) if they have straight line shape, "type II" (curved) if they curve forward elliptically and "type III" (hooked) if they have a sharp slope [1, 3, 4, 16, 17]. In addition to these shapes, Gagey et al. [8] identified a fourth shape, "type IV", with a convex surface.

Shoulder pain is the second most frequent pain in the society with the rate of 19–22% after low back pain [19]. Subacromial impingement syndrome (SIS) is the most common problem that causes shoulder pain and it occurs when the supraspinatus muscle tendon, bursa subacromialis and bicipital aponeurosis were compressed between the humerus, coracoid process and acromion [13].

Many studies on acromion morphology supported that acromion causes differences in the subacromial space according to its different types and these differences are parallel to the pathologies seen in the shoulder [2, 7].

Determining the different acromion types according to their slopes and shapes and the frequency of these types, comparison of the subacromial distances and measurement of the morphometric structures in the shoulder joint make it easier to explain the cause of the SIS as well as various shoulder problems.

Acromial apophysis develops from 4 separate ossification centres. Basiacromion fuses with scapula at the age of 12, while pre-acromion, meso-acromion and meta-acromion fuse with each other at the age between 15 and 18. Failure during this fusing process leads to "os acromiale". This kind of failure most frequently occurs in meso-acromion [7]. The meta-acromion is the origin of the posterior deltoid muscle, the middle fibres of the deltoid muscle begin from the mesoacromion, and the preacromion is the attachment site of both the anterior deltoid fibres and the coracoacromial ligament. Os acromiale usually does not cause any symptoms, but in some cases, it may cause impingement syndrome. It is usually detected incidentally in radiology; however, os acromiale can lead symptoms in some cases [12]. Both the diagnosis and treatment of a painful os acromiale is difficult [9].

Determining the types of acromion; observing the frequencies of acromion types; conducting the morphometric measurements for the length and the slope of the acromion, the length of the coracoid process, the distance between acromion and coracoid process, lateral acromial angle (LAA) and the acromial index (AI) along with the critical shoulder angle (CSA); comparing subacromial distance and detecting the presence of os acromiale can facilitate to explain the reasons of SIS. In this respect, this study aims to put emphasis on the importance of the acromion types, the presence of os acromiale and the morphological measurements of acromion.

MATERIALS AND METHODS

The study was conducted upon the approval of Selcuk University, Faculty of Medicine, Non-Invasive Clinical Research Ethics Committee dated 18.09.2019 and numbered 2019/220. The research was made retrospectively, based on 100 patients of both genders visited to the Department of Orthopaedics and Traumatology at Selcuk University Faculty of Medicine between 2010 and 2019 with the complaints of shoulder pain and underwent magnetic resonance imaging. A 1.5 T magnetic resonance imaging (MRI) device (Siemens Area, Earlangen, Germany) serving in the Radiology Department of Selcuk University Faculty of Medicine was used.

In this study, acromion was examined in three types including type I, type II, and type III (Fig. 1).

Slope of acromion, which was evaluated to cause impingement syndromes, was measured. In order to measure the slope, a line was drawn from the front of the acromion towards the midpoint of the acromion. A second line was drawn from the back of the acromion towards the midpoint of the acromion and the angle between them was calculated as the slope of the acromion (Fig. 2A).

The length of acromion was measured as the distance between anterior end and posterior end of acromion in sagittal section while the length of coracoid process was measured as the distance between the anterior end and posterior end of the coracoid process. In addition, the distance between acromion and coracoid process was measured from acromion's endpoint to coracoid process's endpoint (Fig. 2B).

Another parameter examined was the lateral acromial angle. LAA was measured as the angle between the intersection of a line drawn tangentially from the lower surface of the acromion and a line drawn vertically in the most lateral of glenoid cavity from the superior and inferior (Fig. 3A).

The first distance, the distance between a line drawn vertically from the superior and the inferior in the most lateral of the glenoid cavity and the line drawn from the most lateral of the acromion was defined as 'GA'.

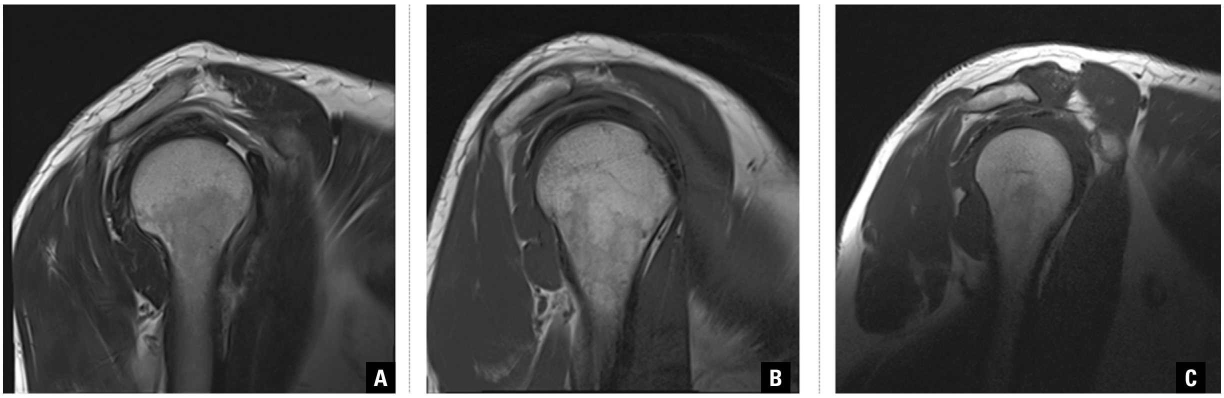

Figure 1. Types of acromion; **A.** Type I (flat); **B.** Type II (curved); **C.** Type III (hooked).

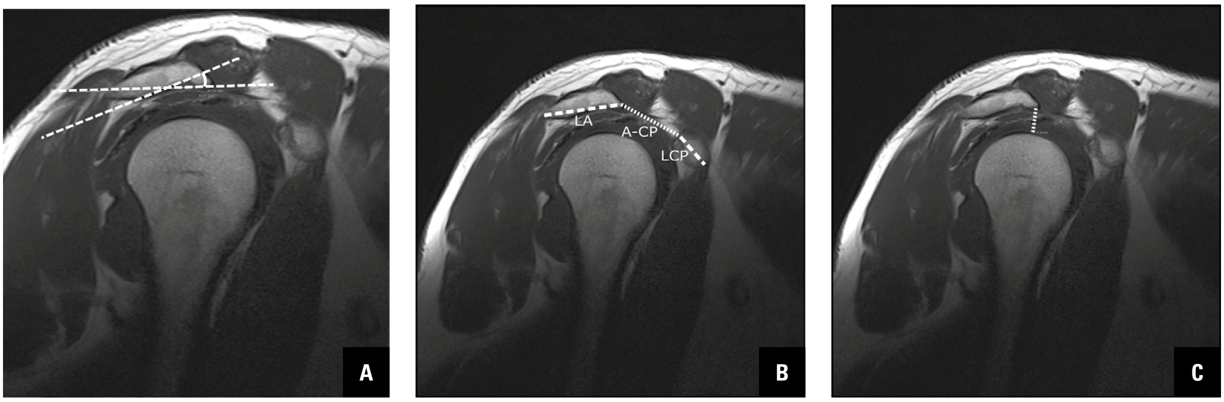

Figure 2. A. Slope of acromion; **B.** Lengths of acromion (LA), lengths of coracoid process (LCP) and the distance between acromion and coracoid process (A-CP); **C.** Acromiohumeral distance.

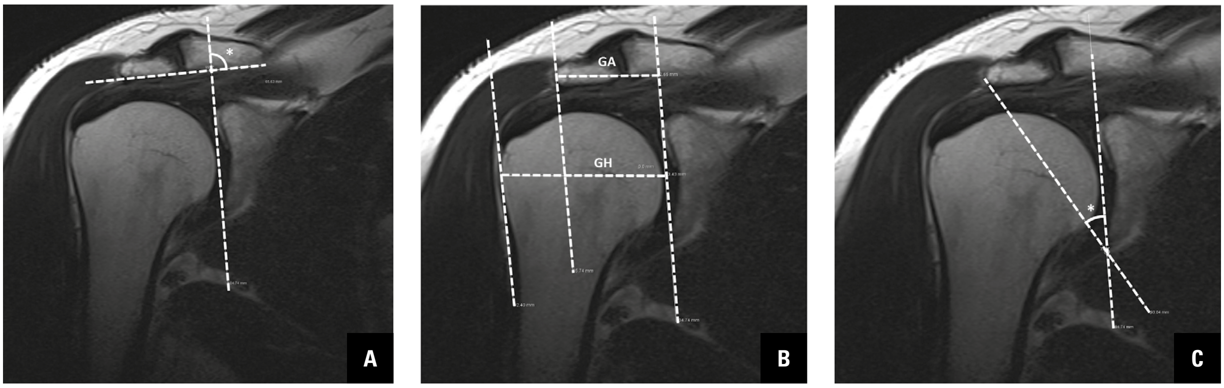

Figure 3. Parameters of acromial morphology in magnetic resonance imaging; **A.** Lateral acromial angle (*); **B.** Acromial index (AI = GA / GH); **C.** Critical shoulder angle (*).

The second distance was defined as 'GH' between a line drawn vertically from the superior to the inferior in the most lateral of the glenoid cavity and the line drawn from the most lateral of the caput humeri. In addition, the acromion index was calculated as the ratio of the GA and GH distances (AI = GA / GH) (Fig. 3B).

The critical shoulder angle was measured as the angle between a line drawn vertically from the superior to the inferior in the most lateral of the glenoid cavity and the line drawn from the most lateral of the acromion to the lowest point of the glenoid cavity (Fig. 3C).

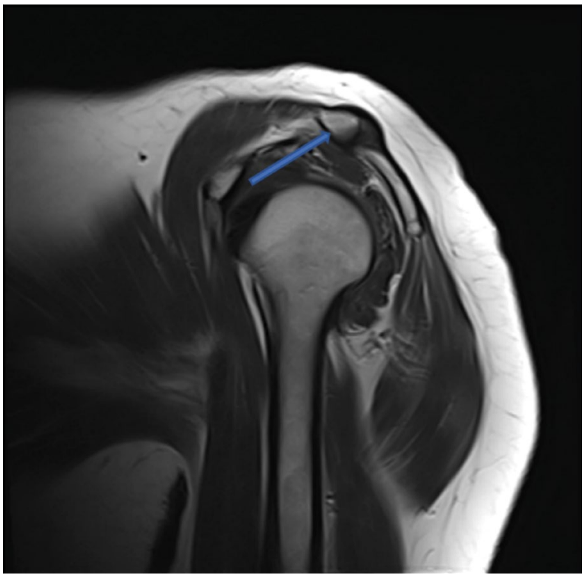

Figure 4. Os acromiale (arrow).

Table 1. Types of acromions by gender

Types of acromions	Females	Males	Total
Type I	11 (18.6%)	10 (24.4%)	21 (21.0%)
Type II	39 (66.1%)	23 (56.1%)	62 (62.0%)
Type III	9 (15.3%)	8 (19.5%)	17 (17.0%)
Total	59	41	100

Data are shown as number (%).

Acromiohumeral distance was measured at the closest distance between the top of the caput humeri and the acromion tip in the sagittal section on MRI (Fig. 2C).

Os acromiale, which is formed as a result of the failure during the fusing of four separate ossification centres in acromion, was observed in sagittal section in MRI for both men and women (Fig. 4).

Statistical analysis

SPSS 25 statistical software was used to analyse data within the scope of this study. During the comparisons with respect to acromion types, ANOVA was conducted if the data distribution was normal. On the other hand, Kruskal-Wallis test among non-parametric tests was used if the data did not follow the normal distribution. During the comparisons according to gender, t-test was implemented in the case of normal distribution and Mann-Whitney U test was used for non-normally distributed data.

RESULTS

The most common acromion was type II acromion with 62% frequency rate. Type II acromion was the most common among both females (39) and males (23). The distribution of acromion types by gender is summarised in Table 1.

Slopes of acromions, lengths of acromions, lengths of coracoid processes, the distances between acromions and coracoid processes, lateral acromial angles, critical acromion angles, acromial indexes and acromiohumeral distances by acromion types are given in Table 2.

While the mean slope of type I acromions was statistically lower than that of type II and type III acromions ($p < 0.05$), no significant difference was found between the mean slopes of type II and type III acromions ($p > 0.05$).

When the lengths were analysed according to gender, the acromions and coracoid processes were observed to be significantly longer in males than females ($p < 0.05$). Moreover, acromiohumeral distance was found to be significantly longer in males than females ($p < 0.05$). The comparisons based on gender are given in Table 3.

Furthermore, negative correlation between LAA and AI as well as LAA and CSA were observed. On the other hand, positive correlation between AI and CSA was found. In addition, there was negative correlation between slope of acromion and acromiohumeral distance.

Regarding the presence of os acromiale, it was observed in 3 women out of 59 and 2 men out of 41, which indicated no significant difference between genders ($p > 0.05$).

DISCUSSION

Shoulder pain is one of the major complaints of the patients in orthopaedic clinics. Physical examination and radiological imaging are essential for evaluating patients. X-ray, computed tomography and MRI are in use. Nowadays MRI is more popular because of its high resolution and visualising soft tissues without using radiation. In this study, all the measurements were done using MRI; the clinical relation to shoulder pain was evaluated with the anatomical variations.

One of the most common problems causing shoulder pain is SIS [10]. Structural changes occurring in acromion can also increase impingement syndromes. Also, various studies proposed that any of the degen-

Table 2. Acromial morphometric measurements by types

	Total	Type I	Type II	Type III	P
Slope of acromion [°]	15.90 ± 7.02	5.58 ± 3.73	18.15 ± 4.71	20.41° ± 4.68	0.000
Length of acromion [mm]	36.21 ± 5.43	34.95 ± 5.18	36.56 ± 5.27	36.49 ± 6.38	0.397
The distance between acromion and coracoid process [mm]	30.48 ± 6.44	30.04 ± 8.14	30.64 ± 5.73	30.40 ± 6.94	0.933
Length of coracoid process [mm]	15.59 ± 3.08	15.87 ± 2.71	15.68 ± 3.44	14.89 ± 1.88	0.607
Lateral acromial angle [°]	78.77 ± 7.35	76.61 ± 8.10	79.17 ± 6.81	80.00 ± 8.22	0.296
Acromial index	0.67 ± 0.09	0.66 ± 0.10	0.67 ± 0.09	0.66 ± 0.09	0.683
Critical acromion angle [°]	34.51 ± 5.38	33.34 ± 6.69	35.17 ± 5.03	33.58 ± 4.73	0.301
Acromiohumeral distance [mm]	9.81 ± 1.96	10.49 ± 2.35	9.63 ± 1.90	9.59 ± 1.49	0.198

Data are shown as mean ± standard deviation.

Table 3. Morphometric measurements of acromion by gender

	Total	Females	Males	P
Slope of acromion [°]	15.90 ± 7.02	16.46 ± 6.73	15.08 ± 7.42	0.336
Length of acromion [mm]	36.21 ± 5.43	34.15 ± 3.80	39.18 ± 6.07	0.000
The distance between acromion and coracoid process [mm]	30.48 ± 6.44	29.55 ± 6.15	31.80 ± 6.69	0.086
Length of coracoid process [mm]	15.59 ± 3.08	14.33 ± 2.25	17.40 ± 3.22	0.000
Lateral acromial angle [°]	78.77 ± 7.35	79.30 ± 7.79	78.01 ± 6.69	0.390
Acromial index	0.67 ± 0.09	0.67 ± 0.10	0.66 ± 0.09	0.676
Critical acromion angle [°]	34.51 ± 5.38	34.55 ± 5.69	34.46 ± 4.97	0.938
Acromiohumeral distance [mm]	9.81 ± 1.96	9.34 ± 1.69	10.48 ± 2.14	0.006

Data are shown as mean ± standard deviation.

erative, anatomical, traumatic, vascular, and mechanical causes can lead to SIS [15].

Many researchers interpreted types of acromion, slope of acromion, length of acromion and their relationships to surrounding structures may be associated with many pathologies such as SIS, rotator cuff injuries and tendinitis [6]. Type of acromion is the most studied parameter within this context [1, 3, 4, 6, 8, 16, 17]. Acromion types are classified as type I, type II and type III [1, 3, 4, 16, 17]. In Boyan et al.'s study (2018) [4], the type of acromion according to tilt there were 15.2% type I and 84.8% type II and no type III acromion. El-Din and Ali (2015) [14] stated that degenerative changes were more common in individuals with type III acromion and that many problems in the shoulder were seen more frequently with increasing age. Within the scope of this study on painful shoulders, the most common acromions were type II acromions with 62% frequency rate while the rate of type I and type III acromions were 21% and 17%, respectively. So, this can be an important factor for the decision on further imaging modality such as MRI. The evaluation of subacromial impingement and the status of soft tissues and their continuity and localizations are important for SIS. On the other hand, type IV acromion was not encountered. It should be noted that the average age of the patients was 53.35 ± 1.10 in this study. Accordingly, it could be interpreted that there might be an increase in the frequency of type III acromions if the average age was higher.

Balke et al. (2013) [3] observed an important relationship between types of acromion and the slopes of acromions. Similarly, in this study, the difference between the mean slopes of type I and type II acromions were found to be significant as well as the difference between the mean slopes of type I and type III acromions. On the other hand, the difference between the mean slopes of type II and type III acromions were not statistically significant.

The averages obtained from the values of the measures of the scapula were significantly higher in the population of male individuals [5]. A lot of studies given, the means of acromion lengths of males are higher than the ones of females [1, 6, 18]. Similarly, the length of acromions and the length of coracoid process of males were found to be significantly higher than the ones of females in our study.

Most of the studies in the literature that measured LAA, AI and CSA were carried out to compare certain pathologies [3, 11]. In this paper, these parameters were analysed according to acromion types and gender and no statistically significant difference were observed. Moreover, the presence of correlation between LAA, AI and CSA were analysed in addition to the similar studies in the literature. In this scope, negative correlations between LAA and AI as well as LAA and CSA were observed. On the other hand, positive correlation between AI and CSA was found.

The decrease in acromiohumeral distance is one of the factors that cause subacromial compression [20]. The mean of acromiohumeral distance in subacromial impingement patients was shorter than that in patients without subacromial impingement [18]. Saupe et al. (2006) [20], stated that acromiohumeral distance less than 7 mm indicates that the rotator cuff muscles may be torn. In this study, the averages of acromiohumeral distance of type I, type II, and type III were measured as 10.49 ± 2.35, 9.63 ± 1.90, and 9.59 ± 1.49, respectively. In addition, it was determined that the mean acromiohumeral distance of females was significantly shorter than that of men. The reason of this finding is assessed to be due to conditions such as postmenopausal osteoporosis considering the age factor. Although there was no significant difference in terms of acromiohumeral distance averages according to acromion types, a negative correlation was found between acromion slope and acromiohumeral distance in this study. It is interpreted that the acromiohumeral distance narrows and this causes more jams and complaints of impingement syndromes as the slope increases. The short distance of acromiohumeral distance can also be suspected by measuring the acromial slope.

Edelson et al. (1993) [7] examined 270 scapulae and found os acromiale in 8.2% of all. This rate was 8% in Hurst et al.'s study (2019) [9]. On the other hand, frequency rate for os acromiale was 5% in this study. It was observed in 3 women out of 59 and 2 men out of 41. According to the results having os acromiale is not common in both genders. So, clinically, presence of os acromiale is not an important factor of shoulder pain for both genders.

This study focuses on the shoulder problems in general; however, expanding the analysis based on the pathologies occurring in rotator cuff muscles individually may provide more comprehensive information. Furthermore, the findings of this study do not reflect healthy individuals, since analysed data was based on measurements made on MRI of patients with shoulder pain. Moreover, increasing the number of patients may provide us more reliable results.

Determining the types of acromions, identifying the relationship of acromions with surrounding structures, morphometric measurements of shoulder joint and detection of the presence of os acromiale help to determine the aetiology and diagnosis of diseases such as SIS that cause shoulder problems. Besides, the comparison of the morphometric measurements of the shoulder joint according to acromion types and gender is advantageous in terms of investigating disease factors around the shoulder.

CONCLUSIONS

It is assessed that the morphometric measurements of the shoulder joint can contribute to the existing literature in a clinical sense and will enable the differentiation of the problems that may occur according to gender and acromion types.

Conflict of interest: None declared

REFERENCES

1. Anetzberger H, Putz R. The scapula: principles of construction and stress. Acta Anat (Basel). 1996; 156(1): 70–80, doi: 10.1159/000147830, indexed in Pubmed: 8960301.
2. Aragão JA, Silva LP, Reis FP, et al. Analysis on the acromial curvature and its relationships with the subacromial space and types of acromion. Rev Bras Ortop. 2014; 49(6): 636–641, doi: 10.1016/j.rboe.2013.10.005, indexed in Pubmed: 26229874.
3. Balke M, Schmidt C, Dedy N, et al. Correlation of acromial morphology with impingement syndrome and rotator cuff tears. Acta Orthop. 2013; 84(2): 178–183, doi: 10.3109/17453674.2013.773413, indexed in Pubmed: 23409811.
4. Boyan N, Ozsahin E, Kizilkanat E, et al. Assessment of Scapular Morphometry. Int J Morphol. 2018; 36(4): 1305–1309, doi: 10.4067/s0717-95022018000401305.
5. Costa AO, Albuquerque PF, Albuquerque Pde, et al. Morphometric analysis of the scapula and their differences between females and males. Int J Morphol. 2016; 34(3): 1164–1168, doi: 10.4067/s0717-95022016000300057.
6. Edelson JG, Taitz C. Anatomy of the coraco-acromial arch. Relation to degeneration of the acromion. J Bone Joint Surg Br. 1992; 74(4): 589–594, doi: 10.1302/0301-620X.74B4.1624522, indexed in Pubmed: 1624522.
7. Edelson JG, Zuckerman J, Hershkovitz I. Os acromiale: anatomy and surgical implications. J Bone Joint Surg Br. 1993; 75(4): 551–555, doi: 10.1302/0301-620X.75B4.8331108, indexed in Pubmed: 8331108.

8. Gagey N, Ravaud E, Lassau JP. Anatomy of the acromial arch: correlation of anatomy and magnetic resonance imaging. Surg Radiol Anat. 1993; 15(1): 63–70, doi: 10.1007/BF01629865, indexed in Pubmed: 8488437.
9. Hurst SA, Gregory TM, Reilly P. Os acromiale: a review of its incidence, pathophysiology, and clinical management. EFORT Open Rev. 2019; 4(8): 525–532, doi: 10.1302/2058-5241.4.180100, indexed in Pubmed: 31538003.
10. Khan Y, Nagy MT, Malal J, et al. The painful shoulder: shoulder impingement syndrome. Open Orthop J. 2013; 7: 347–351, doi: 10.2174/1874325001307010347, indexed in Pubmed: 24082973.
11. Li X, Xu W, Hu N, et al. Relationship between acromial morphological variation and subacromial impingement: A three-dimensional analysis. PLoS One. 2017; 12(4): e0176193, doi: 10.1371/journal.pone.0176193, indexed in Pubmed: 28441418.
12. Mellado JM, Calmet J, Domènech S, et al. Clinically significant skeletal variations of the shoulder and the wrist: role of MR imaging. Eur Radiol. 2003; 13(7): 1735–1743, doi: 10.1007/s00330-002-1660-3, indexed in Pubmed: 12835990.
13. Michener L, McClure P, Karduna A. Anatomical and biomechanical mechanisms of subacromial impingement syndrome. Clin Biomech. 2003; 18(5): 369–379, doi: 10.1016/s0268-0033(03)00047-0.
14. El-Din WA, Ali MH. A morphometric study of the patterns and variations of the acromion and glenoid cavity of the scapulae in Egyptian population. J Clin Diagn Res. 2015; 9(8): AC08–AC11, doi: 10.7860/JCDR/2015/14362.6386, indexed in Pubmed: 26435934.
15. Neviaser RJ, Neviaser TJ. Observations on impingement. Clin Orthop Relat Res. 1990(254): 60–63, indexed in Pubmed: 2182259.
16. Nicholson G, Goodman D, Flatow E, et al. The acromion: Morphologic condition and age-related changes. A study of 420 scapulas. J Shoulder Elbow Surg. 1996; 5(1): 1–11, doi: 10.1016/s1058-2746(96)80024-3.
17. Paraskevas G, Tzaveas A, Papaziogas B, et al. Morphological parameters of the acromion. Folia Morphol. 2008; 67(4): 255–260, indexed in Pubmed: 19085865.
18. Park H, Lee S, Choi Y, et al. Association between subacromial impingement and acromiohumeral distance on MRI. Iranian J Radiol. 2018; 15(2), doi: 10.5812/iranjradiol.13811.
19. Picavet H, Schouten J. Musculoskeletal pain in the Netherlands: prevalences, consequences and risk groups, the DMC3-study. Pain. 2003; 102(1): 167–178, doi: 10.1016/s0304-3959(02)00372-x.
20. Saupe N, Pfirrmann CWA, Schmid MR, et al. Association between rotator cuff abnormalities and reduced acromiohumeral distance. Am J Roentgenol. 2006; 187(2): 376–382, doi: 10.2214/AJR.05.0435, indexed in Pubmed: 16861541.