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The Prevalence of Os Acromiale in Korean Patients Visiting Shoulder Clinic

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Background: The prevalence of os acromiale has been documented to be between 1% and 15% and is known to be clinically associated with subacromial impingement or rotator cuff tear. However, the prevalence of os acromiale in Korea has not yet been determined. The purpose of this study is to evaluate the prevalence of os acromiale in Korean patients who visited shoulder clinics and to investigate the correlations with rotator cuff tear.

Methods: We retrospectively reviewed the X-rays of patients visiting a shoulder clinic at a tertiary hospital in Korea from January 2011 to January 2012 to determine the frequency of os acromiale. X-ray findings were confirmed with magnetic resonance imaging (MRI) for patients who had these images available. MRI was also used to assess the status of the rotator cuff. The correlation between the presence of os acromiale either with gender, hand dominance or rotator cuff tear was analyzed statistically.

Results: A total of 2,946 shoulders from 1,568 patients were analyzed with X-rays. Thirteen cases out of 1,568 patients had an os acromiale; and there were five and eight cases of pre-acromiale and meso-acromiale, respectively. Thus, the prevalence of os acromiale in this study population was found to be 0.7 (7 cases per 1,000 patients). Bilaterality was found in two cases. Os acromiale was not more frequent according to gender (five males versus eight females, $p = 0.525$) and hand dominance was not associated with frequency of os acromiale (seven dominant arms versus six non-dominant arms, $p = 0.631$). A sub-analysis of shoulders with available MRIs (1,074 shoulders) revealed that there were two rotator cuff tears (40%) out of five cases of os acromiale, whereas 607 rotator cuff tears were observed (57%) among 1069 cases without os acromiale. This difference was not statistically significant ($p = 0.656$).

Conclusions: The identified prevalence of os acromiale in Korean patients who visited shoulder clinics is 0.7%, which is much lower as compared with the prevalence of general population from other ethnic groups. No correlation was observed between rotator cuff tears and os acromiale in this study population.

Keywords: *Os acromiale, Rotator cuff tear, Radiography*

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Os acromiale results from failure of fusion in the secondary ossification center of the acromion. Frequently, the distal fragment forms a fibro-cartilaginous union with the rest of the acromion,[1,2] whereas, in some cases, the os acromiale forms a distinct synovial joint with the rest of the acromion.[3] Clinically, os acromiale has been associated with rotator cuff disease.[4-6] Trauma to the os acromiale might result in painful sequelae, which may become chronic if not recognized and being treated.[7] In most cases, an os acromiale is best detected with an axillary lateral radiograph of the shoulder,[5,7] although other

imaging studies including oblique radiographs, magnetic resonance imaging, and computed tomography, have also been used.[8-10)]

The reported prevalence of os acromiale varies from 1.4% to 15% for the general population, with most studies being conducted amongst white and black people.[1-3,11,12)] The rate of bilateral involvement has been reported to range from 33% to 62%.[2,3,12)] However, our outpatient clinic experiences lead us to believe that the prevalence of os acromiale in Koreans is much lower than previously reported from other populations. To our knowledge, no study has assessed the prevalence of os acromiale in Koreans or Asian populations. Based on evidence that os acromiale might have genetic links among different ethnic groups,[3,13,14)] we decided to perform a retrospective radiologic study to estimate the prevalence of os acromiale in Koreans. This study was performed to define the frequency of os acromiale in Korean patients who visited our shoulder clinics, and to determine its relationship to pathological conditions such as rotator cuff tears.

METHODS

This study is a retrospective radiological analysis mainly using simple X-rays. Korean patients who visited our shoulder clinic at a tertiary referral hospital in Seoul, Korea, were included from January 2011 to January 2012. Inclusion criteria for this study were: 1) patients of Korean ethnicity, 2) age over 21 years since the fusion of the acromial apophysis is known to be completed at this age,[3)] and 3) available axillary view, Y (supraspinatus outlet) view and/or 30-degree caudal-tilt view simple X-rays. If there was apparent evidence of recent or remote fractures around shoulder joint in simple X-rays, we excluded such cases from this study (31 cases).

All the radiographs including images shown in this manuscript are being obtained on the patient's first visit to clinic from the study period and are being assessed using the PACS (Picture Archiving Communication System, GE Medical, Milwaukee, WI, USA). Criteria used for diagnosing os acromiale on X-rays are as follows: 1) On axial view (Fig. 1), an os acromiale appears as a clear gap with regular edges. The margins between the os acromiale and scapula are sharp (different from a fractured acromion in which the gap is irregular between the fragments with occasional signs of bone healing). A fractured traction spur was distinguished from an os acromiale (pre-acromiale) by evaluating the Y view and the 30 degree caudal tilt view. The profile of the acromion and any traction spur can be clearly visualized in these views.[5)] 2) The double density sign on antero-posterior X-ray and the cortical irregularity sign on the outlet view, as reported by Lee et al.[11)] were only used to further confirm the presence of an os acromiale seen on axial view. The first density of the double-density sign represents the circumferential cortical margin of either a pre-acromion or a meso-acromion. The second density is created by the anterior cortical margin of the remaining acromial process. These radiographic densities are combined to appear as two elongated cortical rings. The supraspinatus outlet view shows a profile of the acromion, and cortical irregularity of the normally smooth acromion is frequently noted in patients with os acromiale.

In patients who underwent magnetic resonance imaging (MRI) of the shoulder, X-ray findings were confirmed with the MRI. MRI is used for analysis only when the adequate axial and oblique sagittal image with both T1 and T2 sequences were available. The MRI was also used to assess the rotator cuff status of the patients. Criteria used for diagnosing os acromiale on MR were as follows:[10)] 1) The fusion defect was characterized by a low signal

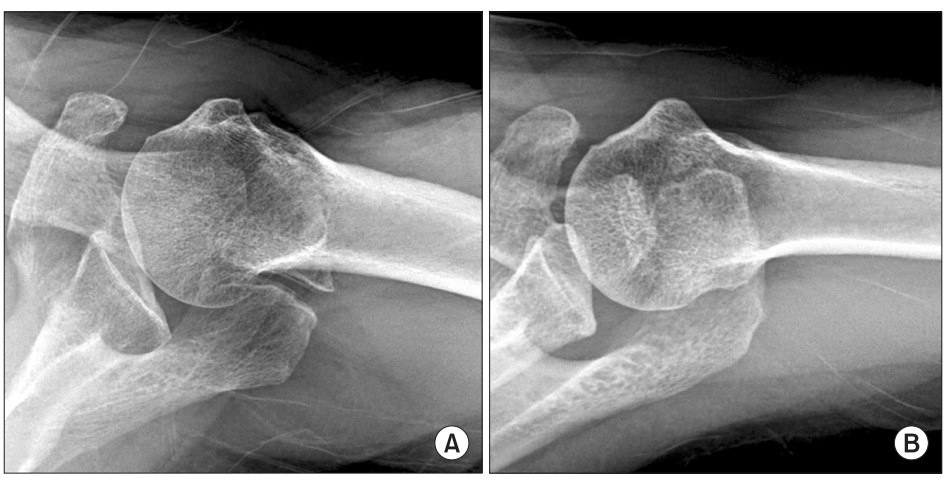

Fig. 1. A meso-acromion (A) and pre-acromion (B) on axial radiograph.

defect intervening in the normally high signal intensity of the distal acromion bony structure on the T1 axial image (Fig. 2). 2) The vertical line sign was used to re-confirm the os acromiale. The "pseudo-acromio-clavicular (AC) joint" was often noted to lie in a more posterior location than that expected for the true AC joint on oblique sagittal images.

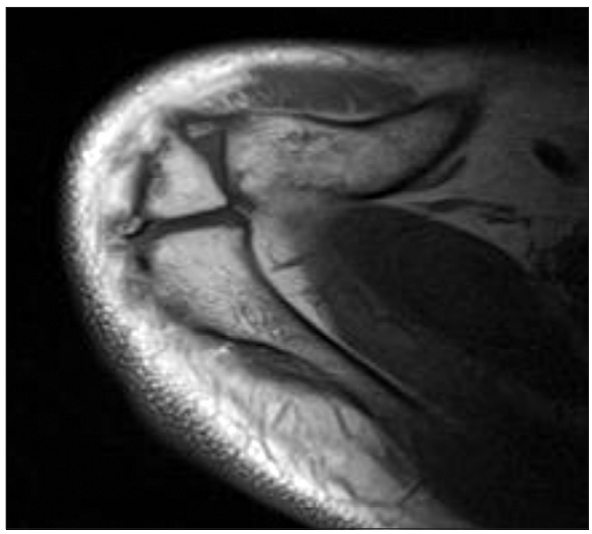

Fig. 2. The fusion defect was seen on the axial T1 magnetic resonance image.

All the X-rays were evaluated by a shoulder fellowship trained orthopedic surgeon. The MRIs were analyzed by the same shoulder surgeon two months after analyzing the X-rays. Cases with doubts regarding the diagnosis based on radiographic appearance were discussed among a panel of five shoulder surgeons with majority decision considered final. Eights cases were discussed among a panel due to its ambiguity in diagnosis. In every case, the patient's age, gender, and hand dominance were being retrieved from electronic medical records. Clinical details such as the final diagnosis and treatments offered were also noted from the records. The correlation between the presences of os acromiale and gender or hand dominance was determined by the chi-square method. The correlation between the presence of an os acromiale and rotator cuff tear was evaluated using Fisher exact test.

RESULTS

A total of 1,568 patients (741 males) were included in this study, but only 2,946 shoulders were assessed as not all patients had radiographs for both sides. Both X-rays and MRIs were available for 1,074 shoulders while only X-rays were taken of the remaining 1,872 shoulders. The average

Table 1. Clinical Diagnosis and Treatment Details of Os Acromiale Cases

Case no.	Type of Os acromiale	MRI	Rotator cuff status on MRI	Final diagnosis	Treatment
1	MA	+	Normal with tendinosis	Frozen shoulder	Arthroscopic pan-capsular release
2	MA	+	Normal	Recurrent dislocation	Capsular plication
3	MA	+	Subscapularis partial tear	Biceps partial tear, subscapularis partial tear	Conservative
4	MA	-	NA	Asymptomatic	-
5	MA	+	PTRCT	Severe glenohumeral arthritis with infraspinatus wasting	Reverse shoulder arthroplasty
6	MA	-	NA	Asymptomatic	-
7	MA	+	FTRCT	FTRCT	Rotator cuff repair
8	MA	-	NA	Asymptomatic	-
9	PA	-	NA	Suspicious impingement syndrome	Conservative
10	PA	-	NA	Asymptomatic	-
11	PA	-	NA	Asymptomatic	-
12	PA	-	NA	Asymptomatic	-
13	PA	-	NA	Asymptomatic	-

MRI: magnetic resonance imaging, MA: meso acromiale, NA: not available, PTRCT: partial thickness rotator cuff tear, FTRCT: full thickness rotator cuff tear, PA: pre-acromiale.

patient age was 55.7 years (range, 21 to 91 years).

There were 13 cases of os acromiale (11 patients) out of 2,946 shoulders. Numbers of pre-acromiale and meso-acromiale were five and eight, respectively. Meta-acromiale was not observed. Bilateral os acromiale was found in two patients (both meso-acromiale). There were five males and eight females with os acromiale (p = 0.524, male vs. female). Os acromiale was found in seven dominant arms and six non-dominant arms (p = 0.631, dominant arm vs. non-dominant arm). The average age of patients with os acromiale was 57.3 years (range, 21 to 68 years), which is similar to the total study population. The youngest patient who had os acromiale in this study was 21 years and all the remaining patients with os acromiale were older than 45 years. The prevalence of os acromiale in Korean patients who visited shoulder clinic was found to be 0.7 (7 cases per 1,000). The details of diagnosis and treatments offered to patients with os acromiale are summarized in Table 1.

When we only evaluated cases with MRI images, among the 1,051 shoulders without os acromiale, 607 rotator cuff tears (partial [302] and full-thickness [305] combined, 58%) were observed. Among five shoulders with os acromiale, two rotator cuff tears (one partial and one full-thickness, 40%) were observed. This difference was not significant after analysis using Fisher exact test (p = 0.656). Since the rotator cuff tear is prevalent in middle-aged patients, we narrowed the study group to the patients who was older than 45 years old. Among 873 patients of middle-aged patients without os acromiale, total 586 rotator cuff tears were observed (67.1%) whereas two rotator cuff tears (50%) among four shoulders with os acromiale were found.

DISCUSSION

Os acromiale was observed in 7 per 1,000 Korean patients who visited the shoulder outpatient clinic. Bilateral os acromiale was found in only two cases (15.4%). The rate of rotator cuff tears for patients with os acromiale was comparable with that of patients without os acromiale, indicating that there is no definitive connection between os acromiale and rotator cuff pathology. The prevalence of os acromiale in the current study population was very low (less than 1%) as compared with other ethnic groups. The current study was not based on the general population; hence, it is dangerous to directly compare the results with other ethnic groups. Since most studies from other ethnic group were conducted with cadaver or normal volunteers in X-ray study, the exact prevalence will be sought only by such study. The reasons for low prevalence in the current study group needs further study, however it might be related to genetic factors or activity-related factors.[13] When reviewing previous studies, black people consistently showed a higher prevalence of os acromiale (13.2%–18.2%) than white people (5.8%–9.5%), indicating genetic influences in the formation of os acromiale (Table 2). Since this is the first report on the incidence of os acromiale in Asian patients, our hypothesis could be confirmed by an analysis of other Asian people in the near future. Due to the fact that the lateral acromion is the insertion site for deltoid

Table 2. Studies of Os Acromiale from Various Ethnic Groups

Study	Published year	Ethnic group	Method	No. of person	Percentage
Sammarco[3]	2000	Black	Skeleton	355	13.2
Case et al.[13]	2006	African	Skeleton	494	18.2
Nicholson et al.[12]	1996	White + Black	Skeleton	210	8.0
Sammarco[3]	2000	White	Skeleton	843	5.8
Grasso[15]	1992	Italian	Radiograph	398	9.5
Liberson[16]	1937	ND*	Radiograph	1,800	1.3
Case et al.[13]	2006	Danish	Skeleton	532	7.7
Edelson et al.[1]	1993	Israel	Skeleton	270	8.2
Coskun et al.[17]	2006	Turkey	Skeleton + radiograph	90	1.0
Present study	2012	Korean	Radiograph	1,568	0.7

*Not described, however, the main ethnic group might be white.

and trapezius muscles as well as various ligaments, activity-related stress has been suggested as one of the possible causes. The rate of adolescent participation in activities requiring upper extremities, particularly overhead sports such as baseball and tennis, seems to be lower in Korea than in western countries, which could be another possible explanation of the low incidence of os acromiale in our study population. These factors require further study.

Previous radiographic studies have reported a lower prevalence of os acromiale as compared to studies using skeletons or cadavers, and the sensitivity of normal radiographs for detecting the os acromiale is considered low.[5,9,12,15] However we think that the sensitivity of the radiographic method utilized in the current study is reasonable, since we examined multiple X-ray projections for each case in addition to confirmation using MRIs whenever possible. Although not all cases had both X-rays and MRIs, we believe that the diagnosis of an os acromiale can be made with high level of confidence on plain axial view since there was perfect concordance rate between X-rays and MRIs. There was no case in which the os acromiale shown on MRI was not being observed on plain X-ray.

The chances of false positive diagnosis arise in cases of a fractured spur of the antero-lateral acromion which may be misdiagnosed as a pre-acromiale. However, even for such cases, the visualization of the fractured spur in the Y view and the 30-degree caudal-tilt view helped in avoiding false diagnosis (Fig. 3). Hence, it is recommended that, in order to diagnose os acromiale using the X-rays, the Y view and 30-degree caudal-tilt view should both be used to ensure proper diagnosis. The double density sign and cortical irregularity sign suggested by Lee et al.[11] were not useful as primary signs, but these signs were indeed helpful for re-confirming the diagnosis previously made based on the axial view.

The weaknesses of our study are, first, its retrospective nature, which increases the chance of biasness. Furthermore, all the X-rays were assessed by a single observer. However, in order to minimize misdiagnosis, any cases with disputes were discussed among a panel of five experienced orthopedic shoulder surgeons and then a final decision was made based on the majority vote. Second, our radiographic studies may have inherent selection bias because all radiographs were taken by patients with either unilateral or bilateral symptomatic shoulders whom visited our shoulder clinic. Third, we cannot correlate any clinical implications confidently with the low prevalence of os acromiale.

Reporting the prevalence on the basis of a hospital outpatient population and applying it to the general population has selection bias, but conducting an anatomical study with skeletons or cadavers is not always feasible and we believe that the large number of cases in this study might be practical second-best solution to document and predict the prevalence in general population of the current situation. However, due to large selection bias, we should limit the prevalence of 0.7% to Korean patients who visited shoulder clinic until more a detailed prevalence study will be conducted. The out-patient population being studied consisted of various shoulder pathologies from traumatic injuries, infections, tumors, instability, rotator cuff pathology, frozen shoulder and so on. Furthermore, the prevalence of os acromiale even in patients with rotator cuff tear has been reported to be similar to that in a standard population,[18,19] thus decreasing the chances of it being reported more or less frequently in conjunction with other specific shoulder pathologies when compared to normal shoulders. The incidence of os acromiale in patients with shoulder pain was found to be 6.8% in one prospective study, which is not higher than the expected incidences of

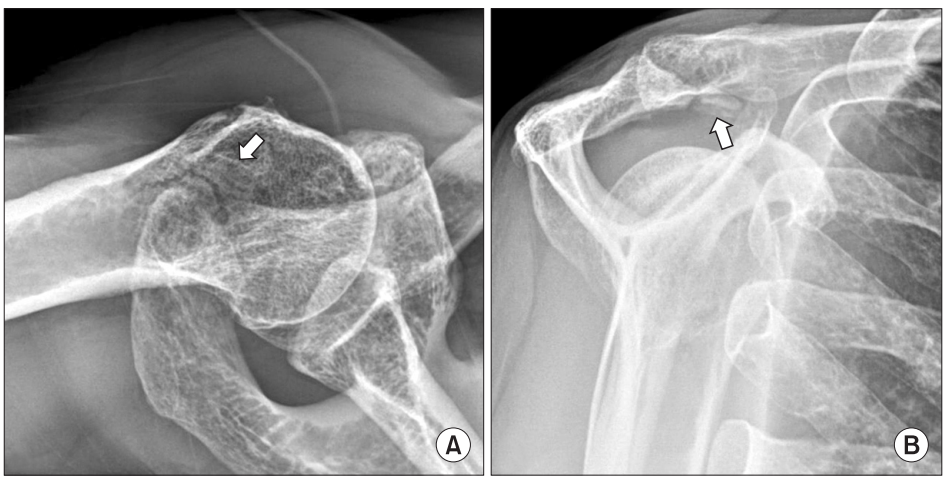

Fig. 3. (A) Axial radiograph giving a false impression of pre-acromion (arrow) (B) Y view of the same patient, clearly showing a fractured acromion spur (arrow).

their own ethnic groups.[20]

In the sub-analysis of patients with MRIs, 57% of shoulders without os acromiale had a rotator cuff tear, as compared to 40% of the shoulders with os acromiale. Since the age is an important factor for the development of rotator cuff tear, we assessed the prevalence of rotator cuff tear with patients older than 45 years old. This analysis did not give any difference of rotator cuff tear rate between patients with and without os acromiale. This is similar to results from previous reports suggesting a similar prevalence of os acromiale between symptomatic patients and the general population.[18,19] Since Neer[21] proposed an association between os acromiale and subacromial impingement, it is believed that this anatomical variant is related to rotator cuff pathology. However, current evidence suggests that the relationship between os acromiale and subacromial pathology is unlikely. Although the very low incidences of os acromiale in this study might have decreased the analytic power for detecting statistical differences, the low incidence itself also suggests that there are fewer clinical implications of os acromiale than previously indicated, especially in Korean.

We conclude that the prevalence of os acromiale in Korean patients who visited shoulder clinic is about 7 cases per thousand (0.7%) which is less than the documented worldwide prevalence of 8% for the general population. Although it would not be totally accurate to speculate the prevalence in the Korean population based on the results of the current study, there might be some genetic differences in Asian populations as compared with other ethnic groups. Rotator cuff tear was not more frequent in patient with os acromiale from the current study group of Korean patients.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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