The Acromial Morphology of Thais in Relation to Gender and Age: Study in Scapular Dried Bone

Arraya Sangiampong MS*,
Supin Chompoopong MS, PhD*, Sanjai Sangvichien MD, PhD*,
Penake Thongtong MD*, Suwarat Wongjittraporn MD*

**Department of Anatomy, Faculty of Medicine, Siriraj Hospital, Mahidol University*

Objective: *The objective of the present study was to determine the acromial shape and examine if there is a correlation between the acromial morphology and genders, ages and sides.*
Material and Method: *The present examined 154 dried Thai scapulas (107 males and 47 females) with age range from 16 to 87 years (mean = 49 $\pm$ 17 years). The acromial morphology of each scapula was studied by the computerized image analysis of digitized photography through the supraspinatous outlet view, with the distance (M) measured from its anterior to posterior end, the height (H) of the resultant curve and the distance (N) from the anterior end to the point perpendicular to the height. The acromial types were defined as type I (flat), II (curved) and III (hooked) with the criteria that N is more than or equal to the 2/3, 1/3 and less than 1/3 of M, respectively.*
Results: *The incidences of types I, II and III were 3.2%, 93.5% and 3.2%, respectively. It was found in both sexes, female (93.6%) and male (93.5%) and in both sides, left (96%) and right (91.1%). With respect to the age range, type II were found in 100% of subjects of less than 30 years, 4.5% in those between 30-60 years, were 4.5% (I), 93.2% (II), 2.3% (III).Those more than 60 years old were 2.3%(I), 90.7% (II) and 7.0% (III). The spur formation on the anterior end of the acromion was found in 14.9% of scapulas, curved type mostly; and it was associated with hooked type in only one scapula.*
Conclusion: *There was no significant type difference between sex, side and age range ($p > 0.05$). The spurs found are not related to acromial morphology and old age.*

Keywords: *Acromion, Acromial process, Aacromial morphology, Scapula*

J Med Assoc Thai 2007; 90 (3): 502-7
Full text. e-Journal: *http://www.medassocthai.org/journal*

The most common causes of pain and disability in the upper limb is inflammation of the rotator cuff tendons and rotator cuff tears that relates to the structure of the acromion[1].The etiology of rotator cuff tears is multifactorial. The primary factors are a curved or hook-shaped anterior end of acromion and subacromial osteophytes. Both of these are reported to involve tearing of the supraspinatus tendon[2]. Differences in the development and morphology of the acromion, and the presence of anterior acromial spurs and inferior acromioclavicular osteophytes decrease the volume of the subacromial space, leading to impingement[3] and the very close contact between the supraspinatus and the anterior inferior part of the acromion, occurring at 90 degrees abduction in internal rotation[4]. The variations in the shape and orientation of the anterior acromion have also been implicated as predisposing factors for the development of rotator cuff problems[5]. Many reports show the incidence of complete rotator cuff tear ranging from 5% to 25%[6-10]. In a Thai cadaveric study reported by Wunnasinthop et al[11], the incidence is not uncommon (12%) when compared to other studies done in developed countries. The relation between the acromial shape and rotator cuff tares in Thai patients might be a predictive value in determining the success of conservative measures and the need for surgery in patients with impingement syndrome.

Correspondence to : Chompoopong S, Department of Anatomy, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkoknoi, Bangkok 10700, Thailand. Phone: 0-2419-7035, Fax: 0-2419-8523, E-mail: siasg@mahidol.ac.th

As identified by Bigliani et al[12], there are three distinct types of acromions; type I (flat), type II (curved) and type III (hooked), based on samples such as cadaveric dissections, the lateral radiographs in the sagittal plane of the anterior slope of acromion[12], three-dimensional MRI and CT reconstruction on the shoulder of patients[13]. Therefore, the purpose of the present study was to determine the acromial shape more completely by photography of dried scapulas in Thais through the supraspinatous outlet view and if there is a relationship between the acromial morphology and genders, ages and sides.

Material and Method

One hundred and fifty four dried cadaveric scapulas of known genders and ages were selected from the collection of Department of Anatomy, Faculty of Medicine, Siriraj Hospital, Mahidol University. Both sides of each scapula were studied for the acromial morphology by computerized image analysis, and categorized by the criterion of Bigliani et al. as type I (flat); type II (curved); and type III (hooked)[12]. All scapulas were photographed (Camedia E-10, Olympus Optical Co, Ltd.) through supraspinatous outlet view. The plane of scapula was adjusted in front of the mirror. Its mirror image showed the "Y" appearance with its three limbs represented in profile. The center of the glenoid cavity was perfectly centred on the junction of these limbs[14] (Fig. 1). The images were transferred to the computer; and the distances were marked, using Adobe Photoshop version 6.0 program as shown in Fig. 1. All distances of each acromial process were measured directly with the computer software (UTHSCSIA Image Tool version 2.0 for Windows). The distance (M) from its anterior to posterior end, the Height (H) of the resultant curve and the distance (N) from the anterior end to the point perpendicular to the height were measured. All measurements were analysed for classification of the acromial types, N is more than or equal to the 2/3, 1/3 and less than 1/3 of M, defined as type I (flat), II (curved) and III (hooked), respectively (Fig. 2)[15].

All scapulas were directly inspected whether or not each contained the spur that appears on the lower surface of the anterior end of the acromial process (Fig. 3).

Statistical analysis was performed by using SPSS program with Pearson Chi-square test to determining the association between the characteristics and Acromial Types or not at $p < 0.05$.

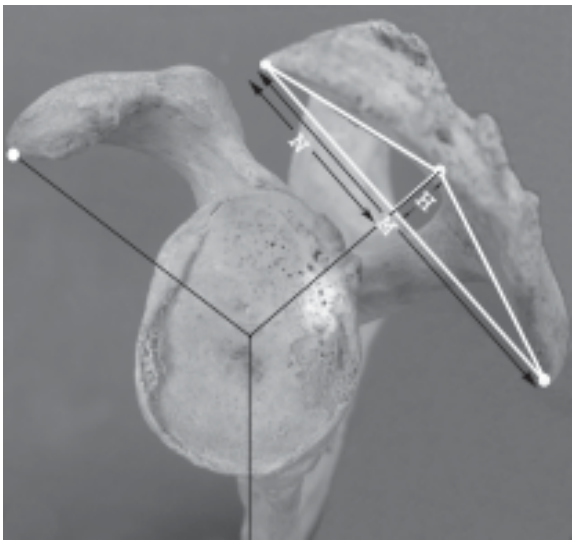

Fig. 1 Digitized photography of a scapula through the supraspinatous outlet viewed by setting the plane of scapula and its mirror image to show the "Y" appearance with its three limbs. The measurement of the distance (M) from its anterior margin to posterior margin of an acromion, the height (H) of the resultant curve and the distance (N) from the anterior margin to the point perpendicular to the height for determining the acromial type

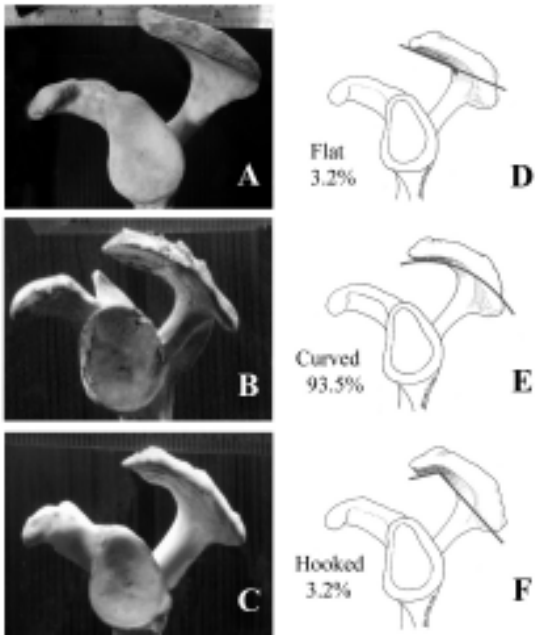

Fig. 2 Three types of scapula and their incidences found in each type: type I, flat type (A & D); type II, curved type (B & E); and type III, hooked type (C & F)

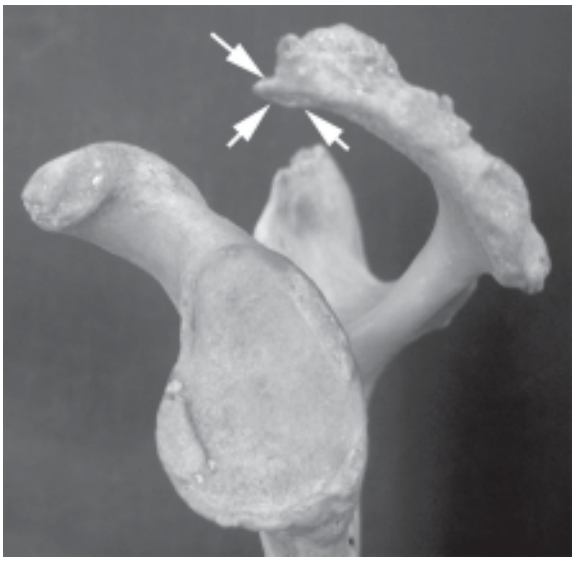

Fig. 3 A spur (arrows) on the anterior acromial end

Results

The age of 154 scapulas (107 males and 47 females) ranged from 16 to 87 years with the mean of 49 $\pm$ 17 years. The distances M and N were measured in all scapulas (data not shown). The acromial shape was categorized by determining M and N as shown in Fig. 1 and they were classified into three different types (Fig. 2).

Tables 1 and 2 showed the distribution of acromial types according to genders and side, respectively. Type II was the most frequently found and it was found in both sexes and sides.

With respect to the age range in Table 3, type II were found in 100% of cases of people less than 30 years and a higher percentage of Type III were found in the older groups. There were no significant type differences between sex, side and age range ($p > 0.05$).

From the direct inspection, the spur as shown in figure 3 was found in 23 scapulas (14.9%). It was associated with hooked type in only one scapula, most of the spurs were found in curved type. The spur was found in 16 scapulas (69.6%) in the age range between 30-60 years, rather than other age ranges (Table 3).

Discussion

The description of acromial morphology has varied among authors and this may lead to confusion when interpreting radiological data and considering the surgical treatment of such conditions. Difficulties should be noted in reproducing quantity radiographs, most data are from radiological views and not from the observation of dried bones. In the past, the reviews by authors are shown in Table 4, radiographic findings of acromial types were reported in cadaveric shoulders and classified as: type I, type II, and type III[12]. MRI was also discovered to be a valid method of determining acromial morphology in three dimensions. There was no difference in the incidence of the acromial morphology between radiographs and MRI in patients, and type II was found most frequently[13,16]. These data differed from the report by Hirano et al[15] indicating

Table 1. Distribution of acromial types according to genders

Sex	n	Type I	Type II	Type III
Female	47	3 (6.4%)	44 (93.6%)	0 (0%)
Male	107	2 (1.9%)	100 (93.5%)	5 (3.2%)
Total	154	5 (3.2%)	144 (93.5%)	5 (3.2%)

$p > 0.05$ by Fisher's exact test and Chi-square test

Table 2. Distribution of acromial types according to sides

Side	n	Type I	Type II	Type III
Left	75	2 (2.7%)	72 (96.0%)	1 (1.3%)
Right	79	3 (3.8%)	72 (91.1%)	4 (5.1%)
Total	154	5 (3.2%)	144 (93.5%)	5 (3.2%)

$p > 0.05$ by Fisher's exact test and Chi-square test

Table 3. Distribution of acromial types and spurs related to age range

Age range (years)	n	Type I	Type II	Type III	Spur
< 30	23	0 (0%)	23 (100%)	0 (0%)	1 (4.4%)
30-60	88	4 (4.5%)	82 (93.2%)	2 (2.3%)	16 (69.6%)
> 60	43	1 (2.3%)	39 (90.7%)	3 (7.0%)	6 (26.1%)

$p > 0.05$ by Fisher's exact test and Chi-square test

Table 4. Reveiws of acromial types by authors

Authors	Sample (No.)	Subject	Mode of study	Acromial types		
				Type I	Type II	Type III
Bigliani et al1986[12]	140	cadavers	radiogragh	17%	43%	39%
Morrison et al 1987[18]	200	patients	radiogragh	18%	41%	41%
MacGillivray et al 1998[13]	98	patients	MRI	40%	52%	8%
Wang et al 2000[16]	32	patients	X-ray	6%	66%	28%
			MRI	6%	69%	25%
Hirano et al 2002[15]	91	patients with RCT	MRI	36.3%	24.2%	39.6%
Getz et al 1996[17]	394	cadavers	radiograph	22.8%	68.5%	8.6%
Sangiampong et al 2006	154	dried bone	photograph	5%	93.5%	8.2%

that type III was most frequently found. They also compared the incidence of each acromial shape between groups of specimens with and without rotator cuff tears, revealing no significant differences. Another study by using radiographs in the 394 cadaveric scapulas revealed only 8.6% of type III acromions[17], whereas the study of Morrison et al[18] in patients revealed 41% of type III acromions and the above studies of the patients also showed 28% (radiographs), 25% (MRI) and 39.6% (MRI) of type III acromions[15,16]. The different results may be a reflection of the selected samples among radiographs, MRI from the patients or dried bones as well as the method of differentiating between acromial types.

Similar to the report of Getz et al[17], which found 8.6% of type III acromions, the present study also found less frequent incidence of type III. The present results revealed 3.2% of type III acromions by studying 154 dried Thai scapulas. The different method of differentiation and classification that the authors designed in the present study by using photography with fixed plane of scapulas and mirror image, instead of radiography through the supraspinatus outlet view, showed the result to be mildly different. Even though Getz et al[17] used the different classification based on the ratio between anterior and posterior angles of the acromial arch, they still concluded that the Bigliani classification system of acromial types remains a reasonable method to distinguish acromial types. This is due to the difficultly in fixing the angulation of radiography in clinical studies using their method. The results of recent attempts to visually classify acromions based on Bigliani et al[12] with direct inspection and photography of scapulas can be used to distinguish adequately between type I, II and type III only in dried bone (not from patients), therefore the incidence of type III acromions were found less frequently than in the previous report. From Table 2, the presented data show no significant difference between the right side and left side; therefore, the acromial shape tends to be symmetric as shown by Getz et al[17].

The acromial shape varied significantly with the sexes. Men are more likely to have type III and women tend to have type I[17]. When the authors considered the relationship between the acromial types and sexes, there was a greater percentage of type II in both men (93.6%) and women (93.5%). The acromial shape also does not vary significantly with the sexes; therefore, there was no relationship between acromial types and the sexes.

Edelson et al[19] reported that hooking of the acromion was not found in subjects under the age of 30 years. They concluded that the hooked configuration develops at later ages as a result of calcification of the acromial attachment of the coracoacromial ligament. In the present study, in the entire group of 154 scapulas there was an increase in the incidence of type III acromions and a decrease in the incidence of type I and II acromions in people (subjects) over 60 years old as the previous study indicated[20]. These results showed the possibility that type I acromions may progress to type II acromions and then further change into type III acromions over time. This finding is also supported by examining the MRI of the patient's shoulders which shows the gradual transition from a flat acromion at a younger age to a more hooked acromion at an older age that was significant in both the midsagittal and lateral-sagittal planes[13]. In any case, whether the acromial morphology is an innate anatomic characteristic or whether it represents a degenerative

process with type I acromions changing to type III acromions over time is still uncertain[20].

As described by Nicholson et al[21] the spur formation on the anterior acromion is an age-dependent process and not related to acromial types. The acromial morphology is a primary anatomic characteristic. They also concluded that the variations seen in the acromial morphologic condition are not acquired from age-related changes and the spur formation and thus contribute to impingement disease independent of and in addition to age-related processes[21]. Other evidence showed that bony spurs on the acromion and a thickening of the fibrocartilaginous layer are not degenerative changes, but they are caused by increased tensile strength of the coracoacromial ligament and are not influenced by age[22]. The present result, examining Thai scapulas confirmed these previous findings that the spur found in 14.94% of cases are not related to acromial morphology and older age.

Conclusion

The present results reveal that the acromial shape of Thai dried scapulas does not vary significantly with age and sex. The highest incidence of types is curved acromion. Acromial shape tends to be symmetric. The relative percentages of the types differ from previously reported values. There is an increase in the incidence of type III and a decrease in type I and II in people over 60 years, showing the possibility that type I may progress to type II and then further change into type III over time. This finding also confirms the previous report that the spurs found are not related to acromial morphology and old age. It seems to be the case that the hooked type and spur may or may not be involved in the degenerative changes or rotator cuff tears, therefore the acromial types from these results will support further study on the incidence of the acromial types of rotator cuff tears in Thai cadavers.

Acknowledgements

The authors wish to thank the Department of Anatomy, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand for the specimens provided, Miss Benjamas Sarakoonpaisarn for help in drawing the pictures and Mr. Suthipol Udompunturak from the Epidimology unit, Siriraj Hospital for his statistical guidance.

References

1. Toivonen DA, Tuite MJ, Orwin JF. Acromial structure and tears of the rotator cuff. J Shoulder Elbow Surg 1995; 4: 376-83.
2. Mayerhofer ME, Breitenseher MJ. [Impingement syndrome of the shoulder]. Radiologe 2004; 44: 569-77.
3. Bigliani LU, Ticker JB, Flatow EL, Soslowsky LJ, Mow VC. The relationship of acromial architecture to rotator cuff disease. Clin Sports Med 1991; 10: 823-38.
4. Graichen H, Bonel H, Stammberger T, Heuck A, Englmeier KH, Reiser M, et al. A technique for determining the spatial relationship between the rotator cuff and the subacromial space in arm abduction using MRI and 3D image processing. Magn Reson Med 1998; 40: 640-3.
5. Zuckerman JD, Kummer FJ, Panos SN. Characterization of acromial concavity. An in vitro computer analysis. Bull Hosp Jt Dis 2000; 59: 69-72.
6. Keyes CL. Observations on rupture of supraspinatus tendon. Based upon a study of 73 cadavers. Ann Surg 1933; 97: 849-56.
7. Neer CS, Craig EV, Fukuda H. Cuff-tear arthropathy. J Bone Joint Surg Am 1983; 65: 1232-44.
8. Ogata S, Uhthoff HK. Acromial enthesopathy and rotator cuff tear. A radiologic and histologic postmortem investigation of the coracoacromial arch. Clin Orthop Relat Res 1990; 39-48.
9. Wilson CL, Duff GL. Pathologic study of de- generation and rupture of the supraspinatus tendon. Arch Surg 1943; 47: 121-35.
10. Skinner HA. Anatomical consideration relative to rupture of the supraspinatus tendon. J Bone Joint Surg Am 1937; 19: 137-51.
11. Wunnasinthop S, Sangiampong A, Pichaisak W, Ittipalin K, Lamsam C. Incidence of rotator cuff tear: a cadaveric study. J Sports Med Assoc Thai 2004; 8: 9-16.
12. Bigliani LU, Morrison DS, April EW. The morphology of the acromion and its relationship to rotator cuff tears [abstracts]. Orthop Trans 1986; 10: 228.
13. MacGillivray JD, Fealy S, Potter HG, O'Brien SJ. Multiplanar analysis of acromion morphology. Am J Sports Med 1998; 26: 836-40.
14. Prato N, Peloso D, Franconeri A, Tegaldo G, Ravera GB, Silvestri E, et al. The anterior tilt of the acromion: radiographic evaluation and correlation with shoulder diseases. Eur Radiol 1998; 8: 1639-46.
15. Hirano M, Ide J, Takagi K. Acromial shapes and extension of rotator cuff tears: magnetic resonance imaging evaluation. J Shoulder Elbow Surg 2002; 11: 576-8.
16. Wang JC, Hatch JD, Shapiro MS. Comparison of

MRI and radiographs in the evaluation of acromial morphology. Orthopedics 2000; 23: 1269-71.
17. Getz JD, Recht MP, Piraino DW, Schils JP, Latimer BM, Jellema LM, et al. Acromial morphology: relation to sex, age, symmetry, and subacromial enthesophytes. Radiology 1996; 199: 737-42.
18. Morrison DS, Bigliani LU. The clinical significance of variations in acromial morphology [abstracts]. Orthop Trans 1987; 11: 234.
19. Edelson JG. The 'hooked' acromion revisited. J Bone Joint Surg Br 1995; 77: 284-7.
20. Wang JC, Shapiro MS. Changes in acromial morphology with age. J Shoulder Elbow Surg 1997; 6: 55-9.
21. Nicholson GP, Goodman DA, Flatow EL, Bigliani LU. The acromion: morphologic condition and age-related changes. A study of 420 scapulas. J Shoulder Elbow Surg 1996; 5: 1-11.
22. Jacobson SR, Speer KP, Moor JT, Janda DH, Saddemi SR, MacDonald PB, et al. Reliability of radiographic assessment of acromial morphology. J Shoulder Elbow Surg 1995; 4: 449-53.

ลักษณะปุ่มกระดูกอะโครเมียนในกระดูกสะบักคนไทยสัมพันธ์กับเพศและอายุ

อารยา เสงี่ยมพงษ์, สุพิน ชมภูพงษ์, สรรใจ แสงวิเชียร, เป็นเอก ธงทอง, สุวรัตน์ วงจิตราภรณ์

จากการศึกษากระดูกสะบักในคนไทย 154 ชิ้น (เพศชาย107 ชิ้น และเพศหญิง 47 ชิ้น) มีอายุเฉลี่ย 49 $\pm$ 17 ปี (อายุตั้งแต่ 16 ถึง 87 ปี) โดยการถ่ายภาพปุ่มกระดูกอะโครเมียนผ่านช่องซุพราสไปเนทัส เอาท์เลท จากนั้นใช้โปรแกรมคอมพิวเตอร์วิเคราะห์ภาพ เพื่อวัดระยะจากปลายหน้าถึงปลายหลังของปุ่มกระดูกอะโครเมียน (M) วัดระยะสูงสุดของความโค้งของปุ่มกระดูกนี้ (H) และวัดระยะจากปลายหน้าถึงจุดที่ลากเส้นตั้งฉากกับจุดสูงสุด (N) แล้วจำแนกชนิดของปุ่มกระดูกอะโครเมียนโดยใช้หลักเกณฑ์ดังนี้ ถ้าค่า N มากกว่าหรือเท่ากับ 2/3, 1/3 และน้อยกว่า1/3 ของค่า M จะสามารถแบ่งได้เป็นชนิดที่หนึ่งลักษณะแบนราบ ชนิดที่สองลักษณะโค้ง และชนิดที่สามลักษณะตะขอ ตามลำดับ ผลการศึกษานี้พบว่าปุ่มกระดูกอะโครเมียน มีลักษณะแบนราบ 3.2% โค้ง 93.5% และตะขอ 3.2% ไม่พบว่ามีความแตกต่างชนิดของปุ่มกระดูกอะโครเมียน อย่างมีนัยสำคัญทางสถิติ ระหว่างเพศและข้าง ($p > 0.05$) ซ้าย (96%) และขวา (91.1%) เมื่อศึกษาในช่วงอายุต่าง ๆ พบว่า ช่วงอายุน้อยกว่า 30 ปี ปุ่มกระดูกอะโครเมียนเป็นชนิดโค้ง 100% อายุระหว่าง 30 ถึง 60 ปี พบชนิดแบนราบ 4.5% โค้ง 93.2% ตะขอ 2.3% และช่วงอายุมากกว่า 60 ปีพบชนิดแบนราบ 2.3% โค้ง 90.7% และตะขอ 7% จากการศึกษาด้วยตาเปล่าพบว่ามีส่วนยื่นของกระดูกออกไปที่เรียกว่าสเปอ เกิดขึ้นที่บริเวณ ปลายหน้าด้านล่าง ของปุ่มกระดูก อะโครเมียน 14.94% และพบว่าส่วนใหญ่สเปอจะเกิดบนปุ่มกระดูกชนิดโค้ง มีเพียงชิ้นเดียวที่เกิดบนชนิดตะขอ