

## Acromial type in Brazilian young adults: a radiological study

### Tipo acromial em adultos jovens brasileiros: um estudo radiológico

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#### Abstract

**Introduction:** curved and hooked acromia play a key role in shoulder impingement syndrome. Little is known about acromial type in the Brazilian population. **Aim:** To describe the acromial profile of Brazilian young adults; to evaluate its correlation with gender and handedness and the occurrence of symmetry between the genders. **Methodology:** forty acromia in 20 Brazilian adults of both genders, aged 21-25 years, were studied. The acromial type was classified through the Bigliani/Epstein method using radiographs in supraspinatus outlet view. **Results:** as there was no gender difference in occurrences of acromial type, we considered the male and female groups together. Thus, among the 20 right acromia, we found 5 type I (25%), 8 type II (40%) and 7 type III (35%). Among the 20 left acromia, we found 4 type I (20%), 11 type II (55%) and 5 type III (25%). The only left-handed volunteer (100%) presented acromial type III in both the right and the left shoulder. Among the 19 right-handed volunteers, 5 (26.3%) presented right acromion type I, 8 (42.1%) had type II and 6 (31.6%) had type III; for the left acromion, 4 (21.1%) presented type I, 11 (57.9%) had type II and 4 (21.1%) had type III. Acromial symmetry occurred in 60% of females and 70% of males. **Conclusion:** type II acromion was predominant, in both the right and the left shoulder in Brazilian young adults. There was no correlation between acromial type and gender. It was not possible to analyze the correlation between acromial type and handedness. Acromial type tended to be symmetrical in our sample. **Keywords:** Shoulder. Scapula. Acromion. Shoulder pain. Rotator cuff tears. Subacromial impingement syndrome.

#### Resumo

**Introdução:** o acrômio curvo e gancho desempenham um papel fundamental na Síndrome do impacto do ombro. Pouco se sabe sobre o tipo acromial na população brasileira. **Objetivo:** descrever o perfil do tipo acromial em adultos jovens brasileiros e avaliar sua correlação com o gênero e a lateralidade e a ocorrência de simetria entre os sexos. **Metodologia:** foram estudados 40 acrômios de 20 adultos brasileiros, de ambos os sexos, com idade entre 21 e 25 anos. O tipo acromial foi classificado pelo método de Bigliani/Epstein nas radiografias de perfil de escápula. **Resultados:** como não houve diferença na ocorrência do tipo acromial quanto ao gênero, consideramos os grupos masculino e feminino juntos. Assim, dos 20 acrômios direitos, foram encontrados 5 (25%) do tipo I, 8 (40%) do tipo II e 7 (35%) do tipo III, enquanto que dos 20 acrômios esquerdos, foram encontrados 4 (20%) tipo I, 11 (55%) tipo II e 5 (25%) tipo III. O único voluntário canhoto (100%) apresentou para o ombro direito e esquerdo o tipo acromial III. Dos 19 voluntários destros, 5 (26,3%) apresentavam acrômio direito tipo I, 8 (42,1%) tipo II e 6 (31,6%) tipo III; para o acrômio esquerdo, 4 (21,1%) apresentavam tipo I, 11 (57,9%) tipo II e 4 (21,1%) tipo III. A simetria acromial ocorreu nos grupos feminino (60%) e masculino (70%). **Conclusão:** o acrômio tipo II foi o mais predominante para os ombros direito e esquerdo em adultos jovens brasileiros. Não houve correlação entre o tipo de acromial e o gênero. Não foi possível analisar a correlação entre o tipo acromial e a lateralidade. O tipo acromial tende a ser simétrico em na amostra estudada.

**Palavras-chave:** Ombro. Escápula. Acrômio. Dor no ombro. Ruptura do manguito rotador. Síndrome do impacto subacromial.

#### INTRODUCTION

The acromion process, a bony prominence of the scapula, forms the summit of the shoulder. It projects firstly lateralward and then curves forward and upward

over the shoulder joint, to articulate with the clavicle at the acromioclavicular joint (GRAY, 1988). Bigliani, Morrison e April (1986), using dried scapulas, classified the acromion according to its undersurface into type I (flat), type II (curved) and type III (hooked). No photographs or diagrams were presented in their Abstract to indicate the intended limits of each category, and interpretation is guided only by the everyday meanings of the words flat, curved and hooked (BIGLIANI; MORRISON; APRIL, 1986).

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Epstein et al. (1993) solved this difficulty by proposing that if the hooklike angulation occurred in the middle third of the acromion, it should be considered curved; while if the

hooklike angulation occurred in the anterior third, the acromion should be considered hooked (Figure 1).

**Figure 1** – Schematic drawing of Bigliani classification of acromial types: type I (flat), type II (curved) and type III (hooked); as refined by Epstein, who proposed for the type II acromion that a slope should be present in its middle third, while acromial type III would present this slope in its anterior third.



Source: Bigliani, Morrison e April 1986; Epstein et al. 1993.

Hamilton (1875) identified the acromial type as a source of shoulder pain. Presence of curved and hooked acromia is believed to play a key role in impingement syndrome and in the pathogenesis of rotator cuff diseases (MORRISON; BIGLIANI, 1987). Many investigations have been conducted to clarify the correlation between acromial type and its pathological contribution to shoulder injuries (BALKE et al., 2013; MORRISON; BIGLIANI, 1987;). Many studies have described the acromial type in North America (BIGLIANI; MORRISON; APRIL, 1986; GETZ et al., 1996; MORRISON; BIGLIANI, 1987), Europe (COSKUN et al., 2006; NATSIS et al., 2007; PARASKEVAS et al., 2008) and Asia (JACINTH et al., 2018; GOSAVI; JADHAV; GARUD, 2015; GUO et al., 2018; MANSUR et al., 2012; SANGIAMPONG et al., 2007). On the other hand, few studies have been conducted with this purpose in Africa (EL-DIN; ALI, 2015; NAIDOO et al., 2015) and South America (ARAGÃO et al., 2014; COLLIPAL et al., 2010; SCHETINO et al., 2017). In a Brazilian sample, acromial types were investigated through dried scapulas of unknown age and gender (CARDINOT et al., 2020). Therefore, little is known about acromial types in the Brazilian population.

The aim of this study was to describe the acromial type profile in Brazilian young adults and to evaluate its correlation with gender and handedness, and occurrence of symmetry between the genders.

## METHODOLOGY

This study was conducted in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of the State University of Rio de Janeiro (COEP no. 038/2006). Non-paid volunteers were recruited and all participants gave their written informed consent to participate in this study.

The study was performed between January 2006 and December 2007. We studied 20 healthy Brazilian adults of

both genders (10 males and 10 females), aged 21 to 25 years. Screening involved applying a questionnaire that asked for information about age, gender, handedness, sporting and professional history, medical history, shoulder injury, shoulder pain and functional limitations.

The following were excluded from the study: foreigners; individuals with injuries to the shoulder joint, such as tendonitis, bursitis or glenohumeral instabilities; individuals who had suffered trauma, fractures or dislocations; individuals who had undergone surgery on this joint; and individuals practicing sports or professional activity in which action from the shoulder joint had been ostensibly required. The purpose of these exclusion criteria was to make it possible to compose a homogeneous sample of healthy young subjects for this study.

A single technician obtained all radiographs. The radiographs on all shoulders were produced with the patient in an orthostatic position (standing upright). The radiographic incidence used was the supraspinatus outlet view, performed with the central beam pointing in the same direction, caudally to the spine at the scapula. The beam was angled at 15° to 25°, varying according to the curvature of each patient's thoracic spine. The radiographs were subsequently scanned to allow better visualization of the acromial type.

The acromial type was classified through the Bigliani method (type I – flat; type II – curved; and type III – hooked), as refined by Epstein. In this refinement, it was proposed that for the type II acromion, a slope would be present in its middle third; while for the type III acromion, this slope would be in its anterior third (Figure 1). Three qualified observers (one orthopedic doctor and two anatomy professors) performed the evaluation of the right and left acromial types. The data collected by each observer were recorded in individual spreadsheets according to female and male subgroups. All the results were compared and a consensus on the most frequent acromial type for

the left side and for the right side was established, among all the 40 acromia evaluated.

The data obtained by each observer were analyzed statistically using the McNemar test and the kappa index ( $p < 0.05$ ). The McNemar test was used to analyze inter-rater agreement. The kappa index was used to assess inter-rater reproducibility; it measures the level of inter-rater agreement beyond what would be expected by chance. This initial analysis enabled assessment of the inter-rater reliability of Bigliani's method for classifying acromial type. It was found that, among the three evaluators of this study, the reproducibility and reliability of this method were very good (CARDINOT et al., 2021).

Following this, the acromial type profile and its correlation with gender and handedness, and occurrences of symmetry between genders, were analyzed. This was done through descriptively representing the variables in contingency tables containing absolute ( $n$ ) and relative (%) frequencies. The associations between these variables were assessed using Fisher's test ( $p < 0.05$ ).

## RESULTS

Out of the 20 Brazilian adults studied, nineteen were right-handed, and only one was left-handed. None of them had functional limitations of the shoulder joint. The right and left shoulders of each volunteer were evaluated, totaling 40 acromia studied.

No association was found between gender and right acromial type ( $p = 0.362$ ). Among the 10 female volunteers, 3 (30%) presented right acromial type I, 5 (50%) had type II and 2 (20%) had type III. Among the 10 male volunteers, 2 (20%) presented right acromial type I, 3 (30%) had type II and 5 (50%) had type III. For the right side, acromial type II predominated among females and type III among males (Table 1).

**Table 1** – Correlation of right acromial type with gender

Right side	Acromial type						
	Gender	I		II		III	
F	3	30.0%	5	50.0%	2	20.0%	10
M	2	20.0%	3	30.0%	5	50.0%	10
<b>Total</b>	<b>5</b>	<b>25.0%</b>	<b>8</b>	<b>40.0%</b>	<b>7</b>	<b>35.0%</b>	<b>20</b>

$p = 0.362$

Source: research data

Furthermore, no association was found between gender and left acromial type ( $p = 0.512$ ). Among the 10 female volunteers, 3 (30%) presented left acromial type I, 5 (50%) had type II and 2 (20%) had type III. Among the 10 male volunteers, 1 (10%) presented left acromial type I, 6 (60%) had type II and 3 (30%) had type III. For the left side, acromial type II predominated among both females and males (Table 2).

As there was no difference in occurrence of acromial type with regard to gender, either on the right side ( $p = 0.362$ ) or the left side ( $p = 0.512$ ), we decided to consider

the male and female subsamples together. Thus, out of the 20 right acromia studied, we found 5 type I (25%), 8 type II (40%) and 7 type III (35%) (Table 1). Out of the 20 left acromia studied, we found 4 type I (20%), 11 type II (55%) and 5 type III (25%) (Table 2).

**Table 2** – Correlation of left acromial type with gender

Left side	Acromial type						
	Gender	I		II		III	
F	3	30.0%	5	50.0%	2	20.0%	10
M	1	10.0%	6	60.0%	3	30.0%	10
<b>Total</b>	<b>4</b>	<b>20.0%</b>	<b>11</b>	<b>55.0%</b>	<b>5</b>	<b>25.0%</b>	<b>20</b>

$p = 0.512$

Source: research data

There was no correlation between acromial symmetry and gender ( $p = 1.000$ ). Among the 10 female volunteers, 4 (40%) had no symmetry and 6 (60%) presented acromial symmetry. Among the 10 male volunteers, 3 (30%) had no symmetry and 7 (70%) had acromial symmetry. For both females and males, there was more occurrence of acromial symmetry than non-symmetry. Because we considered the male and female subsamples together, a total of 65% of our sample presented symmetry (Table 3).

**Table 3** – Occurrence of acromial symmetry between genders

Gender	Acromial symmetry				
	No		Yes		Total
F	4	40.0%	6	60.0%	10
M	3	30.0%	7	70.0%	10
<b>Total</b>	<b>7</b>	<b>35.0%</b>	<b>13</b>	<b>65.0%</b>	<b>20</b>

$p = 1.000$

Source: research data

Regarding handedness, our study had 19 right-handed volunteers, of whom 5 (26.3%) presented right acromial type I, 8 (42.1%) had type II and 6 (31.6%) had type III. The only left-handed volunteer (100%) presented right acromial type III. Out of the 19 right-handed volunteers, 4 (21.1%) presented left acromion type I, 11 (57.9%) had type II and 4 (21.1%) had type III. The only left-handed volunteer (100%) presented left acromial type III. The very small size ( $n = 1$ ) of the left-handed sample prevented analysis of the correlation between handedness and acromial type.

This very small left-handed sample ( $n = 1$ ) also prevented analysis of the correlation between acromial symmetry and handedness. Among the 19 right-handed volunteers, 7 (36.8%) presented no symmetry and 12 (63.2%) had acromial symmetry. The only left-handed volunteer (100%) presented acromial symmetry.

## DISCUSSION

In 1986, Bigliani, Morrison e April developed the classification method for acromial type that is now most



commonly used, through visual inspection among dried bones and radiographs. They described three main types of acromion: type I – flat; type II – curved; and type III – hooked. Type I acromia presented a flat anteroinferior edge, type II acromia had a smooth curved under the surface and type III acromia had a hooked or sharp curved under the surface. They reported the following relative percentages in an American population: 8.6% type I, 42.0% type II and 38.6% type III (BIGLIANI; MORRISON; APRIL, 1986). Since then, this subjective evaluation method has been used for determining the acromial type, whether in dried bones or as seen on radiographs in supraspinatus outlet view.

In our study, the acromial type was classified through the Bigliani method (type I – flat; type II – curved; and type III – hooked), as refined by the Epstein criteria. In these criteria, if the hooklike angulation occurs in the anterior third of the acromion, it should be considered hooked; if it occurs in the middle third, it should be considered curved (BIGLIANI; MORRISON; APRIL, 1986; EPSTEIN et al., 1993).

For the right side, we found that type II acromion was predominant in females and type III acromion in males. For the left side, type II acromion predominated for both genders. However, as there was no statistical difference in occurrence of acromial type in relation to gender, the female and male samples could be analyzed together. Therefore, type II acromion was predominant, both for the right shoulder (40%) and the left shoulder (55%). Type III acromion ranked second, both for the right shoulder (35%) and for the left shoulder (25%). Type I was the least predominant, both for the right shoulder (25%) and for the left shoulder (20%). These results were similar to those of the study by Bigliani, Morrison e April (1986).

Our data showed that symmetry was present between the genders and, thus, the acromial type tended to be symmetrical in our sample (65%). These results were similar to those of the study by Getz et al. (1996) in an American population. They found that acromial morphology was symmetrical in 70.7% of their sample (394 acromia). In their study, type II acromion was predominant (68.5%), followed by type I (22.8%) and type III (8.3%). Our study also showed predominance of type II acromion. However, differently from Getz et al. (1996), who found that type I ranked second, our results showed that type III ranked second in our Brazilian sample.

Some studies on acromial type have been conducted in European countries. Coskun et al. (2006) studied 90 dried scapulas of unknown age and gender and 90 adult patients in a Turkish population. The type of acromion was classified in accordance with the method of Bigliani, Morrison e April (1986). In the group of dried scapulas, 10% were type I, 73% were type II and 17% were type III. In the adult patient group, the radiological evaluation showed that 11% were type I, 66% were type II and 23% were type III. Paraskevas et al. (2008) studied 44 pairs of dried scapulas in a Greek population. The acromial types were classified in accordance with the criteria of Bigliani,

Morrison e April (1986). They found that 26.1% were type I, 55.6% were type II and 18.1% were type III. Type I was more common in females whereas type III was more frequent in males. The acromion had a symmetrical shape in 65.9%, and there was no correlation between shape and gender. Natsis et al. (2007) examined 423 dried scapulas of unknown age and gender in a German sample. The acromial types were classified through visual inspection of the lateral aspect of the acromion process. Four types of acromion were observed: 12.1% type I flat (without any curve); 56.5% type II curved (without any abrupt change in the angle of curvature); 28.8% type III hooked (with an abrupt change in the angle of curvature); and 2.6% type IV convex (with a convex middle third of the undersurface). All of these authors found that type II acromion predominated in their European populations.

Many studies on acromial type profile were developed in Asia. Sangiampong et al. (2007) examined 154 dried Thai scapulas. The type of acromion was classified using the criteria established by Bigliani, Morrison e April (1986). They found no significant differences relating to gender, side or age range. Type II acromion occurred most frequently in all age ranges. Jacinth et al. (2018) and Gosavi et al. (2015) studied 40 and 127 dried scapulas of unknown age and gender in an Indian population, respectively. They used the Bigliani et al. (1986) criteria to classify the acromial type. Jacinth et al. (2018) observed that 72.5% had type II, 22.5% had type I and 5% had type III. Gosavi et al. (2015) found that 82% had type II, 13.3% had type I and 4.7% had type III. Guo et al. (2018) examined 292 dried scapulas in a Chinese population. They classified the acromial type as described by Bigliani, Morrison e April (1986) and according to acromial angle measurements. They classified the acromia into three groups: C-shaped acromion angle, L-shaped acromion angle and double angle-shaped acromion angle. They found that 49.66% had type II, 47.26% had type I and 3.08% had type III. The acromial angle measurements showed that the C and L shapes were predominant (47.26% and 47.95%, respectively) and that the double angle shape was rare (4.79%). The study by Guo et al. (2018) showed that there was a statistically significant association between acromial type and acromial angle. C shape was often related to type I, and L shape was often related to type II acromion. Mansur et al. (2012) studied 68 human dried scapulas of unknown age and gender in a Nepalese population sample. The acromion process was classified into three types, based on the shape: triangular (36.76%), quadrangular (52.94%) or tubular (10.29%). These studies showed that type II acromion predominated in Asia.

Few studies on acromion type have been developed in Africa. Naidoo et al. (2015) examined 182 scapulas in a South African population. The types of acromion were classified using the criteria established by Bigliani, Morrison e April (1986). They found that 34.6% had type I, 51.1% had type II and 14% had type III. El-Din and Ali (2015) examined 160 dried scapulas of unknown age and

gender in an Egyptian population. The acromial type was classified according to the angle of slope, formed by the intersection of a line extending from the tip of the hook to the junction of the hook and a line along the under-surface of the acromion. When this angle ranged from 0° to 12°, the acromion was considered to be type I or flat; from 13° to 27°, type II or curved; and angles above 27° classified the acromion as type III or hooked (TOIVONEN; TUIITE; ORWIN, 1995). They found that 26.88% had type I, 45.62% had type II and 15% had type III. Although few studies have been performed in Africa, they showed that type II acromion was predominant.

Some studies have been conducted in South America. Collipal et al. (2010) studied 36 scapulas of unknown age and gender in a Chilean population. The acromial type was classified in accordance with the criteria of Bigliani, Morrison e April (1986). They found that 8% had type I, 50% had type II and 42% had type III. Aragão et al. (2014), Schetino et al. (2017) and Cardinot et al. (2020) studied 90, 57 and 112 dried scapulas of unknown age and gender in Brazilian populations, respectively. Aragão et al. (2014) and Cardinot et al. (2020) classified the acromia according to the Bigliani et al. (1986) method, whereas Schetino et al. (2017) used the criteria of Toivonen, Tuite, Orwin (1995). Aragão et al. (2014) found that 43.3% had type I (flat), 47.7% had type II (curved) and 9% had type III (hooked). Schetino et al. (2017) observed that 5.20% had type I (11.00°), 57.9% had type II (20.73°) and 36.9% had type III (34.19°). Cardinot et al. (2020) found that 48.2% had type I, 47.3% had type II and 4.5% had type III. These studies, performed on dried scapulas, showed that type II acromion was predominant, and we found the same results through radiographic evaluation on Brazilian young adults.

The main limitation of the present study relates to the quality of development process among our radiographs. These were very dark, which hindered good visualization of the acromion and consequently its classification. However, also in relation to obtaining the radiographs, the strength of our study was the fact that all the radiographic views were obtained by a single radiology technician. Thus, image acquisition bias was avoided, which could have led to wrong assessment of the acromion. Another strong point was that this was a sample of young adults who did not present subacromial osteophytes (ALRADDADI et al., 2020). Presence of this feature would possibly have influenced the classification of the acromial type by making the acromial border indistinguishable. Lack of this feature may explain the very good reproducibility and reliability of the method that was achieved among the three evaluators in our study.

## CONCLUSION

Type II acromion was predominant, both for the right and for the left shoulder; and, the acromial type tended to be symmetrical in this sample of Brazilian young adults.

Furthermore, there was no correlation between acromial type and gender; and, it was not possible to analyze the correlation between acromial type and handedness in this sample.

Considering the characteristics of the sample evaluated (sedentary young adults without functional limitations of the shoulder) and the results from the study (predominance of acromial type II), it was not possible to correlate the acromial type with any functional limitations of the upper limbs. Likewise, no functional difference between the individuals with acromial types II and III could be established.

Our group is continuing with its investigation of the acromial profile of the Brazilian population. We are including age groups up to 80 years, with the aim of studying the effect of aging on the acromial morphotype. In addition, studies on specific populations will also be developed, such as on individuals with previous functional limitations of the shoulder joint and on athletes who do types of sport that require motor actions involving conspicuous use of an upper limb.

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