Original article

Anatomical variations of acromions in brazilian adult's scapulas

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Abstract

Introduction: According to morphology, acromion can be classified into three types: I (flat), II (curved), and III (hooked) and its characteristics are related to age and rotator cuff pathology. Here we have analyzed acromion´s morphology in scapulas of Brazilian human skeleton and tried to establish possible morphofunctional correlations to literature data. **Materials and Methods:** Fifty-seven scapulas from Human Anatomy laboratories of Universidade Federal de Minas Gerais were selected and divided in groups according to acromion´s tip morphology and angle. **Results:** We observed that distribution of acromial morphology was 5,2% type I (flat), 57,9% type II (curved), 36,9% type III (hooked). **Conclusion:** Our data is important to compare Brazilian scapula bones to those from various other regions or races and could contribute to demographic studies of shoulder disease probability in Brazilian population.

Keywords: acromion, scapula, anatomic variation.

1 Introduction

The acromion is related to a variety of shoulder disorders (GILL, MCIRVIN, KOCHER et al., 2002; TUCKER and SNYDER, 2004; RUSSO, VERNAGLIA LOMBARDI, GIUDICE et al., 2007; OH, KIM, LEE et al., 2010; AYDIN, YILDIZ, KALALI et al., 2011; HAMID, OMID, YAMAGUCHI et al., 2012) and its morphology is an important tool in pathology diagnosis.

The shoulder is a complex joint with the greatest range of motion in the human body and, consequently, the high degree of "natural instability" (BARTHEL, KONIG, BOHM et al., 2003). This joint allows movements of flexion, extension, abduction, adduction, external and internal rotations. Moreover, it presents a shallow receptacle, the glenoid fossa (COSKUN, KARAALI, CEVIKOL et al., 2006). The acromion forms the highest part of the shoulder and projects over the glenoid cavity. Its cranial part is convex, rough, subcutaneous, and it is the proximal insertion of some fibers of deltoid muscle. His caudal face is smooth and concave, and its lateral margin is thick and irregular, with three to four tubers that give origin to deltoid tendons. Acromium´s medial margin is shorter than the lateral one, has too portions that give insertion to trapezius muscle, and shows an oval and central small articular surface for acromial end of clavicle. Its apex, which is the meeting point of the two margins, is thin and gives insertion to coracoacromial ligament (STANDRING, 2009).

Acromial morphology is believed to be an important factor in shoulder impairments. The acromium can be the primary etiologic factor in impingement syndrome's pathogenesis, leading to potential rotator cuff disease. The syndrome develops mostly under acromion, but also under coracoid process (BIGLIANI, MORRISON and APRIL, 1986; WANG; HATCH and SHAPIRO, 2000). The predominant theory for the impingement syndrome of rotator cuff muscles (supraspinatus, infraspinatus, teres minor and infrascapularis) classifies the aethiologic factors into anatomical or functional. Anatomic factors include acromial shape and angle (NEER, 1972). Based on acromial´s tip shape, acromial morphology is well described and classified into 3 types. Type I has a flat antero-inferior edge, type

II shows a smooth curve beneath surface, and type III is hooked or sharp beneath surface (BIGLIANI, MORRISON and APRIL, 1986; MORRISON and BIGLIANI, 1987). Many studies showed positive correlation between type III acromions and rotator cuff disease (BIGLIANI, TICKER, FLATOW et al., 1991; EPSTEIN, SCHWEITZER, FRIEMAN et al., 1993; MacGILLIVRAY, FEALY, POTTER et al., 1998; WORLAND, LEE, OROZCO et al., 2003). This morphological classification has been the major diagnostic tool for impingement syndrome and rotator cuff disease (BIGLIANI, MORRISON and APRIL, 1986).

Moreover, surgical approachs as acromioplasty, especially using Neer's technique, show the importance of acromium in impingement syndrome. Surgical procedures achieve better prognosis in patients that have not improved with conservative treatments (BARBIERI, MAZER and CALIL, 1995). Thus, it is important to analyze the bone's structure in shoulder pathological processes.

Based on acromion's shape variations and their functional significance, we analyzed acromion's morphology in scapula bones of Brazilian human skeletons in order to establish possible morphofunctional correlations related to race, geographic region and literature data.

2 Materials and Methods

The study was performed at Human Anatomy laboratories at Biological Sciences Institute and at Faculty of Medicine of Universidade Federal de Minas Gerais (UFMG), Brazil. A total of dry 57 scapulas bones were selected, 28 were being from the right side, and 29 from the left side. The bones belonged to mature specimens, but exact ages and gender were not known. The scapulas were isolated, macroscopically inspected, and grouped according to acromion's tip morphology as previously described (BIGLIANI, MORRISON and APRIL, 1986).

In order to determine acromion's inclination angle, scapula bones were placed on fixed foam at 45 cm to digital camera (Sony Cyber-shot, 10 × Optical Image Stabilized Zoom) placed in support foam. All photos were taken by the same examiner.

Using System for Analysis of Movements – SAM Software (version 1.3 –CDCC-USP-São Carlos/Edson Minatel), we determined acromion´s angle according to Toivonen, Tuite and Orwin (1995). This methodology is easy, does not requite the presence of humerus and angle measurements correspond to the ones described by Bigliani, Ticker, Flatow et al. (1986). The angle is formed by the intersection of a line extending from the tip of the hook to the junction of the hook (A) and a line along the undersurface of the acromion (B) (Figure 1). When angle ranged from 0° to 12°, acromion was considered type I or flat. When angle measured from 13° to 27°, acromion were considered type II or curved. Angles above 27° classified acromion as type III or hooked (Figure 2).

The results were expressed as the mean and the standard error of the mean and percentage of acromions. All analysis

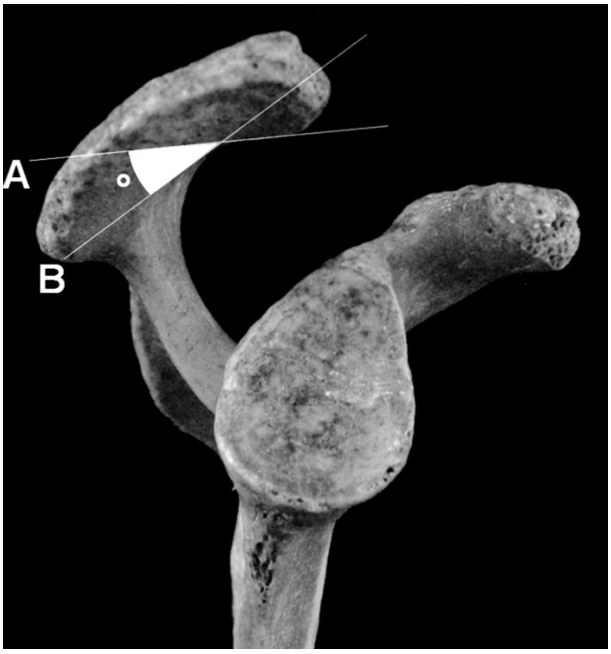

Figure 1. Demonstrative figure of methodology. A and B lines for construction of the acromial angle. Hooked acromion with acromial angle to 35 degrees.

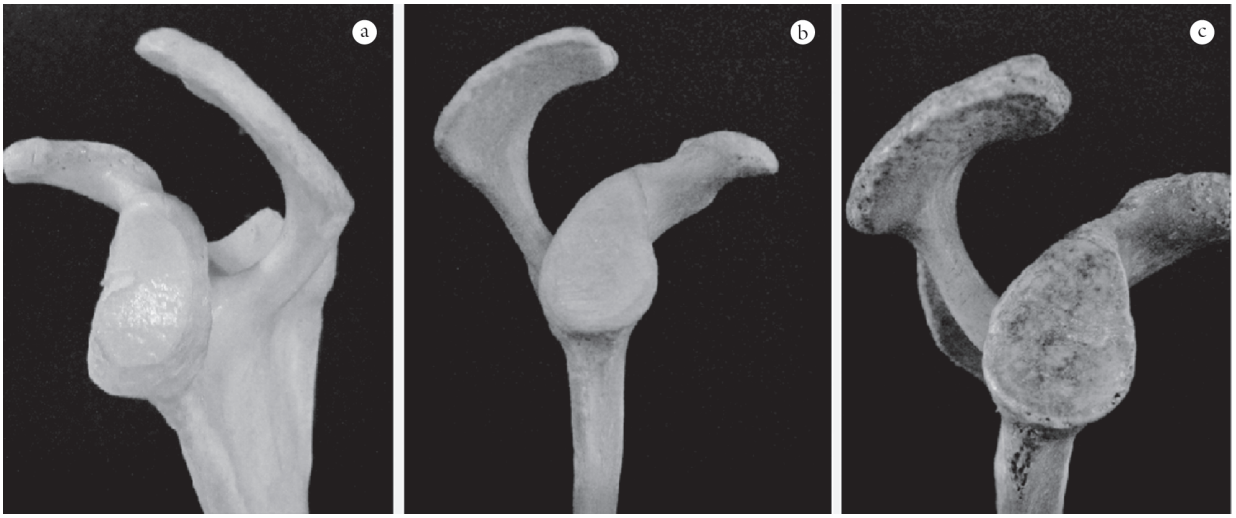

Figure 2. Types of acromions: A) Type I acromion – flat, B) Type II acromion – curved and C) Type III acromion – hooked.

was performed using GraphPad Prism (version 5.01 for Windows, GraphPad Software, San Diego, CA, USA).

3 Results

We found distinct frequencies among acromion types. Type I was found in 5,20% (3) of acromions, type II in 57,9% (33) and the type III in 36,9% (21) (Figure 3). Type II acromions were more frequent in our sample than type I or type III. Measurements of each acromion angle are shown on Figure 4. Table 1 shows mean values of acromion angles according to types, which was 11,00° for flat, 20,73° for curved, and 34,19° for hooked acromions.

4 Discussion

The delicate and complex anatomy of the shoulder comprises several structures. Among them there are bones, muscles, ligaments, fascia, capsule, bursa, blood vessels and nerves. Shoulder joint requires attention since its structures can be easily compressed due to predisposition to some alterations, even if not used incorrectly. Special attention must be given to subacromial space and rotator cuff, highly important structures in adequate functioning of the joint (GREVE, FERREIRA-FILHO, ZOPPI-FILHO et al., 1992).

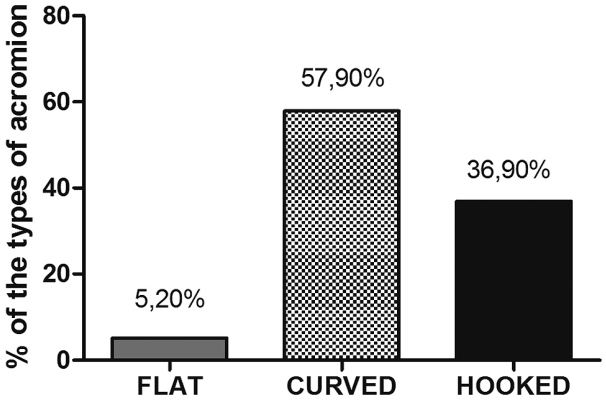

Figure 3. Percentage of the types of acromion scapulae found in the anatomy laboratories of UFMG.

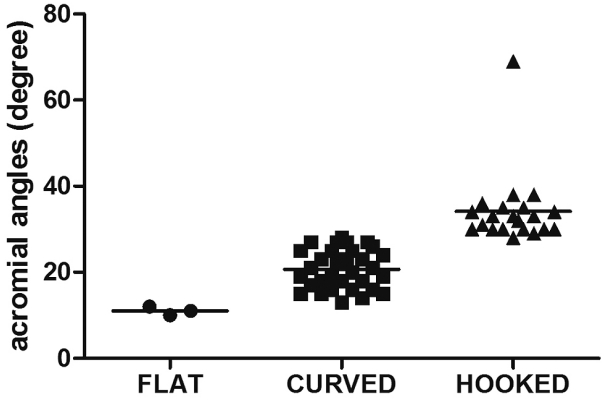

Figure 4. Scatter plot of the angles of the acromial angle (degree) according to the type I (FLAT), II (CURVED) and III (HOOKED).

Table 1. Mean of the acromial angle (degree) according to the type of acromion.

	FLAT	CURVED	HOOKED
MEAN (degree)	11,00° ± 0,57°	20,73° ± 0,78°	34,19° ± 1,90°

Anatomical integrity is essential for precise function of rotator cuff in maintaining joint stability during normal movements such as arm abduction. Mechanic instabilities lead to dysfunctions, injuries and consequent morphological damage. As a result, pain occurs and impingement syndrome is established (GREVE, FERREIRA-FILHO, ZOPPI-FILHO et al., 1992).

The "impingement syndrome" was first described by Neer (1972) and such pathology occurs when rotator cuff is potentially subjected to repeated mechanical impact between humerus greater tuberosity and "coracoacromial arch" during upper limb elevation. Impingement of subacromial structures occurs at the supraspinatus outlet narrowing, as consequence from acromial anteroinferior spur formation, shape or tilt variation, and lower projections from acromioclavicular joint. Moreover, it is known that the distance between acromion and humeral head correlates with the syndrome and that type III acromion contributes to pathology development (TOIVONEN, TUITE and ORWIN, 1995; MacGILLIVRAY, FEALY, POTTER et al., 1998; WORLAND, LEE, OROZCO et al., 2003).

Acromion's shape has also been associated with the presence of impingement syndrome, which is related to age, being the elderly the most susceptible. Nevertheless, it has been speculated that type III acromion is related with degenerative processes rather than anatomical variation, which makes it more frequent in older subjects (WANG and SHAPIRO, 1997; WORLAND, LEE, OROZCO et al., 2003; IKEMOTO, BEZERRA, DO MONTE et al., 2005).

Based on clinical relevance of correlation between syndrome and morphological type of acromion, we aimed here to evaluate the frequency of types I, II, and III acromions in scapulae bones from cadavers in our institution facilities. Here we found higher frequency of type II acromion. Although a few studies have shown a higher frequency of the type III (HIRANO, IDE and TAKAGI, 2002) or type I acromion (SCHIPPINGER, BAILEY, McNALLY et al., 1997), our data are in accordance to a great number of studies in other population samples which shows type II as the most frequent (BIGLIANI, MORRISON and APRIL, 1986; TOIVONEN, TUITE and ORWIN, 1995; GETZ, RECHT, PIRAINO et al., 1996; SHAH, BAYLISS and MALCOLM, 2001; SPEER, OSBAHR, MONTELLA et al., 2001; WORLAND, LEE, OROZCO et al., 2003; PLANELLES, ARRUTI, MIQUÉLEZ et al., 2005; IKEMOTO, BEZERRA, DO MONTE et al., 2005; MAYERHOEFER, BREITENSEHER, ROPOSCH et al., 2005; SANGIAMPONG, CHOMPOOPONG, SANGVICHIEN et al., 2007; NATSIS, TSIKARAS, TOTLIS et al., 2007; PARASKEVAS, TZAVEAS, PAPAZIOGAS et al., 2008; COSKUN, KARAALI, CEVIKOL et al., 2006; COLLIPAL, SILVA, ORTEGA et al., 2010). Regarding Brazilian population, our data are in accordance to a few other works which

describe type II acromion as the most frequent *in vivo* (ODA, LUZETTI and BERTOLINI, 2000; IKEMOTO, BEZERRA, DO MONTE et al., 2005).

We found type III as the second highest acromion type in our study, which is in accordance to several studies (BIGLIANI, MORRISON and APRIL, 1986; WORLAND, LEE, OROZCO et al., 2003; PLANELLES, ARRUTI, MIQUÉLEZ et al., 2005; MAYERHOEFER, BREITENSEHER, ROPOSCH et al., 2005; COSKUN, KARAALI, CEVIKOL et al., 2006; NATSIS, TSIKARAS, TOTLIS et al., 2007; COLLIPAL, SILVA, ORTEGA et al., 2010), including the one with the same methodology (TOIVONEN, TUITE and ORWIN, 1995). However, some other studies have shown that type I acromium was the second most frequent (EPSTEIN, SCHWEITZER, FRIEMAN et al., 1993; GETZ, RECHT, PIRAINO et al., 1996; NICHOLSON, GOODMAN, FLATOW et al., 1996; WANG and SHAPIRO, 1997; MacGILLIVRAY, FEALY, POTTER et al., 1998; SHAH, BAYLISS and MALCOLM, 2001; SPEER, OSBAHR, MONTELLA et al., 2001; HIRANO, IDE and TAKAGI, 2002; PARASKEVAS, TZAVEAS, PAPAZIOGAS et al., 2008), even in Brazilian populational samples (ODA, LUZETTI and BERTOLINI, 2000; IKEMOTO, BEZERRA, DO MONTE et al., 2005). We believe these differences are due to distinct ethnic origin (NELSON, BRAGA, RENNER et al., 2010) in demographic samples that have their own anatomical variations. Also, different methodological approachs or techniques among studies could lead to variations in classifications and analysis.

Unfortunately, we could not access age or clinical data of our subjects, which did not allow us to correlate our findings to medical history. However, we could speculate that our Brazilian sample may be of older individuals, since we have a great frequency of type III acromion (IKEMOTO, BEZERRA, DO MONTE et al., 2005). Also, we could speculate that our population sample would have great probability to develop impingement syndrome, once age was the strongest predictor for impingement syndrome development (BODIN, PETIT, MANAC'H et al., 2012).

5 Conclusion

In our populational sample of Brazilian adult's scapulas, we found a higher percentage of type II acromion. Although other studies are necessary in greater populational samples, our data is important to compare Brazilian scapula bones to those from various other regions or races. Moreover, our findings can contribute to demographic studies of shoulder disease probability in Brazilian population.

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