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The prevalence of acromial spurs in relation to study type and specimens examined

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SUMMARY

Advanced cases of subacromial impingement syndrome usually present with acromial spurs. However, previous studies have reported variations in the prevalence of acromial spurs in shoulders with or without subacromial impingement syndrome as well as with age, sex, and side. Therefore, this study is aimed at investigating the prevalence of acromial spurs in cadaveric shoulders and reviewing the factors leading to the reported variable frequencies. The study examined 220 cadaveric shoulders (110 male and 110 female), with a median age of 82 years (with a range of 53 to 102 years). In 155 shoulders, the rotator cuff tendons were evaluated for tears; acromial spurs were observed in 95 shoulders (43%). No significant association was observed between the prevalence of acromial spurs and sex or side. However, a significant prevalence of spurs (57%) was observed in the oldest-old group, aged ≥ 85 years. Those with acromial spurs also tended to be older (84 years) than those without spurs (81 years). A significant difference in the prevalence of acromial spurs was observed in shoulders with rotator cuff tears compared to those without them: 80% compared to 20%, respectively. Analysis showed a significant number of acromial spurs in shoulders with full-thickness tears (46%) and partial tears (34%). A significant prevalence of acromial spurs was found in shoulders with rotator cuff tears, as well as in aged shoulders. In relevant literature, the prevalence of acromial spurs varies with the type of study undertaken, age, prevalence of rotator cuff tears, and type of radiograph examined.

Key words: Acromial spur – Shoulder – Shoulder degenerative changes – Rotator cuff tears – Subacromial impingement syndrome – Shoulder pain

INTRODUCTION

An acromial spur is an elevated plaque of bone at the tip and undersurface of the acromion (Graves, 1922). Spur formation is usually described as ossification of the acromial attachment of the coracoacromial ligament (CAL) (Edelson, 1995; Fealy et al., 2005; Hernigou, 1994; Natsis et al., 2007; Uhthoff et al., 1988) and corresponds to the CAL acromial attachment pattern (Edelson and Luchs, 1995). Spur formation occurs in the third stage of subacromial impingement syndrome (SIS) (Neer, 1983). The relationship between acromial spurs and rotator cuff tears has been confirmed by a number of authors (Bigliani et al., 1986; Hernigou, 1994; Neer, 1983; Ogata and Uhthoff, 1990; Panni et al., 1996; Postacchini, 1989; Yoshida and Ogawa, 1996; Zuckerman et al., 1992). Thus, the

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Fig 1. Superior views of right scapulae show acromion with (right) and without (left) spur at the anterior acromial edge.

presence of a spur can be used as presumptive evidence of shoulder impingement (Cone et al., 1984). In order to relieve the impingement, resection of the spur is recommended (Neer, 1983).

The prevalence of acromial spurs ranges from 5% to 97% (Gray, 1942; Neer, 1972; Aoki et al., 1980; Cone et al., 1984; Bigliani et al., 1986; Hardy et al., 1986; Postacchini, 1989; Tada et al., 1990; Edelson and Taitz, 1992; Ono et al., 1992; Gohlke et al., 1993; Chun and Yoo, 1994; Hernigou, 1994; Edelson and Luchs, 1995; Getz et al., 1996; Nicholson et al., 1996; Panni et al., 1996; Mahakkanukrauh and Surin, 2003; Flatwo et al., 2005; Ogawa et al., 2005; Taheriazam et al., 2005; Ko et al., 2006; Natsis et al., 2007; Sangiampong et al., 2007; Paraskevas et al., 2008; Oh et al., 2010; Hamid et al., 2012). There is a significant correlation between prevalence and age (Graves, 1922; Cone et al., 1984; Tada et al., 1990; Edelson, 1995; Getz et al., 1996; Ogawa et al., 1996; Panni et al., 1996; Mahakkanukrauh and Surin, 2003; Oh et al., 2010), with individuals with spurs being older than those without (Cone et al., 1984; Tada et al., 1990; Panni et al., 1996). Regarding the side of occurrence, acromial spurs have been reported to be more prevalent in right than left shoulders (Gray, 1942; Edelson, 1995; Miles, 1996; Panni et al., 1996; Mahakkanukrauh and Surin, 2003; Ogawa et al., 2005), perhaps because the majority of the populations studied were right-handed. Furthermore, some studies reported more spurs in males than females (Tada et al., 1990; Edelson, 1995; Ogawa et al., 2005; Paraskevas et al., 2008; Hamid et al., 2012), while others found no difference in prevalence between males and females (Mahakkanukrauh and Surin, 2003; Oh et al., 2010).

This study is aimed at (i) investigating the prevalence of acromial spurs in cadaveric specimens in relation to rotator cuff tears, sex, side, and age, and (ii) reviewing the prevalence of spurs in previous reports in relation to the type of study undertaken, rotator cuff tears, and age.

MATERIALS AND METHODS

This study was a prospective cohort study that investigated the prevalence of acromial spurs in 220 cadaveric shoulders at the Centre for Anatomy and Human Identification (CAHID), University of Dundee, Dundee, UK. The median age at the time of death was 82 years (with a range of 53 to 102 years); there were 110 male and 110 female shoulders, of which 206 were bilateral and 14 unilateral. Blunt dissection was used to determine the presence of an acromial spur at the tip and undersurface of the acromion. Regarding age, shoulders were categorized into three groups: youngest-old (53 to 74 years), middle-old (75 to 84 years), and oldest-old (≥ 85 years) (Lee et al., 2018).

Of 220 shoulders, only 155 showed the presence of a rotator cuff tendon. The rotator cuff tendons were examined for any cuff tears, which were classified, morphologically, into partial and full-thickness tears, as described by Snyder (2006). Rotator cuff tendons with bursal-side fraying fibers, fissures, or a bursal-side tear were considered partial-thickness tears while tears that penetrated the entire tendon, revealing the humeral head, were considered full-thickness tears. Articular partial tears were not considered as their etiology has not been shown to result from bursal degenerative changes (Ko et al., 2006; Ogata and Uhthoff, 1990; Ogawa et al., 1996; Ozaki et al., 1988).

In addition, the prevalence of acromial spurs in previous reports was reviewed. A "traditional" narrative review was conducted to review previous studies that reported the prevalence of acromial spurs in cadaveric shoulders, dry scapulae, clinical images, or intraoperative studies. Data such as the type of study undertaken, the number and age of specimens, and the prevalence of spurs was also recorded. No language or date restrictions were applied during the review. However, conference abstracts and unpublished data were not considered.

The data was collected and analyzed using IBM SPSS 21.0 statistical software with a p-value < 0.05 considered statistically significant. Pearson's chi-square tests were used to determine the correlation between acromial spurs and other factors such as rotator cuff tears, side, sex, and age group. Independent samples t-tests were used to determine differences in the age of shoulders with and without acromial spurs.

RESULTS

Acromial spurs were detected at the anterior

Table 1. Pearson Chi-squared test to evaluate the association between the frequency of acromial spur and factors including shoulder side, sex, and age groups

Categorise	Levels	N 220	Acromial Spur (%) No 125 (57)	Acromial Spur (%) Yes 95 (43)	P-value
Side	Right	108	64 (51)	44 (46)	0.473
	Left	112	61 (49)	51 (54)	
Sex	Male	110	66 (53)	44 (46)	0.341
	Female	110	59 (47)	51 (54)	
Age Groups	Youngest-Old	41	30 (24)	11 (11.5)	0.022
	Middle-Old	74	44 (35)	30 (31.5)	
	Oldest-Old	105	51 (41)	54 (57)	

edge of the acromion within the CAL in 95 specimens (43%) (Fig. 1). Table 1 shows the prevalence of acromial spurs according to sex, side, and age group. With respect to side, spurs were identified in 44 (46%) right and 51 (54%) left shoulders. There were more bilateral (32 (31%)) than unilateral (26 (25%)) spurs. Regarding gender, spurs were detected in 44 (46%) males and in 51 (54%) females. However, the results of the Pearson's chi -squared tests showed no significant correlation between acromial spurs and side or sex ($p > 0.05$).

However, a significant correlation was detected between the prevalence of acromial spurs and age ($p = 0.022$). A greater number of acromial spurs was observed in the oldest-old group (57%) than the youngest-old (11.5%) and middle-old groups (31.5%). In addition, shoulders with spurs were significantly ($p = 0.001$) older (84 ± 8 years) than those without spurs (81 ± 10 years).

Out of 155 shoulders, acromial spurs were observed in 70 (45%). Rotator cuff tears were observed in 77 (50%) shoulders, of which 37 (24%) were partial-thickness and 40 (26%) full-thickness tears. Table 2 shows the prevalence of acromial spurs in relation to rotator cuff tears. Statistical analysis showed a significant correlation ($p < 0.001$) between the prevalence of acromial spurs and rotator cuff tears. Acromial spurs were observed in a significant number (56 [80%]) of shoulders with rotator cuff tears compared to 14 (20%) with intact rotator cuff tendons. Of the shoulders with a rotator cuff tear, spurs were found in 24 (34%) with partial-thickness and 32 (46%) with full-thickness tears.

Table 2. Pearson Chi-squared test to evaluate the association between the prevalence of acromial spurs and rotator cuff tears

Rotator Cuff Tendon	N 155	Acromial Spur (%) No	Acromial Spur (%) Yes	P-value
Normal	78	64 (75)	14 (20)	< 0.001
Tear:	77	21 (25)	56 (80)	
Partial Tears	37	13 (15)	24 (34)	< 0.001
Full-thickness Tears	40	8 (9)	32 (46)	

Table 3 shows the prevalence of acromial spurs reported in 27 studies with a total of 6615 shoulders (range 12 to 1085) with an age range of 16 to 100 years. The mean prevalence of acromial spurs in previous studies was 30%, ranging from 5% to 97%. Specimens in previous studies can be classified into 3 types: dry scapulae (n = 11 studies), cadaveric shoulders (n = 6 studies), and patients (n = 11 studies). In dry specimens, the prevalence of spurs was 23% (6–40%) (Gray, 1942; Neer, 1972; Akoi et al., 1986; Edelson and Taitz, 1992; Edelson and Luchs, 1995; Getz et al., 1996; Nicholson et al., 1996; Mahakkanukrauh and Surin, 2003; Natsis et al., 2007; Sangiampong et al., 2007; Paraskevas et al., 2008), in cadaveric specimens 48% (14-70%) (Bigliani et al, 1986; Tada et al., 1990; Gohlke et al., 1993; Flatwo et al., 1996; Panni et al., 1996; Ogawa et al., 2005), and in patients 39% (5-97%) (Cone et al., 1984; Hardy et al., 1986; Postacchini, 1989; Ono et al., 1992; Chun and Yoo, 1994; Hernigou, 1994; Ogawa et al., 2005; Taheriazam et al., 2005; Ko et al., 2006; Oh et al., 2010; Hamid et al., 2012).

DISCUSSION

This study observed spurs in 43% of shoulders examined, which is comparable to the mean prevalence reported in previous cadaveric studies (48%) (Bigliani et al, 1986; Tada et al., 1990; Gohlke et al., 1993; Flatwo et al., 1996; Panni et al., 1996; Ogawa et al., 2005); however, this is higher than reported by Bigliani et al. (1986) (14%) and lower than Flatwo et al. (1996) (63%) and Ogawa et al. (2005) (70%) study. In addition, a correlation between acromion spurs and rotator cuff tears was observed in this study. A significantly higher prevalence of acromial spurs was found in shoulders with rotator cuff tears (80%), as well as a significantly higher prevalence associated with full-thickness (46%) compared to partial tears (34%). These observations are in accord with previous studies, which reported a higher prevalence in shoulders with rotator cuff tears (Bigliani et al., 1986; Tada et al., 1990; Gohlke et al., 1993; Ogawa et al., 2005; Ko et al., 2006; Oh et al., 2010).

Despite a higher prevalence of acromial spurs in shoulders with rotator cuff tears, there were some shoulders with rotator cuff tears but no acromial spurs; it is possible that the tear can develop from an articular-side tear. It has been reported that shoulders with articular-side partial tears demonstrate less acromion degeneration and prominent acromial spur formation than those with bursal-side partial tears (Ko et al., 2006). Furthermore, rotator cuff tears may develop due to attrition of the rotator cuff tendon against the tough fibers of the CAL, mainly at its subacromial attachment. Histological studies have confirmed changes in the CAL subacromial attachment in shoulders with rotator cuff tears (Ozaki et al., 1988; Ogata and Uhthoff, 1990; Tada et al., 1990). Larger attrition

Table 3. The prevalence of acromial spurs as reported in previous studies

Study	Type	N	Age (years)	Spur (%)
Gray (1942)	Dry scapulae	1085	> 60	240 (22)
	Dry scapulae	80	<60	5 (6)
Neer (1972)	Dry scapulae	100	60	8 (8)
Cone et al. (1984)	Shoulders with pain	103	52	26 (25)
	Pathological specimens	80	*	18 (23)
	Fluoroscopic examination	12	*	9 (75)
Aoki et al. (1986)	Dry scapulae	130	57.5 (34-83)	38(29)
Bigliani et al (1986)	Cadaveric shoulders	140	74 (51-97)	20 (14)
Hardy et al. (1986)	Patients with acute SIS	38	56 (22-89)	26 (68)
Postacchini (1989)	Patients with SIS	18	44 (21-67)	3 (17)
Tada et al. (1990)	Cadaveric shoulders	74	77 (44-93)	34 (46)
Ono et al. (1992)	Shoulders with SIS: - Anteroposterior view - 30° Caudal tilt view	73	60 (25-79)	27 (37) 52 (71)
Edelson & Taitz (1992)	Dry scapulae	200	30-70	46 (23)
Gohlke et al. (1993)	Cadaveric shoulders	57	75(47-90)	22 (39)
Hernigou (1994)	Patients with RCTs	50	*	12 (24)
Chun and Yoo (1994)	Patients with SIS Patients without SIS	100 100	*	52 (52) 5 (5)
Edelson & Luchs (1995)	Dry scapulae	300	> 60	69 (23)
Flatwo et al. (1996)	Cadaveric shoulders	16	78 (50-94)	10 (62.5)
Getz et al. (1996)	Dry scapulae	394	(20-89)	157 (40)
Panni et al. (1996)	Cadaveric shoulders	80	58 (26-82)	35 (44)
Nicholson et al. (1996)	Dry scapulae	420	21-70	61 (14.5)
Mahakkanukrauh & Surin (2003)	Dry scapulae	692	15-100	200 (29)
Ogawa et al. (2005)	Shoulder without pain	644	44 (16-79)	193 (30)
	Cadaveric shoulders	241	77 (38-96)	169 (70)
	Shoulders with RCTs	144	46 (18-66)	120 (83)
TaheriAzam et al. (2005)	Patients with SIS	89	56 (34-80)	8 (9)
Ko et al. (2006)	Patients with partial RCTs	66	52 (25-72)	64 (97)
Natsis et al. (2007)	Dry scapulae	423	*	66 (16)
Sangiampong et al. (2007)	Dry scapulae	154	49 (16-87)	23 (15)
Paraskevas et al. (2008)	Dry scapulae	88	*	19 (21.5)
Oh et al. (2010)	Patients with FT RCTs	106	60 (49-78)	83 (78)
	Patients without RCTs	102	58 (45-79)	59 (58)
Hamid et al. (2012)	Patients with asymptomatic RCTs	216	65 (37-90)	49 (23)

SIS: subacromial impingement syndrome, **RCTs:** rotator cuff tears, (*): not given defects associated with the CAL subacromial insertion have been reported in shoulders with rotator cuff tears than in those with intact rotator cuff tendons (Lee et al., 2001).

Regarding side, previous studies have reported more acromial spurs in right shoulders, but with a bilateral prevalence (Gray, 1942; Edelson, 1995; Miles, 1996; Panni et al., 1996; Mahakkanukrauh and Surin, 2003; Ogawa et al., 2005). Right shoulders have also showed larger and rougher spurs than left shoulders (Gray, 1942; Miles, 1996). In contrast, this study did not observe a difference in the prevalence of acromial spurs in right and left shoulders or in bilateral and unilateral prevalence, suggesting that side plays no role in the development of acromial spurs. Therefore, this study disagrees with previous reports that suggest a higher prevalence of acromial spurs in right shoulders, as well as a greater bilateral prevalence. The development of acromial spurs appears to be associated more with degenerative changes due to aging and the development of shoulder impingement than side.

Regarding gender, more acromial spurs have been observed in males than females (Tada et al., 1990; Edelson, 1995; Ogawa et al., 2005; Paraskevas et al., 2008); however, others have reported a similar prevalence in males and females (Mahakkanukrauh and Surin, 2003; Oh et al., 2010; Hamid et al., 2012). This study did not find a difference in the prevalence of acromial spurs in males and females or any correlation between acromial spurs and the gender of the specimens. Therefore, this study agrees with previous reports that suggest that there is no relationship between acromial spurs and sex.

A correlation between spur prevalence and age has been reported, supporting the view that acromial spurs form as a result of degenerative processes (Graves, 1922; Cone et al., 1984; Tada et al., 1990; Edelson, 1995; Getz et al., 1996; Ogawa et al., 1996; Panni et al., 1996; Mahakkanukrauh and Surin, 2003; Oh et al., 2010); shoulders with spurs tend to be older than those without spurs (Cone et al., 1984; Tada et al., 1990; Panni et al., 1996). Furthermore, spur formation appears to be an age-dependent process in which older individuals have larger spurs than younger individuals (Nicholson et al., 1996). It has been reported that the prevalence of spurs can reach 50% in the sixth decade and 68% in the seventh decade (Ogawa et al., 1996). Another study noted more spurs in patients older than 65 than those younger than 55 (58%) (Oh et al., 2010). In contrast, other studies reported no correlation between the presence of spurs and age (Ogata and Uhthoff, 1990; Sangiampong et al., 2007; Hamid et al., 2012).

The age of the specimens in this study was between 53 and 102 years, making it difficult to compare the younger and older specimens. Nevertheless, they were classified into three groups: youngest-old, middle-old, and oldest-old. A more significant spur prevalence was identified in the oldest-old group than in the other two. In addition, statistical analysis showed that shoulders with acromial spurs were generally older than those without spurs. Thus, this study supports previous studies in that there appears to be a correlation between age and the presence of acromial spurs (Graves, 1922; Cone et al., 1984; Tada et al., 1990; Edelson, 1995; Getz et al., 1996; Ogawa et al., 1996; Panni et al., 1996; Mahakkanukrauh and Surin, 2003; Oh et al., 2010).

The prevalence of acromial spurs varied according to the specimens studied in previous studies. The prevalence of spurs in dry scapulae was lower than in cadaveric specimens and patients. One potential reason for this difference is that the dry scapulae were from individuals of a younger age than the cadaveric specimens or patients. Therefore, it is possible that the prevalence of acromial spurs may vary, depending on the type and age of specimens studied. Regarding the studies on patients, the prevalence of spurs varied according to shoulder diagnosis. Acromial spurs have been reported in 27% (5-30%) of shoulders without pain (Chun and Yoo, 1994; Ogawa et al., 2005), in 38% (9-75%) with pain or SIS (Cone et al., 1984; Hardy et al., 1986; Postacchini, 1989; Ono et al., 1992; Chun and Yoo, 1994; Taheriazam et al., 2005; Oh et al., 2010), and in 56% (23-97%) with rotator cuff tears (Hernigou, 1994; Ogawa et al., 2005; Ko et al., 2006; Oh et al., 2010; Hamid et al., 2012). Furthermore, cadaveric studies reported a higher prevalence of rotator cuff tears in shoulders with an acromial spur (64% [43-86%]) than in those without a spur (16% [4-39%]). Another factor that could influence the presence of an acromial spur is the type of radiograph that is examined. Ono et al. (1992) reported that acromial spur prevalence differed in two different radiographic views, being observed in 37% of anteroposterior radiographs compared to 71% in 30o caudal tilt view radiographs.

Finally, the new finding of the current study is the development of acromial spurs related to aging and rotator cuff tears rather than the shoulder side or sex. The question then arises: are acromial spurs a natural occurrence associated with aging or are they a result of degenerative changes in the shoulder? Moreover, the prevalence of acromial spurs in previous reports varies according to factors such as the type of study, age, rotator cuff tears, and type of radiograph examined. Controlling such elements is recommended for future studies for more reliable outcomes. The strength of this study is the use of a prospective cohort study design based on a high number of elderly cadaveric specimens; however, the study may even be criticized for this. It has been reported that degenerative rotator cuff tears are the most common type of tear among the elderly (Woertler K, 2009). The formation of acromial spurs is also an age-dependent process (Nicholson et al., 1996). Other limitations may include information about the dominant hand, medical history, and occupation of the specimens, which was not available for this study.

Conclusion

On examination of 220 cadaveric shoulders, acromial spurs were observed in 95 (43%). No difference in the prevalence of acromial spurs was observed regarding side and sex; nevertheless, specimens with acromial spurs were older than those without spurs. A significantly higher prevalence of acromial spurs was observed in shoulders with rotator cuff tears. The prevalence of acromial spurs reported in previous studies could have been influenced by four factors: (1) the type of study being undertaken (dry specimens, cadaveric shoulders, and patients), (2) the age of the sample, (3) the diagnosis of shoulder pathology (with or without subacromial impingement syndrome and with or without rotator cuff tears), and (4) the view used in radiographic studies. Future studies should take these factors into consideration.

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