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ARTICLE

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Reliability of radiographic evaluation for acromial morphology

Abstract *Objetive.* Bigliani's classification system of acromial morphology utilizing the standard outlet radiograph has become in accepted method for evaluating patients with rotator cuff disease. This study evaluates the interobserver and intraobserver reliability of Bigliani's classification system using observers at various levels of training.
Patients and design. Supraspinatus outlet view radiographs of 40 patients (aged 18–78 years) with shoulder pain were reviewed twice, 4 months apart, in a masked protocol by six reviewers, including two attending (fellowship-trained) shoulder surgeons, an attending musculoskeletal radiologist, an orthopedic surgery sports fellow, and two orthopedic residents (PGY-2 and PGY-5). The reviewers were given standard diagrams of the Bigliani classification system and were asked to classify each film as a type I, II, or III acromion. Interobserver reliability and intraobserver repeatability values were calculated using kappa statistic analysis (0–0.2 slight, 0.21–0.4 fair, 0.41–0.6 moderate, 0.61–0.8 substantial, and 0.8–1.0 excellent).
Results and conclusion. For each of the two readings, all six observers agreed only 18% of the time. Kappa values for pairwise comparison of interobserver reliability among the six observers ranged from 0.01 to 0.75 (mean 0.35), and intraobserver repeatability ranged from 0.26 (PGY-5 resident) to 0.80 (fellowship-trained surgeon), with a mean of 0.55. Intraobserver repeatability was not significantly different for the different levels of expertise. More definitive criteria are needed to distinguish and classify the acromion.

Key words Acromion · AC joint · Shoulder · Rotator cuff

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Introduction

Subacromial impingement of the rotator cuff is considered to be a frequent cause of shoulder pain. Acromioplasty [1–5] has been the traditional treatment for impingement when there is no rotator cuff tear. Both arthrography and MRI are useful in determining the presence of rotator cuff tears, but have the disadvantages of cost and patient inconvenience. Utilizing plain radiographs, Weiner and Macnab [6] noted that some patients with rotator cuff tears have a diminished acromiohumeral distance. Neer and Poppen [7] coined the term supraspinatus outlet to describe the opening on the lateral radiograph between the acromion and the humeral head, through which the rotator cuff tendons may potentially become impinged by a prominent acromion. Acromial morphology is believed by others to correlate with subacromial enthesophytes or impingement [8, 9].

Bigliani et al. [10] reported a classification system for morphologic changes in the acromion that can be used to provide more information about the status of the rotator cuff. Acromial shape was classified on a lateral radiograph into type I (flat), type II (curved), or type III

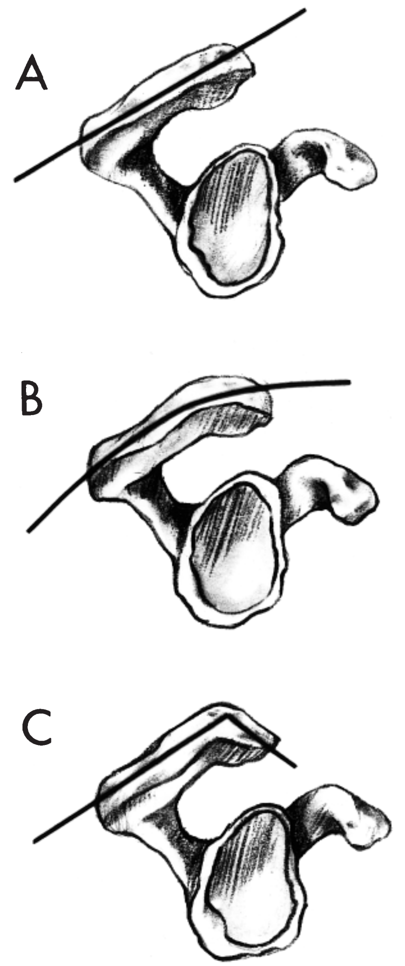

Fig. 1 Schematic representation of the Bigliani classification of acromial morphology: **A** type I (flat), **B** type II (curved), **C** type III (hooked)

(hooked) (Fig. 1). An increased incidence of rotator cuff tears was noted in cadavers with type III acromions. Morrison and Bigliani [11] then reported similar findings in a radiographic study of acromion morphology in patients with impingement.

Although other authors [12, 13] have developed additional radiographic techniques to show the acromion, the supraspinatus outlet view has remained the most commonly used technique [6, 9]. Recently, Ryu [14] and others [15, 16] have suggested that better surgical results are obtained when the acromion is converted to a type I by surgery. Additionally, Vanarthos and Monu [17] have suggested expanding the classification to include a type IV with a concavity on its spur [17].

Despite the widespread use of the outlet view to assess the patient with shoulder pain, only two studies have evaluated the reproducibility of this radiograph [18, 19]. Jacobson et al. [18] noted that frequently there was disagreement about the classification of a particular acromial shape on the outlet view. Consequently, the goal of this study was to evaluate the interobserver reliability and intraobserver reproducibility of this radiograph. Specifically, we were interested in comparing the influence of different levels of training upon interpreting the radiographs, and secondly in comparing readings between radiologists and orthopedists.

Materials and methods

Forty supraspinatus outlet view radiographs of patients aged 18–78 years with shoulder pain were randomly selected from office radiographs by an independent observer. All radiographs were taken by two experienced radiology technologists who were working in the orthopedic clinic. A standard modified outlet view as described by Kilcoyne et al. [13] was utilized. The patient's name plate was covered, and the films were copied for circulation among the observers.

Two fellowship-trained attending shoulder surgeons, an attending musculoskeletal radiologist, an orthopedic surgery sports medicine fellow, a chief orthopedic resident, and a junior orthopedic resident were provided with pictures of the Bigliani classification system and asked to classify each acromion into type I, II, or III. They were instructed to judge the acromial type on the basis of acromial shape regardless of whether or not a spur was present on the anterior edge of the acromion. Three to four months later, the same observers were asked to review the same films again. All observers were masked to their previous answers.

Interobserver reliability and intraobserver repeatability were then calculated using kappa statistics as described by Fleiss [20]. The kappa statistic values were then interpreted as per Landis and Koch [21]: 0–0.2, slight; 0.21–0.4, fair; 0.41–0.6, moderate; 0.61–0.8, substantial; and 0.8–1.0, excellent. Statistical significance was set at $P < 0.05$.

Results

In each of the two readings, all six observers agreed only 18% of the time, and five of the six agreed 40% of the time. Responses included all three types for any one test image 15% of the time for each trial. Agreement did not increase in the second reading compared with the first reading. Kappa values for pairwise comparison of interobserver reliability among the six observers ranged from 0.02 to 0.49 for the first trial (mean 0.30) and 0.01 to 0.75 for the second trial (mean 0.39. Intraobserver repeatability kappa values ranged from 0.26 (PGY-5 resident) to 0.80 (fellowship-trained surgeon), with a mean of 0.55 (Table 1). Intraobserver repeatability was not significantly different ($P < 0.05$) for the different levels of expertise (Table 2). The radiologist had agreement 85% of the time between two readings, with an intraobserver kappa value of 0.75. Comparison of the radiologist with the staff and resident orthopedic surgeons resulted in kappa values from 0.16 (radiologist vs a resident) to 0.60 (radiologist vs an attending surgeon), with an average of 0.44.

Table 1 Kappa values for interobserver reliability: average of the two trials (*A, B* fellowhsip-trained attending shoulder surgeons, *C* attending musculoskeletal radiologist, *D* orthopedic surgery sports medicine fellow, *E* chief orthopedic resident, *F* junior orthopedic resident)

	Observer					
Observer	A	B	C	D	E	F
A	1.00	0.50	0.44	0.38	0.22	0.31
B	0.50	1.00	0.60	0.40	0.10	0.52
C	0.44	0.60	1.00	0.54	0.16	0.48
D	0.38	0.40	0.54	1.00	0.04	0.38
E	0.22	0.10	0.16	0.04	1.00	0.12
F	0.31	0.52	0.48	0.38	0.12	1.00

Table 2 Kappa values for intraobserver repeatability for the two trials (observers as in Table 1)

Observer	Kappa value
A	0.50
B	0.80
C	0.75
D	0.31
E	0.26
F	0.69

Discussion

In order for a classification system to be clinically useful, it must satisfy certain criteria [22]. First, the same observer must be able to repeat the same classification each time the data are reviewed (intraobserver reliability, or repeatability). Second, different observers must be able to agree on the same classification when reviewing the same data (interobserver reliability). After these criteria are met, then the classification system can be tested to see how accurate it is in predicting treatment options or patient outcome. Our study of the acromion morphology is addressing only the first two issues (reliability and repeatability), which should be established and confirmed first before the method is used to test the correlation of imaging with clinical pathology.

Other studies have illustrated problems with radiographic classification systems used in orthopedic surgery. Thomsen et al. [23] found moderate interobserver reliability with both the Lauge-Hansen (kappa value of 0.50) and Weber (kappa value of 0.57) classification systems of ankle fractures. Rasmussen et al. [24] found moderate reliability with the Lauge-Hansen classification of ankle fractures (kappa value of 0.51), and noted that this improved when further instructions were given to the observers. Other studies of the Neer classification system of proximal humerus fractures found poor interobserver reliability (kappa values of 0.26 to 0.50) [14, 19, 25]. Subtle modifications of technical factors such as beam angle can also introduce variability [19].

In this study of the acromion outlet views, the interobserver reliability kappa value was 0.35, which was similar to that of Jacobson et al. [18] who found a kappa value of 0.52. The slightly higher reliability found by Jacobson et al. could be explained by a higher level of expertise of the observers (the radiographs were interpreted only by fellowship-trained shoulder surgeons). However, in our study intraobserver reliability did not correlate well with level of expertise. A trained musculoskeletal radiologist had intra- and interobserver variability similar to values produced by the orthopedic examiners.

One of the difficulties with classifying the acromion is the presence of acromial spurs, which may make the determination of its shape difficult. Ogata and Uhthoff [26] and Edelson and Taitz [27] noted that the spur is not actually a portion of the acromion, but rather a calcification of the coraco-acromial ligament which blends into the acromion at its insertion site. When a spur is present, the true acromial edge may appear indistinct, which may influence its classification. Additionally, other authors have observed technical difficulties in obtaining a reproducible outlet view. Aoki et al. [28] noted that the angle of the radiographic projection may create classification problems by converting an acromion's appearance from a type II into a type I. In an attempt to limit this error, we used two technologists experienced with this technique.

Our results suggest that the Bigliani classification system needs more definitive criteria to classify the acromion. In general, classification systems are used to guide treatment and suggest prognosis. The potential utility of a grading system is compromised when the system is inadequately reliable or reproducible. Studies using this classification may need to be interpreted with caution since these reliability and reproducibility issues suggest unacceptable variability of interpretation and grading of this radiograph.

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