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ORIGINAL ARTICLE

Interobserver and intraobserver reliability of radiographic classification of acromioclavicular joint dislocations

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Hypothesis and background: The classification and treatment of acromioclavicular (AC) joint dislocations remain controversial. The purpose of this study was to determine the interobserver and intraobserver reliability of the Rockwood classification system. We hypothesized poor interobserver and intraobserver reliability, limiting the role of the Rockwood classification system in determining severity of AC joint dislocations and accurately guiding treatment decisions.

Methods: We identified 200 patients with AC joint injuries using the *International Classification of Diseases, Ninth Revision* code 831.04. Fifty patients met inclusion criteria. Deidentified radiographs were compiled and presented to 6 fellowship-trained upper extremity orthopedic surgeons. The surgeons classified each patient into 1 of the 6 classification types described by Rockwood. A second review was performed several months later by 2 surgeons. A κ value was calculated to determine the interobserver and intraobserver reliability.

Results: The interobserver and intraobserver κ values were fair ($\kappa = 0.278$) and moderate ($\kappa = 0.468$), respectively. Interobserver results showed that 4 of the 50 radiographic images had a unanimous classification. Intraobserver results for the 2 surgeons showed that 18 of the 50 images were rated the same on second review by the first surgeon and 38 of the 50 images were rated the same on second review by the second surgeon.

Conclusion: We found that the Rockwood classification system has limited interobserver and intraobserver reliability. We believe that unreliable classification may account for some of the inconsistent treatment outcomes among patients with similarly classified injuries. We suggest that a better classification system is needed to use radiographic imaging for diagnosis and treatment of AC joint dislocations.

Level of evidence: Basic Science Study; Validation of Classification System

Keywords: Acromioclavicular joint; dislocations; interobserver reliability; intraobserver reliability; radiographic reliability; Rockwood classification

This study was determined to be exempt from review by the Western Institutional Review Board: Work Order No. 1-814704-1.

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The acromioclavicular (AC) joint is a common site for shoulder injury. AC joint dislocations represent up to 12% of all shoulder dislocations and 8% of all joint dislocations.[8] Treatment and classification of AC joint dislocations remain controversial. The most common classification in clinical use today remains the Rockwood classification, which identifies 6 types of AC joint injury. Among these, types III and V are the most controversial in regard to recommending operative vs. conservative treatment. Recent publications have advocated more for conservative treatment of type III injuries[4,6,15,18,19,22-24,27] and surgical treatment of types IV and V.[13,18,25,28] However, other authors have called into question the reliability of radiographic classification of AC injuries, particularly Rockwood types III, IV, and V.[1-3,7,11,17,21]

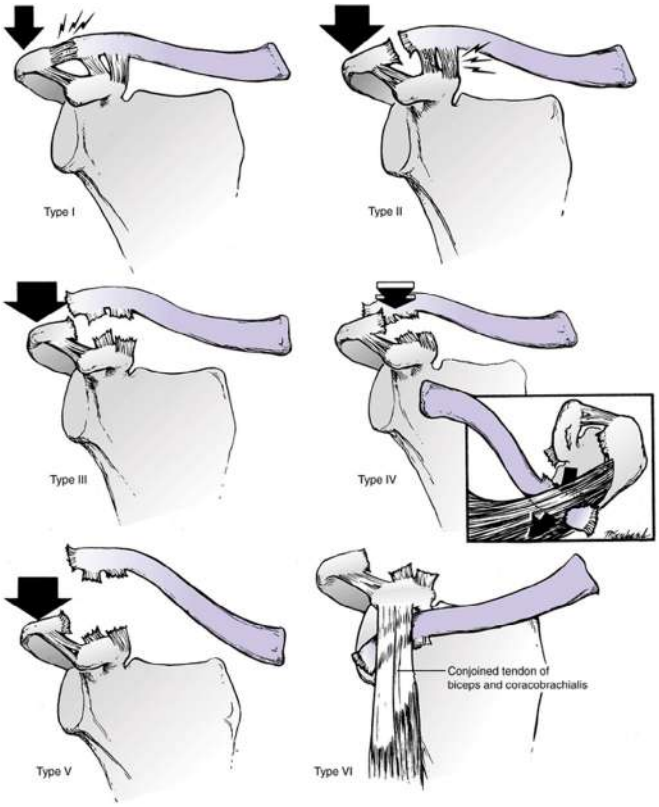
Differences between studies on the treatment of AC dislocations, particularly the controversy about treatment for Rockwood type III, may be due to the difficulty in accurately classifying types III, IV, and V on radiographic imaging. Rockwood types III and V both involve superior displacement of the distal clavicle, and Rockwood type IV dislocations involve a posterior displacement of the clavicle.[8] Distinguishing types III, IV, and V on radiographic imaging can be difficult. Viewing posterior displacement in type IV dislocations requires adequate axillary views.[1,2,7,11,14,16,20,26] Obtaining adequate axillary images may be impossible in patients with acute pain, making radiographic imaging insufficient in accurately differentiating type IV dislocations from types III and V.[7,20,26] In addition, a lack of consensus on the exact amount of posterior displacement required to be type IV may contribute to the inconsistency in accurate grading.[7,11] Rockwood types III and V, both involving superior displacement of the clavicle, are differentiated only by a coracoclavicular distance being 25%-100% greater than the normal side in type III and 100%-300% greater than the normal side in type V (Fig. 1).[8]

The ability to diagnose and to treat AC joint injuries using radiographic imaging requires a classification system that is accurate, reliable, and reproducible.[7] The purpose of this study was to determine the interobserver and intraobserver reliability in using the Rockwood system to classify AC joint dislocations. We hypothesized that there would be poor interobserver and intraobserver reliability, limiting the role of the Rockwood classification system in determining the severity of injury and accurately guiding decisions for operative vs. nonoperative treatment.

Materials and methods

This was an evaluation study looking at the interobserver and intraobserver reliability of the Rockwood classification system. A member of the coding department retrospectively identified 200 patients with AC joint injuries using the *International Classification of Diseases, Ninth Revision* code 831.04. Once a patient was identified, a member of our radiology staff reviewed the radiographs to

Figure 1 Anteroposterior (**A**) and axial (**B**) radiographs showing a Rockwood type III dislocation. Anteroposterior (**C**) and axial (**D**) radiographs showing a Rockwood type V dislocation.



- **Type 1**
  - minor sprain of the fibers of the AC ligaments
- **Type 2**
  - distal end of the clavicle is unstable in the horizontal plane
  - widening of the AC joint. There may be a slight, relative upward displacement of the distal end of the clavicle
- **Type 3**
  - 25% to 100% increase in the coracoclavicular space
- **Type 4**
  - clavicle is posteriorly displaced into or through the trapezius muscle
- **Type 5**
  - coracoclavicular space is increased greater than 100%
- **Type 6**
  - Inferior dislocation of the distal clavicle

Figure 2 Images and descriptions of Rockwood types I-VI.

determine inclusion in the study. Inclusion criteria were patients 18 years of age and older and an AC joint injury with radiographic displacement demonstrating ability to be classified. Exclusion criteria were age <18 years, concurrent fracture in the shoulder girdle that might obscure visualization and radiographic classification of the AC injury, and inadequately presenting radiographs. A total of 50 patients met inclusion criteria. The radiology staff then deidentified the selected patients' radiographs and compiled them into a PowerPoint document (Microsoft, Redmond, WA, USA). The collection of deidentified radiographs was sent by secure e-mail to the surgeons for classification. Radiographs contained a number for use in statistical analysis of interobserver and intraobserver reliability. The numbers were randomly assigned and not based on any patient identifiers.

Fifty patients with an anteroposterior and axillary image were reviewed by the 6 surgeons and classified into 1 of the 6 types described by Rockwood. Two of the 6 surgeons classified the images a second time several months later to evaluate intraobserver reliability. Figure 2, showing descriptions and images of all 6 types described by Rockwood, was supplied to each of the surgeons for reference.

A κ statistic was calculated to measure both the interobserver and intraobserver reliability. The strength of agreement was categorized according to Landis and Koch.[12] A κ value <0.00 was rated poor; 0.00-0.20, slight; 0.21-0.40, fair; 0.41-0.60, moderate; 0.61-0.80, substantial; and 0.81-1.00, almost perfect.

Results

Interobserver results were calculated using a Fleiss κ statistic. Our data resulted in a Fleiss κ value of 0.278, showing only fair agreement among the 6 surgeons. Table I shows all interobserver results. The most common classification in our analysis was type III, whereas the least common classification was type I. Only 4 of the 50 patients were unanimously classified as the same type. Two of these patients (numbers 2 and 40) were unanimously classified as a type V injury; the other two patients (numbers 16 and 25) were unanimously classified as a type III injury. Four of the 50 patients were classified evenly as 2 separate types. Two of these 4 patients (numbers 1 and 14) were classified by 3 of the surgeons as a type III and by the other 3 surgeons as a type IV. The other 2 patients (numbers 12 and 20) were graded by 3 of the surgeons as a type III and by the other 3 surgeons as a type V. Eighteen of the patients had at least 4 of the 6 surgeons classify their injury as a type III, with the other surgeons classifying it as a type II, IV, or V injury.

Intraobserver reliability was calculated using a Cohen κ statistic. Our data resulted in a Cohen κ value of 0.468,

Table I Interobserver results showing each surgeon's Rockwood classification (I-VI) for all 50 patients

Patient No.	Observer 1	Observer 2	Observer 3	Observer 4	Observer 5	Observer 6
1	IV	IV	III	IV	III	III
2	V	V	V	V	V	V
3	IV	IV	III	III	III	III
4	III	V	V	V	V	V
5	II	III	II	III	III	III
6	I	II	II	II	II	II
7	II	II	II	II	II	V
8	II	III	II	II	III	II
9	II	II	III	III	III	I
10	II	III	II	II	II	III
11	IV	IV	III	III	III	III
12	III	III	V	III	V	V
13	V	V	V	V	V	V
14	IV	III	IV	III	IV	III
15	III	II	I	III	II	III
16	III	III	III	III	III	III
17	IV	IV	II	III	III	III
18	IV	III	IV	V	V	III
19	IV	V	V	V	V	III
20	III	III	V	III	V	V
21	III	V	V	V	IV	V
22	II	III	II	III	III	III
23	II	III	II	III	III	III
24	III	III	II	III	III	III
25	III	III	III	III	III	III
26	III	III	III	III	III	V
27	III	III	II	III	III	V
28	III	III	III	III	IV	III
29	I	III	II	III	III	II
30	V	IV	IV	IV	IV	V
31	V	V	III	V	V	V
32	IV	V	IV	IV	IV	V
33	III	III	III	III	V	II
34	IV	V	III	IV	V	III
35	II	III	II	III	III	III
36	II	III	III	III	III	III
37	II	III	II	III	III	III
38	II	III	III	III	III	III
39	II	III	II	III	III	III
40	V	V	V	V	V	V
41	II	III	II	III	IV	III
42	IV	III	III	III	V	III
43	I	II	I	III	II	I
44	III	III	III	V	IV	V
45	III	V	III	V	V	V
46	III	V	III	V	V	V
47	IV	V	V	V	V	III
48	I	II	I	III	II	I
49	III	III	III	V	V	III
50	II	III	II	III	III	III

showing moderate agreement in first and second reviews. Table II shows all intraobserver results. Results showed that 1 surgeon rated 18 of the 50 images the same on second review, whereas the second surgeon rated 38 of the 50 images the same on second review. Of the 18 patients classified by the first surgeon as the same on second review, 3 were type I, 2 were type II, 12 were type III, and 1 was type V injury. The second surgeon classified 38 patients as the same on second review, which included 4 type I, 12 type II, 9 type III, 10 type IV, and 3 type V injuries.

Table II Intraobserver results showing the 2 surgeons' Rockwood classification (I-VI) for all 50 patients on first and second reviews

Patient No.	Observer 1 First review	Observer 1 Second review	Observer 2 First review	Observer 2 Second review
1	III	II	IV	IV
2	V	IV	V	V
3	III	III	IV	IV
4	V	IV	III	V
5	II	II	II	II
6	II	I	I	I
7	V	III	II	II
8	II	II	II	II
9	I	I	II	III
10	III	II	II	II
11	III	III	IV	IV
12	V	IV	III	III
13	V	IV	V	V
14	III	III	IV	IV
15	III	II	III	II
16	III	III	III	II
17	III	III	IV	IV
18	III	IV	IV	IV
19	III	III	IV	V
20	V	IV	III	III
21	V	IV	III	V
22	III	III	II	I
23	III	II	II	II
24	III	II	III	II
25	III	III	III	II
26	V	III	III	III
27	V	III	III	III
28	III	III	III	IV
29	II	I	I	I
30	V	V	V	IV
31	V	IV	V	III
32	V	IV	IV	IV
33	II	III	III	III
34	III	IV	IV	IV
35	III	II	II	II
36	III	II	II	II
37	III	III	II	II
38	III	II	II	II
39	III	II	II	II
40	V	IV	V	V
41	III	II	II	II
42	III	III	IV	IV
43	I	I	I	I
44	V	IV	III	III
45	V	IV	III	III
46	V	IV	III	III
47	III	IV	IV	IV
48	I	I	I	I
49	III	III	III	III
50	III	II	II	II

Discussion

Our study suggests an overall lack of reliability in using the Rockwood classification to grade AC joint dislocations. The Rockwood classification is the most widely used classification system in evaluating AC joint dislocations. It has been well established that Rockwood types I and II should be treated conservatively and types IV and V treated surgically.[4,5,7,9,11,14,16,23] Treatment of Rockwood type III continues to be controversial. Differences in studies for Rockwood type III dislocations may in part be due to the difficulty in accurately classifying them by radiographic imaging, particularly in differentiating them from Rockwood types IV and V. Kraeutler et al and Cho et al have also studied the reliability of the Rockwood classification system.[7,11] Kraeutler et al found that individual surgeons were consistent in their classification of dislocations with an intraobserver κ value of 0.694 (substantial agreement).[11] They found there was less consistency between surgeons with an interobserver κ value of 0.602 (moderate agreement). Cho et al had slightly different findings.[7] Their study found that individual surgeons were less consistent in their classification of dislocations with an intraobserver κ value of 0.474 (moderate agreement). The agreement between surgeons was found to be far less consistent with an interobserver κ value of 0.214 (fair agreement). Our study shows similar results to the study of Cho et al,[7] with an intraobserver κ value of 0.468 (moderate agreement) and interobserver κ value of 0.278 (fair agreement).

Our results showed that despite type III being the most classified injury, only 2 of the 50 patients were unanimously classified as a type III injury. The only other 2 patients with a unanimous classification were both type V injuries. Many patients had significant variations in being classified as a type II, III, IV, or V injury. Eighteen of the 50 patients had at least 4 of the surgeons classify them as a type III injury, with the other surgeons classifying them as a type II, IV, or V injury. An additional 4 patients had split results between type III and types IV and V. Two of these 4 patients had 3 surgeons classify them as type III and 3 surgeons classify them as type IV, whereas the other 2 patients had 3 surgeons classify them as type III and 3 surgeons classify them as type V.

Several reasons have been described for the difficulties in accurately classifying AC dislocations by radiographic imaging. Poor reliability in differentiating Rockwood types III and IV may be due to difficulties in obtaining adequate images as well as lack of consensus in defining Rockwood type IV.[7,10,20,26] Poor reliability in differentiating types III and V is due to the similar superior displacement of the clavicle seen in both types. Cho et al also suggested that there is a lack of consensus among surgeons on the proper classification of coracoclavicular distances between 100% and 300%.[7] The ability to diagnose and to treat AC joint injuries by radiographic imaging requires a classification system that is accurate, reliable, and reproducible. Our study shows a lack of reliability of the

Rockwood classification for AC joint dislocations, leading to possible misdiagnosis and the inconsistent results of treatment for type III dislocations.

Our study had several limitations. First, we did not compare the Rockwood classifications given by our 6 surgeons with the original classification of the primary treating physician or follow up on whether the patients were treated conservatively or surgically. Second, contralateral images were not provided to the surgeons during the rating process or examined as part of the study. Third, we did not perform a power analysis.

As far as strengths of our study, all 6 surgeons involved in the classification of the AC joint dislocations were fellowship-trained upper extremity orthopedic surgeons. Also, our study focused only on the reliability of plain radiographic classification. A survey of treatment recommendations was not performed as we believe the inherent issue with determining treatment for AC dislocations lies within the lack of reliability in classification.

Conclusion

Our study demonstrated that the Rockwood classification system has limited interobserver and intraobserver reliability. Accurate classification of AC joint dislocation is critical in determining appropriate treatment. We believe that unreliable classification may account for some of the disagreement among physicians in treating these injuries and the inconsistent outcomes among patients with similarly classified injuries. We suggest that a better classification system is needed to use radiographic imaging for diagnosis and treatment of AC joint dislocations.

Disclaimer

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