

Inter- and intraobserver reliability of the Rockwood classification in acute acromioclavicular joint dislocations

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Abstract

Purpose The reliability of the Rockwood classification, the gold standard for acute acromioclavicular (AC) joint separations, has not yet been tested. The purpose of this study was to investigate the reliability of visual and measured AC joint lesion grades according to the Rockwood classification.

Methods Four investigators (two shoulder specialists and two second-year residents) examined radiographs (bilateral panoramic stress and axial views) in 58 patients and graded

the injury according to the Rockwood classification using the following sequence: (1) visual classification of the AC joint lesion, (2) digital measurement of the coracoclavicular distance (CCD) and the horizontal dislocation (HD) with Osirix Dicom Viewer (Pixmeo, Switzerland), (3) classification of the AC joint lesion according to the measurements and (4) repetition of (1) and (2) after repeated anonymization by an independent physician. Visual and measured Rockwood grades as well as the CCD and HD of every patient were documented, and a CC index was calculated (CCD injured/CCD healthy). All records were then used to evaluate intra- and interobserver reliability.

Results The disagreement between visual and measured diagnosis ranged from 6.9 to 27.6 %. Interobserver reliability for visual diagnosis was good (0.72–0.74) and excellent (0.85–0.93) for measured Rockwood grades. Intraobserver reliability was good to excellent (0.67–0.93) for visual diagnosis and excellent for measured diagnosis (0.90–0.97). The correlations between measurements of the axial view varied from 0.68 to 0.98 (good to excellent) for interobserver reliability and from 0.90 to 0.97 (excellent) for intraobserver reliability.

Conclusion Bilateral panoramic stress and axial radiographs are reliable examinations for grading AC joint injuries according to Rockwood's classification. Clinicians of all experience levels can precisely classify AC joint lesions according to the Rockwood classification. We recommend to grade acute ACG lesions by performing a digital measurement instead of a sole visual diagnosis because of the higher intra- and interobserver reliability.

Level of evidence Case series, Level IV.

Keywords Acromioclavicular joint · Ac joint · Acute · Separation · Dislocation · Rockwood classification · Intra- and interobserver reliability

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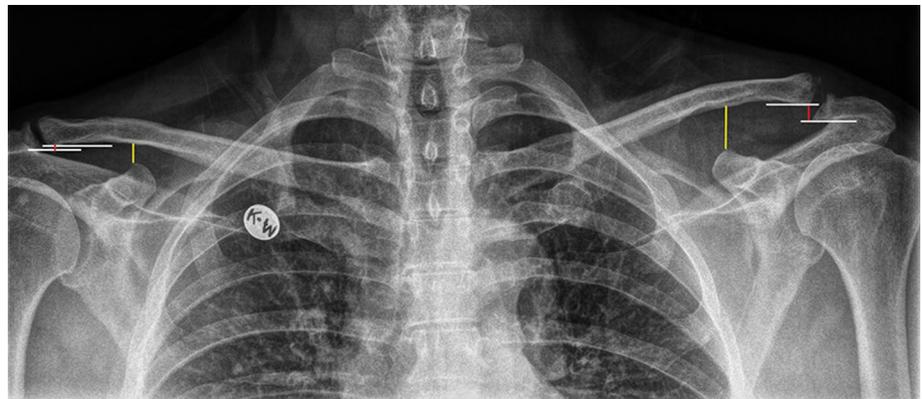
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Table 1 Rockwood classification according to visual diagnosis (AC distance) and measured diagnosis (CC distance)

Rockwood type	CC distance in % (in contrast to contralateral side)	AC distance in width of clavicle
I	–	–
II	0–25 %	Elevation of up to half width
III	>25–100 %	Elevation of up to one width
IV	–	–
V	>100–300 %	Elevation of more than one width
VI	–	–

Fig. 1 AC distance (red) for visual and CC distance (yellow) for measured grading according to the Rockwood classification

Introduction

Acromioclavicular (AC) joint lesions represent approximately 9 % of all shoulder injuries. Acute dislocations mostly occur in athletic patients in their 20s [11, 18]. The first classifications of acute AC joint injuries were introduced by Tossy et al. [19] in 1963 and by Allmann [3] in 1967, who distinguished between grade I to III lesions based on plain radiographs. Rockwood et al. [15] established a more detailed classification grading injuries from I to VI (see Table 1). Although Rockwood et al. [15] graded lesions according to the measured distance between the cranial rim of the coracoid and the caudal border of the clavicle (coracoclavicular distance, CCD), a visual diagnosis of the AC distance (elevation of the clavicle measured in its shaft width) is commonly used as a reference when evaluating AC joint dislocations [8, 14, 16]. It remains unclear whether a visual diagnosis produces comparable results to an exact digital measurement (see Fig. 1).

Furthermore, there is no consensus on which radiographic projection allows the best evaluation of horizontal instability to distinguish between Rockwood Grade II/III/V and Grade IV lesions. The purpose of our study was to determine how reliably AC joint separations can be described by surgeons with different levels of experience according to the Rockwood classification and to determine whether digital measurements provide different results than a simple visual diagnosis. Because radiographic findings in combination with clinical examination constitute the foundation of therapeutic decisions for AC joint separations [6],

we believe that the Rockwood classification of AC joint dislocations needs one standardized approach. The current literature does not provide evidence concerning the reliability of the Rockwood classification, although this classification is used by many physicians worldwide.

The purpose of our study was to determine the reliability of the measured CCD and the calculated CC index (CCI) as well as the visual diagnosis of the clavicle's dislocation in order to find out which method is more reliable and should be recommended in clinical practice.

Materials and methods

This retrospective study included radiographs of 58 patients (mean age 42 years, range 16–73 years) with different types of AC joint injuries treated either conservatively or operatively at the authors' institution between 2008 and 2013. In addition to a clinical examination, every patient received a bilateral panoramic stress view (10 kg fixed on each wrist) and an axial radiograph as primary diagnostics (see Figs. 1, 2). Patients with a history of any ipsilateral shoulder girdle injuries, such as fractures of the clavicle, coracoid or acromion as well as AC joint sprains, were excluded.

The patients' radiographs were rendered anonymous by removing names, dates and any other references to minimize the recognition value. Four investigators (two trained orthopaedic surgeons, current shoulder fellows, with expertise in shoulder surgery and two young residents in their second year) performed the measurements. These



Fig. 2 Measurement on axial radiograph (*horizontal dislocation*)

investigators received written instructions on how to perform the required measurements and the anonymized radiographs. First, each physician was asked to provide a visual diagnosis of the AC joint injury according to the Rockwood classification using both the panoramic stress and axial views. Afterwards, the first digital analysis using Osirix Dicom Viewer (Pixmeo, Geneva, Switzerland) computer software was performed. The measurements included the CCD (in “Pix”) of both shoulders (healthy and injured) on the panoramic stress view to assess the vertical dislocation [5] and the distance (in “Pix”) between the anterior rim of the lateral clavicle and the anterior rim of the acromion to evaluate a possible horizontal dislocation (HD) [21] in the axial view (Fig. 1). Because the literature does not provide a “cut-off” value for horizontal dislocation, the examiners categorized Rockwood type IV lesions using their own clinical judgment. In the second step, the numbers and the order of the radiographs were changed and a second set of measurements was performed 4 weeks later by all four investigators using the same procedure. This study was performed under the guidance of the ethical committee of the University of Witten/Herdecke.

Statistical analysis

After the measurements of all 58 bilateral panoramic stress and axial radiographs, a CCI (CCD injured/CCD healthy)

was calculated. Visual diagnosis (Rockwood I–VI), the CCI, the axial measurements and the assigned Rockwood type (I–VI) after measurement were compared between all four investigators using the Pearson correlation coefficient (PCC) to determine the inter- and intraobserver reliability. The PCC was classified as excellent (0.81–1.00), good (0.61–0.80), moderate (0.41–0.60), fair (0.21–0.40) or poor (0.00–0.20) [10].

Results

The interobserver reliability of the visual diagnosis was good and varied from 0.72 to 0.74. The intraobserver reliability of the visual diagnosis showed a good to excellent correlation (0.67–0.93).

There was discordance between the visual and digitally measured Rockwood grades among the young residents (first analysis and second analysis) in 16 (27.6 %) and 12 (20.7 %) for the first and in 13 (22.4 %) and 6 (10.3 %) cases for the second resident, respectively. Among the trained surgeons, a discrepancy arose in 4 (6.9 %) and 10 (17.2 %) for the first and in 5 (8.6 %) and 8 (13.8 %) patients for the second investigator, respectively.

The CCI between all examiners showed an excellent correlation of 0.85–0.93. The intraobserver reliability (CCI between first and second analysis) displayed an excellent correlation of 0.90–0.97 (young residents, 0.90–0.97; trained surgeons, 0.93–0.96).

The intraobserver reliability of the axial radiograph measurements was good to excellent (0.67–0.98). The interobserver reliability showed a good to excellent correlation (0.62–0.96).

Discussion

The most important finding of the present study was that the grading of AC joint lesions according to Rockwood is reliable for the digital measurement in bilateral panoramic stress and axial radiographs as well as the visual diagnosis, although the measurement was more precise and showed a higher inter- and intraobserver reliability in comparison with the visual diagnosis. The Rockwood classification has been accepted as the gold standard for grading acute AC joint injuries. However, the reliability of this classification for the CC and AC distance has not yet been evaluated. Because both measurement techniques can be used, the classification might differ depending on the method applied. There is general consensus on the appropriate therapy for types I and II (conservative) and types IV through VI (operative) lesions, which is supported by the literature [4, 5].

The therapy for type III injuries still remains controversial, and both conservative and operative treatment protocols appear to produce satisfactory results [7, 13, 17].

The intra- and interobserver reliability for CCD measurement among young residents and trained surgeons with shoulder expertise was excellent (0.90–0.97 and 0.85–0.93, respectively). Acute AC joint lesions can therefore be judged at an early stage of a physician's medical education using the Rockwood classification on bilateral panoramic stress and axial view radiographs. Kraeutler et al. [9] addressed a related issue by anonymizing anteroposterior and axial radiographs of the shoulder after AC injuries. The evaluators were blinded and asked to grade the radiographs in a PowerPoint presentation according to the Rockwood classification and recommend therapy (conservative vs. operative). The main focus of this study was the therapy, which was recommended after radiographic evaluation. Kraeutler et al.'s results showed consistent grading of AC joint dislocations (intraobserver reliability = 0.694), whereas the therapeutic recommendations differed among the participating surgeons. However, in this study, only the reliabilities for a visual diagnosis were evaluated.

In the present study, the measured diagnosis of acute AC joint lesions showed a higher inter- and intraobserver reliability compared with the visual diagnosis. Therefore, we recommend grading AC joint injuries with the assistance of computer software on digital radiographs or with other exact measurement tools on printed radiographs to obtain therapeutic recommendations with the highest accuracy possible. Additionally, the young residents demonstrated a good, rapid learning effect while evaluating the radiographs.

Balke et al. [4] performed a survey of German-speaking trauma and orthopaedic departments, revealing that a panoramic stress view with weight was performed by 90 % of the interviewees and appears to be the standard in the German-speaking area. Interestingly, only 42 % performed additional radiographs to assess horizontal dislocations. Vaisman et al. [20] investigated a novel radiographic index in patients with AC joint injuries for which routine bilateral panoramic stress and axial views were acquired. The authors state that these projections were sufficient for their evaluation, and no other radiograph was necessary. Other institutions use and recommend different radiographs to evaluate horizontal instability, e.g. bilateral Alexander views [1, 2]. A recent consensus of the upper extremity committee of the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine ISAKOS suggests modifying the Rockwood classification with the introduction of injury type IIIa (horizontally stable) and type IIIb (horizontally unstable). To assess this dynamic horizontal stability, a bilateral cross-body adduction view would be necessary [6]. This radiographic view might be

helpful in detecting not only static but also dynamic horizontal instabilities and therefore distinguish between type II/III/V and IV lesions. Since this has a direct influence on the recommended therapy (operative vs. conservative), a proper diagnose of horizontal instabilities can be clinically important. A study by Nemeč et al. [12] compared MRI versus radiographic findings in 44 patients with acute AC joint dislocations (Rockwood I–IV). Accordance between radiography and MRI was found in 23/44 cases (52.2 %). Among the remaining 21 patients, MRI revealed a less severe type in 16 (36.4 %) and a more severe type in 5 (11.4 %) of the cases. Horizontal instability is usually detected in a clinical examination; nonetheless, reliable radiographs for an objective estimation are helpful. The present study shows that bilateral panoramic stress and axial views allow reliable evaluation of measurements used for grading AC joint injuries according to the Rockwood classification.

The Rockwood classification is used worldwide to grade AC joint lesions and recommend therapeutic options; however, the reliability of this classification has not yet been tested. Ideally, the reliability of the Rockwood classification should have been evaluated before the classification was used. We suggest that a bilateral CC distance measurement and a CCI calculation should be included in every AC joint lesion Rockwood grade because the measured diagnosis showed excellent reliability and can be performed by residents early in their training.

This study has certain limitations. The study protocol only included measurements and did not include clinical findings; therefore, we were not able to correlate our measurements to the actual extent of the injury. Another limitation is the fact that the axial view is sometimes not possible to be performed due to patient's discomfort. Furthermore, axial radiographs were firstly not standardized and might secondly not display dynamic horizontal instabilities. Thus, the absolute values of this projection might not correspond and may not reflect the severity of the horizontal instability. Additionally, cut-off values to define Rockwood type IV lesions using the axial view have not yet been defined.

Conclusion

Bilateral panoramic stress and axial radiographs for grading AC joint injuries according to Rockwood's classification are reliable tools when using a digital analysis. Even residents early in their training were able to evaluate dislocations precisely. Therefore, we recommend measuring the CCD in comparison with the contralateral side (by calculating a CC index) and using the original classifications described by Rockwood as a standard for grading acute AC joint dislocations.

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