DOI 10.18019/1028-4427-2019-25-1-15-20

MRI-semiotics of acromioclavicular joint dislocation

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Objective To develop magnetic resonance imaging (MRI) protocol for assessing acromioclavicular joint (ACJ) in patients with dislocation of the acromial end of the clavicle, grading severity of injury after trauma and evaluating outcome of surgical treatment. **Material and methods** MRI was performed for 15 patients with ACJ injury before and after treatment. Based on MRI findings patients were subdivided into three groups depending on the degree of ACJ injury. **Results** In addition to radiography MRI yields important findings on a complex of pathological changes in ligaments, muscles and subcutaneous tissues. The imaging showed edema and a partial-thickness injury to the trapezius muscle (n=7), swollen subcutaneous tissue (n = 15), a glenoid labral tear (n = 4) and a rotator cuff injury (n = 7). **Conclusion** MRI has been particularly effective in characterizing ACJ injuries and associated changes in the bone and soft tissues. The capabilities of MRI in visualization of soft tissues have made this imaging modality invaluable in the assessment of outcomes of the dislocation of the acromial end of the clavicle.

Keywords: acromioclavicular joint, dislocation, magnetic resonance imaging

INTRODUCTION

Acromioclavicular joint (ACJ) injury is usually caused by a fall on an outstretched arm or on the shoulder [1–3]. Dislocation of the acromial end of the clavicle accounts for approximately 10 % of acute shoulder injury and 7 to 25 % of dislocations involving the shoulder [4–7]. Review of long-term outcomes of dislocations of the acromial end of the clavicle showed that poor results were associated with absence of established principles of treatment to consider severity of ligament injury and age of trauma. Reduction technique, treatment and rehabilitation protocol and final prognosis for the patient depend on a type of injury [1, 6, 8]. Accurate diagnosis and identification of the severity of injury using modern classifications is of paramount importance. ACJ injuries can be graded using classifications according to Neer, Craig and Tossy JD [9, 10, 11]. The Rockwood classification for ACJ injuries is widely used in clinical practice [12–16]. Polypositional radiography of glenohumeral joint is commonly used as a routine imaging tool in the diagnosis of ACJ injuries [4, 17–19]. Zanca view radiograph is produced with the load of 3–4 kg applied to the upper limb for comparison of cleidoscapular articulations on both sides [8]. Ultrasound and MR imaging have a well-established role in assessment of ACJ injury [20–22].

MRI is offered to be included in a standardized diagnostic imaging protocol for dislocations of the acromial end of the clavicle, however, no detailed descriptions of MRI-semiotics of ligaments in ACJ injury of different severity could be found [22, 23]. F. Alyas et al., 2008 report possibilities with MR imaging to assess ligamentous structures in acute and chronic injuries [24]. U. Nemec et al., 2011 suggest that, in addition to clinical assessment and radiography, MRI may yield important findings on ligaments that may influence management [25]. K. Izadpanah et al., 2013 suggest that stress MRI facilitates simultaneous acquisition of morphologic and functional information of the ACJ stabilizers. In acute ACJ injuries it helps to distinguish between partial and complete ligament tears. In chronic ACJ injuries it provides functional information of the ligament regrinds [26].

Objective To develop magnetic resonance imaging (MRI) protocol for assessing acromioclavicular joint (ACJ) in patients with dislocation of the acromial end of the clavicle, grading severity of injury after trauma and evaluating outcome of surgical treatment.

Diachkov K.A., Diachkova G.V., Mitina Iu.L., Larionova T.A. MRI-semiotics of acromioclavicular joint dislocation. *Genij Ortopedii*, 2019, T. 25, No 1, pp. 15-20. DOI 10.18019/1028-4427-2019-25-1-15-20. (In Russian)

MATERIAL AND METHODS

MRI was performed for 15 patients with ACJ injury before and after treatment on Siemens Magnetom Symphony Maestro Class 1.5 Tesla scanner for detailed assessment of glenohumeral joint and ASJ. The study protocol consisted of the following sequences for imaging the acromioclavicular joint: a coronal and axial proton density-weighted sequence, an axial, coronal and sagittal T2-weighted sequence with fat suppression and a coronal and sagittal T1-weighted sequence. The algorithm allowed more detailed information on the extent of injury to all components of ACJ and glenohumeral joint. Articular space was measured and compared to the intact side. Coracoclavicular distance (normal width 1–1.3 cm) and acromioclavicular distance (normal width 0.3–0.8 cm) of the injured shoulder were obtained and swelling in the bone and the surrounding tissues visualized (**Fig. 1**).

Statistical analysis. Statistical data analysis was performed using Attestat computer program (I.P. Gaidyshev, 2001) incorporated in Microsoft Excel. $P < 0.05$ was considered statistically significant, with p being the significance level. The results are presented as a statistical formula of $M \pm \sigma$, where M is the arithmetic mean and σ, standard deviation.

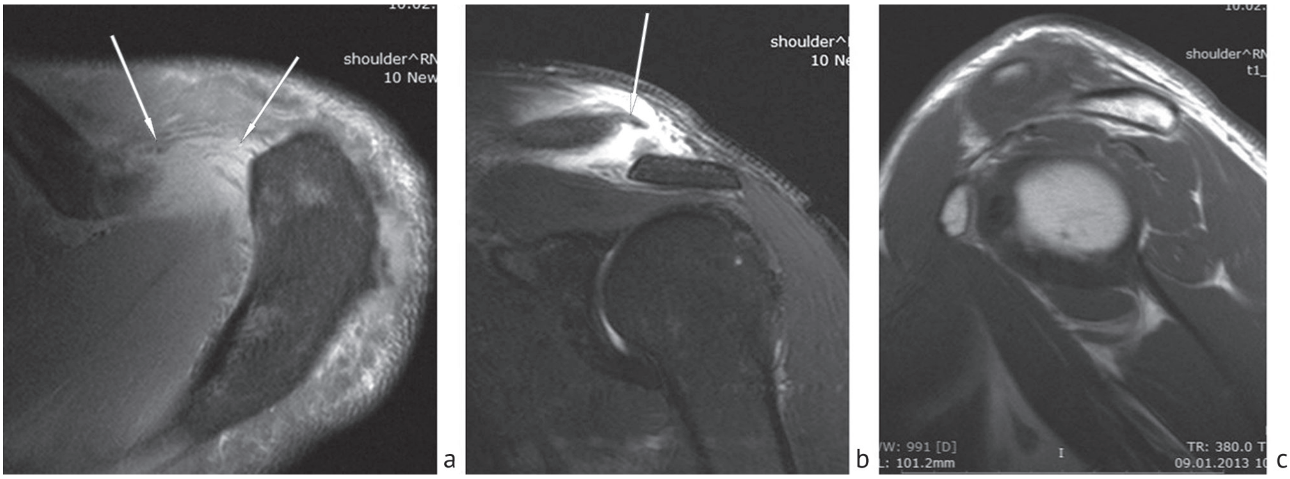

Fig. 1 (a) MRI scan of glenohumeral joint, PD fs, axial plane; (b) MRI scan of glenohumeral joint, T2fs, coronal plane; (c) MRI scan of glenohumeral joint, T1se, sagittal plane

RESULTS AND DISCUSSION

On the basis of MRI findings ACJ injuries were assigned a type according to the Rockwood classification (1984). Three patients had Rockwood type I injuries, seven – type II and five – type III [3] (**Fig. 2**).

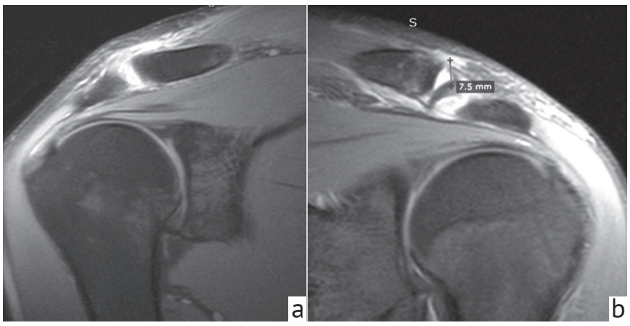

Fig. 2 (a) MRI scan of glenohumeral joint of a 46-year-old patient K., PD fs., Rockwood type I injuries; (b) MRI scan of glenohumeral joint of a 33-year-old patient A., PD fs., Rockwood type II injury (7.5 mm)

Findings of ACJ injury based on Rockwood classification system are presented in Table 1.

Table 1

Distribution of patients by severity of ACJ injury depending on the extent of injury to AC and CC ligaments (number of patients)

Group of patients (extent of injury)	AC ligament	CC ligament
First	3	2
Second	4	5
Third	7	5

An injury to coracoclavicular ligament was associated with nonhomogeneous signal intensity indicating to partial or complete tear. Ligaments and muscles were assessed with classification system of Nemec U et al., 2011 [25] (**Fig. 3**).

Edema of the surrounding soft tissues, edema of the bone marrow at the acromial end of the clavicle and the acromial process were visualized in all the patients. Partial tear and edema of tendinous-muscular strcutures of the trapezius muscle were observed at ACJ of seven patients (**Fig. 4**).

Findings of associated changes in bone structures and soft tissues other than ligament tears are presented in Table 2.

MRI findings showed injured structures of glenohumeral joint with dislocated acromial end of the clavicle in three patients of group I, four patients of group II and four patients of group III. Rotator cuff tear was very common. Residual dislocation of the acromial end of the clavicle (4.6 ± 0.3 mm) was seen in 3 cases (**Fig. 5**).

In the majority of cases, radiographs are the initial imaging modality of choice for diagnosis and classification of AC injuries. Imaging is used to classify ACJ injuries with plain films being sufficient for accurate grading to be added by projectional variations if needed [8, 14, 17]. Nevertheless, controversies in interpretation of radiographs of patients with ACJ injuries are reported by several foreign authors. Visual analysis of ACJ injury diagnosed by the Rockwood classification can be unreliable for accurate diagnosis, and digitally measured parameters can be more precise and reliable between investigators than visual classification alone [14, 17, 19, 27]. J.D. Gorbaty et al., 2016 suggest that reproducibility of the Rockwood classification is likely limited by the inability of a classification based on plain radiographs and pathoanatomy of the injury to fully assess a soft tissue injury [28].

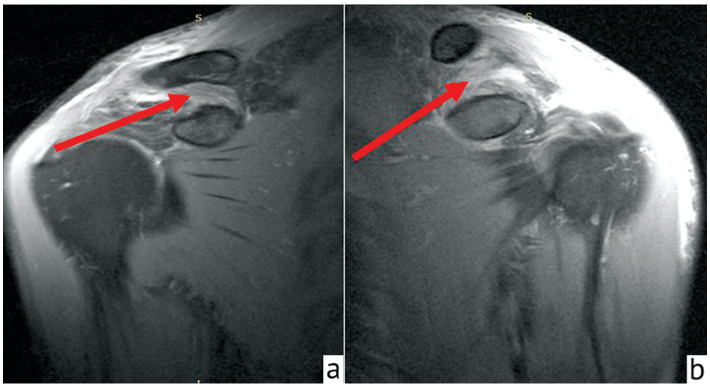

Fig. 3 (a) MRI scan of glenohumeral joint of a 46-year-old patient K., PD fs., sagittal plane showing intact CC ligament; (b) MRI scan of glenohumeral joint of a 33-year-old patient A., PD fs., sagittal plane, showing disruption of the CC ligament

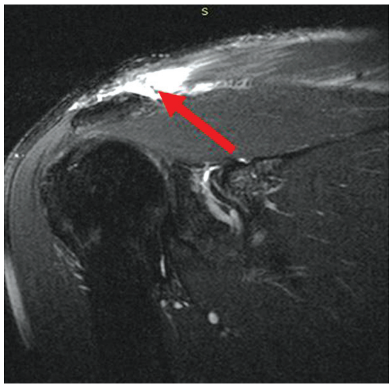

Fig. 4 MRI scan of glenohumeral joint of a 46-year-old patient K., PD fs., sagittal plane showing edema of tendinous-muscular portion of the trapezius muscle

Table 2

MRI – semiotics of associated changes in bone structures and soft tissues with torn ligaments of ACJ (number of patients)

Area of interest	Edema	Partial disruption	Edema and partial disruption
Deltoid muscle	4	–	–
Acromial end of the clavicle	15	–	–
Acromial process	15	–	–
Subcutaneous cellular tissue	15	–	–
Glenohumeral joint	Disruption of glenoid labrum – 4	Rotator cuff injury – 7	–

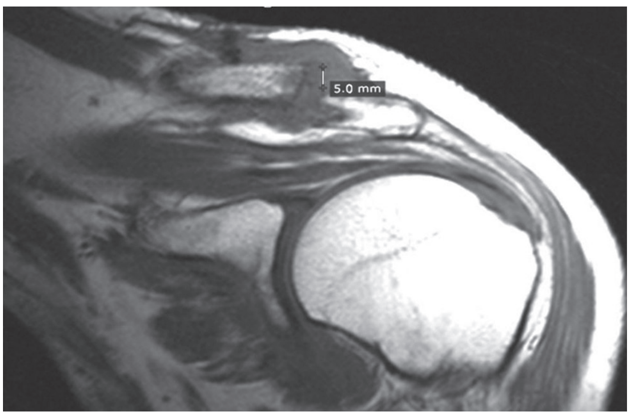

Fig. 5 MRI scan of glenohumeral joint of a 62-year-old patient G., T1WI showing residual clavicle dislocation of 5 mm

Review of a comparatively small number of foreign publications on MR imaging assessment of ACJ sprain or dislocation showed that MRI-semiotics can provide important and detailed morphologic information for surgeons and radiologists [24, 26, 29, 30]. Systemic review of different databases on the utilized imaging modalities for accurate diagnosis of ACJ injury demonstrated that to date, there is no consensus on a gold standard for diagnostic measures needed to classify acute AC joint injuries. There is currently no clear consensus on a protocol for image-based diagnosis and classification of acute AC joint injuries [31]. G.E.Antonio et al., 2003 were the first investigators who made an attempt to grade ACJ injuries using MRI allowing a direct method of classification rather than relying on measurements afforded by routine radiography. The coracoclavicular ligament plays a central role in maintaining ACJ stability, and its appearance should be carefully scrutinized in all patients undergoing shoulder MR imaging. The authors offered MRI-based classification of ACJ injuries with a short list of parameters that are not fully characteristic of the surrounding soft tissues of the shoulder girdle, ACJ and bone structures [32]. In 2011 the Rockwood classification was adapted by U. Nemec et al. to integrate the MRI findings, and the injuries were assigned a type according to this system. Lesions of acromionclavicular, coracoclavicular, coracoacromial ligaments, trapezoid and deltoid muscles according to Rockwood classification were adapted for MRI. With changes in ligaments, muscles and bones structures described in the article, the ligaments were rated according to established criteria for assessing normal status, partial and complete tears, detachments on MR images [25]. More accurate grading of ACJ and shoulder injuries would be practical using MRI findings.

CONCLUSION

1. MRI has been particularly effective in characterizing ACJ injuries and associated changes in the bone and soft tissues.

2. MRI – semiotics of dislocated acromial end of the clavicle include a greater list of pathological changes that can be visualized with MRI in addition to radiography comprising ligament and muscle disruptions of different severity, edema of subcutaneous tissue, tendinous-muscular structures and injury to the soft tissue around the shoulder glenohumeral joint.

3. The capabilities of MRI in visualization of soft tissues have made this imaging modality invaluable in the assessment of outcomes of the dislocation of the acromial end of the clavicle.

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Received: 21.09.2018

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