

Stress MRI of Ligamentous Stabilizers in Acute and Chronic Acromioclavicular Joint Instabilities

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• INTRODUCTION

The current state-of-the-art for diagnosing acromioclavicular joint (ACJ) injuries to its full extent relies on clinical evaluation and plain radiography. Also weighted radiographic view is performed for injury grading [1]. A detailed identification of the injury is not always possible using these techniques and this might explain the high percentage of persisting instability after conservative or operative treatment [2]. Biomechanical tests have shown that not only the reduction of the dislocated ACJ, but rather a complete anatomic reconstruction of all the ligamentous stabilizers can play an important role in reducing the incidence of recurrent joint instability [3]. Such a preoperative treatment planning requires an accurate diagnose of the injury pattern, which may be provided by a functional stress MRI of the ACJ, since it is well known that at rest, even with the latest MRI scanner, a differentiation between a partial tear and a complete rupture can be very difficult in presence of surrounding blood or edema [4]. Our clinical study is aimed to show the feasibility and reliability of stress MRI for simultaneous evaluation of the morphology and the functional integrity of the ACJ ligaments.

• METHODS

The clinical study protocol was tuned on 3 healthy volunteers and then performed on 7 patients. MRI was performed using a 0.25 T open MRI scanner (G-Scan, Esaote, Genova, Italy) with the ability to scan both at rest and under shoulder traction and endowed with dedicated receiving coils. Stress MRI was obtained by loading the examined shoulder by means of a stiff plastic glove, worn by the patient while lying supine with his arm along the body, as shown in Fig. 1. The glove was connected to a sand bag leading to an actual load, after friction, of 6.5 Kg. MRI protocol included, both at rest and under weight-bearing conditions, a 2D proton density- and T2-weighted multi-spin-echo sequence (TR: 3100 ms, TE: 28 ms and 90 ms, FOV: 200×200 mm², matrix size: 256×192) as well as a 3D gradient-echo sequence (TR: 28 ms, TE: 14 ms, FOV: 190×190×90 mm³, matrix size: 200×200×42). The slice thickness was 4 mm and 2 mm for the 2D and 3D sequence, respectively. Slice orientation was planned perpendicular to the coracoid process and parallel to the lateral course of the clavicle in order to image the conoid and trapezoid ligament along their anatomic course. Precise measurements of the coracoclavicular (CC) ligament and ACJ space were properly obtained by a multiplanar reformatting (TeraRecon Aquarius Version 4.3, Foster City, CA, USA) of the 3D data set, as shown in Fig. 2. All patients also experienced stress X-ray examination of both AC joints during the diagnostics work-up of their injury. Radiographic ligament lengths measurements were taken as a standard of reference, intraindividually compared with the 3D MRI ones.

• RESULTS

Slice positioning and complementary image contrasts characterizing our MRI protocol enabled an excellent visualization of the complete ligamentous stabilizers of the ACJ. The application of the 6.5 Kg stress to the examined shoulder was well tolerated by both volunteers and patients, allowing a stable positioning of the arm. In healthy volunteers stress MRI led to a mean widening of the CC distance of 4.0 ± 2.0 mm. The ACJ showed a mean widening of approximately 1.0 ± 0.3 mm. In patient conventional radiography the mean CC distance increased under stress from 16.7 ± 5.2 mm to 18.5 ± 6.1 mm. In MRI the CC distance increased from 14.6 ± 2.7 mm to 16.4 ± 3.2 mm. The mean CC distance expressed as a percentage, it is approximately the same for both methods (10.9 ± 6.5 % with weighted radiography and 12.8 ± 8.3 % with stress MRI).

• DISCUSSION & CONCLUSION

The goal of this study was to establish an easily applicable protocol and setup for the functional assessment of the ACJ ligaments during acute and chronic instabilities in a routine MRI examination. Key features of our technique are patient comfort, even under stress, to avoid possible motion artifacts; easy-to-fit stress device; suitable range of MRI contrast to properly assess different tissues, and acquisition of 3D data sets for multiplanar reconstruction, aimed to proper characterize skew curvature structures. Stress MRI reliability was confirmed by the comparison with stress weighted radiography results, showing an equal percentage increase of the CC distance. In conclusion, we have shown that a weighted shoulder MRI enables simultaneous acquisition of morphologic and functional information of all stabilizers of the ACJ in acute and chronic injuries.

• REFERENCES

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It can provide further information to the reference standard X-ray technique, helpful to improve the classification accuracy of borderline cases. In patients with uncertain grading of acute or chronic ACJ injuries the method can provide relevant information for therapeutic decision making.



Fig. 1: Supine positioning in the open C-shaped MRI scanner. A sand bag (red coloured, bottom left) is attached to the examined shoulder arm by a custom-build rigid glove made of plastic cast.

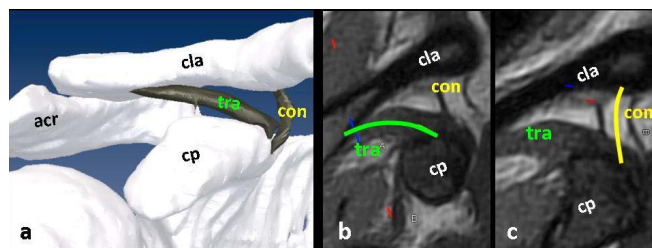


Fig. 2: a) Manual segmentation (MITK, Heidelberg, Germany) based on the acquired 3D MRI images. Clavicle (cla) and scapula, composed of the coracoid process (cp) and acromion (acr) process, were segmented separately from the conoid (con) and trapezoid (tra) ligament. (b) Measurement of the trapezoid ligament length between the center of the coracoclavicular and the coracoideal insertion point along the ligament course. (c) Measurement of the conoid ligament length (con).

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