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ORIGINAL ARTICLE

Correlations of coracohumeral ligament and range of motion restriction in patients with recurrent anterior glenohumeral instability evaluated by magnetic resonance arthrography

Kenji Kanazawa, MD, PhD[a], Yoshihiro Hagiwara, MD, PhD[b,*], Nobuaki Kawai, MD[c], Takuya Sekiguchi, MD[b], Masashi Koide, MD[b], Akira Ando, MD, PhD[d], Hiroyuki Sugaya, MD, PhD[c], Eiji Itoi, MD, PhD[b]

[a]*Department of Orthopaedic Surgery, Iwate Prefectural Central Hospital, Morioka, Iwate, Japan*
[b]*Department of Orthopaedic Surgery, Tohoku University School of Medicine, Sendai, Miyagi, Japan*
[c]*Shoulder & Elbow Center, Funabashi Orthopaedic Hospital, Funabashi, Chiba, Japan*
[d]*Department of Orthopaedic Surgery, Matsuda Hospital, Sendai, Miyagi, Japan*

Background: Evaluation of range of motion (ROM) restriction before treatment of shoulder disorders is important for predicting the final functional outcomes. The purpose of this study was to investigate correlations of thickness of the coracohumeral ligament (CHL) and ROM restriction in patients with recurrent anterior glenohumeral instability.

Methods: Between January 2005 and March 2015, 181 shoulders (137 male and 44 female patients; mean age, 29.3 years) with recurrent anterior glenohumeral instability treated with an arthroscopic Bankart repair were enrolled in this study. We evaluated preoperative ROM, thickness of the CHL, and obliteration of the subcoracoid fat triangle on magnetic resonance arthrography. ROM measurements, including forward flexion (FF), external rotation with the arm at the side (ER), and hand behind the back (HBB), were made in a standing position.

Results: There were significant negative correlations between FF and age ($P < .001$) and between HBB and age ($P < .001$) but not between ER and age ($P = .11$). The thickness of the CHL significantly increased with age ($P < .001$). FF, ER, and HBB were significantly restricted in patients with obliteration compared with those without obliteration ($P < .001$, $P = .004$, $P < .001$, respectively).

Conclusions: Obliteration of the subcoracoid fat triangle and the thickness of the CHL positively correlated with ROM restrictions, and these changes were greater with age in patients with recurrent anterior glenohumeral instability.

Level of evidence: Level II; Retrospective Cohort Design; Prognosis Study

Keywords: ROM restriction; coracohumeral ligament; CHL thickness; subcoracoid fat triangle; anterior glenohumeral instability; magnetic resonance arthrography

*Reprint requests: Yoshihiro Hagiwara, MD, PhD, Department of Orthopaedic Surgery, Tohoku University School of Medicine, 1-1 Seiryo-machi, Aoba-ku, Sendai 980-8574, Japan.

E-mail address: hagi@med.tohoku.ac.jp (Y. Hagiwara).

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Although the range of motion (ROM) of the shoulder decreases with age in the normal population,[7,13] it is well recognized as a complication of postoperative rotator cuff repair (RCR).[14,35] ROM restriction, such as forward flexion (FF), external rotation (ER), and hand behind the back (HBB), occurs at the early phase after RCR, and loss of motion is related to pain and lower outcome scores.[35] Recent studies indicated that recovery after RCR with shoulder stiffness is slower compared with those without.[43] The addition of arthroscopic capsular release to RCR with stiffness shows greater improvement in ROM and functional outcomes.[43] Among the preoperative ROM restrictions, HBB was one of the most important predictors for development of shoulder stiffness after RCR.[35,47] As for recurrent anterior glenohumeral instability, postoperative complications such as shoulder stiffness can occur even with appropriate postoperative management and cause functional disability.[28] Evaluation of ROM restriction before treatment is important for predicting the final functional outcomes. However, there have been no reports on evaluation of preoperative ROM restriction in patients with recurrent anterior glenohumeral instability.

Magnetic resonance imaging (MRI) has been used for evaluating shoulder disorders. As for frozen shoulder, some studies focused on the rotator interval (RI), whereas others focused on the axillary recess.[18,30,31,33,51,52] The most characteristic findings of frozen shoulder were thickening of the coracohumeral ligament (CHL) and complete obliteration of the fat triangle below the coracoid process on standard MRI[31,52] and MR arthrography.[30,33] Although the CHL covers the RI[15,16] and its thickness was directly correlated with restriction in ER,[36,41] a recent study shows that the CHL envelops the whole subscapularis (SSC) and its insertion and appears to function as a holder of the SSC and supraspinatus (SSP) muscles.[4] One study reported that restriction in internal rotation in patients with frozen shoulder was associated with thickness of the CHL on MR arthrography.[30] These findings may suggest that the CHL has an important role in ROM restriction in other shoulder diseases as well.

MR arthrography, with an intra-articular injection of gadolinium-based contrast agent, improved visualization of intra-articular structures.[23,42] It visualizes the articular surface of the rotator cuff better than standard MRI.[23] In addition, it is useful for evaluating the labroligamentous complex in patients with recurrent anterior glenohumeral instability.[10,42] Recent studies have reported that MR arthrography improves a structural analysis of the RI, containing the CHL, because it distends the joint capsule.[12,34] However, the specific MRI findings of the intra-articular structures relating to the ROM restriction are not fully understood, especially in shoulders with recurrent anterior instability.

The purpose of this study was to investigate correlations between thickness of the CHL and ROM restriction in patients with recurrent anterior glenohumeral instability with use of MR arthrography. Multivariate analysis was used to evaluate the risk of ROM restriction. We hypothesized that the thickening of the CHL influenced ROM restrictions and the thickness increased with age.

Materials and methods

Inclusion and exclusion criteria

This is a retrospective case-control study of CHL and ROM restriction in patients with recurrent anterior glenohumeral instability using MR arthrography. Between January 2005 and March 2015, patients with recurrent anterior glenohumeral instability were treated with an arthroscopic Bankart repair at Funabashi Orthopaedic Hospital. We retrospectively reviewed the records of 200 patients who underwent preoperative MR arthrography for evaluation of the Bankart lesion. We divided them into 4 groups based on age: 10s (10-19 years), 20s (20-29 years), 30s (30-39 years), and 40s (40-49 years). Among 200 shoulders, 181 were enrolled in this study. These included 137 male and 44 female patients with a mean age of 29.3 years (range, 13-48). We evaluated the preoperative ROM, thickness of the CHL, and obliteration of the subcoracoid fat triangle. ROM included FF, ER with the arm at the side, and HBB measured with the patients in a standing position. Because there were no patients with severe ROM restrictions like frozen shoulder, we defined the ROM restriction as FF <120° and/or ER <30° and/or HBB <L1 as previously reported.[5,39] We excluded patients with rotator cuff tears, glenohumeral osteoarthritis, chronic joint arthritis, and previous fractures around the shoulder. Revision cases, contrast agent leakage, and unclear visualizations on MR arthrography were also excluded.

MR arthrography protocol

Arthrography was performed by a fluoroscopically guided injection of a maximum of 20 mL of diluted gadolinium (gadoteridol [ProHance], diluted 3:200 with normal saline; Bracco Diagnostics, Princeton, NJ, USA). We stopped the injection when patients felt increased pressure or pain. After the injection, MR arthrograms were obtained with a 1.5T imager (Intera 1.5T; Philips, Amsterdam, The Netherlands) with a phased array surface coil. Patients were positioned with the humerus in internal rotation. T1-weighted spin echo images were obtained in the sagittal oblique plane parallel to the glenohumeral joint. The MRI parameters of the T1-weighted oblique sagittal images were as follows: repetition time, 360 ms; echo time, 21 ms; field of view, 160 mm; and matrix, 288 · 224.

Measurement of CHL

Two orthopedic surgeons with 7 and 11 years of experience, who had no access to the patient's information, measured the thickness of the CHL at the thickest portion on the sagittal oblique T1-weighted spin echo images as previously reported[30,33] (Fig. 1, *A*). We also measured obliteration of the subcoracoid fat triangle on the sagittal oblique images as previously reported.[33] Fat obliteration was classified as normal, partial, or complete[33] (Fig. 1, *B*, *C*, and *D*). We divided them into 2 groups, with obliteration (either partial or complete) and without obliteration (normal). MR images were analyzed using open-source Digital Imaging and Communications in Medicine software OsiriX MD (version 7.0, 64-bit). Measurements were taken to the nearest 0.1 mm, then rounded to the nearest millimeter.