Anatomic considerations in arthroscopic reconstruction of the coraco-clavicular ligament in patients with acromio-clavicular joint dislocation

Kenichi Matsumura¹, Ryo Nakajima² Shinji Imai²

¹Tane General Hospital, Japan; ²Shiga University of Medical Science, Japan

Background: Arthroscopic reconstruction of the coraco-clavicular ligament has been described in some studies. Few published reports have considered the importance of anatomic reconstruction. The present study reports the importance of anatomic reconstruction and evaluates the position of the reconstructed ligaments and the clinical and radiographic results of arthroscopic reconstruction of coraco-clavicular ligament.

Material and Methods: Arthroscopic reconstruction of the coraco-clavicular ligament using a Fiber tape and Dog Bone Button (Arthrex) was performed in 8 shoulders between June 2014 and November 2015. The mean age was 39.9 years (range, 28 to 55 years). The mean follow-up period was 9.1 months (range, 4 to 20 months). The injuries were as follows: Rockwood type 3 (n=6), Rockwood type 4 (n=1), and Rockwood type 5 (n=1). We evaluated the position of the bone tunnel on CT images, and the extent of the tunnel widening and loss of reduction using radiography. The subjective patient outcomes were evaluated.

Results: The distance from the lateral side of the clavicle to the clavicular tunnel was 28.8 ± 5.2 mm. If we divided the sagittal view of clavicle into three columns (anterior, middle, posterior), 1 shoulder was anterior, 4 shoulders were middle, and 3 shoulders were posterior. The distance from the anterior aspect of the coracoid to the coracoid tunnel was 29.2 ± 5.3 mm. Intraoperative reduction was lost in 6 patients (75%). The clavicular tunnel width was 5.5 ± 1.0 mm. The coracoid tunnel width was 5.1 ± 0.9 mm. One patient reported experiencing slight pain. The subjective patient outcomes were excellent in 6 cases and good in 2 case.

Discussion: Although our clinical results were mostly satisfactory, we experienced tunnel widening and a loss of reduction. We hypothesize that the reason for this is that the position of the bone tunnel in these studies tended to differ from the anatomic attachment of the coraco-clavicular ligament; thus, we could not reconstruct the coraco-clavicular ligament in the anatomic position.

Conclusion: Arthroscopic reconstruction of the coraco-clavicular ligament is recommended in patients with acromio-clavicular joint dislocation. However, in order to decrease the enlargement of the bone tunnel and the loss of reduction, it was suggested that we should reconstruct the bone tunnel in the anatomic position.
Prognostic Factors To Succeed In Surgical Treatment of Chronic Acromioclavicular Dislocations

Johannes Barth¹, Fabrice Duparc² and SFA³

¹Centre Ostéo-Articulaire des Cèdres, Grenoble, France; ²University Hospital of Rouen, France; ³French Society of Arthroscopy, Paris, France

a) Background
Treatment of chronic acromioclavicular joint dislocation (ACJD) remains a poorly known and controversial subject. Given the many surgical options, it is not always easy to determine which ones are indispensable. The aim of the study was to analyze which surgical steps are correlated with better anatomical (radiological) results and functional results at one year postoperatively, after chronic acromioclavicular (AC) joint stabilization.

b) Material
22 surgeons in 14 centers participated in the multicentric prospective study promoted by the French Society of Arthroscopy, from July 2012 to July 2013 for the inclusions. The follow-up continued until September 2014 to obtain at least one year of follow-up. We included patients presenting with a chronic AC joint dislocation (type III, IV or V according to Rockwood classification) defined as if surgery was performed at least 21 days after the injury. The common step was coracoclavicular stabilization using an arthroscopic procedure. It could rely on a synthetic fixation device, or a tendinous graft.

The surgeon investigators were asked to include only patients with coracoclavicular stabilization procedure under arthroscopic control. Additional procedures could be chosen freely but needed to be documented in the database: i.e. concomitant acromioclavicular stabilization, use of a biologic graft, distal clavicle excision, and use of peroperative fluoroscopy.

c) Method
The clinical parameters analyzed were: pain (Visual Analogic Scale), a subjective functional incapacity score (Quick Dash), and an objective functional score (Constant and Murley score).

The anatomical results were evaluated in both plans on plain X-Rays: Zanca AP view for the vertical displacement, and axillary view for the horizontal displacement. Moreover, we used Tauber’s imaging protocol to assess persistent dynamic instability of the AC joint.

Statistical analysis: the qualitative variables were compared in a contingency table using a Chi² test or Fisher’s exact test. The medians were compared using Mann and Whitney and Kruskal Wallis tests. Spearman’s rank correlation coefficient was used for quantitative variables.

d) Results
Based on a series of 140 operated ACJDs, we included 24 chronic ACJDs. The mean time to surgery was 46 weeks (range, 1 month to 4 years). The patients’ mean age was 41 years, with a majority of males (75%), 72% of whom participated in recreational sports. Professionally, 40% of the subjects had jobs involving manual labor. We noted 40% grade III, 24% grade IV, and 36% grade V injury according to the Rockwood classification. In 92% of cases, coracoclavicular stabilization was provided by a double button implant, reinforced with a
biological graft in 88% of the cases. In 29%, millimeters to centimeters of the distal clavicle were resected and acromioclavicular stabilization was associated in 54%. We observed complications in 33% of the cases (8): stiffness (2), osteolysis around clavicle hardware (2), coracoid process fracture (1), and failure by hardware disassembly (3). At 1 year postoperative, 21 patients underwent clinical and radiological follow-up (87.5%). Only 35% of the patients were satisfied or very satisfied, whereas 100% of them would recommend the operation. Full-time work was resumed in 91% of the cases and all sports could be resumed in 86%. The pre- and postoperative values at 1 year changed as follows: the mean Constant score improved from 61 to 87 (p = 0.00002); the subjective QuickDASH score decreased from 41 to 9 (p = 0.00002); and radiologically significant reduction of the initial displacement was observed in the vertical plane (p < 10⁻³) and the horizontal plane (p = 0.022).

The gravity of the initial Rockwood grade, the BMI, and the context of work compensation were correlated with the Constant score at 1 year (p=0.01). Time to surgery influenced the radiological result. For the coracoclavicular ratio, we observed a mean 114% for time to surgery <3 months and a mean 183% for time to surgery >3 months, but the difference was not significant. In the horizontal plane, a significant difference was demonstrated in terms of residual displacement (if time to surgery was <3 months 202% and if time to surgery was >3 months 341%; p = 0.02). Resection of the distal extremity of the clavicle did not influence the final result at 1 year in terms of pain, the Constant score, the QuickDASH score, or acromioclavicular stability (NS). Preoperative image intensifier guidance did not influence the anatomical result at 1 year (NS). The type of the graft and the type of reconstruction did not seem to influence the final anatomic result of the acromioclavicular stabilization (NS). The type of reconstruction anatomic or non-anatomic did not influence the functional or anatomic result (NS). Protection of the repair with a sling for 6 weeks significantly improved the functional and anatomical results (p = 0.04).

e) Discussion

Although some authors have already shown better functional results in cases of early management, we were surprised that for chronic ACJDs, time to surgery also influenced the anatomic results. Defining failure of functional treatment therefore should not be delayed because it becomes more difficult to control secondary reduction loss. Carofino and Mazzocca proposed systematically beginning functional treatment for all grade III and V cases of ACJD for 6–12 weeks before considering functional result failure.

The strength of this study is its prospective design investigating a homogenous series (use of a biological graft in 88% of the cases) with no associated lesions and a good 1-year follow-up rate. The main limitations of this study were the small sample size (<30) limiting the study’s statistical power, and the great variability of surgical treatments in terms of time to surgery (1 month to 5 years after injury).

f) Conclusion

In this study, the favorable prognostic factors found were: time to surgery less than 3 months (p = 0.02), associated acromioclavicular stabilization, and postoperative immobilization with a sling extended to 6 weeks. However, resection of the distal clavicle did not influence the final result.

Level of proof: Level II prospective non-randomized comparative study.
Treatment of Acromioclavicular Dislocation with Suture Anchor on Coracoid Process

Chung-Hsun Chang
Department of Orthopaedics, National Taiwan University Hospital

Introduction
Treatment of acromioclavicular dislocation is still controversial. Here we reported a novel method for coracoclavicular fixation with a suture anchor inserted into coracoid process.

Methods
The surgical procedures are as the following: after insertion of a double loaded suture anchor into coracoid process, one tail of the suture stands are passed underneath the coracoid process to one side, and the other tail of the suture stands are passed to the other side. Then these 2 stands are passed through the clavicle to reproduce conoid and trapezoid part of the coracoclavicular ligament anatomically. In acute cases, the torn acromioclavicular ligaments are repaired. In chronic cases, the coracoacromial ligaments are reconstructed with palmaris longus.

Results
There were 5 patients (3 were acute and 2 were chronic) received the above procedures for their dislocated acromioclavicular joints. One acutely dislocated patient got her acromioclavicular joint redislocated 2 weeks after surgery due to poor protection. All the other 4 patients had good results with reduced acromioclavicular joints and unlimited activities of daily living.

Conclusion
Dislocation of acromioclavicular joint can be treated with suture anchor into coracoid process for coracoclavicular fixation.
Comparison of Shoulder Range of Motion between Nonsurgical and Surgical Treatments for Shoulder Stiffness

Akihiko Hasegawa1,2, Teruhisa Mihata1,2, Yasuo Itami1,2, Masashi Neo1

1Department of Orthopedic Surgery, Osaka Medical College, Takatsuki, Osaka, Japan
2Department of Orthopedic Surgery, Daiichi Towakai Hospital, Takatsuki, Osaka, Japan

Background

Shoulder stiffness is common in the working population. Therapy can be conservative (including anti-inflammatory drugs and physical therapy) or surgical. Arthroscopic capsular release has been reported to allow controlled and complete release of the contracted capsule and to provide more immediate improvement than conservative therapy; however, treatment of shoulder stiffness remains controversial. The purpose of this study was to compare the change in shoulder range of motion (ROM) between nonsurgical treatment and arthroscopic capsular release for shoulder stiffness.

Materials and Methods

We retrospectively reviewed our database and included patients with shoulder stiffness treated between 2013 and 2015. The inclusion criteria for this study were (1) a painful shoulder stiffness for at least one month; (2) restriction of passive external rotation of at least 50% compared with the unaffected shoulder; (3) restriction of passive forward flexion of less than 120°; (4) pain at night causing a sleep disturbance and inability to lie on the affected side; and (5) completion of more than 5 months of follow-up. The exclusion criteria were (1) evidence of glenohumeral joint arthritis; (2) evidence of full-thickness rotator cuff tear; (3) any fracture involving the shoulder girdle; and (4) previous surgery to the involved shoulder. Our final study group included 34 patients with shoulder stiffness (17 males and 17 females, mean 62.8 years). Sixteen shoulders in 16 patients (8 males and 8 females, mean 62.3 years) were treated nonsurgically (group N), and 18 shoulders in 18 patients (9 males and 9 females, mean 62.8 years) underwent arthroscopic capsular release (group A). For group N, a physical therapy intervention was started after the medical examination. For group A, 360° arthroscopic capsular release was performed under the general anesthesia following interscalene regional block. The day after the surgery, a physical therapy program was started. Average follow-up duration of group N was 8.0 months and that of group A was 8.3 months. Passive shoulder ROM was measured before initial treatment, at 1, 3, and 5 months after treatment, and at final follow-up. Maximum internal rotation was recorded as the highest vertebral body that the patient was able to reach with the thumb of the affected arm. To calculate the average of
maximum internal rotation, we converted each internal rotation ROM to a scale of 0 to 12, where Buttock=0, Sacrum=1, L5=2, L4=3, L3=4, L2=5, L1=6, Th12=7, Th11=8, Th10=9, Th9=10, Th8=11, Th7=12. Wilcoxon signed-rank test were used for statistical analysis. P values of less than 0.05 were considered statistically significant.

Results
Before initial treatment, ROM (flexion, abduction, external rotation, and internal rotation) in group A (82.5°, 67.2°, 12.8° and Sacrum, respectively) and that in group N (95.6°, 77.2°, 18.3 and Sacrum, respectively) showed no significant difference (p=0.06, 0.07, 0.14, and 0.67, respectively). At 1 month after treatment, ROM in group A (155.3°, 133.3°, 41.9°, and L3, respectively) was significantly larger than that in group N (135.0°, 106.6°, 31.9°, and L5, respectively) (p=0.0004, 0.0032, 0.02 and 0.0093 respectively). However, there was no significant difference in ROM between the two groups at 3 or 5 months after treatment or at final follow-up. At final follow-up, ROM in group A was 159.4°, 146.7°, 48.3°, and L1, respectively, while that in group N was 156.3°, 145.9°, 40.6°, and L2, respectively (p=0.61, 0.85, 0.14 and 0.42 respectively). ROM in both group A and that in group N increased significantly: by 76.9°, 60.6°, respectively for flexion (P<0.0001, P<0.0001, respectively), by 79.4°, 68.8°, respectively for abduction (P<0.0001, P<0.0001, respectively), by 35.6°, 22.3°, respectively for external rotation (P<0.0001, P<0.0001, respectively), by 5 vertebral body levels, 3 vertebral body levels, respectively for internal rotation (P<0.0001, P=0.0012, respectively) at final follow-up. There were no intra-operative or post-operative complications in the thirty-four patients. Specifically, there was no recurrence requiring a release, axillary nerve dysfunction, infection, osteoarthritis, or shoulder instability.

Discussions
This study showed that the earlier improvement of passive ROM in group A than group N. At 1 month after treatment, ROM in group A was significantly larger than that in group N for all directions (flexion, abduction, external rotation, and internal rotation). On the other hand, there was no significant difference in ROM between the group A and group N at more than 3 months after treatment. Previous studies reported that shoulder stiffness responds well to nonsurgical treatment in 70% to 90% of patients and arthroscopic capsular release should be performed in patients unresponsive to conservative treatment. In this study, only 16 of 34 (47.1%) patients were treated non-surgically. We think this is because most of patients in this study were treated non-surgically before visiting our hospital. Average duration of the disorder before the first visit to our hospital was 8.4 months in this study set. Our results suggest that arthroscopic capsular release might be recommended to patients with persistent shoulder stiffness if they want early improvement of shoulder symptoms. The limitations of this study include its non-randomized
study design, with a small sample size. The outcome of the group N might be overestimated because the patients underwent surgery after failing nonsurgical treatment were excluded from the analysis. The other issue that needs to be highlighted is that active ROM, muscle strength, and pain scale are not measured. Those can be subjects of further research.

**Conclusions**
Arthroscopic capsular release was useful for increasing shoulder ROM within 1 month after treatment in patients with shoulder stiffness. However, there was no significant difference in shoulder ROM between nonsurgical treatment and arthroscopic capsular release at more than 3 months after treatment. Early arthroscopic capsular release improves shoulder symptoms quickly.
Arthroscopic treatment of greater tuberosity avulsion fracture using a double-row technique in elderly

Binsong Qiu, Qin Bi, Haifeng Gu, Chen Zhao, Jihang Chen
Zhejiang provincial people’s hospital, Hangzhou, China

Background: Arthroscopic treatment of greater tuberosity avulsion fracture using a double-row technique was reported with a good result in many authors. But few authors evaluate the effectiveness of this procedure in elderly.

Material: A retrospective analysis was made on the clinical data of 13 patients with the acute greater tuberosity avulsion fracture after acute shoulder dislocation. There were 2 males and 11 females with an average age of 64.6 years (range, 60-73 years). 3 left shoulders and 10 right shoulders were affected.

Methods: All cases accepted arthroscopic treatment using a double-row technique with anchor. The cases were evaluated by X-ray films, VAS score and UCLA score.

Results: All cases were successfully performed operations and all cases were followed up 12-35 months (mean, 16.1 months). X-ray films of all cases showed good reduction after operation immediately. But 4 cases showed mal reduction in X-ray films after surgery 3 days, and 2 cases of those were revised by cannulated screw and suture. 1 case showed mal reduction in X-ray films after surgery 3 weeks. The failure rate was 38.5%. The average fracture healing time was 8.7 weeks (range, 6-12 weeks). At last follow-up, the mean VAS score was 1.5±1.2, the mean UCLA shoulder function score was 29.3±2.1.

Discussion: Osteoporosis was often accompanied in the elderly especially in female. The suture screw usually could not insert tightly in the greater tuberosity site without cortical bone when the greater tuberosity fractured. The screw or outside row suture would loose after surgery in some cases.

Conclusion: Although the functional recovery was satisfactory, arthroscopic treatment of greater tuberosity avulsion fracture using a double-row technique with high failure rate was not a good choose in elderly patients.
Gelatin-grafted poly(L-lactide) electrospun fibrous membranes for healing improvement after rotator cuff repair

Song Zhao¹, Jinzhong Zhao²
¹ Department of Orthopaedics, Zhongda Hospital, School of Medicine, Southeast University, 87 Ding Jia Qiao Road, Nanjing, 210009, Jiangsu, China
² Department of Arthroscopic Surgery, Shanghai Jiao Tong University Affiliated Sixth People’s Hospital, 600 Yishan Road, Shanghai, 200233, P.R. China

Background: Rotator cuff tears (RCTs) are a common cause of shoulder pain and disability in middle and older age. Despite improvements in the understanding of this disease process and advances in surgical treatment, rotator cuff (RC) repair failure rates remain high. Insufficient healing capacity is likely the main factor for failure of reconstruction.

Materials and methods: We fabricated implantable biodegradable gelatin-grafted poly(L-lactide) (PLLA) fibrous membranes using electrospinning technology and evaluated them using in vitro cell proliferation assays. Then, we established chronic rat RCT models and randomly assigned rats into one of three groups. In group 1 (n=48), the detached supraspinatus tendon was repaired to its anatomic footprint (transosseous repair). In groups 2 and 3, the rats underwent transosseous repair and were implanted with either pure PLLA membranes (n=48) or gelatin-PLLA membranes (n=48) to augment the repairs. The animals were killed at 2, 4, and 8 wk postoperatively, which was followed by histomorphometric and biomechanical evaluation.

Results: Histologic observations revealed that gelatin-PLLA membranes have excellent biocompatibility and biodegradability. At 2, 4, and 8 wk postoperatively, the gelatin-PLLA membranes significantly increased the area of glycosaminoglycan staining at the tendon-bone interface compared with the control group (P < 0.05) and significantly improved collagen organization, as measured by birefringence under polarized light at the healing enthesis compared with the control and PLLA groups (P < 0.05). Biomechanical testing revealed that the gelatin-PLLA group had a greater ultimate load to failure and stiffness than the control group at 4 and 8 wk (P < 0.05). The gelatin-PLLA membranes had the highest stress of the healing enthesis.

Conclusions: Local application of gelatin-PLLA fibrous membranes to the healing tendon-bone interface after RC repair in a rat chronic RCT model was found to strengthen the healing enthesis, increase the area of fibrocartilage, and improve collagen organization compared with repair alone. Augmentation with gelatin-grafted PLLA may enhance healing after RC repair and might eventually lead to improvement of clinical surgical outcomes.
Effect of hypercholesterolemia on fatty infiltration and the quality of tendon-to-bone healing in a rabbit model of a chronic rotator cuff tear: electrophysiological, biomechanical, and histological analyses

Seok Won Chung1, HaeBong Park2, Jieun Kwon3, Sae Hoon Kim4, and Joo Han Oh4

1Konkuk University; 2CM Chungmu Hospital; 3National Police Hospital; 4Seoul National University

Background: The incidence of healing failure after rotator cuff repair is high, and fatty infiltration is a crucial factor in healing failure. The purpose of this study was to verify the effect of hypercholesterolemia on fatty infiltration and the quality of tendon-to-bone healing and its reversibility by lowering the cholesterol level in a chronic tear model using the rabbit supraspinatus.

Materials and Methods: Forty-eight rabbits were randomly allocated into four groups (12 each). After 4 weeks of a high-cholesterol diet (Groups A and B) and a regular diet (Groups C and D), the supraspinatus tendon was detached and left alone for 6 weeks, then repaired in a transosseous manner (Groups A, B, and C). Group D served as a control. Group A continued to receive the high-cholesterol diet until the final evaluation (6 weeks after repair); however, at the time of repair, Group B was changed to a general diet with administration of a cholesterol-lowering agent (simvastatin). Histological evaluation of the fat-to-muscle proportion was performed twice, at the time of repair and the final evaluation, and an electromyographic (EMG) test, mechanical test, and histological test of tendon-to-bone healing were performed at the final evaluation.

Results: For the EMG test, Group A showed a significantly smaller area of compound muscle action potential compared with Groups C and D (all p < 0.01), and Group B showed a larger area than Group A, almost up to the level of Group C (p = 0.312). Similarly, Group A showed significantly lower mechanical properties both in load-to-failure and stiffness compared with Groups C and D (all p < 0.05). In addition, although not significantly different, the mechanical properties of Group B were higher than those of Group A (load-to-failure: group A = 42.01N and group B = 58.23, p = 0.103; stiffness: group A = 36.32N/mm and group B = 47.22N/mm, p = 0.153). For the histological test, Groups A and B showed a significantly higher fat-to-muscle proportion than Groups C and D at 6 weeks after detachment (all p < 0.05), but at the final evaluation, Group B showed a decreased fat-to-muscle proportion (from 64.02 ± 11.87% to 54.68 ± 10.47%; p = 0.146), different from Group A, which showed increased fat-to-muscle proportion (from 59.26 ± 17.80% to 78.23 ± 10.87%; p = 0.015). Groups B and C showed better tendon-to-bone interface structures than Group A, which showed coarse and poorly organized collagen fibers with fat interposition.

Discussion and Conclusion: Hypercholesterolemia had a deleterious effect on fatty infiltration and the quality of tendon-to-bone repair site, and lowering hypercholesterolemia seemed to halt or reverse these harmful effects. Systemic diseases such as hypercholesterolemia should be tightly controlled during the perioperative period of rotator cuff repair.