Arch Orthop Trauma Surg (2011) 131:363–369
DOI 10.1007/s00402-010-1216-y

ARTHROSCOPY AND SPORTS MEDICINE

Asymptomatic acromioclavicular joint arthritis in arthroscopic rotator cuff tendon repair: a prospective randomized comparison study

Jaehwa Kim · Juhwan Chung · Hyunsoo Ok

Received: 1 July 2010 / Published online: 15 December 2010

Abstract
Hypothesis Arthroscopic acromioclavicular joint (ACJ) resection for asymptomatic ACJ arthritis combined with rotator cuff repair leads to more satisfactory pain relief and decrease reoperation rate when inferiorly directed osteophytes present at the undersurface of ACJ.
Materials and methods Between January 2006 and May 2008, a total of 83 patients (83 shoulders), 40 males and 43 females, who were planned to have arthroscopic repair of a tear measuring 1–3 cm in the anterior-posterior dimension with advanced ACJ arthritis with inferiorly directed osteophytes at the undersurface of the ACJ on MRI were entered into this study. Patients were randomized into two groups. Group 1 included 31 patients, who underwent arthroscopic distal clavicle resection combined with rotator cuff repair. Group 2 included 52 patients, who underwent isolated rotator cuff repair. Patients were evaluated preoperatively and postoperatively using the University of California Los Angeles (UCLA) score and the American Shoulder and Elbow Surgeons (ASES) score. Pain, tenderness on ACJ, and cross body adduction test were compared between groups.
Results The mean follow-up was 31.7 months (range 34–38). The UCLA scores and ASES scores were lower in group 1 at week 6 ($p < .05$), and week 12 ($p < .05$), but higher at the last follow-up at 2 years ($p < .05$) postoperatively. VAS score was higher in group 1 at week 6 ($p < .05$), and at week 12 ($p < .05$), but lower in group 2 at the last follow-up ($p < .05$). Only in group 2, two (3.8%) cases developed ACJ pain during follow-up and one (1.9%) case underwent reoperation for additional ACJ resection.
Conclusions This study shows that distal clavicle resection combined with rotator cuff repair for asymptomatic ACJ arthritis with inferiorly directed osteophytes lower functional scores due to temporary pain in early postoperative periods, but better functional outcomes with satisfactory pain relief and no reoperation rate were observed after 2 years.

Keywords Acromioclavicular joint · Arthroscopic · Arthritis · Distal clavicle resection

Introduction

Age-related degeneration of acromioclavicular joint begins early during the second decade of life, and outlet impingement typically begins at the anteroinferior aspect of the acromion and progress medially to involve the acromioclavicular joint [1–3]. And, the presence of inferiorly directed osteophyes at the undersurface of the acromioclavicular arthritis with rotator cuff disease has been reported to be related [4–7].

The casual relation of inferiorly directed osteophytes of the advanced acromioclavicular joint arthritis on the preoperative MRIs to arthroscopic rotator cuff repair has not been proved, so it should not be overlooked. This asymptomatic, coincidental, advanced acromioclavicular joint arthritis may not progress and remain asymptomatic, but those inferiorly directed osteophytes may contribute to the

J. Kim (✉) · J. Chung · H. Ok
Department of Orthopaedic Surgery, CHA Bundang Medical Center, School of Medicine, CHA University, 351 Yatap-dong, Bundang-gu, Seongnam-si, Gyeonggi-do, Korea
e-mail: jjuhhwan@hanmail.net

J. Chung
e-mail: juicemom@hanmail.net

H. Ok
e-mail: mdohs@naver.com

impingement of the shoulder, and overall shoulder problem. So the potential for suboptimal results after arthroscopic rotator cuff repair remains [5, 8, 9].

Important considerations for distal clavicle resection are development of postoperative acromioclavicular joint pain and symptomatic instability which make virtually possible to avoid this procedure whether it is by open or arthroscopic. But, in recent reports, arthroscopic acromioclavicular joint resection for degenerative change within the acromioclavicular joint has been shown to be an effective procedure with excellent or good outcome by either open or arthroscopic resection. The outcomes of arthroscopic acromioclavicular joint resection for asymptomatic acromioclavicular joint arthritis have been reported to be unsuccessful when it's combined with acromioplasty. They suggested excision of small inferior acromioclavicular osteophytes during subacromial decompression may convert a painless joint to a symptomatic condition. However, the outcomes of arthroscopic acromioclavicular joint resection for asymptomatic acromioclavicular joint arthritis with inferiorly directed osteophyte has not been reported when it's combined with arthroscopic rotator cuff repair [10–15].

The purpose of our study was to evaluate general shoulder pain, the overall shoulder function after combined rotator cuff repair and acromioclavicular joint resection in patients with concomitant asymptomatic acromioclavicular arthritis.

Materials and methods

A total of 83 patients (83 shoulders) who were planned to have a rotator cuff repairs in the arthroscopic surgery center of our hospital between January 2006 and May 2008 were entered into this study. This study was approved by the Institutional Review Board of our hospital.

Inclusion criteria for this study were (1) rotator cuff tears measuring 1–3 cm in the anterior-posterior dimension, the tear size was measured using a calibrated probe introduced through the posterior portal while viewing from the lateral portal, (2) the dominant shoulder in whom at least 6 months of conservative treatment had failed, (3) advanced acromioclavicular joint arthritis on MRIs, grade 4 according to Stein [16], demonstrating subacromial fat effacement, joint space narrowing, and irregularity with presence of inferiorly directed osteophytes at the undersurface of acromioclavicular joint on both coronal and sagittal MRI images (Fig. 1), (4) absence of localized pain and tenderness at the acromioclavicular joint, (5) negative on both cross body adduction and lidocaine test, and (6) no previous nonoperative management for acromioclavicular joint arthritis. Exclusion criteria included patients who had (1) previous fracture history in ipsilateral shoulder, (2) workers' compensation patients, (3) a mini-open or open procedure, (4) other pathology in glenohumeral joint including biceps tendinitis, labral detachment lesion, and (4) absence of inferiorly directed osteophytes at the undersurface of the acromioclavicular joint on both coronal and sagittal MRI images.

In regard to the genesis of the rotator cuff tear, we defined as a traumatic tear when patient's symptom developed after a traumatic event. All traumatic tears included in this study were caused by only minor injuries including sports injury, minor slips, etc.

Review of MR images were performed by two experienced musculoskeletal radiologists (13 and 7 years in experience, respectively) in consensus using PACS (picture archiving and communication system, Marosis, Infinitti, Seoul, Republic of Korea) workstations.

Patients were randomized into two groups by random number table. Group 1 included 31 patients who underwent arthroscopic distal clavicle resection combined with rotator cuff repair. Group 2 included 52 patients who underwent isolated rotator cuff repair.

All arthroscopic distal clavicle resections and complete arthroscopic rotator cuff repairs were performed by the

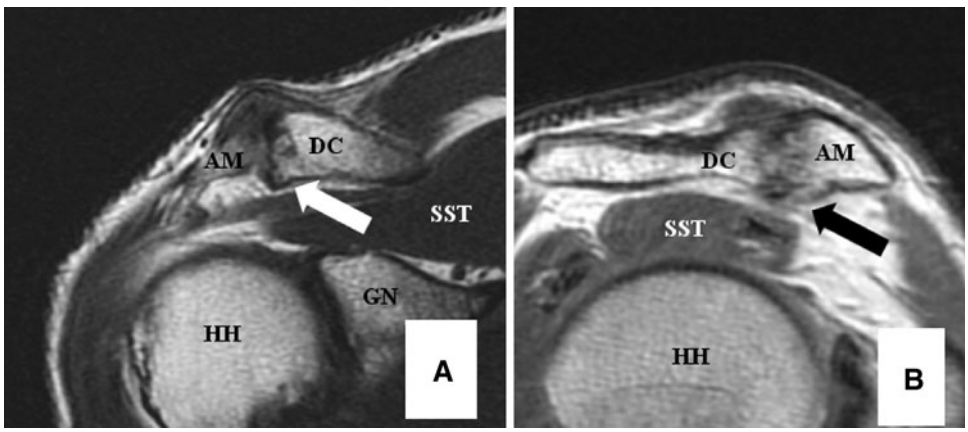

Fig. 1 On coronal and sagittal image, the presence of inferiorly directed osteophyes [*white arrow* on coronal image (**a**) *dark arrow* on sagittal image (**b**)] at the undersurface of the acromioclavicualr joint was observed. *AM* acromion, *DC* distal clavicle, *SST* supraspinatus tendon, *HH* humeral head, *GN* glenoid

senior author (J.H.K.). And preserving superior and posterior acromioclavicular capsular ligament using a standard posterior subacromial portal with a 4.0-mm arthroscope for a viewing portal and anterior portal for a working portal for distal clavicle resection. And all torn rotator cuff was repaired using double-row fixation using suture anchors.

Postoperative management was the same for both groups. The arm was supported using a sling with an abduction pillow for 6 weeks. On the first postoperative day, the patients began passive range-of-motion exercises, including passive forward flexion, external rotation, and pendulum and pulley exercises. Active-assisted motion was initiated at 6 weeks postoperatively. A return to recreational activity with heavy demands on the shoulder or to manual labor was delayed for 6 months.

For clinical evaluation, patients were evaluated preoperatively and postoperatively at 6 weeks, 12 weeks, 1 year, and the last follow-up at 2 years using the University of California Los Angeles (UCLA) score and the American Shoulder and Elbow Surgeons (ASES) score. In addition, visual analogue scale (VAS), tenderness on acromioclavicular joint, and cross body adduction test after procedure were compared between groups. All patients were followed up for more than 2 years, but two patients in group 1 and four patients in group 2 were lost to final follow-up.

For statistic analysis, data were analyzed with student *t*-test for comparing clinical results between groups. Significance was set at $p < .05$.

Results

16 cases were males, and 24 cases were females in group 1, and 15 cases were male, and 28 cases were female in group 2 ($p > .05$). The average age of patients were 59.8 years in group 1 and 55.2 years in group 2 ($p > .05$). 12 cases in group 1 and 16 cases in group 2 were traumatic tears ($p > .05$), 19 cases in group 1 and 36 cases in group 2 were non-traumatic tears ($p > .05$). Mean time to rotator cuff repair was 9.8 months in group 1 and 8.8 months in group 2 ($p > .05$). Number of patients who underwent acromioplasty was five in group 1, and eight in group 2 ($p > .05$). Mean size of distal clavicle resection was 5.23 mm in group 1 and 5.41 mm in group 2 ($p > .05$). Mean size of rotator cuff tear was 27.2 mm in group 1 and 24.7 mm in group 2 ($p > .05$). Mean follow-up period was 32.8 months in group 2 and 31.9 months in group 2 ($p < .05$). There was no statistic difference between the two groups with respect to age, sex, mean tear size of rotator cuff tendon, mean size of resected size of distal clavicle and time of follow-up (Table 1). Overall, all patients had a clinical successful outcome by both UCLA and ASES scores at the last follow-up. Both groups showed

Table 1 Comparison of groups

	Group 1	Group 2	*P* value
Sex (no.)			.72
Male	16	24	
Female	15	28	
Total	31	52	
Age (year)	59.8 ± 5.2	55.2 ± 6.1	.662
Traumatic tears			
No. of patients	12	16	
Mean time to repair (mo)	7.2 ± 2.6	8.0 ± 2.2	.61
Non-traumatic tears			
No. of patients	19	36	
Mean time to repair (mo)	10.2 ± 2.6	9.7 ± 3.1	.78
Mean time from diagnosis to			
Rotator cuff tendon repair (mo)	9.8 ± 2.6	8.8 ± 2.1	.569
Combined with Acromioplasty	5	8	.23
Mean size of			
Distal clavicle resection (mm)	5.23 ± 1.1	5.41 ± 1.4	.32
Mean tear size of			
Rotator cuff tendon (mm)	27.2 ± 3.7	24.7 ± 3.1	.23
Follow-up period (mo)	32.8 ± 4.1	31.9 ± 4.9	.89

The values are given as the mean and 95% confidence interval

significant improvements statistically at all time intervals compared with preoperatively ($p < .05$). For both of the UCLA scores and ASES scores, there was statistic difference between groups at week 6 ($p < .05$), week 12 ($p < .05$), and the last follow-up at 2 years ($p < .05$). The mean final UCLA score was 33.7 in group 1 and 30.8 in group 2. And the mean final ASES score was 92.5 in group 1 and 88.7 in group 2 (Figs. 2, 3; Table 2). Also, visual analogue scale (VAS) at the last follow-up showed significant improvement in both groups compared with preoperatively ($p < .05$), and VAS score was higher in group 1 at week 6 ($p < .05$), and at week 12 ($p < .05$), and higher in group 2 at the last follow-up ($p < .05$) with statistic significance (Fig. 4; Table 3).

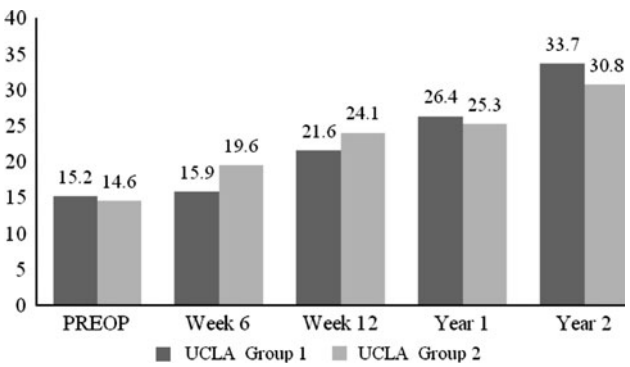

Fig. 2 In group 1, the UCLA score was lower at week 6 (<.05), and week 12 (<.05), but higher at year 2 (<.05) postoperatively

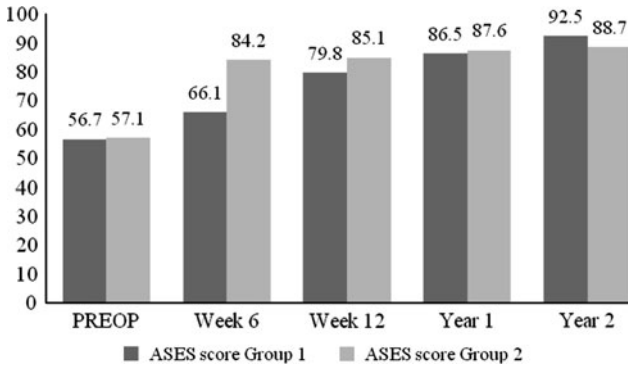

Fig. 3 In group 1, the ASES score was lower at week 6 (<.05), and week 12 (<.05), but higher at year 2 (<.05) postoperatively

On clinical examination, no case showed residual acromioclavicular joint pain in group 1, and two (3.8%) cases showed newly developed acromioclavicular joint pain at the final follow-up in group 2, and it did not showed statistic significant difference between groups ($p = .19$) (Figs. 5, 6). All patients with newly developed acromioclavicular joint pain were positive on cross body adduction test (Fig. 7). Among 2(3.8%) cases with newly developed acromioclavicular joint pain, one (1.9%) case underwent reoperation for additional acromioclavicular joint resection (Fig. 6). This reoperation rate did not show statistic significant difference between groups ($p = .21$). No patients exhibited instability and heterotrophic ossification of the acromioclavicular joint after arthroscopic distal clavicle resection.

Discussion

Regarding the natural history of the acromioclavicular joint arthritis in relation to rotator cuff, the age-related progression of the acromioclavicular joint degeneration was shown in previous studies including the study of DePalma [17]. In his study, the degenerations of the acromioclavicular joint were observed in all specimens after the fifth decade. Cuomo et al. demonstrated that over 60% of shoulders with full thickness rotator cuff tears showed inferiorly directed osteophytes of the acromioclavicular joint compared with aged matched counterparts [5]. They emphasized that the presence of the inferiorly directed osteophytes was associated with rotator cuff rather than age-related acromioclavicular joint degeneration without osteophytes.

The role of these osteophytes in impingement syndrome has been reported. Kessel and Watson reported the painful arc syndrome and they defined refractory impingement syndrome that resistant impingement syndrome to conventional treatment was related with degenerative changes in acromioclavicular joint arthritis, and distal clavicle resection resulted satisfactory pain relief [8]. Cuomo et al. described impingement of rotator cuff at the undersurface of acromioclavicular joint. He described contact of the acromioclavicular joint with rotator cuff in glenohumeral abduction of 60° and internal rotation of 60° [5]. Rathburn and Macnab demonstrated a "critical zone" of hypovascularity located approximately 1 cm medial to the insertion of the supraspinatus tendon on the greater tuberosity. These studies demonstrated acromioclavicular joint attributed to rotator cuff impingement in a combination of mechanical abrasion from inferiorly directed osteophytes and incomplete healing from hypovascularity [18]. These may provide evidence that inferiorly directed osteophytes mechanically and biologically related with rotator cuff tear and its healing environment.

Watson demonstrated one third of patients with rotator cuff tear needed distal clavicle resection for acromioclavicular joint arthritis for satisfactory pain relief [19], but no predictable factors have not been found for progression of acromioclavicular joint arthritis. Therefore, orthopaedic surgeons experience difficulties in preoperative assessment, but they seem to overlook, because rotator cuff repairs is their primary concern and interest, probably. On preoperative assessment of rotator cuff repair, we often encounter advanced acromioclavicular joint arthritis on MRIs. Accurate diagnosis and proper management of acromioclavicular joint arthritis is important, but evidence based protocol of asymptomatic acromioclavicular joint arthritis combined with rotator cuff repair has not been published. When acromioclavicular joint arthritis is prominent on preoperative radiological evaluation and patient doesn't complaint any discomfort at the time of rotator cuff repair, surgeon's decision on acromioclavicular

Table 2 Average scores

UCLA score						ASES score				
Group	Preop	6 week	12 week	1 year	2 year	Preop	6 week	12 week	1 year	2 year
1	15.2	15.9	21.6	26.4	33.7	56.7	66.1	79.8	86.5	92.5
2	14.6	19.6	24.1	25.3	30.8	57.1	84.2	85.1	87.6	88.7
P value	.09	.003	.005	.004	.004	.216	.0001	.001	.004	.0009

UCLA University of California Los Angeles, *ASES* American Shoulder and Elbow Surgeons

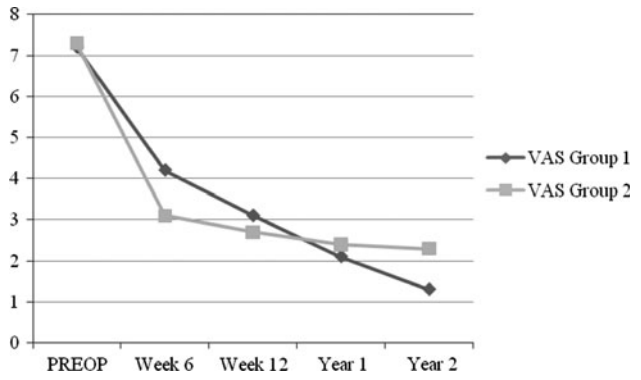

Fig. 4 In group 1, the VAS score was higher at week 6 (<.05), and week 12 (<.05), but lower at year 1 (<.05) and year 2 (<.05) postoperatively

Table 3 In group 1, the VAS score was higher at week 6, but became lower than group 2 from year 1 postoperatively

Group	Preop	6 week	12 week	1 year	2 year
1	7.2	4.2	4.1	2.1	1.7
2	7.3	3.1	2.7	2.4	2.3
P value	.35	.012	.002	.004	.0002

VAS Visual Analogue Scale

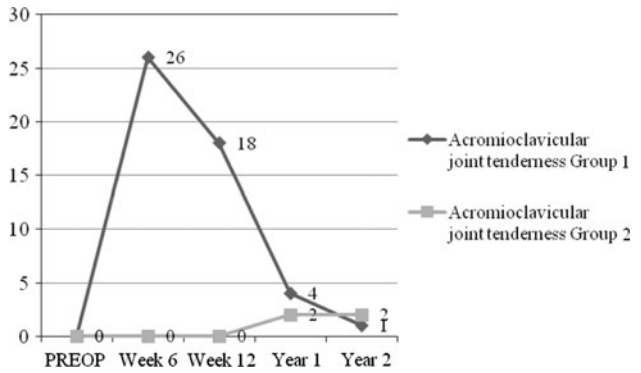

Fig. 5 ACJ tenderness was shown at week 6, and week 12 only in group 1, but at year 1 and year 2 postoperatively, 2 cases of group 2 showed newly developed ACJ tenderness

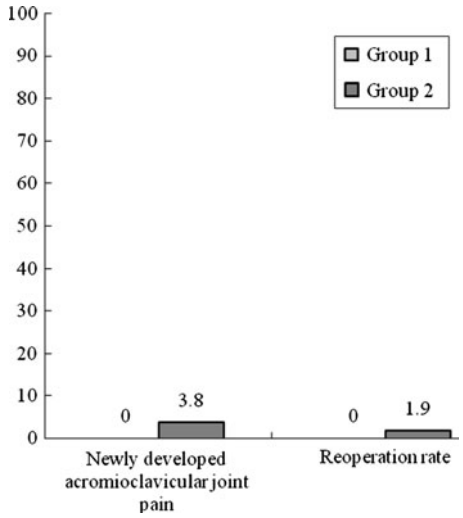

Fig. 6 Only in group 2, two cases (3.8%) showed newly developed ACJ pain, and among them, one case (1.9%) underwent additional arthroscopic ACJ resection

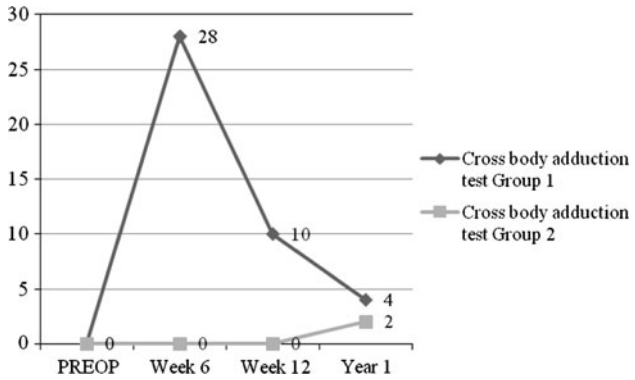

Fig. 7 Cross body adduction test was positive at week 6, and week 12 postoperatively only in group 1, but at year 1 postoperatively, 2 cases of group 2 were positive on cross body adduction test

joint arthritis is hard to make whether to resect distal clavicle simultaneously with rotator cuff repair or precede isolated rotator cuff repair only. The results of our study demonstrated that distal clavicle resection for asymptomatic acromioclavicular joint arthritis would lead to good functional outcome with no reoperation rate, when the inferiorly directed osteophytes are present at the undersurface of the acromioclavicular joint on both coronal and sagittal MRI images, but they didn't show statistic difference compared with the group that underwent isolated rotator cuff repair.

In report of Weber [20], only three cases were required late distal clavicle resection among 1259 cases that underwent arthroscopic subacromial decompression without distal clavicle resection after 7 year follow- up. And he implicated uncertainty of development of postoperative acromioclavicular joint pain and symptomatic instability. The results of our study were consistent with Weber's study. Importance of maintaining inferior acromioclavicular joint capsule and avoiding violation of the most critical superior and posterior aspects of the joint capsule has been proposed in previous studies [21, 22]. Kuster et al. described importance of inferior acromioclavicular ligament and capsule, but our senior author (J.H.K) performed distal clavicle resection and removed osteophyte at the undersurface of distal clavicle without maintaining the integrity of the inferior acromioclavicular joint capsule (Fig. 8) [9]. Continued pain and symptomatic instability remains controversial issue after distal clavicle resection, but only one case developed continued postoperative

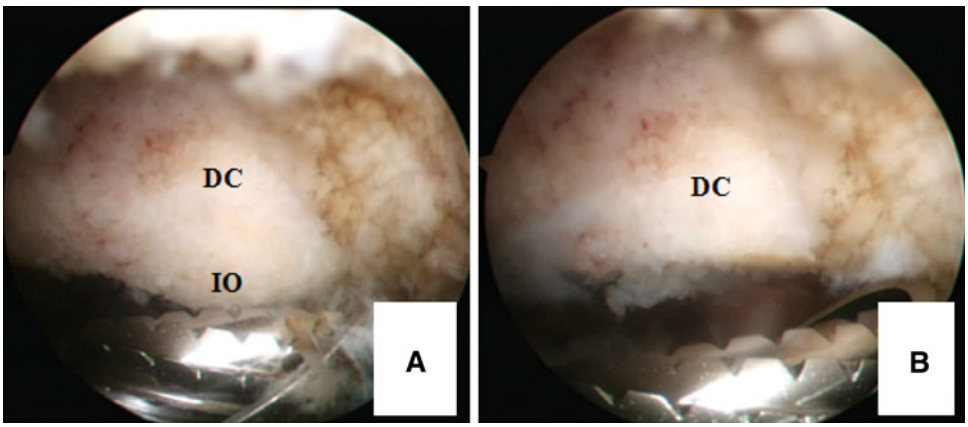

Fig. 8 (**a**) Inferiorly directed osteophyte is shown at the undersurface of distal clavicle. (**b**) Using anterior portal, inferiorly directed osteophytes were removed with motorized bur

acromioclavicular joint pain in group 1, but symptomatic instability was not observed.

Data in our study demonstrated good functional results in both groups at the final follow-up regardless of resection for asymptomatic acromioclavicular joint arthritis. The mean final UCLA scores were 33.7 and 32.8, and the mean final ASES scores were 90.5 and 88.7 in groups 1 and 2, respectively. But, at week 6, and week 12, UCLA score was better in group 2 with statistic significance between groups ($p < .05$, $p < .05$, respectively). It is conceivable that the additional violation of the subacromial space and autologous blood from marrow bleeding from partially resected distal clavicle lead to a inflammatory state that cause temporary pain which slows recovery initially, but it could influence outcome positively after all.

In our study, all patients agreed to have partial resection of distal clavicle when they were explained about MRI findings of their acromioclavicular joints, and uncertainty about the natural course. Among them, only one (3.2%) case showed residual acromioclavicular joint pain after acromioclavicular joint resection, and two (3.8%) cases in group 2 developed acromioclavicular joint pain and one (2.9%) case of them underwent reoperation for additional acromioclavicular joint resection. It seems little higher percentage of reoperation rate compared to Weber's study, but indications of reoperation after isolated rotator cuff repair without acromioclavicular joint resection is also not been introduced. And it could be dependent on surgeon's preference whether to perform reoperation after arthroscopic rotator cuff repair or maintain nonoperative treatments. In our case, impingement of repaired tendon was observed by inferiorly directed osteophyte on the postoperative MRIs at 2 years with recalcitrant pain in shoulder abduction and adduction after nonoperative treatment for 6 months using oral NSAIDs, and three times of triamcinolone injection.

The strengths of our study are the prospective and randomized format. And this is the first study about asymptomatic acromioclavicular joint arthritis which combined with the outcome of arthroscopic rotator cuff repairs. There are several weaknesses of this study. First, sample size is relatively small. Second, we did not use a more rotator cuff/acromioclavicular joint specific score. We did not include any information regarding medical comorbidities in this study. So this could influence overall physical activities, and it could skew the results of overall shoulder function if there was a large number of patients.

In conclusion, the results of our study show that distal clavicle resection combined with rotator cuff repair for asymptomatic acromioclavicular joint arthritis with inferiorly directed osteophytes results lower initial functional scores due to additional procedure and temporary pain, and better functional outcome with more satisfactory pain relief and no reoperation rate than the group with isolated rotator cuff repair. Acromioclavicular joint resection should not be based solely on MRI findings, but on the basis of this study, we suggest arthroscopic distal clavicle resection for asymptomatic acromioclavicular joint arthritis when it's combined with rotator cuff repair if acromioclavicular joint arthritis is advanced and presented with inferiorly directed large osteophytes.

Conflict of interest None.

References

1. Neer C (1990) Cuff tears, biceps lesions, and impingement. Shoulder reconstruction. Philadelphia, WB Saunders, pp 63–70
2. Edelson J (1996) Patterns of degenerative change in the acromioclavicular joint. J Bone Joint Surg Br Vol 78(2):242
3. Henry M, Liu S, Loffredo A (1995) Arthroscopic management of the acromioclavicular joint disorder: a review. Clin Orthop Relat Res 316:276
4. Neer C, Poppen N (1987) Supraspinatus outlet. Orthop Trans 11:234
5. Cuomo F et al (1998) The influence of acromioclavicular joint morphology on rotator cuff tears* 1. J Shoulder Elbow Surg 7(6):555–559
6. NEER C (1983) Impingement lesions. Clin Orthop Relat Res 173:70

7. Petersson C, Gentz C (1983) Ruptures of the supraspinatus tendon the significance of distally pointing acromioclavicular osteophytes. Clin Orthop Relat Res 174:143
8. Kessel L, Watson M (1977) The painful arc syndrome. Clinical classification as a guide to management. J Bone Joint Surg Br 59(2):166
9. Kuster M, Hales P, Davis S (1998) The effects of arthroscopic acromioplasty on the acromioclavicular joint. J Shoulder Elbow Surg 7(2):140–143
10. Gartsman G (1993) Arthroscopic resection of the acromioclavicular joint. Am J Sports Med 21(1):71
11. Rabalais R, McCarty E (2007) Surgical treatment of symptomatic acromioclavicular joint problems: a systematic review. Clin Orthop Relat Res 455:30
12. Cadet E, Ahmad C, Levine W (2006) The management of acromioclavicular joint osteoarthrosis: debride, resect, or leave it alone. Instr Course Lect 55:75
13. Matthews L, Parks B, Pavlovich L (1999) Arthroscopic versus open distal clavicle resection: a biomechanical analysis on a cadaveric model. Arthrosc J Arthrosc Relat Surg 15(3):237–240
14. Flatow E et al (1995) Arthroscopic resection of the distal clavicle with a superior approach. J Should Elb Surg/Am Should Elb Surg 4(1 Pt 1):41–50
15. Sher J et al (1995) Abnormal findings on magnetic resonance images of asymptomatic shoulders. J Bone Joint Surg 77(1):10
16. Stein B et al (2001) Detection of acromioclavicular joint pathology in asymptomatic shoulders with magnetic resonance imaging. J Shoulder Elbow Surg 10(3):204–208
17. DePalma A (1957) Degenerative changes in the sternoclavicular and acromioclavicular joints in various decades. Thomas, Springfield, IL
18. Rathbun J, Macnab I (1970) The microvascular pattern of the rotator cuff. J Bone Joint Surg Br 52(3):540
19. Watson M (1978) The refractory painful arc syndrome. J Bone Joint Surg Br Vol 60(4):544
20. Weber S (1999) Coplaning the acromioclavicular joint at the time of acromioplasty: a long-term study. Arthroscopy 15:555
21. Fukuda K et al (1986) Biomechanical study of the ligamentous system of the acromioclavicular joint. J Bone Joint Surg 68(3):434
22. Klimkiewicz J et al (1999) The acromioclavicular capsule as a restraint to posterior translation of the clavicle: a biomechanical analysis. J Shoulder Elbow Surg 8(2):119–124