Coracoid process transfer and distal clavicle resection for chronic acromioclavicular separation

Hiroaki Inui, MD, PhD*, Shin Osawa, PhD, Kie Mimori, MD, PhD

Nobuhara Hospital & Institute of Biomechanics 720 Haze Issaicho, Tatsunoshi, Hyogo, Japan

Background: Dewar's procedure for transferring the coracoid process with the short head of biceps and coracobrachialis was reported in 1965 for treatment of both acute and chronic acromioclavicular (AC) joint separation, but little contemporary literature exists around the procedure. We report the clinical results of coracoid process transfer with excision of the lateral end of the clavicle for chronic AC joint separation.

Methods: Fifty-one patients (39 men and 12 women, mean age 46 ± 16 years) were included in the study. Clinical outcomes were evaluated using the American Shoulder and Elbow Surgeons and the Japanese Orthopaedic Association scores, as well as by measuring active range of motion in the shoulder, before-after (minimum follow-up time of 24 months [27 ± 3 months]) surgery. Plain radiographs were used to examine stability of the AC joint and bone union of the graft.

Results: The mean American Shoulder and Elbow Surgeons and Japanese Orthopaedic Association scores increased (from 61 ± 14 to 91 ± 6, and from 54 ± 9 to 89 ± 8, respectively) at the time of final follow-up. There were no differences in active elevation and external rotation between before-after operation. Six patients whose grafts were fractured or displaced showed complete or partial loss of reduction of the AC joint.

Conclusion: By transferring the coracoid process, the AC joint regained stability after chronic joint separation. Although potential complications related to the graft still need to be addressed, Dewar's procedure and lateral clavicle resection could be a reliable treatment of chronic AC joint separation.

Most acromioclavicular (AC) separations could become minimally symptomatic with time, but some chronic separations result in persistent symptoms and require surgical intervention.[13] The Weaver–Dunn procedure[20] of transferring the coracoacromial (CA) ligament to the distal end of the clavicle has been a common surgical procedure with several modifications of temporary augmentation techniques. Experimental studies have shown, however, that due to the weakness of the transferred CA ligament comparing with normal, intact coracoclavicular (CC) ligaments[9,10] subluxation or complete redislocation often occur after the procedure.[19,21] Anatomic reconstruction with autograft or allograft can provide an improved stability,[14,18] but the procedure is costly, technically demanding with possible negative aspects at graft harvesting site or increased risk of inflammatory response and disease transmission. After Dewar and Barrington[5] described a method transferring the coracoid process with the short head of biceps and coracobrachialis, several authors[1,8] reported their results in both acute and chronic cases. Recent publications on this procedure are scarce. In this study, we report the clinical results of coracoid process transfer for chronic AC joint separation.

Materials and methods

Between 2010 and 2018, a total of 68 patients with chronic AC separation underwent Dewar's procedure and excision of the lateral end of the clavicle at our institution. An AC-joint injury older than 3 months was defined as chronic. Intolerable pain and functional disability after conservative treatment were used as indications for surgery. One patient with rheumatoid arthritis and two patients who underwent previous surgery of the shoulder joint were excluded from this study. Two patients, whose combined rotator cuff injuries were repaired at the same surgery session, were also excluded from the study. That left 63 patients eligible for consideration. Of those, 12 patients were lost before the minimum study follow-up of 2 years or had incomplete datasets, and 81% (51
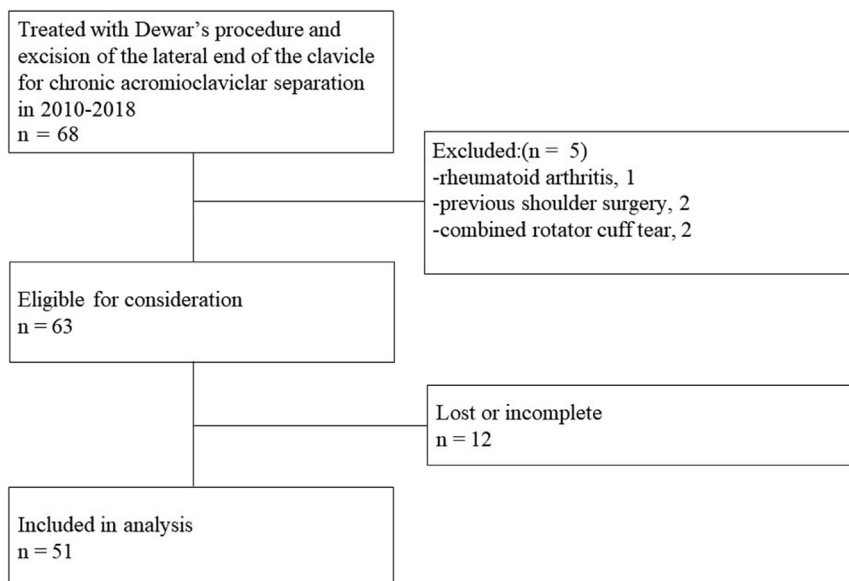
Figure 1 Flowchart of patient selection.

of 63) were analyzed retrospectively (Fig. 1). The study protocol was approved by the institutional review board of our hospital (no. E 253). Although the study included patients treated before it was approved by the board, each patient provided written informed consent prior to their surgery for being included in any treatment study.

Clinical and radiographic assessment

American Shoulder and Elbow Surgeons (ASES) scores and Japanese Orthopaedic Association (JOA) scores were obtained from patients preoperatively and at the final follow-up. Shoulder elevation and external rotation were assessed using both active and passive range of motion (ROM) with the patient in sitting position. Muscle strength was evaluated by the manual muscle test on a scale of 0-5, where 5 = normal amount of resistance to applied force, 4 = ability to move the segment (the arm) through its ROM against strong to moderate pressure, 3 = ability to move the segment through its ROM against gravity, 2 = ability to move the segment through its ROM but not against gravity, 1 = presence of contraction in the muscle without joint motion, and 0 = no muscle contraction. Strength of shoulder elevation was measured with the thumb up, and external rotation strength was measured with the arm at the side. The elbow flexion strength was measured in 90° of elbow flexion. These assessments were performed by senior physical therapists (none of the authors) preoperatively and at the final follow-up.

All patients had preoperative plain radiographs and computed tomography scans, and were classified by the surgeon as having Rockwood III-V injuries (Fig. 2A). The radiographs in two positions at the last follow-up were used to determine whether each AC joint maintained the position (Fig. 2 B andC). According to the method of Jiang et al,[11] the maintenance of reduction of the AC joint in the radiographs with arm dependent position was defined as (1) a maintained reduction (Fig. 2B); no side-to-side difference was seen; (2) a partial loss of reduction (Fig. 3A); there was a side-to-side difference of less than the width of the clavicle; and (3) a complete loss of reduction (Fig. 3B); there was a side-to-side difference of more than the width of the clavicle. The radiographs with arm elevation were used to evaluate maintenance of reduction in

the anteroposterior direction. The radiographs at the last follow-up were also used to determine whether the graft bone was fused to the clavicle or not.

Surgical procedure and postoperative management

The patient was placed in the beach-chair position under general anesthesia. A curved skin incision was made from posterior to the AC joint to the tip of coracoid process. The AC joint was inspected and the intra-articular disc with a 5 mm segment of the distal clavicle was resected. The width of resection was determined to prevent bone-to-bone contact after operation.[2] The anterior deltoid was split and the coracoid process was exposed. The coracoid was osteotomized 1 cm proximal to the tip of the process with the conjoined tendon (the short head of biceps and coracobrachialis) preserving the pectoralis minor and the CA ligament attachments to the coracoid base proximal to the site of osteotomy. Osteoperiosteal decortication was performed anterior bottom of the clavicle at the distal site of the conoid tubercle and a screw hole was directed posteriorly to the upper clavicle. A 4 mm Arbeitsgemeinschaft für Osteosynthesefragen (AO) short thread cancellous screw and washer (Depuy Synthes Companies, Raynham, MA, USA; Johnson & Johnson Medical Devices, Newbrunswick, NJ, USA) were used to secure the graft, while the shoulder and the elbow were flexed. Fixing the graft provided the reduction of the AC joint. There was no need of reducing and securing the position before the transfer. Lastly, upper surface of the joint and the deltotrapezial fascia were repaired. A schematic drawing of the procedure is shown in Fig. 4.

Postoperatively, the shoulder was kept in a sling for six weeks. Each patient was supervised by a physical therapist. Patients began pendulum exercises and assisted ROM exercises. Active exercises were started at week 6 post surgery. Resistive strengthening exercises were initiated at 2 months, and all occupational or sports activities were permitted at 6 months.

Statistical analysis

Data are presented as mean ± SD. We compared findings between the unstable and stable groups using unpaired *t*-test, and between the preoperative and postoperative time points, using
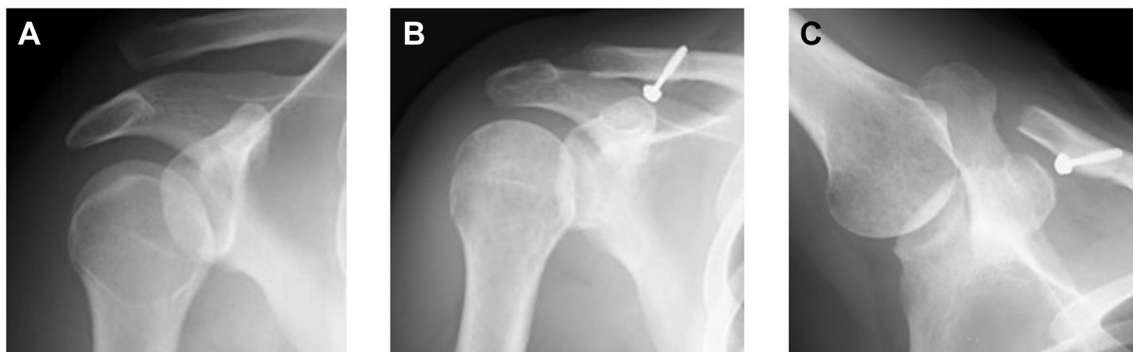
Figure 2 (**A**) The plain radiograph shows complete AC joint separation. (**B**) The AC joint maintained reduction in the radiograph with arm dependent position. (**C**) The AC joint maintained reduction in the radiograph with arm elevation. *AC, acromioclavicular.*
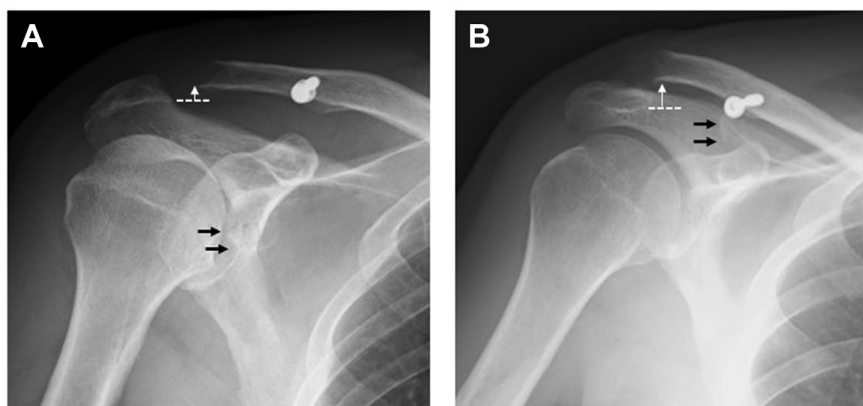

Figure 3 (**A**) The plain radiograph shows partial loss of reduction. Distal end of the clavicle moves upward less than the width of the clavicle from the level of acromial undersurface *(the white dotted line)*. The graft *(black arrows)* displaces to the anterior glenoid. (**B**) The plain radiograph shows complete loss of reduction. Distal end of the clavicle moves upward more than the width of the clavicle from the level of acromial undersurface. The graft *(black arrows)* displaces inferiorly.
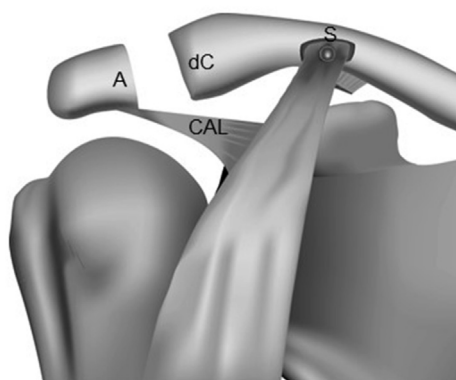

Figure 4 Schematic drawing of the procedure. The coracoid tip with the conjoined tendon was secured to the clavicle at the distal site of the conoid tubercle using a screw *(S)*. The coracoacromial ligament was still preserved to the acromion *(A)*. The intra-articular disc of the acromioclavicular joint and the distal clavicle were resected.

paired *t*-test. Categorical parameters were analyzed with the chi-square test.

Results

The procedure improved ASES scores (preoperative 61 ± 14 to postoperative 91 ± 6, mean difference 30 [95% confidence interval {CI}: 26-35]; $P < .01$). Similarly, JOA scores improved (preoperative 54 ± 9 to postoperative 89 ± 8, mean difference 35 [95% CI: 31-38]; $P < .01$). There were no differences in active elevation (preoperative $139 \pm 21°$ to postoperative $146 \pm 14°$, mean difference 6° [95% CI: -1 to 14]; $P = .08$), or in active external rotation (preoperative $52 \pm 25°$ to postoperative $53 \pm 20°$, mean difference 1° [95% CI: −8 to 10]; $P = .83$) at the last follow-up.

There were 24 Rockwood type III, 1 type IV, and 26 type V injuries. All the patients were confirmed to have complete reduction in the radiographs taken immediately after operation. Based on the reduction observed in the radiographs with arm dependent position at the last follow-up, patients were allocated to two groups (Table I): 45 (stable group) patients of the 51 maintained reduction and 6 (unstable group) patients had loss of reduction. One of these six patients showed complete loss of reduction, whereas the other five patients showed partial loss of reduction according to the method of Jiang et al.[9] Each patient in the stable group also maintained complete reduction in the radiographs with arm elevation. All the six patients in unstable group had the graft bones fractured or displaced at some point (3-8 weeks) post surgery (Fig. 3). There were no differences between the groups in ASES scores (mean difference 1 [95% CI: −5 to 7]; $P = .72$), in JOA scores mean difference 2 [95% CI: −6 to 9]; $P = .67$), in active elevation (mean difference 1° [95% CI: −12 to 14]; $P = .89$), or in external rotation (mean difference 6° [95% CI: −12 to 25]; $P = .51$) at the last follow-up. In two patients, the metal screws were backed out, but the grafts remained fused, maintaining reduction of the AC joint.

Table I
Patients characteristics.

	Unstable (N = 6)	Stable (N = 45)	*P* Value
Mean age (yr)	47 ± 10	42 ± 17	.55[*]
Gender (male / female)	6 / 0	33 / 12	.87[†]
Rockwood type (III/IV/V)	3 / 0 / 3	21 / 1 / 23	.15[†]
Preoperative ASES	60 ± 5	61 ± 15	.90[*]
Preoperative JOA	53 ± 5	55 ± 9	.63[*]
Preoperative elevation (°)	129 ± 21	141 ± 21	.21[*]
Preoperative external rotation (°)	54 ± 17	51 ± 26	.78[*]

ASES, American Shoulder and Elbow Surgeons; *JOA*, Japanese Orthopaedic Association.

[*]Analyzed with the unpaired test.
[†]Analyzed with the chi-square test.

All patients regained muscle strength to the level 5 of manual muscle test in shoulder elevation and external rotation and elbow flexion 6 months after the procedure, and all (except one patient who did not want another surgery) of them had removal of the screws. At surgery of screw removal, closed manipulation was performed in two patients because of limited ROM, and additional resection of distal clavicle was performed in one patient who had continued pain at the joint. Screw removal was done routinely because we previously experienced two patients with irritation at the site; but we don't think routine removal was necessary.

Discussion

Some chronic AC separations result in persistent symptoms and require surgical intervention.[13] Many surgical techniques have been reported for the treatment of chronic AC separation, but there is no gold standard, ideal technique.[15,17]

In 1967, Dewar and Barrington[5] described a method transferring the coracoid process with the short head of biceps and coracobrachialis. Several authors[1,8] reported its use in the past, but limited recent evidence on the procedure has been published. Many surgeons would be familiar with the coracoid osteotomy because the Bristow−Latarjet procedure transferring the coracoid is a common surgery for anterior shoulder instability with significant glenoid bone defects,[12] and we thought the procedure could be a useful treatment option for chronic AC separations.

In the current study, the coracoid was osteotomized 1 cm proximal to the tip of the coracoid process. We made a particular effort in preserving the CA ligament and the pectoralis minor. There is a risk sacrificing the CA ligament which is against anterior-superior migration of the humeral head if a patient later has a large rotator cuff tear. Also, detachment of the pectoralis minor was avoided in order to avoid the altering scapular position and motion.[3] One anatomic study[6] showed the lengths from the tip to the anterior pectoralis minor, and from the tip to the anterior CA ligament averaged 4.6 mm and 7.8 mm, respectively. The widths of their insertions were 11.8 mm for the pectoralis minor and 17.9 mm for the CA ligament, supporting most of their fibers were preserved during the osteotomy.

Dewar's is a simple procedure with the transfer of the coracoid tip. We observed all the joints were reduced when fixing the tip of the coracoid process to the clavicle. Reducing the AC separation which might be difficult for chronic cases was not necessary before the transfer. We thought it was meaningful to explore the potential and expand the uses of this conventional technique. Postoperative ASES scores reportedly averaged 95.1 for the CC reconstruction and 87.9 for the Weaver−Dunn procedure.[4] The scores for the coracoid process transfer were compatible with those previous reports. Postoperative plain radiographies showed there was no widening

in the CC space as long as the graft was fused to the clavicle. Narrowing in the CC space was not observed either. However, we must admit that the complication rate was rather high. Pseudoarthrosis of the coracoid graft in the Bristow−Latarjet procedure was pointed out to be usually related to the unicortical or single screw fixation.[7] Using two screws for a longer graft might prevent fracture or displacement of the bone graft with chronic AC separation as well. If the complications about fixing the graft are solved, the procedure could be salvage after failure of an anatomic reconstruction in addition to being a primary procedure.

The current study has several limitations. It was a retrospective study, and there was no control group to compare with. Biomechanical assessment of the procedure is needed. Plain radiographs only in two positions were used for assessment. Most patients showed reduction of the AC joint, but radiographs under stress loading would be needed to detect subtle instability.[4] Some author added tenodesis at the coracoid bed after this Dewar's procedure to reconstruct the CC ligaments.[16] Further experimental study could determine whether just the muscle transfer would work to reconstitute a static stabilizer.

Conclusion

By transferring the coracoid process, the AC joint regained stability after chronic joint separation. Although potential complications related to the graft still need to be addressed, Dewar's procedure and lateral clavicle resection could be an option for chronic AC joint separation.

Disclaimers:

References

1. Berson BL, Gilbert MS, Green S. Acromioclavicular dislocations: treatment by transfer of the conjoined tendon and distal end of the coracoid process to the clavicle. Clin Orthopaedics Relat Res 1978;135:157-64.
2. Branch TP, Burdette HL, Shahriari AS, Carter FM 2nd, Hutton WC. The role of the acromioclavicular ligaments and the effect of distal clavicle resection. Am J Sports Med 1996;24:293-7.
3. Carbone S, Moroder P, Runer A, Resch H, Gumina S, Hertel R. Scapular dyskinesis after Latarjet procedure. J Shoulder Elbow Surg 2016;25:422-7. https://doi.org/10.1016/j.jse.2015.08.001.
4. Clarke HD, McCann PD. Acromioclavicular joint injuries. Orthop Clin North America 2000;31:177-87.
5. Dewar FP, Barrington TW. The treatment of chronic acromio-clavicular dislocation. J Bone Jt Surg Br 1965;47:32-5.
6. Dolan CM, Hariri S, Hart ND, McAdams TR. An anatomic study of the coracoid process as it relates to bone transfer procedures. J Shoulder Elbow Surg 2011;20:497-501. https://doi.org/10.1016/j.jse.2010.08.015.
7. Domos P, Lunini E, Walch G. Contraindications and complications of the Latarjet procedure. Shoulder Elbow 2018;10:15-24. https://doi.org/10.1177/1758573217728716.
8. Ferris BD, Bhamra M, Paton DF. Coracoid process transfer for acromioclavicular dislocations. A report of 20 cases. Clin Orthopaedics Relat Res 1989;242:184-94.
9. Harris RI, Wallace AL, Harper GD, Goldberg JA, Sonnabend DH, Walsh WR. Structural properties of the intact and the reconstructed coracoclavicular ligament complex. Am J Sports Med 2000;28:103-8.
10. Jari R, Costic RS, Rodosky MW, Debski RE. Biomechanical function of surgical procedures for acromioclavicular joint dislocations. Arthroscopy 2004;20:237-45. https://doi.org/10.1016/j.arthro.2004.01.011.

11. Jiang C, Wang M, Rong G. Proximally based conjoined tendon transfer for coracoclavicular reconstruction in the treatment of acromioclavicular dislocation. J Bone Jt Surg Am 2007;89:2408-12. https://doi.org/10.2106/jbjs.f.01586.

12. Levy DM, Cole BJ, Bach BR Jr. History of surgical intervention of anterior shoulder instability. J Shoulder Elbow Surg 2016;25:e139-50. https://doi.org/10.1016/j.jse.2016.01.019.

13. Mazzocca AD, Arciero RA, Bicos J. Evaluation and treatment of acromioclavicular joint injuries. Am J Sports Med 2007;35:316-29. https://doi.org/10.1177/0363546506298022.

14. Mazzocca AD, Santangelo SA, Johnson ST, Rios CG, Dumonski ML, Arciero RA. A biomechanical evaluation of an anatomical coracoclavicular ligament reconstruction. Am J Sports Med 2006;34:236-46. https://doi.org/10.1177/0363546505281795.

15. Nolte PC, Lacheta L, Dekker TJ, Elrick BP, Millett PJ. Optimal management of acromioclavicular dislocation: current perspectives. Orthop Res Rev 2020;12: 27-44. https://doi.org/10.2147/orr.s218991.

16. Selim NM. Open anatomic coracoclavicular ligament reconstruction by modified Conjoint tendon transfer for treatment of acute high-grade acromioclavicular dislocation. Arthrosc Tech 2018;7:e1157-65. https://doi.org/10.1016/j.eats.2018.07.013.

17. Takase K, Hata Y, Morisawa Y, Goto M, Tanaka S, Hamada J, et al. Treatment of acromioclavicular joint separations in Japan: a survey. JSES Int 2021;5:51-5. https://doi.org/10.1016/j.jseint.2020.09.008.

18. Thomas K, Litsky A, Jones G, Bishop JY. Biomechanical comparison of coracoclavicular reconstructive techniques. Am J Sports Med 2011;39:804-10. https://doi.org/10.1177/0363546510390482.

19. Tienen TG, Oyen JF, Eggen PJ. A modified technique of reconstruction for complete acromioclavicular dislocation: a prospective study. Am J Sports Med 2003;31:655-9. https://doi.org/10.1177/03635465030310050401.

20. Weaver JK, Dunn HK. Treatment of acromioclavicular injuries, especially complete acromioclavicular separation. J Bone Jt Surg Am 1972;54:1187-94.

21. Weinstein DM, McCann PD, McIlveen SJ, Flatow EL, Bigliani LU. Surgical treatment of complete acromioclavicular dislocations. Am J Sports Med 1995;23:324-31.