Double-Loop Suture Repair for Acute Acromioclavicular Joint Disruption

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Background: Although it has been established that surgical treatment for acromioclavicular joint disruption (types IV-VI and type III in overhead throwing athletes and heavy laborers) is preferred, the literature is inconclusive about the best type of surgery.

Purpose: With the goal of avoiding the potential complications of hardware use, the authors present a coracoclavicular functional stabilization technique with the intention to restore the anteroposterior and superior displacement of the clavicle.

Study Design: Case series; Level of evidence, 4.

Methods: From 1999 to 2003, 38 patients with an acute, complete acromioclavicular joint separation (34 men, 4 women; mean age, 33.5 years) underwent surgical reconstruction with the described coracoclavicular loop stabilization technique. With this technique, the superior and anteroposterior displacement of the clavicle can be easily controlled using 2 pairs of Ethibond No. 5 nonabsorbable sutures—one passed in front and the other behind the clavicle, through a central drill hole, 2 cm from its lateral end, directly above the base of the coracoid process (at the corresponded attachment of coracoclavicular ligaments). Passive shoulder motion was encouraged by the second postoperative day.

Results: Thirty-four patients were available for the last clinical and radiologic evaluation. At a mean follow-up of 33.2 months (range, 18-59 months), the mean Constant-Murley score was 93.5 points (range, 73-100 points), and 2 cases with slight loss of reduction (less than half of the width of the clavicle) were detected. Complications included 1 case with superficial infection and 1 patient (basketball player) with persistent tenderness in the acromioclavicular joint without signs of secondary arthritis. The incidence of periarticular ossification was 17.6% and did not affect the final outcome. Secondary degenerative changes were not detected.

Conclusion: Considering the nearly anatomical reconstruction, the avoidance of hardware complications, and the low rate of recurrence, this technique may be an attractive alternative to the management of acute acromioclavicular joint separations.

Keywords: acromioclavicular (AC) joint; acromioclavicular joint disruption; coracoclavicular (CC) stabilization; double-loop suture repair

More than 70 different surgical procedures have been described for the treatment of acute acromioclavicular (AC) joint separations, and no standard has been established.† Current techniques are associated with frequent complications such as loosening, breakage, and migration of hardware; erosion of the clavicle; fracture of the coracoid; foreign-body reaction; loss of reduction; and postoperative osteoarthritis.[11,12,19,20,22,24,30]

Avoiding the potential complications of any hard material use, we present an anatomical, minimally invasive coracoclavicular (CC) cerclage technique (Figure 1) for the treatment of acute AC joint separation, which has been performed so far in 38 patients. The intention with this technique is to restore both the superior and anteroposterior displacement of the clavicle and thus to facilitate early joint motion.

MATERIALS AND METHODS

Between February 1999 and June 2003, 38 patients underwent surgical reconstruction for acute AC joint disruption in our department by the senior surgeon, who developed the presented technique. One patient died for reasons unrelated to the treatment, and 3 missed the final follow-up appointment. Thirty-four patients, 31 men and 3 women with a mean age of 33.5 years (range, 21-61 years), were

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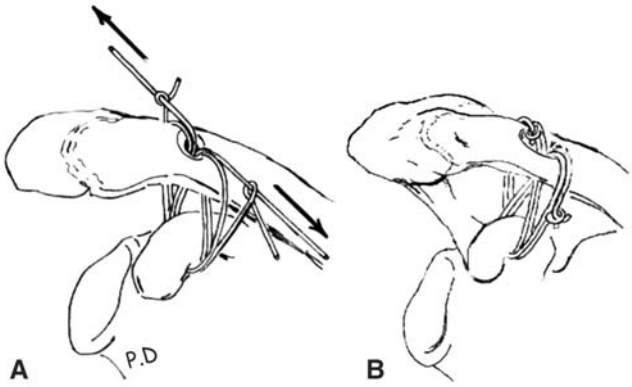

Figure 1. Schematic representation of our coracoclavicular functional stabilization technique. A, suture passage and control of anteroposterior displacement by applying equal force to different directions. B, final knotting of the sutures.

available for clinical and radiologic assessment in a mean follow-up period of 33.2 months (range, 18-59 months) (Table 1). Involvement in a traffic accident was the most common mode of injury (38.2%), followed by sports activities (29.4%), simple falls (23.6%), and falls from height (8.8%). The right shoulder was injured in 20 patients and the left shoulder in 14. Eleven patients were professional or semiprofessional athletes, 13 were heavy manual laborers, and the rest were very active before the operation.

Initial radiologic investigation consisted of 3 views: AP with 10° cranial tilt of the beam (Zanca view), true axillary in a supine position, and comparative stress radiography of both AC joints. All cases were classified as type III (n = 24) (Figure 2I) or type V (n = 10) (Figure 2II) separations according to Rockwood classification.[28] A type III dislocation (complete disruption of both AC and CC ligaments) was considered on radiographs if the distal end of the clavicle was elevated more than or equal to 75% to 100% of the width of the articular surface of the distal clavicle, whereas the clinical diagnosis was based on the presence of a painful palpable step off and remaining clavicular protuberance during shoulder anterior elevation (Figure 2). The diagnosis of a type V separation (as per type III but with associated detachment of the deltotrapezial fascia) was suspected by the marked superior displacement of the clavicle on plain radiographs (125% to 200%) and was definitively confirmed during the operation. In 3 cases that were considered to be type III dislocations on radiographs, a separation of the deltotrapezial fascia was also identified, despite the lesser degree of clavicular superior translation in preoperative radiographs.

All operations were performed within the first 10 days after the injury. Fourteen patients with late presentation (more than 2-3 weeks) and another 3 patients with associated fractures of the distal end of the clavicle were not included in the study. Vascular or neurologic complications were not identified. Associated injuries of the skeleton were present in 7 patients, all of whom had been involved in traffic accidents.

Follow-up Evaluation

The functional outcome was assessed at the final follow-up with the Constant and Murley scoring system by an independent registrar (S. A. S.) who was not involved with the initial management. Pain, performance of daily activities, range of motion, and strength were scored on a scale of 1 to 100, with 100 being an excellent score. The isometric power of the shoulder was assessed by assigning a maximum of 25 points when a patient could resist a maximal weight of 12 kg at 90° of shoulder abduction or when the resisted weight was less than or equal to the resisted weight on the contralateral noninjured arm. All patients were asked about the current level of their athletic performance and whether they had modified their occupations because of the injury.

Radiographic evaluation was routinely performed postoperatively at 6 months, 1 year, and at the latest follow-up, consisting of both AP (Zanca) and axillary views. The position of the AC joint and the presence of degenerative changes and periarticular ossifications were reviewed by the first 2 authors and 1 associated professor in orthopaedics (E. P.) who was not involved in the initial treatment. Ossifications were classified as absent, minor, or major; minor ossifications represented spots or small ossicles located in the CC ligaments, whereas major ossifications were considered as almost complete bridging between the clavicle and the coracoid process.

Surgical Technique

Under general or regional anesthesia by interscalene block, the patient was placed in the beach-chair position, and the entire upper extremity was prepared and draped in a manner to allow full and unrestricted arm positioning during the procedure. Three doses of a second-generation cephalosporin were usually administered for infection prophylaxis.

A “strap” skin incision was designed based on the standard anatomical landmarks: anterior portion of the acromion, distal clavicle, and coracoid process (Figure 3.1). It started 2 to 3 cm posterior to the AC joint and was extended to the tip of the coracoid process. The incision was carried down longitudinally through the subcutaneous tissues, in line with the superior cortex of the clavicle.

Full-thickness soft tissue flaps from the anterior deltoid and posterior trapezius were prepared to ensure an adequate soft tissue envelope for closure. In 10 cases, the deltotrapezial fascia was already disrupted and confirmed the type of dislocation (type V). The AC and CC ligaments were totally detached in all 34 cases. If ruptured, the meniscus was excised; this was necessary in 7 cases.

The anterior deltoid muscle was split thereafter in line with its fibers, approximately 2 cm distally, toward the tip of the coracoid process, to facilitate its exposure. A curved soft tissue elevator was used to bluntly dissect the tissues medially and laterally for suture passage around the coracoid process. A curved suture passer was used to pass 4 braided polyester Ethibond Excel No. 5 sutures (Ethicon, Johnson & Johnson, Somerville, NJ) around the base of the coracoid process (Figure 3.2), as close as possible to its base. The ends

TABLE 1
Data of the 34 Fully Evaluated Patients

Patient	Age/ Sex	Occupation/ Sport	Side	Mechanism of Injury	Follow-up, mo	Type of Separation[a]	Constant Score	Periarticular Ossification	Complications
1	47/male	Builder	Right	Traffic accident	59	III	94	Minor	
2	30/male	Firefighter	Right	Traffic accident	53	V	95		
3	40/male	Laborer	Right	Simple fall	52	III	100		
4	25/male	Football (semiprofessional)	Right	Sport activities	51	V	90		
5	45/male	Builder	Left	Traffic accident	50	III	94		Superficial infection
6	38/male	Laborer	Right	Traffic accident	48	III	100	Minor	
7	23/male	Basketball (professional)	Left	Sport activities	46	III	83		Pain in sport activities
8	45/female	Laborer	Right	Simple fall	44	V	92		
9	54/male	Tennis (semiprofessional)	Right	Simple fall	41	III	100		
10	29/male	Soldier	Left	Sport activities	40	III	95		
11	29/male	Truck driver	Right	Traffic accident	38	V	100	Minor	
12	27/male	Swimming (professional)	Right	Traffic accident	37	III	100		
13	28/male	Basketball (semiprofessional)	Left	Simple fall	36	III	100		
14	36/male	Laborer	Left	Traffic accident	34	V	86		Slight loss of reduction
15	38/female	Dancer	Right	Traffic accident	34	III	92		Slight loss of reduction
16	26/male	Laborer	Left	Sport activities	32	V	96		
17	28/male	Volleyball (semiprofessional)	Right	Traffic accident	31	III	94		
18	22/male	Wrestling (semiprofessional)	Left	Sport activities	30	V	90		
19	27/male	Carpenter	Left	Sport activities	30	III	100		
20	54/male	Laborer	Right	Fall from height	29	III	90	Major	
21	61/male	Builder	Left	Simple fall	28	III	73		Restricted shoulder motion
22	25/male	Laborer	Right	Traffic accident	27	V	90		
23	42/male	Builder	Left	Fall from height	27	V	92		
24	50/male	Laborer	Right	Simple fall	26	III	92		
25	30/male	Swimming (professional)	Right	Traffic accident	25	III	98		
26	28/male	Engineer	Right	Simple fall	24	III	92		
27	37/male	Laborer	Right	Fall from height	22	III	80	Minor	
28	21/male	Laborer	Left	Traffic accident	21	V	92		
29	29/male	Tennis (semiprofessional)	Left	Sport activities	20	III	92		
30	27/male	Laborer	Left	Traffic accident	20	III	98	Minor	
31	22/male	Laborer	Right	Sport activities	19	III	96		
32	32/male	Laborer	Left	Simple fall	19	III	100		
33	25/male	Javelin thrower (semiprofessional)	Right	Sport activities	18	III	92		
34	22/female	Tennis (professional)	Right	Sport activities	18	III	100		

[a]According to Rockwood classification.[28]

of the sutures were pulled back and forward in a "sawing" motion, and the affected shoulder was lifted from the sutures to ensure their adequate placement beneath the coracoid.

At this point, the clavicle was prepared and a hole was drilled through its superior cortex with a 4.5-mm drill, placed in the center of the clavicle and 2 cm proximal to its distal end, which corresponded to the CC ligament attachment. The sharp edges of the clavicular hole were smoothed with a small curette to avoid any damage to the sutures. The 4 Ethibond sutures were passed through the clavicular hole

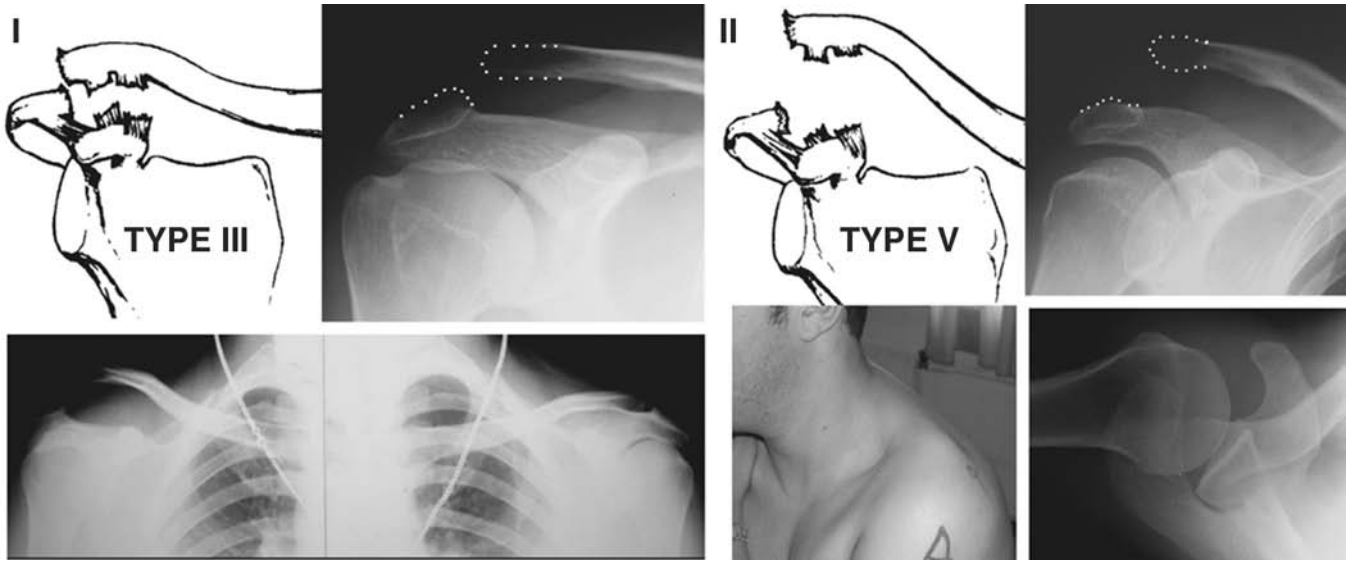

Figure 2. I, type III acromioclavicular joint disruption and preoperative radiographs consisted of AP view with 10° cranial tilt of the beam (Zanca view) and comparative stress radiography of both AC joints. II, type V dislocation demonstrated in both AP and axillary views as well as the clinical appearance of an acute acromioclavicular joint separation.

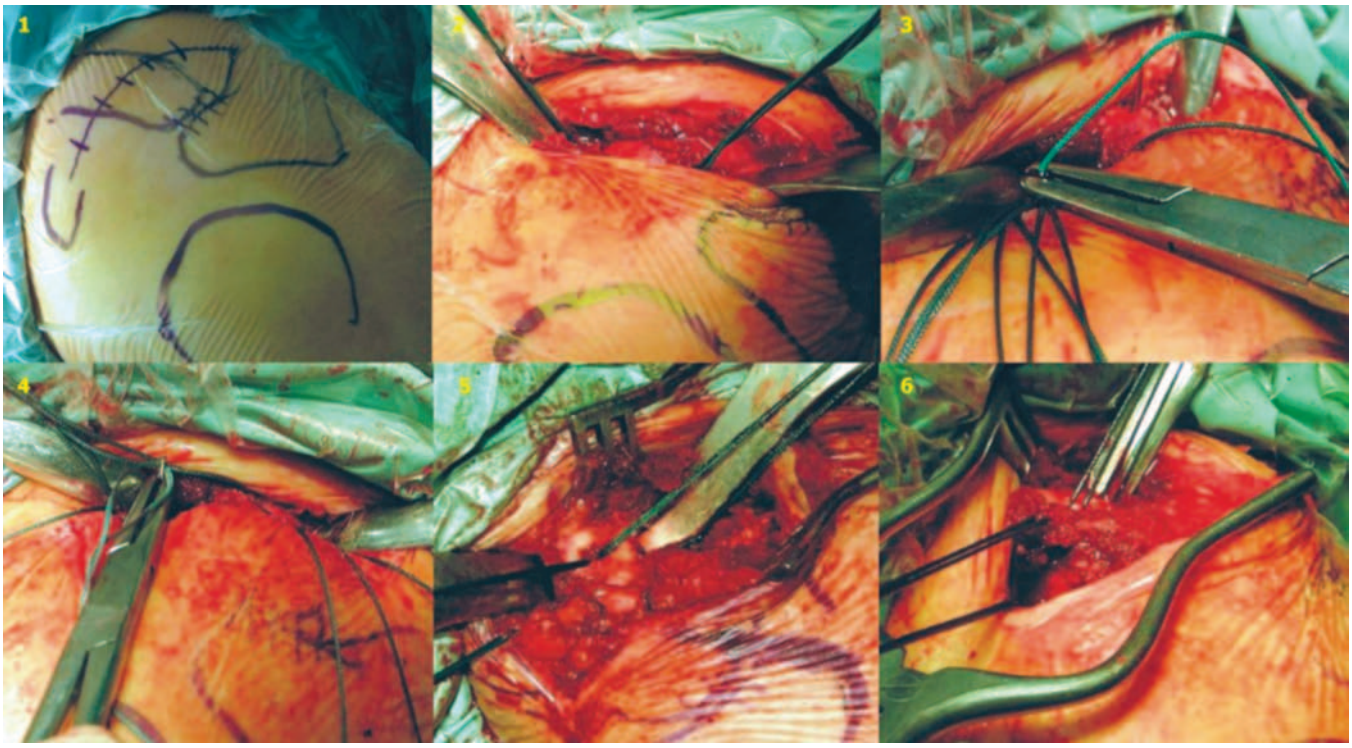

Figure 3. Intraoperative images of the proposed technique (see text for details).

(Figure 3.3) using the incorporated needles; the needles were cut off thereafter. The sutures must slide free underneath the coracoid process and through the clavicular hole.

Two sutures were used for the anterior retention of the clavicle and were kept apart, tagged with a clip. The free ends of the other 2 sutures (not those through the hole) were carefully passed behind the clavicle to provide its posterior retention. This was achieved after each suture was incorporated in a free needle, which was passed as close as possible to the inferior border of the distal clavicle

(Figure 3.4). As soon as the sutures were in place, the surgeon held the 2 pairs in opposite directions, anteriorly and posteriorly (Figure 3.5), being able to correct the anteroposterior displacement of the clavicle, while the assistant reduced the dislocation with a blunt instrument, thus correcting the vertical displacement (Figure 3.6).

The clavicle was held in the reduced position, and each pair of sutures was tied off. The clavicle was fixed in a slightly overreduced position during tying off, and the knots were placed near or beneath the anterior and posterior edges of the clavicle.

The adequacy of the reduction was then assessed; just before closure, the arm was placed through a complete range of motion to assess the security of the repair. The deltotrapezial flaps were reapproximated over the superior aspect of the lateral clavicle using absorbable sutures in a figure-of-8 manner; the knots were completely covered. The subcutaneous tissue and the skin were closed with absorbable sutures. A Velpeau dressing, converted to a simple hanging sling at the second postoperative day, secured the arm to the chest wall after the operation.

No effort was made to directly repair the disrupted AC and CC ligaments. The proposed technique can be applied in chronic AC separations (>3-4 weeks) but with the additional resection of the distal 0.8 to 1.0 cm of the clavicle.

Rehabilitation

Rehabilitation initially consisted of active range of motion exercises for the elbow, wrist, and hand. The patient was discharged 1 to 2 days after the operation and guided to perform passive shoulder motion by means of pendulum exercises. Passive-assistive shoulder exercises were initiated 2 to 3 weeks later, but the patient remained in the supine position and was allowed forward elevation up to 90° only, external rotation up to 30°, and internal rotation only to the chest wall. Forward elevation was limited to 90° to minimize clavicular rotation, which may compromise the repair. Range of motion was advanced at 5 to 6 weeks, still in the supine position, until full active range of motion was regained. A strengthening program was started thereafter, usually 2 to 3 months postoperatively, and included isometric exercises with progression to resistive exercises. Heavy lifting or any other activity that would result in significant downward traction on the upper extremity was avoided for 3 to 4 months postoperatively. Strenuous use of the arm, including significant athletic activity, was not advised until 5 to 6 months postoperatively.

RESULTS

At a mean follow-up period of 33.2 months, the mean Constant-Murley score was 93.5 points (range, 73-100 points), and only 1 patient (No. 7) had significant pain in vigorous athletic activities and marked tenderness over the AC joint without radiologic evidence of redislocation or degenerative arthritis. As he was a professional basketball athlete, he abandoned sport activities but was able to return to his prior occupation. No deep infections were noted except from 1 patient who had a superficial infection

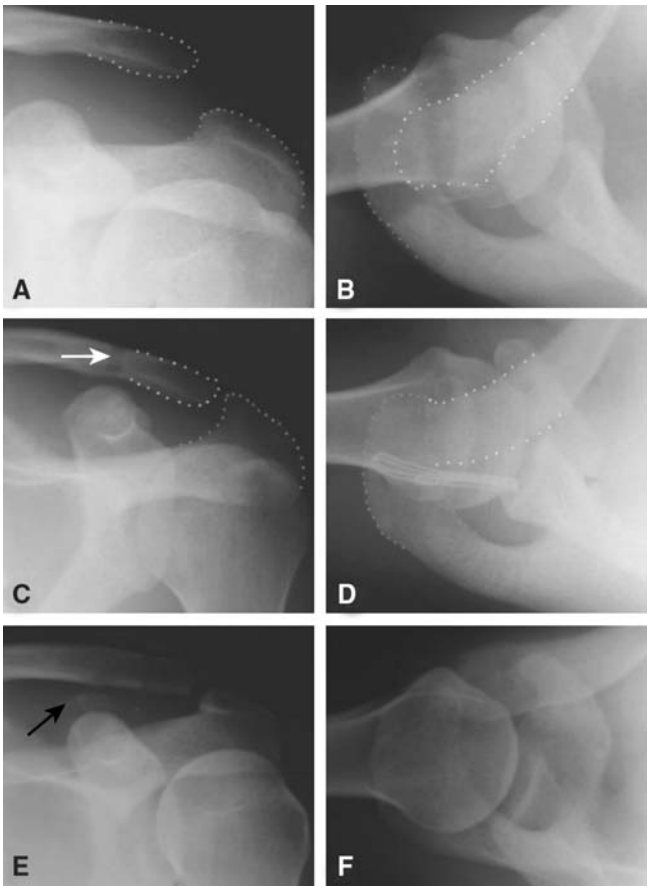

Figure 4. Preoperative (A, B) and postoperative (C, D) radiographs of a complete acromioclavicular joint separation treated with our technique. Adequate reduction was achieved in both AP and vertical planes, which remained in place 2 years after the operation (E, F). The white arrow indicates the drill hole in the distal clavicle. The minor ossification of the ligaments near the coracoid (black arrow) in this case did not affect the final clinical outcome (patient No. 30).

that was easily managed by orally administered antibiotics. A 61-year-old builder (No. 21) had restricted shoulder motion 28 months after the procedure, but the level of his physical activity had already been reduced before the injury, as indicated by his low Constant-Murley score (69%) in the unaffected shoulder.

All athletes except one returned to the same level of athletic performance at a mean period of 6 months after the procedure. None of the other patients modified their occupations because of the injury.

Radiologic evidence of posttraumatic AC joint degeneration was not detected. Slight loss of reduction (less than 50% of the width of the clavicle) was noted in 2 patients (No. 14 and No. 15), but their functional outcome was very good. Thirty-two patients (94%) maintained reduction of the AC joint in both AP and vertical planes (Figure 4). Finally, the incidence of periarticular ossification was very low (17.6%) and did not affect the final outcome. Major ossification was seen in only 1 patient, without any influence in shoulder motion.

DISCUSSION

Surgical treatment of the injured AC joint is well established in types IV, V, and VI, but the ideal management for type III separations remains controversial and continues to evolve, with a trend in most series toward nonoperative treatment.[2,7,14,28] Prospective studies comparing nonoperative and operative treatment of these injuries have shown similar results with no great advantage of either treatment.[17,27]

Some patients, however, particularly those involved in overhead throwing sports or heavy manual labor, may develop pain and mechanical symptoms interfering with their ability to perform their usual sports or jobs. The disruption of the synchronous scapuloclavicular rotation[28] that normally occurs with overhead activity is the main cause of this disability and has led some authors to recommend surgical repair or reconstruction.[10,30,33]

In a countrywide anonymous survey of 210 German trauma departments, Bäthis et al[3] asked about diagnostic procedures and treatment strategies for AC injuries. One hundred four questionnaires (49%) were returned and evaluated. For type I and II injuries, most clinics recommended nonoperative treatment, whereas for more severe AC injuries (Rockwood IV to VI), all clinics recommended operative intervention. On the other hand, 84% of the clinics would operate on type III AC injury—especially in athletes or overhead workers. Although 38% of the clinics believed that nonoperative treatment is equal to or better than operative treatment, only 13% were managing type III injuries nonoperatively!

Not only is the decision for operative treatment inconclusive in the literature, but the ideal type of reconstruction remains controversial as well. More than 70 procedures have been described for the treatment of complete AC joint separations, including dynamic muscle transfers, AC joint fixation, excision of the distal clavicle with coracoacromial (CA) ligament reconstruction, CC loop fixation, reconstruction with tendon autografts, and combinations or modifications of these techniques as well as arthroscopic procedures. The goal of each of these procedures is to reduce the dislocation and create an environment for soft tissue healing and stabilization of the distal clavicle. It is uncertain, however, whether current surgical techniques restore normal anatomy to allow return to unimpeded repetitive overhead activity.

Older techniques, such as transfer of the tip of the coracoid process together with the attached conjoined tendon[6] or Bosworth CC screw fixation,[4] have fallen out of favor. The coracoid transfer bypasses the site of disruption, does not provide static stability, and appears to have more risks involved than necessary, such as injury to the musculocutaneous nerve, nonunion of the transferred coracoid, and loss of fixation or screw breakage. Rockwood et al[28] popularized the Bosworth technique along with repair of the ligaments for acute injuries requiring operative treatment. The screw is supposed to unload the repair during healing, but removal is recommended between 8 and 10 weeks postoperatively, as soon as the CC ligaments have healed. Common complications include ossification between the coracoid and the clavicle, osteolysis, loosening, and screw breakage.

Another widespread technique is fixation across the AC joint with wires, threaded pins, screws, or hook plates,[12,21,25,29] usually accompanied by repair or augmentation of the AC or CC ligaments. Serious concerns still exist regarding pin migration or breakage,[19,24] pin-site infection, fixation failure, and redislocation after pin removal. Mayr et al[20] noticed that in 28.1% of their patients, no "durable" anatomical reconstruction of the joint was achieved using a temporary transfixation of the joint by a centrally drilled Kirschner wire combined with a polydioxanone augmentation of the CC ligament and a suture of the AC ligament. Subjective rating and range of motion of these patients were significantly lower compared with those with a lasting anatomical reconstruction of the AC joint. Reapproximation of the disrupted AC joint with hardware may lead to further damage to the articular cartilage and meniscus, resulting in degenerative arthritis.[30] Percutaneous or blind pinning of the AC joint is another described technique, but it does not allow CC augmentation, reattachment of the deltotrapezial fascia, or AC joint debridement.[12]

In 1972, Weaver and Dunn[32] described a technique that involves transfer of the CA ligament into the distal end of the clavicle after approximately a 10- to 12-mm resection has been accomplished. Although this has become a very popular procedure, especially in old AC separations, it has been shown that the transferred CA ligament alone does not approach the strength of an intact CC ligament; CC screw and additional augmentation, such as sutures, tapes, or screws, that keep the AC joint reduced while the ligament transfer heals, have been recommended.[8,10]

Ponce et al[26] have recently described a Weaver and Dunn "variant" for AC reconstruction that is augmented with 9 No. 1 absorbable sutures wrapped in the fashion of a high-tension cable cord. For overhead throwing athletes and revision cases, the augmentation is performed with tendon autografts (palmaris longus or semitendinosus). Tienen et al[31] have proposed stabilization of the AC joint with absorbable sutures and transfer of the CA ligament to the superior aspect of the clavicle to reinforce the fixation. A common criticism of CA transfer is the consequences of altering an important restraining mechanism to upward migration of the shoulder. Moreover, Diederichsen et al[9] demonstrated a response, probably of reflex origin, from mechanoreceptors in the CA to the shoulder muscles. The potential existence of a synaptic connection between the CA mechanoreceptors and shoulder muscles may lead to imbalance of muscle coordination and functional joint stability.

Several authors have proposed various cerclage, sling, or loop techniques to fashion a CC loop that tethers the coracoid to the clavicle using wires, sutures, Dacron or Mersilene tapes, or other synthetic loops of absorbable or nonabsorbable material.[15,16,18,33] These materials perform well in biomechanical studies but have posed some problems with erosion through the distal clavicle, anterior displacement, and infection.[11] The loop is usually passed around the base of the coracoid, as in our technique, and then through a drill hole of various diameters and positions at the superior cortex of the clavicle or around the clavicle itself. Baker et al[1] conducted a cadaveric study to examine the AC joint congruity after single CC loop repair using a suture placed through 3 different clavicular holes (anterior,

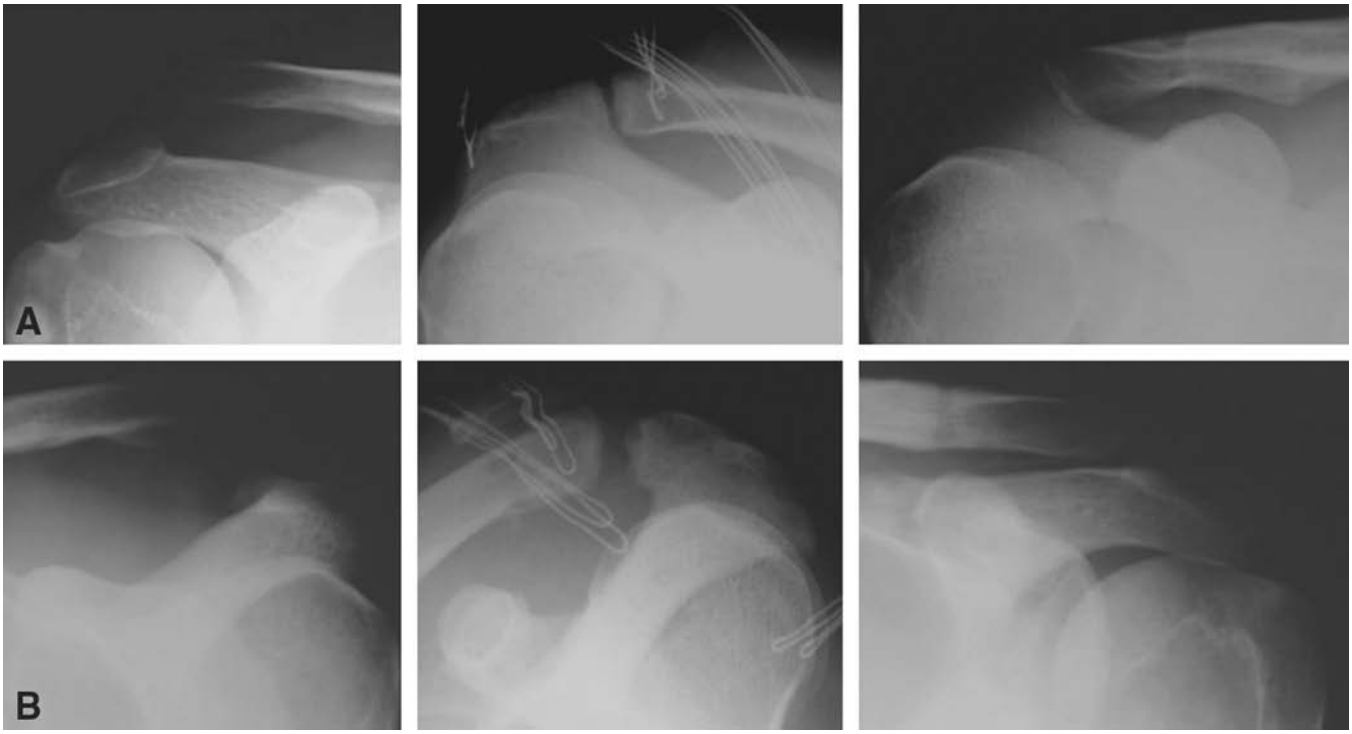

Figure 5. Two cases of type III acromioclavicular joint separation treated with our technique and the maintenance of reduction 3.2 years (A, patient No. 3) and 4 years (B, patient No. 13) after the operation. Note that there was no evidence of either heterotopic ossification or posttraumatic osteoarthritis.

middle, and posterior) and concluded that none of the above methods can fully restore the AC joint congruity, whereas the more anterior the hole, the lesser the degree of anterior displacement achieved. Jerosch et al[13] investigated the more "anatomical" between 8 different AC joint stabilization techniques and found that a simple coracoid sling led to significant anterior displacement of the clavicle. In their opinion, a bone anchor system for distal fixation and a "medialized" hole in the clavicle restore the anatomy best. Finally, Breslow et al[5] demonstrated similar stability for the CC fixation using either suture anchors or No. 5 nonabsorbable braided sutures around the base of the coracoid, whereas Motamedi et al[23] found no significant difference in the mean failure loads of the intact CC ligament complex, polydioxanone augmentation, and either of the 2 types of braided polyethylene augmentation (around the clavicle or through a 2.5-mm clavicular hole).

Placement of the augmentation device is crucial for adequate reduction of the clavicle relative to the acromion. If the fixation loop is not accurately placed at the base of the coracoid, it tends to displace the clavicle anteriorly.[22] Furthermore, if the loop of material is passed over the top of the clavicle, it may erode through its lateral end and produce a fracture, or it can slip and lead to failure of the repair.

We believe that the main advantage of our technique is that the surgeon can control both the anteroposterior and vertical displacement, placing the clavicle at its anatomical position and allowing the disrupted AC ligaments to easily heal (Figures 4 and 5).

The 4.5-mm drill hole in the center of the clavicle is necessary for the 4 sutures to slide readily, whereas their "sawing" effect is minimized not only by smoothing the sharp cortical edges of the hole with a curette but also by the equal tensioning force applied to both anterior and posterior borders of the distal clavicle during knotting. As soon as the superior displacement of the clavicle is corrected, this equal anteroposterior force in the horizontal plane can reduce the clavicle in its anatomical position relative to the acromion, thus minimizing the risk of further anterior displacement. To our knowledge, no other similar technique with the use of a double pair of sutures in both the anterior and posterior aspects of the clavicle has ever been described or tested in biomechanical studies.

The proposed anatomical method of CC functional stabilization seems to be a promising operative procedure for acute AC joint separations, but some limitations still exist. The number of patients was small, but one must consider the rarity of injury and the small percentage of high-demand patients who need surgical intervention. The mean follow-up period was quite short (33 months), but as the clavicle remained reduced for a minimum of 18 months after surgery, we do not expect a deterioration of clavicular posture in the long term. Similarly, longer follow-up will be necessary to determine the incidence of posttraumatic arthritis, but the achievement of nearly anatomical congruity of the AC joint by both the vertical and anteroposterior corrections of clavicular displacement should minimize the progression of arthritis. Finally, the biomechanical

characteristics of the proposed loop augmentation technique need further investigation in cadaveric studies, especially regarding loads of failure and the amount of anterior displacement of the clavicle during 3-dimensional arm motion.

CONCLUSION

The minimal invasive characteristics and the simplicity of our technique can restore the damaged anatomy without sacrificing any tendons or ligaments. By controlling both the vertical and anteroposterior displacement of the clavicle with 2 different pairs of sutures placed in the exact anatomical position of the disrupted CC ligaments, the main disadvantage of CC loop techniques—the anterior displacement of the distal clavicle—is easily avoided. No hardware is necessary, thus eliminating the potential dangers for pin migration, breakage, infection, screw loosening, and reoperation for material removal.

REFERENCES

1. Baker JE, Nicandri GT, Young DC, Owen JR, Wayne JS. A cadaveric study examining acromioclavicular joint congruity after different methods of coracoclavicular loop repair. *J Shoulder Elbow Surg*. 2003;12:595-598.
2. Bannister GC, Wallace WA, Stableforth PG, Hutson MA. The management of acute acromioclavicular dislocation: a randomised prospective controlled trial. *J Bone Joint Surg Br*. 1989;71:848–850.
3. Bäthis H, Tingart M, Bouillon B, Tiling T. Current therapeutic strategies for acromioclavicular injuries: results of a survey at German Trauma Departments. *Unfallchirurg*. 2001;104:955–960.
4. Bosworth BM. Acromioclavicular separation: new method of repair. *Surg Gynecol Obstet*. 1941;73:866-871.
5. Breslow MJ, Jazrawi LM, Bernstein AD, Kummer FJ, Rokito AS. Treatment of acromioclavicular joint separation: suture or suture anchors? *J Shoulder Elbow Surg*. 2002;11:225-229.
6. Brunelli G, Brunelli F. The treatment of acromioclavicular dislocation by transfer of the short head of the biceps. *Int Orthop*. 1988;12: 105-108.
7. Clarke HD, McCann PD. Acromioclavicular joint injuries. *Orthop Clin North Am*. 2000;31:177-187.
8. Deshmukh AV, Wilson DR, Zilberfarb JL, Perlmutter GS. Stability of acromioclavicular joint reconstruction: biomechanical testing of various surgical techniques in a cadaveric model. *Am J Sports Med*. 2004;32:1492-1498.
9. Diederichsen LP, Norregaard J, Krogsgaard M, Fischer-Rasmussen T, Dyhre-Poulsen P. Reflexes in the shoulder muscles elicited from the human coracoacromial ligament. *J Orthop Res*. 2004;22:976-983.
10. Dumontier C, Sautet A, Man M, Apoil A. Acromioclavicular dislocations: treatment by coracoacromial ligamentoplasty. *J Shoulder Elbow Surg*. 1995;4:130-134.
11. Guttmann D, Paksima NE, Zuckerman JD. Complications of treatment of complete acromioclavicular joint dislocations. *Instr Course Lect*. 2000;49:407-413.
12. Hellmich A, Sievers U. Operative repair of acromioclavicular separation via transcutaneous Kirschner wire fixation: results of follow-up examinations in 45 patients. *Aktuelle Traumatol*. 1988;18:9-13.
13. Jerosch J, Filler T, Peuker E, Greig M, Siewering U. Which stabilization technique corrects anatomy best in patients with AC-separation? An experimental study. *Knee Surg Sports Traumatol Arthrosc*. 1999;7: 365-372.
14. Jobe FW, Bradley JP. The diagnosis and nonoperative treatment of shoulder injuries in athletes. *Clin Sports Med*. 1989;8:419-438.
15. Kappakas GS, McMaster J. Repair of acromioclavicular separation using Dacron prosthesis graft. *Clin Orthop Relat Res*. 1978;131: 247-251.
16. Kiefer H, Claes L, Burri C, Holzwarth J. The stabilizing effect of various implants on the torn acromioclavicular joint: a biomechanical study. *Arch Orthop Trauma Surg*. 1986;106:42-46.
17. Larsen E, Bjerg-Nielsen A, Christensen P. Conservative or surgical treatment of acromioclavicular dislocation: a prospective, controlled, randomized study. *J Bone Joint Surg Am*. 1986;68:552-555.
18. Lemos MJ. The evaluation and treatment of the injured acromioclavicular joint in athletes. *Am J Sports Med*. 1998;26:137-144.
19. Lindsey RW, Gutowski WT. The migration of a broken pin following fixation of the acromioclavicular joint: a case report and review of the literature. *Orthopedics*. 1986;9:413-416.
20. Mayr E, Braun W, Eber W, Ruter A. Treatment of acromioclavicular joint separations: central Kirschner-wire and PDS-augmentation. *Unfallchirurg*. 1999;102:278-286.
21. Mlasowsky B, Brenner P, Duben W, Heymann H. Repair of complete acromioclavicular dislocation (Tossy stage III) using Balser's hook plate combined with ligament sutures. *Injury*. 1988;19:227-232.
22. Morrison DS, Lemos MJ. Acromioclavicular separation: reconstruction using synthetic loop augmentation. *Am J Sports Med*. 1995;23: 105-110.
23. Motamedi AR, Blevins FT, Willis MC, McNally TP, Shahinpoor M. Biomechanics of the coracoclavicular ligament complex and augmentations used in its repair and reconstruction. *Am J Sports Med*. 2000;28:380-384.
24. Norrell H Jr, Llewellyn RC. Migration of a threaded Steinmann pin from an acromioclavicular joint into the spinal canal: a case report. *J Bone Joint Surg Am*. 1965;47:1024-1026.
25. Paavolainen P, Bjorkenheim JM, Paukku P, Slatis P. Surgical treatment of acromioclavicular dislocation: a review of 39 patients. *Injury*. 1983; 14:415-420.
26. Ponce B, Millet P, Warner JJP. Acromioclavicular joint instability: reconstruction indications and techniques. *Oper Tech Sports Med*. 2004;12:35-42.
27. Press J, Zuckerman JD, Gallagher M, Cuomo F. Treatment of grade III acromioclavicular separations: operative versus nonoperative management. *Bull Hosp Jt Dis*. 1997;56:77-83.
28. Rockwood CA Jr, Williams GR Jr, Young DC. Disorders of the acromioclavicular joint. In: Rockwood CA Jr, Matsen FA III, eds. *The Shoulder*. 2nd ed. Philadelphia, Pa: WB Saunders; 1998:483-553.
29. Sim E, Schwarz N, Hocker K, Berzlanovich A. Repair of complete acromioclavicular separations using the acromioclavicular-hook plate. *Clin Orthop Relat Res*. 1995;314:134–142.
30. Taft TN, Wilson FC, Oglesby JW. Dislocation of the acromioclavicular joint: an end-result study. *J Bone Joint Surg Am*. 1987;69:1045-1051.
31. Tienen T, Oyen F, Eggen P. A modified technique of reconstruction for complete acromioclavicular dislocation: a prospective study. *Am J Sports Med*. 2003;31:655-659.
32. Weaver JK, Dunn HK. Treatment of acromioclavicular injuries, especially complete acromioclavicular separation. *J Bone Joint Surg Am*. 1972;54:1187-1194.
33. Weinstein DM, McCann PD, McIlveen SJ, Flatow EL, Bigliani LU. Surgical treatment of complete acromioclavicular dislocations. *Am J Sports Med*. 1995;23:324-333.