Changes in Surgical Procedures for Acromioclavicular Joint Dislocation Over the Past 30 Years

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Abstract

Generally, surgical treatment is recommended for Rockwood type 5 traumatic acromioclavicular joint dislocations. Since 1980, the authors have performed the modified Dewar procedure, the modified Cadenat procedure, and anatomical reconstruction of the coracoclavicular ligaments for this injury. The goal of this study was to determine the ideal surgical procedure for acromioclavicular joint dislocations by comparing these 3 procedures.

The modified Dewar procedure was performed on 55 patients (Dewar group), the modified Cadenat procedure was performed on 73 patients (Cadenat group), and anatomical reconstruction of the coracoclavicular ligaments was performed on 11 patients (reconstruction group). According to the UCLA scoring system, therapeutic results averaged 27.3 points in the Dewar group, 28.2 in the Cadenat group, and 28.4 in the reconstruction group. The incidence of residual subluxation or dislocation in the acromioclavicular joint was evaluated at final radiographic follow-up. Subluxation occurred in 21 patients in the Dewar group, 18 in the Cadenat group, and 3 in the reconstruction group. Dislocation occurred in 3 patients in the Dewar group. Osteoarthritic changes in the acromioclavicular joint occurred in 20 patients in the Dewar group, 9 in the Cadenat group, and 1 in the reconstruction group.

The modified Cadenat procedure can provide satisfactory therapeutic results and avoid postoperative failure or loss of reduction compared with the modified Dewar procedure. However, the modified Cadenat procedure does not anatomically restore the coracoclavicular ligaments. Anatomic restoration of both coracoclavicular ligaments can best restore acromioclavicular joint function.

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Figure: Anteroposterior radiographs of a 41-year-old man showing an acromioclavicular joint dislocation preoperatively (A) and its treatment using the modified Dewar procedure (B).
Various treatment methods, both conservative and surgical, have been used for traumatic acromioclavicular joint dislocations. Generally, surgical treatment is recommended for Rockwood type 4, 5, and 6 dislocations. However, surgical and conservative treatments for type 3 dislocations are controversial and have not been standardized. Many surgical procedures have been considered and reported in the literature, with no consensus at present.

Since 1980, the current authors have performed the modified Dewar procedure for the reduction of the dislocated acromioclavicular joint using the dynamic muscle strength of the conjoined tendon. However, this procedure has various problems, including damage by surgical invasion and long-term immobilization. In consideration of these problems, since 1995 the authors have performed the modified Cadenat procedure, which reconstructs the coracoaclavicular ligaments using the coracoacromial ligaments. However, anatomic restoration of the coracoclavicular ligaments can best restore acromioclavicular joint function. Based on the anatomical data for the structures of the trapezoid and conoid ligaments, these procedures do not aim to anatomically reconstruct the coracoclavicular ligaments. Therefore, the authors have attempted to correctly reconstruct the anatomy of the coracoclavicular ligaments (trapezoid and conoid ligaments) using the ipsilateral palmaris longus tendon and an EndoButton (Smith & Nephew Endoscopy, Andover, Massachusetts) as the reconstructing ligament and fixation material, respectively.

The goal of this study was to discover the ideal surgical procedure for acromioclavicular joint dislocations by comparing the modified Dewar procedure, the modified Cadenat procedure, and anatomical reconstruction of the coracoclavicular ligaments.

**Materials and Methods**

According to Rockwood’s classification, on plain radiographs all patients were evaluated as having type 5 traumatic acromioclavicular joint dislocations.

**Modified Dewar Procedure**

The modified Dewar procedure was performed in 55 patients (Dewar group) between 1980 and 1994. The group comprised 51 (92.7%) men and 4 (7.3%) women with a mean age of 34.5 years (range, 16-66 years) at surgery. The right side was affected in 29 (52.7%) patients and the left side in 26 (47.3%) patients. The mechanism of injury was a traffic accident in 25 (45.5%) patients, a sports accident in 19 (34.5%), and other causes in 11 (20%) patients. Mean follow-up was 50 months (range, 33-106 months).

During the procedure, the coracoid process was directly confirmed through the deltopectoral approach. Then, approximately 1.5 cm of the tip of the coracoid process was osteomized and detached, along with the coracobrachialis muscle and short head of the biceps brachialis muscle. The dislocated acromioclavicular joint was fixed using 2 K-wires, preserving the intra-articular disk as much as possible, and the torn capsule and acromioclavicular ligaments were sequentially repaired. Finally, the detached coracoid process was fixed with these muscles to the anterior side of the clavicle approximately 3 cm from the distal edge of the clavicle using a screw with a spike washer (Figure 1).

Postoperative treatment consisted of immobilization with a Velpeau bandage for 5 weeks. Beginning at postoperative week 6, forward elevation by passive movement in the supine position and pendulum exercises were prescribed. The K-wires were removed 6 weeks postoperatively (Figure 2).

**Modified Cadenat Procedure**

Between 1995 and 2009, the modified Cadenat procedure was performed in 73 patients with acromioclavicular joint dislocations (Cadenat group). The group comprised 66 (90.4%) men and 7 (9.6%) women with a mean age of 35.4 years at surgery (range, 16-63 years). The right side was affected in 41 (56.2%) patients and the left side in 32 (43.8%) patients. The mechanism of injury was traffic accident in 30 (41.1%) patients, sports accident in 18 (24.7%), work accident in 8 (11%), and other causes in 17 (23.3%). Time from injury to surgery was less than 2 weeks in 65 (89%) patients (acute cases),...
between 2 weeks and 1 month in 5 (6.8%) patients (subacute cases), and more than 1 month in 3 (4.1%) patients (chronic cases). Fifty-three (72.6%) of these patients had participated in sports activities before injury, and 48 (65.8%) patients, including 32 contact sports players, engaged in high-level sports activities. Mean follow-up was 30 months (range, 14-75 months).

During the procedure, the coracoid process was directly confirmed through the deltopectoral approach. Initially, the coracoacromial ligaments at the acromial insertion site and a small bone tip were detached (Figure 3). The dislocated acromioclavicular joint was fixed using a hook plate, preserving the intra-articular disk as much as possible, and the torn capsule and acromioclavicular ligaments were sequentially repaired. Finally, the detached coracoacromial ligament with the bone tip was fixed to the anterior side of the clavicle using a screw with a spike washer in a position that allowed sufficient tension to be obtained (Figure 4).

Postoperative treatment consisted of immobilization with a Désault bandage for 2 weeks. Beginning at postoperative week 4, forward elevation by passive movement in the supine position and pendulum exercises were prescribed (Figure 5). The Wolter clavicular plate was removed 4 months postoperatively.

**Anatomical Reconstruction of the Coracoclavicular Ligaments**

Since 2008, the authors have reconstructed the anatomical structure of the coracoclavicular ligaments (trapezoid and conoid ligaments) with an artificial ligament and the ipsilateral palmaris longus tendon used as substitute ligaments, respectively (reconstruction group). Eleven patients with acromioclavicular joint dislocations underwent this procedure. The group comprised 11 men with a mean age of 38.6 years at surgery (range, 19-67 years). The right side was affected in 7 (63.6%) patients and the left side in 4 (36.4%) patients. The mechanism of injury was traffic accident in 2 (18.2%) patients, sports accident in 4 (36.4%), and a fall in 5 (45.5%). Mean time from injury to surgery was 16.3 days (range, 9-30 days). Mean follow-up was 17 months (range, 12-43 months).

The double-bundle procedure reconstructing both the trapezoid and conoid ligaments was performed. Initially, a 16-cm or longer length of the palmaris longus tendon was excised from the ipsilateral side as the substitute for the conoid ligament (Figure 6A). An artificial ligament (Dacron; Smith & Nephew Endoscopy) was used for reconstructing the trapezoid ligament (Figure 6B). An EndoButton was used for fixation of the tendon or artificial ligament on the coracoid process side, and a screw with a spike washer was used on the clavicle side. The excised palmaris longus tendon was fashioned into a quadruple-stranded graft with a minimal length of 4 cm for reconstructing the conoid ligament. During these preparations, the EndoButton was placed at the loop end of the conoid graft and the artificial ligament at the other end of the conoid graft. The conoid ligament reconstruction was performed under arthroscopy. To acquire firm fixation and prevent sinking...
of the EndoButton, the soft tissue under the surface of the coracoid process was cleaned to expose the cortex through the anterior portal.

To create a bone tunnel for reconstructing the conoid ligament, a 2-mm diameter K-wire was inserted from the conoid tubercle of the clavicle to the base of the coracoid process under arthroscopy. Then, a 4-mm bone tunnel was created for the conoid graft using a cannulated drill bit with a diameter matched with the graft diameter by overdrilling along that wire from the clavicle. Similarly, another 2-mm diameter K-wire was inserted from the 1.5-cm medial portion from the lateral end of the clavicle to the medial side of the body of the coracoid process for reconstructing the trapezoid ligament. Finally, each graft was introduced through the anterior portal to the clavicle tunnel and fixed on the undersurface of the base of the coracoid process by the EndoButton, respectively (Figure 7). Then, the clavicle side of each graft was fixed together by a screw with a spike washer. No temporary fixation of the acromioclavicular joint was performed.

Postoperative treatment consisted of immobilization with a Désault bandage for approximately 1 week. Beginning at postoperative week 2, only a sling was used, and pendulum exercises were prescribed. All immobilization was discontinued at 2 weeks postoperatively (Figure 8).

Therapeutic Results and Statistical Analysis
Therapeutic results were evaluated based on the UCLA scoring system (30 points), which consists of pain, function, range of motion, and strength, excluding the patient’s satisfaction. Also, radiographic findings were evaluated, including the occurrence of osteoarthritic changes and the complete reduction or lack thereof in the acromioclavicular joint.

Statistical analysis evaluated the differences among the 3 groups. A P level less than .05 using the Mann-Whitney U test was considered significant.

RESULTS
According to the UCLA scoring system, mean therapeutic result was 27.3 points (range, 18-30 points) in the Dewar group, 28.2 points (range, 24-30 points) in the Cadenat group, and 28.4 points (range, 24-30 points) in the reconstruction group. When the results were examined, no significant difference among these groups was observed. However, regarding postoperative range of motion, 59 (80.8%) of 73 patients in the Cadenat group recovered more than 160° forward elevation and 160° abduction at 3 months postoperatively, but 21 (38.1%) of 55 patients in the Dewar group required approximately 1 year to gain their preinjury range of motion. The remaining patients did not regain their preinjury range of motion.

The incidence of residual subluxation or dislocation in the acromioclavicular joint was evaluated at final radiographic follow-up. In the Dewar group, subluxation that represented less than 5 mm of superior translation of the clavicle occurred in 14 (25.5%) patients, subluxation that represented 5 to 10 mm of superior translation of the clavicle occurred in 7 (12.7%) patients, and complete dislocation occurred in 3 (5.5%) patients. In the Cadenat group, subluxation that repre-
sent less than 5 mm of superior translation of the clavicle occurred in 18 (24.7%) patients, and subluxation that represented more than 5 mm of superior translation of the clavicle or redislocation occurred in 0 patients. In the reconstruction group, subluxation that represented less than 5 mm of superior translation of the clavicle occurred in 3 (27.3%) patients, and subluxation that represented more than 5 mm of superior translation of the clavicle or redislocation occurred in 0 patients.

Osteoarthritic changes occurred in the acromioclavicular joint in 20 (36.4%) patients in the Dewar group, 9 (12.3%) patients in the Cadenat group, and 1 (9.1%) patient in the reconstruction group.

**DISCUSSION**

Acromioclavicular joint separations are frequently treated in clinical practice. The degree or direction of translation of the clavicle against the acromion depends on the injury states of the acromioclavicular and coracoclavicular ligaments and detachment of deltoid or trapezius muscle from the clavicle. Rockwood et al and Tossy et al classified the degree or direction of displacement in acromioclavicular joint separations into 6 and 3 types, respectively. Generally, Rockwood type 5 dislocations are considered a good indication for surgical treatment. Many surgical treatments exist for acromioclavicular joint dislocation, including repair of the acromioclavicular ligament (Phemister procedure or Neviaser procedure), fixation between the clavicle and the coracoid process (Bosworth procedure), reconstruction of the coracoclavicular ligament using the coracoacromial ligament (Weaver-Dunn procedure and Cadenat procedure), and dynamic stabilization of the coracoclavicular joint by the transferred conjoined tendon (Dewar procedure).

Between 1980 and 2008, the current authors performed 2 different surgical procedures (modified Dewar procedure and modified Cadenat procedure), which were not anatomical reconstruction of the coracoclavicular ligament, in patients with Rockwood type 5 acromioclavicular joint dislocations. The modified Dewar procedure has some disadvantages, including a long period required for range of motion recovery, a high frequency of residual subluxation or dislocation, and postoperative osteoarthritic changes on the acromioclavicular joint. In particular, the latter 2 disadvantages were considered to result from the dynamic stabilization of the acromioclavicular joint by the conjoined tendons. Skjeldal et al reported that nonoperative treatment gave equal or better long-term functional results compared with the modified Dewar procedure in acute acromioclavicular dislocations, and they did not recommend the procedure in acute cases.

Considering these disadvantages, the current authors began performing the modified Cadenat procedure on patients with acromioclavicular joint dislocations in 1995. Patients undergoing the modified Cadenat procedure needed a mean of 3.4 months to return to their occupation and a mean of 3.1 months to return to preinjury-level sports activities. However, the modified Cadenat procedure also has some disadvantages. The mechanism of stabilization for the acromioclavicular joint is established by the coracoacromial ligament transferred from the acromion to the clavicle. This transferred coracoacromial ligament does not anatomically reconstruct the trapezoid and conoid ligaments that compose the coracoclavicular ligament. The conoid ligament attaches anatomically to the conoid tubercle, which is located at the posterior edge of the clavicle, and the clavicle can make an axial rotation during forward elevation of the shoulder joint. However, in the modified Cadenat procedure, it is possible that this axial rotation of the clavicle is restricted because the transferred coracoacromial ligament is fixed to the anterior edge of the clavicle. For this reason, even if the dislocated acromioclavicular joint is reduced in a normal position, it is possible that osteoarthritic changes can occur to the acromioclavicular joint. The Weaver-Dunn procedure, in which the transferred coracoacromial ligament is inserted into the distal edge of the resected clavicle, is close to anatomical reconstruction of the trapezoid ligament. However, this procedure does not aim to reconstruct the anatomical acromioclavicular joint due to the distal clavicle resection.

To reconstruct the coracoacromial ligaments, Yoo et al used the semitendinosus tendon, Sloan et al used the lateral half slip of the conjoined tendon, Lädermann et al and Marchie et al used suture threads, and Wei et al and Salzmann et al used an artificial ligament. However, of these procedures, only the method using an artificial ligament achieved reconstruction of the anatomical coracoacromial ligaments. In addition, using an artificial ligament for the procedure may make it impossible to acquire the same function as the congenital ligaments.

The current authors performed a double-bundle procedure with an artificial ligament and the palmaris longus tendon for anatomical reconstruction of the trapezoid and conoid ligaments, respectively. On considering its location, features, and operative demerits, the authors believe that the palmaris longus tendon is a suitable substitute for the ligament. However, this tendon is thin and short for reconstructing the trapezoid and conoid ligaments. Therefore, the authors used the palmaris longus tendon to reconstruct the conoid ligament, which is mainly responsible for stabilization of the superior translation of the clavicle.

This procedure aimed to anatomically reproduce the distribution and attachment sites of the trapezoid and conoid ligaments. Although the excision of the palmaris longus tendon is a disadvantage, anatomical reduction of the acromioclavicular joint was accomplished in 8 (72.7%) of 11 patients. Also, it is possible to perform this surgical technique under...
arthroscopy. During the follow-up period, no osseous erosion on the clavicle and no displacement of the EndoButton were noted. However, fracture of the coracoid process or the clavicle is possible intraoperatively. Therefore, the tunnel creation in the coracoid process or the clavicle should be carefully performed.

CONCLUSION

The modified Cadénat procedure can provide satisfactory therapeutic results and avoid postoperative failure or loss of reduction of acromioclavicular joint separations compared with the modified Dewar procedure. However, the modified Cadénat procedure does not anatomically restore the coracoclavicular ligaments. Anatomic reconstruction of both coracoclavicular ligaments can best restore acromioclavicular joint function.

REFERENCES


