Resection Arthroplasty of the Sternoclavicular Joint*

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ABSTRACT: The results of resection of the medial end of the clavicle to treat a painful sternoclavicular joint in fifteen patients were retrospectively reviewed. The patients fell into two groups: eight patients who had had a primary arthroplasty of the sternoclavicular joint in which the costoclavicular ligament was left intact (group I), and seven patients who had had revision of a failed arthroplasty of the sternoclavicular joint and in whom the costoclavicular ligament had to be reconstructed (group II). The results for these two groups were compared at an average of 7.7 years postoperatively. All eight patients in group I had an excellent result. In sharp contrast, three patients in group II had an excellent result, three had a fair result, and one had a poor result. We conclude that preservation or reconstruction of the costoclavicular ligament is essential at the time of resection of the medial portion of the clavicle in order to obtain a satisfactory result.

Sir Astley Cooper, in 1832, was probably the first to describe resection of the medial end of the clavicle to treat posterior dislocation of the sternoclavicular joint[10]. Since that time, numerous authors have described various operative procedures for the treatment of an unstable or degenerative sternoclavicular joint[3,12,16,17,24,27,31].

In any type of operative procedure on the sternoclavicular joint, it is necessary to preserve, repair, or reconstruct the costoclavicular ligament (the rhomboid ligament) to maintain the stability of the medial portion of the clavicle in relation to the manubrium. In 1954, Abbott and Lucas described the importance of the costoclavicular ligament with regard to the treatment of problems related to the sternoclavicular joint[1]. Those authors pointed out that resection of the medial portion of the clavicle resulted in cephalad displacement and instability of the remaining portion of the clavicle if the resection included a portion of the clavicle that was lateral to the costoclavicular ligament. Since then, a number of authors have described the importance of this ligament in opposing the cephalad pull on the medial portion of the clavicle imparted by the sternocleidomastoid muscle and various movements of the shoulder[5,6,11,24,29,32-35].

The purpose of the present report was to review the results of resection of the medial portion of the clavicle in two groups of patients who had been managed between 1972 and 1990. In the first group of patients (group I), the medial portion of the clavicle was resected, with maintenance of the costoclavicular ligament. In the second group (group II), a previous failed arthroplasty of the sternoclavicular joint was revised, with reconstruction of the costoclavicular ligament.

Materials and Methods

We retrospectively analyzed two groups of patients who had had resection of the medial end of the clavicle to treat problems related to the sternoclavicular joint (Table I). The sternoclavicular joint was evaluated with routine radiographs and a computed tomography scan in order to compare it with the contralateral, normal joint.

Group I

Group I consisted of eight patients, six men and two women, in whom a primary resection of the medial end of the clavicle with maintenance of the costoclavicular ligament had been performed by the senior one of us (C. A. R., Jr.). The diagnosis was post-traumatic degenerative joint disease of the sternoclavicular joint in two patients, chronic unreduced posterior dislocation of the clavicle in two, chronic anterior dislocation following a fracture-dislocation in two, chronic posterior dislocation following a fracture-dislocation in one, and traumatic anterior subluxation in one. All of the patients had chronic pain in the affected sternoclavicular joint as well as grinding, popping, and crepitus with movement of the shoulder. The average age at the onset of the symptoms was thirty years (range, fourteen to forty-five years), and the average age at the time of the operation was thirty-five years (range, twenty-three to forty-six years).

Group II

Group II consisted of seven patients, five men and two women, who had had resection of the medial end of the clavicle with reconstruction of the costoclavic-

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TABLE I
DATA ON THE PATIENTS

Case	Gender, Age *(Yrs.)*	Preoperative Diagnosis	Previous Treatment	Duration of Follow-up *(Yrs.)*	Score on Rating Scale *(Points)*					
					Pain	Range of Motion	Strength	Limitation	Subjective Result	Total Score*
Group I										
1	M, 38	Chronic unreduced posterior dislocation		2.0	3	3	3	3	3	15
2	M, 36	Post-traumatic degenerative joint disease		5.3	2	3	3	2	3	13
3	F, 30	Traumatic anterior subluxation		4.8	2	3	3	2	3	13
4	M, 27	Chronic anterior dislocation following fracture-dislocation		1.7	3	3	3	2	3	14
5	M, 23	Chronic anterior dislocation following fracture-dislocation		14.5	3	3	3	3	3	15
6	M, 31	Chronic unreduced posterior dislocation		5.4	3	3	3	3	3	15
7	F, 46	Post-traumatic degenerative joint disease		10.0	3	3	3	3	3	15
8	M, 45	Chronic posterior dislocation following fracture-dislocation		2.0	3	3	3	3	3	15
Group II										
9	M, 20	Anterior dislocation following fracture-dislocation	Open reduction and internal fixation with threaded pin	18.3	3	3	2	3	3	14
10	M, 33	Traumatic anterior subluxation	Resection of medial portion of clavicle	10.0	2	2	1	1	2	8
11	M, 18	Traumatic anterior dislocation	Open reduction and internal fixation with pin, resection of medial portion of clavicle	10.5	1	2	2	1	2	8
12	F, 34	Post-traumatic degenerative joint disease	Resection of medial portion of clavicle ×2	7.3	3	3	2	2	3	13
13	M, 30	Spontaneous atraumatic anterior dislocation	Resection of medial portion of clavicle	5.0	1	2	1	1	1	6
14	F, 34	Spontaneous atraumatic anterior dislocation	Resection of medial portion of clavicle	3.3	1	2	2	2	2	9
15	M, 42	Traumatic anterior dislocation	Open reduction and internal fixation with pins	16.3	2	3	3	2	3	13

*A total score of 13, 14, or 15 points indicates an excellent result; 10, 11, or 12 points, a good result; 7, 8, or 9 points, a fair result; and less than 7 points, a poor result.

ular ligament. They had been referred to the senior one of us because of persistent pain and deformity in the sternoclavicular joint after a failed arthroplasty of the joint performed elsewhere without maintenance or reconstruction of the costoclavicular ligament. The diagnosis was traumatic anterior dislocation or subluxation in three patients, spontaneous atraumatic anterior dislocation in two, anterior dislocation following a fracture-dislocation in one, and post-traumatic degenerative joint disease in one. The average age at the onset of the symptoms was thirty years (range, fifteen to forty-two years), and the average age at the time of the operation was thirty years (range, eighteen to forty-two years).

Rating Scale

As we were not aware of any published data on the results of arthroplasty of the sternoclavicular joint, we developed a rating scale with which to evaluate our patients (Table II). A maximum of 3 points each was assigned for pain, range of motion, strength, limitation, and the subjective result. According to this scale, a total score of 13, 14, or 15 points indicated an excellent result; 10, 11, or 12 points, a good result; 7, 8, or 9 points, a fair result; and less than 7 points, a poor result.

Anatomy of the Sternoclavicular Joint

The sternoclavicular joint is diarthrodial and is the only true articulation between the upper extremity and

the axial skeleton. The articular surface of the clavicle is much larger than the articular facet on the sternum, and both surfaces are covered with fibrocartilage. The enlarged bulbous medial end of the clavicle is concave front-to-back and convex vertically, creating a saddle-type joint with the curved clavicular notch of the sternum[27,28]. The joint surfaces are not congruent.

Because less than half of the medial portion of the clavicle articulates with the cephalad angle of the sternum, the sternoclavicular joint has the distinction of having the least amount of osseous stability of the major joints of the body[27,28]. If a finger is placed in the superior sternal notch, one can feel that, with motion of the upper extremity, a large part of the medial portion of the clavicle is completely cephalad to the articulation with the sternum. There is so much joint incongruity that the integrity has to come from the surrounding ligaments, including the intra-articular disc ligament, the extra-articular costoclavicular ligament, the capsular ligament, and the interclavicular ligament (Fig. 1).

TABLE II

RATING SCALE USED TO EVALUATE THE RESULTS OF ARTHROPLASTY OF THE STERNOCLAVICULAR JOINT*

Category	Score *(Points)*
Pain	
None	3
Slight	2
Moderate	1
Severe (at rest)	0
Range of motion	
Normal	3
Slight restriction (<25%)	2
Moderate restriction (25-50%)	1
Severe restriction (>50%)	0
Strength	
Normal	3
Slight weakness (<25%)	2
Moderate weakness (25-50%)	1
Severe weakness (>50%)	0
Limitation	
None	3
Slight	2
Moderate	1
Severe	0
Subjective result	
Excellent	3
Good	2
Fair	1
Poor	0

*A total score of 13, 14, or 15 points indicates an excellent result; 10, 11, or 12 points, a good result; 7, 8, or 9 points, a fair result; and less than 7 points, a poor result.

Operative Technique

The surgeon must be totally familiar with the anatomy immediately cephalad and posterior to the sternoclavicular joint before the operation. Additionally, we suggest that a thoracic surgeon be available or be a part of the surgical team in the event of vascular complications. The risk of this potentially fatal complication is particularly high with chronic unreduced posterior dislocations.

With the patient supine on the operating table, three or four towels, or a small sandbag, are placed between the scapulae. The skin incision, which is approximately eight to ten centimeters long, begins cephalad to the superior border of the medial aspect of the clavicle and extends to the notch of the manubrium and then caudad three to four centimeters onto the anterior surface of the manubrium (Fig. 2). A deep incision is made along the medial four to five centimeters of the clavicle across the capsular ligament and caudad onto the manubrium (Fig. 3). The periosteum is dissected carefully off the medial portion of the clavicle with care being taken to preserve the periosteum for later closure and to preserve the costoclavicular ligament

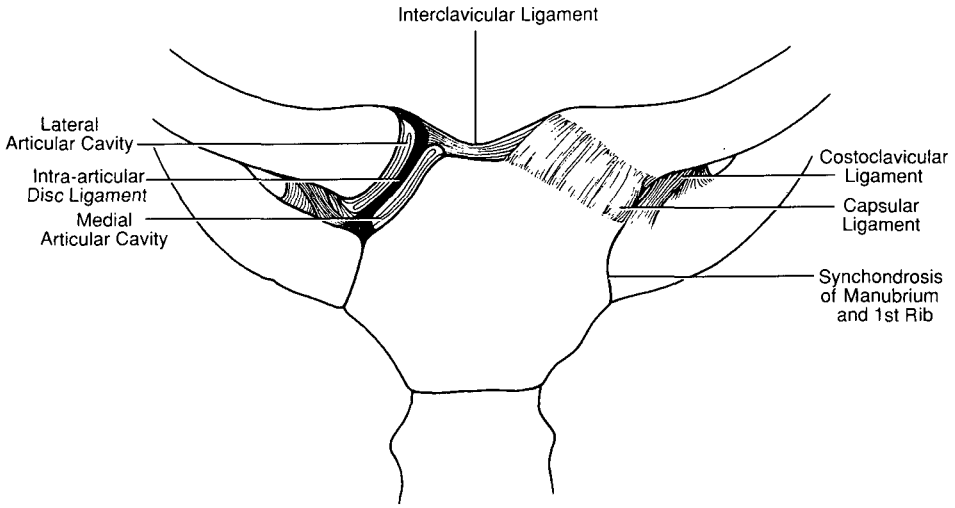

FIG. 1

Illustration demonstrating the ligaments of the sternoclavicular joint, including the intra-articular disc ligament, the interclavicular ligament, the costoclavicular ligament, and the capsular ligament.

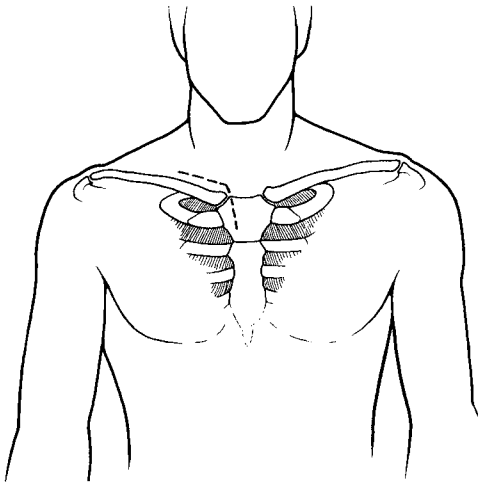

FIG. 2

Illustration demonstrating the skin incision, which should be made along the superior border of the medial aspect of the clavicle to the notch of the manubrium and then continued caudad on the manubrium for three to four centimeters.

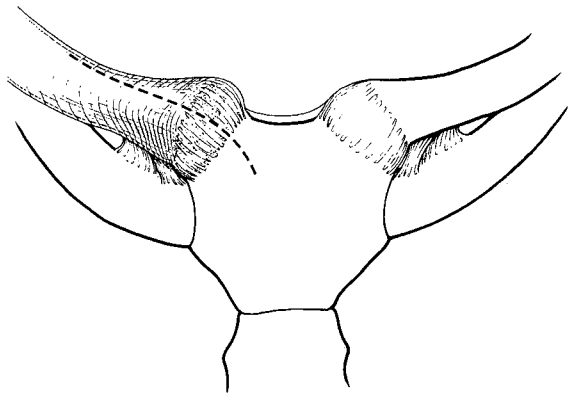

FIG. 3

Illustration demonstrating the deep incision that is made along the medial four to five centimeters of the clavicle across the capsular ligament and onto the manubrium.

(Fig. 4). While the sternal head of the sternocleidomastoid muscle can be preserved, the clavicular head is reflected free. The capsular ligament is opened carefully to expose the joint. The capsular ligament and the intra-articular disc ligament may need to be debrided to expose the sternoclavicular joint. However, if the intra-articular disc ligament is intact, it is preserved for stabilization of the joint at the time of closure.

Procedure When the Costoclavicular Ligament Is Intact

After exposure of the medial portion of the clavicle, a curved one or two-centimeter-wide retractor is passed posterior to the clavicle to isolate it and to protect the vital posterior vascular structures during resection of the medial portion of the clavicle. An oblique incision is made through the periosteum of the medial portion of the clavicle from lateral superior to medial inferior so that the prominent superior prominence can be removed. The caudad aspect of the osteotomy site must be placed medial to the stabilizing costoclavicular ligament to allow resection of 1.5 centimeters of the medial portion of the clavicle. Care is taken to avoid injury of the stabilizing costoclavicular ligament. Excision of the medial portion of the clavicle is facilitated by placement of a series of holes through both cortices of the clavicle at the intended site of the osteotomy. An air-powered drill with a side-cutting bit is used to make the holes and to complete the osteotomy (Fig. 5). The anterior and superior corners of the clavicle are beveled with an air burr. The periosteal tube is carefully repaired around the residual portion of the clavicle (Fig. 6).

If the sternal attachment of the intra-articular disc ligament is intact, a non-absorbable number-one cottony Dacron suture (Deknatel, Fall River, Massachusetts) can be woven through the ligament so that the ends of the suture exit through the free end of the ligament. The medullary canal of the medial end of the clavicle is drilled and curetted to receive the transferred capsular ligament as well as the intra-articular disc ligament, if available. Two small drill-holes are then placed in the superior cortex of the remaining medial portion of the clavicle, approximately one centimeter lateral to the site of the resection. The free ends of the suture are passed into the medullary canal of the clavicle and out the two small drill-holes in the superior cortex of the clavicle. While the clavicle is held in a reduced anteroposterior position in relation to the first rib and the sternum, the sutures are used to pull the ligament tightly into the medullary canal of the clavicle. The combination of fixing the intra-articular disc ligament into the clavicle and of tying the non-absorbable sutures

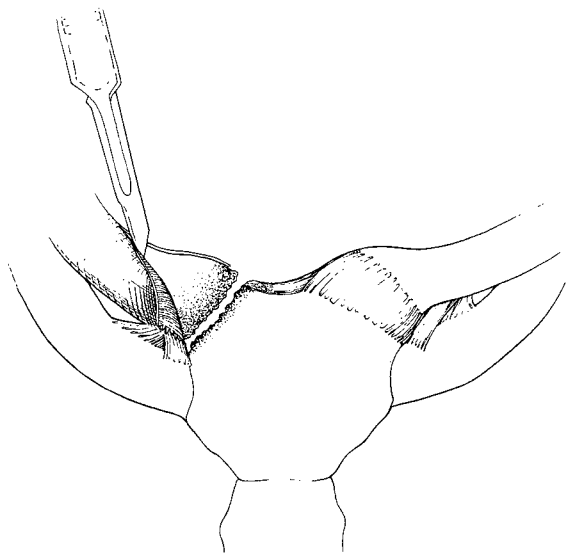

FIG. 4

Illustration demonstrating how the periosteum is carefully dissected off the medial portion of the clavicle. Care is taken to preserve the periosteal tube for later closure and to protect and preserve the costoclavicular ligament.

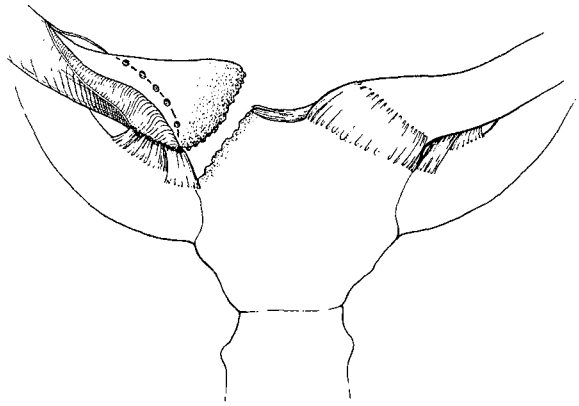

FIG. 5

Illustration demonstrating how the drill-holes are made through both of the cortices of the clavicle at the intended site of the osteotomy. An air-powered side-cutting drill is then used to complete the osteotomy.

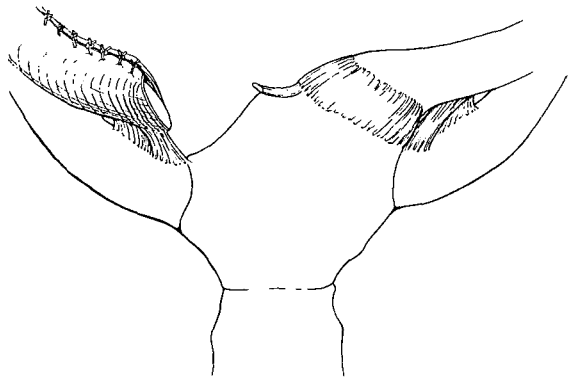

FIG. 6

Illustration demonstrating how closure of the periosteal tube secures a stabilized medial end of the clavicle when the costoclavicular ligament is intact. If the sternal attachment of the intra-articular disc ligament is intact, as it occasionally is with a traumatic dislocation, this ligament can be passed into the medullary canal for additional support.

through the costoclavicular ligament and around the periosteal tube stabilizes the remaining medial end of the clavicle.

Procedure When the Costoclavicular Ligament Is Absent

When the costoclavicular ligament is absent, as is usually the case in chronic dislocation of the sternoclavicular joint, it is necessary to re-establish the continuity of the remaining portion of the clavicle to the first rib. After any prominences on the remaining medial portion of the clavicle have been resected, two or three pieces of non-absorbable suture (one-millimeter Dacron tape) are passed around the remaining medial end of the clavicle and its periosteal tube and then through the residual scar of the old costoclavicular ligament on the dorsal surface of the first rib (Fig. 7). Closure of the periosteal tube stabilizes the medial portion of the clavicle to the first rib. In some patients, it may be necessary to pass additional sutures around or through holes in the first rib for stability. However, care must be taken not to tighten the sutures so much that the medial end of the clavicle is compressed onto the first rib. If the intra-articular disc ligament can be preserved, it should be used, as described, to help to stabilize the reconstruction.

Postoperative Management

All of the shoulders were immobilized in a sling for six weeks. On the second day, the patient was allowed to perform gentle pendulum exercises but was cautioned against active flexion or abduction of the shoulder above 90 degrees. Forceful pushing, pulling, and lifting were avoided for three months. Beginning at eight to twelve weeks, the patient began strengthening exercises. If the costoclavicular ligament was intact, the patient was permitted to return to his or her usual activities and job, including manual labor, at eight to twelve weeks. However, if the costoclavicular ligament had been reconstructed, the patient was restricted from returning to strenuous manual labor.

Results

Group I

The average duration of follow-up was 5.7 years (range, 2.0 to 14.5 years). Each of the eight patients had an excellent result and was completely satisfied (Table I). The pain had resolved completely in all but two patients, who reported slight discomfort during manual labor. Three patients had slight limitation in the performance of strenuous activities or sports requiring overhead motion.

Group II

The average duration of follow-up was 10.1 years (range, 3.3 to 18.3 years). Only three patients had an excellent result (Table I). The primary procedure in two (Cases 9 and 15) of these three had consisted of open reduction and internal fixation of the sternoclavicular

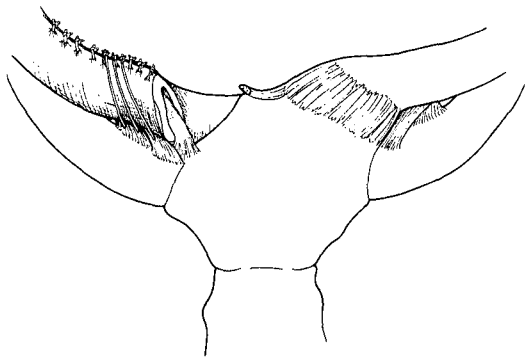

FIG. 7

Illustration demonstrating how closure of the periosteal tube includes sutures that pass through the stump of the old costoclavicular ligament on the first rib when the costoclavicular ligament is not intact. It may be necessary to pass sutures through drill-holes or around the first rib for stability.

joint with pinning for anterior dislocation following a fracture-dislocation and for a traumatic anterior dislocation, respectively. The severe discomfort and limitation caused by subsequent chronic instability and degenerative spurring of the joint were reduced dramatically after resection of the medial portion of the clavicle and reconstruction of the costoclavicular ligament. The third patient who had an excellent result (Case 12) had had residual fragments of bone posteriorly displaced after two previous resections of the medial end of the clavicle. The fragments posterior to the sternum were removed, one centimeter of the medial portion of the clavicle was resected, and the costoclavicular ligament was reconstructed.

Four patients had a fair or poor result; all had been managed previously with resection of the medial portion of the clavicle.

The three patients (Cases 10, 11, and 14) who had a fair result had had a revision procedure to resect more of the medial portion of the clavicle and to restabilize the medial portion of the clavicle to the first rib. In one (Case 11), this procedure had been preceded by an unsuccessful attempt at open reduction and internal fixation with pinning of a traumatic anterior dislocation of the sternoclavicular joint. These three patients had a decrease in the symptoms and were satisfied with the result at an average of 7.9 years (3.3, 10.0, and 10.5 years) postoperatively.

The patient who had a poor result (Case 13) had been seen for a spontaneous atraumatic anterior dislocation of the sternoclavicular joint that was initially treated with resection of the medial portion of the clavicle without stabilization of the clavicle to the first rib. Before the index procedure, the patient reported persistent instability and worsening pain. We performed a revision in which the medial portion of the clavicle was stabilized to the first rib with one-millimeter Dacron tape. Postoperatively, the patient did well and, against our advice, returned to his job as a laborer. Four years postoperatively, the result for this patient was excellent. However, five years postoperatively, he had sudden, severe pain while lifting a heavy weight overhead. A painful and unstable clavicle necessitated a second revision to restore stability of the clavicle to the first rib. At the time of the latest follow-up examination, the pain and instability had decreased, but the patient was unable to return to strenuous manual labor. On the basis of our experience with this patient, we recommend that a patient not return to strenuous labor after reconstruction of the costoclavicular ligament.

Discussion

Spontaneous atraumatic anterior dislocations and subluxations have a benign natural course and do not necessitate specific treatment other than education and reassurance of the patient. Furthermore, one of us and Odor[29] reported increased symptoms, and even disastrous results, in patients who were managed operatively for these conditions.

The course of a traumatic anterior dislocation is less predictable. Unlike posterior dislocation, closed reduction of an acute anterior dislocation is usually unstable[25]. We do not agree with authors who recommend an operative procedure if a closed reduction is not achieved[14,20,23,36]. Persistent anterior displacement of the medial end of the clavicle usually does not cause serious problems[27,28]. Operative treatment of an unstable anterior dislocation is justified only for patients who continue to have severe pain and marked functional impairment[4,15,21,22,30]. If an operation is performed, the critical part of the procedure is the stabilization of the medial portion of the clavicle to the first rib.

In most patients, degenerative problems of the sternoclavicular joint, such as osteitis condensans, sternoclavicular hyperostosis, and postmenopausal osteoarthrosis, can be controlled successfully with conservative treatment, such as rest, moist heat, and anti-inflammatory medications[7,24,28,34,35]. Occasionally, because of an intra-articular fracture or persistent pain due to a degenerative problem, the medial end of the clavicle must be resected. This situation is analogous to resection of the lateral end of the clavicle because of an intra-articular fracture or osteoarthrosis of the acromioclavicular joint.

An operative procedure is indicated for persistent subluxation or dislocation of the sternoclavicular joint that does not respond to non-operative treatment or that constitutes a danger to the patient. The latter circumstance occurs with chronic unreduced posterior dislocation because of the compression of and subsequent erosion into the great vessels, the trachea, or the esophagus by the medial aspect of the clavicle. However, acute posterior dislocations can be treated effectively with closed reduction, which is usually successful and stable[8,24,26,28,30].

The need for a ligamentous repair or reconstruction has been recognized by authors who have reported on different types of procedures for the treatment of dislocations of the sternoclavicular joint[2,3,9,13,17,18,24-26,28,29,31,32,34-36].

In order to keep the sternoclavicular joint in a reduced position, some surgeons have fixed it with pins or wires. Since tremendous force is applied on these pins whenever the upper extremity is moved, fatigue breakage or migration of pins, or both, is common and can lead to fatal complications. Instances of death and near death resulting from migration and penetration of the pins into the heart and great vessels were recently reported by Lyons and one of us[19].

We believe that if the medial end of the clavicle is to be resected, the resection must be accompanied by removal of a sufficient amount of bone and either by maintenance of an intact costoclavicular ligament whenever possible or by reconstruction of the ligaments that stabilize the remaining portion of the clavicle to the first rib.

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