Review Article

Management of Traumatic Sternoclavicular Joint Injuries

Gordon I. Groh, MD
Michael A. Wirth, MD

Abstract

Traumatic sternoclavicular joint injuries account for <3% of all traumatic joint injuries. Proper recognition and treatment are vital because these injuries may be life threatening. Injuries are classified according to patient age, severity, and, in the setting of dislocation, the direction of the medial clavicle. Anterior injuries are far more common than posterior injuries. Posterior dislocation may be associated with complications such as dyspnea, dysphagia, cyanosis, and swelling of the ipsilateral extremity as well as paresthesia associated with compression of the trachea, esophagus, or great vessels. These life-threatening complications may present at the time of injury but can develop later, as well. Radiography has been largely supplanted by CT for evaluation of this injury, although an oblique view developed by Wirth and Rockwood is useful in evaluating isolated sternoclavicular injury. MRI is useful in differentiating physeal injury from sternoclavicular dislocation in patients aged <23 years.

From the Blue Ridge Bone and Joint Clinic, Asheville, NC (Dr. Groh), and the Department of Orthopaedics, University of Texas Health Science Center, San Antonio, TX (Dr. Wirth).

Dr. Groh or an immediate family member has received royalties from Encore Medical; is a member of a speakers' bureau or has made paid presentations on behalf of ArthroCare, DePuy, and DJO; serves as a paid consultant to or is an employee of ArthroCare, DePuy, Ascension Orthopedics, UPex, and DJO; has received research or institutional support from Ascension Orthopaedics and DePuy; and has stock or stock options held in UPex. Dr. Wirth or an immediate family member serves as a board member, owner, officer, or committee member of the American Shoulder and Elbow Surgeons; has received royalties from DePuy; is a member of a speakers' bureau or has made paid presentations on behalf of and serves as a paid consultant to or is an employee of DePuy and Tornier; and has stock or stock options held in Tornier.

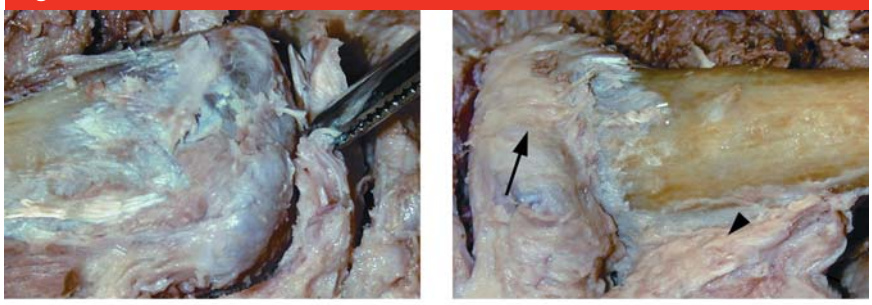
J Am Acad Orthop Surg 2011;19:1-7

Sternoclavicular joint injury has been reported to account for only 3% of all shoulder girdle injuries.[1] Some orthopaedic surgeons will never see or treat a sternoclavicular dislocation during their entire careers. Although rare, sternoclavicular dislocations are associated with several life-threatening complications because of the close proximity of the hilar structures. These structures include the trachea, esophagus, and lungs, any of which may be damaged in traumatic injury. Systematic evaluation and treatment is essential to successful management of traumatic sternoclavicular joint injuries.

Anatomy

The clavicle is the first long bone to ossify and does so by intrauterine week 5. However, the epiphysis at the medial end of the clavicle is the last of the long bones to appear and is the last epiphysis to close. It does not ossify until age 18 to 20 years. The epiphysis does not fuse with the shaft of the clavicle until age 23 to 25 years.[2] The sternoclavicular joint is freely mobile, and it functions in almost all planes, including the transverse (ie, in rotation). This small, diarthrodial joint is the only true articulation between the upper extremity and the axial skeleton. The ligamentous supporting structure, which comprises the intra-articular disk, costoclavicular, capsular, and interclavicular ligaments, yields a strength that can withstand the forces directed at the joint and accounts for a low dislocation rate (Figure 1, A). The costoclavicular (rhomboid) ligament is the strongest supporting ligament and is made up of two separate bands, which give it

Figure 1



A B

A, The articular disk ligament (held by forceps) attached to the right medial clavicle appears normal after removal of the capsular ligaments. **B,** Left medial clavicle demonstrating the anterior sternoclavicular capsular ligament (arrow) and the rhomboid appearance of the costoclavicular ligament (arrowhead). (Reproduced with permission from Wirth MA, Rockwood CA Jr: Disorders of the sternoclavicular joint, in Rockwood CA Jr, Matsen FA III, Wirth MA, Lippitt SB, Fehringer EV, Sperling JW, eds: *The Shoulder*, ed 3. Philadelphia, PA, WB Saunders, 2009, pp 527-558.)

a twisted appearance. These separate fibers provide critical resistance to both anterior and posterior rotation forces of the medial clavicle[3] (Figure 1, B). The capsular ligaments also provide anteroposterior and rotational stability.[4]

Mechanism of Injury

Given the strong support provided to the sternoclavicular joint by the surrounding ligaments, dislocation requires tremendous force. Direct anteromedial force to the joint typically results in the clavicle being pushed posteriorly behind the sternum into the mediastinum. Examples of this mechanism of injury include an athlete's being jumped on while lying supine or a kick delivered to the front of the medial clavicle. By comparison, indirect force, (eg, motor vehicle accidents) the most common mechanism of injury, may result in either anterior or posterior force across the sternoclavicular joint.[5,6] Motor vehicle accidents and athletic injuries account for >80% of injuries to this joint.[7-9]

Clinical Indications

Sprain and Subluxation

In a mild sprain, the ligaments of the sternoclavicular joint remain intact. The patient reports pain and tenderness with palpation over the joint. Swelling may be present, but no instability is noted. Swelling and pain become more pronounced as the ligaments are stretched, which results in subluxation of the joint. Pain is marked with motion of the ipsilateral extremity. Laxity of the joint may be apparent compared with the contralateral joint.

Dislocation

Severe pain and deformity accompany dislocations of the sternoclavicular joint. Surprisingly, clinical examination to determine the direction of the dislocation may be inconclusive because of swelling. In addition to swelling, compression of the vital structures posterior to the joint may occur with dislocation injuries. The orthopaedic surgeon should keep this potential life-threatening complication in mind while performing the clinical evaluation.

Anterior sternoclavicular injuries may exhibit prominence of the medial clavicle. This prominence is more easily appreciated while the patient is in the supine position. Posterior dislocation is less common than anterior dislocation. Patients with posterior dislocation demonstrate a higher level of pain, and the corner of the sternum may be discerned as the medial clavicle is displaced posteriorly.[7] However, swelling may preclude an accurate clinical assessment of injury. Patients with posterior displacement may report shortness of breath or difficulty breathing because of compression of the trachea or pneumothorax. Similarly, compression of the esophagus may result in dysphagia. Compression of the posterior vascular structures can result in decreased circulation to the ipsilateral extremity or venous congestion in the extremity or neck. Tingling or numbness may be the predominant complaint with compression of the brachial plexus. Posterior sternoclavicular dislocation or associated injuries may render the patient medically unstable.

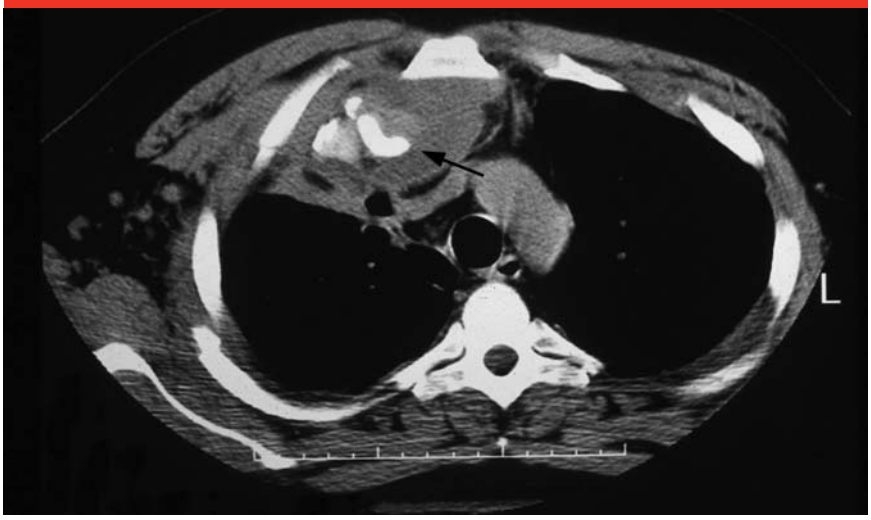
Radiographic Evaluation

In general, routine radiographic studies of the sternoclavicular joint are difficult to interpret due to overlap of the medial clavicle, ribs, sternum, and vertebrae. However, Wirth and Rockwood[10] developed an oblique view of the sternoclavicular joint, called the serendipity view, that permits comparison of the injured clavicle to the normal clavicle. The serendipity view is obtained by pointing the radiographic beam at a 40° angle tilted cephalically with the beam centered on the sternoclavicular joint. The technique is best suited for isolated sternoclavicular injuries.

CT is more effective than radiography for evaluation of sternoclavicular injury because sprains, dislocations, and medial clavicle fractures are easily distinguishable (Figure 2). To facilitate an accurate diagnosis, the patient's history and the mechanism of injury should be communicated to the radiologist, and a CT scan of the chest should be obtained to identify injuries to the structures that surround the sternoclavicular joint. The scan also should include both medial clavicles so that the injured joint can be compared with the contralateral joint.

In children and young adults, MRI may also be used to distinguish a dislocation of the sternoclavicular joint from a physeal injury. MRI displays soft tissue and allows assessment of the trachea, esophagus, and great vessels as well as the integrity of the costoclavicular ligament and attachments of the intra-articular disk. However, CT is the preferred imaging modality in the setting of acute injury because of its speed, availability, and ability to delineate soft-tissue and bony injuries.

Figure 2



Axial CT scan demonstrating a right posterior sternoclavicular dislocation (arrow). (Reproduced with permission from Rockwood CA Jr, Wirth MA: Injuries to the sternoclavicular joint, in Rockwood CA Jr, Green DP, Bucholz RW, et al, eds: *Rockwood and Green's Fractures in Adults*, ed 4. Philadelphia, PA, Lippincott-Raven, 1996, vol 2, p 1439.)

Management

Anterior Strain and Subluxation

Ice and analgesics are used in the initial treatment of anterior strain and subluxation of the sternoclavicular joint. Subluxation can be reduced by directing the shoulders posteriorly and medially. A clavicle strap or a sling and swathe can then be used to support the injury. The patient is protected from further injury by immobilizing the ipsilateral extremity for 6 weeks.

Anterior Dislocation

Closed reduction of anterior dislocation is the current treatment of choice,[11] although there is still some controversy regarding management because good long-term results have been reported with nonsurgical management.[12] Closed reduction can be performed with the patient under sedation or local or general anesthesia. The patient is placed supine on a table with a 3-inch pad placed between the shoulders. Pressure on the medial clavicle is applied in a posterior direction. If the joint remains reduced, the ipsilateral extremity is immobilized with a figure-of-8 or Velpeau-type sling for 6 weeks to promote healing.

Most anterior sternoclavicular dislocations are unstable after closed reduction, but closed reduction is performed because, when successful, it results in improved cosmesis. Numerous methods of open reduction have been described;[13-15] however, the authors do not recommend open reduction for these unstable injuries because the potential complications may outweigh the end results.

Posterior Dislocation

Management of these injuries requires radiographic evaluation and a careful history and physical examination. Dyspnea, choking, or hoarseness is indicative of pressure on the mediastinum. Mediastinal involvement requires prompt consultation with a thoracic or cardiothoracic surgeon.

Closed Reduction

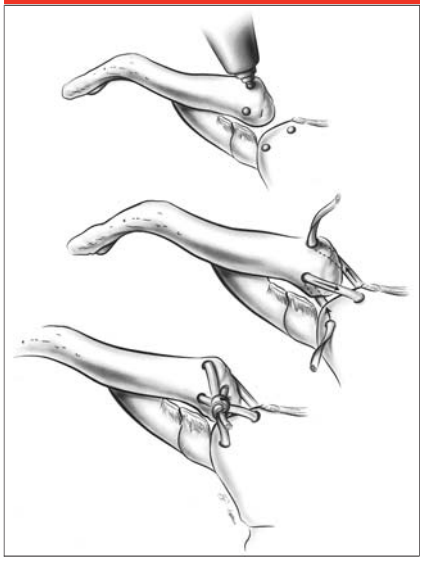
Open techniques are typically not required to reduce acute posterior sternoclavicular injuries. Furthermore, once the reduction is achieved by closed reduction, it is typically stable.[16,17] We recommend having a thoracic surgeon available during closed reductions in the event of mediastinal involvement.

The patient is placed supine on the operating table while under sedation or general anesthesia. A 3- to 4-inch-thick bolster is placed between the scapulae to extend the shoulders. The ipsilateral extremity is positioned near the edge of the table, allowing the arm to be extended and abducted (Figure 3). Initially, gentle traction is applied to the abducted extremity in line with the clavicle while countertraction is applied by

Figure 3

Intraoperative photograph demonstrating closed reduction of a posterior sternoclavicular dislocation. A sandbag or bolster is placed between the shoulders, and lateral traction is applied to the arm against countertraction as the arm is brought into extension.

Figure 4



Drawings demonstrating drill holes placed in the clavicle and manubrium. The semitendinosus graft is weaved through the holes in a figure-of-8 fashion and sutured into position, which provides stability comparable to that of an intact sternoclavicular joint. (Reproduced with permission from Spencer EE Jr, Kuhn JE: Biomechanical analysis of reconstructions for sternoclavicular joint instability. *J Bone Joint Surg Am* 2004;86[1]:98-105.)

an assistant, who steadies the patient. Traction on the arm is slowly increased while the arm is brought into extension. If this reduction technique is unsuccessful,[18] traction may be applied to the arm in adduction while posterior pressure is applied to the shoulder to lever the clavicle over the first rib.

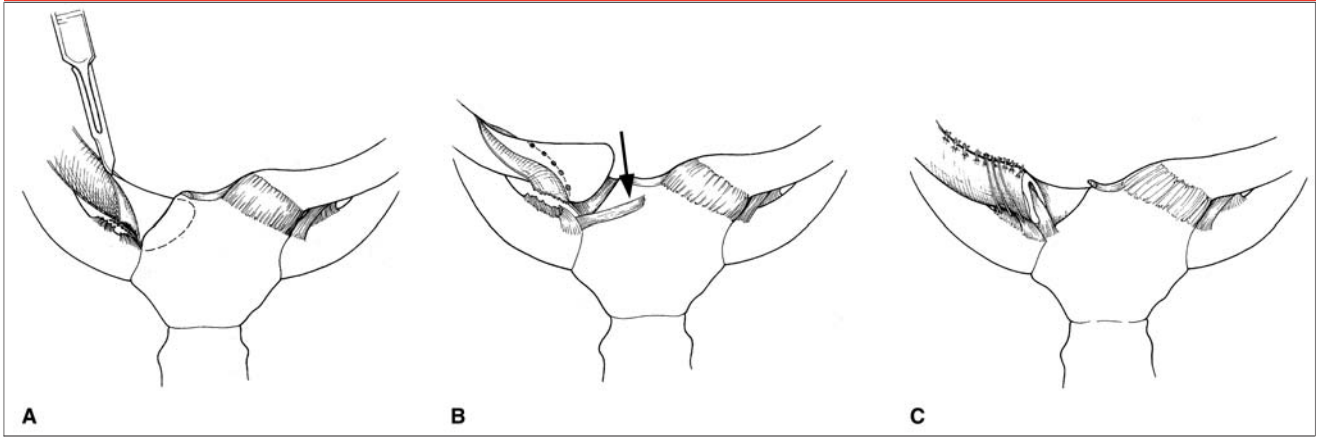
If the traction techniques are unsuccessful, an assistant grasps the medial clavicle and pushes down in an effort to dislodge it from the sternum. In some cases, it may be impossible to grasp the medial clavicle because of swelling. The skin is then surgically prepped, and a sterile towel clip is used to grasp the clavicle percutaneously. The clip should not penetrate the dense cortical bone of the clavicle but should be used to grasp completely around the clavicle. Applying traction through the affected limb and lifting anteriorly on the clavicle usually reduces the dislocation. The reduction may be accompanied by an audible snap and can be noted visually or by palpation. The reduction should be confirmed with intraoperative radiographs. We recommend use of a figure-of-8 clavicle strap or sling for 4 weeks to promote soft-tissue healing.

Open Reduction

When closed reduction fails in patients with a closed physis, open reduction is indicated. Management is required because unreduced posterior dislocations are associated with numerous complications, including thoracic outlet syndrome, vascular compromise, and erosion of the medial clavicle into vital posterior structures. These potentially life-threatening complications may arise acutely or from chronic posterior dislocations. Open reduction of the sternoclavicular joint always should be performed with a thoracic surgeon assisting or immediately available.

Once the patient is placed under general anesthesia, he or she is placed supine with a bolster between the scapulae. The involved extremity is draped free to allow the intraoperative use of traction. A folded sheet around the thorax can be used to provide countertraction. A 5- to 7-cm incision is made that runs parallel to the superior border of the medial clavicle and extends over the sternum. One goal of exposure is preservation of as much anterior capsular structure as possible. Following exposure, reduction can be achieved with a combination of traction/countertraction and lifting anteriorly on the medial clavicle. The reduction will be stable if the anterior capsule is undamaged by the initial injury or when enough of the anterior capsule has been preserved during exposure. Instability of the medial clavicle can be addressed by a variety of surgical techniques.[13-15] In a biomechanical study, Spencer and Kuhn[4] described a figure-of-8 reconstruction using a semitendinosus graft that provided stability close to that of the intact sternoclavicular joint (Figure 4).

Figure 5



Drawings demonstrating resection of the medial clavicle. **A,** Subperiosteal exposure of the medial end of the clavicle. **B,** Excision of the medial clavicle is facilitated by drilling holes at the intended site of the osteotomy. Note preservation of the capsular ligament (arrow). **C,** The capsular ligament is secured to the medial clavicle with sutures exiting the superior cortex of the clavicle. Closure of the periosteal sleeve and fixation of these structures to the costoclavicular ligaments is accomplished with multiple 1-mm Dacron sutures. (Reproduced with permission from Rockwood CA Jr, Wirth MA: Disorders of the sternoclavicular joint, in Rockwood CA Jr, Matsen FA III, Wirth MA, Lippitt SB, Fehringer EV, Sperling JW, eds: *The Shoulder*, ed 3. Philadelphia, PA, WB Saunders, 2009, pp 527-558.)

We have achieved good to excellent stability by resecting the medial clavicle.[19] The medial clavicle is resected and the residual clavicle secured anatomically to the periosteum of the first rib with 1-mm Dacron tape. After the medial clavicle is exposed subperiosteally, the remnants of the intra-articular or capsular ligaments are identified and preserved (Figure 5, A). These structures are tagged with a 1-mm Dacron suture, with the suture exiting the avulsed free end of the ligament. The medial clavicle is then resected while the posterior vascular structures are protected with a curved Crego or ribbon retractor. The resection includes 1 cm of clavicle inferiorly and curves laterally to include 2 cm (Figure 5, B). Care must be taken not to damage the remaining costoclavicular (rhomboid) ligament.

The medullary canal of the clavicle is then drilled and curetted to receive the transferred disk and capsular ligaments. Two superior holes are drilled in the clavicle 1 cm lateral to the resection. The free sutures are then shuttled through the medullary canal and through the drill holes to accept the sutures from the ligament transfer (Figure 5, C). The sutures are then used to secure the transferred ligament into the clavicle while the clavicle is held in a reduced position.

The procedure is completed by passing multiple 1-mm sutures around the reflected periosteal tube, clavicle, and any residual costoclavicular ligament. These sutures restore the normal space between the clavicle and first rib. If the repair is tenuous, it may be augmented by the reconstruction method described by Spencer and Kuhn.[4] Typically, the clavicular head of the sternocleidomastoid is detached because it is a superior deforming force on the medial clavicle.

A figure-of-8 clavicle splint is used for 4 weeks after open reduction or resection. A sling is used for an additional 6 to 8 weeks. Patients should not elevate the arm ≥60° during this time and should use the extremity only for hygiene. After 12 weeks, patients may gradually increase the use of the arm for activities of daily living. However, we do not recommend that patients return to heavy labor activities when they have undergone medial clavicle resection.

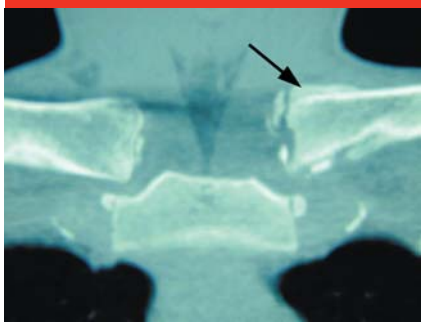
Physeal Injuries of the Medial Clavicle

The closed reduction maneuvers previously described are performed for anterior or posterior injury (Figure 6). Open reduction of the physeal injury is seldom indicated, except for an irreducible posterior displacement with symptoms of compression of mediastinal structures. After reduction, a figure-of-8 splint is used for 4 weeks.

Complications of Surgical Management

Complications of surgical management include postoperative infection, loss of reduction, and posttraumatic arthritis.[8,20-22] The most serious complications arise from the use of pins that cross the sternoclavicular joint. The torque applied to these pins can

Figure 6



Axial CT scan obtained 3 months after closed reduction of a posterior left sternoclavicular dislocation in an 18-year-old patient. New bone formation (arrow) is readily apparent within the periosteal sleeve of the medial clavicle.

cause migration and fatigue failure of the hardware. Reports of migration of intact or broken pins and wires into the heart, pulmonary artery, subclavian artery, innominate artery, and aorta are common in the literature.[20,23-37] No transfixing device, regardless of diameter, should be used across the sternoclavicular joint.

Summary

Sternoclavicular injuries are rare but can be associated with serious short- and long-term complications. Anterior injuries are typically unstable even after reduction but are well tolerated by patients. Few patients may develop late degenerative changes after anterior dislocation; they can be treated with medial clavicle excision and ligament reconstruction.

Posterior sternoclavicular dislocations can be immediately associated with pneumothorax, laceration or occlusion of the great vessels, rupture of the esophagus, brachial plexus compression, and recurrent laryngeal nerve injury. Late complications of retrosternal dislocation can include tracheoesophageal fistula, stridor, and dysphagia. Careful physical examination is required to detect these complications in the patient with a sternoclavicular joint injury.

Radiography has largely been supplanted by CT examination for viewing bony detail. In the nonacute setting, MRI may be helpful in differentiating a physeal injury from a sternoclavicular dislocation in a patient aged <23 years. Physeal injuries can typically be managed with closed reduction alone; these injuries rarely require open reduction except for irreducible posterior dislocations in the setting of mediastinal compression.

In contrast to anterior dislocations, acute posterior dislocations are typically amenable to closed reduction and are stable after reduction. Because of the possibility of late onset of life-threatening complications, all unreduced posterior dislocations should be surgically reduced with a thoracic surgeon present. Resection of the medial clavicle and reconstruction of the costoclavicular ligaments have yielded good results. Transfixing pins should never be used at the sternoclavicular joint because of the risk of hardware failure and migration.

References

Citation numbers printed in **bold type** indicate references published within the past 5 years.

1. Cave EF, ed: *Fractures and Other Injuries*. Chicago, IL, Year Book Publishers, 1958.
2. Webb PA, Suchey JM: Epiphyseal union of the anterior iliac crest and medial clavicle in a modern multiracial sample of American males and females. *Am J Phys Anthropol* 1985;68(4):457-466.
3. Bearn JG: Direct observations on the function of the capsule of the sternoclavicular joint in clavicular support. *J Anat* 1967;101(pt 1):159-170.
4. Spencer EE Jr, Kuhn JE: Biomechanical analysis of reconstructions for sternoclavicular joint instability. *J Bone Joint Surg Am* 2004;86(1):98-105.
5. Mehta JC, Sachdev A, Collins JJ: Retrosternal dislocation of the clavicle. *Injury* 1973;5(1):79-83.
6. Hening CF: Retrosternal dislocation of the clavicle: Early recognition, xray diagnosis and management. *J Bone Joint Surg Am* 1968;50:830.
7. Nettles JL, Linscheid RL: Sternoclavicular dislocations. *J Trauma* 1968;8(2):158-164.
8. Waskowitz WJ: Disruption of the sternoclavicular joint: An analysis and review. *Am J Orthop* 1961;3:176-179.
9. Omer GE Jr: Osteotomy of the clavicle in surgical reduction of anterior sternoclavicular dislocation. *J Trauma* 1967;7(4):584-590.
10. Wirth MA, Rockwood CA: Disorders of the sternoclavicular joint, in Rockwood CA Jr, Matsen FA III, Wirth MA, Lippitt SB, eds: *The Shoulder,* ed 4. Philadelphia, PA, Saunders, 2009, pp 527-560.
11. Féry A, Sommelet J: Sternoclavicular dislocations: Observations on the treatment and result of 49 cases [French]. *Int Orthop* 1988;12(3):187-195.
12. de Jong KP, Sukul DM: Anterior sternoclavicular dislocation: A long-term follow-up study. *J Orthop Trauma* 1990;4(4):420-423.
13. Bankart AS: An operation for recurrent dislocation (subluxation) of the sternoclavicular joint. *Br J Surg* 1938;26:320-323.
14. Key JA, Conwell HE, eds: *The Management of Fracture, Dislocations, and Sprains*, ed 5. St. Louis, MO, CV Mosby, 1951, pp 458-461.
15. Burrows HJ: Tenodesis of subclavius in the treatment of recurrent dislocation of the sterno-clavicular joint. *J Bone Joint Surg Br* 1951;33(2):240-243.
16. Wirth MA, Rockwood CA: Complications following repair of the sternoclavicular joint, in Bigliani LU, ed: *Complications of the Shoulder*. Baltimore, MD, Williams & Wilkins, 1993, pp 139-153.
17. Groh GI, Wirth MA, Rockwood CA Jr: Treatment of traumatic posterior sternoclavicular joint dislocations. *J Shoulder Elbow Surg* 2010;Jun 23: [Epub ahead of print].
18. Buckerfield CT, Castle ME: Acute traumatic retrosternal dislocation of the clavicle. *J Bone Joint Surg Am* 1984;66(3):379-385.
19. Rockwood CA Jr, Groh GI, Wirth MA, Grassi FA: Resection arthroplasty of the

sternoclavicular joint. *J Bone Joint Surg Am* 1997;79(3):387-393.

20. Brown JE: Anterior sternoclavicular dislocation: A method of repair. *Am J Orthop* 1961;31:184-189.
21. Eskola A, Vainionpää S, Vastamäki M, Slätis P, Rokkanen P: Operation for old sternoclavicular dislocation: Results in 12 cases. *J Bone Joint Surg Br* 1989; 71(1):63-65.
22. Lunseth PA, Chapman KW, Frankel VH: Surgical treatment of chronic dislocation of the sterno-clavicular joint. *J Bone Joint Surg Br* 1975;57(2):193-196.
23. Salvatore JE: Sternoclavicular joint dislocation. *Clin Orthop Relat Res* 1968; 58:51-55.
24. Clark RL, Milgram JW, Yawn DH: Fatal aortic perforation and cardiac tamponade due to a Kirschner wire migrating from the right sternoclavicular joint. *South Med J* 1974;67(3):316-318.
25. Gerlach D, Wemhöner SR, Ogbuihi S: 2 cases of pericardial tamponade caused by migration of fracture wires from the sternoclavicular joint [German]. *Z Rechtsmed* 1984;93(1):53-60.
26. Leonard JW, Gifford RW Jr: Migration of a Kirschner wire from the clavicle into the pulmonary artery. *Am J Cardiol* 1965;16(4):598-600.
27. Richman KM, Boutin RD, Vaughan LM, Haghighi P, Resnick D: Tophaceous pseudogout of the sternoclavicular joint. *AJR Am Roentgenol* 1999;172(6):1587-1589.
28. Smolle-Juettner FM, Hofer PH, Pinter H, Friehs G, Szyskowitz R: Intracardiac malpositioning of a sternoclavicular fixation wire. *J Orthop Trauma* 1992; 6(1):102-105.
29. Worman LW, Leagus C: Intrathoracic injury following retrosternal dislocation of the clavicle. *J Trauma* 1967;7(3):416-423.
30. Pate JW, Wilhite JL: Migration of a foreign body from the sternoclavicular joint to the heart: A case report. *Am Surg* 1969;35(6):448-449.
31. Song HK, Guy TS, Kaiser LR, Shrager JB: Current presentation and optimal surgical management of sternoclavicular joint infections. *Ann Thorac Surg* 2002; 73(2):427-431.
32. Nordback I, Markkula H: Migration of Kirschner pin from clavicle into ascending aorta. *Acta Chir Scand* 1985; 151(2):177-179.
33. Jelesijević V, Knoll D, Klinke F, Sine K, Dittrich H: Penetrating injuries of the heart and intrapericardial blood vessels caused by migration of a Kirschner pin after osteosynthesis [Croatian]. *Acta Chir Iugosl* 1982;29(suppl 2):274-277.
34. Liu HP, Chang CH, Lin PJ, et al: Migration of Kirshner wire for the right sternoclavicular joint into the main pulmonary artery: A case report [Chinese]. *Changgeng Yi Xue Za Zhi* 1992;15(1):49-53.
35. Rubinstein ZJ, Morag B, Itzchak Y: Percutaneous removal of intravascular foreign bodies. *Cardiovasc Intervent Radiol* 1982;5(2):64-68.
36. Schechter DC, Gilbert L: Injuries of the heart and great vessels due to pins and needles. *Thorax* 1969;24(2):246-253.
37. Sethi GK, Scott SM: Subclavian artery laceration due to migration of a Hagie pin. *Surgery* 1976;80(5):644-646.