

Arthroscopic Sternoclavicular Joint Resection Arthroplasty: A Technical Note and Illustrated Case Report

Ryan J. Warth, M.D., Jared T. Lee, M.D., Kevin J. Campbell, B.S., and
Peter J. Millett, M.D., M.Sc.

Abstract: Open resection arthroplasty of the sternoclavicular (SC) joint has historically provided good long-term results in patients with symptomatic osteoarthritis of the SC joint. However, the procedure is rarely performed because of the risk of injury to vital mediastinal structures and concern regarding postoperative joint instability. Arthroscopic decompression of the SC joint has therefore emerged as a potential treatment option because of many recognized advantages including minimal tissue dissection, maintenance of joint stability, avoidance of posterior SC joint dissection, expeditious recovery, and improved cosmesis. There are, however, safety concerns given the proximity of neurovascular structures. In this article we demonstrate a technique for arthroscopic SC joint resection arthroplasty in a 26-year-old active man with bilateral, painful, idiopathic degenerative SC joint osteoarthritis. This case also highlights the pearls and pitfalls of arthroscopic resection arthroplasty for the SC joint. There were no perioperative complications. Four months postoperatively, the patient had returned to full activities, including weightlifting, without pain or evidence of SC joint instability. One year postoperatively, the patient showed substantial improvements in the American Shoulder and Elbow Surgeons score; Single Assessment Numeric Evaluation score; Quick Disabilities of the Arm, Shoulder and Hand score; and Short Form 12 Physical Component Summary score over preoperative baseline values.

Symptomatic osteoarthritis of the sternoclavicular (SC) joint is an uncommon pathology that can produce significant pain and disability in some patients. Although conservative management typically results in symptomatic improvement, a small subset of patients will have recalcitrant pain and continued shoulder disability. Surgical management is therefore indicated after a course of nonoperative therapy fails to provide symptomatic relief.

Traditionally, open resection arthroplasty of the SC joint has been the treatment of choice in patients with

intractable pain and dysfunction as a result of SC joint osteoarthritis. Good to excellent outcomes have been reported after open resection arthroplasty in several series¹⁻³; however, an open approach to the SC joint requires some posterior dissection, potentially placing vital mediastinal structures at risk. In addition, over-resection of the medial clavicle with a large capsulotomy may lead to postoperative instability because of the need for intraoperative ligament detachment.

As reported by Tavakkolizadeh et al.⁴ in 2009, arthroscopy of the SC joint was originally thought to enhance patient outcomes by improving visualization, minimizing surgical trauma, limiting the risk to vital retrosternal structures, avoiding postoperative instability, and hastening recovery times while also improving cosmesis. Because of these advantages and with the addition of new encouraging outcomes data,⁵ SC joint arthroscopy has become a viable and, potentially, favorable modality for the treatment of symptomatic SC joint osteoarthritis in carefully selected patients. However, very few orthopaedic surgeons or arthroscopists have experience with the technique.

Therefore the purposes of this article are (1) to describe pertinent arthroscopic anatomy related to the SC joint, (2) to present and demonstrate a technique for arthroscopic SC joint resection arthroplasty, and (3) to

From the Steadman Philippon Research Institute (R.J.W., J.T.L., K.J.C., P.J.M.); and The Steadman Clinic (J.T.L., P.J.M.), Vail, Colorado, U.S.A.

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Address correspondence to Peter J. Millett, M.D., M.Sc., Center for Outcomes-based Orthopaedic Research, Steadman Philippon Research Institute, 181 W Meadow Dr, Ste 1000, Vail, CO 81657, U.S.A. E-mail: drmillett@thesteadmanclinic.com

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illustrate a case in which bilateral SC joint decompressions were necessary in a young, active patient with symptomatic degenerative osteoarthritis of the SC joint.

Surgical Anatomy

Ligamentous Stabilizers

Relevant periarticular ligaments involved with joint stability include the anterior and posterior capsular ligaments, the intra-articular disk ligament, the interclavicular ligament, and the costoclavicular ligament.

The anterior capsular ligament is a discrete thickening of the anterior capsule that overlies the costoclavicular ligament. The ligament runs from the posterior aspect of the manubrium to the posterior and superior aspect of the medial clavicle, just superior to the articular surface. Capsular tissue that is inferior and lateral to the anterior capsular ligament is relatively patulous and has been described as a preferred location for intra-articular injections and arthroscopic portal placement.⁶

The posterior capsular ligament corresponds to a thickening of the entire posterior capsule. The ligament arises on the posterior aspect of the manubrium and attaches to the posterosuperior aspect of the medial clavicle near the insertion of the anterior capsular ligament. Several studies have found the posterior capsular ligament to be the most important ligament for anteroposterior stability—restoring its function has been the primary focus of newer reconstruction techniques.^{7,8}

The interclavicular ligament is a thick band that runs along the superior bony surfaces between both the left and right SC joints and inserts superomedially onto each SC joint capsule. Contrary to previous reports,^{8,9} we have consistently found the interclavicular ligament in all specimens. In a recent cadaveric study performed at our institution, we found that the central portion of the ligament has limited connectivity to the superior aspect of the manubrium and likely plays a minimal role in resisting superior migration of the medial clavicle as a result of a downward force on the distal clavicle (unpublished data, Steadman Philippon Research Institute, 2013).

The intra-articular disk ligament is a very thick and dense ligament that arises from the chondral junction of the first rib and passes through the SC joint to create 2 separate joint spaces. The intra-articular portion of the ligament, commonly referred to as the intra-articular disk, covers the cartilaginous portion of the medial clavicle and attaches posteriorly and superiorly to the articular cartilage. At its periphery, the intra-articular disk also forms various attachments with the SC joint capsule, thus reinforcing the anterior and posterior capsular ligaments. Several studies have documented variable morphologies

of the intra-articular disk. DePalma¹⁰ found the intra-articular disk to be complete in 97% of specimens. However, other authors have found that up to 52% of patients may have an incomplete disk.^{6,9,11,12} van Tongel et al.⁶ found an association between degenerative articular disks and increased articular surface degeneration, both of which increased with patient age. Histologic studies have found the intra-articular disk to be a fibrocartilaginous structure similar to the menisci in the knee and the intra-articular disk of the acromioclavicular joint.¹² The disk is more closely associated with the clavicle than the sternum, and most of the motion across the SC joint occurs between the articular cartilage of the manubrium and the medial surface of the disk.¹³ The primary function of the intra-articular disk has been debated in the past; however, researchers have suggested that the disk functions to decrease perceived bony incongruity between the articular surfaces¹⁰ and to diminish the force transmission between the medial clavicle and the manubrium.¹⁴

The costoclavicular ligament, also known as the rhomboid ligament, is a stout ligament found between the costochondral junction of the first rib and the costoclavicular tubercle on the inferior aspect of the medial clavicle. Cave¹⁵ described the ligament as being composed of 2 separate anterior and posterior fascicles with an intervening bursa. The anterior fascicle ran from medial to lateral and the posterior fascicle ran from lateral to medial, resulting in a “twisted” appearance. However, our recent dissections have indicated that the costoclavicular ligament sometimes exists as a single, robust ligament since we were unable to reliably distinguish between anterior and posterior fasciculi (unpublished data, Steadman Philippon Research Institute, 2013). Several authors have proposed that the costoclavicular ligament is the predominant stabilizer of the medial clavicle.^{1,15,16} It has been shown that preservation of this ligament is essential to maintain stability after resection arthroplasty. Echoing the results of other authors,¹⁷ we recommend resection of no more than 8 to 10 mm of bone from the medial clavicle to preserve the many functions of the intact costoclavicular ligament.

Chondral Surfaces

The articular surfaces of the medial clavicle have been described as being composed of hyaline cartilage; however, histologic studies have suggested that fibrocartilage may become predominant as a person ages.^{10,18} In our dissection we found that only 67% of the medial clavicle was covered with articular cartilage (unpublished data, Steadman Philippon Research Institute, 2013)—most of this cartilage was found anteriorly and inferiorly, confirming the results reported by other authors.⁶ The remaining portions of the medial clavicle that were not covered with articular cartilage served as attachment

sites for the interclavicular ligament, the anterior and posterior SC ligaments, and the intra-articular disk. In our dissection of the medial clavicle, we also identified a tubercle located anteriorly at approximately the 9:30 clock-face position (end-on view of the right clavicle from medial to lateral) that extended longitudinally along the insertion of the clavicular head of the pectoralis major muscle (pectoralis ridge). We believe this to be an important landmark to assess rotational alignment of the medial clavicle during ligament reconstruction and orientation during SC joint arthroscopy (Fig 1).

Case Description

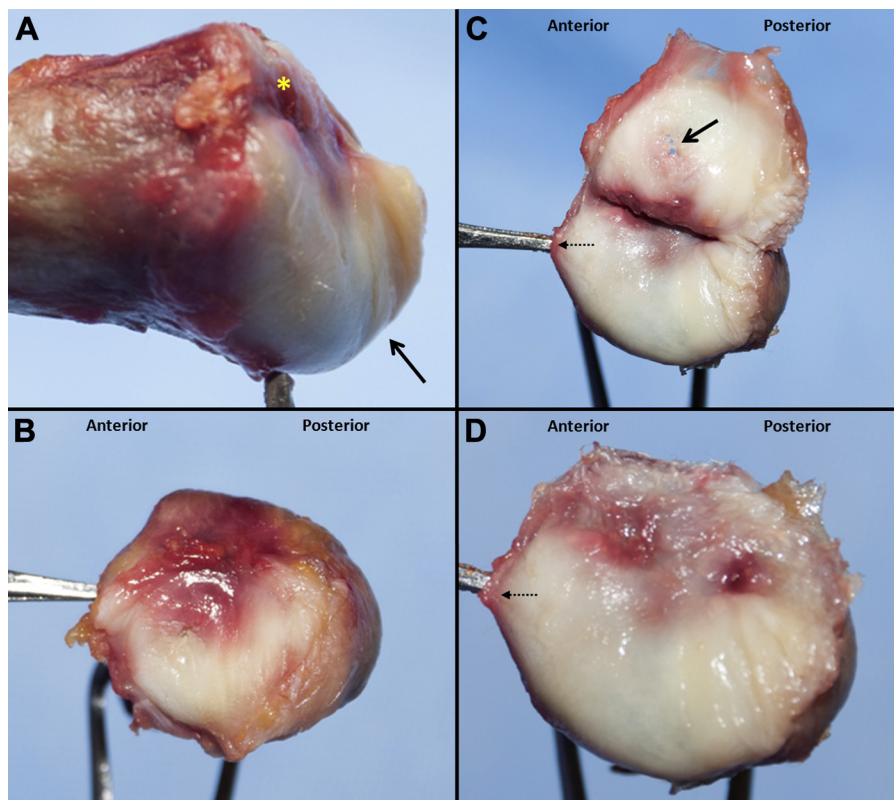
A 26-year-old right hand–dominant office worker sustained an anterior labral tear to his left shoulder while weightlifting approximately 2 years before presentation. He underwent arthroscopic labral repair by a surgeon in his hometown and, during rehabilitation, began to have pain in both the right and left SC joints. He went back to his surgeon, who then found an anterior labral tear in the patient's right shoulder for which he underwent arthroscopic repair. However, the SC joint pain was never alleviated despite extensive physical therapy and multiple corticosteroid injections. Because of this pain, he was very limited in his recreational activities and sought treatment by the senior surgeon.

On physical examination, glenohumeral range of motion was full and symmetric bilaterally. The patient had full rotator cuff strength with negative apprehension, Speed, and O'Brien tests. He was tender to palpation over both SC joints with mild swelling and with no evidence of instability. He had moderate crepitation over his SC joints with a simulated throwing motion; however, no subluxation or dislocation was observed. Outside magnetic resonance images showed bilateral SC joint degeneration with possible degeneration of the intra-articular disks. A computed tomography scan showed cystic and sclerotic changes of both medial clavicles with manubrial irregularity consistent with SC joint osteoarthritis. A small subchondral cyst was also noted on the anterior aspect of the left medial clavicle (Fig 2). A diagnosis of bilateral SC joint degenerative osteoarthritis without instability was made. Because of recalcitrant pain and failed nonoperative therapy, the patient elected to undergo surgical treatment with arthroscopic SC joint decompression after an extensive discussion of the risks and benefits of surgery. We recommend a staged approach. Thus arthroscopic decompression of the right SC joint was undertaken first, and the left SC joint was treated 17 days later.

Surgical Technique

In this case, the surgical techniques for SC joint decompression were identical for both the left and right

Fig 1. (A) Cadaveric dissection photograph of a right medial clavicle from anterior to posterior showing the insertional area of the anterior capsular ligament, posterior capsular ligament, and intra-articular disk ligament (asterisk). The intra-articular disk can also be seen as it covers the articular cartilage of the medial clavicle (arrow). (B) End-on view of right medial clavicle with remaining intra-articular disk. (C) The intra-articular disk is flipped upward, showing the articular cartilage of the medial clavicle. Small perforations can be seen through the intra-articular disk (solid arrow). The pectoralis ridge is present at the anterior 9:30 clock-face position (dashed arrow) and may be an important landmark to aid in joint orientation during arthroscopy of the SC joint. (D) With the intra-articular disk removed, it can be seen that the articular cartilage covers approximately 67% of the medial clavicle. The pectoralis ridge can also be identified anteriorly at the 9:30 clock-face position (dashed arrow).



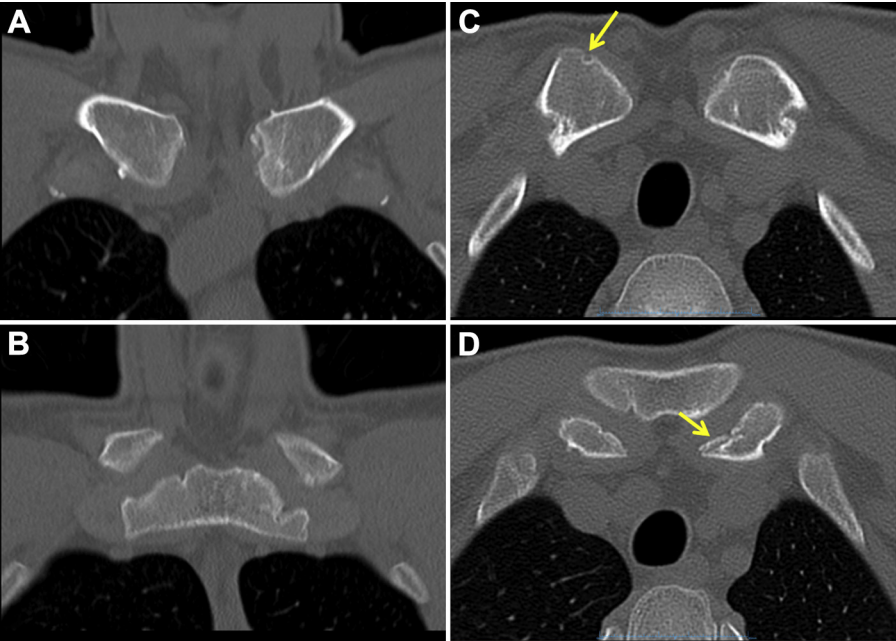


Fig 2. Computed tomography scans obtained at initial clinical presentation. (A) A coronal slice shows irregularity and sclerotic changes of both medial clavicles. (B) A subsequent coronal slice shows irregularities of the manubrial articular facets; however, this finding is not uncommon in asymptomatic individuals.²¹ (C) An axial slice shows a subchondral cyst on the left medial clavicle (arrow), which was removed with an arthroscopic curette (Fig 6). Sclerotic changes can also be seen over the articular surfaces of both medial clavicles. (D) A subsequent axial slice shows an intra-articular loose body located within the right SC joint (arrow).

SC joints. The intraoperative findings and therapeutic interventions for both joints are summarized in Table 1. A detailed description of the procedure for decompression of the patient’s left SC joint is provided later and in Video 1.

Equipment and Personnel

In addition to standard arthroscopic equipment, a radiofrequency tissue ablator (ArthroCare, Austin, TX) and 30° and 70° 2.7-mm-diameter arthroscopes (Smith & Nephew Endoscopy, Andover, MA) were used to achieve complete visualization of the articular

surfaces and the intra-articular disk. The on-call thoracic surgeon was made aware of the procedure, and a thoracotomy tray was also immediately available in the event of inadvertent thoracic penetration of arthroscopic instruments. The infusion pump was set at a pressure of 30 mm Hg to ensure capsular distention, to maintain adequate visualization, and to achieve hemostasis throughout the procedure. Because of technical complexity, a skilled first assistant was necessary to aid in patient safety. The role of the assistant was to help with patient positioning, arthroscopic visualization, and intraoperative dynamic examination such that the

Table 1. Summary of Intraoperative Findings, Therapeutic Interventions, and Instrumentation Required for Therapeutic Interventions

Joint	Intraoperative Findings	Therapeutic Intervention	Instrumentation Required
Right SC joint	Synovitis	Synovectomy	ArthroCare radiofrequency probe
	Loose bodies	Morcellation	Arthrex 4.0-mm high-speed shaver
	Intra-articular disk tear	Total discectomy	ArthroCare arthroscopic biter
			ArthroCare hook-tip radiofrequency probe
Left SC joint	Chondral degeneration of clavicular facet	<8 mm of bone resected	Arthrex 4.0-mm high-speed burr
	Chondral degeneration of manubrial facet	Debridement of entire chondral surface	Arthrex 4.0-mm high-speed shaver
	Synovitis	Synovectomy	Arthrex 4.0-mm high-speed shaver
	Complete intra-articular disk	Total discectomy	
	Chondral degeneration of clavicular facet	<8 mm of bone resected	ArthroCare radiofrequency probe
	Subchondral cyst	Complete excision	ArthroCare arthroscopic biter
	Chondral degeneration of inferior manubrial facet	Debridement of inferior chondral surface	ArthroCare hook-tip radiofrequency probe
			Arthrex 4.0-mm full-radius resector

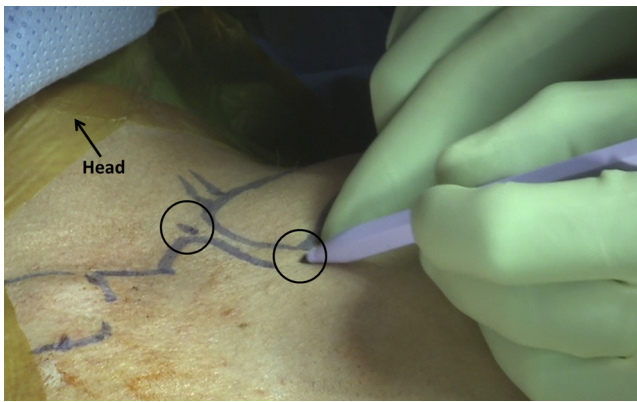


Fig 3. A sterile marking pen was used to outline the surface contours of the medial clavicle, sternal facet, and jugular notch. Portal positions (circles) were planned to minimize damage to the anterior SC ligament.

operation could be completed in a safe and efficient manner.

Patient Positioning

The patient was taken to the operating room and was placed supine in approximately 30° of reverse Trendelenburg inclination. After the induction of general anesthesia, an endotracheal tube was placed to ensure a secure airway given the proximity of the trachea to the operative field. A bolster was placed beneath the thoracic spine and between the scapulae to retract the scapulae, thus increasing the operating space between the medial clavicle and the manubrium. At this point, examination under anesthesia was undertaken and showed no evidence of either SC joint instability or glenohumeral instability. The left upper extremity was

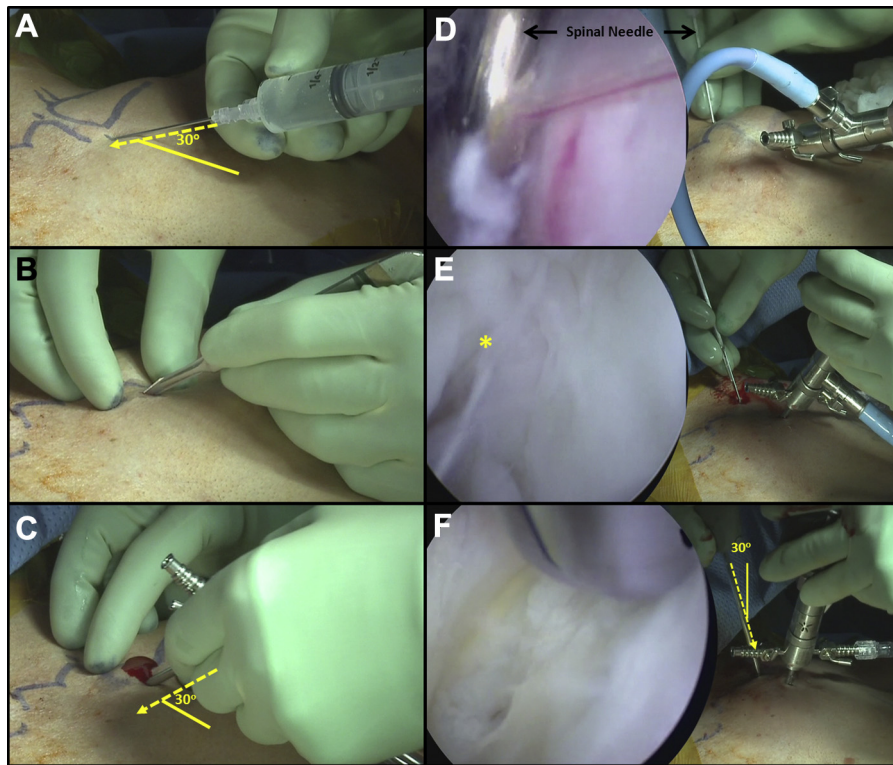


Fig 4. (A) After the spinal needle was inserted with 30° of caudal angulation from the horizontal plane, the joint was insufflated with normal saline solution to distend the joint capsule and to aid in arthroscope angulation. (B) After the spinal needle was removed, a small stab incision was made in the same location with a No. 11 blade. (C) The 2.7-mm arthroscope was gradually and bluntly inserted into the clavicular compartment of the joint with approximately 30° of caudal angulation from the horizontal plane to maximize visualization while also minimizing damage to the anterior SC ligament.^{19,22} A distinct “pop” was heard as the arthroscope penetrated the joint capsule and therefore entered the SC joint. (D) Under direct visualization through the inferior viewing portal, a spinal needle was inserted into the joint through the previously marked site for superior portal placement with approximately 30° of caudal angulation from the vertical plane (outside-in technique). (E) After removal of the spinal needle, a second small stab incision was made in the same location to prepare for insertion of arthroscopic working instruments using the same angulation as the previously removed spinal needle. Fraying of the intra-articular disk was also seen in the accompanying arthroscopic view from the inferior portal (asterisk). (F) Arthroscopic instruments were inserted with approximately 30° of caudal angulation from the vertical plane to minimize damage to the anterior SC ligament. Diagnostic arthroscopy and debridement were then begun.

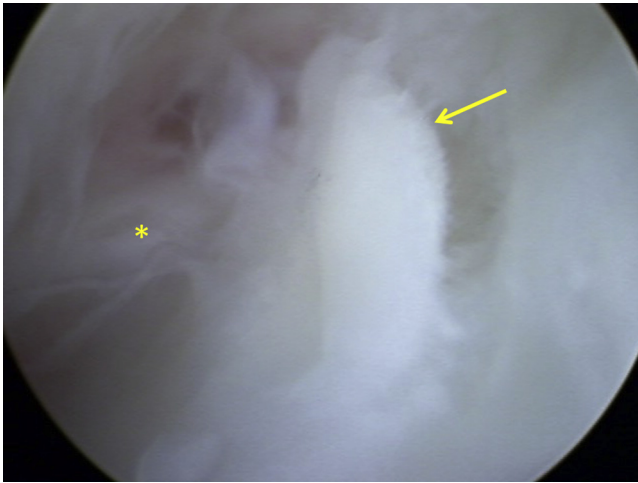


Fig 5. Arthroscopic view from the inferior portal showing significant chondral wear of the left medial clavicle before joint decompression. A large chondral flap can be identified (arrow) in addition to significant fraying of the medial clavicular articular cartilage (asterisk).

then widely prepared and draped free to the contralateral midclavicular line such that intraoperative dynamic examination could be performed without compromising sterility. The floor controls for the arthroscopic instruments were situated such that the operating surgeon could stand on the side of the affected shoulder while also facing the high-definition arthroscope output monitors, which were situated above the head of the operating table. The assistant was positioned near the left shoulder of the operating surgeon throughout the case.



Fig 6. Arthroscopic view from the superior portal after resection of approximately 7 mm of bone from left medial clavicle articular facet. Resection of 5 to 10 mm of bone is necessary to expose the underlying cancellous bone without damaging the supporting ligaments, such as the costoclavicular and superior SC ligaments.^{17,19} In this case approximately 7 mm of bone was resected.

Portal Placement

The SC joint was palpated to identify important bony landmarks. A marking pen was then used to outline the coronal contour of the medial clavicle, the manubrial articular facet, and the jugular notch to aid in arthroscopic portal placement (Fig 3). Approximately 1 cm inferior to the inferior joint line, an 18-gauge spinal needle was introduced into the joint with 30° of cephalad angulation from the horizontal plane. The joint was then insufflated with normal saline solution to distend the joint capsule and to determine the appropriate angle for portal placement. After removal of the spinal needle, a small stab incision was made through the skin and subcutaneous tissues with a No. 11 blade. The 2.7-mm arthroscope was gently inserted into the clavicular (lateral) compartment of the SC joint, again with 30° of cephalad angulation, with care taken not to penetrate or otherwise damage the posterior capsule because this has been shown to be the most important ligament for maintaining anteroposterior SC joint stability.^{7,8} A distinct “pop” was heard as the arthroscope bluntly penetrated the anterior joint capsule and thus entered the joint. Once this inferior viewing portal was established, an accessory superior portal was created under direct arthroscopic visualization by an outside-in technique. A second small stab incision was made 1 cm superior to the superior joint line to avoid damaging the anterior SC ligament.^{19,20} Arthroscopic instruments were then inserted using a technique similar to that described earlier; however, the devices were initially angulated inferiorly toward the inferior portal with approximately 30° of caudal angulation from the vertical plane. Figure 4 shows the step-by-step procedure for establishing arthroscopic portals.

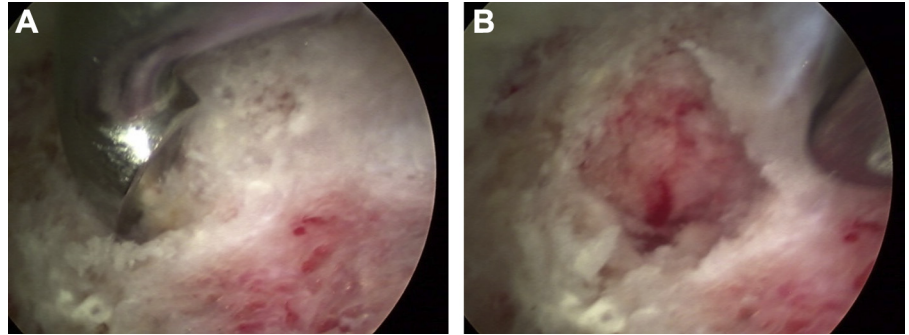
Diagnostic Arthroscopy

After creation of both arthroscopic portals, diagnostic arthroscopy was performed using a combination of 30° and 70° arthroscopes to fully evaluate the joint. Diagnostic arthroscopy involves inspection of the intra-articular disk and a complete evaluation of the clavicular articular surface. Because the disk is typically complete, the sternal articular surface can only be seen by repositioning the arthroscope more medially after the disk has been resected. A switching stick may be used to rotate the working and viewing portals, which can aid in complete visualization. In this case diagnostic arthroscopy showed significant synovitis, a complete intra-articular disk, and chondral damage involving both the sternal and clavicular facets of the SC joint (Fig 5).

Joint Decompression

Arthroscopic synovectomy was first performed with a radiofrequency probe (ArthroCare) to aid in visualization while also removing a potential source of joint

Fig 7. (A) As viewed through the inferior portal, a subchondral cyst, which was identified on a preoperative computed tomography scan (Fig 1C), was successfully located on the anterior aspect of the medial clavicle during arthroscopic decompression of the left SC joint. An angled curette was introduced into the joint in preparation for cyst removal. (B) By use of an angled curette, the subchondral cyst was completely removed and its margins were resected to a stable border.



pain. The clavicular facet was visualized, and 6 to 7 mm of bone was resected with a 4.0-mm high-speed burr and shaver (Arthrex, Naples, FL), creating approximately 12 mm of space between the clavicular and manubrial articular facets (Fig 6). A small subchondral cyst, which was identified on a preoperative computed tomography scan, was also removed from the medial clavicle with an angled curette (Fig 7). The intra-articular disk, which was found to be complete without central perforation, was resected to a stable margin using an arthroscopic biter and a hook-tip radio-frequency probe (ArthroCare). Remnants of the intra-articular disk were removed with a 4.0-mm high-speed full-radius resector (Arthrex). The sternal facet was then visualized and debrided inferiorly where chondral wear was clearly evident. A remnant of the intra-articular disk was also removed from this area (Fig 8). Bone was not resected from the sternal facet. Throughout the decompression procedure, care was taken to preserve the anterior, posterior, and superior SC joint capsule and associated ligaments. Under direct visualization through both arthroscopic portals, dynamic SC joint examination was undertaken by moving the arm through a full range of motion to ensure joint stability and relief of bony impingement. The portal sites were then closed with buried No. 3-0 absorbable sutures (Monocryl; Johnson & Johnson,

New Brunswick, NJ). The patient was placed in a sling and a cryotherapy device (GameReady [CoolSystems], Concord, CA) for comfort before transfer to the post-anesthesia care unit. The shoulder was not immobilized postoperatively.

Postoperative Rehabilitation

Early passive motion was initiated and encouraged in the immediate postoperative period. Active and active-assisted motion began at approximately 1 week postoperatively, and the sling was used for the first 2 weeks for comfort, followed by a gradual return to normal activities.

Results

The patient returned to his high-demand recreational activities, including weightlifting, without modification at approximately 4 months postoperatively. One year after surgery, the American Shoulder and Elbow Surgeons score improved by 52 points; the Single Assessment Numeric Evaluation score improved by 31 points; the Quick Disabilities of the Arm, Shoulder and Hand score improved by 38.8 points; and the Short Form 12 Physical Component Summary score improved by 17.9 points (Table 2). Results may be optimized after consideration of the pearls and pitfalls presented in Table 3.

Fig 8. (A) Arthroscopic view from the superior portal showing articular degeneration of the inferior aspect of the sternal facet. A remnant of the previously resected intra-articular disk can be seen (asterisk). (B) The tip of the probe points to the inferior aspect of the sternal facet after debridement of chondral wear and resection of the intra-articular disk remnant. The clavicular facet can also be seen (asterisk), highlighting the relative preservation of the sternal facet relative to the clavicular facet, which has been recommended by other authors.^{5,19}

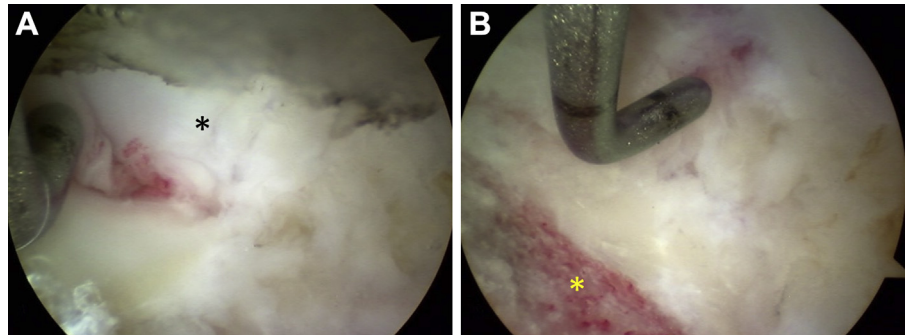


Table 2. Summary of Outcome Scores Obtained 12 Months After Bilateral Arthroscopic SC Joint Decompression

Outcomes Measure	Preoperative	Postoperative
ASES score (scale from 0 to 100, where 100 indicates best score)	43	95
SANE score (scale from 0 to 100, where 100 indicates best score)	60	91
QuickDASH score (scale from 100 to 0, where 0 indicates best score)	41.1	2.3
SF-12 PCS score (scale from 0 to 100, where 100 indicates best score)	33.9	51.4

ASES, American Shoulder and Elbow Surgeons; QuickDASH, Quick Disabilities of the Arm, Shoulder and Hand questionnaire; SANE, single assessment numeric evaluation; SF-12 PCS, Short Form 12 Physical Component Summary.

Discussion

Several authors have reported satisfactory outcomes after resection arthroplasty of the degenerative SC joint.¹⁻³ Rockwood et al.¹ reported good to excellent outcomes in 8 patients with SC joint arthritis after open resection with a mean follow-up of 5.7 years—all patients were completely satisfied with their results. Pingsmann et al.² evaluated outcomes in 8 women who underwent open isolated resection arthroplasty of the SC joint for painful arthritis. Again, all 8 patients were completely satisfied with the result at a mean follow-up

of 31 months. In patients with anterior instability, Panzica et al.³ also reported good to excellent outcomes in 6 patients treated with open resection arthroplasty with a mean follow-up of 9.9 years.

Although good to excellent outcomes have been reported after open resection arthroplasty of the SC joint, this operation is rarely performed because of concern regarding vital mediastinal structures located deep to the operative field and a general unfamiliarity with local surgical anatomy. In addition to a prolonged recovery period, open capsulotomy can compromise the patency of supporting ligaments that confer joint stability. Arthroscopy of the SC joint, on the other hand, has several advantages that are typically viewed as improvements over the open approach. Arthroscopy allows for a 360° view from within the joint, thus allowing for a complete evaluation of all the joint surfaces and the intra-articular disk. Surgical risks to the mediastinal vessels, trachea, and supporting SC ligaments are mitigated when proper instrument insertion technique is used and when bony resection of the medial clavicle does not exceed 10 mm.¹⁷ When compared with the open approach, arthroscopy of the SC joint may also hasten recovery and provide excellent cosmesis.

In this case, bilateral arthroscopic SC joint resections were performed in a young, active male patient without

Table 3. Valuable Pearls and Pitfalls for Arthroscopic Decompression of SC Joint

	Pearls	Pitfalls
Preoperative imaging	MRI is used for evaluation of the intra-articular disk. CT scan is used for evaluation of joint congruity, joint angulation, cyst formation, and loose bodies.	Irregularity of the manubrium is a common imaging finding and should not elevate suspicion for joint degeneration. ²¹
Equipment and personnel	Endotracheal intubation should always be performed because the operative field is nearly immediately superficial to the trachea and mediastinal vessels. Always work with a skilled first assistant. At a minimum, always notify an on-call general surgeon of the procedure and always have a thoracotomy tray immediately available.	Lack of experience of the primary surgeon and/or supporting personnel may place the patient at risk of severe complications.
Patient positioning	Use an interscapular bolster of sufficient size to open up both SC joints anteriorly. Evaluate the patient for SC joint instability (EUA) to eliminate the possibility that instability may have been present before the surgical procedure.	An interscapular bolster that is too small will not create the space needed to operate effectively.
Portal placement	Initial joint insufflation may be incomplete in patients with an intact intra-articular disk. The inferior portal should be created first with 30° cephalad angulation from the horizontal plane. The superior portal should be created using an outside-in technique under direct visualization with a spinal needle.	Portals initially created either too perpendicular or too parallel to the coronal plane minimize visualization and working space. Instruments inserted hastily or with high force and speed place the posterior SC ligament and vital retrosternal structures at risk of perforation.
Diagnostic arthroscopy	Always first identify the posterior capsule to ensure that the arthroscope is situated within the joint. ²²	Lack of a systematic approach may result in missed diagnoses.
SC joint decompression	Bone should not be resected from the sternal facet. ^{19,22}	Removing >10 mm of the medial clavicle increases the risk of postoperative SC joint instability. ¹⁷
Postoperative rehabilitation	Passive motion should be encouraged immediately after surgery. A sling should only be used for comfort.	Immobilization of the affected arm is unnecessary and increases the risk of shoulder stiffness.

CT, computed tomography; EUA, examination under anesthesia; MRI, magnetic resonance imaging.

perioperative complications or postoperative SC joint instability. The patient returned to his preinjury level of function 4 months postoperatively and showed substantial improvements in outcomes scores over his preoperative baseline values at 1 year of follow-up (Table 2). Recently, Tytherleigh-Strong and Griffith⁵ also reported no complications and no cases of postoperative instability in a series of 10 patients with SC joint osteoarthritis treated with arthroscopic medial clavicle excision. After a mean follow-up period of 28 months, these 10 patients showed considerable improvements in outcomes scores compared with preoperative baseline values.

Despite its numerous advantages, arthroscopy of the SC joint is an uncommon procedure and should not be performed by inexperienced surgeons. Generally, this procedure should only be performed in high-volume SC joint referral centers with cardiothoracic backup in which surgeon experience and anatomic familiarity are sufficient to safely and correctly perform the operation. When performed in experienced hands, however, arthroscopic SC joint decompression can be a safe and effective treatment method for symptomatic SC joint osteoarthritis.

References

1. Rockwood CA Jr, Groh GI, Wirth MA, Grassi FA. Resection arthroplasty of the sternoclavicular joint. *J Bone Joint Surg Am* 1997;79:387-393.
2. Pingsmann A, Patsalis T, Michiels I. Resection arthroplasty of the sternoclavicular joint for the treatment of primary degenerative sternoclavicular arthritis. *J Bone Joint Surg Br* 2002;84:513-517.
3. Panzica M, Zeichen J, Hankemeier S, Gaulke R, Krettek C, Jagodzinski M. Long-term outcome after joint reconstruction or medical resection arthroplasty for anterior SCJ instability. *Arch Orthop Trauma Surg* 2010;130:657-665.
4. Tavakkolizadeh A, Hales PF, Janes GC. Arthroscopic excision of sternoclavicular joint. *Knee Surg Sports Traumatol Arthrosc* 2009;17:405-408.
5. Tytherleigh-Strong G, Griffith D. Arthroscopic excision of the sternoclavicular joint for the treatment of sternoclavicular osteoarthritis. *Arthroscopy* 2013;29:1487-1491.
6. van Tongel A, MacDonald P, Leiter J, Pouliart N, Peeler J. A cadaveric study of the structural anatomy of the sternoclavicular joint. *Clin Anat* 2012;25:903-910.
7. Spencer EE, Kuhn JE, Huston LJ, Carpenter JE, Hughes RE. Ligamentous restraints to anterior and posterior translation of the sternoclavicular joint. *J Shoulder Elbow Surg* 2002;11:43-47.
8. Bearn JG. Direct observations on the function of the capsule of the sternoclavicular joint in the clavicular support. *J Anat* 1967;101:159-170 (pt 1).
9. Renfree KJ, Wright KW. Anatomy and biomechanics of the acromioclavicular and sternoclavicular joints. *Clin Sports Med* 2003;22:219-237.
10. DePalma AF. Surgical anatomy of the acromioclavicular and sternoclavicular joints. *Surg Clin North Am* 1963;43:1541-1550.
11. Shimada K, Takeshige N, Moriyama H, Miyauchi Y, Shimada S, Fujimaki E. Immunohistochemical study of extracellular matrices and elastic fibers in a human sternoclavicular joint. *Okajimas Folia Anat Jpn* 1997;74:171-179.
12. Emura K, Arakawa T, Terashima T, Miki A. Macroscopic and histological observations on the human sternoclavicular joint disc. *Anat Sci Int* 2009;84:182-188.
13. Barbaix E, Lapierre M, Van Roy P, Clarijs JP. The sternoclavicular joint: Variants of the discus articularis. *Clin Biomech (Bristol, Avon)* 2000;15(suppl 1):S3-S7.
14. Brossman J, Stäbler A, Preidler K, Trudell D, Resnick D. Sternoclavicular joint: MR imaging—Anatomic correlation. *Radiology* 1996;198:193-198.
15. Cave AJ. The nature and morphology of the costoclavicular ligament. *J Anat* 1961;95:170-179.
16. Tubbs RS, Shah NA, Sullivan BP, et al. The costoclavicular ligament revisited: A functional and anatomic study. *Rom J Morphol Embryol* 2009;50:475-479.
17. Bisson LJ, Dauphin N, Marzo JM. A safe zone for resection of the medial end of the clavicle. *J Shoulder Elbow Surg* 2003;12:592-594.
18. Jurik AG. *Imaging of the sternocostoclavicular region*. New York: Springer; 2007;29-35.
19. Tytherleigh-Strong G, Getgood AM, Griffiths DE. Arthroscopic intra-articular disk excision of the sternoclavicular joint. *Am J Sports Med* 2012;40:1172-1175.
20. Wijeratna MD, Turmezei TD, Tytherleigh-Strong G. The relevant anatomy of the sternoclavicular joint in relation to arthroscopic surgical approaches. *Skeletal Radiol* 2013;42:473-478.
21. Tuscano D, Banerjee S, Terk MR. Variations in normal sternoclavicular joints; a retrospective study to quantify SCJ asymmetry. *Skeletal Radiol* 2009;38:997-1001.
22. Tytherleigh-Strong G. Arthroscopy of the sternoclavicular joint. *Arthrosc Tech* 2013;2:e141-e145.