Snapping Scapula Syndrome

Meredith A. Lazar, Young W. Kwon and Andrew S. Rokito


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Snapping scapula syndrome, also known as *scapulothoracic crepitus or bursitis*, was first described in 1867 by Boinet. The severity of the sounds associated with this syndrome were stratified by Mauclaire in 1904 as froissement (rustling), frottement (rubbing), or craquement (cracking), the latter of which was used to denote a sound so loud it must be pathological. The sound is produced by a tactile-acoustic phenomenon occurring as a consequence of an anomalous tissue between the thoracic wall and the scapula. While most patients deem these sounds as a peculiar irregularity that does not produce symptoms, some report a clear correlation between the sounds and pain. With an increasing knowledge base and advancing surgical technology, the available treatment modalities for such patients are continuing to evolve. This review will discuss the current approach to the diagnosis and treatment of patients with snapping scapula syndrome.

**Anatomy and Function of the Scapulothoracic Joint**

The scapula is a large, flat, triangular bone that lies along the posterior surface of the thoracic cage between the second and seventh ribs. It has two surfaces (ventral and dorsal), three borders (superior, axillary, and vertebral), and three angles (supromedial, inferomedial, and lateral). The scapula, in its static resting position, lies approximately 5 cm lateral to the spine on the posterior aspect of the thorax, is angled 30° to 40° in relation to the coronal plane, and is tipped anteriorly 10° to 20° with respect to the sagittal plane. The scapula is part of the superior shoulder suspensory complex, which provides attachments to the axial skeleton. Its only skeletal connections are the acromioclavicular and coracoclavicular ligaments. Consequently, the scapula relies primarily on the surrounding muscles for support and stability. The contour of the scapula may vary, and, in one anatomic study, abnormalities were consistently found at the superomedial and inferior poles of the scapula.

The articulation between the scapula and the thoracic cage is one of the most incongruent in the human body. The scapulothoracic pseudojoint has three layers: superficial, intermediate, and deep. Each layer consists of muscles and bursae. The superficial layer comprises the trapezius and latissimus dorsi muscles (Fig. 1). This layer can be associated with a well-circumscribed inferior angle bursa, measuring 1.9 × 2.4 cm on the average, located between the inferomedial angle of the scapula and the superficial fibers of the latissimus dorsi muscle. The intermediate layer consists of the rhomboid major, rhomboid minor, and levator scapulae muscles. The trapezial bursa lies between the trapezius muscle and the base of the scapular spine and averages 4.3 × 2.7 cm in size. This bursa is particularly important as it provides a smooth surface over which the scapula rotates.

In the intermediate layer, along with the trapezial bursa, is the spinal accessory nerve, which crosses the superior border of the scapula approximately 2.7 cm lateral to its superomedial angle as it enters the interval between the superomedial angle and the trapezius muscle just lateral to the levator scapulae muscle. The dorsal scapular nerve is also in this vicinity as it enters the scapulothoracic region and travels deep to or through the levator scapulae parallel to the medial border of

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the scapula before innervating the rhomboid muscles. The transverse cervical artery is divided by the levator scapulae muscle into the dorsal scapular artery and a branch that runs with the spinal accessory nerve. The suprascapular nerve is also in proximity as it travels obliquely across the superior border of the scapula and courses toward the suprascapular notch. These structures are all at risk during operative treatment of scapulothoracic bursitis and must be carefully avoided during dissection.

The deep layer consists of the serratus anterior and subscapularis muscles and contains two discrete major bursae (Figs. 2-A and 2-B). The scapulothoracic, or supraserratus, bursa is located between the serratus anterior muscle and the thoracic cage and averages 9 × 7.4 cm in size. The subscapularis, or infraserratus, bursa is located between the serratus anterior and subscapularis muscles, is inconsistently present, and averages 5.3 × 5.3 cm.

The scapula plays a crucial role in the function of the upper extremity by providing a stable base for glenohumeral motion. In addition, the scapula glides against the thoracic wall to augment shoulder motion. Scapular motion is required to maintain optimal muscle length-tension relationships and alignment of the glenohumeral joint during elevation of the upper extremity. Biomechanical analyses of normal scapular motion have revealed that the scapula can simultaneously rotate and translate along three axes to support glenohumeral motion. The ratio of glenohumeral to scapulothoracic movement (GH/ST ratio) in various planes has been extensively studied and has been shown to be approximately 2:1 in both forward flexion and abduction. However, among the various planes, the GH/ST ratio has been found to vary in a nonlinear fashion depending on the position of the arm relative to the scapula. Several studies have shown the GH/ST ratio to range from 1.25 to 3.2, with the ratio in forward flexion being slightly higher on average than the ratio in abduction. Specific rehabilitation protocols for stretching and strengthening the pectoral muscles, scapular retractors and elevators, and glenohumeral abductors and external rotators can increase the GH/ST ratio, which promotes scapular stability and improves glenohumeral motion.

Pathophysiology of Scapulothoracic Bursitis
Scapulothoracic bursitis may occur following a single traumatic insult or as a result of a series of repetitive motions of the scapulothoracic joint. In most cases, the bursitis is believed to be caused by abnormal motion between the anterior surface of the scapula and the thoracic cage. In 1933, Milch and Burman re-
Anterior (Fig. 2-A) and cross-sectional (Fig. 2-B) views of the deep bursae in the scapulothoracic joint: the scapulothoracic and subscapularis bursae.
ported on a small series of patients with scapulothoracic bursitis and suggested that the pain was caused by an abnormal forward curvature of the superomedial angle of the scapula due to various skeletal or soft-tissue abnormalities. 

Scapulothoracic crepitus may be produced by an unusual shape of the scapula. In a cadaver study, bending of >35° was noted in 8.6% (sixty) of 700 specimens. Approximately 6% of scapulae demonstrate a hook-shaped prominence, known as the Luschka tubercle, at their superomedial angle. This tubercle may enlarge and articulate with the thoracic cage, resulting in painful crepitus. However, a clear causal relationship between this morphology and the presence of scapulothoracic bursitis has not been demonstrated.

Osteochondroma is the most prevalent benign tumor of the scapula and has been implicated as a common cause of snapping scapula syndrome. An extensive review of the literature identified eighty-nine cases of snapping scapula syndrome, with osteochondroma being the cause in 16% (fourteen) of the cases. Approximately 6% of scapulae demonstrate a hook-shaped prominence, known as the Luschka tubercle, at their superomedial angle. This tubercle may enlarge and articulate with the thoracic cage, resulting in painful crepitus. However, a clear causal relationship between this morphology and the presence of scapulothoracic bursitis has not been demonstrated.

Other, less common, skeletal causes of scapulothoracic crepitus include skeletal exostoses and other osseous tumors, especially if they arise from the ventral surface of the scapula, and fracture malunion of either the ribs or the scapula. The scapula is the second most frequent location of chondrosarcoma, which must be considered in the differential diagnosis of lesions in the scapulothoracic space.

Scapulothoracic bursitis may also occur following loss of dynamic control of scapular motion. Abnormal scapular motion can be caused by muscle overuse, muscle imbalance following nerve injury, or pathological conditions of the glenohumeral joint. Scapular dyskinesis has been observed in patients with known glenohumeral joint pathology and in specific series has been reported of fourteen of twenty-two patients with shoulder instability, seven of seven patients with impingement, and fifteen of fifteen patients with rotator cuff abnormalities. Muscle atrophy secondary to nerve injury, trauma, or prior operative treatment can lead to diminished soft-tissue interposition between the scapula and the thoracic cage, resulting in scapulothoracic crepitus and pain. When soft-tissue interposition is diminished, the scapula tilts, and thus a normally shaped scapula can appear to have an abnormally curved shape and dig into the chest wall. The superomedial angle of the scapula then impinges along the chest wall during scapulothoracic motion and creates inflammation in the scapulothoracic space. Atrophy of the serratus anterior following injury to the long thoracic nerve as well as subscapularis atrophy in patients with thoracic outlet syndrome have also been implicated as etiologies of scapulothoracic crepitus.

Normal scapular motion along the thoracic cage is particularly important to athletes, and a history of overuse during activities such as swimming, pitching, weight training, gymnastics, and football has been implicated in the onset of symptoms.

A phenomenon described in pitchers known as SICK (scapular malposition, inferior medial border prominence, coracoid pain and malposition, and dyskinesis of scapular movement) has recently been recognized as an overuse musculo fatigue syndrome that has many of the same features as scapulothoracic bursitis.

Other causes of scapulothoracic bursitis include prior operative treatment that violated the periscapular musculature. For example, in one series, snapping scapula syndrome developed in fifteen of 100 patients in whom thoracic outlet syndrome had been treated with resection of the first rib. We have observed scapulothoracic bursitis in women who have undergone cosmetic breast procedures that involved sub-serratus exploration with implant placement.

**Clinical Presentation**

**History**

Patients with snapping scapula syndrome who seek medical treatment primarily report activity-related pain and crepitus. These symptoms may have an insidious onset, occur after a change in activity pattern, or be associated with trauma. The clinician should identify possible precipitating factors and question the patient regarding the duration and severity of the symptoms. In addition, symptoms such as shoulder girdle or neck pain and weakness should be documented. Other relevant elements of the history include hand dominance, occupation, and activity level, which may help to reveal causative factors. Crepitus associated with a soft-tissue lesion or muscle imbalance is typically softer than that associated with a skeletal lesion. In addition, skeletal lesions may initially present with subtle findings such as a painless, enlarging mass that does not cause crepitus and that can be misdiagnosed as scapulothoracic bursitis. In the absence of an identifiable lesion, the clinician must inquire about the frequency, level, and character of sports activities because those who engage in repetitive throwing, swimming, gymnastics, or weight-lifting are particularly susceptible to the development of scapular dyskinesis or bursitis.

**Physical Examination**

The spine must first be inspected for any excessive curvature as this will create an abnormal contour about the thoracic cage, which in turn will directly alter scapular motion. In one series, six of nine patients diagnosed with snapping scapula syndrome demonstrated kyphosis of the upper thoracic spine with no history of Scheuermann adolescent kyphoscoliosis. Other postural conditions that have been associated with scapulothoracic dysfunction include a forward-tilted head, rounded shoulders, abducted and forward-tipped scapulae, and suboccipital extension. Patients should also be assessed for sources of referred pain, including cervical radiculopathy, neurological injuries, and pathological changes in the glenohumeral joint.

The shoulder girdle should then be inspected for any scapular asymmetry. This can be subtle and its identification can require careful assessment. In the presence of scapular dysfunction resulting from a nerve injury, patients have difficulty abducting the arm and may compensate by shifting the entire trunk in order to perform tasks that require arm abduction. The position of the scapula should be documented during both ascending and descending shoulder motions as well as during scapular protraction, retraction, and rotation.
Palpation of the periscapular region may reveal focal tenderness at the medial scapular border over the superomedial and/or inferomedial bursae. Adduction and internal rotation of the shoulder allow these borders to be accessed for easier palpation. Patients often know how to reproduce the snapping by elevating and depressing the shoulder, and when they do so the crepitus can be localized from the undersurface of the scapula. The active and passive ranges of motion of the shoulder should be carefully examined for any limitations.

The strength of the scapular musculature, specifically the trapezius, rhomboids, levator scapulae, serratus anterior, and latissimus dorsi muscles, should also be assessed. The trapezius muscle strength is evaluated by having the patient shrug the shoulders against resistance. The rhomboids and levator scapulae can be tested by having the patient place the hands on the hips and push the elbows backward against resistance. The scapulae can be tested by having the patient press against the hips and push the elbows backward against resistance. The rhomboids and levator scapulae muscle strength is evaluated by having the patient shrug the shoulders against resistance. The rhomboids and levator scapulae can be tested by having the patient place the hands on the hips and push the elbows backward against resistance. The scapulae can be tested by having the patient press against the hips and push the elbows backward against resistance.

In the presence of a lesion, so-called clunking may be observed when the arm is abducted from 90° to 180°. Pseudo-winging of the scapula can be observed if a skeletal lesion pushes against the thorax to displace the scapula away from the body. Weakness in the major scapular stabilizers (serratus anterior, trapezius, and rhomboid muscles) may present as different patterns of scapular winging. An injury of the long thoracic nerve causing atrophy of the serratus anterior results in lateral scapular winging. Injury to the spinal accessory nerve that results in trapezius atrophy may cause the shoulder to droop or rotate forward more medially and is often more subtle than the winging associated with dysfunction of the serratus anterior. Scapular winging becomes more evident with motion and stress testing. To evaluate for scapular winging, the examiner should observe the scapula and palpate the inferomedial angle during elevation. The scapula should also be observed while the patient pushes against a wall or performs a push-up, as these maneuvers accentuate the asymmetric movement of the scapula. If a neurological injury is suspected, electromyographic studies (electromyography and/or measurement of nerve conduction velocities) can be performed to determine whether the results correlate with those of the clinical examination.

Posterior capsular tightness may also be present, especially in throwing athletes. Evaluating external and internal rotation of both shoulders with the humerus at 90° in the coronal plane is useful to assess capsular tightness. The upper trapezius and the pectoralis minor are other common sites of myofascial tightness. Hypertonia in athletes with shoulder pain can also contribute to scapular dyskinesis.

**Imaging**

Imaging modalities used in the evaluation of snapping scapula syndrome include plain radiographs, computed tomography, magnetic resonance imaging, and ultrasonography. Standard radiographs of the scapula include a true anteroposterior view (with the scapula lying flat against the cassette or the beam tilted to account for the scapular angle), a tangential transscapular (or Y) view (with the beam pointed in line with the spine of the scapula), and an axillary lateral view (to assess the glenohumeral joint). These projections help identify skeletal irregularities such as osteochondromas, a Luschka tubercle, rib abnormalities, or alterations at the superomedial or inferomedial angle of the scapula. Lesions that arise from the ventral surface of the scapula are particularly apparent in the scapulothoracic space on the Y view, as are sagittal plane deformities at the superomedial or inferomedial angle. Unfortunately, these lesions are not always readily visible on radiographs, and fluoroscopy has been suggested as an adjunctive tool to dynamically visualize the grating or snapping of the scapula. Several case reports have documented the utility of cineradiography to identify skeletal lesions in patients with scapulothoracic crepitus.

The efficacy of computed tomography scanning for the routine evaluation of scapulothoracic crepitus has remained controversial. While a retrospective study did demonstrate high intrarater and interrater agreement with regard to the assessment of computed tomography scans for scapular crepitus, the interpretations of these scans did not correlate well with the clinical findings. Therefore, the authors suggested that the routine use of computed tomography was not justified for patients with the clinical diagnosis of scapulothoracic crepitus. Similarly, a more recent study demon-
The authors of that study also noted that computed tomography scans, especially three-dimensional reconstructions, were reliable in detecting abnormalities and incongruities between the scapula and the thoracic cage in multiple planes, suggesting that these images may be important adjuncts to plain radiographs for the planning of operative treatment of scapulothoracic crepitus. Given these findings, we believe that a computed tomography scan would be a useful adjunct to plain radiographs if a bone or cartilage lesion is visible and requires further characterization for preoperative planning (Fig. 5).

Magnetic resonance imaging is better than computed tomography scans for identifying and characterizing soft-tissue masses. Higuchi et al. reported their experience with using magnetic resonance imaging to evaluate scapulothoracic bursitis and found it to be more useful than computed tomography scans for assessing fluid-filled bursal tissue as well as for distinguishing scapulothoracic bursitis from elastofibroma. They and other authors concluded that magnetic resonance imaging is a valuable tool for assessing these so-called pseudotumors in the scapulothoracic bursa.

Ultrasound has also been used to identify and treat scapulothoracic pathology. Specifically, by identifying the bursal tissue dynamically, it can be used for image-guided injection. Thus far, however, the use of ultrasound for diagnosis or treatment of scapulothoracic crepitus appears to be infrequent and published data are mostly limited to case reports.

Nonoperative Treatment

The majority of patients with scapulothoracic crepitus or bursitis can be managed successfully without operative treatment. An operation is required only for patients who have a clearly identifiable osseous or soft-tissue mass. Nonoperative treatment options include physical therapy, anti-inflammatory medications, and corticosteroid injections.

The goals of rehabilitation for patients with snapping scapula syndrome are improving muscle strength and balance, addressing postural conditions (such as excessive thoracic kyphosis), and core strengthening. It is believed that poor posture with the head and shoulders tipped forward causes the posterior scapular stabilizers to weaken relative to the anterior pectoral muscles, which leads to imbalances that may change the scapular resting position and decrease scapular elevation. Kibler and McMullen identified three stages of rehabilitation based on a program in which the shoulder is considered to be part of a kinetic chain system. The kinetic chain model depicts the body as a system of interdependent parts that work in a proximal-to-distal sequence to impart a desired action at the distal segment. In kinetic chain shoulder rehabilitation, the lower limbs and the trunk are integrated into most of the exercises, which reinforces normal movement patterns from the outset. Arm elevation requires full scapular retraction, which is incumbent on spine and hip extension to accommodate scapular motion. Therefore, shoulder function is dependent on thoracic spinal control, which must be reestablished with physical therapy prior to strengthening individual shoulder muscles. Lower scapular stabilization can be

![Fig. 4 Tangential radiograph of a scapular osteochondroma (arrow), demonstrating how these lesions may encroach on the scapulothoracic space and cause bursitis.](image1)

![Fig. 5 Three-dimensional computed tomography reconstruction in the coronal plane, demonstrating an osteochondroma (arrow) along the anterior surface of the scapula.](image2)
facilitated through contraction of the contralateral gluteus maximus muscles through the thoracolumbar fascia, which connects to the latissimus dorsi muscle. Efficient shoulder motion and muscle activation occur in this proximal-to-distal sequence, which is the basis for the ten-week rehabilitation protocol. The program progresses in a stepwise fashion from the acute phase (zero to three weeks), to the recovery phase (three to eight weeks), and finally to the maintenance phase (six to ten weeks) with specific exercises prescribed at each interval, bearing in mind that function, rather than time, determines a patient’s overall progress with this protocol.

In the acute phase, the goal of rehabilitation is to reduce pain. Consequently, those movements and positions associated with discomfort are limited. Trunk flexion and rotation exercises are performed so that scapular motion can be achieved without moving the arm, which may be painful. Patients are instructed to perform so-called safe co-contractions, in which the hand is supported so that the gravitational force on the arm is eliminated and pain is minimized. Abnormal scapular motion has been attributed to excessive activation of the upper trapezius muscle combined with decreased control of the lower trapezius and the serratus anterior muscle. To restore muscle control and balanced coactivation, exercises that selectively recruit weaker muscles over hyperactive muscles are recommended. Stretching maneuvers are performed in conjunction with closed-kinetic-chain exercises, in which the hand is relatively fixed (such as in modified push-ups) and which require less muscle activation than open-chain exercises (dumbbell press and machine-rowing).

In the recovery phase of rehabilitation, strengthening is performed with motion, which is dependent on the proper posture that has already been established in the acute phase. Closed-kinetic-chain exercises are advanced and should be performed in multiple planes and levels of elevation to reproduce scapular motion in its varied positions. Cools et al. performed an electromyographic study to elucidate which shoulder girdle exercises selectively activate middle and lower portions of the trapezius and serratus anterior muscles over the upper trapezius muscle to restore balance to the scapulothoracic musculature. Side-lying forward flexion, side-lying external rotation, and prone horizontal abduction with external rotation all had favorable upper-to-lower trapezius-muscle recruitment ratios (Figs. 6-A, 6-B, and 6-C). These arm elevation and rotation exercises should be added and weights should be increased as tolerated by the patient during this recovery phase of rehabilitation. Exercises are also performed to continue to strengthen the kinetic chain. Core strength endurance training helps to facilitate dynamic postural control for prolonged periods of time.

The maintenance phase begins once good scapular control and motion have been achieved. Plyometric (dynamic stretch-shortening) exercises such as tossing a medicine ball and open-chain exercises such as the walking lunge with a shoulder dumbbell press are advanced and integrated. Performance of strengthening exercises in various planes while loading the glenohumeral joint is also prescribed.

Ciullo reported excellent results in sixty-two of seventy-two patients treated with a combination of diathermy, ultrasound, and iontophoresis along with periscapular and rotator cuff muscle strengthening. In another study, Groh et al. found good or excellent results in twenty-two of thirty patients treated with periscapular muscle strengthening.

A corticosteroid and/or local anesthetic can be injected into the scapulothoracic bursa for diagnostic and therapeutic purposes. These injections are best administered with the patient prone and in the so-called chicken-wing position, with the shoulder extended and internally rotated to elevate the medial border of the scapula. Care must be taken to direct the needle parallel to the chest wall as pneumothorax is a potential complication. The injection should be directed to-
clinical benefits of this modality have not been demonstrated, however.

**Operative Treatment**

**Indications**

Operative management may be considered for patients who have undergone a prolonged course of nonoperative treatment with little or no improvement\(^{16,26,66}\). Ideally, these patients should be able to localize the pain to the superomedial or inferomedial angle of the scapula. The operative outcome is more reliable if the diagnosis can be confirmed with a preoperative injection of local anesthetic\(^{2,5,55,58}\). Lehtinen et al. suggested that failure to receive at least temporary relief from an injection should be a relative contraindication to operative management\(^{5}\). Other relative predictors of a poor operative outcome include the ability to voluntarily produce the snapping sound from the scapula, involvement in a Workers’ Compensation claim or litigation, and documented nerve deficits\(^{5}\).

**Open Techniques and Results**

To our knowledge, the first report of operative treatment for snapping scapula was published in 1950\(^{5}\). The procedure was performed with the use of local anesthesia in three patients who were asked to move the shoulder during the operation in order to identify the portion of the scapula responsible for the symptoms so that it could be resected. Subsequent studies have shown good outcomes following open partial scapular resection, usually for treatment of a distinct osseous abnormality\(^{27,23,44,55,59,61}\).

The procedure is typically performed with the patient in either the prone or the lateral decubitus position with the involved extremity draped free. With internal rotation of the shoulder, the medial border of the scapula can be lifted away from the thoracic cavity. The location of the skin incision is vertical, is in line with the medial border of the scapula, and is centered either superiorly or inferiorly depending on the site of the primary pathological findings. For operative dissection of the superomedial angle of the scapula (Fig. 8), the trapezius muscle may be split in line with its fibers over the scapular spine to expose the underlying structures. During this portion of the procedure, it is imperative to protect the spinal accessory nerve, which crosses the superior border of the scapula just lateral to the superomedial angle—i.e., between the superomedial angle and the trapezius muscle just lateral to the levator scapulae\(^{5}\). The levator scapulae and rhomboid muscles can be released subperiosteally as needed to expose the anteromedial border of the scapula. Care must be taken when the rhomboids are detached to avoid injury to the dorsal scapular nerve, which is approximately 2 cm medial to the medial scapular edge\(^{56}\). Finally, the involved osseous anomaly and/or the inflamed bursae can be isolated and resected. With this approach, the rhomboids are detached subperiosteally in order to preserve the short Sharpey fibers of the tendinous insertions, which may be reattached through drill holes to their appropriate position\(^{55}\). Although postoperative regimens may vary, most authors have recommended a period of immobili-
zation in a sling for up to four weeks to allow the muscles to heal to the bone, followed by exercises for restoration of the range of motion and for strengthening.26,27,33,55,56

Open treatment for scapulothoracic crepitus and bursitis has resulted in good-to-excellent outcomes in the majority of patients.18,33,56,62 McCluskey and Bigliani treated nine patients with refractory scapulothoracic bursitis at the supraserratus bursa with isolated open bursectomy.56 Fibrotic bursal tissue between the serratus anterior muscle and the thoracic cavity was excised. They reported six excellent and two good results. The remaining patient experienced a spinal accessory nerve deficit that required a tendon transfer, and only a fair outcome was achieved.

More recently, Nicholson and Duckworth reported on seventeen patients in whom scapulothoracic pain had been treated with an open operative technique.55 All of their patients had a satisfactory outcome after an average duration of follow-up of 2.5 years. In addition to removal of bursal tissue, the superomedial angle of the scapula was resected in five patients. The authors noted that open osseous resection was able to address other abnormalities about the area as well as provide easy access to the trapezial bursa.25 In this and other series in which removal of a portion of the superomedial angle was reported, gross and histological examination showed the resected bone to be essentially normal.18,44,55,59

Like resection for the treatment of supraserratus bursitis, operative treatment of inferomedial scapulothoracic bursitis has yielded satisfactory outcomes. In a small series of four professional baseball pitchers, Sisto and Jobe performed an open bursectomy at the inferior angle of the scapula.23 Histological evaluation of the resected tissue revealed evidence of chronic inflammation. All patients experienced complete or nearly complete relief of symptoms and were able to return to baseball at their previous level of competition.

Arthroscopic Techniques and Results
Although technically demanding, arthroscopic surgery for snapping scapula syndrome offers several theoretical advantages over open operative treatment. These include minimizing dissection and preserving muscle attachments, thereby eliminating the need for postoperative immobilization and potentially shortening the rehabilitation period.9 Other advantages include an improved cosmetic appearance and potentially decreased hospital stays.

The patient is usually positioned prone with the arm extended and internally rotated to accentuate the medial border of the scapula.9 Some authors have recommended the lateral decubitus position as it allows concurrent evaluation of the glenohumeral joint.9 Once the patient is positioned, the osseous landmarks are marked on the skin in anticipation of portal placement (Fig. 9).

All standard portals should be established at least 3 cm medial to the medial border of the scapula to avoid injuring the dorsal scapular nerve and vessels. Along the vertical axis,
Superior visualization portal should be placed just inferior to the scapular spine to allow access to both the superomedial and the inferomedial angle of the scapula. Under arthroscopic visualization, the inferior working portal is then created midway between the scapular spine and the inferomedial scapular angle. The instruments should point away from the coracoid process to prevent damage to the suprascapular nerve and vessels, which travel just medial to the base of the coracoid.

The visualization and working portals may be interchanged as needed intraoperatively for improved access to the bursal tissues. Portals placed superior to the scapular spine may result in injury to the dorsal scapular nerve and vessels or the spinal accessory nerve, and should be avoided.

If access to the superomedial angle of the scapula from these portals is limited, a second working portal can be created superiorly and laterally. With use of a so-called inside-out technique, this superolateral portal can be located along the superior border of the scapula at a distance that is one-third of the distance between the superomedial angle and the acromion. Cadaver dissection and clinical outcome studies have demonstrated that this portal can be established without excessive risk to the suprascapular nerve and vessels.

During the bursectomy, it is important to maintain a proper orientation relative to the thoracic cavity and clearly identify the soft-tissue structures prior to débridement. In some patients, the bursal tissue is easily identifiable while, in others, the tissue appears to be thickened or fibrotic (Fig. 10). An advantage to arthroscopic débridement is that the periosteal sleeve of the rhomboid attachment is maintained, which avoids the need for muscle reattachment and thus eliminates the necessity for postoperative immobilization.

After the bursectomy is completed, the arm may be moved under direct visualization by the surgeon and if the superomedial angle is deemed prominent a partial scapular resection can be performed. If there is no prominence, the scapulothoracic space may be temporarily deflated by removing all of the arthroscopy fluid. An examination may then be performed with the patient under anesthesia to determine if the superomedial angle of the scapula impinges on deeper structures. If there is osseous impingement, the scapula can then be skeletonized with a radiofrequency tissue ablator, and the superomedial angle can be resected with use of a high-speed burr. Although the exact extent of bone resection has been debated, most authors have recommended removing 2 to 3 cm of bone from the superomedial corner of the scapula.

Before the procedure is completed, the scapulothoracic joint should be examined with the patient under anesthesia to ensure that no impinging structures remain.

Most reports on the outcomes of arthroscopic surgery for scapulothoracic bursitis and crepitus are small case series with short-term follow-up. In general, however, good-to-excellent results have been reported in the majority of patients. Failures have been attributed mostly to poor patient selection and technical difficulties.

In a recent longer-term follow-up study, thirteen patients underwent arthroscopic scapulothoracic bursectomy with or without bone resection of the superomedial angle. At a mean of 6.8 years following surgery, all patients still reported...
some degree of scapulothoracic crepitus. Nine of the thirteen patients, however, reported less pain and improved function. The authors, therefore, suggested that residual scapulothoracic crepitus does not preclude a satisfactory outcome. In addition, they emphasized the importance of patient selection as their four patients with a failure included those with a history of drug abuse, C7 radiculopathy with clear scapular winging, and severe thoracic scoliosis

Combined Techniques and Results

Although the specific indications are still unclear, a combined arthroscopic and open approach may be appropriate for some patients. Bursectomy allows débridement of all inflamed tissue that may be the source of pain, and partial scapular resection (when indicated on the basis of the intraoperative examination) relieves the osseous impingement that contributes to the bursitis. Lehtinen et al. reported on sixteen patients with scapulothoracic bursitis and crepitus who were treated with either an all-arthroscopic procedure, an all-open procedure, or a combined procedure in which the bursectomy was completed in an arthroscopic fashion but bone resection was performed with use of an open approach. At an average of three years postoperatively, thirteen of the sixteen patients were satisfied with the result and had improved function. With such a limited number of patients, however, it was unclear if any particular approach was superior to the others. In another series, twelve patients were followed after they had undergone a combined arthroscopic bursectomy and mini-open scapular resection. At a mean of three years, the pain had decreased significantly in ten of the twelve patients.

The theoretical advantage of a combined approach is that arthroscopy provides better visualization and access to the bursal tissue for a more complete bursectomy and an open approach provides improved exposure so that the surgeon is better able to judge and then resect the superomedial or inferomedial angle of the scapula when indicated. In the literature, the recommended amount of bone resection has varied. It is believed that a more appropriate resection of bone can be performed through an open approach; however, with an open approach, the muscles must be detached from the scapula and then reattached through bone tunnels, thus requiring a more extended postoperative immobilization period and a delay in the initiation of the rehabilitation protocol.

Overview

Scapulothoracic crepitus or bursitis, also known as snapping scapula syndrome, has been recognized for more than a century. However, the entity is often underappreciated and is probably underdiagnosed. Without a definable skeletal lesion, most radiographic imaging modalities have been shown to be of little value in identifying the pathological entity and directing treatment. Thus, although this entity can be associated with either skeletal or soft-tissue anomalies or lesions, the diagnosis is generally established on the basis of the clinical history and physical examination alone. Nonoperative management with anti-inflammatory medications, supervised physical therapy, and corticosteroid injections is usually successful in alleviating symptoms. Operative intervention can be considered for patients whose symptoms persist and cause substantial disability. Open, arthroscopic, and combined techniques have been reported to have successful outcomes. The literature, however, consists mostly of small case series with varying operative indications and techniques. Further investigation is needed to clearly establish optimal treatment options for this complex condition.

Meredith A. Lazar, MD
Young W. Kwon, MD, PhD
Andrew S. Rokito, MD
Department of Orthopedics,
New York University Hospital for Joint Diseases,
301 East 17th Street, 14th Floor, New York, NY 10003.
E-mail address for M.A. Lazar: Meredith.Lazar@nyumc.org

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