Technique and Outcomes of Arthroscopic Scapulothoracic Bursectomy and Partial Scapulectomy

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Purpose: The purpose of this study was to assess the efficacy of arthroscopic scapulothoracic bursectomy in patients with snapping scapula syndrome with a minimum of 2 years' follow-up. **Methods:** In this institutional review board–approved retrospective study, 23 shoulders in 21 consecutive patients were identified that had undergone arthroscopic treatment of snapping scapula syndrome. Each patient described mechanical symptoms with failure of nonsurgical modalities and reported symptomatic relief from a local anesthetic injection before surgical intervention. Preoperative and postoperative pain and functioning levels were assessed with the American Shoulder and Elbow Surgeons (ASES), QuickDASH (shortened version of the Disabilities of the Arm, Shoulder and Hand questionnaire), and Single Assessment Numeric Evaluation (SANE) shoulder scores, and patient satisfaction was recorded on a 10-point visual analog scale. Univariate and paired *t* tests were used for data analysis. Significance was established at $P \leq .05$. **Results:** The mean age at the time of surgery was 33 years (SD, 14 years). A scapulothoracic bursectomy alone was performed in 2 shoulders, and the remaining 21 shoulders underwent both bursectomy and scapuloplasty of the superomedial or inferomedial scapular border. At a mean follow-up of 2.5 years (SD, 0.57 years), a significant improvement in the median ASES score was noted, from 53 points (range, 17 to 83 points) preoperatively to 73 points (range, 32 to 100 points) postoperatively ($P = .001$). The mean SANE and QuickDASH scores at follow-up were 73 (SD, 27) and 35 (SD, 30), respectively. Overall, median patient satisfaction with surgical outcome was 6 of 10 (range, 1 to 10). Of the shoulders, 3 (13%) underwent revision for persistent scapulothoracic pain. **Conclusions:** Snapping scapula syndrome can be a debilitating disorder. Although significant pain and functional improvement can be expected after arthroscopic bursectomy and scapuloplasty, the average postoperative ASES and SANE scores remain lower than expected. **Level of Evidence:** Level IV, retrospective case series.

The scapulothoracic articulation is a critical component of normal shoulder function. The convex chest wall and concave anterior scapula typically form a congruent articulation that is able to glide smoothly on the interposed muscular and bursal layers. Though uncommon, abnormalities within this articulation can result in pain or mechanical symptoms.[1,2] These disorders range from mildly symptomatic, intermittent bursitis to recalcitrant crepitus that may result in considerable pain and disability in some circumstances.[3]

Disorders of the scapulothoracic articulation can be characterized based on etiology.[4,5] When no mechanical symptoms are present, the pain is likely due to an overuse syndrome resulting in symptomatic bursitis. This is frequently seen in young active patients and overhead athletes.[6] By contrast, the presence of mechanical symptoms may indicate the presence of abnormal bony or soft-tissue morphology within the scapulothoracic articulation. Repeated impingement

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of these structural irregularities often results in concomitant inflammation, bursitis, and scapular snapping.

Literature supports initial nonoperative management regardless of the etiology of the scapulothoracic pain.[6] It is recognized, however, that bursitis occurring in the absence of an anatomic lesion responds more favorably to nonoperative management than when an anatomic lesion can be identified. When symptoms do not respond to nonsurgical measures or in the presence of structural abnormalities, surgical intervention is often necessary. Open techniques have historically resulted in substantial symptomatic relief.[2] However, release of muscular insertions from the scapula can result in considerable morbidity and may slow rehabilitation.[1,7]

Recently, arthroscopic techniques have been developed to minimize surgical morbidity, improve cosmesis, and accelerate rehabilitation. An understanding of the arthroscopic anatomy is critical to avoid the numerous neurovascular structures in this area, yet it is unfamiliar to many surgeons. There are also few clinical reports available to gauge the efficacy of an arthroscopic technique. The purpose of this study was to present the surgical outcomes of a large consecutive series of patients with scapulothoracic bursitis and describe an arthroscopic approach to scapulothoracic bursectomy and partial scapulectomy. It was our hypothesis that arthroscopic scapulothoracic bursectomy and partial scapulectomy would result in improved subjective shoulder outcome scores at a minimum of 2 years' follow-up.

METHODS

After obtaining institutional review board approval, we performed a retrospective review of prospectively collected data identifying all patients aged 18 years or older treated arthroscopically for snapping scapula syndrome in whom the index procedure had been performed a minimum of 2 years earlier. By use of these criteria, 23 shoulders in 21 consecutive patients were identified over a 4-year period.

Each patient described mechanical symptoms with failure of nonsurgical modalities and reported symptomatic relief from a local anesthetic injection placed along the involved scapular border before surgical intervention. Three-dimensional imaging was obtained in each patient before surgical intervention to confirm bursal inflammation, characterize bony anatomy, and rule out the presence of scapulothoracic masses. Despite a detailed analysis, none of the subjects had demonstrable bony anatomic abnormalities with 3-dimensional imaging. Pain levels preoperatively and at a minimum of 2 years postoperatively were assessed (using a 10-point visual analog scale [VAS], where 0 indicates no pain), in addition to American Shoulder and Elbow Surgeons (ASES),[8] Single Assessment Numeric Evaluation (SANE),[9] and QuickDASH (shortened version of the Disabilities of the Arm, Shoulder and Hand questionnaire)[10] shoulder-specific scores. Failures were defined as occurring in those patients requiring revision surgery for clinically persistent scapulothoracic crepitus. Overall patient satisfaction with surgical outcome was also recorded. A univariate Wilcoxon rank sum test and χ^2 were used for analysis of data. Significance was established at $P \leq .05$.

Arthroscopic Anatomy

The scapula is stabilized on the chest wall by its surrounding musculature and is connected to the axial skeleton through the acromioclavicular and sternoclavicular joints. The levator scapulae and rhomboid musculature attach to the medial border of the scapula.[3] The dorsal scapular nerve and artery run just deep to this musculature, approximately 1 to 2 cm medial to the medial border of the scapula (Fig 1). The trapezius muscle originates from the thoracic and cervical spinous processes and inserts along the scapula,

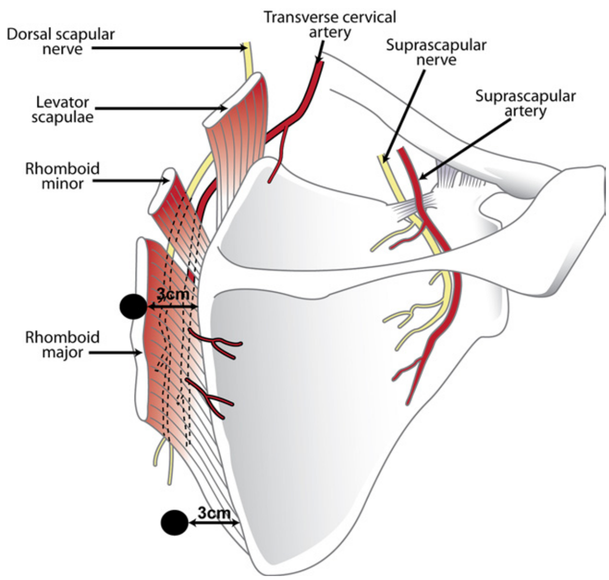

FIGURE 1. Posterior view of right scapula showing the relevant neuroanatomy bordering the scapula. It should be noted that the portal sites are approximately 3 cm medial to the medial scapular border to avoid these structures.

superficial to the rhomboid musculature. The trapezius is innervated by the spinal accessory nerve, which runs deep to the muscle with the superficial branch of the transverse cervical artery. The main branches of these structures are at risk with portal placement cranial to the scapular spine.

The serratus anterior and subscapularis muscles are interposed between the chest wall and anterior scapula and provide a soft-tissue articulation for the scapulothoracic joint.[11] The serratus anterior originates from the ribs and inserts on the anterior surface of the medial scapula. It is innervated by the long thoracic nerve, which lies on its anterior border. The anterior surface of the scapula is the origin of the subscapularis, which is innervated along its anterior border by the upper and lower subscapular nerves. These structures are generally at low risk for injury during an arthroscopic resection.

The suprascapular notch is located just lateral to the junction of the medial two-thirds and lateral one-third of the superior border of the scapula. The suprascapular nerve and artery run toward the notch from an anterior and cranial origin. An accessory superior portal can be made at the junction of the medial one-third and lateral two-thirds of the distance between the superomedial angle and lateral acromion to facilitate resection of the superomedial scapula.[12] Although we do not routinely use this portal, it avoids neurovascular structures near the superomedial scapular angle and the suprascapular neurovascular bundle more laterally.[13]

Bursal tissue lies between muscular planes and facilitates gliding of the scapulothoracic joint (Fig 2). The supraserratus and infraserratus bursae are reliably present in dissections and at endoscopy.[14] The infraserratus bursa is located anterior to the serratus anterior, between it and the chest wall.[3,15] Conversely, the supraserratus bursa is located between the subscapularis and serratus anterior.[3]

Minor bursae are also described but are inconsistently present and typically found in response to pathologic scapulothoracic motion.[3,6,7] Typically, 4 are described and are located at the inferior angle of the scapula, superomedial border of the scapula either deep or superficial to the serratus anterior muscle, and deep to the trapezius muscle located at the medial base of the scapular spine. Preoperative evaluation is critical to determine which of these bursae are symptomatic; however, bursae located along the superomedial border and inferior angle of the scapula are most commonly symptomatic.[7]

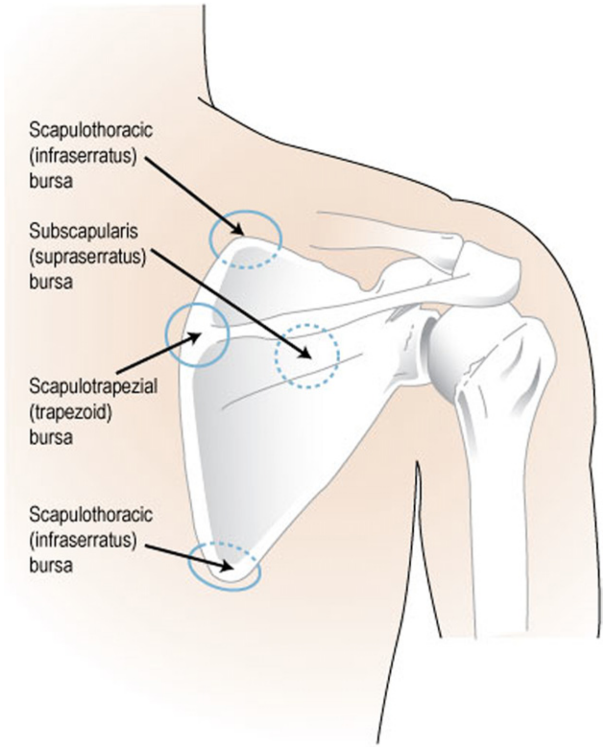

Figure 2. Posterior view of right scapula showing the anatomic location of bursae that commonly become inflamed and symptomatic. Dotted lines indicate areas underlying the bony scapular borders.

Technique

The patient is positioned in the prone position with the nonoperative arm tucked to the side. The posterior thorax is prepared widely, and the operative extremity is placed into a sterile stockinet. The dorsum of the operative hand is positioned into the small of the back, effectively placing the glenohumeral joint into extension and near maximal internal rotation. This position is commonly known as the "chicken-wing position" (Fig 3). Winging of the scapula aids portal placement by increasing the potential space between the scapula and the chest wall.[1,7] Additional separation may be accomplished by placing a medially directed force on the lateral shoulder, causing additional bayonet apposition of the scapular body.

Bony landmarks and symptomatic points confirmed before anesthesia were marked, and approximately 100 mL of normal saline solution with bupivacaine and epinephrine was infused to distend the infraserratus bursa and improve surgical hemostasis. Portals were established 3 cm medial to the medial scapular border and kept inferior to the scapular spine to reduce

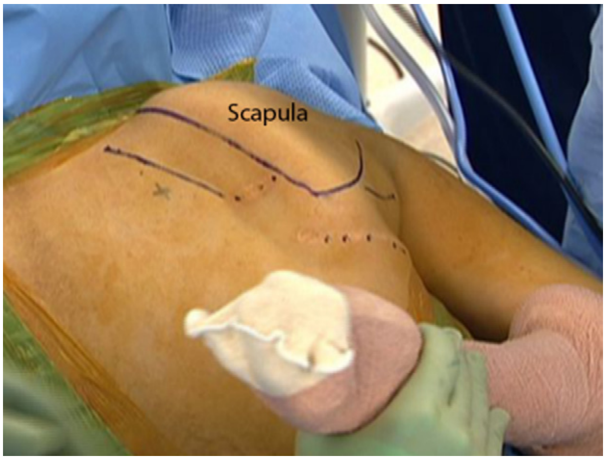

FIGURE 3. Surgically prepared right scapula with the patient in the prone position. The dorsum of the operative hand is positioned into the small of the back, effectively placing the glenohumeral joint into extension and near maximal internal rotation. This position is commonly known as the chicken-wing position.

the risk of injury to the main branches of traversing neurovascular structures. Medial placement also allows bursal entry more parallel to the chest wall, thereby decreasing the risk of thoracic penetration.[11]

An initial viewing portal was made 3 cm medial to the inferomedial angle of the scapula, and a 30° arthroscope was introduced (Fig 2). Fluid pressure was routinely maintained at or below 50 mm Hg. A second medial portal was placed by triangulation, located 3 cm medial to the scapula just inferior to the medial confluence of the scapular spine (Fig 2). A diagnostic arthroscopy was performed once adequate visualization was established. The intercostal muscles and ribs were visualized inferiorly, the subscapularis was visualized laterally, and the rhomboid and levator musculature was identified medially. A spinal needle was placed along the superomedial scapular border for additional orientation (Fig 4). Red muscle fibers of the subscapularis were not resected because a shaver or radiofrequency ablator was used to clear bursal tissue and fibrous bands in order to skeletonize the superomedial scapular border. The supraserratus bursa was accessed similarly by bluntly penetrating the serratus anterior.

The superomedial angle of the scapula was exposed by removing the underlying muscular attachments with a radiofrequency probe. If crepitus or snapping of the scapula was clinically evident after the superomedial angle of the scapula was exposed, spinal needles were placed to mark the extent of the planned resection.[1] An arthroscopic scapuloplasty was then performed with a high-speed bur, removing a triangular section of bone of approximately 2 cm (superior to inferior) by 3 cm (medial to lateral). Resection adequacy is determined by removing the scapular border convexity as determined arthroscopically and typically requires resection of 2 to 3 cm of bone (Fig 4). A dynamic examination of the scapula with the patient under anesthesia should also be routinely performed to ensure adequate clearance to ensure that residual mechanical crepitation does not persist. The suprascapular nerve can be at risk if this resection is taken too far laterally. To ensure that the nerve is protected, arthroscopic instruments should proceed no further than the spinal needle placed to mark the extent of scapular resection.[12] The resection is viewed from both portals to ensure that it is smooth and that there is adequate clearance (Figs 5 and 6). Because the scapular bone is quite thin, a rasp is typically used to contour resected edges. The arm is dynamically ranged to ensure that no mechanical crepitation remains.

A superior accessory portal has also been described to aid the resection of the superomedial scapula.[12,13] It is located at the junction of the medial one-third and lateral two-thirds of the distance between the superomedial scapular angle and the lateral acromion. The trocar is advanced in a medial and caudal direction. It is important to remain relatively close to the anterior portion of the scapula to avoid intrathoracic penetration. Although this portal can be helpful, it was not used in this series. Portals are closed routinely, and a sling is applied postoperatively.

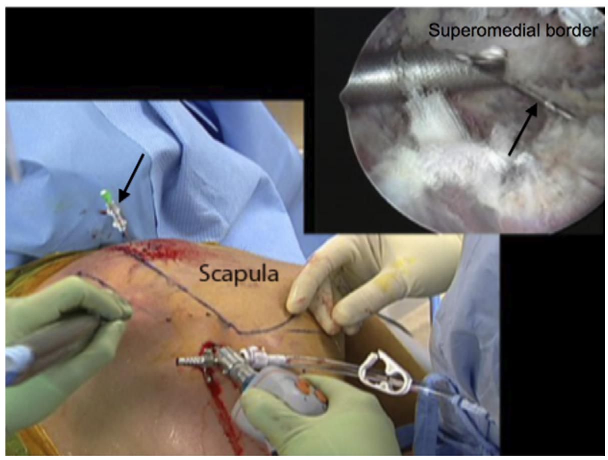

FIGURE 4. Intraoperative image of a right scapula in the prone position. A second medial portal may be placed by triangulation, located 3 cm medial to the scapula, just inferior to the medial confluence of the scapular spine. A spinal needle (arrow) can be placed along the superomedial scapular border for additional orientation.

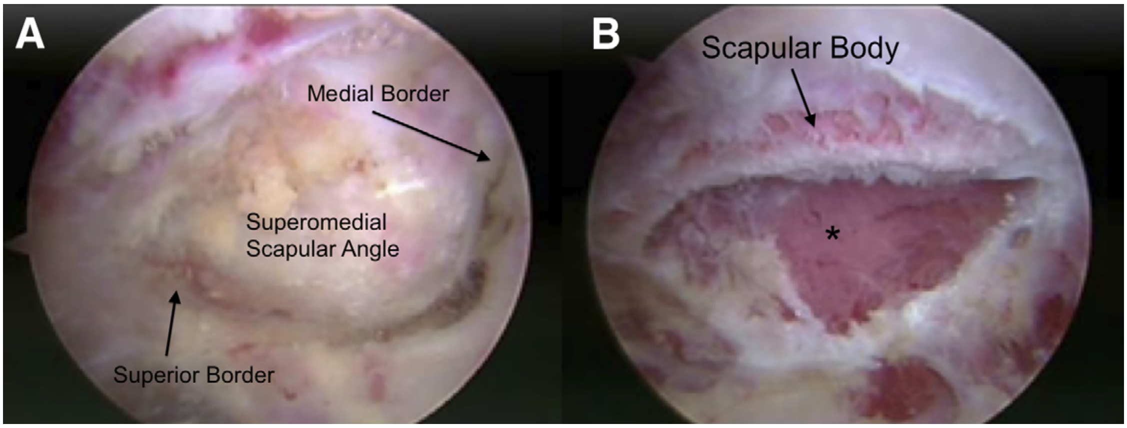

FIGURE 5. Arthroscopic images of a left scapula with the patient in the prone position from the inferomedial scapular portal (A) before and (B) after resection of the superomedial border of the scapula (asterisk).

Rehabilitation

Arthroscopic bursectomy and scapuloplasty are typically performed as outpatient procedures; a sling is applied for postoperative comfort only, and its use is discontinued within the first 48 hours postoperatively. Because there is no true joint capsule, there is typically a moderate amount of swelling that occurs that can extend into the ipsilateral breast. This typically resolves within a few hours postoperatively. Active and passive motion begins immediately and includes scapular protraction and retraction. Patients are then allowed to progress as tolerated under the guidance of an experienced therapist. Patients typically begin isometric strengthening of the glenohumeral joint at 4 weeks, and periscapular strengthening begins around the eighth postoperative week. Return to sports and overhead activities typically occurs around the second to third postoperative month based on progress with therapy.

RESULTS

Minimum 2-year follow-up was available for 21 of 23 shoulders (91%). The mean age at the time of scapula surgery in this series was 33 years (range, 19 to 58 years). There were 12 men and 9 women. The median duration of symptoms before presentation was 2.0 years (range, 2 months to 12 years). No scapulo-

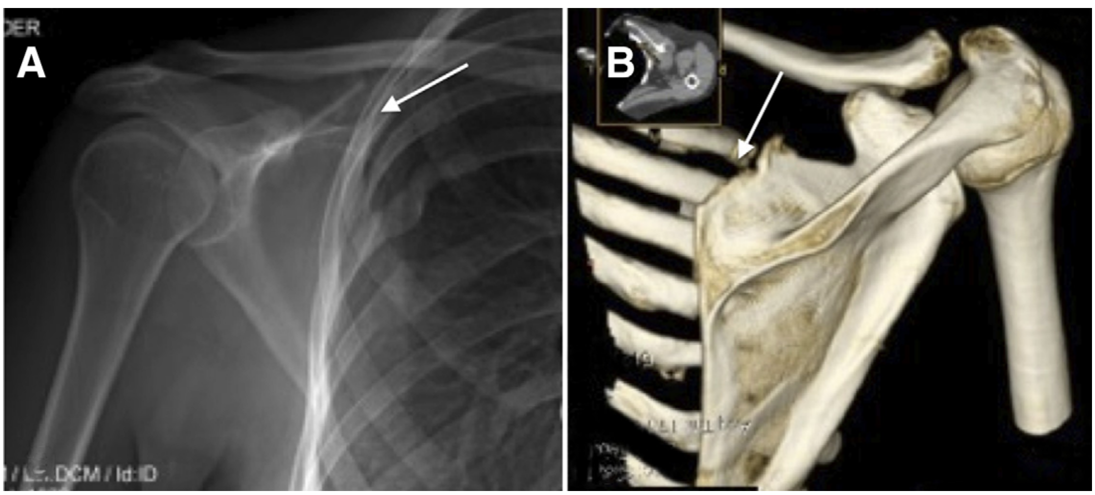

FIGURE 6. (A) Anteroposterior shoulder radiograph and (B) 3-dimensional computed tomography reconstruction of a right shoulder after arthroscopic scapuloplasty and bursectomy. The absence of the superomedial scapular angle (arrows) should be noted.

thoracic bony or soft-tissue masses were identified on 3-dimensional imaging. A scapulothoracic bursectomy alone was performed in 2 shoulders because of the lack of mechanical symptoms on physical examination.

At a mean follow-up of 2.5 years (SD, 0.6 years), a significant improvement in the median ASES score was noted, improving from 53 points (range, 17 to 83 points) preoperatively to 73 points (range, 32 to 100 points) postoperatively ($P < .001$). The median VAS score for pain at its worst decreased from 9 (range, 5 to 10) to 5 (range, 0 to 10) ($P < .001$). The mean SANE and QuickDASH scores at follow-up were 74 (SD, 27) (range, 15 to 100) and 35 (SD, 30) (range, 0 to 89), respectively. Patient satisfaction with surgical outcome was 6 of 10 (range, 1 to 10). Overall patient satisfaction was higher in women (9 of 10; range, 2 to 10) than in men (2 of 10; range, 1 to 9) ($P = .043$).

A correlation between age and both ASES scores ($\rho = -0.616$, $P = .006$) and overall patient satisfaction ($\rho = -0.675$, $P = .004$) was identified. This correlation indicates that younger patients had smaller improvements in the ASES score and were less satisfied with their outcome overall. Patients who underwent arthroscopic bursectomy alone were significantly less satisfied with the procedure compared with those who received both bursectomy and scapuloplasty ($P = .045$).

Two patients required ipsilateral shoulder surgery unrelated to the scapula after the index procedure (glenoid fracture, subacromial decompression with biceps treatment) postoperatively. Of 23 shoulders, 3 (13%) were revised for persistent pain and scapulothoracic crepitus and were considered failures. Two shoulders underwent a revision scapuloplasty at 4 weeks and 16 months, whereas the third shoulder underwent a scapulothoracic bursectomy 7 months after the index procedure without additional symptomatic improvement. No surgical complications were noted in this series of patients.

DISCUSSION

This series shows that a significant improvement in both the ASES score and VAS score for pain can be achieved after arthroscopic management of scapulothoracic crepitus. It appears that this technique provides a reliable and safe method of decompression for surgeons with a thorough appreciation of arthroscopic scapulothoracic neuroanatomy. It is also apparent that although symptomatic improvement with surgery was considerable, incomplete resolution of symptoms occurred.

Although the cause of persistent pain despite scapuloplasty and complete bursectomy remains unclear, several possible explanations exist. First, superomedial adventitial bursae may exist in an infraserratus or supraserratus location.[14] Unless directly accessed or a scapuloplasty is performed, only the infraserratus bursa is typically removed. Therefore incomplete pain resolution may occur if this bursa is symptomatic and not addressed. For this reason, it is now our routine practice to expose this border in all patients regardless of the presence of mechanical symptoms. Alternatively, recurrent fibrous adhesions have been noted in several revision cases. It is possible that these adhesions become symptomatic in some patients and can be addressed with revision bursectomy and physical therapy.

Snapping scapula syndrome can be managed successfully with a focused scapulothoracic and shoulder girdle rehabilitation program in many patients.[15] When appropriately applied, success rates of these programs have been reported to resolve symptoms in 50% to 80% of patients.[16,17] Therapeutic exercise appears to be most successful in patients in whom no anatomic abnormality can be identified on imaging studies. Under these circumstances, bursal irritation is typically the result of shoulder girdle overuse syndromes and responds well to activity modification, nonsteroidal agents, or therapeutic injection.

Scapulothoracic bursitis and snapping scapula syndrome have traditionally been managed using open surgical techniques.[2] In general, authors have reported successful outcomes using open procedures and appear to respond more favorably when a structural abnormality is present.[14,18-24] Other authors have similarly reported high rates of subjective pain relief and return to desired activity levels in this patient population.[2,25] The results of arthroscopic management of snapping scapula syndrome appear to be similarly successful in small cohorts of patients.[15,26]

Comparative studies of open and arthroscopic surgical techniques are not currently available to our knowledge. For this reason, the optimal management technique is not firmly established.[27,28] Arthroscopic approaches, however, may provide several advantages over traditional open techniques. To this end, muscles are typically detached and ultimately repaired to the medial border of the scapula during open procedures. Muscular detachment may increase surgical morbidity and dysfunction if the repair fails or denervation occurs. Avoiding muscular detachment may also facilitate accelerated rehabilitation protocols. By contrast, it is clear that arthroscopic intervention is a technically demanding procedure primarily because surgeons are unfamiliar with the arthroscopic anatomy of this region.

Although outcomes detailing the open or arthroscopic surgical management of snapping scapula syndrome appear encouraging, more quantitative reports indicate that some magnitude of disability persists postoperatively. Lien et al.[29] reported a significant improvement in ASES and pain scores in a series of 12 patients. Despite this improvement, the mean postoperative ASES and pain scores were 88 and 2.3 points, respectively. Other authors have reported that in the absence of a discernible bony abnormality, satisfactory outcomes are achieved in only 70% of patients.[30] Our series supports these findings and suggests that a significant improvement in patient satisfaction scores and pain levels can be reliably expected. Yet, to date, surgical intervention is not likely to relieve all shoulder symptoms or restore normal shoulder function in all patients. This is an important patient education consideration when discussing surgical intervention with prospective patients.

We acknowledge several limitations to this study. The data were retrospectively reviewed; however, recall and observation biases were minimized by the prospective data collection of our clinical database. In addition, the series size precludes detailed analysis of specific prognostic indicators for patient outcomes, and a comparative group was not included in this series. Considering the rarity of this disorder and the frequent success of nonsurgical intervention, a large series capable of this type of analysis will be difficult to accrue. Two patients subsequently required ipsilateral shoulder surgery unrelated to the index procedure (glenoid fracture, subacromial decompression with biceps treatment). It is unclear what effect these additional procedures had on reported outcomes.

CONCLUSIONS

Snapping scapula syndrome can be a debilitating disorder. Although significant pain and functional improvement can be expected after arthroscopic bursectomy and scapuloplasty, the average postoperative ASES and SANE scores remain lower than expected.

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