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## Compression of the suprascapular nerve by a ganglion cyst of the spinoglenoid notch: the arthroscopic solution

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**Abstract** We evaluated an all arthroscopic technique for treating suprascapular nerve entrapment by cyst formation in the spinoglenoid notch. Eight patients showed positive MRI and EMG findings with clinical sign of weakness and pain and with atrophy of the muscle. All patients underwent an all-arthroscopic procedure. The patients were evaluated preoperatively and 6 weeks and 3 months postoperatively and for the latest follow-up by clinical examination, MRI, and EMG. All patients improved in terms of pain, strength, and function. We found six superior labrum anterior and posterior

(SLAP) lesions. In these patients the cyst was drained, and the SLAP lesion was repaired. In two patients there was no communication between the joint and the cyst, and therefore capsulotomy was performed and left open. The results of our study show that arthroscopic decompression of the suprascapular nerve can be achieved by an all arthroscopic technique if the cyst formation is located at the spinoglenoid notch.

**Keywords** Arthroscopy · Ganglion cyst · Spinoglenoid notch · Suprascapular nerve entrapment

### Introduction

Suprascapular nerve compression is a rare [8, 44] but important entity that is often missed in clinical practice. It causes varying degrees of supraspinatus and/or infraspinatus atrophy, weakness of abduction and external rotation of the shoulder, and vague shoulder pain (Fig. 1). Compression can occur along the whole course of the suprascapular nerve by trauma [4, 12, 13, 49], neuritis [23, 32], or progressive compressive lesion [4]. Traumatic causes include direct trauma with fractures of the scapula, direct compression of the nerve, repetitive overuse, and forceful rotational motions with crushing or stretching the nerve [16, 24, 49]. The anatomy has been well described. The nerve is a mixed motor and sensory peripheral nerve arising from the superior trunk of the brachial plexus (fifth and sixth cervical nerves) with a variable contribution from the fourth cervical nerve root of about 22% [30]. The nerve runs through the posterior triangle of the neck and then lateral towards the supraglenoid notch. Here the supragle-

noid artery and vein cross the superior transverse ligament superiorly whereas the nerve passes beneath the ligament through the notch. After passing the notch the nerve releases a motor branch that usually innervates the supraspinatus muscle by means of two branches [6, 31, 35, 47]. A superior articular branch sends sensory fibers to the coracoclavicular and coracohumeral ligaments, the AC-joint and the subacromial bursa [1, 31]. Then the suprascapular nerve continues inferiorly towards the spinoglenoid notch and gives off another sensory branch to the posterior aspect of the glenohumeral joint capsule [10]. The nerve then courses around the scapular spine and passes through a fibro-osseous tunnel formed by the spinoglenoid ligament and the spine of the scapula. There it terminates in two, three, or four motor branches innervating the infraspinatus muscle [6, 31, 35, 47].

Two regions of lesions must be differentiated: (a) lesions at the supraglenoid notch and (b) lesions at the spinoglenoid notch. Lesions at the supraglenoid notch are caused by anatomical variants of the notch itself and by the superior transverse ligament [9, 10, 13, 14, 37, 38]. Patho-



**Fig. 1** Atrophy of the infraspinatus fossa

logical conditions such as calcifications bifid and trifid ligaments or hypertrophy have been described [2, 20, 45]. Furthermore, fractures involving the supraglenoid notch are responsible for traumatic lesions of the suprascapular nerve. Suprascapular nerve dysfunction at the supraglenoid notch, abbreviated SNES by Vastamäki and Göransson [48], was first described by Thomas [43] in 1936 but not under this term and later by Kopell and Thompson [28] in 1959 and involves the supraspinatus and infraspinatus muscle. Vague pain can also be present because proximal lesions of the nerve are more likely to cause pain than more distal ones.

Lesions at the spinoglenoid notch (suprascapular nerve entrapment inferior, SNEI), can be due to entrapment of the nerve beneath the spinoglenoid ligament. Especially overhead athletes such as volleyball, football, baseball, and tennis players complain of weakness and little pain. Several authors have hypothesized that the nerve is injured as a result of the anatomy of the spinoglenoid notch and the stress that is placed on the nerve by repetitive overhead activities [7, 11, 16, 17, 26, 29, 39, 40]. Another reason for injury of the nerve can be compression by a mass, most likely by a ganglion cyst. Other masses such as synovial sarcoma, Ewing sarcoma, chondrosarcoma, bone cyst, and metastatic renal-cell sarcoma have been reported [19, 41].

In our series we deal with patients having suprascapular nerve compression at the spinoglenoid notch (SNEI). The aim of our study was twofold. First we describe the surgical technique for the shoulder arthroscopist and, second, to determine whether the arthroscopic procedure with closure of the one-way valve mechanism is sufficient to decompress the suprascapular nerve and restore normal function of the shoulder.

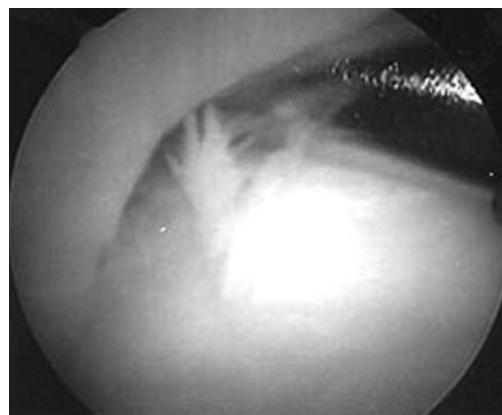
## Material and methods

Between July 1998 and November 2001 eight patients underwent surgical treatment for cysts at the spinoglenoid notch. Mean age was 39 years (range 24–58) at time of surgery; there were seven men and one woman. The one woman was the only patient involved in an overhead sport (tennis); all of the others participated either in no sports or only in sports without overhead stress. The patients presented to our Department for weakness and/or pain of the involved shoulder that has been bothering them for a mean of 9.25 months (2–36). Except one patient who reported the onset of symptoms after a clavicle fracture no patient could recall a traumatic episode causing their complaints.

All patients had a preoperative magnetic resonance imaging (MRI) and electromyography (EMG) studies that led to the diagnosis of compression of the suprascapular nerve by a cystic formation at the spinoglenoid notch. Other pathologies such as cervical spine degeneration or disc herniation, central neurological disorders, and rotator cuff lesions were ruled out. The patients were routinely followed at 6 weeks, 3 months, and now for the latest follow-up after a mean follow-up period of 27 months (13–49 months). At the latest follow-up MRI and EMG studies were carried out. EMG studies were performed by neurologists in the patient's home town and not by the authors. The clinical examination was rated according to the score of Constant and Murley. The Simple Shoulder Test of the University of Washington was used to evaluate patients' subjective function and satisfaction. The significance of differences between pre- and postoperative values was tested by the paired *t* test and was set at  $P < 0.05$ .

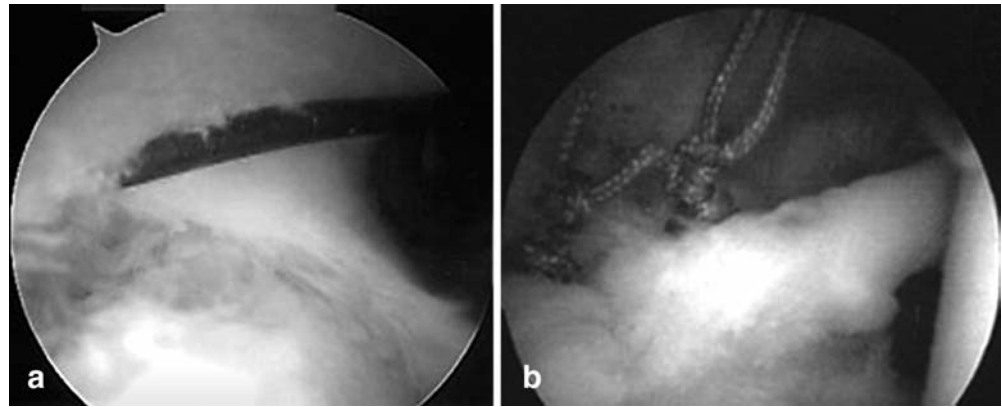
## Operative technique

After examination under anesthesia the patient was placed in a semisitting beach-chair position. A standard posterior portal was established and diagnostic arthroscopy was performed. In the case of a superior labrum anterior and posterior (SLAP) lesion the lesion is probed after creation of an anterior portal with a cannula. The SLAP complex is lifted, and the probe is easily passed underneath the labrum into the spinoglenoid notch (Fig. 2). Then a third posterolateral portal (port of Wilmington) is created, and the



**Fig. 2** SLAP lesion viewed from a posterior portal and inspected with a probe. The probe is easily passed underneath the SLAP lesion into the cyst

**Fig. 3** The cyst is drained by manual pressure onto the infraspinatus fossa. **a** A rod or probe can be used to keep the valve open. Thereafter a SLAP repair is performed. **b** Final result



arthroscope is switched to that portal, the SLAP lesion is mobilized either from the anterior or the posterior. The entrance to the cyst is widened using a rasp or a meniscus punch, and the cyst is drained into the joint by putting manual pressure into the infraspinatus fossa; the nerve is decompressed (Fig. 3a). Then a formal SLAP repair is performed. We prefer the use of biodegradable suture anchors (Bio-FASTak, Arthrex, Naples, Fla., USA). Depending on the size of the lesion and its extension posteriorly or anteriorly one to three anchors must be inserted (Fig. 3b).

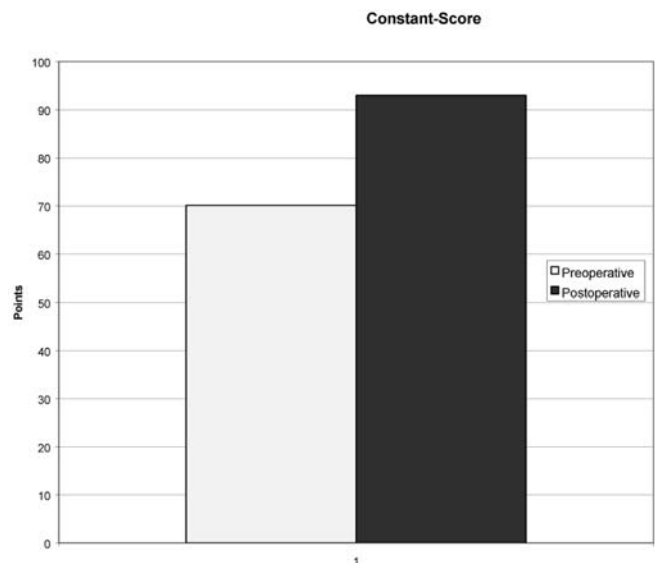
If no SLAP lesion is detected, a capsulotomy is performed. For this a knife or punch is inserted from the posterior portal with the scope in the lateral portal, and the joint capsule is incised superior to the glenoid labrum. The incision must be large enough to drain the cyst sufficiently. The incision is left open. In both cases the cyst's membrane is débrided using a slotted whisker shaver. This prevents harm to the nerve. At the end of the procedure a drain is inserted into the joint that is removed 24 h postoperatively. After a SLAP repair the shoulder is immobilized for 3 weeks in an abduction pillow of 20° abduction, with immediate passive mobilization within 60° of abduction and flexion, and 0° of external rotation. After 6 weeks and free passive range of motion (ROM) active exercises and muscle strengthening is commenced. Return to athletic or overhead activity is allowed not before 3 months. After capsulotomy the arm is immobilized for 24 h, and early passive ROM exercises are begun for 3 weeks. Then active ROM exercises commence.

## Results

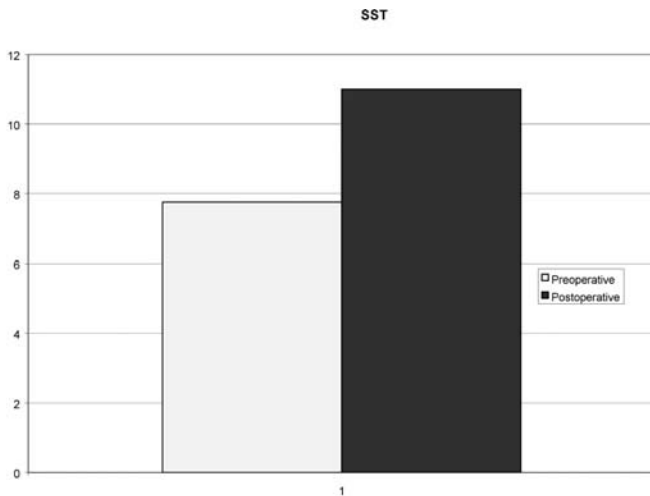
The preoperative Constant score was 70 out of 100 possible points. Preoperative MRI showed ganglion cysts in all patients. In four cases the MRI was suspicious for a SLAP lesion. Seven of the EMG studies confirmed compression of the suprascapular nerve, with three showing involvement of both infra- and supraspinatus muscles. One patient with normal EMG complained only of pain as his single problem; all others experienced weakness for external rotation. Pain was not a symptom in three patients, and three showed

additional weakness for abduction. Visible atrophy of the infraspinatus muscle in the infraspinatus fossa was noted in seven of the eight patients. At examination under anesthesia five patients showed increased anterior/posterior translation, in one with a noticeable click phenomenon. No patient suffered from instability, and no dislocations were reported. Six SLAP lesions were detected during surgery: one type I, one type IV, and four type II. Capsulotomy was performed in two patients without a SLAP lesion. The patient with the SLAP type I lesion underwent nerve decompression and débridement of the SLAP region; the other patients with SLAP lesions underwent decompression of the suprascapular nerve by draining the cyst and formal suture anchor SLAP repair.

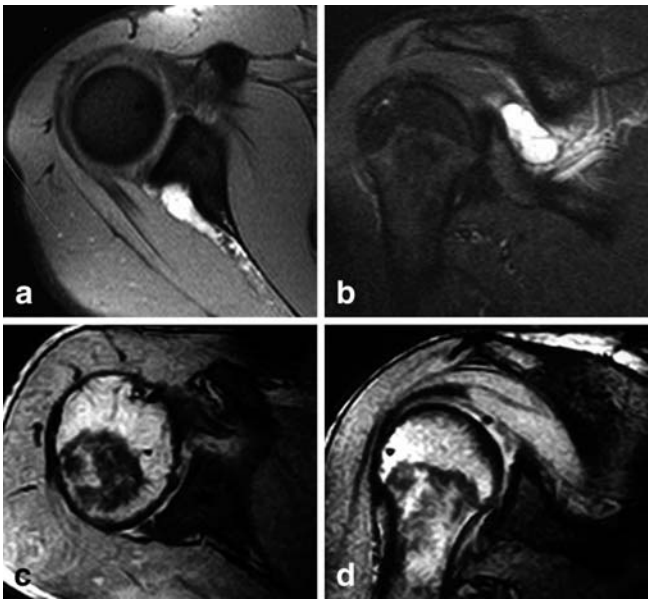
After a mean follow-up of 27 months (13–49) the mean postoperative Constant score had improved significantly to 93 points ( $P < 0.000035$ ; Fig. 4). One patient suffered from a postoperative frozen shoulder with remaining limited ROM (Constant score 79). The Simple Shoulder Test improved from 7.75 yes answers to 11 yes answers post-



**Fig. 4** Pre- and postoperative Constant scores



**Fig. 5** Pre- and postoperative Simple Shoulder Test results



**Fig. 6** a, b Preoperative MRI of a right shoulder (patient no. 8) showing cyst formation at spinoglenoid notch. c, d Postoperative MRI control of the same patient; no recurrence of the cyst formation

operatively ( $P < 0.02$ ; Fig. 5) MRI follow-up showed no recurrence of the cyst (Fig. 6), and EMG was normal in all patients including the one who already had normal EMG preoperatively. The other patients except the one with a frozen shoulder reported normal shoulder function compared to the contralateral shoulder. EMG studies all showed remission of the neurogenic lesion. Atrophy in the infraspinatus fossa was also fully reversible. All patients reported normal external rotation strength (see also Table 1). Follow-up MRI revealed no recurrence in seven patients and recurrence or persistence in one. In this patient (no. 2) the remaining cystic mass was so small that it did not lead

to nerve entrapment syndrome. The patient showed normal function at follow-up with no pain. No peri- or postoperative complications occurred except in the patient with the frozen shoulder.

## Discussion

The anatomy of the suprascapular nerve is well described in the literature, and the possible ways of damaging it are well known. Ganglion cysts, one possible cause of damage, compress the nerve at the spinoglenoid notch and depending on their size also irritate the supraspinatus motor branches, lead to external rotation and abduction weakness and vague pain [36]. The cysts form either because of a lesion of the capsulolabral complex at the superior/posterosuperior glenoid in the shoulder [18, 33, 45, 46] or because of myxoid degeneration of the capsule [27]. The exact genesis of cystic formation at the spinoglenoid notch has not yet been accurately elucidated. Some authors believe it to be due to lesion of the capsulolabral complex of the glenohumeral joint because at surgery they have found these lesions. These lesions may be traumatic or due to repetitive overuse and show avulsion of the labrum off the glenoid rim, similar to a SLAP lesion. Joint fluid then drains out of the joint through these lesions, thus forming a cyst with a one-way valve mechanism [8, 15, 25, 46]. Others have detected no communication with the joint and believe that formation of the cysts originates within the fibers of the posterior glenohumeral joint capsule [3, 21, 27, 34, 42, 44]. Ferrick and Marzo [18] postulate that there are two different types of these periarticular cysts, with the mechanisms taking place in different situations.

The size of the cyst is variable. It can measure only a few millimeters, causing only symptoms in the infraspinatus muscle, or it can be as huge as to extend into the spinoglenoid notch [3], compressing also the motor branches of the supraspinatus and the sensory branches causing pain. In our series six patients showed concomitant lesions of the capsulolabral complex in terms of a SLAP lesion; only in two patients no communication between the joint and the cyst was found.

Treatment options for ganglion cysts at the spinoglenoid notch vary from conservative means to operative excision of the cyst. Aspiration guided by ultrasound or computed tomography is the less invasive method. In the literature eight cases are reported with one recurrent symptomatic cyst [5, 19, 22, 46]. The gold standard for cysts causing suprascapular nerve entrapment with positive EMG studies is open excision as reported in many studies. In a review article Cummins et al. [10] counted 28 cases of open excision of the ganglion cyst with adequate follow-up information in which the glenohumeral joint was not inspected by arthroscopy. The results showed complete resolution of pain in all but one patient. Strength also improved in the majority of patients; improvement in muscle

**Table 1** Summary of patients' characteristics, including pre- and postoperative Constant scores (CS), Simple Shoulder Test (SST), and symptoms; cyst size in millimeters measured on the coronal slices of MRI (ER weakness on external rotation, ABD weakness on abduction, EUA examination under anesthesia)

	Patient no. 1	Patient no. 2	Patient no. 3	Patient no. 4	Patient no. 5	Patient no. 6	Patient no. 7	Patient no. 8
Sex	Male	Male	Male	Male	Male	Female	Male	Male
Age (years)	34	37	44	24	51	58	39	25
Occupation, sport	Baker	Physician, fitness	Salesman	Med. student, skater	Physician	Architect, tennis	Salesman, fitness	Med. student, rowing
Duration of symptoms (months)	3	3	3	12	6	9	36	2
Onset	No trauma	No trauma	No trauma	Clavicle	No trauma	No trauma	No trauma, re-cyst after open surgery	No trauma
Symptoms	ER	ER, ABD pain	ER	ER ABD	ER pain	ER ABD pain	Pain	ER pain
Size preop. coronal	20×8	18×8	18×6	15×8	18×8	15×7	20×10	14×8
Size postop. coronal	None	6×3	None	None	None	None	None	None
Pathology	None	None	SLAP IV	SLAP II	SLAP II	SLAP I	SLAP II	SLAP II
Treatment	Capsulotomy	Capsulotomy	Decompression, SLAP repair	Decompression, SLAP repair	Decompression, SLAP repair	Decompression, débridement	Decompression, SLAP repair	Decompression, SLAP repair
CS preop.	80	76	55	85	64	63	63	75
CS postop.	100	100	88	100	79	85	96	96
Follow-up (months)	18	30	40	22	19	49	19	13
Function at follow-up	Normal	Normal	Normal	Normal	Status post frozen shoulder	Normal	Normal	Normal
SST preop.	10	8	6	11	8	6	8	5
SST postop.	12	12	12	12	5	11	12	12
EUA	2+ ap 2+ sulcus	Normal	Normal	2+ ap 1+ sulcus	2+ ant 2+ sulcus	Normal	Click 1+ ant	2+ ant 2+ sulcus

atrophy was the slowest. Three symptomatic cysts recurred, and in three patients the cysts were found intraoperatively. This demonstrates the need for an accurate evaluation in preoperative diagnostics. The disadvantages of the two options are the inability to assess the glenohumeral joint and identify or treat intra-articular lesions that may have contributed to the formation of the cyst. The last option involves arthroscopy. Some authors start with arthroscopic exploration of the joint to detect intra-articular lesions, such as capsulolabral ones, treat these arthroscopically and then perform open excision of the cyst. Fehrman et al. [15] reported six patients who underwent arthroscopic evaluation and open cyst excision. In all patients a posterior capsulolabral injury was detected and arthroscopically débrided. No repair was carried out. One patient reported only partial relief while the others showed complete relief. They concluded that arthroscopy adds to intra-articular diagnosis and treatment before open excision.

Moore et al. [33] examined 22 ganglion cysts, 16 of which were operated on by three different surgeons. Five of these 16 had open excision alone, six underwent a combined procedure, and in five arthroscopic decompression of the cyst alone was performed. At arthroscopy 10 of the 11 scoped shoulders were noted to have an associated SLAP lesion. In five the cyst was drained, and the SLAP lesions were repaired using the Suretac device (Acufex Microsurgical, Mansfield, Mass., USA). In the other six cases the cyst was not adequately seen, and therefore only the SLAP lesion was débrided, and the procedure was converted to open excision. Fifteen of the 16 operated patients had excellent results, not distinguishing between the type of operation. Fifteen follow-up MRI studies were performed, ten of which showed complete resolution of the cyst and four only partial resolution with a remaining size of less than 1 cm<sup>3</sup>. In one case there was no change in the size. At arthroscopy no SLAP lesion was found, and open excision led to an initial excellent result. After 9 months the patient developed symptoms, and MRI showed a recurrent cyst. At revision arthroscopy a small SLAP lesion was found which was believed to have been missed at the index arthroscopy.

Iannotti and Ramsey [25] are the only authors to treat cysts at the spinoglenoid notch by arthroscopy alone. They reported three patients whose cysts were decompressed through the labral tear or a capsulotomy near the junction of the capsule and the labrum if no tear was present. The ganglion was drained into the joint by manual pressure over the cyst. All three patients were pain free and returned to normal external rotation strength. Chochole et al. [8] performed arthroscopic repair of a SLAP lesion without drainage of the cyst in one case. The symptoms had resolved by 12 weeks, with negative follow-up MRI findings.

In our cohort we performed a suture anchor SLAP repair in those six patients in whom we found SLAP lesions and performed capsulotomy in the remainder. We believe that in the presence of a SLAP lesion the one-way valve

mechanism leading to the cyst formation must be closed thoroughly. In our experience the suture anchor repair is suitable for this goal. We do not have experience with the use of tacks. If there is no communication between the joint and the cyst in terms of a SLAP lesion, it is debatable whether the cyst is created by myxoid degeneration of the surrounding tissue. In these cases a large capsulotomy was performed and left open. The one patient showing a recurrent cyst is one of the two patients undergoing capsulotomy and drainage of the cyst.

In our follow-up MRI studies, all but one showed no recurrent cyst. We strongly believe that this is due to our surgical procedure, but one must bear in mind that the cysts often resolve by themselves, meaning that the symptoms would resolve regardless of whether surgery is performed. However, the patients presented with symptoms of nerve compression, and we found that surgery to decompress the nerve was indicated soon after establishing the diagnosis. The timing of follow-up MRI is in accordance with other studies. Iannotti and Ramsey [25] performed MRI follow-up 2, 4, and 5 months after surgery. No other author performed direct postoperative control.

Ferrick and Marzo [18] in a case report emphasized not only cyst formation but also possible concomitant instability of the shoulder. They performed open excision of a cyst. After initial improvement the patient complained of unchanged pain and reproduced a mechanical click on forward elevation. At examination under anesthesia a 2+ posterior instability was found. Arthroscopy revealed a labral tear at the 9 o'clock position which was repaired by a biodegradable tack. Three months postoperatively the patient believed his shoulder to be improved by 80%.

In our series five patients showed increased anteroposterior drawer testing and a positive sulcus sign was detected in four. A mechanical click was observed in one patient. Since the labral lesions always involved the SLAP complex, one can argue that these lesions lead to increased glenohumeral translation and inferior subluxation because the periarticular fiber system has been injured. On the other hand, all patients with a capsulolabral lesion should show increased translation. We think that the observed increase in translation is due mainly to a constitutional laxity of the joint capsule rather than to the labral lesion. No patients suffered from symptoms of instability or microinstability or had experienced dislocations prior to the surgery. Although there are no reports on complications with the large open approach, we believe that the open procedure increases perioperative morbidity. The results of our study can provide no empirical support for this because a control group that underwent open excision was not available. The results in our patients with resolution of weakness, atrophy, and pain underline that open excision in our hands is not necessary in ganglion cysts of the spinoglenoid notch.

In summary, in symptomatic ganglion cyst formations with suprascapular nerve entrapment we recommend ar-

throscopic exploration of the glenohumeral joint, arthroscopic drainage of the cyst, either through an existing SLAP lesion or through a juxtaglenoid capsulotomy, and formal repair of the SLAP lesion or leaving the capsulotomy open. The recommended treatment options have

yielded good results in the studied patients. Open excision with increased morbidity and a large surgical exposure should be reserved for cases that do not respond to the other treatment options.

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