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SHOULDER

Arthroscopic management of suprascapular neuropathy of the shoulder improves pain and functional outcomes with minimal complication rates

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Abstract
Purpose The purpose of this study was to systematically assess the arthroscopic management of suprascapular neuropathy, including the aetiology, surgical decision-making, clinical outcomes, and complications associated with the procedure.
Methods Three databases [PubMed, Ovid (Medline), and Embase] were searched. Systematic literature screening and data abstraction was performed in duplicate to present a review of studies reporting on arthroscopic management of suprascapular neuropathy. The quality of the included studies was assessed using level of evidence and the MINORS (Methodological Index for Nonrandomized Studies) checklist.
Results In total, 40 studies (17 case reports, 20 case series, 2 retrospective comparative studies, and 1 prospective comparative study) were identified, including 259 patients (261 shoulders) treated arthroscopically for suprascapular neuropathy. The most common aetiology of suprascapular neuropathy was suprascapular nerve compression by a cyst at the spinoglenoid notch (42%), and the decision to pursue arthroscopic surgery was most commonly based on the results of clinical findings and investigations (47%). Overall, 97% of patients reported significant improvement in or complete resolution of their preoperative symptoms (including pain, strength, and subjective function of the shoulder) over a mean follow-up period of 23.7 months. Further, there was a low overall complication rate (4%) associated with the arthroscopic procedures.
Conclusion While most studies evaluating arthroscopic management of suprascapular neuropathy are uncontrolled studies with lower levels of evidence, results indicate that such management provides patients with significant improvements in pain, strength, and subjective function of the shoulder, and has a low incidence of complications. Patients managed arthroscopically for suprascapular neuropathy may expect significant improvements in pain, strength, and subjective function of the shoulder.
Level of evidence Level IV, systematic review of level II to IV studies.

Keywords Suprascapular · Neuropathy · Shoulder · Arthroscopy

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Introduction

Suprascapular neuropathy is a relatively uncommon condition which manifests clinically as shoulder pain and disability including weakness of forward flexion, abduction, and external rotation [2, 40, 52]. Dysfunction of the suprascapular nerve can occur as the result of a compression or traction mechanism. The aetiology of this condition is variable and includes massive rotator cuff tears [32], rotator cuff tears associated with muscle atrophy and/or fatty infiltration [54], labral tears with associated para-labral cysts [13, 35, 53],

mass lesions impinging the suprascapular and/or spinoglenoid notches [19], and repetitive overhead activities [25]. Overall, suprascapular neuropathy is reported to be the cause of 1–2% of all shoulder pain, with a prevalence of up to 33% in overhead athletes [7, 60].

While activity modification, non-steroidal anti-inflammatory drugs, and physical therapy account for the major non-operative treatment modalities [33], surgical options aim to correct the cause of compression. These strategies range from aspiration and decompression of ganglion cysts, release of transverse scapular ligament at the suprascapular notch and/or spinoglenoid ligament at the spinoglenoid notch, repairing labral tears, and repairing rotator cuff tears. While historically many of these procedures had been performed via open procedures, numerous techniques have been described to approach the decompression of the suprascapular nerve arthroscopically [7].

Shoulder arthroscopy as a minimally invasive procedure has generally become increasingly popular as it lends many benefits over open surgery, including decreased risk of infection, less violation of soft tissue, improved post-operative pain, and shorter hospital stays [4]. In its application for suprascapular neuropathy, individual reports have reported positive outcomes [23, 37]. However, there has been no systematic review that has summarized the existing clinical literature on this topic. Therefore, the purpose of this study was to systematically assess the arthroscopic management of suprascapular neuropathy, including the aetiology, surgical decision-making, clinical outcomes, and complications associated with the procedure. It was hypothesized that shoulder arthroscopy provides patients with suprascapular neuropathy significant improvement in pain and function of the shoulder with relatively minimal complications.

Materials and methods

Search strategy

The methodology used in the present study is similar to that used in other systematic reviews conducted at the authors' institution [22]. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) statement was used for the reporting of study selection [34]. The online databases PubMed, EMBASE, and Ovid (Medline) were used to search for the literature addressing the use of shoulder arthroscopy for suprascapular neuropathy from database inception until 17 February 2017. The search terms "shoulder", "arthroscop*", and "suprascapular" were used (Appendix Table 4). No attempt was made to evaluate the grey literature since this evidence is not subject to the same transparency requirements and scrutiny as studies in peer-reviewed journals.

Study screening

Two reviewers independently screened the titles, abstracts, and full-text articles. Any disagreements were discussed between reviewers and a senior author (ORA) to determine study inclusion when necessary. The references of the eligible, included studies were then screened to include any additional articles that may not have been captured by the initial search strategy. The search strategy is outlined in Fig. 1.

Assessment of study eligibility

The research questions and inclusion and exclusion criteria were determined a priori. The inclusion criteria included English-language studies, human studies, and studies investigating arthroscopic management of suprascapular neuropathy. Studies of all levels of evidence and all study designs that reported any outcomes including pain, range of motion, complications, and outcome scores were included. The exclusion criteria included cadaveric studies, conference papers, book chapters, review articles, and technical reports with no outcome data.

Data abstraction

Two reviewers collected data in duplicate and recorded them in a Microsoft Excel 2007 spreadsheet (version 2007, Microsoft Inc, Redmond, Washington, USA). Data regarding study year of publication, author, study design, sample size, per cent female patients, age, follow-up, aetiology, history, physical examination, diagnostic investigations, conservative management, surgical decision-making, arthroscopic management, outcomes, and complications were abstracted from all included studies. Two reviewers independently evaluated the abstracts and assigned a level of evidence (levels I–IV) to each included study using the AAOS classification scheme [57].

Quality assessment

The two reviewers independently assessed the level of evidence (level I–level IV) of the included studies using the American Academy of Orthopedic Surgeons (AAOS) classification system [57]. The MINORS (Methodological Index for Nonrandomized Studies) checklist was used as well in order to assess the methodological quality of the included studies [49]. The MINORS checklist grades comparative studies out of a maximum score of 24 and non-comparative studies out of 16. The senior author was consulted for any discrepancy among the reviewers. All eligible studies were

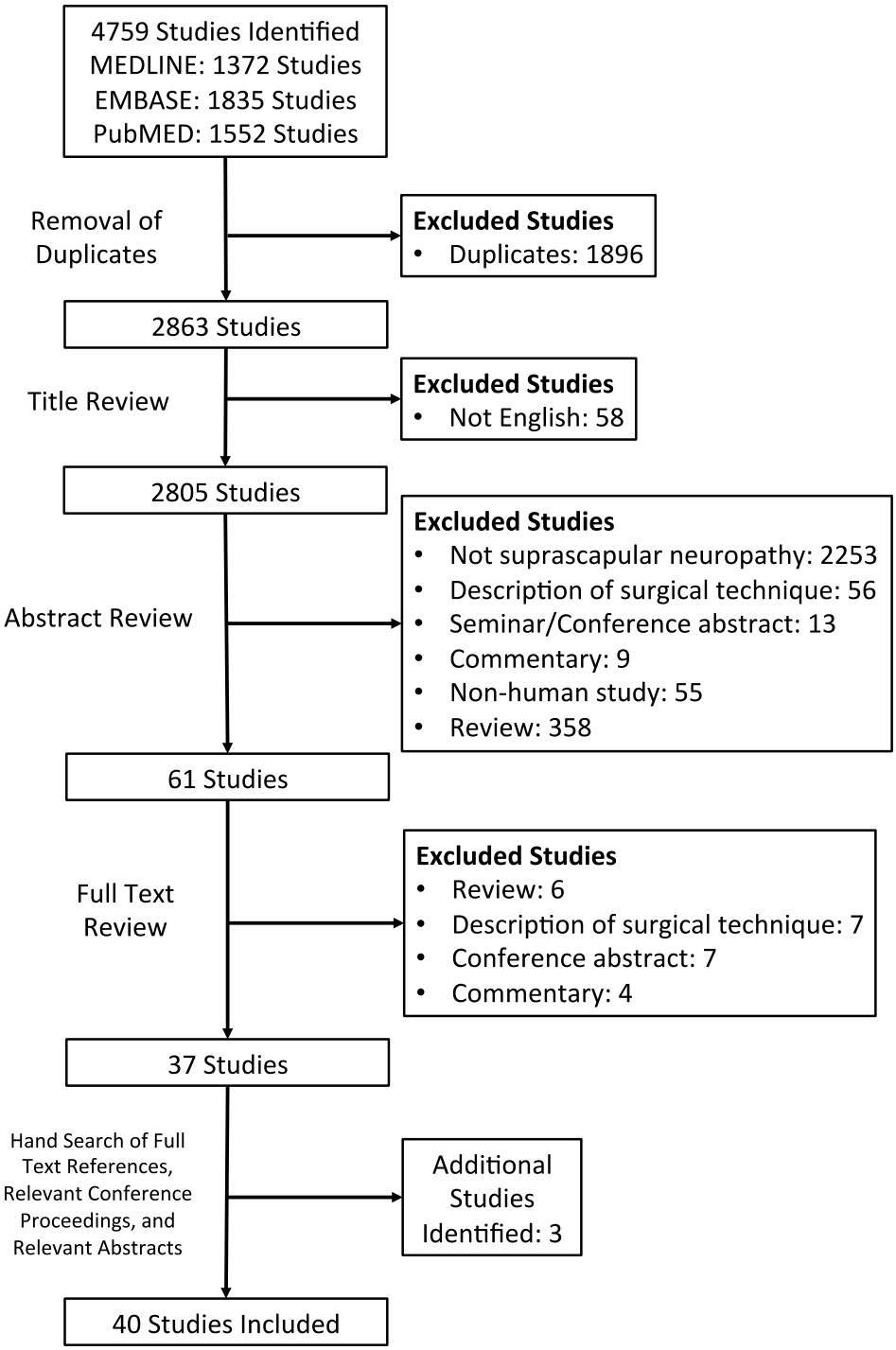

Fig. 1 PRISMA flow diagram demonstrating the systematic review of the literature for arthroscopic management of suprascapular neuropathy

included in this review regardless of level of evidence and study quality.

Assessment of agreement

Inter-reviewer agreement for the title, abstract, and full-text articles was calculated using a kappa (κ) statistic. An intraclass correlation coefficient (ICC) was calculated for the quality assessment using the MINORS criteria. Agreement was categorized a priori as follows: κ/ICC of 0.61 or greater was considered substantial agreement; κ/ICC of 0.21–0.60, moderate agreement; and κ/ICC of 0.20 or less, slight agreement [26].

Statistical analysis

The primary outcome assessed was pain (assessed via VAS and NRS scores), particularly the change in pain from the pre-operative level to the final follow-up post-operatively. Secondary outcomes including paraesthesia, nerve, and muscle function were recorded as well. Due to the limited reporting, these data were not combined in a meta-analysis and are summarized descriptively. Descriptive statistics calculated from the data included means, proportions, standard deviations, and ranges. All statistics were calculated using Minitab® statistical software (version 17, Minitab Inc., State College, Pennsylvania, USA).

Results

Search strategy

The initial search of three databases resulted in 4759 total studies. A total of 1896 studies were immediately removed as duplicates resulting in 2863 studies. A systematic screening approach removed articles failing to meet inclusion criteria and resulted in 40 available full-text articles for review (Fig. 1). There was almost perfect agreement among reviewers at the title ($\kappa = 0.863$; 95% CI 0.815–0.911), abstract ($\kappa = 0.857$; 95% CI 0.724–0.990), and full-text ($\kappa = 1.00$; 95% CI 1.00–1.00) screening stages.

Study characteristics

In total, 259 patients (261 shoulders) with a mean age of 47.0 years (range 16–88) underwent arthroscopic decompression for suprascapular neuropathy. Of the included patients, 37.8% were female and they were followed up for a mean of 23.7 months (range 3–92) (Table 1). None of the included studies performed an a priori power analysis for sample size calculation.

Study quality

Of the 40 included studies, 17 case reports and 20 case series were identified, which were level IV evidence, 2 retrospective comparative studies were identified, which were level III evidence, and 1 prospective comparative study was identified, which was level II evidence. For non-comparative studies, the median MINORS score was 9 out of 16 (range 7–12), whereas the median MINORS score for comparative studies was 14 out of 24 (range 12–15). Overall, 100% of studies had a clearly stated aim, 92.5% had appropriate endpoints, 90% had an appropriate follow-up period, and 95% had loss of follow-up less than 5%. However, only 7.5% of studies had prospective collection of data and no studies had unbiased assessment of study endpoints. The overall inter-rater agreement for the MINORS score was high, with an ICC of 0.86 (95% CI 0.78–0.94).

Aetiology and surgical management decision-making

Suprascapular nerve (SN) compression was due to various aetiologies including a cyst at the spinoglenoid notch (110 shoulders, 42.1%), the transverse scapular ligament at the suprascapular notch (54 shoulders, 20.7%), a massive rotator cuff tear (50 shoulders, 19.2%), the spinoglenoid ligament at the spinoglenoid notch (16 shoulders, 6.1%), a cyst at the suprascapular notch (10 shoulders, 3.8%), a bony, stenotic suprascapular foramen (3 shoulders, 1.1%), branches of the suprascapular artery (1 shoulder, 0.4%), an intraosseous glenoid cyst (1 shoulder, 0.4%), and unreported aetiologies (46 shoulders, 17.6%). In 32 (12.3%) shoulders, the aetiology was a combination of the aforementioned pathologies. With respect to surgical decision-making, in 18 studies (45%), the decision to pursue arthroscopic management was made after failure of non-operative management strategies, in 19 studies (47.5%) the decision was based on clinical findings and investigations only, and in 3 studies (7.5%) arthroscopic management was pursued after failed ultrasound-guided aspiration of ganglion cysts (Tables 2 and 3). Diagnostic imaging modalities are summarized in Table 2, and non-operative management modalities and arthroscopic techniques are summarized in Table 3.

Outcomes

Of the 259 patients from the 17 case reports, 20 case series, and 3 comparative studies, 248 patients (95.8%) reported complete resolution or improvement in pre-operative symptoms. Specifically, of the 186 patients for whom pain outcomes were reported, 82 patients experienced complete resolution of pain, 94 patients experienced improvement in pain symptoms, and 10 patients experienced no pain relief. The visual analogue scale (VAS) was used to measure pain in 63 patients, and the results demonstrated a reduction in the VAS score from 7.3 pre-operatively to 1.6 post-operatively. Of the 84 patients for whom strength outcomes were reported, 28 patients regained complete shoulder strength, 54 patients achieved improvement in shoulder strength, and 2 patients experienced no improvement in pre-operative weakness, chiefly with regard to external rotation strength. Of the 32 patients for whom muscle atrophy outcomes were reported, 17 patients obtained complete resolution of muscle atrophy, while 15 patients experienced improvement in muscle atrophy, including the supraspinatus and infraspinatus muscles. Notably, assessment of muscle atrophy was based on gross inspection in 7 studies and MRI findings in 1 study. Of the 32 patients for whom range of motion outcomes were

Table 1 Characteristics of included studies and patients

References	Study design (level of evidence)	MINORS score (mean)	Sample size (patients/shoulders)		Per cent female	Age (years)	Follow-up time (months)
Agrawal et al. [1]	Retrospective case study, IV	9	1/1		100	41	NR
Arriaza et al. [3]	Retrospective case series, IV	9	4/4		50	18.6 (16–20)	18.5 (12–24)
Baums et al. [5]	Retrospective case study, IV	9	1/1		0	31	29
Bilsel et al. [6]	Retrospective case series, IV	9	16/16		31.3	40.5 (32–52)	26 (12–48)
Bruce and Dorizas [8]	Retrospective case study, IV	9	1/1		0	51	6
Chen et al. [9]	Retrospective case series, IV	9	3/3		33	33 (21–40)	14.3 (8–26)
Chochole et al. [10]	Retrospective case study, IV	7	1/1		0	46	3
Clavert and Thomazeau [11]	Retrospective case series, IV	9	9/9		44.4	37.6 (21–66)	18 (6–30)
Costouros et al. [12]	Retrospective case series, IV	8	6/6		16.7	57 (41–73)	12
Fernandes and Fernandes [14]	Retrospective case series, IV	9	2/2		0	17.5 (16–19)	5 (3–7)
Garcia Junior et al. [15]	Prospective case series, IV	11	9/10		90	69.5 (58–80)	16.6 (9–25)
Gupta et al. [16]	Retrospective case study, IV	9	1/1		0	22	6
Hashiguchi et al. [17]	Retrospective case series, IV	9	6/6		16.7	48.5 (34–70)	63.7 (34–92)
Hashiuchi et al. [18]	Retrospective case study, IV	9	1/1		0	42	35
Hosseini et al. [20]	Retrospective case study, IV	9	1/1		100	27	6
Houtz and McCulloch [21]	Retrospective case study, IV	9	1/1		0	52	12
Lannotti et al. [27]	Retrospective case series, IV	9	3/3		NR	32 (27–35)	10.33 (4–15)
Kim et al. [23]	Prospective Comparative, II	15	Group 1: SLAP repair only	14/14	42.9	34.2 (28–44)	31.4 (25–46)
			Group 2: SLAP repair + cyst decompression	14/14	35.7	36.8 (32–48)	33.6 (24–58)
Lafosse et al. [24]	Prospective case series, IV	12	10/10		20	50.4 (36–73)	15 (6–27)
Leclere et al. [28]	Retrospective case series, IV	9	4/4		50	48.5 (38–58)	6.5 (6–7)
Lee et al. [29]	Retrospective case study, IV	7	1/1		0	23	4
Leitschuh et al. [30]	Retrospective case study, IV	9	1/1		0	30	18
Lichtenberg et al. [31]	Retrospective case series, IV	9	8/8		12.5	39 (24–58)	27 (13–49)
Nakama et al. [36]	Retrospective case series, IV	9	2/2		50	33.5 (26–41)	30 (24–36)
Oizumi et al. [37]	Retrospective case series, IV	9	25/25		56	63.9 (41–77)	18.5 (12–30)

Table 1 (continued)

References	Study design (level of evidence)	MINORS score (mean)	Sample size (patients/shoulders)		Per cent female	Age (years)	Follow-up time (months)
Pillai et al. [39]	Retrospective Comparative, III	12	6/6		50	42 (33–61)	15.2 (12–27)
Prasad et al. [41]	Retrospective case study, IV	9	1/1		100	38	12
Radic et al. [42]	Retrospective case study, IV	9	1/1		0	16	6
Rhee et al. [43]	Retrospective case study, IV	9	1/1		0	41	24
Rizzello et al. [44]	Retrospective case series, IV	9	3/4		100	40 (28–57)	5.3 (2–12)
Savoie et al. [45]	Retrospective Comparative, III	14	Group 1: rotator cuff repair + SN release	22/22	36.4	58.9 (42–74)	28 (18–40)
			Group 2: rotator cuff repair only	22/22	31.8	61.9 (45–88)	28 (18–39)
Sergides et al. [46]	Retrospective case study, IV	8	1/1		100	54	3
Shah et al. [47]	Retrospective case series, IV	7	24/24		37	49.3 (36–85)	22.5 (3–44)
Shimokobe et al. [48]	Retrospective case series, IV	9	2/2		0	40.5 (36–45)	21 (18–24)
Tan et al. [50]	Retrospective case study, IV	9	1/1		100	39	22
Tashjian and Burks [51]	Retrospective case series, IV	9	4/4		NR	NR	6
Werner et al. [55]	Retrospective case study, IV	7	1/1		0	35	3
Westerheide et al. [56]	Retrospective case series, IV	9	14/14		NR	41 (27–63)	51 (24–73)
Yi et al. [58]	Retrospective case study, IV	9	1/1		0	22	12
Youm et al. [59]	Retrospective case series, IV	10	10/10		20	47.7 (35–56)	10.2 (6–27)

reported, 18 patients achieved full shoulder range of motion, while 14 patients obtained improvement in shoulder range of motion. Specifically, the methods regarding range of motion assessment were not reported in the included studies. Of the 51 patients for whom post-operative EMG results were reported, 25 patients' EMGs demonstrated resolution of suprascapular neuropathy, while 26 patients' EMGs demonstrated improvement in suprascapular neuropathy. Post-operative EMGs were completed at a mean time of 6.9 months (range 3–48) after the surgical procedure. Of the 74 patients for whom post-operative MRI results were reported, 70 patients' MRIs demonstrated complete resolution of cysts, while 4 patients' MRIs demonstrated persistent cysts. Of the 2 patients with post-operative ultrasound imaging, both patients demonstrated complete resolution of cysts on ultrasound. Of the 76 patients for whom return to activity outcomes were reported, 37 patients returned to daily activities and work by an average time of 12.3 months (range 3–22) post-operatively, while 39 patients returned to sports by an average time of 9.4 months (range 3–28) post-operatively. Moreover, of the 93 patients for whom the Constant score was reported, the mean Constant score improved from 61.4 pre-operatively to 91.4 post-operatively. Of the 28 patients for whom a subjective shoulder value (SSV) was reported, the mean SSV improved from 37.7 pre-operatively to 67.7 post-operatively. Of the 24 patients for whom an American Shoulder and Elbow Surgeons (ASES) score was reported, the mean ASES score improved from 36.5 pre-operatively to 70.6 post-operatively. Of the 22 patients for whom a simple shoulder test (SST) was reported, the mean SST improved from 5.5 pre-operatively to 11.3 post-operatively. Of the 57 patients for whom a University of California Los Angeles Shoulder (UCLA) score was reported, the mean UCLA score improved from 11.0 pre-operatively to 28.5 post-operatively. Of the 4 patients for whom a quick disabilities of the arm, shoulder and hand (qDASH) score was reported, the mean

Table 2 Aetiology, clinical presentation, and investigations for suprascapular neuropathy

References	Aetiology	History	Physical examination	Diagnostic investigations performed
Agrawal et al. [1]	Double crush phenomenon: compression of SN by bony, stenotic SSN foramen and SGL at the SGN	Persistent shoulder pain Symptom onset: she jerked her shoulder pulling on a cart Symptom duration: 7 years	Posterior and superior shoulder pain	Electrodiagnostic study: SN neuropathy at both the SSN and SGN, consistent with a "double crush" phenomenon Magnetic resonance arthrogram: NR Selective SN block: excellent but transient relief of her pain
Arriaza et al. [3]	Compression of SN by TSL at SSN	Pain at rest and at night Competitive swimmers Symptom duration: 13 months ± 7.4	Sulcus sign positive bilaterally Jobe, Yocum, and Hawkins mildly positive Mild scapular dyskinesia Supraspinatus and infraspinatus atrophy Significant weakness (3/5) in abduction and external rotation	EMG of supraspinatus and infraspinatus muscles: acute and chronic denervation–reinnervation potentials, moderate increase in latency (5.4–10.4 m/s), small amplitude decrease MRI: type II SLAP lesion and SS + IS degeneration (75%), no lesions (25%)
Baums et al. [5]	Compression of SN by cyst in SGN	Shoulder pain with weakness worse at night and radiation to arm Open ganglion excision from spinoglenoid notch with 7 months symptom relief Competitive volleyball player Symptom duration: 10 months	IS atrophy and 4/5 external rotation strength Cross-adduction and O'Brien's tests positive	EMG: lesion of SN supplying IS MRI: 3.4 cm cystic mass in the SGN
Bilsel et al. [6]	Compression of SN by cyst in SGN	Shoulder weakness, fatigue and pain Symptom duration: 3.5 months, range 1–14	IS atrophy	EMG and nerve conduction velocity tests: SN compression to IS MRI: type II SLAP tears, SGN cyst
Bruce and Dorizas [8]	Compression of SN by bony, stenotic SSN foramen	Posterior shoulder pain	Slight atrophy and weakness of SS and IS	XR: Calcific tendinitis in SS tendon MRI: perilabral cyst or other mass Nerve conduction study: neuropathy of the SN
Chen et al. [9]	Compression of SN by cyst in SGN	Shoulder pain worsened with overhead activities Night pain with arm in overhead position Symptom onset: forced abduction (33%), after softball (33%), during volleyball serving (33%) Symptom duration: 2 weeks to 5 years	IS atrophy ER strength 3–4/5 Limited active forward flexion due to pain Tenderness at SGN with mild swelling of IS and SS fossa Positive subacromial impingement and O'Brien's tests (66%)	XR: normal (33%), bone spur at superior margin of the glenoid (33%), mild degenerative changes (33%) Subacromial local anaesthetic injection: no pain relief or improvement in ER strength (33%), relief of impingement syndrome (33%), MRI: 2–3 cm spinoglenoid cyst ± extending to a type II SLAP tear (66%) EMG: partial denervation of SN at or distal to SGN

Table 2 (continued)

References	Aetiology	History	Physical examination	Diagnostic investigations performed
Chochole et al. [10]	Compression of SN by glenoid labral cyst extending from cranial glenoid to SSN	Shoulder pain worse at night and worsened with heavy lifting Weakness with abduction and overhead motions Symptom onset: heavy lifting as construction worker Symptom duration: 4 months	IS atrophy Weakness in abduction and ER Flexion–extension: 120° to 30°, abduction: 90°, ER: 50°, IR: painful to S1	XR: post-traumatic acromioclavicular arthrosis MRI: glenoid labral cyst extending from cranial glenoid to SSN EMG: lesion of SN to IS
Clavert and Thomazeau [11]	Compression of SN by SGL at the SGN	Shoulder pain Symptom duration: 16 months (7–60)	NR	EMG: distal motor conduction latency MRI: no cyst or rotator cuff pathology
Costouros et al. [12]	Compression of SN by traction of torn rotator cuff musculotendinous complex	Shoulder pain Symptom onset: traumatic fall Symptom duration: 8 months (3–12)	Weakness in abduction and ER IS and SS atrophy (83.3%) Active flexion: 117° (70°–140°), active ER: 16° (20°–50°), ER lag 28° (15°–50°)	MRI: massive tear of IS and SS with medial and inferior retraction and severe fatty infiltration and atrophy of IS and SS EMG and NCV: increased spontaneous activity, fibrillation, sharp waves, polyphasic activity, and reduction in amplitude and evoked potentials, involving SN; EMG SS score grade 1 (100%), EMG IS score grade 2 (50%) and score grade 1 (50%)
Fernandes and Fernandes [14]	Compression of SN by cyst at SGN	Posterior shoulder pain ± radiation to lateral arm (50%) Symptom onset: getting out of car and turning arm (50%) Symptom duration: 5 months–1 years	IS atrophy ER weakness Positive Patte and IS test	XR: normal MRI: cyst in SGN, lesion in posterior labrum EMG: compression of SN motor branch to IS (50%), negative (50%)
Garcia Junior et al. [15]	Compression of SN by TSL at SSN	Shoulder pain Irreparable rotator cuff injuries (retraction >5 cm) with mild–moderate glenohumeral arthropathy	NR	EMG: SN compression
Gupta et al. [16]	Compression of SN by cyst at SSN	Shoulder pain, worsened with overhead activities Weakness limiting daily activities, including lifting Symptom onset: lifting heavy object Symptom duration: 6 months	Weak abduction and ER; SS and IS 3/5 Abduction to 90° and ER to 15°	MRI: multiloculated cyst abutting anterior labrum along anterior surface of glenoid, extending posteriorly and superiorly through SSN into the intramuscular planes of SS, compressing neural bundle in SSN; atrophic changes in SS and IS

Table 2 (continued)

References	Aetiology	History	Physical examination	Diagnostic investigations performed
Hashiguchi et al. [17]	Compression of SN by SGL and cyst at SGN	Pain or dullness in posterior or deep shoulder Pain at rest and night pain Symptom onset: fall (16.7%), lifting heavy object (16.7%), unknown cause (66.7%) Symptom duration: 3.2 months (0.5–6)	IS atrophy and weakness Tenderness of IS belly Limited ROM	XR: normal MRI: 1–4 cm cyst extending from the posterosuperior labrum to the spinoglenoid notch (100%), small SS tendon tear (33.3%), SLAP lesion confirmed connection to a cyst (83.3%), oedema and atrophy of IS (50%) EMG (33.3%): denervation of IS (33.3%)
Hashiuchi et al. [18]	Compression of SN by cyst at SSN	Atraumatic shoulder pain with pain at night and rest (87 mm on VAS) Symptom duration: 1 months	Hypoesthesia (70% of contralateral side) on the posteroinferior lateral side Limited ROM due to pain: 90° flexion, 80° abduction IS atrophy Weakness in abduction and ER	XR: normal MRI: cyst posterior to SSN, no inflow of contrast agent from joint to cyst
Hosseini et al. [20]	Compression of SN by TSL at SSN	Atraumatic shoulder pain and weakness Symptom duration: 2 years	SS and IS atrophy Weak abduction (4/5) and ER (3/5) Positive O'Brien's test	MRI: IS and SS atrophy, no cyst or rotator cuff pathology EMG: proximal lesion of SN with spontaneous activity of SS and IS
Houtz and McCulloch [21]	Compression of SN by TSL at SSN, as well as main trunk and 2 branches of suprascapular artery	Posterior shoulder pain and History of subacromial decompression with acromioplasty	Atrophy of periscapular muscles Weak forward flexion, abduction, and ER	EMG and nerve conduction study: dysfunction of SN at or proximal to SSN with mild denervation of IS and SS MRI: oedema and moderate atrophy of IS and SS, no lesion in SSN
Lannotti et al. [27]	Compression of SN by cyst at SGN	Posterior shoulder pain and weakness exacerbated by overhead activities Clicking and grinding sensation (33%) Symptom onset: throwing injury (33%), atraumatic (66%) Symptom duration: 15.7 months (5–36)	Tenderness of IS fossa IS atrophy with weak ER (3/5) Painful forward flexion, ER, with associated clicking (33%)	EMG: moderately severe acute denervation of IS branch of SN MRI: ganglion cyst at SGN extending from posterior–superior labrum, IS atrophy

Table 2 (continued)

References	Aetiology	History	Physical examination	Diagnostic investigations performed
Kim et al. [23]	Compression of SN by cyst at SGN	Atraumatic, chronic pain at posterosuperior aspect of shoulder Symptom onset: sports injury (35.7%), MVC (14.2%), fall (7.1%), and repetitive overhead activity (28.5%), unknown cause (14.2%) Symptom duration: 26.8 months (10–48) Atraumatic, chronic pain at posterosuperior aspect of shoulder Symptom onset: sports injury (28.5%), MVC (14.2%), fall (7.1%), military training (7.1%), repetitive overhead activity (28.5%), unknown cause (14.2%) Symptom duration: 28.3 months (12–58)	Decreased and/or painful ER and abduction	MRI: spinoglenoid ganglion cyst
Lafosse et al. [24]	Compression of SN by TSL at SSN	Posterior shoulder pain at rest and exacerbated by overhead activities Acromioclavicular joint arthritis (30%) Symptom duration: >6 months	IS and SS atrophy Weakness of abduction and ER	EMG: SS latency 4.5 ms, IS latency 5.1 ms, SS amplitude 0.6 mV, IS amplitude 1.0 mV
Leclere et al. [28]	Compression of SN by TSL at SSN	Atraumatic superior and posterior shoulder pain (3–8 out of 10 in severity) and weakness worsened with overhead activities, ER History of cyst excision (25%) Symptom duration: 5.5 years (1.5–13)	IS and SS atrophy Weak abduction and ER	MRI: complete atrophy of SS and IS with fatty infiltration EMG: severe SN neuropathy (75%) Fluoroscopically guided injection of anaesthetic and cortisone at SSN provided immediate and complete pain relief
Lee et al. [29]	Compression of SN by cyst at SGN	Atraumatic, posterior shoulder pain worsened with overhead activities, with night symptoms Symptom duration: 9 months	Full, painless ROM, with no atrophy or weakness	MRI: ganglion cyst in SGN
Leitschuh et al. [30]	Compression of SN by cyst at SGN	Insidious onset shoulder pain worsened with overhead activities Numbness on posterior aspect of shoulder Symptom duration: 11 months	Pain with resisted forward flexion 2–3 cm area of decreased sensation inferior to the mid-scapular spine Tender over distal SS	EMG: normal SN MRI: 3 cm cyst at SGN, SLAP tear
Lichtenberg et al. [31]	Compression of SN by cyst at SGN	Shoulder pain (62.5%) Symptom onset: unknown (87.5%), post-traumatic (12.5%) Symptom duration: 9.25 months (2–36)	Weakness in ER (87.5%) and abduction (37.5%) IS atrophy in IS fossa (87.5%) Increased anterior–posterior translation (62.5%)	MRI: ganglion cyst (100%), SLAP lesion (50%) EMG: compression of SN (87.5%), involved IS and SS (37.5%)

Table 2 (continued)

References	Aetiology	History	Physical examination	Diagnostic investigations performed
Nakama et al. [36]	Compression of SN by cyst at SSN	Atraumatic shoulder pain and weakness, worse at night Symptom duration: 2 months (1–3)	IS atrophy and weak ER Tenderness over IS fossa	XR: normal MRI: 2 cm ganglion cyst in SS fossa EMG: IS denervation
Oizumi et al. [37]	Compression of SN by TSL at SSN	Dull or deep shoulder pain	Decreased sensation at lateral and posterior aspect of shoulder SS and IS atrophy and/or weakness	NCV: delay in 1 pt SN nerve block with local anaesthesia: positive
Pillai et al. [39]	Compression of SN by cyst at SGN	Shoulder pain and weakness Symptom duration: 114.6 days (20–373)	ER weakness (45% contralateral side)	MRI: para-labral cyst in SGN
Prasad et al. [41]	Compression of SN by intraneural cyst at SGN and SSN	Atraumatic shoulder pain, radiating down arm with paraesthesia in palm Symptom duration: 2 weeks	IS and SS weakness and atrophy Reduced sensation in volar arm with positive Tinel sign in infraclavicular region	EMG: SN neuropathy proximal to SSN, with denervation, reinnervation, and fibrillations in IS and SS MRI: labral tear posterior to biceps labral complex; Cyst travelling along SN through SGN and SSN, towards upper trunk of brachial plexus; SS and IS oedema, without atrophy MR arthrogram: intraarticular contrast extending from labral tear into intraneural cyst US: confirmation of MRI findings
Radic et al. [42]	Compression of SN by cyst at SGN and SSN	Atraumatic shoulder pain and weakness Symptom duration: 12 weeks	IS and SS atrophy 4/5 abduction and ER strength Positive O'Brien's test	MRI: cyst from posterosuperior glenoid labrum extending past SGN and SSN, IS and SS atrophy EMG: moderate to severe denervation of IS and SS
Rhee et al. [43]	Compression of SN by cyst at SGN	Shoulder pain, worsened with overhead activities, with night symptoms	IS atrophy and weakness (3/5) Posterior shoulder tenderness	XR: normal MRI: 1.5–2 cm cyst in SGN EMG and nerve conduction studies: lesion of SN to IS, abnormal spontaneous activity and reduced interference pattern of IS
Rizzello et al. [44]	Compression of SN by cyst near SGN	Shoulder pain and weakness Symptom duration: 8 months (3–12)	Tenderness in the suprascapular and subscapular spaces Subspinosus hypotrophy and weak ER O'Brien's and Speed test positive	XR: normal MRI: cyst near SGN (33%), below SS EMG: increased latency time of SN and one run short of positive sharp waves in the SS
Savoie et al. [45]	Direct compression of SN (NR) and indirect compression of SN (massive rotator cuff tear)	Previous failed rotator cuff repair	NR	MRI: rotator cuff tear retracted to or medial to glenoid, Goutallier grade 4 atrophy
		Previous failed rotator cuff repair		MRI: rotator cuff tear retracted to or medial to glenoid, Goutallier grade 3 atrophy

Table 2 (continued)

References	Aetiology	History	Physical examination	Diagnostic investigations performed
Sergides et al. [46]	Compression of SN by ossified TSL at SSN	Atraumatic shoulder pain, localized to scapular region, with weakness Symptoms worsened with overhead activities Symptom duration: 6 months	Weakness in abduction (3/5) and ER (3/5) Atrophy of IS and SS Limited ROM: 60° abduction, 15° ER	XR: normal EMG: denervative changes with fibrillation and P waves on rest and reduction in motor units on active movement of IS and SS Nerve conduction studies: slowing of SN (11.5) MRI: IS and SS atrophy and fatty infiltration, no cysts, thickening, or ossification
Shah et al. [47]	Compression of SN by TSL at SSN, cyst at SGN, and/or SGL at SGN	Dull, deep, posterior shoulder pain insidious in onset (45.8%) or post-injury (54.2%) Night pain and weakness Symptom onset: traction injury (25%), fall (16.7%), MVC (12.54%), acute neck compression (4.2%) Symptom duration: 3 months to >10 months	IS and SS atrophy Weakness with ER and initiating abduction	CT arthrogram or MRI: cyst in SGN (25%); atrophy, oedema, and/or fatty infiltration of IS and/or SS (16.7%) EMG/NCV: positive for SN pathology (88.9%) Steroid injection into SSN (11.1%): positive in pt with negative EMG/NCV
Shimokobe et al. [48]	Compression of SN by cyst at SSN	Atraumatic shoulder pain with overhead activity and weakness with ER Symptom duration: 1.5 years (1–2)	IS atrophy and weak ER (4/5)	XR: normal MRI: cyst in SS fossa
Tan et al. [50]	Compression of SN by cyst at SGN	Atraumatic, posterior shoulder pain worsened with overhead activities and IR Shoulder weakness and night pain Symptom duration: 2 months	Pain on IR and overhead abduction Weakness of IS and SS Positive O'Brien's test	US: cyst near posterior aspect of shoulder MRI: supraglenoid labral cyst extending posteriorly to SGN, with SLAP lesion
Tashjian and Burks [51]	Compression of SN by cyst at SGN	NR	Weak ER, with normal forward flexion strength	EMG and Nerve Conduction Studies (50%): axonal suprascapular neuropathy to IS MRI: labral tear with associated cyst at SGN
Werner et al. [55]	Compression of SN by cyst at SSN	Shoulder pain and weakness in ER Symptom onset: minor shoulder trauma Symptom duration: 1 years	IS and SS atrophy and weakness Limited ER to 35° Signs of irritation of the long head of the biceps	XR: normal MRI: 2 cm ganglion cyst in inferior part of SS fossa with direct SN compression, moderate IS and SS atrophy EMG and ENoG: delayed SN conduction, signs of denervation, and decreased voluntary electrical potentials of both SS and IS CT arthrogram: cyst communicating with posterior labrum

Table 2 (continued)

References	Aetiology	History	Physical examination	Diagnostic investigations performed
Westerheide et al. [56]	Compression of SN by cyst at SGN	Shoulder pain (100%), with radiation (50%), night pain (57.1%), worsened with overhead motion (57.1%) or simple motion (14.3%) Symptom duration: 7.5 months	IS atrophy (71.4%) and weakness (100%) ER 4/5 (78.6%), 3/5 (14.3%), 1/5 (7.1%)	MRI: 3 cm spinoglenoid cyst (100%), IS signal change (57.1%), labral pathology (85.7%) EMG (78.6%): denervation of IS (78.6%)
Yi et al. [58]	Compression of SN by intraosseous glenoid cyst	Atraumatic shoulder pain, with night symptoms VAS 3 at rest and VAS 8 with activity Symptom duration: 2 years	Atrophy of IS Tenderness over IS fossa Weak ER and forward flexion Active ROM: 170° forward flexion, 85° ER and IR in 90° of abduction Positive compression–rotation test	XR: radiolucent, circular, cystic lesion with a sclerotic rim MRI: cystic lesion in trabecular bone of glenoid with partial protrusion into SSN, compressing SN
Youm et al. [59]	Compression of SN by cyst at SGN	Symptom duration: 9.2 months (3–36)	ER weakness (60%)	NCV: SN neuropathy (40%) MRI: unstable SLAP tear with associated cyst

qDASH score improved from 22.7 pre-operatively to 1.1 post-operatively. Of the 9 patients for whom a Short Form Health Survey (SF-36) score was reported, the mean SF-36 score was 122.9 post-operatively. Finally, of the 28 patients for whom a Rowe score was reported, the mean Rowe score improved from 52.8 pre-operatively to 94.7 post-operatively. Collectively, these results were reported at a mean final follow-up period of 23.7 months (range 2–92) (Table 3).

Complications

Of all 259 patients in this review, one patient (0.4%) had a superficial soft tissue infection, which was successfully treated with oral antibiotics. Another patient (0.4%, 1/259) had post-operative pain along the direction of the long head of the biceps due to a partial rupture, which resolved after performing a subpectoral biceps tenodesis. One patient (0.4%, 1/259) experienced loss of sensation around the skin incision, which resolved at the final follow-up visit. Additionally, one patient (0.4%, 1/259) developed adhesive capsulitis of the shoulder post-operatively. Finally, of the 50 patients who underwent rotator cuff repair, there were 6 (12.0%, 6/50) rotator cuff tears that failed to heal, and 5 (10.0%, 5/50) of these patients were dissatisfied with their functional outcome (Table 3).

Discussion

The most important finding of the present study was that 96% of the included patients reported significant improvement in or complete resolution of their pre-operative symptoms. Specifically, there was significant improvement in pain (measures using NRS and VAS scores), shoulder strength, and subjective scoring scales (including the Constant, SSV, ASES, SST, and UCLA shoulder scales). Moreover, there was a low overall complication rate associated with the arthroscopic procedures. With regard to surgical decision-making, in approximately half of the included studies, the decision to pursue arthroscopic management was made after failure of non-operative management strategies, whereas the decision was based on clinical findings and investigations only in the other half of studies. The included studies were primarily of lower levels of evidence with only 3 comparative studies identified in the literature.

There are several sources of debate across the literature investigating arthroscopic surgery for the management of suprascapular neuropathy, including surgical timing. Specifically, the present systematic review included multiple studies reporting that shortened time from symptom onset to arthroscopic surgery correlated with improved outcomes. Specifically, Bilsel et al. [6] and Pillai et al. [39] attribute the delay to arthroscopic management resulting in greater

Table 3 Management of suprascapular neuropathy and outcomes following arthroscopic surgery

References	Initial conservative management	Decision to purse surgical management based on:	Arthroscopic management	Outcomes	Complications
Agrawal et al. [1]	NR	Clinical presentation and investigations	Semi-lateral decubitus position Posterior, anterolateral, lateral, and modified superomedial portal Glenohumeral exploration followed by the subacromial space Partial burscectomy of posterior and medial walls, decompression of superior and lateral walls of SSN, transection of SGL	Resolution of posterior and superior shoulder pain	None
Arriaza et al. [3]	Rest, NSAIDs, and physical therapy	Clinical presentation, investigations, and failure of non-op management	Beach chair position with 3-kg traction on the arm Standard portals plus a medial Neviaser portal to release the transverse ligament Glenohumeral exploration followed by the subacromial space Burscectomy, release of the transverse ligament at the SSN, and neurolysis of the SN	Complete pain relief at 2 weeks Return to pre-injury swimming level at 7 ± 1 months with improvement of 15 km/wk Bilateral symmetric muscle mass Pre-op to post-op scores: 22.6 ± 4 to >34 ± 1 (UCLA), 22.7 ± 7 and 1.1 ± 1 (qDASH), 6 ± 1 to >0.25 (VAS), 4 to >5 (manually tested strength)	None
Baums et al. [5]	Physical therapy and NSAIDs for 10 months	Clinical presentation, investigations, and failure of non-op management	Type II SLAP lesion refixed with two suture anchors Cyst drained by manual pressure on the IS fossa using a probe to keep the valve open	Pain completely resolved Constant score improved from <74–94 EMG and MRI: normal at 29 months	None
Bilsel et al. [6]	Rest, medical and physical therapy for 3.5 months (1–14)	Clinical presentation, investigations, and failure of non-op management	Beach chair position Posterior, anterior, and anterolateral portals Spinal needle used to decompress cyst, which was then debrided with a shaver, followed by SLAP repair	Pre-op to >post-op: 60 to >80% (ER strength compared to contralateral side), 65 to >86 (constant), 7 to >2 (VAS)	Superficial soft tissue infection successfully treated with oral antibiotics (6.25%)

Table 3 (continued)

References	Initial conservative management	Decision to purse surgical management based on:	Arthroscopic management	Outcomes	Complications
Bruce and Dorizas [8]	NR	Clinical presentation and investigations	Posterolateral, lateral portals Debridement of calcium deposits on SS tendon Debridement of congenital bony SSN	Recovered nearly 100% of SS and IS strength (manual testing) at 6 months	None
Chen et al. [9]	Physical therapy, rest, and anti-inflammatory medications for 6 weeks	Failure of non-op management (100%), failure of CT-guided aspiration of cyst, with recurrence 3 months later (50%)	Resection of spinoglenoid cyst Repair of SLAP tear with suture anchors	Asymptomatic ± full return to sport (66%), mild pain 2° arthrosis (33%) Full IR and ER strength Lack of 10° active forward elevation (33%), lack of 5° ER (33%) MRI: no cyst recurrence, healing of SLAP lesion EMG: complete resolution of SN neuropathy	None
Chochole et al. [10]	NR	Clinical presentation and investigations	Debridement of cyst	Full recovery with no pain and full ROM at 12 weeks MRI: dissolution of cyst EMG: reinnervation of SN to IS	None
Clavert and Thomazeau [11]	NR	Clinical presentation and investigations	Semi-reclined position Posterior and superolateral portals Debridement of subacromial bursa Division of the SGL	Clinical improvement (88.9%), persistent weakness (11.1%) Pre-op to post-op: 54 to >81 (Constant score) EMG: improved distal motor conduction latency, no correlation in pre-op severity with post-op functional recovery	None

Table 3 (continued)

References	Initial conservative management	Decision to purse surgical management based on:	Arthroscopic management	Outcomes	Complications
Costouros et al. [12]	Physical therapy, NSAIDs, and subacromial injection for >3 months	Clinical presentation, investigations, and failure of non-op management	Beach chair position Posterior, lateral, anterior, and posterolateral portals Acromioplasty in all cases of rotator cuff repair Tendon tear repaired using margin convergence method along with direct reinsertion of tendon in bone using bioabsorbable anchors and double-row technique if the entire tear was reparable, or by partial reinsertion of posterior component of tendon tear if supraspinatus was irreparable	Complete pain relief at 1 years Pre-op to post-op: 117° to 143° (flexion), 10° to 39° (ER), 28° to 4° (ER lag) EMG/NCV: recovery of SN palsy at 6 months; EMG SS score grade 4 (80%) and grade 3 (20%), EMG IS score grade 4 (60%) and score grade 5 (40%)	None
Fernandes and Fernandes [14]	NR	Clinical presentation and investigations	Drainage of the cyst using periosteal elevator and soft tissue shaver blades Repair of posterosuperior labral tear	Resolution of shoulder pain, ER weakness, and IS atrophy MRI: remission of cyst EMG: complete axonal reinnervation of SN, normal action potential for IS	None
Garcia Junior et al. [15]	NR	Clinical presentation and investigations	Deckchair position with backrest 60° to the floor and arm flexed, without traction Lateral, posterior, Neviaser, accessory (above scapular spine) portals Bursectomy for visualization Resection of TSL to release SN	Pain relief (100%) Raw scale of pain: 88% improvement Pre-op to post-op: 11.7 (8–22) to >26.1 (14–33) (UCLA score) Post-op SF-36: 122.9 (107–142) Scapular notch (Natsis): type III (80%), type IV (10%), type II (10%)	None
Gupta et al. [16]	Physiotherapy	Clinical presentation, investigations, and failure of non-op management	Decompression of cysts adjacent to the SSN Cysts within SS could not be reached arthroscopically	Pain, weakness, and atrophy of SS and IS improved at 6 months MRI: persistent cysts in suprascapular region	None

Table 3 (continued)

References	Initial conservative management	Decision to purse surgical management based on:	Arthroscopic management	Outcomes	Complications
Hashiguchi et al. [17]	NR	Clinical presentation and investigations (100%); failure of US-guided needle aspiration of cyst—no improvement in symptoms (16.7%)	Lateral decubitus position using a traction sling Posterior portal SLAP lesion expanded in anteroposterior direction to extravasate cyst contents (50%) Release of the posterior to superior capsule over the cyst, followed by drainage (50%) SLAP repair with suture anchors (100%) Suture repair of supraspinatus tear (33%) Release of spinoglenoid ligament (<100%)	Pain resolution at 7.2 weeks (1 day–20 weeks) Normal muscle strength MRI: disappearance (66.7%) or reduction (33.3%) of spinoglenoid cyst, improvement in IS oedema (100%), Pre-op to post-op: 60.5 (51–68) to >97.2 (96–100) (Constant score), 7.7 (6–10) to >1.5 (0–5) (VAS) at 1 weeks	None
Hashiuchi et al. [18]	NR	Clinical presentation and investigations	Beach chair position US-guided arthroscope insertion and needle decompression, followed by arthroscopic cyst capsule removal	Alleviation of pain and hypoesthesia on POD1 Improved ROM: 160° flexion and 140° abduction MRI: no recurrence of cyst at 35 months	None
Hosseini et al. [20]	Intense rehabilitation programme for 2 years	Failure of non-op management	Modified Nevasier portal Type II SLAP repair with suture anchors TSL divided	Asymptomatic with full ROM at 6 months Improved strength: 5/5 abduction, 4/5 ER EMG: no spontaneous muscular activity, normal potentials during maximal innervation of SS and IS	None
Houtz and McCulloch [21]	Physical therapy	Clinical presentation, investigations, and failure of non-op management	Beach chair position Lateral and Nevasier portals Division and resection of TSL Compression of SN by main trunk and 2 branches of suprascapular artery, released by cauterizing smallest branch	Painless, full ROM, 5/5 rotator cuff strength at 6 months Return to manual labour at 1 years EMG: no signs of active denervation, normal recruitment, and full 100% interference pattern	None

Table 3 (continued)

References	Initial conservative management	Decision to purse surgical management based on:	Arthroscopic management	Outcomes	Complications
Lannotti et al. [27]	NSAIDs and physical therapy	Failure of non-op management	Posterior, anterosuperior and accessory posterolateral portals Decompression of cyst with blunt probe and digital pressure over IS fossa Detachment of posterior capsulolabral complex (33%) or capsulotomy (33%) to reach cyst, followed by labral repair and/or re-attachment of complex	Asymptomatic, with improvement in ER weakness and IS atrophy at 1 years MRI: no recurrence of cyst (3.7 months, range 2–5)	
Kim et al. [23]	Physical and medical therapy for >6 months	Functional disability despite conservative care	Semi-sitting beach chair position Posterior, anterosuperior, and anteroinferior portals Only SLAP repair with suture anchors (group 1) SLAP lesion mobilized, entrance to cyst widened using tissue elevator, cyst drained with manual pressure to IS fossa, followed by SLAP repair with suture anchors (group 2)	Pre-op to post-op: 58.5 to >96.8 (constant score), 52.1 to >94.2 (Rowe score) VAS: 0.6 (0–4) Return to work (92.8%) and sports (92.8%) MRI: resolution of cyst (92.8%), pt with persistent cysts were asymptomatic, IS and/or teres minor atrophy (28.6%)	Post-op pain along direction of long head of the biceps due to rupture, resolved by performing subpectoral biceps tenodesis (7.1%)
				Pre-op to post-op: 61.2 to >97.8 (constant score), 53.5 to >95.1 (Rowe score) VAS: 0.5 (0–4) Return to work (92.8%) and sports (92.8%) MRI: resolution of cyst (85.7%), pt with persistent cysts were asymptomatic, IS and/or teres minor atrophy (35.7%)	Loss of sensation around the skin incision, resolved at final follow-up (7.1%)

Table 3 (continued)

References	Initial conservative management	Decision to purse surgical management based on:	Arthroscopic management	Outcomes	Complications
Lafosse et al. [24]	Physiotherapy and subacromial injection	Clinical presentation, investigations, and failure of non-op management	Beach chair position with arm in flexion and 3 kg of longitudinal traction Posterior, lateral, anterolateral, and SN portals Subacromial anteromedial burscectomy Resection of TSL with scissors through additional portal 1.5 cm lateral to SN portal and notch plasty of lateral SSN if necessary Arthroscopic distal clavicle resection (30%)	Persistent SS and IS atrophy, but 192% and 215% increase in SS and IS strength Pre-op to post-op: 7.0 to >14.5 (pain score), 60.3 to >83.4 (constant score) EMG (80%): normalization of the conduction velocity, distal latency, amplitude, and voluntary motor action potential for SS and IS (70%); partial improvement in EMG, but complete pain resolution (10%)	None
Leclere et al. [28]	Activity modifications, chiropractic adjustments, and physical therapy	Response to injection (33%), EMG and MRI findings (33%), clinical presentation and investigations (33%)	Release of TSL (100%) Subacromial decompression (50%)	Pain relief (100%) Subjective shoulder value 80–90% Improved ER strength (75%) Persistent ER weakness with no improvement or IS and SS fatty infiltration on MRI (25%)	None
Lee et al. [29]	NSAIDs and physiotherapy for >2 months	Failure of non-op management	Posterior and accessory posterolateral portals Capsulotomy followed by cyst decompression Grade 1 labral tear, not treated	Resolution of pain at 4 months MRI: cyst resolution at 3 months	None
Leitschuh et al. [30]	NR	Failure of US-guided needle aspiration of cyst performed twice with return of symptoms after 3 months	Arthroscopic decompression of cyst and type II SLAP tear repaired with suture anchors	Asymptomatic with daily activities and weight lifting at 18 months	None

Table 3 (continued)

References	Initial conservative management	Decision to purse surgical management based on:	Arthroscopic management	Outcomes	Complications
Lichtenberg et al. [31]	NR	Clinical presentation and investigations	Semi-sitting beach chair position Posterior, anterior, posterolateral, and lateral portals In case of SLAP lesion: labrum lifted, probe passed to SGN, cyst widened using rasp, cyst drained with manual pressure on IS fossa, cyst debrided with shaver, followed by SLAP repair with suture anchors If no SLAP: capsulotomy superior to glenoid labrum, cyst incised and drained, then debrided with shaver Drain inserted into joint and removed 24 h post-op	Asymptomatic (87.5%) Reversal of IS atrophy and normal ER strength Pre-op to post-op: 70 to >93 (constant score), 7.75 to >11 (SST) MRI: no recurrence of cyst (87.5%), recurrence of small cyst without SN entrapment symptoms (12.5%) EMG: remission of neurologic lesion	Post-op frozen shoulder (12.5%)
Nakama et al. [36]	NSAIDs	Failure of non-op management and US-guided cyst aspiration with return of symptoms after 3 months	Posterior and anterior portals Arthroscopy-guided needle aspiration (50%) or debridement (50%) of cyst Injection of autologous fibrin sealant, made from patients' blood, into cyst	No SN symptoms and full ER strength at 2.5 years (2–3) MRI: no recurrence of cyst	None
Oizumi et al. [37]	NR	Clinical presentation and investigations	Beach chair position Mid-lateral, anterolateral, coracoclavicular, SN portal Retraction of SS, followed by dissection of TSL	Pain relief (88%) Sensory disturbance resolved in all shoulders	None
Pillai et al. [39]	Physical therapy, activity modification, and rest	Failure of non-op management, evidence of SN dysfunction, and MRI documentation of both a spinoglenoid cyst and type II SLAP lesion	Modified beach chair position Posterior, anterior, accessory anterosuperior portal Posterosuperior labrum elevated, blunt instrument introduced medially through SLAP tear to decompress the cyst SLAP tear repaired using suture anchors Subacromial decompression (16.7%)	Pre-op to post-op: 45% to 85% (ER strength, percentage of unaffected side) Trend towards increased gain in external rotation strength post-op in pt with a shorter pre-operative duration of weakness	None

Table 3 (continued)

References	Initial conservative management	Decision to purse surgical management based on:	Arthroscopic management	Outcomes	Complications
Prasad et al. [41]	NR	Clinical presentation and investigations	Anterior and posterior portals Repair of SLAP tear with suture anchors Decompression of cyst with rasper	Complete functional recovery US and MRI: resolution of cyst at 3 months and 1 years EMG: reinnervation of IS and SS by SN	
Radic et al. [42]	Rest and physiotherapy	Clinical presentation, investigations, and failure of non-op management	Anterosuperior, posterolateral, lateral, and modified Neviaser portals Repair of superior and posterior labrum tears with suture anchors Para-labral cyst decompression with shaver suction and pressure over cyst with probe Division of TSL	Mild residual wasting of IS and SS but improved strength Return to rowing at 3 months EMG: reinnervation of IS and SS with resolution of fibrillations in IS at 3 months MRI: resolution of cyst at 3 months	None
Rhee et al. [43]	NR	Clinical presentation and investigations	Semi-reclined position Debridement of "discoid" labrum 1 cm capsulotomy at capsulolabral junction posterosuperiorly Decompression of cyst with blunt dissection towards SGN and digital pressure over IS fossa	Asymptomatic at returned to work at 2 years Resolution of atrophy and weakness	
Rizzello et al. [44]	NSAIDs, physiotherapy, rest and local corticosteroid injection for 2 months	Clinical presentation, investigations, and failure of non-op management	Blunt dissection to SGN, manual pressure over IS fossa to decompress cyst through labral defect Type II (66%) and III (33%) labral repair with suture anchors	MRI: resolution of cyst (2 months–1 years) EMG: SN reinnervation signs	None

Table 3 (continued)

References	Initial conservative management	Decision to purse surgical management based on:	Arthroscopic management	Outcomes	Complications
Savoie et al. [45]	NR	Clinical presentation and investigations	Rotator cuff repair with SN release	Pre-op to post-op: 7.91 to >27.86 (UCLA), 2.95 to >7.00 (UCLA pain), 2.59 to >7.73 (UCLA function), 1.18 to >4.59 (UCLA forward flexion), 1.18 to >4.23 (UCLA strength)	Rotator cuff tear failed to heal (13.6%)
			Rotator cuff repair alone	Pre-op to post-op: 11.77 to >29.09 (UCLA), 2.45 to >7.45 (UCLA pain), 3.73 to >8.09 (UCLA function), 2.68 to >4.36 (UCLA forward flexion), 2.91 to >4.23 (UCLA strength)	Rotator cuff tear failed to heal (13.6%)
Sergides et al. [46]	NR	Clinical presentation and investigations	Posterior, lateral, anterior, Neviaser, and SSN portals Ossified TSL was sectioned Rotator cuff rupture was repaired	Immediate pain relief post-op (VAS < 4) and return to daily activities at 3 months EMG: improvement in SN at 6 months	None
Shah et al. [47]	NR	Clinical presentation and investigations	Beach chair position Posterior, lateral, anterolateral, and superior portals Burscectomy ± acromioplasty if impingement syndrome Transection of TSL, SGL, and decompression of cyst at SGN SLAP repair (11.1%), biceps tenodesis (3.7%) and capsular release (3.7%)	Pain relief (71%) by 9.4 weeks ± 8.73 Pre-op to post-op: 36.5 to >70.6 (ASES), 37.7 to >64.8 (SSV), 7.6 to >2.9 (VAS) ASES improvement in 75% pt SSV improvement in 71% pt	None
Shimokobe et al. [48]	NSAIDs	Clinical presentation, investigations, and failure of non-op management	Beach chair position Posterior and anterior portals Cyst could not be visualized, but area from MRI was debrided regardless Labral tears repaired with suture anchors	Painless, full ROM, with full ER strength and resolution of IS atrophy at 2 years Returned to work as manual labourer MRI: no evidence of cyst at 3 months	None

Table 3 (continued)

References	Initial conservative management	Decision to purse surgical management based on:	Arthroscopic management	Outcomes	Complications
Tan et al. [50]	NR	Clinical presentation and investigations	Cyst decompression and type 2 SLAP repair with suture anchors	Asymptomatic, with full ROM, strength, and return to work and sport at 22 months US: resolution of cyst at 10 weeks Constant score 96/100	None
Tashjian and Burks [51]	NR	Clinical presentation and investigations	Beach chair position High and low rotator cuff interval portals, posterior portal, and port of Wilmington Needle aspiration of cyst at SGN followed by probe pressure to release final material No shaving or excision of cyst Standard superior labral repair	Return to normal work and sport without limitation Improved ER strength MRI: cyst resolution and healing of labral repairs	None
Werner et al. [55]	NR	Clinical presentation and investigations	Posterior portal Subacromial burscectomy Gentle retraction of IS followed by incision of cyst and aspiration with shaver Repair of type 2 SLAP tear with suture anchors	Minimal SN symptoms, nearly full ER strength at 3 months EMG and ENoG: signs of recovery	None
Westerheide et al. [56]	Rest, ice, NSAIDs, physical therapy, and/or cortisone injections	Clinical presentation, investigations, and failure of non-op management	Posterior and anterior portals If SLAP lesion exists, decompress through lesion If labrum normal, 1 cm capsulotomy at posterior–superior glenoid rim, blunt dissection to cyst at SGN, decompress with shaver and suction, removing cyst wall, repeat through anterior portal Keep dissection 1 cm medial to glenoid to avoid iatrogenic SN injury Address type I SLAP tears with debridement and type II SLAP tears with suture anchors	ER 5/5 (71.4%), 4/5 (14.3%), with improvement in all pt Constant–Murley score: 94 (max = 100) Pre-op to post-op: 4.3/12 to >11.5/12 (SST) Improvement (28.6%), worsening (14.3%), or no change (57.1%) in activity level Average satisfaction: 1.5, where 1 = fully satisfied, 13 = dissatisfied	None

Table 3 (continued)

References	Initial conservative management	Decision to purse surgical management based on:	Arthroscopic management	Outcomes	Complications
Yi et al. [58]	None	Clinical presentation and investigations	Beach chair position No SLAP lesion Arthroscopy-assisted needle aspiration of ganglion cyst	IS fossa tenderness resolved immediately post-op Asymptomatic at early follow-up MRI: no recurrence of cyst at 1 years	None
Youm et al. [59]	NR	Clinical presentation and investigations	Lateral decubitus position Posterior and anterior portals Cyst was decompressed sublabrally through superior labral lesion with blunt instruments and mechanical shaver Pressure was placed on the cyst with a probe and over trapezius to further decompress cyst SLAP repair with suture anchors	Resolution of pain and weakness (100%) MRI (80%): complete resolution of cyst and healing of superior labral repair at 6 months (3–14) NCV (40%): improvement in SN neuropathy	None

muscle weakness pre-operatively, which resulted in poorer VAS scores and less improvements in ER strength. Shah et al. reported that patients receiving surgery within a year of symptom onset were significantly more likely to experience good and excellent outcomes, which allows surgeons to more accurately predict prognosis in patients planning on undergoing arthroscopic management. On the other hand, the results reported by Kim et al. [23] disagreed with the aforementioned studies, as they found no correlation between the duration of pre-operative symptoms and post-operative resolution of muscle atrophy. These findings warrant future research into the effect of surgical timing on patient outcomes.

Another important concept relates to outcomes following labrum repair or debridement performed with or without cyst decompression. Specifically, a comparative study by Kim et al. [23] demonstrated no difference in outcomes in patients who received a SLAP repair versus those who received a SLAP repair in combination with cyst decompression. They attributed these results to a one-way valve mechanism created by repetitive use or trauma, causing the labrum to avulse off the glenoid rim, allowing joint fluid to drain through the lesion, and forming a cyst [31]. As such, they described that arthroscopic cyst resection cannot ensure elimination or non-recurrence of the cyst and that the technical challenges of arthroscopic cyst resection may preclude one from routinely performing this procedure. However, a comparative study by Piatt et al. [38] demonstrated that patients receiving a labral repair in combination with cyst decompression achieved better outcomes than those who received isolated labral treatment. It was theorized by Hashiguchi et al. [17] that patients without a formal cyst decompression might experience poor outcomes due to a delay in achieving cyst resolution, and therefore, persistent compression by the cyst in the post-operative period, contributing to pain and additional symptoms.

Another method of suprascapular nerve decompression, first described by Costouros et al. [12] in 2007, involves isolated rotator cuff repair. The pathology they described included suprascapular nerve traction and compression around the base of the spine of the scapula as a result of the inferior and medial retraction of the supraspinatus and infraspinatus tendons in rotator cuff tears. After performing a rotator cuff repair, the suprascapular nerve moved laterally and away from the scapular spine, relieving any tension on the nerve. Additionally, in 2016, Savoie et al. [45] compared patients receiving an isolated rotator cuff repair to those receiving an additional suprascapular nerve decompression procedure, and they found superior outcomes in the latter group. In an extension to the description by Costouros et al. [12], they explained that over time, as scar tissue develops at the site of the rotator cuff tear, the laterally retracted nerve is held out of its anatomical location in part by local adhesions that form. Therefore, surgical release of these adhesions likely allows the nerve to achieve an even more accurate anatomical position, accounting for the improved recovery within this group.

The primary limitations in this review included the lack of high-quality studies investigating arthroscopic management for suprascapular neuropathy. The included studies were mostly case reports or case series, with limited sample sizes and retrospective collection of data. The paucity of comparative studies precludes definitive conclusions on the efficacy of arthroscopic management of suprascapular neuropathy in comparison to other procedures. Further, the included non-randomized and non-comparative studies may be prone to selection bias in the patients that are recruited to be participants in the study. Moreover, the reporting of certain data within the studies was not always consistent, including information regarding clinical presentation, conservative management regimens, arthroscopic technique, and clinical outcome scores. Finally, the overwhelming positive results found in this review to be associated with arthroscopic management of suprascapular neuropathy may be due to expertise bias and consequently have limited generalizability to a broader surgeon audience. Specifically, since arthroscopic decompression of the suprascapular nerve is a technically challenging procedure with multiple potential risks, including neurovascular injury, the excellent results achieved within the included studies may be influenced by expert surgeons who perform the operation and publish on the subject more frequently.

The clinical relevance of this study is that patients with suprascapular neuropathy who are managed with arthroscopic surgery may expect significant improvements in pain and functional outcomes. Additionally, the likelihood of experiencing a complication as a result of surgery is low.

Conclusions

While most studies evaluating arthroscopic management of suprascapular neuropathy are uncontrolled studies with lower levels of evidence, results indicate that such management provides patients with significant improvements in pain, strength, and subjective function of the shoulder, and has a low incidence of complications.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Funding No funding has been received for this study.

Ethical approval Ethical approval was not obtained because this study was a literature review.

Informed consent Informed consent was not obtained because this study was a literature review.

Appendix

See Table 4.

Table 4 Detailed search strategy

Medline: 1372 studies		Embase: 1835 studies		PubMed: 1552 studies	
Strategy	Studies	Strategy	Studies	Strategy	Studies
1. Arthroscopy/or arthroscop*.mp.	25,593	1. Arthroscopic surgery/or arthroscopy/or arthroscop*.mp.	37,737	1. Arthroscop*	30,751
2. Suprascapular.mp.	977	2. Suprascapular.mp.	1540	2. Suprascapular	1150
3. Nerve compression syndromes/	9704	3. Nerve compression/	13,217	3. Decompression	38,888
4. Neuropathy.mp.	56,868	4. Neuropathy/	49,236	4. Neuropathy	61,650
5. Cyst.mp. or cysts/	95,433	5. Cyst/	51,817	5. Entrapment	14,413
6. Decompression/or decompression, surgical/or decompression.mp.	34,557	6. Entrapment.mp. or peripheral neuropathy/	62,371	6. Cyst*	240,702
7. Peripheral nervous system diseases/or entrapment.mp.	33,865	7. Decompression/or decompression surgery/or nerve decompression/or decompression.mp.	53,896	7. Suprascapular OR decompression OR neuropathy OR entrapment OR cyst*	351,972
8. 2 or 3 or 4 or 5 or 6 or 7	213,379	8. 2 or 3 or 4 or 5 or 6 or 7	216,392	8. 1 and 7	1552
9. 1 and 8	1372	9. 1 and 8	1835		

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