MARTIN J. KELLEY, PT, DPT, OCS[1] • **THOMAS E. KANE,** DPT[2] • **BRIAN G. LEGGIN,** PT, DPT, OCS[1]

Spinal Accessory Nerve Palsy: Associated Signs and Symptoms

Spinal accessory nerve palsy (SANP) is common following neck dissection surgery or lymph node excision,[2,6,9,11,13-15,27-29,31,43,46,48,49,52,53] blunt or penetrating trauma to the lateral neck region,[2,11] and cervical stretch injuries.[32] Spinal accessory nerve injury results in trapezius paralysis or dysfunction and a diagnostic cluster of signs and symptoms, including shoulder girdle depression, trapezius atrophy, scapular dyskinesis, loss of shoulder active abduction, and shoulder/neck pain.[6,9,11,13-15,28,29,31,46,48,49,53,52] Establishing a diagnosis of SANP can be a clinical challenge and is often delayed or missed.[3,4,11,42,55] Conservative treatment is usually initiated; however, nerve repair, nerve grafting, or neurolysis may be performed after penetrating or known iatrogenic injury.[27,42] Chronic SANP may also be treated with a muscle transfer procedure.[3,4]

• **STUDY DESIGN:** Retrospective case series.

• **BACKGROUND:** Spinal accessory nerve palsy (SANP) is common following neck dissection surgery and can occur with blunt or penetrating trauma to the lateral neck region and cervical stretch injuries. Early detection of SANP remains a clinical challenge and the condition is often misdiagnosed. The purpose of this case series is to describe the associated history, signs, and symptoms related to SANP and increase awareness of the scapular flip sign as a clinical sign associated with SANP.

• **CASE SERIES DESCRIPTION:** Twenty subjects (13 male, 7 female) presented with pain and decreased shoulder function following head and neck surgery or posttrauma. All patients were thoroughly examined and the scapular flip sign was assessed. All patients presented with a cluster of signs and symptoms, including trapezius atrophy, shoulder girdle depression, limited active shoulder abduction to less than 90°, shoulder pain, and shoulder weakness. A positive scapular flip sign was present in all cases. The middle and lower trapezius were rated as 0/5, based on manual muscle testing, indicating no identifiable muscle activation against resistance.

• **DISCUSSION:** A typical history and consistent signs and symptoms were found related to SANP. A strong relationship appeared between the presence of the scapular flip sign and SANP. The suspected mechanism for the scapular flip sign is the unopposed pull of the humeral external rotators by the inactive middle and lower trapezius. Early identification of SANP can assist with the prognosis, explain persistent impairments and functional deficits, motivate appropriate diagnostic testing and interventions, and help maximize outcome. Further research to validate the scapular flip sign and establish a clinical prediction rule for the diagnosis of SANP should be performed.

• **LEVEL OF EVIDENCE:** Diagnosis, Level 4.

J Orthop Sports Phys Ther 2008;38(2):78-86. doi:10.2519/jospt.2008.2454

• **KEY WORDS:** *examination, neck, shoulder, trapezius*

The spinal accessory nerve is a cranial nerve originating as 2 parts: the accessory portion from the medulla and the spinal part from the lateral portion of the ventral column. The spinal portion ascends and enters the skull through the foramen magnum to join the accessory part. The spinal accessory nerve then exits through the jugular foramen at the base of the skull, passes obliquely, penetrating the upper third of the sternocleidomastoid (SCM) muscle. The spinal accessory nerve continues subcutaneously through the posterior triangle floor and enters the upper trapezius (**FIGURE 1**).[17] Both the SCM and trapezius muscle receive motor innervation from the spinal accessory nerve. Although most authors agree the spinal accessory nerve provides the trapezius with primary motor innervation, not all agree regarding nerve anatomy. Kiener[26] reported intraoperative electromyography findings revealing a distinct cranial branch of the spinal accessory nerve that separately innervates the upper trapezius. The cervical plexus (C2-C4) also innervates the trapezius providing some motor input in approximately 20% of the population.[40]

Spinal accessory nerve injury commonly occurs during neck dissection surgery.[2,6,9,11,13-15,27-29,31,43,46,48,49,52,53] Neck dissection surgery is performed to treat head and neck carcinoma and is categorized into 3 different procedures: radical

[1]Musculoskeletal Team Leader, University of Pennsylvania, Philadelphia, PA. [2]Staff Physical Therapist, King of Prussia Physical Therapy and Sports Rehabilitation, King of Prussia, PA. The protocol used in this case series was approved by the Institutional Review Board at the University of Pennsylvania Medical Center. Address correspondence to Martin J. Kelley, PT, DPT, OCS, Penn Presbyterian Medical Center-University of Pennsylvania Health System, 1 Medical Office Building, Suite 110, 39th and Market St, Philadelphia, PA 19104. E-mail: martin.kelley@uphs.upenn.edu

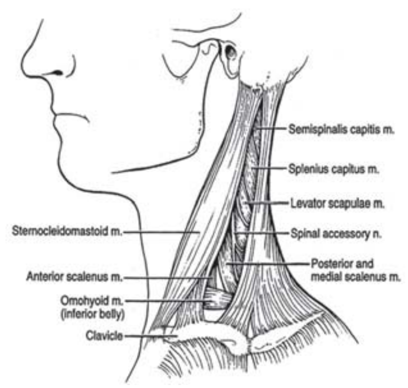

FIGURE 1. The spinal accessory nerve (SAN) crosses obliquely in the posterior triangle. (Reproduced with permission of Kuhn, JE. The scapulothoracic articulation: anatomy, biomechanics, pathophysiology and management. In: Iannotti JP, Williams GR, eds. *Disorders of the Shoulder: Diagnosis and Management.* Philadelphia, PA: Lippincott Williams & Wilkins; 1999).

TABLE 1 Demographic and Patient Characteristics

Mean age	51 y
Age range	18-79 y
Gender	13 male, 7 female
Involved side	11 right, 9 left
Dominant side	18 right hand, 2 left hand
Type of surgery	6 radical neck dissections, 7 modified radical neck dissections, 2 selective neck dissections, 1 endarterectomy, 1 mandibular lengthening
Primary site of cancer	5 tonsillar carcinoma, 4 thyroid carcinoma, 1 pharyngeal carcinoma, 1 palate carcinoma, 1 carcinoma base of tongue, 3 unknown location
Nonoperative injuries	1 rugby injury, 1 carrying heavy lumber, 1 carrying heavy bag

neck dissection (RND), modified radical neck dissection (MRND), and selective neck dissection (SND).[47] During the RND, all levels of lymph nodes are resected along with the spinal accessory nerve, the SCM muscle, and the internal jugular vein. Functional outcomes following RND are inferior to spinal accessory nerve-sparing procedures due to the resultant chronic trapezius dysfunction.[7,9,13,33,43,50,53] The MRND and SND procedures were developed to spare the spinal accessory nerve, thus limit trapezius dysfunction; however, significant incidence of spinal accessory nerve injury has been reported[6,10,13,14,52,53] that might have resulted from nerve manipulation.[6,29,43,50,52] The MRND requires lymph node dissection at all levels, but the spinal accessory nerve is usually spared. The SND can vary in technique depending on the location and size of the primary tumor and targeted or suspicious lymph nodes. All nonlymphatic structures are spared, including the spinal accessory nerve. Therefore, the clinician needs to rule out a SANP in any patient treated following neck dissection surgery and any surgical procedure or trauma involving the lateral neck region.

Spinal accessory nerve injury results in trapezius dysfunction causing both static and dynamic shoulder girdle alterations.[7,22] The trapezius is divided into 3 distinct heads: upper, middle, and lower. The upper fibers descend from the base of the skull and cervical spine to insert on the posterior distal third of the clavicle and acromion, creating a long suspension lever arm, which statically prevents shoulder girdle depression. The middle and lower fibers extend from the thoracic spine and insert on the scapular spine base and triangular aponeurosis. The middle and lower trapezius fibers statically and dynamically tether the scapula to the thoracic spine, limiting excessive protraction. Each head of the trapezius has a primary dynamic function on the scapula. The upper trapezius elevates, the middle trapezius retracts, and the lower trapezius depresses. In unison, the primary function of the trapezius is to upwardly rotate the scapula during shoulder elevation, forming a force couple with the serratus anterior.[18,37] SANP results in the loss of trapezius static restraint, causing shoulder girdle depression and protraction.[6,7,15,46,53] Dynamically, trapezius dysfunction results in dramatically altered scapular kinematics and limited shoulder elevation.[7,13,14,22,46,53]

Diagnosis of SANP is typically achieved by identifying associated signs such as trapezius atrophy, depressed shoulder girdle, scapular dyskinesis, trapezius weakness, and limited shoulder active abduction.[6,9,11,13-15,28,29,31,46,48,49,53,52] Unfortunately, many of these signs are observational and unreliably recognized, which may explain a high rate of misdiagnosis.[3,4] Assessing scapular dyskinesis is unreliable.[25] Reliability and validity of manual muscle testing is controversial[5,16,38,39] and testing the upper trapezius by scapular shrugging is suspect because the levator scapula and rhomboid can adequately perform this activity.[23,36,41] Additionally, the proposed muscle test positions for the middle and lower trapezius can be provocative in the early postoperative/postinjury period. Early identification of SANP can assist with the prognosis by explaining persistent impairments and functional deficits, enabling appropriate diagnostic testing and interventions, and maximizing outcomes.[3,4,14,27,44,46]

The purpose of this case series is to (1) describe the associated history, signs and symptoms related to SANP and (2) increase awareness of the scapular flip sign as a simple clinical sign associated with SANP.

CASE SERIES DESCRIPTION

The series consisted of 20 patients (13 male, 7 female), ranging from 18 to 79 years of age (mean, 51). Initial physical therapy examination ranged from 1 to 17 months following onset (mean, 4 months). **TABLE 1** shows the demographic and patient characteristics.

TABLE 2 MANUAL MUSCLE TESTING RESULTS AND ACTIVE AND PASSIVE RANGE OF MOTION VALUES AND MEANS FOR ABDUCTION AND FLEXION*

	Abduction Involved (°)		Flexion Involved (°)		MMT			
	AROM	PROM	AROM	PROM	UT	MT	LT	SCM
RND								
Patient 1	20	120	90	130	0/5	0/5	0/5	Absent
Patient 2	40	130	95	135	0/5	0/5	0/5	Absent
Patient 3	65	155	110	160	0/5	0/5	0/5	Absent
Patient 4	70	145	115	155	0/5	0/5	0/5	Absent
Patient 5	80	140	120	145	0/5	0/5	0/5	Absent
Patient 6	70	155	130	160	0/5	0/5	0/5	Absent
Mean	58	141	110	148	...	...	...	...
MRND								
Patient 7	60	130	80	135	0/5	0/5	0/5	NA
Patient 8	70	155	100	160	0/5	0/5	0/5	0/5
Patient 9	40	135	100	140	0/5	0/5	0/5	0/5
Patient 10	50	155	120	160	0/5	0/5	0/5	0/5
Patient 11	70	150	125	150	0/5	0/5	0/5	NA
Patient 12	70	155	145	165	1/5	0/5	0/5	5/5
Patient 13	65	150	130	160	1/5	0/5	0/5	NA
Mean	61	147	114	153	...	...	...	...
SND								
Patient 14	80	155	140	160	0/5	0/5	0/5	5/5
Patient 15	90	165	150	165	2/5	0/5	0/5	NA
Mean	85	160	145	163	...	...	...	...
Surgical non-cancer								
Patient 16	40	120	120	130	0/5	0/5	0/5	5/5
Patient 17	60	160	135	160	0/5	0/5	0/5	NA
Mean	50	140	128	145	...	...	...	...
Non-operative								
Patient 18	80	155	140	160	2/5	0/5	0/5	5/5
Patient 19	85	155	150	160	2/5	0/5	0/5	5/5
Patient 20	90	165	160	165	0/5	0/5	0/5	5/5
Mean	85	158	150	162	...	...	...	...

Abbreviations: AROM, active range of motion; LT, lower trapezius; MMT, manual muscle testing; MRND, modified radical neck dissection; MT, middle trapezius; NA, not available; PROM, passive range of motion; RND, radical neck dissection; SCM, sternocleidomastoid; SND, sparing neck dissection; UT, upper trapezius.
** Range of motion values for the uninvolved side were within normal limits.*

History

Nine patients presented to physical therapy with a diagnosis of SANP: 1 following a stretch injury, 6 following RND, and 2 following MRND. The other 5 patients post-MRND and the 2 patients post-SND had prescriptions identifying the surgical procedure and impairments, and 4 had a prescription that read "spinal accessory nerve palsy?" The provided diagnosis in 4 of the 5 patients remaining in the noncancer group was shoulder impingement in 2 patients, frozen shoulder in 1 patient, and "scapular dyskinesia" in the remaining patient.

Pain complaints varied among the patients, but a pattern could be appreciated. Patients in the noncancer group, with the exception of the patient who had the endarterectomy, reported a period (approximately 3 to 14 days) of pain/achiness in the scapular region following the identified event. At the time of their initial therapy visit the patients in this group only complained of scapular region pain or occasional shoulder pain with repetitive arm use. The patients who had neck dissections all had postoperative pain about the neck and scapula, but it was difficult to distinguish pain related to surgery from that related to spinal accessory nerve injury. A trend of greater pain was associated with extensive neck dissection. The most common complaint among all patients was shoulder weakness.

Examination

All patients were examined by the first author (M.J.K.). On clinical examination, all patients presented with dramatic trapezius atrophy and a depressed shoulder girdle. The cervical spine and shoulder were thoroughly examined. Cervical spine motion was not objectively measured but visually judged to be restricted to some extent, especially for extension, contralateral side bending, and rotation to both sides in all 16 patients having neck dissection surgery and endarterectomy. Some motion discomfort was present to varying extent and was localized to the neck, superior scapula, and supraclavicular region. The other individuals in the noncancer group had normal pain-free cervical motion. Shoulder range of motion was measured with a standard goniometer (**TABLE 2**).[23]

All 20 patients presented with a positive scapular flip sign. The scapular flip sign, initially described by Kelley,[20,21] was performed with the patient standing, arm at the side, and elbow flexed to 90°. The examiner resisted glenohumeral external rotation at the distal forearm while visually examining the scapula. A positive scapular flip sign was present if the medial scapular border was noted to "flip" or lift from the thoracic wall during resisted shoulder external rotation (**FIGURE 2A**).

An upper-quarter screen was performed and no neurologic deficits were noted in the upper extremity muscles other than the trapezius. Relative shoulder external rotator and abductor weakness was present in most patients upon manual muscle testing, but the weakness appeared related to the effect of having recent surgery or trapezius absence resulting in compromised proximal shoulder girdle fixation.

The SCM and trapezius (upper, middle, and lower) muscles were tested using Kendall and McCreary[23] techniques. **TABLE 2** shows strength grade results. SCM testing was not warranted in the 6 patients post-RND because it was surgically excised.

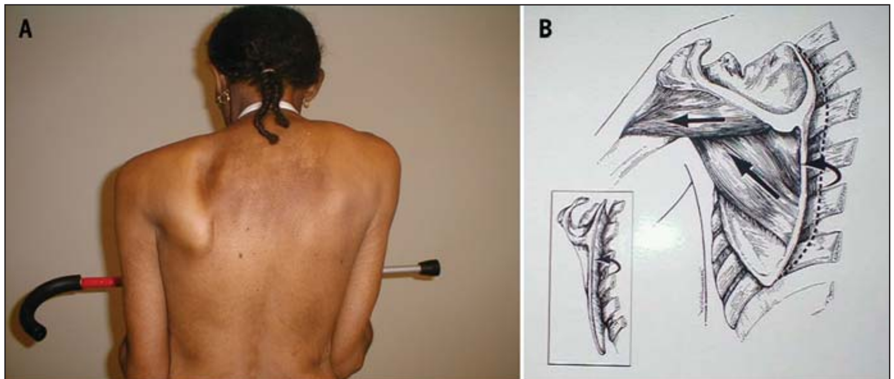

FIGURE 2. (A) A patient with a spinal accessory nerve palsy (SANP) demonstrating a positive scapular flip sign on the left during bilateral resisted shoulder external rotation. (B) Schematic demonstrates a positive scapular flip sign. During resisted humeral external rotation the pull of the infraspinatus and posterior deltoid on the scapula is unopposed by the inactive middle and lower trapezius, causing the medial border of the scapula to "flip" off the thoracic wall. (Reproduced with permission of Kelley, MJ. Clinical evaluation of the shoulder. In: Mackin EL, Callahan AD, Skervin TM, Schneider AH, Osterman AL, eds. *Rehabilitation of the Hand.* 5th ed. Oxford, UK: Mosby; 2002).

TABLE 3 Electrodiagnostic Testing Results Before and After Initial Physical Therapy Visit

	Pre-PT EMG	Muscle Tested	Pre-PT NCS	Post-PT EMG	Muscle Tested	Post-PT NCS
Patient 17	NP	...	NP	Abnormal	UT	NP
Patient 18	NP	...	NP	Normal-clinically abnormal	UT	NP
Patient 19	Normal	UT	NP	Abnormal	UT, MT, LT	Abnormal
Patient 20	Abnormal	UT	NP	...	...	...

Abbreviations: EMG, electromyography; LT, lower trapezius; MT, middle trapezius; NCS, nerve conduction study; NP, not performed; PT, physical therapy; UT, upper trapezius.

Five patients demonstrated some activity of the anterior one-third to two-thirds of the upper trapezius. Patients with partial return of the upper trapezius tended to have better active arm elevation.

Electromyography (EMG) was performed 6 to 12 weeks following symptom onset before coming to physical therapy in 2 patients without cancer-related onset. A summary of their findings is found in **TABLE 3**. Complete electrodiagnostic testing of the trapezius (EMG of all 3 sections and a nerve conduction study [NCS] of the spinal accessory nerve) was only performed in 1 patient.

Based upon the history and physical examination findings (**TABLE 4**), the clinical diagnosis for all patients was primary SANP resulting in pain, limited shoulder elevation, and functional deficits. One patient had a secondary frozen shoulder.

Possible differential diagnoses included cervical radiculopathy, brachial plexopathy/neuritis, and long thoracic nerve palsy.

DISCUSSION

A clear relationship is present between SANP and a history of neck dissection or lymph node excision.[2,6,9,11,13-15,27-29,31,43,46,48,49,52,53] Donner and Kline[11] found 59 of 83 cases (70%) with SANP were related to neck dissection surgery. Kim et al[27] reported that the etiology of 91% of 111 patients surgically treated for SANP was iatrogenically induced either by lymph node biopsy

TABLE 4 Spinal Accessory Nerve Palsy Associated History and Examination Findings

History	Signs
Neck dissection/lymph node excision	Shoulder girdle depression (drooping)
Blunt or penetrating trauma to the lateral neck	Trapezius atrophy
Cervical stretch injury	Limited active coronal plane abduction
Symptoms	Scapular dyskinesis
Scapular/neck pain	Scapular flip sign
Shoulder weakness	Sternocleidomastoid absent/weak
	Weakness of middle and lower trapezius

or tumor excision. The spinal accessory nerve is often injured during neck dissection surgery because the nerve is manipulated causing traction or devascularization.[6,10,29,43] The incidence of SANP associated signs and symptoms is 47% to 100%,[9,15,43,46] 18% to 77%,[13,15,31,48] and 31% to 40%,[6,9,43,52] following a RND, MRND, and SND, respectively. Recognize that not every patient, following neck dissection, has significant symptoms at the time of follow-up and that not all studies report on all associated signs and symptoms. MRND and SND spare the spinal accessory nerve, but nerve traction can result in temporary nerve damage and trapezius motor interruption that shows recovery beyond 3 months.[6,10,29,43,46,50] Regardless of the type of neck dissection, abnormal electrodiagnostic studies were found in 75% to 100% of patients who underwent SND[6,14,29,43] and in 100% of patients following MRND[14,29,49] up to at least 3 months following surgery. Preservation of the cervical plexus has not been found to decrease symptoms or improve function.[13] Therefore, patients following neck dissection are an excellent population to observe and determine the common cluster of signs, symptoms, and special test associated with SANP.

The absence of electrodiagnostic studies in patients after neck dissection in this series is a limitation. However, considering the high incidence of spinal accessory nerve injury following neck dissection, the presence of SANP signs and symptoms in our patients and the fact that the average length of time from surgery to examination was 3 months for our patients following neck dissection, it is likely that the patients in our series had a spinal accessory nerve injury.

Pain

Pain complaints following neck dissection are common. Lower pain scores have been reported in SND and MRND when compared to RND.[43,50] Moderate to severe pain was reported following RND and MRND in 60% and 52% of cases, respectively.[13] Cappiello et al[6] compared disability in patients following 2 different types of SND and found that 80% to 85% of patients had no pain complaints, and only mild pain was found in the remaining patients at least 1 year from surgery. Sixty-nine percent of patients with spinal accessory nerve dysfunction had pain complaints at 3 years following neck dissection surgery.[53]

All patients who underwent neck dissection in this series complained of neck and/or scapular pain. Greater pain complaints were noticed in those having a more extensive surgical intervention. Many patients had achiness in the upper scapular region that may have been related to the neck dissection, spinal accessory nerve injury, or levator scapula/rhomboid overload. The static suspensatory role and dynamic responsibility of the levator scapula and rhomboid is magnified with trapezius paralysis.[3,4,6] It is possible that all patients post neck dissection in this series had pain complaints because most were examined soon after surgical intervention.

Patients in the noncancer group did appear to have a pattern of pain complaints. Four of the 5 patients reported an interval of pain and achiness immediately following the identified event. The short interval of pain may represent the nerve injury response.[19] At the time of the physical therapy examination, pain was only present in the scapular region or occasionally in the lateral shoulder area with repetitive use. The intermittent scapular pain described with repetitive use may represent levator scapulae and rhomboid overuse,[3,4,6] while improper scapular mechanics may cause rotator cuff irritation.[37]

Trapezius Atrophy and Shoulder Girdle Depression

Trapezius muscle atrophy and a depressed shoulder girdle are hallmark signs of SANP (**FIGURE 3**).[15,53] Although all patients in our series presented with atrophy, an examiner may be deceived by the residual flaccid trapezius and misdiagnose a patient if only visual inspection is relied upon or an incomplete examination performed. This may explain why several referring physicians in our series did not identify the SANP. Five patients had partial return of the upper trapezius that may have led to the false impression that all trapezius heads were active.

All patients in this series had a depressed shoulder girdle. Caversaccio et al[7] measured shoulder depression in patients following RND and MRND and found the operated shoulder 3.9 cm lower than the unoperated side. Van Wilgen et al[53] found that all patients presenting with trapezius atrophy had a depressed shoulder girdle. Shoulder girdle depression most likely results from trapezius paralysis/dysfunction and the loss of trapezius static support to oppose the upper extremity downward force.[3,4,15]

Sternocleidomastoid Muscle

Cappellio[6] found SCM EMG abnormalities in 40% and 45% of patients who had 2 types of SND performed. Dissection above the SCM innervation can result in motor interruption.[6] In this series, the

FIGURE 3. Patient with spinal accessory nerve palsy (SANP) demonstrates significant left trapezius atrophy and shoulder girdle depression.

SCM was absent as in all patients following a RND. Several other patients demonstrated SCM paralysis following neck dissection. The SCM should always be examined if trapezius weakness is noted. Paralysis or weakness of this muscle is a strong indicator that the spinal accessory nerve has been injured. None of the patients in the noncancer group had weakness of the SCM.

Shoulder Range of Motion

SANP following neck dissection can result in limited active range and functional deficits.[13,14,50] All patients in our series had greater active shoulder flexion than coronal plane abduction. We found a similar loss of active flexion (36°) as reported in previous studies.[13,14] The patients in our noncancer group had a loss of active flexion (17°) similar to those who underwent a SND (20°).[14] Shoulder flexion is probably less affected by SANP because the serratus anterior is a more effective scapular upward rotator in flexion compared with coronal plane abduction.[12,18,34]

The loss of active abduction was significantly more in our patients (90.2°) than reported in other studies.[14,13,53] The early time frame from surgery to examination could explain this difference because the patients with neck dissection in this series were an average of 3 months from surgery versus 6 months to 2 years in other studies.[13,14,53] Trapezius reinnervation has been shown to significantly improve after 6 months and may result in greater active range of motion.[14] Compensation from other scapular muscles over time may also result in improved abduction. When measuring active abduction, we strictly maintained coronal plane abduction while externally rotating the arm, which may have resulted in recording less active abduction. End range measurements were recorded if the arm moved anteriorly out of coronal plane. Although patients in the noncancer group only demonstrated a 19° loss of active flexion, they still had limited active abduction of 90° or less.

Lower and Middle Trapezius Muscle Testing

Kendall and McCreary's lower and middle trapezius muscle test positions were used in this series because these positions demonstrate the highest levels of middle and lower trapezius muscle activation.[12,23,38,39,41] Kendall and McCreary[23] strongly advocated maintaining the humerus in external rotation when testing the middle trapezius to prevent rhomboid activation. Mosely et al[41] found significant middle trapezius and rhomboid activation during prone horizontal abduction with neutral arm rotation. However, when external rotation was performed during prone horizontal abduction, rhomboid activity did not reach qualifying activation criteria while the middle trapezius continued to demonstrate significant activation (manual muscle testing, 96%). In our series, all patients had a 0/5 strength grade of the middle and lower trapezius. No palpable rhomboid activity was noted as long as correct test positions were maintained. If humeral internal rotation was allowed during the middle trapezius test, rhomboid activation was palpable. Allowing rhomboid activation may result in misdiagnosis or mislead the clinician regarding trapezius strength. Trapezius muscle test positions were well tolerated even by patients following neck dissection.

Scapular Dyskinesis

Scapular dyskinesis refers to observable alterations in the scapular position or motion during coupled scapulohumeral movements.[24,54] Although scapular dyskinesis is associated with SANP and was appreciated in our patients, dyskinesis alone cannot confirm the diagnosis.[25,35,37] Caversaccio et al[7] and Kelley et al[22] found significantly reduced upward rotation in patients following RND when using different 3-dimensional tracking devices. Interestingly, Caversaccio et al[7] reported that the distance between the scapular spine and the thoracic spine increased at 90° of elevation in patients who had RND, presumably as a result of overcompensation of the serratus anterior pulling the scapula into protraction.

Scapular Flip Sign

The scapular flip sign is proposed as a clinically relevant test to identify abnormal scapular motion associated with SANP and trapezius paralysis. Kelley et al[20,21] first described this sign as associated with SANP. More recently Chan et al[8] reported on the same sign being present in 6 patients with SANP, but the sign was referred to as the "resisted external rotation sign." A positive scapular flip sign was present in all patients in our series. We propose that the scapular flip sign is distinct from medial scapular winging associated with long thoracic nerve palsy for 2 reasons: the abnormal scapular displacement produced by the flip sign assessment is different from patients with long thoracic nerve palsy or serratus anterior weakness, and the manner of promoting the scapular winging varies.

Patients with long thoracic nerve palsy demonstrate significant scapular winging during active shoulder flexion (**FIGURE 4A**). Serratus anterior insufficiency creates medial scapular winging because the entire scapula drifts posteriorly. Resisting shoulder flexion results in the same scapular displacement. Although some variation is seen among patients with SANP, shoulder flexion can be achieved without medial winging because the serratus is intact (**FIGURE 4B**). Active abduction is limited in the patient with SANP, and dyskinesis may be noted; however, the medial border does not significantly displace off the thorax (**FIGURE 4C**).

A positive scapular flip sign and mechanism of displacement are seen in **FIGURE 2**. The clinician resists shoulder external rotation while the arm is at the side. Resisting the glenohumeral external rotators results in significant activity of the infraspinatus and posterior deltoid.[45,51] In the presence of SANP, the pull of the infraspinatus and posterior deltoid is unopposed by the middle and lower trapezius, causing the medial scapular border to "flip" off the thoracic wall. Scapular motion during a positive flip sign occurs through a vertical axis. Although medial border winging can be distinctly produced in patients having a long thoracic nerve or SANP, the mechanisms of displacement are different.

The scapular flip sign was also present in patients with partial return of the upper trapezius. The upper trapezius acts as a scapular upward rotator and elevator, therefore, even when active, it cannot oppose the pull of the humeral external rotators. The middle and lower trapezius appear to play the major role stabilizing the scapular medial border during resisted humeral external rotation. The rhomboids were clinically intact in all patients; however, ineffective in stabilizing the scapular medial border when assessing for the scapular flip sign.

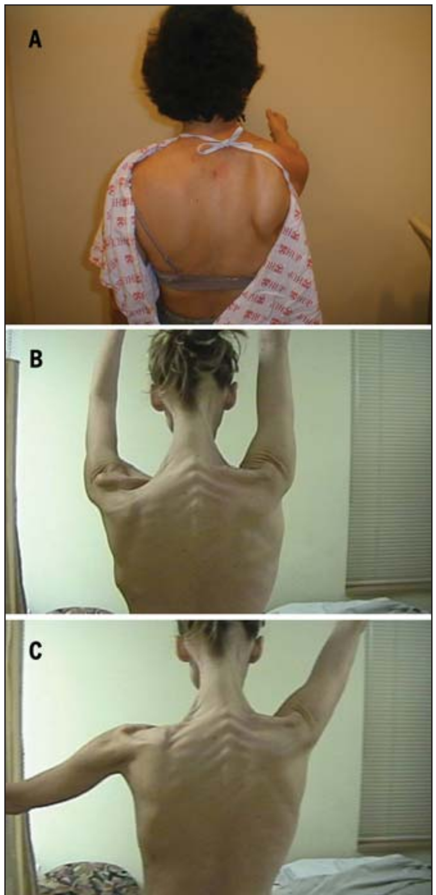

FIGURE 4. (A) Active shoulder flexion causing medial winging in a patient with long thoracic nerve palsy. (B) Medial winging is not evoked during active flexion in patients with spinal accessory nerve palsy (SANP). (C) Active coronal plane abduction in a patient with spinal accessory nerve palsy (SANP). Note the absence of medial winging.

Diagnosis

Diagnosing patients with SANP can be challenging.[11,55] In our series only 9 of the 15 patients post neck dissection surgery were referred to physical therapy with a diagnosis of SANP. Identifying patients with a SANP after neck dissection is essential because poor outcomes may occur if early physical therapy is not initiated.[6,14] Only 1 patient in the noncancer group presented with a diagnosis of SANP, while the other 4 patients were misdiagnosed. Three patients were sent for electrodiagnostic testing after their initial physical therapy visit because their history and examination was consistent with SANP.

If a SANP is suspected a comprehensive EMG/NCS should be performed. However, electrodiagnostic testing has inherent difficulties. Bigliani et al[4] reported that 12 of 22 patients with SANP had inaccurate or incomplete EMG examinations. Performing an EMG on a patient with significant trapezius atrophy is technically demanding because the needle may penetrate the atrophied muscle and enter a neurologically intact muscle below, resulting in a false negative. EMG, although considered the gold standard for evaluating nerve function, is operator dependent. In addition, if a NCS is not performed on the spinal accessory nerve or only 1 portion of the trapezius is assessed, the examination may be considered incomplete.[3,4] Performing EMG/NCS too early may result in false negative studies; therefore, testing is usually deferred for 6 weeks following suspected onset.[1]

The diagnostic process for SANP should also rule out other diagnoses such as cervical radiculopathy, brachial plexopathy/neuritis, and long thoracic nerve palsy. These pathologies can cause some combination of cervical/scapular pain, shoulder girdle depression, limited shoulder motion, and scapular dyskinesis (but not isolated trapezius paralysis). High-velocity trauma causing excessive stretching of the cervical region may injure the spinal accessory nerve, but also involves the brachial plexus, affecting multiple upper extremity muscles.[30]

That a single examiner performed all examinations might have introduced bias. The inclusion of only those cases presenting with SANP-associated signs and symptoms might have as well. However, the authors strongly believe that this series represents the clinical presentation of patients with SANP.

CONCLUSION

This case series highlighted the history, symptoms, and examination findings associated with SANP. SANP should always be considered when examining patients following neck dissection or other surgical procedures involving the neck. SANP should also be ruled out in patients who have a history of blunt or penetrating trauma to the lateral neck region and cervical stretch injuries.

Testing for the scapular flip sign is easy and appears to be associated with SANP. The scapular flip sign can be used in the early postoperative period without invoking pain or tissue trauma. Further testing of the trapezius heads can be performed using manual muscle testing techniques or electrodiagnostic studies.

Future research should be performed to identify trapezius muscle activation in patients with suspected SANP when the flip sign is performed. A diagnostic validity study on consecutive patients with appropriate inclusion criteria would determine validity of the flip sign. Finally, establishing a clinical prediction rule for SANP would be beneficial. Correlation of the associated history, signs, and symptoms to comprehensive electrodiagnostic studies is recommended. ◉

REFERENCES

1. Aminoff MJ. *Electromyography in Clinical Practice: Clinical and Electrodiagnostic Aspects of Neuromuscular Disease.* New York, NY: Churchill Livingstone; 1993.
2. Berry H, MacDonald EA, Mrazek AC. Accessory nerve palsy: a review of 23 cases. *Can J Neurol Sci.* 1991;18:337-341.
3. Bigliani LU, Compito CA, Duralde XA, Wolfe IN. Transfer of the levator scapulae, rhomboid major, and rhomboid minor for paralysis of the trapezius. *J Bone Joint Surg Am.* 1996;78:1534-1540.
4. Bigliani LU, Perez-Sanz JR, Wolfe IN. Treatment of trapezius paralysis. *J Bone Joint Surg Am.* 1985;67:871-877.
5. Bohannon RW. Make tests and break tests of elbow flexor muscle strength. *Phys Ther.* 1988;68:193-194.
6. Cappiello J, Piazza C, Giudice M, De Maria G, Nicolai P. Shoulder disability after different selective neck dissections (levels II-IV versus levels II-V): a comparative study. *Laryngoscope.* 2005;115:259-263.
7. Caversaccio M, Negri S, Nolte LP, Zbaren P. Neck dissection shoulder syndrome: quantification and three-dimensional evaluation with an optoelectronic tracking system. *Ann Otol Rhinol Laryngol.* 2003;112:939-946.
8. Chan PK, Hems TE. Clinical signs of accessory nerve palsy. *J Trauma.* 2006;60:1142-1144.
9. Cheng PT, Hao SP, Lin YH, Yeh AR. Objective comparison of shoulder dysfunction after three neck dissection techniques. *Ann Otol Rhinol Laryngol.* 2000;109:761-766.
10. Chepeha DB, Taylor RJ, Chepeha JC, et al. Functional assessment using Constant's Shoulder Scale after modified radical and selective neck dissection. *Head Neck.* 2002;24:432-436.
11. Donner TR, Kline DG. Extracranial spinal accessory nerve injury. *Neurosurgery.* 1993;32:907-910; discussion 911.
12. Ekstrom RA, Donatelli RA, Soderberg GL. Surface electromyographic analysis of exercises for the trapezius and serratus anterior muscles. *J Orthop Sports Phys Ther.* 2003;33:247-258.
13. El Ghani F, Van Den Brekel MW, De Goede CJ, Kuik J, Leemans CR, Smeele LE. Shoulder function and patient well-being after various types of neck dissections. *Clin Otolaryngol Allied Sci.* 2002;27:403-408.
14. Erisen L, Basel B, Irdesel J, et al. Shoulder function after accessory nerve-sparing neck dissections. *Head Neck.* 2004;26:967-971.
15. Ewing MR, Martin H. Disability following radical neck dissection; an assessment based on the postoperative evaluation of 100 patients. *Cancer.* 1952;5:873-883.
16. Frese E, Brown M, Norton BJ. Clinical reliability of manual muscle testing. Middle trapezius and gluteus medius muscles. *Phys Ther.* 1987;67:1072-1076.
17. Gray H, Pick TP, Howden RH. *Anatomy.* New York, NY: Crown Publishers; 1977.
18. Inman VT, Saunders JB, Abbott LC. Observations of the function of the shoulder joint. 1944. *Clin Orthop Relat Res.* 1996;3-12.
19. Kauppila LI, Vastamaki M. Iatrogenic serratus anterior paralysis. Long-term outcome in 26 patients. *Chest.* 1996;109:31-34.
20. Kelley M. Clinical evaluation of the shoulder. In: Mackin E, Callahan A, Skirven T, Schneider L, Osterman A, eds. *Rehabilitation of the Hand and Upper Extremity.* St Louis, MO: Mosby; 2002.
21. Kelley MJ, Brenneman S. The Scapular Flip Sign: An Examination Sign to Identify the Presence of a Spinal Accessory Nerve Palsy. *APTA Combined Sections Meeting.* New Orleans, LA: 2000.
22. Kelley MJ, McClure PW, Bialker J, Cheville A. 3-Dimensional Scapular Kinematics in Patients With a Spinal Accessory Nerve Palsy. *APTA Combined Sections Meeting.* Tampa, FL: 2003.
23. Kendall F, McCreary E. *Muscle Testing and Function.* 3rd ed. Baltimore, MD: Williams & Wilkins; 1982.
24. Kibler B. Role of the scapula in the overhead throwing motion. *Contemp Orthop.* 1991;22:525-532.
25. Kibler WB, Uhl TL, Maddux JW, Brooks PV, Zeller B, McMullen J. Qualitative clinical evaluation of scapular dysfunction: a reliability study. *J Shoulder Elbow Surg.* 2002;11:550-556.
26. Kierner AC, Burian M, Bentzien S, Gstoettner W. Intraoperative electromyography for identification of the trapezius muscle innervation: clinical proof of a new anatomical concept. *Laryngoscope.* 2002;112:1853-1856.
27. Kim DH, Cho YJ, Tiel RL, Kline DG. Surgical outcomes of 111 spinal accessory nerve injuries. *Neurosurgery.* 2003;53:1106-1112; discussion 1102-1103.
28. Koybasioglu A, Bora Tokcaer A, Inal E, Uslu S, Kocak T, Ural A. Accessory nerve function in lateral selective neck dissection with undissected level IIb. *ORL J Otorhinolaryngol Relat Spec.* 2006;68:88-92.
29. Koybasioglu A, Tokcaer AB, Uslu S, Ileri F, Beder L, Ozbilen S. Accessory nerve function after modified radical and lateral neck dissections. *Laryngoscope.* 2000;110:73-77.
30. Kozin F. Injuries of the brachial plexus. In: Iannotti J, Williams GR, eds. *Disorders of the Shoulder: Diagnosis and Management.* Philadelphia, PA: Lippincott Williaims & Wilkins; 2007:
31. Krause HR. Reinnervation of the trapezius muscle after radical neck dissection. *J Craniomaxillofac Surg.* 1994;22:323-329.
32. Kuhn JE, Plancher KD, Hawkins RJ. Scapular Winging. *J Am Acad Orthop Surg.* 1995;3:319-325.
33. Kuntz AL, Weymuller EA, Jr. Impact of neck dissection on quality of life. *Laryngoscope.* 1999;109:1334-1338.
34. Laumann U. *Kinesiology of the Shoulder: Electromyographic and Stereophotogrammetric Studies. Surgery of the Shoulder.* Philadelphia, PA: B.C. Decker; 1984.
35. Ludewig PM, Cook TM. Alterations in shoulder kinematics and associated muscle activity in people with symptoms of shoulder impingement. *Phys Ther.* 2000;80:276-291.
36. Ludewig PM, Cook TM. Contribution of selected scapulothoracic muscles to the control of accessory scapular motions. *J Orthop Sports Phys Ther.* 1997;25:77-80.
37. Ludewig PM, Cook TM, Nawoczenski DA. Three-dimensional scapular orientation and muscle activity at selected positions of humeral elevation. *J Orthop Sports Phys Ther.* 1996;24:57-65.
38. Michener LA, Boardman ND, Pidcoe PE, Frith AM. Scapular muscle tests in subjects with shoulder pain and functional loss: reliability and construct validity. *Phys Ther.* 2005;85:1128-1138.
39. Michener LA, Pidcoe PE, Firth AM. Reliability and validity of scapular muscle strength testing in patients with shoulder pain and functional loss [abstract]. *Med Sci Sports Exerc.* 2003;35:S252.
40. Miyata K, Kitamura H. Accessory nerve damages and impaired shoulder movements after neck dissections. *Am J Otolaryngol.* 1997;18:197-201.
41. Moseley JB, Jr., Jobe FW, Pink M, Perry J, Tibone J. EMG analysis of the scapular muscles during a shoulder rehabilitation program. *Am J Sports Med.* 1992;20:128-134.
42. Nakamichi K, Tachibana S. Iatrogenic injury of the spinal accessory nerve. Results of repair. *J Bone Joint Surg Am.* 1998;80:1616-1621.
43. Orhan KS, Demirel T, Baslo B, et al. Spinal accessory nerve function after neck dissections. *J Laryngol Otol.* 2007;121:44-48.
44. Patten C, Hillel AD. The 11th nerve syndrome. Accessory nerve palsy or adhesive capsulitis? *Arch Otolaryngol Head Neck Surg.* 1993;119:215-220.
45. Reinold MM, Wilk KE, Fleisig GS, et al. Electromyographic analysis of the rotator cuff and deltoid musculature during common shoulder external rotation exercises. *J Orthop Sports Phys Ther.* 2004;34:385-394.
46. Remmler D, Byers R, Scheetz J, et al. A prospective study of shoulder disability resulting from radical and modified neck dissections. *Head Neck Surg.* 1986;8:280-286.
47. Robbins KT, Medina JE, Wolfe GT, Levine PA, Sessions RB, Pruet CW. Standardizing neck dissection terminology. Official report of the Academy's Committee for Head and Neck Surgery and Oncology. *Arch Otolaryngol Head Neck Surg.* 1991;117:601-605.
48. Saunders JR, Jr., Hirata RM, Jaques DA. Considering the spinal accessory nerve in head and

neck surgery. *Am J Surg.* 1985;150:491-494.

49. Sobol S, Jensen C, Sawyer W, 2nd, Costiloe P, Thong N. Objective comparison of physical dysfunction after neck dissection. *Am J Surg.* 1985;150:503-509.

50. Terrell JE, Welsh DE, Bradford CR, et al. Pain, quality of life, and spinal accessory nerve status after neck dissection. *Laryngoscope.* 2000;110:620-626.

51. Townsend H, Jobe FW, Pink M, Perry J. Electromyographic analysis of the glenohumeral muscles during a baseball rehabilitation program. *Am J Sports Med.* 1991;19:264-272.

52. van Wilgen CP, Dijkstra PU, van der Laan BF, Plukker JT, Roodenburg JL. Shoulder complaints after neck dissection; is the spinal accessory nerve involved? *Br J Oral Maxillofac Surg.* 2003;41:7-11.

53. van Wilgen CP, Dijkstra PU, van der Laan BF, Plukker JT, Roodenburg JL. Shoulder complaints after nerve sparing neck dissections. *Int J Oral Maxillofac Surg.* 2004;33:253-257.

54. Warner JJ, Micheli LJ, Arslanian LE, Kennedy J, Kennedy R. Patterns of flexibility, laxity, and strength in normal shoulders and shoulders with instability and impingement. *Am J Sports Med.* 1990;18:366-375.

55. Williams WW, Twyman RS, Donell ST, Birch R. The posterior triangle and the painful shoulder: spinal accessory nerve injury. *Ann R Coll Surg Engl.* 1996;78:521-525.

@ MORE INFORMATION
WWW.JOSPT.ORG