Scoping review of the literature on shoulder impairments and disability after neck dissection

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Accepted 6 December 2012
Published online 1 April 2013 in Wiley Online Library (wileyonlinelibrary.com). DOI 10.1002/hed.23243

ABSTRACT: *Background.* The purpose of this article was to provide a review of the literature on shoulder disability after neck dissection.

Methods. A literature review was performed using Ovid Medline and Embase databases. A total of 306 abstracts and 78 full-text articles were reviewed. Forty-two articles were eligible for inclusion.

Results. Patients undergoing nerve-sacrifice neck dissections have greater disability and lower quality of life scores than those undergoing neck dissections with the least manipulation (ie, selective neck dissections). Shoulder impairments can still occur in patients undergoing selective neck dissections. Disability typically improves over time in patients undergoing nerve-sparing neck dissections.

Conclusion. There was significant variability in the literature in terms of the prevalence and recovery of shoulder morbidity after neck dissection. This variability may not just be related to surgical technique or rehabilitation, but also to study design, definitions, and the variability in disability questionnaires used. © 2013 Wiley Periodicals, Inc. *Head Neck* **36**: 299–308, 2014

KEY WORDS: shoulder disability, neck dissection, literature review, head and neck cancer

INTRODUCTION

Health status outcome measurement such as disability and quality of life (QOL) has become a critical issue in both research and clinical endeavors in head and neck oncology.[1] One of the most widely accepted definitions of disability is the World Health Organization (WHO) International Classification of Functioning (ICF), Disability and Health taxonomy that identifies the consequences of disease and treatment; namely, impairments, activity limitations, and restrictions in social participation.[2–4] Impairment is defined by the ICF as a significant deviation or loss in the physiologic function(s) of a body system or an anatomic part of the body.[2,4] Activity limitations are difficulties an individual may face in the execution of a task or action, whereas participation restrictions are problems an individual may experience in involvement in a life situation.[2,4] In accordance with the ICF, a complete assessment of outcome for any health condition or intervention requires an evaluation of health status outcomes in these domains.[2,4] Health-related quality of life (QOL) is a subjective, multi-attribute construct defined by the WHO as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, standards, and concerns.''[5,6]

It has long been recognized that the temporary or permanent denervation of the trapezius muscle secondary to spinal accessory nerve (cranial nerve XI) injury during a neck dissection results in shoulder-related disability. In 1952, Ewing and Martin[7] were the first to report that resection of cranial nerve XI with a radical neck dissection resulted in significant shoulder impairments, including pain, and reduction in strength and range of motion (ROM). In 1961, Nahum and Marmor reported that shoulder impairment after a radical neck dissection is characterized by shoulder droop, winged scapula, inability to shrug, and a dull nonlocalizing pain that was exacerbated by movement, particularly shoulder abduction.[8] Other contemporary authors reported that these shoulder impairments resulted in significant limitations in daily activities, work-related tasks, and recreation.[9,10] With the recognition of the impact of shoulder disability on patients, surgeons developed modifications of the radical neck dissection, including the modified radical neck dissection and selective neck dissections that preserved cranial nerve XI without compromising oncologic outcomes.[11,12] However, despite preservation of cranial nerve XI, shoulder disability was still reported after these less radical procedures.[13,14]

There has been a significant amount of literature assessing shoulder disability in patients undergoing both nerve-

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Contract grant sponsor: This work was supported by a Cancer Care Ontario, Ontario Cancer Research Network, and Canadian Institutes for Health Research grant.

sparing and nerve-sacrificing neck dissections.[15–18] The purpose of this scoping review was to provide a literature review of shoulder impairments, activity limitations, and participation restrictions after neck dissection. The overall goal was to highlight the extent of the problem, as well as the significant variability in outcomes and results, and the wide variability in the measurement tools used to assess these outcomes. By identifying the gaps in the existing literature, areas of focus for future efforts can be illuminated.

METHODS

Search strategy

A scoping review of the literature evaluating shoulder impairments, activity limitations, and participation restrictions after neck dissection for head and neck cancer was performed using Ovid Medline and Embase databases (from 1980 to July 2011). The electronic search was restricted to articles published in the English language using the following medical subject heading terms or text words: shoulder, upper extremity, disability, activity limitations, impairment, function, limitations, questionnaire, spinal accessory nerve, shoulder syndrome, morbidity, pain, symptoms, quality of life, neck dissection, and head and neck cancer. The electronic search was supplemented by cross-referencing potentially relevant citations from the reference lists of identified publications. All abstracts from the search strategy were reviewed for eligibility.

Selection of studies for inclusion

All abstracts and citations were reviewed for relevance. Two independent reviewers reviewed any abstracts or citations deemed potentially relevant in full-text form. Full-text articles were included in this review only if consensus was achieved between reviewers based on the following inclusion and exclusion criteria.

Inclusion and exclusion criteria

Studies were eligible for inclusion if they reported on either evaluation of patients' impairments, activity limitations and/or participation restrictions, or evaluation of shoulder range of motion, strength, or electrophysiological studies of trapezius function after neck dissection. Studies must have included more than 5 patients. Review articles were excluded. Studies that evaluated methods/techniques of prevention of shoulder disability after neck dissection were also excluded. The studies that met inclusion criteria were reviewed in terms of the construct being evaluated, study design (ie, cross-sectional vs prospective), outcome measures, and the reported outcomes.

RESULTS

There were a total of 306 abstracts or citations reviewed and 78 full-text articles reviewed in duplicate for eligibility for inclusion. There were a total of 42 articles eligible for inclusion. For the review, the terms used by the authors to describe the construct measured will be provided in quotations. For the studies described in the following literature review, Tables 1, 2, 3, and 4

TABLE 1. Summary of studies assessing shoulder function and disability after radical neck dissection.

Author	Year	Journal	Type of study	Comparison groups	No. of patients	No. of neck dissections	Mean age, y	Laterality	ROM or strength assessed	EMG	Patient self-report measure used	Measurement period
Carenfelt et al[9]	1981	Acta Otolaryngol	C	RND vs MRND	53	53	Not described	UND	ROM & strength	No	Pain	2 to 7 y post-op
Short et al[13]	1984	Am J Surg	C	SND vs MRND vs RND vs patients with no ND	35	35	60	UND	ROM & strength	No	Own	>6 wk post-op
Shone et al[19]	1991	J Laryngol Otol	C	RND	46	46	56	UND	ROM	No	Pain and own	>6 mo
Dijkstra et al[20]	2001	Head Neck	C	SND vs MRND vs RND & operated vs nonoperated side	177	181	60	UND & BND	ROM	No	Own	Mean of 13 d post-op
Fialka et al[21]	1988	J Craniomaxillofac Surg	P	Pre-op vs post-op	43	43	53	UND	ROM	Yes	Pain verbal rating scale	1 mo & 4 mo post-op
Leipzig et al[22]	1983	Am J Surg	C	MRND & RND	109	Not described	Not described	Not described	ROM & strength	No	Pain & own	Immediate post-op & at 6 mo post-op
Krause et al[23]	1992	Int J Oral Maxillofac Surg	C	RND	54	54	33–84 (range only provided)	UND	No	Yes	Own	All >6 mo post-op, mean 29 mo post-op
Saunders et al[24]	1985	Am J Surg	C	RND vs MRND vs RND with cable graft	100	146	57	UND & BND	ROM	No	Own	Mean of 6.2 y post-op, and 6 mo–19 y
Hillel et al[25]	1989	J Otolaryngol	R	No comparison	11	11	59	UND	ROM	No	Own	Mean of 22 mo post-op

Abbreviations: ROM, range of motion; EMG, electromyography; C, cross-sectional; RND, radical neck dissection; MRND, modified radical neck dissection; UND, unilateral neck dissection; SND, selective neck dissection; ND, neck dissection; BND, bilateral neck dissection; P, prospective; R, retrospective.
Term "own" refers to questionnaires devised solely for the study without any methodologic principles applied.

TABLE 2. Summary of studies assessing shoulder function and disability after modified radical neck dissection and selective neck dissection.

Author	Year	Journal	Type of study	Comparison groups	No. of patients	No. of neck dissections	Mean age, y	Laterality	ROM or strength assessed	EMG	Patient self-report measure used	Measurement period
van Wilgen et al[26]	2003	J Craniomaxillofac Surg	R	SND (no comparison group)	50	60	63	UND & BND	No	No	SDQ & Groningen scale	>1 y after
Salerno et al[27]	2002	Laryngoscope	C	Physiotherapy vs no physiotherapy	60	Not described	59	Not described	ROM & strength	Yes	Constant's Score	15, 30, 90 & 180 d post-op
Güldiken et al[28]	2005	Auris Nasus Larynx	P	Pre-op vs post-op	25	50	Not described	BND	ROM	No	Modified NDII	Pre-op, 1 mo, 3 mo, 6 mo, & 18 mo post-op
Carr et al[29]	2009	Head Neck	R	Different types of SND	65	65	62	UND	None	No	DASH	>0.5 y post-op
Oz et al[30]	2009	Eur J Cancer Care	R	SND and MRND vs patients with no ND	20	35	60	UND & BND	ROM	No	NPNPQ and NPDS	>1 y post-op
Watkins et al[31]	2011	Head Neck	C	SND vs nonoperated side and SND and adjuvant treatment	34	58	UND & BND	ROM & strength	No	No	Modified Constant's score	>6 mo from surgery
Celik et al[32]	2009	Head Neck	P	Pre-op vs Post-op	30	41	Not described	UND & BND	ROM & strength	Yes	None	Pre-op, 21st day post-op, & 6 mo post-op
Murer et al[33]	2011	Head Neck	C	SND vs SNB	29	29	65	UND	ROM & strength	No	NDII & Modified Constant's score	>1 y
Köybasioglu et al[34]	2000	Laryngoscope	P	Pre-op vs post-op & SND vs MRND	20	24	54	UND & BND	No	Yes	None	Pre-op, 3 wk to 3 mo post-op

Abbreviations: ROM, range of motion; EMG, electromyography; R, retrospective; SND, selective neck dissection; UND, unilateral neck dissection; BND, bilateral neck dissection; SDQ, Shoulder Disability Questionnaire; C, cross-sectional; P, prospective; NDII, Neck Dissection Impairment Index; DASH, Disabilities of the Arm, Shoulder, and Hand Questionnaire; MRND, modified radical neck dissection; ND, neck dissection; NPNPQ, Northwick Park Neck Pain Questionnaire; NPDS, Neck Pain and Disability Scale.

highlight the year of publication, sample size, comparison groups, outcome measures, and time of assessment.

Studies evaluating shoulder-related outcomes after neck dissection

Radical neck dissections (nerve-sacrifice neck dissections). Shoulder pain is the most frequent "complaint'' after radical neck dissection. The degree of severity of pain is highly variable between studies: severe pain requiring daily use of analgesia is unusual.[9,19,35,57] Dijkstra et al,[20] using a visual analog scale, reported that 70% of 42 patients who underwent radical neck dissection reported having pain before discharge from the hospital. Fialka et al,[21] using a pain verbal rating scale, found that 77% of 43 patients who underwent radical neck dissection, assessed between 1 and 6 months after surgery, had severe or strong shoulder pain. Shone et al[19] noted that only 30% of 46 patients who were all greater than 6 months from their unilateral radical neck dissection reported moderate–severe or severe pain related to the shoulder on a questionnaire devised by the authors. An additional 30% of patients reported some degree of pain most days or every day. Carenfelt et al[9] noted that discomfort and pain only became significant beyond 3 months after surgery. Although Short et al[13] reported that 9 of 12 patients (75%) in their series had some degree of shoulder pain, the average score was 2.7 on a pain scale of zero to 5.

Impairments in shoulder strength and ROM have frequently been described after radical neck dissection. Leipzig et al[22] found that nearly all of their 35 patients who underwent a radical neck dissection had reduced shoulder strength and ROM measured at 6 months after surgery, compared with their preoperative assessment. Krause et al[23] noted variability in severity in both clinical examination and electromyography (EMG) results in 54 patients who underwent radical neck dissection. With a mean time from surgery of 29 months, they also found that 31% experienced severe limitations of ROM combined with severe pain, whereas 41% only mild discomfort. Other authors, including Fialka et al[21] and Saunders et al,[24] have also reported variable results. The most commonly reported activity limitations in daily life included lifting, raising or carrying objects, and leaning or lying on the ipsilateral shoulder.[15,25,58] Shone et al[19] found that 77% of patients had difficulty with everyday tasks such as dressing, combing their hair, hanging up clothes, and reaching a high shelf. Nine patients (19.5%) reported that they could no longer pursue activities they enjoyed (ie, participation restrictions) before surgery such as tennis, darts, gardening, or fishing and 11 of 24 patients (46%) who were employed before surgery stopped working in the long-term (ie, 6 months) specifically because of shoulder-related problems. Of those patients still employed at the time of the study, 12 of these patients changed their occupation because of their shoulder problems. Table 1 summarizes the studies assessing shoulder function and disability after radical neck dissection in terms of year of publication, sample size, comparison groups, intervention, outcome measures, and time of assessment.

TABLE 3. Studies comparing shoulder-related outcomes between the different types of neck dissections.

Author	Year	Journal	Type of study	Comparison groups	No. of patients	No. of neck dissections	Mean age, y	Laterality	ROM or strength assessed	EMG	Patient self-report measure used	Measurement period
Sobol et al[14]	1985	Am J Surg	P	SND vs MRND & RND	35	44	56	UND & BND	ROM	Yes	Own	Pre-op, Mean 17 wk post-op; range 11–39 wk; EMG at 1 y post-op
El Ghani et al[35]	2002	Clin Otolaryngol Allied Sci	C	SND vs MRND vs RND & operated vs nonoperated side	59	80	61	UND & BND	ROM	No	Own	Between 4 mo & 5 y post-op
van Wilgen et al[36]	2004	Int J Oral Maxillofac Surg	R	SND vs MRND	137	137	61	UND & BND	No	No	SDQ	>1 y post-op
Chepeha et al[37]	2002	Head Neck	C	SND vs MRND	54	64	57	UND & BND	ROM & strength	No	Constant's Score	Mean of 34 mo post-op; all >11 mo post-op
Erisen et al[38]	2004	Head Neck	P	Pre-op vs post-op & RND vs SND + MRND vs no surgery	57	92	57	UND & BND	ROM	Yes	None	Mean of 27 mo post-op; ROM testing between 4–6 mo post-op
Rogers et al[39]	2007	Br J Oral Maxillofac Surg	C	SND vs MRND & RND	100	87	63 (median)	UND & BND	No	No	NDII, SDQ, UW-QOL	Mean 12 mo (range 3–38 mo)
Selcuk et al[40]	2008	Tumori	P	Pre-op vs post-op & SND vs MRND	26	32	Not described	BND	ROM	Yes	SPADI	Pre-op, 6 wk & 6 mo post-op
Taylor et al[41]	2002	Head Neck	C	SND vs MRND	54	64	57	UND & BND	No	No	NDII	Mean of 34 mo post-op; all >11 mo post-op
Cheng et al[42]	2000	Ann Otol Rhinol Laryngol	P	Pre-op vs post-op & RND vs SND vs MRND	21	21	50	UND	Strength	Yes	None	1 & 6 mo post-op
Remmler et al[43]	1986	Head Neck Surg	P	Pre-op vs post-op & RND vs SND vs MRND	90	103	56	UND & BND	ROM & strength	Yes	None	Pre-op, 1 mo, 3 mo, 6 mo, & 12 mo post-op
Umeda et al[44]	2010	Oral Surg Oral Med Oral Pathol Oral Radiol Endod	C	SND vs MRND	90	105	Not described	UND & BND	ROM	No	No	3 mo post-op
Orhan et al[45]	2007	J Laryngol Otol	P	Pre-op vs post-op & RND vs MRND	21	42	61	BND	No	Yes	NDII, SDQ, UW-QOL	Pre-op & 9 mo post-op
Zibordi et al[46]	1988	Ann Otol Rhinol Laryngol	C	RND vs SND and MRND	36	44	58	UND & BND	Strength	Yes	None	>1 mo post-op
Shah et al[47]	2001	Head Neck	C	SND vs MRND vs RND	51	51	62	UND	No	No	Own	5–90 mo post-op
Cappiello et al[48]	2005	Laryngoscope	R	SND vs MRND	40	Not described	62	UND & BND	ROM	Yes	Own	>1 y post-op
Tsuji et al[49]	2007	Laryngoscope	C	Different types of SND and cervical nerve-sparing vs cervical nerve-sacrificing	54	70	65	UND & BND	No	Yes	None	>21 d post-op
Inoue et al[50]	2006	Arch Otolaryngol Head Neck Surg	C	SND vs MRND vs RND	74	115	61	UND & BND	ROM	No	Own	Mean of 36 mo; range 12 mo–23 y post-op
Nibu et al[51]	2010	Int J Clin Oncol	P	Pre-op vs post-op & SND vs MRND rehabilitation vs no rehabilitation	224	308	62	UND & BND	ROM	No	Own	1, 3, 6, and 12 mo post-op
Schuller et al[52]	1983	Head Neck Surg	C	RND vs MRND	243	Not described	Not described	UND	No	No	Own	Between 6 mo and 5 y post-op

Abbreviations: ROM, range of motion; EMG, electromyography; P, prospective; SND, selective neck dissection; MRND, modified radical neck dissection; RND, radical neck dissection; UND, unilateral neck dissection; BND, bilateral neck dissection; C, cross-sectional; R, retrospective; SDQ, Shoulder Disability Questionnaire; NDII, Neck Dissection Impairment Index; UW-QOL, University of Washington Quality of Life; SPADI, Shoulder Pain and Disability Index.

TABLE 4. Studies assessing differences in scores on health-related quality of life questionnaires among the different types of neck dissections.

Author	Year	Journal	Type of study	Comparison groups	No. of patients	No. of neck dissections	Mean age, y	Laterality	ROM or strength assessed	EMG	Patient self-report measure used	Measurement period
Kuntz et al[53]	1999	Laryngoscope	P	Pre-op vs post-op & RND vs SND vs MRND	84	84	59	UND	No	No	UW-QOL	Pre-op, 6 mo & 12 mo post-op
Terrell et al[54]	2000	Laryngoscope	C	RND vs SND + MRND vs normal controls (no surgery)	175	224	61	UND & BND	No	No	HN-QOL	Not described
Laverick et al[55]	2004	Arch Otolaryngol Head Neck Surg	P	SND vs no ND	220	259	62	UND & BND	No	No	UW-QOL	Pre-op, 6 mo, 12 mo, & >18 mo post-op
Schiefke et al[56]	2009	Head Neck	C	Pre-op vs post-op and SND vs SNB	25	49	25	Not mentioned	ROM & strength	No	EORTC QLQ-C30; Constant's Shoulder scale	>9.5 mo post-op

Abbreviations: ROM, range of motion; EMG, electromyography; P, prospective; RND, radical neck dissection; MRND, modified radical neck dissection; UND, unilateral neck dissection; UW-QOL, University of Washington Quality of Life; C, cross-sectional; BND, bilateral neck dissection; HN-QOL, head and neck-quality of life; ND, neck dissection; SND, selective neck dissection; EORTC QLQ-C30, European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30-questions.

Selective and modified radical neck dissections (nerve-sparing neck dissections). There is significant variability in terms of the reported prevalence of shoulder impairments and activity limitations after modified radical neck dissection and selective neck dissection.[20,36] Some of the variability can be attributed to how authors defined and measured "disability.'' Some authors measured symptoms alone,[21,26,59] others evaluated impairments in ROM and strength,[27,37,38] whereas other authors reported on activity limitations.[39–41,53,60] No standard tool was used to assess activity limitations between studies. Table 2 summarizes the studies assessing shoulder function and disability after modified radical neck dissection and selective neck dissection in terms of year of publication, sample size, comparison groups, intervention, outcome measures, and time of assessment.

Salerno et al[27] reported that complaints of "shoulder impairment'' after modified radical neck dissection occurred in up to 40% of patients. Van Wilgen et al[26] reported that 28% of 52 patients who underwent selective neck dissection experienced long-term pain, particularly with activities such as moving the arm or shoulder, reaching above the shoulder, or carrying heavy objects. Güldiken et al[28] assessed 25 patients before and after "functional neck dissection'' (with no clarification of the exact type of nerve-sparing neck dissection) using the Neck Dissection Impairment Index (NDII) questionnaire. The mean NDII score at 1 year after surgery was 98.2 of 100 (range, 95–100), with higher scores signifying less disability. Although minimal disability was noted, pain and stiffness scores at the last follow-up were worse than preoperative scores ($p < .005$). On ROM assessment, there were no significant differences between the preoperative and postoperative scores at 18 months. Carr et al[29] also found, when using the Disabilities of the Arm Shoulder and Hand Questionnaire (DASH), that patients who underwent selective neck dissection had minimal postoperative dysfunction. Overall, 23% reported no upper limb dysfunction, 54% reported mild upper limb dysfunction, 1% reported moderate dysfunction, and 8% reported severe dysfunction.

Although associated with minimal shoulder disability, selective neck dissection is not without its morbidity. Oz and Memis[30] compared shoulder and neck pain, along with ROM, between 20 patients who underwent a cranial nerve XI-sparing neck dissection and 20 healthy age-matched subjects. Two pain scales were used for assessment; the Northwick Park Pain Questionnaire and the Neck Pain and Disability Scale. On average, patients were 16 months after their neck dissection. Although not severe in magnitude, shoulder pain scores were higher and ROM testing (goniometric evaluation) lower in the surgical group than in the control group.[30] Murer et al[33] evaluated patients undergoing either sentinel node biopsy (with no cranial nerve XI dissection) or elective neck dissection (type not described) with the NDII and Constant Shoulder Score more than 1 year after surgery. Overall mean scores on both instruments were high (ie, minimal morbidity); however, scores were statistically significantly higher (ie, lower disability) in the patients undergoing sentinel node biopsy. Watkins et al[31] evaluated shoulder function in 34 patients undergoing selective neck dissection using a modified Constant's Score. Their results

showed a negative effect on shoulder function after selective neck dissection, in spite of saving cranial nerve XI when compared to the nonoperated side. A few studies have assessed shoulder morbidity after selective neck dissection without manipulation of cranial nerve XI by avoiding dissection of level IIb. Celik et al[32] found no statistically significant differences in shoulder movement and strength testing between preoperative values and values at either the 21st day or the 6-month postoperative follow-up assessment. There was a statistically significant change in EMG scores between preoperative and both postoperative time periods, with the worst scores reported at 21 days postoperative. In a similar patient population, Koybaşioğlu et al[61] found that distal latencies and compound muscle action potentials were statistically significantly lower at the third week and third month postoperative compared with preoperative values. Although no motor unit potentials were found in 8 patients in the early postoperative period, in the late postoperative period, there were no motor unit potential losses in any of the patients.

Studies comparing shoulder-related outcomes between the different types of neck dissections

Shoulder impairment tends to occur in the early postoperative period after most radical neck dissections and a significant proportion of nerve-sparing neck dissections,[27,60] although patients who underwent selective neck dissection exhibit less impairment and fewer activity limitations.[14,20,36,37,40] The initial decline in shoulder function tends to be followed by progressive improvement in both patients who undergo selective neck dissection and modified radical neck dissection as reinnervation occurs.[22] This typically takes between 6 months and 1 year, depending upon the degree of injury.[42,43,62] Although similar rates of shoulder impairment in the early postoperative period have been reported in patients who underwent radical neck dissection and modified radical neck dissection, the patients who underwent radical neck dissection have significantly worse shoulder ROM, strength, pain, and activity limitations than those who underwent modified radical neck dissection in the longer term (ie, >6 months after surgery).[13,14,22–24,28,42–44,53,54] Table 3 summarizes the studies comparing shoulder-related outcomes between the different types of neck dissections.

Using a questionnaire modified from NDII, Orhan et al[45] noted that patients who underwent modified radical neck dissections reported significantly less "disability'' compared with patients who underwent radical neck dissection. On electrophysiological assessment, decreases in amplitude and EMG scores were more prominent in the radical neck dissection group compared with the modified radical neck dissection group. The amplitude of the trapezius motor response improved with time in the patients who underwent modified radical neck dissection but patients never reached their preoperative values by 9 months after surgery. Zibordi et al[46] compared patients undergoing functional neck dissections (ie, those that included lateral cervical node bearing tissue while preserving the sternocleidomastoid, cranial nerve XI and IJV) with 10 patients who underwent a radical neck dissection. Mean follow-up time from surgery was 3.5 years (range, 1 month–10 years). Both strength testing and EMG results were significantly better in the functional neck dissection group. In the functional neck dissection group, EMG scores were reported as normal in 84.1% of patients and there were slight peripheral neurogenic lesions in 13.6% of patients. In comparison, 100% of the 10 patients who underwent radical neck dissection had severe peripheral neurogenic lesions. Similar results were found for muscle testing for each group. Umeda et al[44] recently reported that there was severe limitation in shoulder abduction at 3 months after all nerve-sacrifice surgeries, whereas 90 of 96 patients who underwent a cranial nerve XI-preserving neck dissection maintained their normal shoulder function. Based on patient interviews, El Ghani et al[35] reported that 50% of patients who underwent a radical neck dissection reported severe "activity disability,'' compared with less than 26% of patients who underwent modified radical neck dissection ($p = .009$). Pain was also significantly worse after a radical neck dissection. Shah et al[47] and Saunders et al[24] reported similar findings with significantly less "disability'' or "shoulder-related symptoms'' after modified radical neck dissection compared with radical neck dissection when measured greater than 6 months from surgery.

There is variability in the literature on whether patients who undergo selective neck dissection have less shoulder-related impairment, activity limitation, and participation restrictions than patients who undergo modified radical neck dissection. Van Wilgen et al[36] evaluated patients using the shoulder disability questionnaire (SDQ) and found that there was greater "disability'' after modified radical neck dissection compared with selective neck dissection. Similar results were reported by Taylor et al[41] using the NDII and Chepeha et al[37] using the Constant Shoulder Score. Both noted that patients who underwent selective neck dissection had statistically significantly higher NDII scores (ie, less disability) than those who underwent modified radical neck dissection. All patients in these 3 studies were at least 11 months from surgery. On the other hand, Cappiello et al[48] reported that on subjective testing (greater than 1 year from surgery) there was no difference between patients who underwent a selective neck dissection with or without level V dissection in terms of self-reported shoulder pain, functional limitations, and shoulder strength. However, level V dissection was also associated with greater EMG abnormalities. In both groups, electroneurographic data showed statistically significant abnormalities on the operated side compared with the nonoperated shoulder. In contrast, Tsuji et al[49] were not able to show any statistically significant differences on EMG evaluation of the trapezius muscle of patients, based on whether or not dissection of level V was done, in all patients undergoing nerve-sparing neck dissections. However, the group that had level V dissected had the lowest mean EMG scores (not statistically significant).

Inoue et al[50] assessed patients who underwent different types of neck dissections greater than 1 year prior. Scores for stiffness and appearance were lower in patients who underwent any type of neck dissection compared with a control group of patients who did not undergo a neck

dissection ($p < .001$). Scores for pain and numbness in patients who underwent selective neck dissection were significantly better than those who underwent modified radical neck dissection or radical neck dissection. Shoulder droop and arm abduction scores in patients after radical neck dissection was significantly worse than in those who underwent either selective neck dissection or modified radical neck dissection; however, all neck dissection patients had reduced arm abduction compared with the control group. Similarly, Nibu et al[51] reported that patients who underwent a modified radical neck dissection and radical neck dissection greater than 1 year prior reported more shoulder pain and numbness compared to patients who underwent a selective neck dissection. Furthermore, in those that underwent a selective neck dissection, the shoulder and neck pain tended to improve, whereas no improvement was observed after radical neck dissection or modified radical neck dissection. Scores for arm abduction tests were significantly better in patients in whom the cranial nerve XI was preserved compared to scores in whom it was resected. Rogers et al[39] used 3 measures that include assessment of shoulder disability to evaluate patients who underwent selective neck dissection, modified radical neck dissection, or radical neck dissection. The mean time from surgery was 1 year. They found that the highest levels of shoulder disability were reported by patients after radical neck dissection and the lowest after selective neck dissection. Scores were similar between the selective neck dissection patients and those who never underwent a neck dissection. Schuller et al[52] found that of 203 patients employed before neck dissection, only 104 (51.2%) returned to their usual occupation after treatment. A similar rate of unemployment was found between patients who underwent modified radical neck dissection and radical neck dissection.

Studies assessing differences in scores on health related quality of life questionnaires among the different types of neck dissections

Studies have attempted to assess the relationship between the type of neck dissection and scores on QOL questionnaires (Table 4). Using the University of Washington Quality of Life (UW-QOL), a head and neck cancer-specific QOL questionnaire, Laverick et al[55] found that those who underwent unilateral selective neck dissection had lower scores (ie, worse QOL) more than 1 year after surgery compared with patients who did not undergo a neck dissection, but better scores than those who underwent a modified radical neck dissection. Similarly, Schiefke et al,[56] using the general health-related European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30-questions, showed a statistically significant decrease in QOL in those having undergone selective neck dissection as opposed to the normal population. However, there was no statistically significant differences in QOL questionnaire scores seen between those having undergone sentinel lymph node biopsy and those undergoing selective neck dissections, despite differences on the Constant Shoulder Score.[33] Van Wilgen et al[63] found that shoulder abduction and pain scores (measured on a visual analog scale) in patients who underwent a neck dissection (radical neck dissection, modified radical neck dissection, or selective neck dissection) were significantly related to several domains (social-functioning domain and limitation from physical-problem domain) on a general overall QOL questionnaire (RAND-36 QOL). Kuntz et al[53] showed that although the shoulder domain scores on the UW-QOL questionnaire differed based on type of neck dissection, there were no significant differences in the other QOL domain scores (subjective appearance, activity, recreation, chewing, swallowing, or speech). Rogers et al[39] reported that, despite objective and subjective shoulder deficits after neck dissection, patients reported shoulder impairment as significantly less important to their QOL than other functional deficits, such as speech and swallowing difficulties.

DISCUSSION

Shoulder-related morbidity has been a long-recognized problem after neck dissection. There still remains considerable uncertainty about the true extent of impairments, activity limitations, and participation restrictions, particularly after nerve-sparing neck dissections. There has been a considerable amount of research in this area, as well as some review articles.[15–17] This current systematic review reports on the scope of the problem of shoulder morbidity in patients undergoing neck dissection. The purpose of the review is not only to report on shoulder-related outcomes but also to highlight the weaknesses of the literature.

As has been noted for many decades, patients who underwent radical neck dissection frequently have shoulder impairments, particularly pain and functional limitations, which can interfere with their ability to function in everyday life. Impairments and activity limitations in these patients tend to be prolonged and moderate to severe. However, there is variability in the reported frequency and severity of pain, as well as the prevalence of activity limitations or participation restrictions. Much of this variability is attributed to the different patterns of innervation to the trapezius, with the cervical plexus contributing significant innervation in up to 25% of patients as confirmed by EMG studies.[7,21,23,49]

There is also significant variability in the reported prevalence of shoulder impairments, activity limitations, and participation restrictions after all types of modified radical neck dissection and selective neck dissection. Overall, it seems that patients with nerve-sparing neck dissections less frequently have long-term shoulder-related morbidity than those that undergo a radical neck dissection. The long-term differences between patients who undergo modified radical neck dissection and selective neck dissection remain less clear, with the literature showing that patients who undergo selective neck dissection tend to have better outcomes. The difference between patients who underwent selective neck dissection and modified radical neck dissection is greater in the early postoperative period and seems to decline with time as recovery of nerve function occurs. In patients undergoing selective neck dissection, many have no reduction in reported impairments, including pain and activity limitations, and if they do have short-term changes, these seem to

improve in the vast majority of patients. However, in both groups, the frequency and severity of shoulder disability, as well as findings on electrophysiologic studies, varies between studies. Some of this variability in morbidity within and between neck dissection groups may be attributed to the differences in innervation patterns to the trapezius muscle, as well as the development of adhesive capsulitis of the shoulder joint in patients who do not undergo physiotherapy.[23,40,64–66] Variability in the literature can also be attributed to the inherent weaknesses of the studies and, in particular, the multiplicity of constructs measured and the variability of the measures that have been used to measure the same construct.

There are many weaknesses within the current literature, which not only likely account for some of the significant variability on the prevalence of shoulder-related morbidity after neck dissection but also make interpretation of the literature difficult. As can be seen in Table 1, the majority of studies are retrospective and cross-sectional in design with relatively small patient numbers. There is wide variation in inclusion criteria of the different types of neck dissection (ie, selective neck dissection, modified radical neck dissection, and/or radical neck dissection). Furthermore, nonstandardized terminologies have frequently been used in these studies to describe the different types of neck dissections. Some studies included only unilateral neck dissections, whereas others included patients who underwent bilateral neck dissections, although the latter patients may have more impairments and functional limitations than the former. Studies varied in terms of comparative groups; some studies compared outcomes between the different types of neck dissections, whereas others compared preoperative and postoperative differences, or the neck dissection side with the nonsurgical side. Other studies provided no comparison group. There was heterogeneity between studies in terms of the time from surgery when patients were assessed: short-term (<6 months from surgery) versus long-term (>12 months) outcomes. Studies that only included patients after 1 year would exclude many of the patients with poor prognosis that do not survive the observation time period, who may have more-advanced disease, and poorer shoulder outcomes. This would potentially bias the results of any study to giving better shoulder outcomes and would also exclude all the patients with temporary morbidity from shoulder paresis.

Another major weakness that needs to be highlighted by this review is the significant variability in patient-based self-report questionnaires used to assess symptoms, activity limitations, and participation restrictions. Despite the fact that the NDII is the only shoulder disability questionnaire that has been specifically developed and validated in patients undergoing neck dissection,[41] its use has been limited to only a few studies. The lack of a standard questionnaire makes the comparison of results between studies difficult and the literature is compromised by numerous studies that have reported shoulder outcomes using data from questionnaires that were designed by the investigators without consideration of accepted principles of questionnaire development.[14,24,35,47,48] Although other studies have used questionnaires with acceptable methodologic development, many of these questionnaires were developed for evaluation of other pathologies and diagnoses and have not undergone assessment of their psychometric properties (ie, sensibility, reliability, and validity) in the head and neck patient population.[26,28,29,37,40,60,61,67]

Further, confounding the literature are the various terms that were used by investigators to describe shoulder outcomes after neck dissection, including "shoulder-related quality of life,'' "shoulder disability,'' "shoulder syndrome,'' "shoulder dysfunction,'' and "shoulder impairment.'' This review demonstrates the multiplicity of constructs measured and the variability of the measures that have been used to measure the same construct. Despite using these various terms, few authors clearly described the conceptual framework of the "impairment,'' "dysfunction,'' or "disability'' they were measuring or reporting. Upon examining each of the studies, it is apparent that the authors were mainly assessing constructs similar to the WHO ICF definition of impairments, activity limitations, and participation restrictions, despite using the term "disability.''

Another drawback to the literature is that the majority of studies seem to focus on symptoms such as pain, impairments in ROM and strength, and limitations in the ability to carry out activities of daily living or recreational activities. There is limited assessment on the impact that impairments and activity limitations have on patients' everyday life (ie, participation restrictions or disability). There have been some reports of changes in occupation status after neck dissection; however, these studies frequently used nonvalidated measures and were mainly assessing occupational status after radical neck dissection and occasionally selective neck dissection.[27,52] These limitations make evaluation of the literature difficult and need to be recognized in interpreting the review.

Another factor that makes interpretation of the literature difficult is the fact that there is also significant variability between studies in terms of the different treatments patients underwent and the indications. There are differences in terms of whether patients underwent surgery alone versus surgery with either preoperative or postoperative radiotherapy. In addition, patients may have been included that underwent neck dissection for persistent or recurrent disease after radiotherapy. Such differences in interventions may also account for differences in reported outcomes.

Although several authors have tried to assess the impact of the extent of neck dissection on QOL, such an analysis is made difficult by the fact that there are many different factors that contribute to overall QOL in patients with head and neck cancer. Patients with more aggressive neck dissections (ie, radical neck dissection or modified radical neck dissection) often have more advanced disease that in of itself can influence overall scores on global QOL. Furthermore, these same patients may have undergone more extensive resections in addition to adjuvant radiotherapy or chemoradiotherapy that likely will have an even greater impact on a patient's QOL than shoulder-related problems.

In summary, manipulation of cranial nerve XI at the time of neck dissection does result in shoulder pain, reduction in shoulder ROM and strength, and activity limitations related to the shoulder. The extent of cranial

nerve XI manipulation does influence outcomes. Radical neck dissection is associated with the greatest impairment and activity limitations and selective neck dissection with the least. The extent of shoulder impairment and activity limitations reported in the literature after any type of neck dissection is highly variable. Some of the variability and difficulties in comparing studies is related to the lack of a recognized, uniformly accepted instrument to measure shoulder-related outcomes. Further research is still required, not only to determine the true prevalence of impairments, activity limitations, and participation restrictions, but also to develop and assess ways to predict those at risk for long-term shoulder-related morbidity and to intervene to prevent it from occurring. In order to move forward, a standardized, patient-based self-report measurement tool for assessing shoulder impairments, activity limitations, and participation restrictions, which meets recognized standards for development and evaluation of its psychometric properties in patients with head and neck cancer undergoing neck dissection, needs to be used.

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