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Quality of Life, Shoulder Range of Motion, and Spinal Accessory Nerve Status in Five-Year Head and Neck Cancer Survivors

Sarah M. Eickmeyer, MD.,
Departments of Physical Medicine and Rehabilitation, Medical College of Wisconsin, Milwaukee WI

Christine K. Walczak, MPT,
Rehabilitation Services, Froedtert Hospital, Milwaukee, WI

Katherine B. Myers, BSN, RN.,
Department of Otolaryngology & Communication Sciences, Medical College of Wisconsin, Milwaukee WI

D. Richard Lindstrom, MD.,
Osler Medical Ear, Nose and Throat Specialty Practice, Melbourne, FL*

Peter Layde, MD, MSc., and
Department of Emergency Medicine. Medical College of Wisconsin, Milwaukee WI

Bruce H. Campbell, MD, FACS.
Department of Otolaryngology & Communication Sciences, Medical College of Wisconsin, Milwaukee WI

Abstract

Objective—To determine the association of neck dissection and radiation treatment for head and neck cancer (HNC) with subsequent shoulder range of motion (ROM) and quality of life (QOL) in 5-year survivors.

Design—Cross-sectional convenience sample

Setting—Otolaryngology clinics at tertiary care hospital and Veterans Affairs medical center

Patients—5-year, disease-free, HNC survivors

Corresponding author: Sarah M. Eickmeyer, MD, Assistant Professor, Medical College of Wisconsin, Department of Physical Medicine and Rehabilitation, 9200 W. Wisconsin Avenue, Milwaukee, WI 53226. Phone: (414) 805-7342. Fax: (414) 382-5155. seickmeyer@mcw.edu.

*During the conduct of this study, Dr. Lindstrom was a resident in the Department of Otolaryngology & Communication Sciences at the Medical College of Wisconsin.

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Methods—Demographic and cancer treatment information was collected, including type of neck dissection (none, spinal accessory "nerve sparing" and "nerve sacrificing") and radiation. QOL questionnaires were administered, and shoulder ROM was measured.

Main Outcome Measurements—University of Washington Quality of Life (UWQOL), Functional Assessment of Cancer Therapy Head and Neck (FACT-HN), and Performance Status Scale for Head and Neck (PSS-HN). Shoulder ROM measurements included abduction, adduction, flexion, extension, internal and external rotation.

Results—One hundred and five survivors completed QOL surveys; 85 survivors underwent additional shoulder ROM evaluations. The nerve sacrifice group exhibited significantly poorer scores for UWQOL measures of disfigurement, level of activity, recreation/entertainment, speech, shoulder disability, and willingness to eat in public, FACT functional well-being, and FACT-HN ($p<.05$). Shoulder ROM for flexion and abduction was poorest in the nerve sacrifice group ($p<.05$). Radiation was associated with significantly worse UWQOL swallowing ($p<.05$), but no other differences were found for QOL or ROM measurements. Decreased QOL scores were associated with decreased shoulder flexion and abduction ($p<.05$). Survivors with decreased shoulder abduction had significantly ($p<.05$) worse scores in disfigurement, recreation/entertainment, employment, shoulder disability, and FACT emotional well-being.

Conclusions—Sparing the spinal accessory nerve during neck dissection is associated with significantly less long-term shoulder disability in 5-year HNC survivors. QOL measures demonstrated the highest level of function in the no dissection group, an intermediate level of functioning with nerve sparing, and poorest function when the nerve is sacrificed. Decreased shoulder flexion and abduction is associated with reduced QOL in long-term HNC survivors.

Keywords

Cancer Survivor; Shoulder Function; Spinal Accessory Nerve; Neck Dissection; Quality of Life; Rehabilitation Quality of Life; Shoulder Range of Motion; Spinal Accessory Nerve Status in Five-Year Head and Neck Cancer Survivors

INTRODUCTION

Shoulder dysfunction is common after neck dissection in head and neck cancer (HNC) survivors and as survival times increase, may contribute to significant morbidity in these patients. Neck surgery can damage the spinal accessory nerve (cranial nerve XI) and denervate the trapezius and sternocleidomastoid muscles. Loss of muscle function can compromise shoulder movement and lead to secondary sequelae, such as adhesive capsulitis, rotator cuff impingement, and myofascial pain.[1–4] Additionally, damage to the cervical plexus can cause neuropathic pain in the neck region, typically involving the C2-C4 dermatomes.[5] All of these impairments may contribute to reduced range of motion (ROM), particularly abduction and flexion,[6,7] lead to decreased performance of activities of daily living (ADLs)[8], and contribute to chronic pain. Subjective complaints of shoulder dysfunction and pain have a large impact on quality of life (QOL).[4,9–12] The degree of physical impairment may be less with procedures that preserve the spinal accessory nerve ("nerve sparing surgery") including modified radical and selective neck dissections, as compared to radical neck dissections that sacrifice the spinal accessory nerve ("nerve

sacrificing surgery”).[13–15] Even among selective neck dissections, more extensive surgery is associated with worse shoulder ROM and QOL.[16]

The effect of shoulder ROM on a HNC survivor’s QOL depends on type of neck dissection and may change over time. As might be expected, patients undergoing nerve sacrificing surgery report worse QOL scores and shoulder ROM than those with nerve sparing surgery in the immediate post-operative period.[13–16] However, some studies suggest that these differences are less apparent 1–3 years later.[17–20] Objective losses of shoulder function observed with nerve sacrificing surgery are still present 1 year after surgery, while reports of improvement in shoulder ROM after nerve sparing surgery have been conflicting.[21–24] Little is known about return of shoulder function and the relationship with QOL in longer-term head and neck cancer survivors.

This study sought to evaluate a number of variables associated with shoulder ROM, QOL, and functional shoulder use for 5-year HNC survivors. We investigated the following:

1. Whether the type of neck dissection or radiation is associated with long-term QOL in 5-year HNC survivors.
2. Whether the type of neck dissection or radiation is associated with shoulder ROM measurements in 5-year HNC survivors, particularly reduced shoulder abduction and flexion.
3. Whether reduced shoulder abduction or flexion is associated with diminished QOL or functional use of the shoulder.

METHODS

SUBJECTS

A cross-sectional convenience sample of long-term HNC survivors was recruited over a 12-month period from an academic, tertiary care hospital and from an affiliated Veterans Affairs medical center. All survivors were being followed at regular intervals in the otolaryngology clinic at the time of the study. Eligible survivors included all patients who had been treated for squamous carcinoma of the oral cavity, pharynx, larynx, sinuses, or neck whose treatment had been concluded for at least five years before the study. In addition, each survivor must have been free of disease for at least three years. Approximately 150 survivors were eligible for the study. Subjects were reimbursed for travel expenses and participation. Approval of the study was granted by the Institutional Review Board at the two hospitals.

PROCEDURE

Demographic information was collected for each patient. This included race, gender, stage and site of index cancer (oral cavity, pharynx, larynx, hypopharynx, other), interval since treatment, and treatment of index tumor (surgery, radiation therapy, or the two combined). Additionally, all patients were classified by type of neck dissection (none, spinal accessory nerve sparing, and nerve sacrificing) and location of neck dissection (right, left or bilateral).

Patients were also queried about handedness (right, left or ambidextrous), and asked whether they had received instruction in shoulder exercise after surgery.

QOL questionnaires were administered by the study coordinator. A single physical therapist measured shoulder ROM, including abduction, adduction, flexion, extension, internal and external rotation for both arms using a goniometer. ROM was tested in a seated position; internal and external rotation were tested with the shoulder adducted to neutral and elbow flexed to 90 degrees. Those that could not or refused to travel to the medical center for the ROM testing were offered the QOL questionnaires via mail survey with telephone supplementation; these survivors' records were also reviewed for demographics, staging, and treatment. After an initial mailing, non-responders were sent a second set of QOL questionnaires two weeks later.

OUTCOMES MEASURES

Four QOL questionnaires were administered using the same format reported in a prior study.[25] The University of Washington Quality of Life scale (UWQOL) is an instrument aimed primarily at HNC patients which provides a series of choices in several domains.[26] The patient chooses the statement most closely reflecting his/her current situation in pain, disfigurement, activity, recreation/entertainment, employment, eating (chewing and swallowing), speech and shoulder disability with "1" being totally functional and "5" being completely incapacitated. The Functional Assessment of Cancer Treatment (FACT) questionnaire is a general QOL instrument that asks the patient to rate whether a statement is "not at all" to "very much" true over the past seven days. FACT domains include physical well-being, social/family well-being, relationship with doctor, emotional well-being, and functional well-being.[27] The Functional Assessment of Cancer Therapy Additional Concerns for Head and Neck (FACT-HN) module is a series of additional concerns related to the head and neck region that are written in the same style as the FACT questions.[28] FACT-HN concerns include oral comfort, breathing, voice, eating, appearance, tobacco, alcohol, and communication. The FACT and FACT-HN questions were scored on a 0–4 scale, with some reverse items, such that an overall domain score of "0" is the worst function and "44" is the best function. The Performance Status Scale for Head and Neck (PSS-HN) is a three-domain questionnaire that gives the patient a series of statements to choose from describing eating in public, understandability of speech, and normalcy of diet.[29] The PSS-HN is scored on a 0–100 scale, where "0" is the worst function and "100" is the best function.

Additional information about functional shoulder use was gained using a locally derived 16-item Activities of Daily Living (ADL) questionnaire, including such upper limb activities as ability to bathe, groom, or shave. Participants were asked how they could perform these activities as compared to before their cancer diagnosis and treatment. A score of "1" indicated the same ability as before cancer, "2" with less ability, and "3" indicated unable to perform the task.

STATISTICAL ANALYSIS

Summary statistics were reported by means and standard deviation for continuous variables. Frequencies and percents were used to describe the distributions of categorical variables. Analysis of variance was used to compare means of continuous responses (questionnaire, ROM measurements) between types of neck dissection and the presence or absence of radiation. Chi square test was used to compare the distributions of categorical variables between types of neck dissection and the presence or absence of radiation. The comparisons sought statistically significant differences at the *p* level of .05.

RESULTS

One hundred and five survivors participated in the study. Seventeen completed only the mailed QOL questionnaire and did not undergo objective testing. Participants were mainly men, white and married (Table 1). The most common cancer sites were the larynx, oral cavity, and oropharynx. Approximately 50% had surgical treatment as part of their management; 14 had surgery alone and 35 had surgery with radiation. The majority received radiation therapy; 56 received radiation therapy alone without surgery. Only three patients received chemotherapy along with radiotherapy and were included with the radiation therapy group for analytical purposes. Of subjects that had neck surgery, 33 had nerve sparing and 16 had nerve sacrificing procedures. Eighteen had left neck dissection, 22 had right neck dissection, and 9 had bilateral dissection.

Eighty-six subjects also underwent shoulder ROM testing. One patient was unable to complete the shoulder ROM testing, leaving 85 patients for complete analysis (Table 2). Forty-seven patients had no neck dissection, 24 had nerve-sparing neck dissection, and 14 had nerve-sacrificing neck dissection. The majority were right-hand dominant. Most patients had not received instruction in shoulder exercise after surgery. Only 15% had received exercise instructions from a physical or occupational therapist, 6% from a physician or nurse, and an additional 6% reported getting shoulder exercise instructions from both a medical and therapy provider.

QOL AND CANCER TREATMENT

Impairment scores for UWQOL subjective disfigurement, level of activity, self-reported recreation/entertainment, speech, and shoulder disability were worst for the nerve sacrifice group ($p<.05$) (Table 3). The scores for PSS-HN willingness to eat in public, FACT functional well-being, and FACT-HN additional concerns ($p<.05$) were poorest for the nerve sacrifice group. For QOL domains, scores were worst for nerve sacrificing surgery, intermediate for nerve-sparing surgery and best for the no surgery group. For individuals undergoing surgery (sacrificing or sparing), there was a tendency to perform worse than those of the no surgery group.

Comparing the two surgical groups, QOL scores did not differ for most domains except for the worse shoulder disability on the UWQOL for the nerve sacrifice group compared to the nerve-sparing group ($p<.05$) (Table 3). Radiation treatment was associated with worse

swallowing on the UWQOL ($p<.05$), but had no significant effect on other QOL subscales (Table 4).

SHOULDER DYSFUNCTION AND CANCER TREATMENT

Poor right-sided flexion and abduction correlated with neck dissection type, being worse for nerve sacrifice ($p<.05$) (Table 5). Decreased left abduction trended similar to right abduction. Shoulder ROM performance did not correlate with the presence or absence of radiation therapy ($p<.05$) (Table 6). Additionally, the type of neck dissection was associated with worse self-reported ability to perform upper extremity ADLs in the nerve sacrifice group compared to the nerve-sparing group ($p<.05$) as reported on the ADL questionnaire (Table 3).

SHOULDER DYSFUNCTION AND QOL

Decreased right shoulder abduction was associated with worse QOL scores in the UWQOL domains of disfigurement, chewing, speech and shoulder disability ($p<.05$), as well as the FACT emotional well-being scale ($p<.05$). Decreased left shoulder abduction was associated with worse QOL scores in the UWQOL domains of recreation/entertainment and employment ($p<.05$), as well as the FACT emotional well-being scale ($p<.05$). Decreased right shoulder flexion was associated with worse QOL scores in the UWQOL domains of employment and shoulder disability ($p<.05$); decreased left shoulder flexion was associated with worse score in UWQOL employment only. Decreased internal rotation was only associated with worse QOL scores in the UWQOL recreation/entertainment domain ($p<.05$). There were no significant associations between shoulder ROM and the PSS-HN scale.

DISCUSSION

This study demonstrates that 5-year HNC survivors have persistent impairments in shoulder ROM, ability to perform basic ADLs, and QOL in related domains of shoulder disability, recreation and employment. Reduced ROM and QOL were related to the type of neck dissection and not radiation treatment. Notably, very few subjects received rehabilitation treatments such as physical or occupational therapy, which can improve shoulder ROM, increase functional arm use, and potentially reduce long-term disability.

With improvements in cancer treatments over the past three decades, the number of HNC survivors is increasing.[30] HNC survivors are living many years with the long-term effects of cancer and its treatment. These functional issues often significantly impact physical function, reduce QOL, and are frequently unrecognized by oncology providers.[31] Locoregional control and overall survival data still drive the medical and surgical decision making for HNC patients. However, because survival benefits are often negligible, especially with improving surgical and radiation techniques, the real difference between treatments might rest in the QOL, costs, and late effects on cancer survivors' physical function.[32] Because of this, the incorporation of other factors into the decision-making process, such as the varied aspects of a patient's QOL and function after any given treatment, must be considered.

Surgical treatment has evolved over time from radical neck dissections that sacrifice the spinal accessory nerve to an increased use of modified and selective neck dissections, resulting in improvements in QOL measures with spinal accessory nerve sparing procedures.[9,10,17] In contrast to these studies, our study found that poor QOL scores persist in 5-year cancer survivors with nerve sacrificing and sparing procedures. The nerve-sacrificing surgery group has overall worse QOL scores, but many of these findings are not significantly different when directly comparing the two surgery groups. Only UWQOL shoulder disability and self-reported ability to perform ADLs are significantly different between the surgical groups, suggesting that the nerve sacrificing procedures directly affects shoulder function and disability. Undergoing neck surgery, regardless of type, leads to degradation in QOL measures for patients compared to the non-surgical group. Additionally, deteriorated QOL persists with time and does not resolve as suggested in earlier studies. It is possible that despite sparing the spinal accessory nerve, there is additional damage of muscles involved in swallowing and speech. Importantly for physiatrists, the only long-standing difference in QOL between surgical groups in long-term HNC survivors appears to be related to shoulder function and disability, suggesting an opportunity for targeted rehabilitation intervention to improve shoulder function in this cohort.

In contrast to other studies of longer-term HNC survivors that reported a slight benefit in overall QOL for surgical over chemoradiation treatment,[32–35] our study found that radiation therapy was not associated with worse QOL, except for UWQOL swallowing, in most domains in survivors 5 or more years after treatment. This conclusion is limited by the small number of patients who did not receive radiation (n=14) in our cohort compared to those who did (n=91). Furthermore, caution is necessary when comparing our finding to others because different QOL scales were used.

Several studies have objectively assessed shoulder function after neck dissection, using ROM measurements. Up to one year after surgery, previous studies show patients undergoing nerve sparing surgery have limitations in shoulder flexion and abduction ranging from 140–160 degrees, while those with nerve sacrificing surgery are often limited to less than 140 degrees of flexion or abduction.[7,21,23,24,36] In our study, subjects with nerve sparing surgery have fewer limitations in ROM compared to nerve sacrifice. However, average ROM measurements are slightly lower in our cohort of 5-year survivors than previous studies of 1-year survivors. Subjects with nerve sparing surgery have flexion and abduction limitations around 140 degrees. Subjects with nerve sacrificing surgery had flexion and abduction ranges of 100–140 degrees. Interestingly, abduction and flexion are decreased in the non-surgery group, which is similar to the nerve sparing group and much less than age-expected values (which range between 150–180 degrees for flexion and abduction).[37] Many of these patients received chemoradiation as part of their treatment, however there were no significant difference in ROM measurements between groups that had and had not received radiation. Other studies confirm that the addition of radiation or chemoradiation to neck dissection did not worsen shoulder ROM, but subjects who received chemoradiation alone still had ROM deficits compared to age-expected values.[38,39] This may reflect the presence of radiation fibrosis changes, which can affect soft tissue flexibility and are difficult to objectively measure.[1] Other musculoskeletal co-morbidities including myofascial pain, rotator cuff pathology, and adhesive capsulitis are common in the aging

population and may be made worse by underlying residual effects of previous cancer treatment. This suggests the importance of a full functional evaluation and additional rehabilitation for all HNC survivors, not just those who have had surgical treatment.

Of previous studies of objective shoulder dysfunction after neck dissection, only Van Wilgen studied the relationship between shoulder ROM and QOL measures in 1-year survivors and found that reduced shoulder abduction was associated with reduced QOL in several domains.[4] Similarly, our study of 5-year survivors shows reduced shoulder abduction is associated with reduced QOL in domains of disfigurement, chewing, speech and shoulder disability, recreation/employment as well as emotional well-being. Reduced flexion is associated with worse QOL in employment and shoulder disability. Due to the small number of left handed survivors included in our sample, meaningful comparisons between side of neck dissection, side of ROM deficit, and handedness were limited. However, the main deficits for the entire group were in right flexion and abduction, and the majority of the subjects were right handed, possibly reflecting our biased convenience sample. Clearly, for some survivors of HNC the persistence of shoulder dysfunction and disability continues to affect related QOL domains in the long-term survival period, demonstrating the need for further rehabilitation intervention to regain functional shoulder use for daily activities and return to societal roles such as recreation and employment.

Our study confirmed that many subjects, particularly those with nerve sacrifice, report decreased ability to perform basic daily ADLs due to shoulder disability. Rehabilitation interventions such as physical or occupational therapy may help patients regain independence in ADLs after neck dissection[40] and improve QOL and arm abduction.[41,42] Regardless of the integrity of the accessory nerve, rehabilitation can have an important role is treating the “shoulder syndrome” by preventing adhesive capsulitis and reducing myofascial pain in the shoulder girdle.[43,44] Of note, very few subjects (27%) in our study received instruction in shoulder ROM exercises after surgery for HNC. Only 21% received instructions in a home exercise program from a physical or occupational therapist. Given the poor long-term outcomes for functional shoulder use reported by our subjects, this suggests underutilization of rehabilitation services. Very few studies have examined targeted therapy interventions for shoulder dysfunction after HNC surgery, but a randomized study of post-operative physical therapy improved ROM, shoulder disability and QOL compared to control.[45] Additional work shows that adjuvant progressive resistance exercise may additionally reduce shoulder pain and disability.[46,47] Better understanding of the poor long-term prognosis for shoulder impairment in HNC survivors will lead to future study of focused therapy interventions across the disease spectrum, starting at diagnosis and initial cancer treatment. Early rehabilitation intervention may reduce long-term disability for HNC survivors, who are living much longer with persistent functional deficits related to cancer treatment. Thus, we support early intervention to improve long-term QOL and patient outcomes, as well as potentially reducing the overall cost of care.[48]

Limitations in our study include the lack of obtaining neck ROM measurement to assess deficits in cervical motion. Other studies have found reduced cervical motion, which degrades QOL and upper body function.[23] We did not include electromyography to delineate the occurrence of muscle denervation or signs of reinnervation in the trapezius.[21]

Future studies should also include a measure of psychological depression to assess the effect of mood disorder on QOL. ROM measurements were not obtained on subjects who did not travel to the medical center, so an unknown sampling bias may be present if they were functionally different have those tested. The ADL questionnaire was subject to recall bias as it asked subjects to compare their current function to remote function. Future studies should include patient validated outcome measures of physical function and upper extremity function. Lastly, this cohort of HNC survivors was studied prior to the current rising incidence of human papilloma virus (HPV)-related HNC, which tends to affect younger patients and is often treated with concurrent chemoradiation instead of neck dissection.[49] It is unknown whether the increase in HPV-related HNC survivors will have similar functional deficits in the future, but additional studies are needed.

CONCLUSION

5-year HNC survivors report persistent deficits in QOL related to impaired shoulder ROM, and very few patients received appropriate rehabilitation services. While neck dissection at the time of cancer treatment is associated with long-term decreased QOL and shoulder ROM, shoulder dysfunction is common in all our subjects regardless of treatment type, with persistent deficits in ROM and ability to complete ADLs even in the group that did not receive neck surgery. Decreased QOL correlates primarily with diminished shoulder abduction and flexion in this cohort of 5-year HNC survivors. Shoulder ROM and QOL measures demonstrate the best function in the non-surgical group, intermediate function in the nerve sparing group, and the worst function in the nerve sacrifice group. However, the difference between the two surgical groups is not pronounced, except for QOL related to shoulder function and disability. Very few patients, only 27%, received formal physical therapy or any instruction in shoulder exercises after treatment for HNC, suggesting an opportunity for rehabilitation consultation and intervention. The HNC population is underserved by available rehabilitation services. Moving forward, physiatrists must partner with oncology providers to prevent and treat functional deficits after cancer treatment. Future studies should address the appropriate timing for rehabilitation assessments and the relationship between early rehabilitation interventions and long-term functional and QOL outcomes after HNC treatment.

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Table 1

Patient characteristics of entire group: demographic variables, cancer site, and cancer treatment received

		N=105 (%)
Sex		
	Male	77 (73.3)
	Female	28 (26.7)
Age [yr± SD]		65.3 [9.3]
Race		
	Caucasian	92 (87.6)
	African American	12 (11.4)
	Native American	1 (0.0)
Marital Status		
	Married	65 (61.9)
	Single	25 (23.8)
	Divorced	15 (14.3)
Education [yr±SD]		12.0 [3.5]
Cancer site		
	Larynx	36 (34.3)
	Oral cavity	28 (26.7)
	Oropharynx	27 (25.7)
	Hypopharynx	9 (8.6)
	Other	5 (4.8)
Treatment		
	Radiation alone	56 (53.3)
	Surgery alone	14 (13.3)
	Surgery/radiation	35 (33.3)
Type of surgery		
	No neck surgery	56 (53.3)
	Nerve sparing surgery	33 (31.4)
	Nerve sacrificing surgery	16 (15.2)
Side of surgery		
	Left neck dissection	18 (36.7)
	Right neck dissection	22 (44.9)
	Bilateral neck dissection	9 (18.4)

Table 2

Patients in shoulder range of motion subgroup: surgery type, dominant hand and exercise instruction received after neck surgery

	N = 85 (%)
No neck surgery	47 (55.3)
Nerve sparing surgery	24 (28.2)
Nerve sacrificing surgery	14 (16.5)
Right-handed	79 (92.9)
Left-handed	4 (4.7)
Ambidextrous	2 (2.4)
No exercise instruction	62 (72.9)
Exercise from PT or OT	13 (15.3)
Exercise from MD or RN	5 (5.9)
Exercise from both	5 (5.9)

PT = physical therapist; OT = occupational therapist; MD = physician; RN = nurse

Table 3

Effect of neck dissection type on quality of life outcome measures for entire group (N=105)

		No neck surgery (N=56)	Nerve sparing (N=33)	Nerve sacrifice (N=16)	p-value (among all groups)	p-value (between surgery groups)
UWQOL mean score (SD)	Pain	1.57 (0.97)	1.70 (0.73)	1.88 (0.62)	.44	.40
	Disfigurement	1.60 (0.71)	2.12 (0.60)	2.38 (0.72)	**<.0001***	.20
	Activity	1.70 (0.83)	2.12 (0.82)	2.19 (0.83)	**.03***	.79
	Recreation/ Entertainment	1.68 (0.61)	1.94 (0.79)	2.13 (0.62)	**.04***	.41
	Employment	3.43 (1.80)	4.03 (1.62)	4.44 (1.36)	.07	.39
	Chewing	1.41 (0.56)	1.58 (0.66)	1.63 (0.72)	.32	.81
	Swallowing	1.61 (0.65)	1.79 (0.93)	1.81 (0.54)	.42	.92
	Speech	1.58 (0.63)	1.88 (0.82)	2.00 (0.63)	**.045***	.61
	Shoulder Disability	1.41 (0.63)	1.85 (0.76)	2.38 (0.81)	**<.0001***	**.03***
PSS-HN mean score (SD)	Eating in public	88.64 (21.95)	75.76 (31.55)	75.00 (24.15)	**.04***	.93
	Understandability of Speech	82.40 (20.86)	73.48 (23.33)	70.31 (22.76)	.07	.66
	Normalcy of Diet	83.15 (26.05)	77.58 (30.11)	76.25 (22.17)	.52	.88
FACT mean score (SD)	Physical	25.09 (3.55)	24.94 (3.05)	23.81 (3.95)	.43	.28
	Social /Family	24.70 (4.02)	23.21 (4.35)	23.51 (5.44)	.27	.84
	Emotional	21.80 (2.43)	22.00 (2.38)	19.94 (4.99)	.05	.05
	Functional	24.95 (4.13)	22.61 (5.12)	21.50 (5.87)	**.01***	.50
FACT-HN mean score (SD)	Additional Concerns	27.10 (6.68)	24.67 (6.60)	22.63 (6.93)	**.04***	.32
ADL mean score	Activities of Daily Living	1.13	1.26	1.48	NS	**.0001***

UWQOL = University of Washington Quality of Life scale; PSS-HN = Performance Status Scale for Head and Neck; FACT = Functional Assessment of Cancer Treatment; FACT-HN = Functional Assessment of Cancer Therapy Additional Concerns for Head and Neck; ADL = Activities of Daily Living; SD = standard deviation.

*p<.05

Table 4

Effect of radiation treatment on quality of life outcome measures for entire group (N=105)

		No XRT (N=14)	XRT (N=91)	p-value
UWQOL mean score (SD)	Pain	1.36 (0.50)	1.70 (0.89)	.16
	Disfigurement	1.79 (0.58)	1.90 (0.76)	.59
	Activity	1.71 (0.91)	1.93 (0.84)	.37
	Recreation/ Entertainment	1.71 (0.61)	1.85 (0.70)	.51
	Employment	4.50 (1.29)	3.66 (1.75)	.09
	Chewing	1.21 (0.43)	1.54 (0.64)	.07
	Swallowing	1.29 (0.47)	1.76 (0.75)	**.02***
	Speech	1.57 (0.65)	1.77 (0.72)	.34
	Shoulder Disability	1.57 (0.85)	1.71 (0.76)	.52
PSS-HN mean score (SD)	Eating in public	89.29 (27.24)	81.39 (26.12)	.30
	Understandability of Speech	83.93 (15.83)	76.74 (23.10)	.26
	Normalcy of Diet	88.57 (19.94)	78.99 (27.59)	.22
FACT mean score (SD)	Physical	25.36 (2.76)	24.77 (3.56)	.56
	Social /Family	24.69 (3.20)	23.95 (4.54)	.56
	Emotional	22.93 (1.14)	21.37 (3.14)	.07
	Functional	25.21 (2.42)	23.45 (5.14)	.21
FACT-HN mean score (SD)	Additional Concerns	27.57 (5.87)	25.36 (6.96)	.26

XRT = radiation therapy; UWQOL = University of Washington Quality of Life scale; PSS-HN = Performance Status Scale for Head and Neck; FACT = Functional Assessment of Cancer Treatment; FACT-HN = Functional Assessment of Cancer Therapy Additional Concerns for Head and Neck; ADL = Activities of Daily Living; SD = standard deviation.

* $p<.05$

Table 5

Effect of neck dissection type on average shoulder range of motion measurements in subgroup analysis (N=85)

Measurement	No neck surgery (N=47)	Nerve sparing (N=24)	Nerve sacrificing (N=14)	p-value
R flexion (SD)	140.30° (20.04)	138.42° (22.26)	122.71° (20.37)	**.02***
L flexion	142.91° (17.96)	145.75° (17.22)	139.07° (21.66)	.56
R abduction	138.51° (34.04)	141.21° (32.75)	102.57° (39.93)	**.002***
L abduction	146.83° (25.42)	145.17° (30.12)	127.21° (35.26)	.08
R external rotation	58.26° (12.67)	56.83° (12.46)	58.93° (18.40)	.88
L external rotation	57.66° (13.22)	55.83° (12.75)	54.21° (12.47)	.65
R internal rotation	70.96° (12.36)	70.96° (9.12)	64.93° (23.09)	.33
L internal rotation	70.89° (11.60)	67.21° (11.96)	72.21° (12.68)	.35

R = right; L = left; SD = standard deviation. Normal values of shoulder range of motion expressed in degrees are as follows: flexion 150°, abduction 150°, external rotation 90°, internal rotation 70° .[37]

* $p<.05$

Table 6

Effect of radiation therapy on average range of motion measurements in subgroup analysis (N=85)

Measurement	No XRT (N=11)	XRT (N=74)	p-value
R flexion (SD)	130.00° (19.99)	137.89° (21.61)	.26
L flexion	137.64° (22.43)	143.89° (17.65)	.29
R abduction	131.64° (27.59)	133.61° (38.30)	.87
L abduction	135.55° (32.58)	144.26° (28.60)	.36
R external rotation	55.27° (14.16)	58.36° (13.50)	.48
L external rotation	56.36° (11.94)	56.61° (13.09)	.95
R internal rotation	66.73° (14.78)	70.45° (13.84)	.41
L internal rotation	68.73° (7.04)	70.27° (12.46)	.69

XRT = radiation therapy; R = right; L = left; SD = standard deviation. Normal values of shoulder range of motion expressed in degrees are as follows: flexion 150°, abduction 150°, external rotation 90°, internal rotation 70°.[37]

*p<.05