Association Between Multimodality Neck Treatment and Work and Leisure Impairment
A Disease-Specific Measure to Assess Both Impairment and Rehabilitation After Neck Dissection

K. Kelly Gallagher, MD; Assuntina G. Sacco, MD; Julia Shin-Jung Lee, MS, MPH; Rodney Taylor, MD, MSPH; Eric J. P. Chanowski, MD; Carol R. Bradford, MD, MS; Mark E. Prince, MD; Jeffrey S. Moyer, MD; Gregory T. Wolf, MD; Francis P. Worden, MD; Avraham Eisbruch, MD; Douglas B. Chepeha, MD, MSPH, FRCSC

IMPORTANCE This study describes the effect of adjuvant treatment on shoulder-related quality of life, leisure activities, and employment for patients undergoing neck dissection for head and neck cancer.

OBJECTIVE To explore the association between treatment outcome and shoulder-related on critical daily life functions such as employment and recreation.

DESIGN, SETTING, AND PARTICIPANTS Cross-sectional study of patients with head and neck cancer at a tertiary care hospital.

EXPOSURES Level V-sparing selective neck dissection or modified radical neck dissection sparing the accessory nerve, with or without radiation therapy and/or chemotherapy.

MAIN OUTCOMES AND MEASURES Patients completed the Neck Dissection Impairment Index (NDII), with scores ranging from 0 to 100 and higher scores indicating better shoulder functioning and shoulder-related quality of life, and underwent objective testing with the Constant-Murley Shoulder Function Test (Constant test) at least 12 months after the completion of all adjuvant treatment. Additional outcome measures related to physical therapy, pain medication use, leisure activity, and employment status.

RESULTS We evaluated 167 patients who underwent 121 selective neck dissections and 46 modified radical neck dissections. The median (range) NDII score was 90 (10-100). Patients with modified radical neck dissection reported lower scores than those with selective neck dissection (85 [10-100] vs 92 [30-100]; P = .01). Multivariable analysis showed that advanced-stage disease (mean, 77 [range, 25-100] vs 87 [18-100]; P = .006), radiation therapy (80 [10-100] vs 88 [50-100]; P = .03), and chemotherapy (77 [30-100] vs 83 [18-100]; P = .002) were associated with greater shoulder impairment. The NDII and Constant test were well correlated (0.64; P < .001). Change in leisure activity was correlated with greater impairment (median [range] NDII score, 90 [18-100] for patients with no change vs 53 [10-100] for patients with change, P = .005; Constant score, 85 [12-100] vs 68 [10-88], P = .004). Patients who remained employed or resumed working had higher median (range) NDII scores (94 [10-100] and 88 [75-100], respectively) than those who limited or stopped working (70 [10-100]), which also correlates with greater shoulder impairment (P < .001).

CONCLUSIONS AND RELEVANCE More aggressive treatment, either in the form of increased surgical dissection, radiation therapy, or chemotherapy, was associated with worse shoulder function and quality of life. The degree of impairment perceived by the patient and measured in objective testing was correlated with leisure activity and employment status. These findings may stimulate further investigation related to optimizing quality of life following neck dissection.

Published online October 1, 2015.
Patients with head and neck cancer have varying degrees of shoulder impairment following neck dissection. Ewing and Martin first described the “shoulder syndrome” associated with radical neck dissection to include shoulder pain, limited abduction, and scapular winging. Modifications of the radical neck dissection were designed to limit morbidity while achieving equivalent oncologic outcomes. However, even with accessory nerve–sparing neck dissections, shoulder dysfunction can be seen. Shoulder syndrome is thought to be multifactorial and can be due to devascularization of the accessory nerve and/or cervical plexus, Wallerian degeneration, and/or variable innervation of the trapezius.

The extent of dissection in level V causes shoulder morbidity, but there still remain questions about the effect of radiation therapy and chemotherapy when added adjuvantly to surgery. Some studies show little to no effect from adjuvant treatment; however, we previously showed that radiation therapy does impair quality of life as measured through the Neck Dissection Impairment Index (NDII) and shoulder function as assessed by the Constant-Murley Shoulder Function Test (Constant test).

We had 3 aims that involved validation, assessment of other treatment modalities, and anchoring shoulder disabilities to everyday work and leisure activities. As an initial step, this study aimed to determine whether a subjective measurement of shoulder-related quality of life (NDII) was correlated with a validated, objective measurement of shoulder function: the Constant test. We sought to evaluate the factors that may influence shoulder impairment, including type of neck dissection, radiation therapy, and chemotherapy, and their effect on overall shoulder-related quality of life after neck dissection. Although it has been shown that neck dissection causes shoulder syndrome, this has not been related to the effect on such anchors as patients’ employment status and recreation activities. The purpose of this study was to explore and develop the relationship between treatment, outcome, and effect on critical daily life functions such as employment and recreation.

Methods

Study Design

A cross-sectional study was performed to evaluate shoulder-related quality of life following neck dissection in patients with head and neck cancer who presented to the Department of Otolaryngology–Head and Neck Surgery at the University of Michigan Health System. The institutional review board at the University of Michigan approved this study. Informed consent was obtained in the clinic or when returned by the patient in response to a mailing.

Patient Population

Patients were eligible if they had head and neck cancer, the surgical resection included a neck dissection, and they were free of disease at the time of assessment. Each assessment was performed at least 12 months following neck dissection and the completion of any adjuvant treatment. Patients were excluded if they underwent radical neck dissection, had previous shoulder impairment or injury, had reconstructive surgery that involved the shoulder, or were unable to speak English. Additionally, for patients who underwent bilateral neck dissection with completion of separate shoulder assessments, only the side of the neck with the most extensive neck dissection was included. Based on these eligibility criteria, 167 patients were eligible to participate (Table).

There were 127 men and 40 women, with a mean (range) age of 57 (29-85) years. A total of 121 selective neck dissections (SNDs) and 46 modified radical neck dissections (MRNDs) were evaluated. All SNDs spared level V. The surgical procedures for levels I to IV were the same for the SND and MRND groups. The cervical nerve rootlets were sacrificed in the MRND group. Of 167 patients, 136 (81%) had squamous cell carcinoma. Seventy-nine (47%) patients had T1 to T2 tumors, 54 (32%) patients had T3 to T4 tumors, and 3 (2%) patients had an unknown primary site. Fifty-seven (34%) patients had stage I to II disease, and 48 patients (59%) had stage III to IV disease. The patients who did not have squamous cell carcinoma were not staged. One hundred twenty-five (75%) patients received radiation therapy; 54 patients received preoperative radiation therapy and 71 patients received postoperative radiation therapy. Twenty-four patients received preoperative concomitant chemoradiation therapy, and 3 received postoperative concomitant chemoradiation therapy. The NDII was completed in all 167 patients at a median (range) posttreatment time of 28.2 (12-84) months. The Constant test was completed in 120 of 165 (73%) patients at a median (range) posttreatment time of 17.0 (12-80) months.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>SND (n = 121)</th>
<th>MRND Sparing CN XI (n = 46)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (range), y</td>
<td>58.1 (34-83)</td>
<td>55.5 (29-84)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>90</td>
<td>37</td>
</tr>
<tr>
<td>Female</td>
<td>31</td>
<td>9</td>
</tr>
<tr>
<td>Squamous cell carcinoma stage, No. (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>26 (21)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>II</td>
<td>29 (24)</td>
<td>2 (4)</td>
</tr>
<tr>
<td>III</td>
<td>22 (18)</td>
<td>9 (19)</td>
</tr>
<tr>
<td>IV</td>
<td>37 (30)</td>
<td>30 (65)</td>
</tr>
<tr>
<td>Radiation therapy, No. (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>40 (33)</td>
<td>14 (30)</td>
</tr>
<tr>
<td>Postoperative</td>
<td>45 (37)</td>
<td>26 (56)</td>
</tr>
<tr>
<td>Chemotherapy</td>
<td>25 (20)</td>
<td>18 (39)</td>
</tr>
<tr>
<td>Contralateral SND performed</td>
<td>7 (5)</td>
<td>6 (13)</td>
</tr>
<tr>
<td>Constant-Murley Shoulder Function Test score, median (range)</td>
<td>85 (12-100)</td>
<td>79 (12-98)</td>
</tr>
<tr>
<td>Neck Dissection Impairment Index, median (range)</td>
<td>92 (30-100)</td>
<td>85 (10-100)</td>
</tr>
</tbody>
</table>

Abbreviations: CN XI, spinal accessory nerve; MRND, modified radical neck dissection; SND, selective neck dissection.
Figure 1. Neck Dissection Impairment Index

**Neck Dissection Impairment Index**

As a result of the cancer TREATMENT OF YOUR NECK, how much have you been bothered by the following over the past 4 WEEKS?

1. Are you bothered by neck or shoulder pain or discomfort?
2. Are you bothered by neck or shoulder stiffness?
3. Are you bothered by difficulty with self-care activities because of your neck or shoulder (for example, combing hair, dressing, bathing, etc)?
4. Have you been limited in your ability to lift light objects because of your shoulder or neck?
5. Have you been limited in your ability to lift heavy objects because of your shoulder or neck?
6. Have you been limited in your ability to reach above for objects because of your shoulder or neck?
7. Are you bothered by your overall activity level because of your shoulder or neck?
8. Has the treatment of your neck affected your participation in social activities?
9. Have you been limited in your ability to do leisure or recreational activities because of your neck or shoulder?
10. Have you been limited in your ability to do work (including work at home) because of your neck or shoulder?

Respondents answered "not at all," "a little bit," "a moderate amount," "quite a bit," or "a lot."

Standardization for score of 100 [(raw score - 10)/40] × 100.

Outcome Measures

Outcome measures included the NDII and Constant test. Pain control regimen, physical therapy, leisure activity, and employment status were also evaluated.

The NDII is a validated, 10-item, self-administered instrument that is designed to specifically address post-neck dissection shoulder-related quality-of-life issues perceived by patients (Figure 1). Patients are asked to rate their degree of bother over the last 4 weeks regarding shoulder pain, stiffness, limitations with reach or lifting light or heavy objects, overall activity level, participation in social activities, and limitations in leisure and work. Each of the 10 survey items are scored on a Likert scale from 1 to 5 points, with scores then transformed to allow a 0 to 100-point cumulative scale, where higher cumulative scores denote better shoulder function and shoulder-related quality of life. In our patient population, this survey was completed at least 12 months longer following completion of all treatment. Patients were asked to complete the survey at the time of their follow-up clinic visit or through participation by mail for those patients who no longer returned for follow-up.

The Constant test is a validated, cross-disease administered test, which is an objective measure of shoulder impairment. A subjective portion of the test includes patient quantification of degree of shoulder impairment related to pain during daily activity, recreation, work, sleep, and movement. Objective measures include formal evaluation of range of motion, as well as static weight testing. The test is scaled to a 100-point cumulative score where higher scores denote better shoulder function. The Constant test was performed during a clinic visit at least 12 months after following completion of treatment. For patients who no longer returned for follow-up, the Constant test could not be performed.

To assess use of medication and physical rehabilitation, patients were asked whether pain medication was required for continued shoulder discomfort. Patients who indicated that they required pain medication reported medication type and frequency of administration. Patients were also asked whether they received physical therapy. If they underwent physical therapy, they were asked the type, length of therapy, responsibility for coverage of costs, and perceived benefit from therapy.

To "anchor" the disability from neck treatment, leisure activity and employment status were used as additional measures of overall functional status and ability to participate in important life activities. The additional questions to assess these measures are given in Figure 1.

Statistical Analysis

Variables under study included age, sex, body mass index, defect, T stage, overall stage, radiation therapy, chemotherapy, neck dissection type, use of pain medication, physical therapy, change in leisure activity, change in employment status, NDII score, and Constant test score.

Each defect was classified as oral tongue, oral cavity excluding oral tongue, oropharynx, hypopharynx, or skin. Adjuvant therapy was defined for each patient based on type (radiation therapy and/or chemotherapy) and timing relative to surgery (preoperative vs postoperative). Neck dissection type was classified as SND or MRND. Patients with bilateral neck dissection were classified according to the side of the most extensive surgical dissection.

For the statistical analysis the most severe score was used for each patient, and this outcome variable is denoted NDII severe. Pain medication, physical therapy, and change in leisure activity were classified as yes/no responses. Employment status was classified as full-time employed, part-time employed, unemployed, retired, or disabled, and any change relative to pretreatment status was recorded.

A univariate tabulation was performed of the demographic, disease, treatment, and outcome variables. The distribution of the outcome variables was nonparametric. Bivariate comparison of NDII scores and Constant test scores by demographic, disease, and treatment variables was performed using Wilcoxon rank-sum test and Kruskal-Wallis statistics. The variables that were shown to be statistically significant in the bivariate analysis were then modeled with a repeated-measures, multivariate analysis. We also evaluated the collinearity between the 2 outcome measures (NDII and Constant test), using the Pearson correlation coefficient.

Results

The overall median (range) NDII score was 90 (10-100), with lower NDII scores reported for patients who underwent MRND (dissection of level V) compared with patients who underwent SND (85 [30-100] vs 92 [10-100]; P = .01) (Figure 2 and Figure 3). Multivariate analysis showed that advanced-stage disease (P = .006), radiation therapy (P = .03), and chemotherapy (P = .002) also led to greater shoulder impairment (Figure 4). The correlation between NDII and Constant test scores was 0.64 (P < .001).
Change in leisure activity was correlated with greater shoulder impairment. The median (range) NDII score was 53 (10-100) for patients who reported a negative change vs 90 (18-100) for patients who reported no change (P = .005) (Figure 3); the median (range) Constant test score was 68 (10-88) for patients who reported a negative change vs 85 (12-100) for patients who reported no change (P = .004).

Patients who remained employed or resumed working reported high median (range) NDII scores of 94 (75-100) and 88 (33-100), respectively, whereas patients who limited or stopped working had lower NDII scores (70 [10-100]) (Figure 3). The subjective NDII scores relating to employment status were correlated with the Constant test’s objective assessment of shoulder impairment (P < .001). Patients requiring pain medication reported greater shoulder impairment (median [range] NDII score, 58 [10-100]) for patients requiring medication vs 86 [30-100] for those not requiring it, P < .001; Constant test, 66 [10-98] for patients requiring medication vs 83 [44-100] for those not requiring it, P < .001). This reflects appropriate use of pain medications for patient perception of diminished shoulder function, and the patient reporting is validated by diminished function when assessed by the Constant test.

Scores on the NDII showed no significant difference regarding perceived benefit of physical therapy (P = .07) whereas the Constant test scores were statistically significantly better when patients perceived a benefit from physical therapy (P = .047).

Discussion

The NDII has been previously validated as a disease-specific quality-of-life instrument12; here we demonstrate that it has
the ability to independently discriminate between patients who underwent dissection of level V, radiation treatment, and chemotherapy. More extensive surgery in patients with head and neck cancer has been previously correlated with overall decreased quality of life. More specifically, it has been shown that neck dissections that sacrifice the spinal accessory nerve (CN XI) result in impaired shoulder function and decreased quality of life. In our patient population, however, all patients undergoing either SND or MRND had CN XI spared. Our study suggests that the additional dissection of level V involved in CN XI-sparing MRND leads to impaired shoulder function. This information could be used in counseling patients with respect to postoperative expectations to help tailor post–neck dissection rehabilitation.

A clinical review of accessory nerve shoulder dysfunction illustrated a need to further assess the effects of physiotherapy on functional outcome and quality of life. We assessed the perceived benefit of physical therapy, and patients who underwent physical therapy felt statistically significantly better as assessed by the Constant test’s objective measure of shoulder function. Our study is one of few to show a patient-rated subjective benefit of physiotherapy on post–neck dissection shoulder function. Due to the design of the study we cannot provide any further information on the specific intervention or duration of intervention that resulted in the perceived benefit of physical therapy. However, it is interesting that the Constant test results are statistically significant because this test includes tests of shoulder strength and mobility that should directly measure neck- and shoulder-related rehabilitation. Future investigation should be carried out to better quantify the minimum duration and intensity of therapy necessary to improve shoulder function after neck dissection with assessments before and after the intervention. The ability to pursue therapy on the basis of patient resources and socioeconomic status was not assessed. These factors could also undergo future investigation.

For the first time, we were able to correlate this subjective assessment (NDII), which reflects patients’ perceptions, with an objective assessment that reflects physical ability (Constant test) and anchor these measures to leisure activities and employment. The fact that the NDII and Constant test correlate well serves to further validate the NDII instrument. We have also shown that the NDII correlates shoulder impairment with life pursuits—both employment and leisure activities. This correlation further illustrates that the NDII accurately reflects overall quality of life related to shoulder function. Whereas others have looked at employment disability with respect to overall cancer treatment, this study provides the first evidence that escalating treatment of the neck with more radical surgery, the addition of radiation therapy, the addition of chemotherapy, or the need for salvage neck dissection after radiation therapy was associated with a negative change in employment status.

Our data suggest that use of radiation therapy and/or chemotherapy is correlated with poorer shoulder function and quality of life. This is in contrast to findings from Watkins et al, in which shoulder impairment was documented in patients who underwent SND, but there was no significant effect for patients who received adjuvant therapy. In the study by Watkins et al, radiation therapy and chemotherapy did not confer poorer shoulder function, but the total sample was 34 patients, and only 7 of these patients had neck dissection alone. This is a small control group with an underpowered effect size. Our group is larger with longer follow-up. These 2 design differences may help explain why Watkins et al did not find that radiation therapy or chemotherapy was associated with diminished shoulder function. There were 2 other studies that showed no disability with radiation therapy but were limited by short duration of follow-up (3 months) and use of the Shoulder Disability Questionnaire, in which patients were classified in a binary manner as having or not having shoulder complaints.

We recognize the potential for reporter bias with our administration of the Constant test because only 73% of patients could return to clinic for follow-up to complete objective testing. This is an expected trade-off with longer follow-up testing. We used NDII scores and demographic, disease, and treatment variables to compare the patients who returned for follow-up to the patients who had not returned to evaluate the level of reporter bias in the sample. There was no significant difference between these groups. We also recognize the limitation in our study’s cross-sectional design; associations are drawn, but causal inferences are limited without a prospective longitudinal study.

**Conclusions**

Overall, increased treatment, either in the form of increased surgical dissection and/or in the form of adjuvant radiation therapy or adjuvant concomitant chemoradiation therapy, was associated with worse shoulder function and quality of life. Shoulder impairment was significantly worse in patients undergoing neck dissection who underwent MRND, radiation therapy, or chemotherapy or had more advanced disease. The

---

**Figure 4. Radiation Therapy and Chemotherapy by Neck Dissection Impairment Index (NDII) Severe Score**

For patients who underwent bilateral neck dissection with completion of separate shoulder assessments, only the side of the neck with the most extensive neck dissection was included (severe score). Patients who received other treatment modalities in addition to neck dissection (radiation therapy [Kruskal-Wallis $P = .003$] or chemotherapy [Wilcoxon rank-sum $P = .03$]) had worse subjective shoulder function as evidenced by lower mean NDII scores.
subjective NDII was well correlated to the objective Constant test of shoulder function. Importantly, poorer shoulder function appears to confer disability with respect to leisure activities and employment status after neck treatment. This article anchors quality of life and shoulder function change to differences in leisure and employment opportunities.

REFERENCES