The Effects of More Conservative Neck Dissections and Radiotherapy on Nodal Yields From the Neck

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Objective: To determine the effects of conservative neck dissections (NDs) and preoperative radiotherapy on the quantitative recovery of lymph nodes from the neck.

Design: Retrospective review of case series. Data were obtained for age, preoperative TNM staging, type of ND, preoperative radiotherapy, total nodal yield (tNY), and positive nodal yield (pNY). The tNY and pNY were analyzed with factorial analysis of variance (ANOVA) to determine differences among types of ND and the effect of radiotherapy.

Setting: Tertiary care center for head and neck cancer.

Patients: Consecutive sample of 135 NDs in 110 patients with cancer of the head and neck.

Results: A significant difference in tNY was found among dissections ($P<.001$, ANOVA). Supraomohyoid ND had a significantly lower mean tNY (9.9 nodes) than both radical ND and modified radical ND (21.8 and 26.3 nodes, respectively; $P<.05$). Functional ND also had a significantly lower tNY (16.1 nodes) than modified radical ND ($P<.05$); the differences between radical ND and both functional ND and modified radical ND were not statistically significant. Positive nodal yield was not different among the types of dissections ($P=.62$). Preoperative radiotherapy significantly decreased mean tNY from 22.0 to 17.1 nodes ($P=.02$) over all types of dissections. Differences in tNY among dissection types were independent of the effect of radiotherapy. The presence or absence of preoperative radiotherapy had no significant effect on pNY ($P=.18$).

Conclusions: Conservative modifications of the classic radical ND differ with respect to the quantity of cervical lymph nodes excised, but survival may not be altered since the pNY is not significantly different. When compared with the radical ND, the modified radical ND and functional ND do not compromise the quantity of cervical nodes excised. Radiotherapy significantly reduces the quantity of cervical nodes, but a significant number of nodes will still remain.


Since the classic radical neck dissection was first described by Crile in 1906,1 block dissection of the neck for treatment of cancer of the head and neck has been the subject of several modifications. Considerable debate has emerged in the literature regarding the selection of the most appropriate type of neck dissection, with radical, modified radical, lateral, and functional neck dissections each being used for various primary sites, tumor histopathologic characteristics, and nodal staging. During the past 2 decades, there has been considerable momentum toward less radical neck dissections that spare functionally and cosmetically important structures in the neck. Several studies have described survival results and recurrence rates for these various types of neck dissections, but there is limited information on the lymph node yield of the various different types of dissection, and the relationship of the nodal yield to the N stage and previous radiotherapy to the neck.

Because the goal of the neck dissection is to remove all clinically evident metastatic nodal disease, and in most cases the “at-risk” nodal groups for a given primary tumor site, the relative yield in terms of total nodes excised for these various types of neck dissections should have importance in the clinical outcomes of these cases. This is more pertinent given the reported rates of occult positive pathologic nodes in elective neck dissection specimens.2,3 The total nodal yield (tNY) of a neck dissection should correlate with the effectiveness of the cervical lymphadenectomy, and offer insight into the ability of these...
MATERIALS AND METHODS

The medical records, operative notes, and pathology results were reviewed for 133 consecutive patients undergoing neck dissection at a single institution. Data were collected regarding patient demographics, tumor histopathologic characteristics, tumor staging, and previous treatment including radiotherapy. The clinical nodal status of each side of the neck was staged according to American Joint Committee on Cancer (AJCC) guidelines as N1, N2, or N3 based on size and number of nodes within that side. The type of neck dissection was classified and recorded with respect to type: radical (dissection of neck regions I through V, with sacrifice of the accessory nerve, sternocleidomastoid muscle, and the jugular vein) (RND), modified radical (same as the radical dissection but sparing the accessory nerve) (MRND), functional (regions I through V, sparing the accessory nerve, sternocleidomastoid muscle, and the internal jugular vein) (FND), suprathyroid (regions I and II) (SOHND), lateral (regions II through IV) (LND), or suprathyroid (regions I and II) (SND). The pathology data were carefully reviewed to determine the total number of recovered lymph nodes and the number of nodes positive for metastatic tumor for each neck dissection. All neck dissection specimens were processed using standard pathology techniques. After formalin fixation, the neck dissection specimen was divided into regions I through V. All visually detectable lymph nodes were then harvested from the specimen, sectioned, and submitted for microscopic analysis; size criteria were not used to exclude nodes from histologic analysis. The dissection specimens were examined by several head and neck pathologists.

Patients with incomplete records, inadequate documentation of operative technique, or inconsistent staging were excluded. Data were then structured and analyzed using a spreadsheet and the SPSS statistical package system (SPSS Inc, Chicago, Ill.). The tNY and positive nodal yield (pNY) rates were analyzed with respect to type of neck dissection and the presence or absence of preoperative radiotherapy using factorial analysis of variance (ANOVA). Where appropriate, the Tukey honestly significant difference test was used to determine whether significant differences, if any, existed between the individual types of dissection in their rates of nodal recovery.

One hundred thirty-three consecutive patients who underwent neck dissection were studied. After careful review of their medical records, 23 patients were noted to have had either nonstandard neck dissections (17 patients) or revision neck dissections (6 patients) and were thus excluded. One hundred thirty-five neck dissections were completed in the remaining 110 patients. All dissections were performed by senior surgeons in a tertiary care center. Table 1 lists summary data for patient demographics and tumor staging.

One hundred twenty-three (91.1%) of the 135 neck dissections were performed for cases of squamous cell carcinoma of the upper aerodigestive tract or skin. The remaining 12 cases (8.9%) were divided among papillary carcinoma of the thyroid (n=7), melanoma (n=3), undifferentiated carcinoma (n=1), and adenocarcinoma (n=1). The most common primary sites requiring neck dissection were the oral cavity and oropharynx. The percentage of contributions of various primary sites are shown in Figure 1. There were 42 RNDs, 39 MRNDs, 18 FNDs, 19 SOHNDs, 11 LNDs, and 6 SNDs performed. This distribution is diagrammed in Figure 2, along with the distribution of radiated and nonradiated cases for each type of dissection. The preoperative nodal staging distribution for each type of neck dissection is presented in Figure 3.

Because of small sample sizes, the lateral and suprathyroid neck dissections were omitted from the remaining statistical analysis. This allowed statistical evaluation of 118 dissections in 110 patients consisting of RND, MRND, FND, and SOHND with respect to the rate of tNY, rate of pathologically confirmed pNY, and nodal recovery difference between the different dissection types. The mean tNY and the mean pNY for each type of dissection are given in Table 2. The mean tNY for all types of dissection was 20.5 nodes per neck. There was a significant difference in the mean tNY rates among the different types of neck dissections (P<.001, factorial ANOVA). The MRND seemed to produce the highest overall nodal recovery rates (26.3 nodes), followed by RND (21.8 nodes), FND (16.1 nodes), and SOHND (9.9 nodes). The strongest difference was found between the SOHND and both the RND and MRND, at the .05 significance level (Tukey honestly significant difference method). In addition, the nodal recovery difference between the MRND and the FND was statistically significant (P<.05). Although the tNY of the MRND was paradoxically higher than that of the RND, this difference was not statistically significant. These statistical results are summarized in Table 3. These differences remained significant even when the interaction effect of radiotherapy was included (significance of interaction=.26).

The overall rate of pathologically pNY for all types of dissections combined was 2.3 nodes per neck (Table 2). The rate of pNY was fairly consistent among the different types of neck dissections, and no statistical difference could be found between the different dissection types (P=.62, factorial ANOVA). Similarly, the presence or absence of previous radiotherapy did not have a significant effect on the rate of pNY (significance of interaction=.74) among dissections.
The effect of preoperative radiotherapy on tNY and pNY is also demonstrated in Table 2. The mean number of nodes recovered in a nonradiated neck was 22.0 vs 17.1 nodes in radiation cases. The difference in tNY rates between cases with and without preoperative radiotherapy did reach statistical significance ($P = .02$) over all types of dissections. However, no difference was found for the effect of preoperative radiotherapy on pNY ($P = .18$) over all types of dissections. These effects were independent of the effects of dissection type (significance of interaction $=.26$).

The presence of cervical metastases has been consistently shown to be a major factor determining survival in patients with head and neck cancer.6,7 Earlier this century, Crile and others were successful in proposing the radical neck dissection to address cervical metastases of head and neck cancer. Since the early 1900s, several morbidity-reducing modifications of the RND have taken place, resulting in often misleading terminology.4 The types of neck dissection studied in this report are those widely used in the current literature. These less aggressive types of dissection will likely increase in proportion as quality-of-life and postoperative morbidity issues merge with increasing technical expertise and cost-containment efforts.

Several authors have reported tNYs ranging from 20 to 40 nodes in RNDs.8-10 Other studies have reported higher tNYs, especially when narrow-field serial sectioning or special fixation techniques are used.7 Our average recovery rate of 21.8 nodes for RND specimens is therefore near the low end of that reported in the literature, although we did not use specialized techniques. Byers11 has previously noted in a nonstatistical comparison that the modified types of neck dissections tend to recover...
17 nodes, or roughly half of the number of nodes recovered in a classic RND. However, it was also noted that the FND recovered a mean of 31 nodes. Our data indicated a much lower rate of recovery for FNDs than that reported in the literature.

These data did elucidate a significant difference regarding tNY rates among the 4 types of neck dissections that were statistically analyzed. The strongest difference identified suggests that the nodal recovery rate for the SOHND was generally significantly less than that of the RND and MRND (Table 2). This would be intuitively expected since the SOHND excludes regions IV and V, and therefore encompasses less of the node-bearing tissue of the neck. In addition, a significant difference was found between the MRND and the FND, with the MRND recovering significantly more nodes: 26.3 vs 16.1 nodes. This is notable because theoretically, both dissections encompass the same volume of lymphatic-bearing tissue. The main technical difference is the preservation of conceptually non-node-bearing tissues such as the internal jugular vein and the sternocleidomastoid muscle. Based on the theory and study of several authors, one would expect similar nodal recovery rates from these 2 types of dissections. These data, however, argue that the MRND does recover significantly more nodes than the FND. If this differential is confirmed by further study, the quantitatively superior lymphadenectomy of the MRND merits consideration when selecting the type of neck dissection for patients who are at high risk for regional recurrence. The failure to identify a statistically significant difference in tNY recovery rates between the RND and the MRND suggests that techniques to preserve the accessory nerve to prevent postoperative morbidity do not quantitatively compromise the completeness of the cervical lymphadenectomy. In fact, the MRND tended to recover more nodes, 26.3 vs 21.8, than the RND. This is likely because the RND is used for higher-staged disease and more often after radiotherapy, and a large positive node (or nodes) in the specimen makes pathologic recovery of additional nodes more difficult, especially when extracapsular spread is present. Importantly, the differences in tNY among the types of neck dissection were independent of the effect of prior radiotherapy.

The data did not identify any significant differences in the rates of pNY. This is understandable because regardless of the type of dissection, pNY tends to be small (Table 2). Also, if the type of dissection selected is appropriate, the dissection should at least remove the clinically suspected positive nodes. Although a trend was noted for RND to recover more positive nodes, this is offset by the fact that the RND is usually favored when the preoperative nodal staging is higher. This bias is graphically seen in Figure 3. In addition, one could expect a bias for cases with higher preoperative staging to recover more positive nodes, and, statistically, this was noted. The absence of a notable difference between the MRND and RND further suggests that MRND is a sound alternative to the RND on a pathologic basis, since these dissections are often selected for similar nodal stages, and no statistical difference in pNY was demonstrated. Because grossly positive nodal disease is unlikely to remain in situ after neck dissection, a large difference in positive nodal recovery between the RND and MRND would be attributed to occult positive nodes around the accessory nerve that the RND removed. The lack of a demonstrable difference argues that such nodes are adequately extirpated by the MRND.

There is limited information in the literature regarding the effect of radiotherapy on the yield of lymph nodes from neck dissection. Zarbo and Crissman report a decrease in yield from 20 nodes without preoperative radiation to 6 to 10 nodes for cases with preoperative radiation, and this effect of radiotherapy has been corroborated by others. The demonstrated overall nodal yield of 17.1 nodes for radiated necks was therefore higher than would be expected from the literature. There was a significant statistical difference found in pNY between those cases with (mean total nodes, 17.1) and without (mean total nodes, 22.0) preoperative radiation. This indicates that radiotherapy reduces the nodal load in the neck, but even after preoperative radiation, a significant number of cervical lymph nodes remain, and neck dissection is capable of removing them. This does not, however, suggest that these nodes still necessarily harbor

### Table 2. Total and Positive Nodal Recovery by Dissection Types and Radiation Therapy (XRT)*

<table>
<thead>
<tr>
<th></th>
<th>All Patients</th>
<th>RND</th>
<th>MRND</th>
<th>FND</th>
<th>SOHND</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total nodal yield</strong></td>
<td>20.5 (12.0)</td>
<td>21.8 (10.9)</td>
<td>26.3 (11.1)</td>
<td>16.1 (10.8)</td>
<td>9.9 (9.3)</td>
</tr>
<tr>
<td>With XRT</td>
<td>17.1 (9.2)</td>
<td>18.1 (9.0)</td>
<td>19.4 (6.1)</td>
<td>14.8 (10.3)</td>
<td>11.4 (13.0)</td>
</tr>
<tr>
<td>Without XRT</td>
<td>22.0 (12.9)</td>
<td>24.5 (11.5)</td>
<td>28.4 (11.5)</td>
<td>16.4 (11.3)</td>
<td>9.4 (8.1)</td>
</tr>
<tr>
<td><strong>Positive nodal yield</strong></td>
<td>2.3 (3.6)</td>
<td>2.7 (3.8)</td>
<td>2.5 (4.4)</td>
<td>1.2 (1.1)</td>
<td>1.7 (2.4)</td>
</tr>
<tr>
<td>With XRT</td>
<td>1.8 (2.9)</td>
<td>1.9 (2.0)</td>
<td>2.0 (4.6)</td>
<td>0.5 (0.6)</td>
<td>2.4 (3.9)</td>
</tr>
<tr>
<td>Without XRT</td>
<td>2.5 (3.8)</td>
<td>3.4 (4.7)</td>
<td>2.7 (4.4)</td>
<td>1.4 (1.2)</td>
<td>1.4 (1.7)</td>
</tr>
</tbody>
</table>

* Data are mean (SD) number of nodes. See the footnote to Table 1 for an explanation of abbreviations.

### Table 3. Comparison of Neck Dissections*

<table>
<thead>
<tr>
<th></th>
<th>RND</th>
<th>MRND</th>
<th>FND</th>
<th>SOHND</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RND</strong></td>
<td>-4.5</td>
<td>5.7</td>
<td>11.9</td>
<td></td>
</tr>
<tr>
<td><strong>MRND</strong></td>
<td>10.2</td>
<td>16.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FND</strong></td>
<td>6.2</td>
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</tbody>
</table>

* Numbers represent difference in total nodal recovery between the 2 dissections (row minus column). See the footnote to Table 1 for an explanation of abbreviations. Boldface data denote statistically significant differences (Tukey honestly significant difference test for factorial analysis of variance with P < .05).
viable tumor, since radiation is clinically effective in eradicating metastatic neck disease. In addition, the functional status of these remaining nodes in lymphatic flow after radiotherapy cannot be determined solely by histopathologic study. The presence or absence of preoperative radiation did not significantly alter pNY. This is to be expected since most dissections were performed for clinically evident (N1-N3) disease, and a dissection after radiation is usually performed for either advanced-stage or persistent disease. The applicability of information on pNY also may have less bearing in the light of studies by Sessions and Schuller et al that have suggested that the number and percentage of pathologically positive nodes in the dissected neck have limited effect on overall survival. In contrast, others have found prognostic value with respect to location and number. The number of positive nodes also seems to have less prognostic importance for local control when both neck dissection and postoperative radiation are used.

This study is subject to the same criticisms of other retrospective studies. One such problem is the effect of preoperative nodal staging on the recovery of nodes: higher-staged disease was likely to get a “more” radical dissection. Naturally, a larger prospective study would be able to better account for the added dimension of the preoperative staging of the neck on nodal recovery, but it would still be unlikely that an N0 neck would receive an RND, or that an N2 neck would undergo SOHND, and therefore this selection bias will remain. When additional multivariate analysis was performed with N as a covariate, no changes in the statistical results for tNY and pNY were found. Nevertheless, statistical significance was found for effects of both the type of dissection and previous radiation therapy on the tNY from the dissected neck, even when the interaction effect between these 2 variables was included. Certainly, clinical studies examining the survival rates after different types of dissection have major bearing on justifying the aggressiveness or conservatism in the selection of the appropriate dissection. Especially for the N0 or N1 neck, correlating the recurrences in the neck, the location of the recurrence, and the survival with the tNY (and pNY) would be of interest to determine whether tNY (or pNY) is itself a prognostic variable. The data presented herein and a larger study may help bridge the gap from surgical theory to clinical locoregional control in the treatment of the neck in malignant diseases of the head and neck.

To summarize, we present the following conclusions:

1. The tNY differs among types of neck dissection, with the RND and MRND yielding more nodes than the SOHND, and the MRND yielding more than the FND.

2. The rate of pNY is not statistically different among different types of neck dissections.

3. Radiotherapy does achieve a significant reduction in the nodal content of the neck. After radiotherapy, however, a significant number of lymph nodes will remain in the neck.

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REFERENCES


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