THE CAROTID SHEATH: AN ANATOMICOPATHOLOGIC STUDY

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Abstract: Background. Recurrences in the neck after neck dissections occur even in previously operated fields. Although the pathogenesis is unclear, it is well established that recurrences commonly occur at the jugular chain of nodes close to the carotid artery. We investigated the carotid sheath as possibly responsible for such regional recurrences.

Methods. Patients undergoing therapeutic or elective neck dissections were prospectively enrolled. Following surgery, the carotid sheath was resected throughout its entire length, fixated in formalin, and histologically examined.

Results. Pathologic assessment of carotid sheaths harvested from 34 patients who underwent 40 uncomplicated neck dissections revealed fibro-fatty tissue and scarce neutrophilic infiltration in all 40 specimens. Four lymphoid aggregates composed almost exclusively of B cells were found at the carotid bifurcation level in three patients. No cancer cells were detected.

Conclusion. The absence of cancer cells in patients with metastatic nodes argues against the need to resect the carotid sheath as part of a routine neck dissection. The occurrence of lymphoid aggregates within it, however, may indicate its participation in the pathogenesis of nodal recurrence following neck dissection. © 2004 Wiley Periodicals, Inc. Head Neck 26: 594–597, 2004

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Recurrences after neck dissections in the pathologically negative neck occur in 5% to 8% of the patients with no evidence of recurrence at the primary site.1 Such regional recurrences are associated with a poor prognosis and a decreased survival. Many approaches were developed in an effort to decrease the rate of regional recurrence.

Complete resection of all the nodal regions that drain the primary tumor as well as of all the regions containing the involved lymph nodes is probably the most important factor in decreasing regional recurrence. This objective is achieved by tailoring the neck dissection for each patient and by the use of postoperative irradiation for those with pathologically positive nodes.1,2 The extent of the neck dissection, especially for patients with nodal disease, is still a matter of debate in the literature. While some authors recommend a radical neck dissection for all patients with pathologically involved nodes, a more conservative approach has been proposed, involving...
the use of selective neck dissection followed by postoperative radiotherapy for N1 disease, with similar survival rates.\textsuperscript{2,3} No benefit was proved for the more aggressive dissections, and, importantly, regional recurrences still occur in surgical fields of the neck even after radical neck dissection\textsuperscript{3,4} These recurrences may result from inadequate excisions of areas of nodal disease in which some of the lymphatics are left intact.

One such area may be the carotid sheath, which is not routinely removed as part of a standard neck dissection. The carotid sheath may be directly involved with the tumor in patients with large nodal metastases and extensive extracapsular extension; for them it will be routinely resected as part of the specimen. The role of the carotid sheath as a potential origin of nodal recurrence after neck dissection in patients without direct invasion by the cancerous process, however, was not previously explored. The purpose of the current study was to investigate the anatomic and pathologic characteristics of the carotid sheath in search of a possible explanation for nodal recurrence at this region after neck dissection.

**PATIENTS AND METHODS**

Patients with various head and neck tumors who were scheduled for neck dissection as part of their treatment protocol were prospectively enrolled in this study. One patient was diagnosed with neurofibromatosis and required a neck dissection for complete tumor removal. All the other patients presented with malignant neoplasms of the head and neck (Table 1). All patients underwent a thorough physical examination before surgery, and if a murmur was heard over the carotid artery, Doppler ultrasound of the carotid was performed to rule out arteriosclerosis, which was an exclusion criterion for this study. Diffuse extensive fibrosis of the neck following irradiation was a contraindication to minimize the risk of carotid blowout after surgery. Patients with tumors abutting the carotid artery were excluded. All patients signed an informed consent form to participate in this study, which was approved by the Institutional Review Board.

The selected type of neck dissection was tailored to the primary tumor: a supraomohyoid neck dissection (levels I–II) for oral cavity and parotid primary tumors as well as for facial skin cancers, a lateral neck dissection (levels II–IV) for laryngeal and hypopharyngeal primary tumors, and posterolateral neck dissection (levels II–V) for skin cancer arising posterior to the tragus. When positive nodes from differentiated thyroid cancer were detected, a modified radical neck dissection (levels II–VI) was performed, preserving the internal jugular vein, the spinal accessory nerve, and the sternocleidomastoid muscle. In these cases, level I was removed only when positive nodes were found at level II close to the submandibular gland. In cases of palpable regional metastases greater than 1 cm from squamous cell carcinoma (SCC), either a modified radical neck dissection with preservation of the spinal accessory nerve, if possible, or a selective neck dissection, followed by radiation treatment was performed.

The length of the carotid sheath that was resected matched the extent of the neck dissection: the sheath was resected from above the carotid bifurcation to the level of the omohyoid muscle in cases of supraomohyoid neck dissection and from above the bifurcation through the entire length of the carotid artery in the neck in cases of lateral or modified radical neck dissection.

The neck dissection was performed in a routine manner, and dissection at the area of the carotid sheath was performed using a scalpel. The walls of the carotid artery were essentially completely free of any fatty tissue at the end of the neck dissection. The carotid sheath was then separated at the area of the carotid bifurcation using sharp scissors and carefully resected inferiorly along the length of the dissection. It was then removed, and the area of the carotid bifurcation was marked with a silver clip. Resected specimens were fixed in 10% buffered formalin. The area marked by a silver clip was submitted separately. After paraffin embedding, 3-μm serial sections were performed through the block. The microsections were stained with hematoxylin-eosin stain and examined by a head and neck physician.

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**Table 1. Location of primary tumors.**

<table>
<thead>
<tr>
<th>Site of primary tumor</th>
<th>No. patients ($N = 34$)</th>
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<tbody>
<tr>
<td>Oral cavity</td>
<td>10</td>
</tr>
<tr>
<td>Skin</td>
<td>8</td>
</tr>
<tr>
<td>Larynx</td>
<td>5</td>
</tr>
<tr>
<td>Thyroid</td>
<td>4</td>
</tr>
<tr>
<td>Parotid</td>
<td>3</td>
</tr>
<tr>
<td>Unknown primary</td>
<td>2</td>
</tr>
<tr>
<td>Oropharynx</td>
<td>1</td>
</tr>
<tr>
<td>Neurofibromatosis</td>
<td>1</td>
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pathologist. If lymphoid aggregates were present, immunophenotyping was done using CD20 (a marker for B-lymphocytes) and CD3 (a marker for T-lymphocytes).

RESULTS
During a 1-year period, 43 patients underwent 50 neck dissections at the Tel-Aviv Sourasky Medical Center. Thirty-five of these patients were included in this study; the other eight patients were excluded owing to extensive fibrosis of the neck following radiotherapy or because the patient refused to take part in the study. Twenty-eight patients underwent a unilateral neck dissection, and six underwent bilateral neck dissection. One patient originally included in the study was found to have extensive fibrosis of the neck during the neck dissection and was subsequently excluded. The remaining 34 patients underwent 40 neck dissections, followed by resection of the carotid sheath as planned.

Nodal staging was performed separately for each side of the neck (ie, the two sides of the neck in a patient who underwent bilateral neck dissection were staged separately as N0, N1, N2a/b, N3) (Table 2). Five patients had extracapsular extension (three patients with N3 disease and two with N2b disease). Resections of the carotid sheath were easy to perform and added only 5 to 10 minutes to the duration of the surgical procedure. They were all carried out uneventfully, and no patients had associated postoperative bleeding or neurologic sequelae.

All specimens of the resected carotid sheaths were composed of fibro-fatty tissue, and scattered neutrophilic infiltration was common (Figure 1). Four discrete lymphoid aggregates that were clearly different from the commonly found neutrophilic infiltrate were found within the carotid sheaths in three patients (Figure 2). Immunophenotyping of these aggregates showed them to be composed almost exclusively of B cells (Figure 3). No tumor cells were found within any of the studied carotid sheaths.

<table>
<thead>
<tr>
<th>N classification</th>
<th>No. patients (N = 40)</th>
</tr>
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<tbody>
<tr>
<td>N0</td>
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<tr>
<td>N1</td>
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<td>N2a</td>
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</tr>
<tr>
<td>N2b</td>
<td>13</td>
</tr>
<tr>
<td>N3</td>
<td>6</td>
</tr>
</tbody>
</table>

FIGURE 1. H&E stained carotid sheath with fibrofatty tissue and neutrophilic infiltrates.

FIGURE 2. A carotid sheath (H&E stain) with a discrete lymphoid aggregate.

FIGURE 3. Immunostaining of the lymphoid aggregates showed the cells to be composed mainly of B-lymphocytes.
DISCUSSION

Regional recurrence after neck dissection remains a significant cause of failure and death in patients with SCC of the head and neck. However, the carotid artery has never been evaluated as a possible site of origin for such recurrences. Because patients with cancer abutting the carotid sheath were excluded from the current study, direct invasion of the carotid wall by the cancerous tumor was not expected. We looked for other factors that could explain recurrence at that region, such as free cancer cells within the carotid wall or lymphoid tissue along the carotid sheath that might harbor cancer cells. Of the 40 neck dissections, 39 were performed for malignant tumors and none of the specimens was found to harbor cancer cells within the carotid sheath, not even in those patients with large positive lymph nodes with extracapsular extension, sometimes in proximity to the carotid artery.

The finding of lymphoid aggregates within the carotid sheath in four specimens was interesting and has not been previously reported. Piffer\textsuperscript{5} performed a mesoscopic and microscopic study of the human carotid sheath in 40 anatomic specimens and found that the carotid sheath is always present and constitutes a complete cover around the neurovascular complex. He found subdivisions that envelop the internal jugular vein, the internal carotid artery, and cranial nerves IX, X, and XI. Having detected no lymphoid tissue within the specimens, he concluded that the carotid sheath is composed of fibroelastic tissue only. Waltner-Romen et al\textsuperscript{6} recently studied the carotid artery bifurcations from healthy babies (victims of accidents or sudden infant death syndrome) and accidentally found vascular-associated lymphoid tissue within the arterial intima of these pathologic specimens. The authors concluded that the intima of normal carotid arteries always harbor lymphatic aggregates.

Although we did not study the carotid arterial intima of our patients, we agree that it is possible that lymphoid aggregates occur within the intima and the overlying sheath of the carotid artery. The predominance of B cells within these aggregates was clearly different than the commonly found neutrophilic infiltrates, and this would appear to suggest that the lymphoid aggregates are, indeed, a separate entity.

The role of the lymphoid tissue, which is in proximity to the carotid sheath, as a potential site of drainage and recurrence of aerodigestive tract cancers and the need for resection of the carotid sheath remain unclear. We would, however, like to again emphasize that none of our patients had metastatic lymph nodes abutting the carotid sheath, and the results of this study should not encourage surgeons to refrain from resection of the carotid sheath in cases in which it is close or adherent to a cancerous process. The fact that none of our patients had metastatic tumor cells within the carotid sheath or within the newly reported lymphoid aggregates, however, does not support the role of routine carotid sheath resection as a way of decreasing regional recurrences. The finding of lymphoid aggregates within the carotid sheath of some of our study patients warrants further investigation.

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REFERENCES