Lymph Nodes of the Perimandibular Area and the Hazard of the Hayes Martin Maneuver in Neck Dissection

Giancarlo Tirelli, MD1 and Alberto Vito Marcuzzo, MD1

Abstract

Objective. To provide an anatomic description of submandibular nodes at risk of being left undissected during neck dissection (ND) and to assess whether the Hayes Martin maneuver is a safe procedure in oncologic surgery of level IB nodes.

Study Design. Prospective study.

Setting. Academic medical center.

Subjects and Methods. We recruited 62 patients who were candidates for level IB ND. Perifacial nodes (PFNs) were identified and their characteristics noted. The Hayes Martin maneuver was simulated, and its oncologic safety was tested.

Results. The study included 63 NDs. PFNs were identified in 84% of cases: their number ranged from 0 to 5, and their mean greatest diameter was 12.45 mm. Anterior PFNs were found to be in direct contact with the marginal mandibular nerve. In 59% of NDs, the Hayes Martin maneuver would have failed to remove all PFNs.

Conclusions. The PFNs were identified in 84% of cases and ranged in number from 0 to 5. In some cases, the distinction between retro- and preglandular nodes and PFNs is not useful. The Hayes Martin maneuver may not be oncologically sound for complete treatment of level IB nodes.

Keywords

neck dissection, perifacial lymph nodes, submandibular lymph nodes, perifacial nodes, submandibular nodes, marginal nerve, marginal mandibular nerve, Hayes Martin maneuver, neck metastases, cervical metastases

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Nodal status is a critical prognostic factor in head and neck cancer and the most significant in the treatment of patients with oral and oropharyngeal squamous cell cancer.1,2 Neck dissection (ND) has represented the main treatment of cervical node metastases since the 19th century. The first lymphadenectomies envisaged a very extensive approach with the removal of major neck structures, such as main vessels and nerves (radical ND). The concept of conservative ND was introduced by Suarez in 1963, revisited by Bocca, and later progressively refined to arrive at selective ND.1 The concept of selective ND presumes knowledge of lymphatic drainage sites and an accurate surgical anatomy classification of lymphatics of the neck.

The most followed and precise classification of cervical nodes was published by Robbins et al in 2002, and it divides the nodes into 6 levels. In the Robbins classification, the lower border of the mandible is of particular importance because it represents the upper limit of the ND and divides the lymph nodes of the submental (level IA) and submandibular (level IB) space from those of the face.3 The mandibular nodes are 1 of the 4 subgroups of the facial nodes described by Rouviere. These nodes are located adjacent to the facial vessels, at the anterior border of the masseter muscle, overlying the horizontal ramus of the mandible, and may occasionally be involved with cancer of the head and neck.4,5 The submandibular nodes lie within the boundaries of the anterior belly of the digastric muscle anteriorly, the stylohyoid muscle posteriorly, and the mandible superiorly, and according to the Robbins classification, they correspond to level IB. Rouviere noted that 3 to 6 lymph nodes occupy the submandibular region and that the number is usually inversely proportional to the size. He described 5 groups of submandibular nodes in relation to the anterior facial vein (AFV) and the submandibular gland: preglandular, retro-glandular, intraglandular, prevascular, and retrovascular. In 1998, DiNardo added a group called “submandibular deep nodes” (Figure 1).

Perifacial nodes (PFNs) is the term by which many authors call the retrovascular and prevascular nodes, defined in relation to the AFV.5,6 PFNs are a group of nodes that arise along the course of the AFV near the lower

1Department of Otorhinolaryngology and Head and Neck Surgery, Azienda Sanitaria Universitaria Integrata di Trieste–ASUITS, Trieste, Italy

Corresponding Author:
Alberto Vito Marcuzzo, MD, Department of Otorhinolaryngology and Head and Neck Surgery, Azienda Sanitaria Universitaria Integrata di Trieste–ASUITS, Strada di Fiume 447, 39149, Trieste, Italy.
Email: avmarcuzzo@gmail.com
mandibular border and drain from the oral and oropharyngeal mucosa and from the skin and subcutaneous tissue of the face. In the past, the German anatomist and pathologist Hermann Stahr described a constant node that is found just where the facial artery crosses the horizontal ramus of the mandible.7 The anatomist did not specify if the position of the node is above or under the lower border of the mandible; given the described characteristics it is probable that the node of Stahr corresponds to a PFN.

A common misconception is to consider PFNs as facial nodes rather than cervical nodes.6,8 Although PFN involvement by lymphatic metastases is documented in the literature, the AFV is not always well dissected in its cranial course, owing to the presence of the marginal mandibular nerve (MMN) in this area, which crosses the vein laterally.8,9 Iatrogenic injury to the MMN is in fact an aesthetic issue for the patient and a potential cause of medicolegal action.10 For this reason, in clinical practice, the AFV is often interrupted and ligated, and the cranial portion of the vein is lifted to protect the MMN in a flap consisting of the trunk of the vein and the superficial cervical fascia, which is elevated and reflected superiorly (Hayes Martin maneuver; Figure 2). Although this maneuver is safe for protecting the MMN, it may preclude clearance of the nodes along the cranial portion of the AFV.11

Metastases to PFNs from squamous cell cancer have been reported in 3% of temporal bone cancers, 5.5% of tongue cancers, 7% of head and neck skin cancers, 8% of oropharynx cancers, and 7.5% to 35% of oral cavity primaries.2,8,12

The present study aimed to provide an anatomic description of nodes of the submandibular area that are virtually at risk of being left undissected during conventional ND. The relationship of the lymph nodes with the MMN and AFV was also noted. Secondarily, we assessed the number of cases in which performance of the Hayes Martin maneuver would have led to leaving lymph nodes in the submandibular space undissected.

**Materials and Methods**

This prospective study was approved by the local ethics committee (CRO Aviano National Cancer Institute, Institute for Research and Healthcare, Aviano, Italy), and all patients gave their signed informed consent.

**Inclusion Criteria**

We recruited 62 consecutive patients diagnosed with oral, oropharyngeal, or facial skin squamous cell carcinoma and clinically negative neck who were candidates for an elective unilateral or bilateral ND that included level IB nodes according to the Robbins classification. Consistent with the aims of the study, we considered bilateral ND as 2 separate surgical specimens. Pretreatment evaluation was carried out according to the 2015 guidelines of the National Comprehensive Cancer Network.

**Exclusion Criteria**

We excluded patients who had already undergone surgery or radiotherapy in the neck and mouth region, patients with
Pathologically positive nodes, and patients who denied consent.

**Surgical Procedure: Dissection of Level IB**

All NDs were performed by the same surgeon with the aid of nerve integrity monitoring (NIM) for the MMN (electromyographic monitoring system: NIM-Response 2.0; Xomed Medtronic, Inc, Jacksonville, Florida). During surgery, we took care to keep the patient’s head at the same angle of inclination. Before starting dissection of the submandibular area, the surgeon ligated the AFV approximately 1 to 2 cm below the lower mandibular border and performed the Hayes Martin maneuver. Once the standard dissection of level IB had been completed, the surgeon repositioned the flap in its normal anatomic position and started to dissect the facial vessel in its cranial portion, tracking the course of the MMN with the aid of the NIM stimulator and transposing it superiorly; he then removed the nodes hidden by the Hayes Martin maneuver. We considered the Hayes Martin maneuver a theoretical failure in all cases in which the reflected flap enveloped some PFNs, making their removal impossible.

**Lymph Nodes**

If macroscopically evident, all level IB nodes within 1 to 2 cm below the inferior border of the mandible were identified, and their number and relationship with the AFV, MMN, and submandibular gland were noted. We considered PFNs to be all nodes lying adjacent to the AFV within 1 to 2 cm below the mandibular border that were superficial to or contained within the superficial cervical fascia. We named the PFN anterior to the AFV “anterior PFN” and the PFN posterior to the vein “posterior PFN.” All these nodes were removed separately from the ND specimen, measured along the greatest diameter, and sent for histopathologic examination. Lymph nodes found above the inferior border of the mandible (facial/mandibular nodes) were not considered in the study.

**Marginal Nerve Function**

MMN function was clinically evaluated on the first postoperative day and, in the case of nerve palsy, at regular intervals during the normal oncologic follow-up until the weakness had resolved.

**Results**

**Population**

The study included 47 patients, 36 men (77%) and 11 women (23%) with a mean age of 64 years (range, 46-85) at surgery, who underwent a total of 63 NDs (29 unilateral, 17 bilateral). The primary cancer site was the oral cavity for 25 patients (53%), the oropharynx for 12 (26%), and the skin of the face for 10 (21%).

**Node Number**

A total of 97 nodes were identified. Their number ranged from 0 to 5 (mean, 1.6), with at least 1 node being found in 53 NDs (84%, 41 patients; Figure 3). The characteristics of the patients’ primary tumors are summarized in Table 1.

**Relationship with the AFV**

In our series of NDs, at least 1 anterior PFN was found in 48 NDs (76%) and at least 1 posterior PFN in 33 NDs (49%). Only anterior PFNs were identified in 20 NDs (32%) and only posterior in 5 (8%). Both anterior and posterior PFNs were found in 28 NDs (44%; Table 2).

**Relationship with the Submandibular Gland**

In our series of ND, nodes close to the AFV were exclusively superficial to submandibular gland in 51 cases (81%). PFNs were anterior to submandibular gland in 5 cases (8%) and posterior in 7 cases (11%).

**Dimension and Histologic Findings**

PFNs had a mean greatest diameter of 12.5 mm (range, 4-23 mm; SD = 5 mm), as compared with 12.3 mm (range, 4-23 mm; SD = 5.3 mm) for anterior PFNs and 12 mm (range, 5-17 mm; SD = 4.5 mm) for posterior PFNs. Histopathology indicated signs of inflammation in 41 nodes (42%).

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*Figure 2. Hayes Martin maneuver: 1, submandibular gland; 2, mylohyoid muscle; 3, digastric muscle; 4, anterior facial vein; 5, marginal mandibular nerve; 6, flap; 7, lymph nodes.*

*Figure 3. Number of perifacial nodes and number of lymph nodes hidden by the Hayes Martin maneuver: Colored bars: number of neck dissections distributed by number of perifacial lymph nodes found in every specimen. White bars: number of dissections in which at least 1 node would have been left in the surgical field.*
Marginal Mandibular Nerve

Only the anterior PFNs were in direct contact with the MMN, as seen in 38 cases (60%). All posterior PFNs and the remaining anterior PFNs were 5 mm from the MMN. Despite this, only 4 patients in our series had postoperative MMN palsy, which was temporary and resolved within 30 days.

Hayes Martin Maneuver

In 37 NDs (59%), at least 1 node would have been left in the neck if the Hayes Martin maneuver had been performed, for a total of 48 nodes. In 28 NDs (76%), only 1 node would have been left undissected; in 7 cases (19%), 2 nodes; and in 2 cases (5%), 3 nodes. The mean greatest diameter of these nodes was 7.4 mm (range, 4-12 mm; SD = 2.5 mm).

Discussion

The submandibular nodes are not infrequently involved in head and neck cancer, and they represent the most common site for metastases from squamous cell carcinoma of the mouth.6,11 Nodal recurrence of level IB in head and neck cancer has also been reported in the literature, a possible result of the fact that the complex anatomy of the structures of this area makes it one of the most difficult areas to dissect.13,14 MMN injury is a complication that causes an aesthetic deficit that has an impact on the patient’s perceived appearance and quality of life and could result in medicolegal action. Many authors have described methods for preserving the MMN during submandibular dissection, but the anatomic variability of the nerve does not provide definite landmarks to help prevent nerve injury.10,15,16 For this reason, many surgeons ligate the AFV approximately 1 to 2 cm below the lower mandibular border and lift the cranial portion of the vein to protect the MMN with the flap that is elevated with the vessel17. Some authors, however, describe the maneuver by stating that the vein is ligated 2 fingerbreadths below the inferior mandibular margin, a limit that we consider unacceptable as it is likely to completely conceal level IB.11

This maneuver was first described by Hayes Martin and is nowadays commonly performed. Nevertheless, the Hayes Martin maneuver cannot ensure complete clearance of the PFN.11 Because of this and because of the common misconception of considering PFNs as facial nodes, these lymph nodes are at risk of not always being well dissected during ND. In the literature, classification of the PFNs as submandibular nodes is controversial. In an anatomic, clinical, and pathologic study of lymphatics of the submandibular space published in 1998, DiNardo described PFNs as a subgroup of submandibular nodes, and this view was endorsed by other authors.2,6 More recently, PFNs have been considered a separate group of nodes not included among the cervical nodes.8,9 In our opinion, following the Robbins criteria, whereby the lower mandibular border is the upper limit of level IB, the PFNs fall within the submandibular node group and should not be considered a separate group. Consequently, they should always be removed during ND that includes level IB. Although the PFNs represent a poorly classified entity, their involvement in squamous cell cancer of the mouth, oropharynx, skin, and temporal bone has been often been reported in the literature.2,6,8,9,18 Cases of isolated PFN metastases were recently reported in patients with oral cancer originating from the buccal mucosa and tongue.19

To our knowledge, this is the first study that analyzes the anatomic characteristics and relationships of the nodes of the submandibular region at risk of remaining undissected in a consecutive series of ND. The only 2 published reports investigating the number of PFNs revealed an average of 2.1 PFNs for every ND (range, 0-8).2,12 In our study, we found 1.6 PFNs (range, 0-5), but we considered a more limited area because we believe that the lymph nodes at greater

| Table 1. Characteristics of the Primary Tumors of Patients in Whom Perifacial Nodes Were Identified: Site, Subsite, and T Size.a |
| Site: Subsite | T1-T2 | T3-T4 |
| Oral cavity, 20 (49) | | |
| Floor, 9 (22) | | |
| Tongue, 3 (7) | | |
| AC, 4 (10) | | |
| Trigon, 3 (7) | | |
| Trig., 1 (2) | | |
| HP, 1 (2) | | |
| Oropharynx, 11 (27) | | |
| Tonsil, 5 (12) | | |
| TB, 4 (10) | | |
| PW, 2 (5) | | |
| Skin of the head, 10 (24) | | |
| Cheek, 4 (10) | | |
| Scalp, 1 (2) | | |
| Nose, 2 (5) | | |
| PA, 3 (7) | | |
| Abbreviations: AC, alveolar crest; HP, hard palate; PA, preauricular area; PW, posterior wall; TB, tongue base. |
| aValues are presented as n (%) patients. |

| Table 2. Number of Neck Dissections Distributed by Number of Anterior and Posterior PFNs. |
| Posterior PFNs | Anterior PFNs |
| 0 Nodes | 1 Node | 2 Nodes | 3 Nodes |
| 0 nodes | 10 | 17 | 3 | 2 |
| 1 node | 3 | 21 | 2 | 1 |
| 2 nodes | 2 | 0 | 0 | 1 |
| 3 nodes | 0 | 1 | 0 | 0 |
| Abbreviation: PFN, perifacial node. |
risk of being left undissected are those that might be concealed by a Hayes Martin maneuver. Consequently, we defined as PFNs all nodes encountered 2 cm below the lower mandibular border along the course of the AFV that were superficial to or contained within the superficial cervical fascia. The cutoff distance of 1 to 2 cm was chosen because it is usually the limit where the AFV is ligated in a Hayes Martin maneuver, and consequently, it represents the inferior boundary of the area in which nodes are at risk of being left in the surgical field. It should also be noted that the mean size of the PFN nodes in our series might have been influenced by the inflammatory status typical of nodes in head and neck cancer even in the absence of metastases. Classically, PFNs are described as nodes encountered where the MMN crosses the AFV. Our study confirms the view that in the majority of cases, there is close contact between the MMN and the anterior PFNs.

While concerns of MMN injury exist, in our series, there were no recorded cases of permanent MMN palsy, in part a possible result of the use of an NIM system. In our opinion, accurate identification of the course of the MMN is a fundamental step in PFN dissection, and the surgical procedure for level IB dissection should always provide for identification of the MMN before dissection of the area of the cranial portion of the AFV is started.

In some cases, depending on the course of the AFV, nodes adjacent to the vessel could be situated posterior or anterior to the submandibular gland; therefore, the distinction between retro- and preglandular nodes and posterior PFNs is not useful. Given the finding that in 60% of cases, the PFNs are in direct contact with the MMN and that the rest of the PFNs are <5 mm from the MMN, we suggest adopting the term “perimarginal nodes” to indicate those lymph nodes that are at risk of not being harvested during level IB dissection. These perimarginal nodes may include the anterior PFNs and posterior PFNs as well as the retroglandular and preglandular nodes.

The main limit of the study is the low number of patients. This work does not provide information on the incidence of PFN metastasis and therefore on the indication to remove them. However, some of the aforementioned articles suggest removing PFNs, especially in oral carcinomas and even in N0 cases if the cancer involves the tongue or buccal mucosa. In the near future, more substantial studies will be needed to give definitive indications to PFN removal in relation to the primary cancer and the state of the neck. Nevertheless, this would not be possible without precise anatomic knowledge of the PFNs and an accurate description of a surgical technique that provides complete removal of these lymph nodes without damaging the MMN.

In a further study, we will analyze the incidence of pN+ in the perimarginal nodes according to the site and stage of the head and neck cancer. One interesting aspect deserving future investigation is the extent to which resection of the submandibular gland can influence the complete removal of the PFNs. To our knowledge, no study in the literature has analyzed this aspect in relation to the PFNs.

Conclusions

The aim of this study was to elucidate the role of the nodes of the submandibular area in surgical anatomy of the neck and to describe their morphologic characteristics and relationships. The PFNs are a subgroup of the submandibular nodes (level IB) that have been frequently and erroneously described as facial nodes or as a separate node group. In our series, the PFNs were identified in 84% of cases, in which they ranged in number from 0 to 5, with a predominance of cases with 2 nodes. The PFNs can be anterior and/or posterior to the AFV. In some cases, nodes adjacent to the AFV could also be situated posterior or anterior to the submandibular gland; therefore, the distinction between retro- and preglandular nodes and PFNs is not useful. The surgical procedure for removing these nodes during level IB dissection should ensure identification of the MMN before dissection of the area around the cranial portion of the AFV is started, as these nodes are in close contact with the nerve. In addition, this study shows that the Hayes Martin maneuver is not a safe procedure for removing level IB nodes. Finally, we suggest the term “perimarginal nodes” to indicate the anterior and posterior PFNs and the pre- and retroglandular nodes in contact with AFV. These nodes are at risk of not being harvested during dissection of level IB nodes.

Author Contributions

Giancarlo Tirelli, conception of the article, interpretation of data, revision of the paper for important intellectual content; final approval of the version to be published, responsibility for content of manuscript; Alberto Vito Marcuzzo, conception of the article, data analysis, drafting the article, acquisition of data, drawings and images creation, final approval of the version to be published, responsibility for content of manuscript.

Disclosures

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