Neck dissection: past and present

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The presence of lymph node metastasis to the neck is accepted as one of the single most important adverse prognostic indicators of survival in squamous cell carcinoma of the head and neck. Neck dissection in its various forms is the standard surgical treatment for clinical and subclinical metastatic cancer to the neck. This paper is a review of the anatomy of the neck, history and specific types of neck dissection, indications, therapeutic options, and current challenges in the treatment of metastatic neck disease.

Key words: Head and neck neoplasms, surgery - Neck dissection - Lymph node excision.

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Historical perspectives

Surgical lymphadenectomy of the neck was first discussed in the late 19th century amongst surgeons such as Kocher, Billroth, von Langenbeck and von Volkman, who explored removal of portions of lymph-node bearing tissue.[1] Kocher is credited with the first published technique, written in 1880, in which he discussed removing lymph-node bearing tissue of the submandibular triangle to access a tongue cancer. Several decades later, George Crile published "Excision of Cancer in the Head and Neck" in JAMA, and is thus acknowledged as the pioneer of the modern neck dissection. In this paper, Crile

reported the results of 132 operations, and described his operative technique as a radical block dissection. He described the resection of all cervical lymph node groups in the setting of an oral composite resection and palpable cervical lymphadenopathy. Crile compared his surgery to "Halstead's operation for cancer of the breast" and practiced this belief for patients with palpable nodes. At this time, however, the perioperative mortality approached 10% due to infection, pneumonia, hemorrhage and shock; therefore, it was not widely accepted.[2]

When ionizing radiation was discovered, physicians were quick to change their emphasis of treatment. However, the limitations of radiation were soon discovered around the same time as the advent of blood transfusions, antibiotics, and endotracheal anesthesia, making surgery a safer option. In 1951, Hayes Martin reviewed 1450 neck dissections in his paper "Neck Dissection" which lead the wide acceptance of radical neck dissection (RND).[2] Martin believed that

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the internal jugular vein, spinal accessory nerve, and sternocleidomastoid muscle must be removed for oncologic cure and this became the standard for neck dissections.[3] At this time, however, controversy developed concerning when to perform a "prophylactic" neck dissection in a clinically negative neck. Martin believed the idea to be "illogical and unacceptable," which he presented in his paper "The Case for Prophylactic Neck Dissection".[4]

Controversy also developed when the functional neck dissection was introduced. Osvaldo Suarez, an Argentinian otolaryngologist published the first description of this technique in the Revista de Otorrinolaringologia in 1963. Suarez astutely noted that the RND was often not enough for cure as some patients would recur immediately after surgery, while other patients had experienced "unnecessary mutilation" as the postoperative complications routinely included severe facial and cerebral edema, shoulder dysfunction, skin necrosis, and carotid rupture. He described a technique in which all of the lymphatic bearing tissue could be eliminated without removing the SCM, omohyoid, submandibular gland, IJ, and the accessory nerve, and called this the functional neck dissection. E. Bocca observed Suarez in the operating room, adapted his ideas, and further popularized the technique in the English language.[5] Of note, in the American literature, the functional neck dissection was called the modified RND. These ideas and techniques were accepted as studies began to show no detriment to oncologic outcome. The selective neck dissection, a modification of the MRND which preserves nodal levels next evolved as studies of lymphatic drainage and patterns of metastatic disease were reviewed.[6] The trend towards more limited dissections was made in the 1980s. The head and neck database of 2 635 neck dissections from 1984-1994 at Memorial Sloan-Kettering Cancer Center showed the transition: from 1984-1988, 44% of ND were radical; from 1989-1993, only 27% were radical.[7] Today, research continues to be performed in efforts to give patients the best oncologic and functional outcome.[6]

Anatomy

Discussions about neck dissection must involve a thorough understanding of the anatomic relationships of the important structures encountered during the surgical procedure (Figure 1).

The vascular supply to the skin of the neck must be well understood prior to performing a neck dissection. Poorly placed skin incisions can result in wound breakdown, flap necrosis, and ultimately exposure of underlying vital structures. The blood supply to the skin of the neck is predominately derived from branches of the transverse cervical, suprascapular, facial, and occipital arteries. The platysma is pierced by these vessels and subsequently forms a superficial plexus that runs predominately in a vertical manner. As a result of this anatomy, the incisions that are most likely to protect against breakdown are the apron type incisions (Latyschevsky and Freund).

The first important structure to identify is the platysma muscle. This muscle is located anterolaterally in the neck and is just deep to the subcutaneous tissue. Locating this muscle allows one to create an easily identifiable plane under which skin flaps can be raised. The next vital structure that should be identified is the marginal mandibular nerve. The identification of this nerve is especially important when performing dissection of the submandibular triangle. The nerve can be located approximately 1 cm anterior to and below the angle of the mandible just after incising the superficial layer of the deep cervical fascia. This incision should be made in a manner parallel to the nerve. The nerve can then be found deep to this fascia but superficial to the anterior facial vein.

The spinal accessory nerve is another vital landmark during neck dissection. This nerve can be found just below the jugular foramen, medial to the digastric and stylohyoid muscles, and posterior to the internal jugular vein. The nerve runs in an oblique manner toward the medial aspect of the sternocleidomastoid muscle at approximately the junction of the superior and middle thirds. The nerve can then be traced through the muscle where it
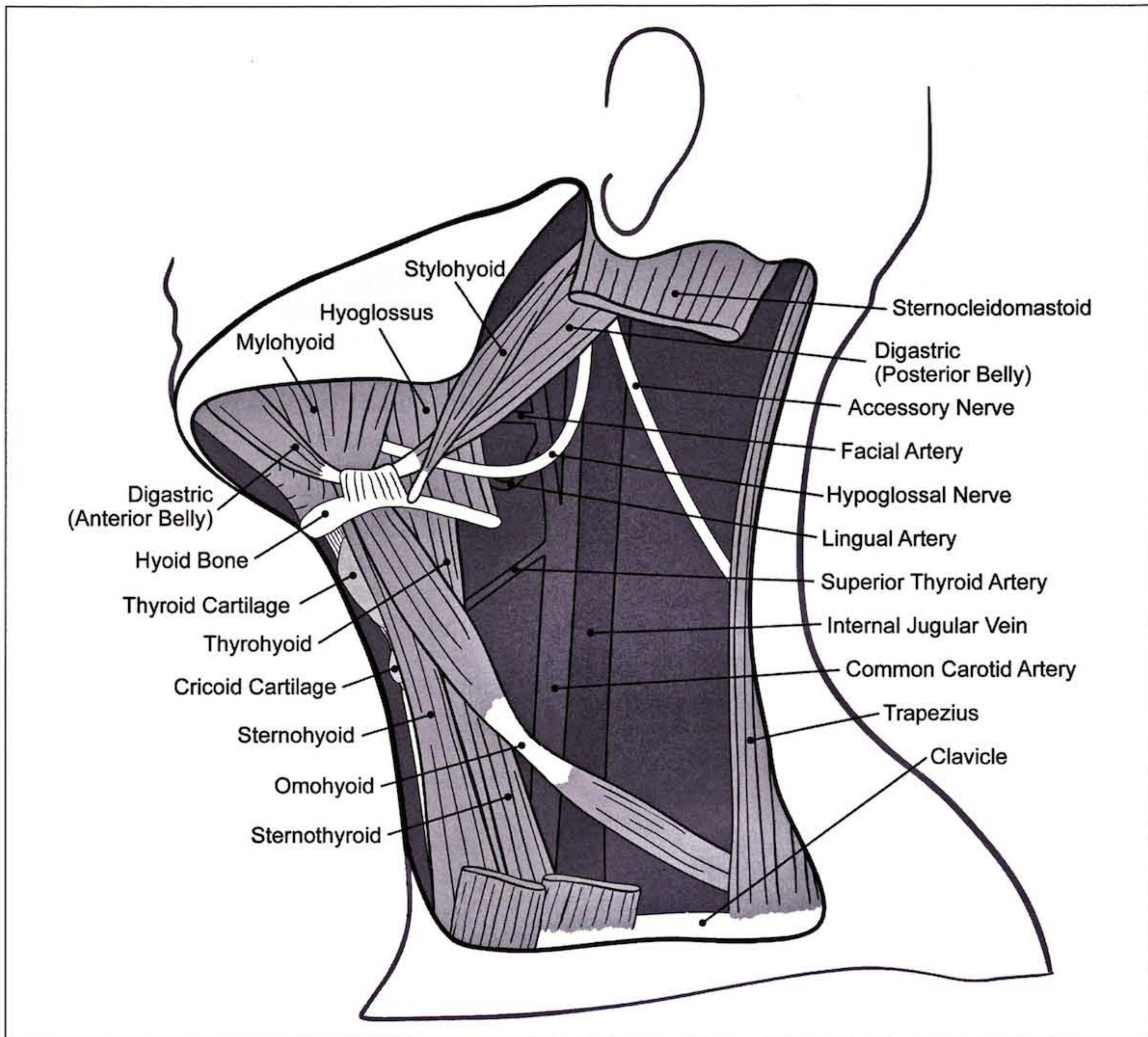
Figure 1.—Illustration of the basic anatomy of the neck, including important structures that serve as boundaries of different lymph node levels.

exits posteriorly just superior to Erbs point. From this location the nerve continues through the posterior triangle of the neck until it crosses the anterior border of the trapezius. The nerve does not enter the trapezius muscle at this point, it simply continues this course along the deep surface of the muscle.

The thoracic duct can be located in the base of the neck, deep to the left common carotid artery and vagus nerve. It continues upward and forward behind the internal jugular vein and in front of the anterior scalene muscle. The duct is anteromedial to the thy-rocervical trunk. It ultimately opens into the internal jugular, the subclavian vein, or a junction formed by these two vessels.

Lymphatics of the neck are divided into lymph node regions. Currently there are six levels used to designate specific lymph node groups (Figure 2).

Level I is made up of the submental (IA) and submandibular (IB) nodal groups. The submental group is bounded by the anterior belly of the digastric muscle, the hyoid bone, and the mandible. The submandibular group is bounded by the anterior belly of the digastric, the sylohyoid, and the madible.
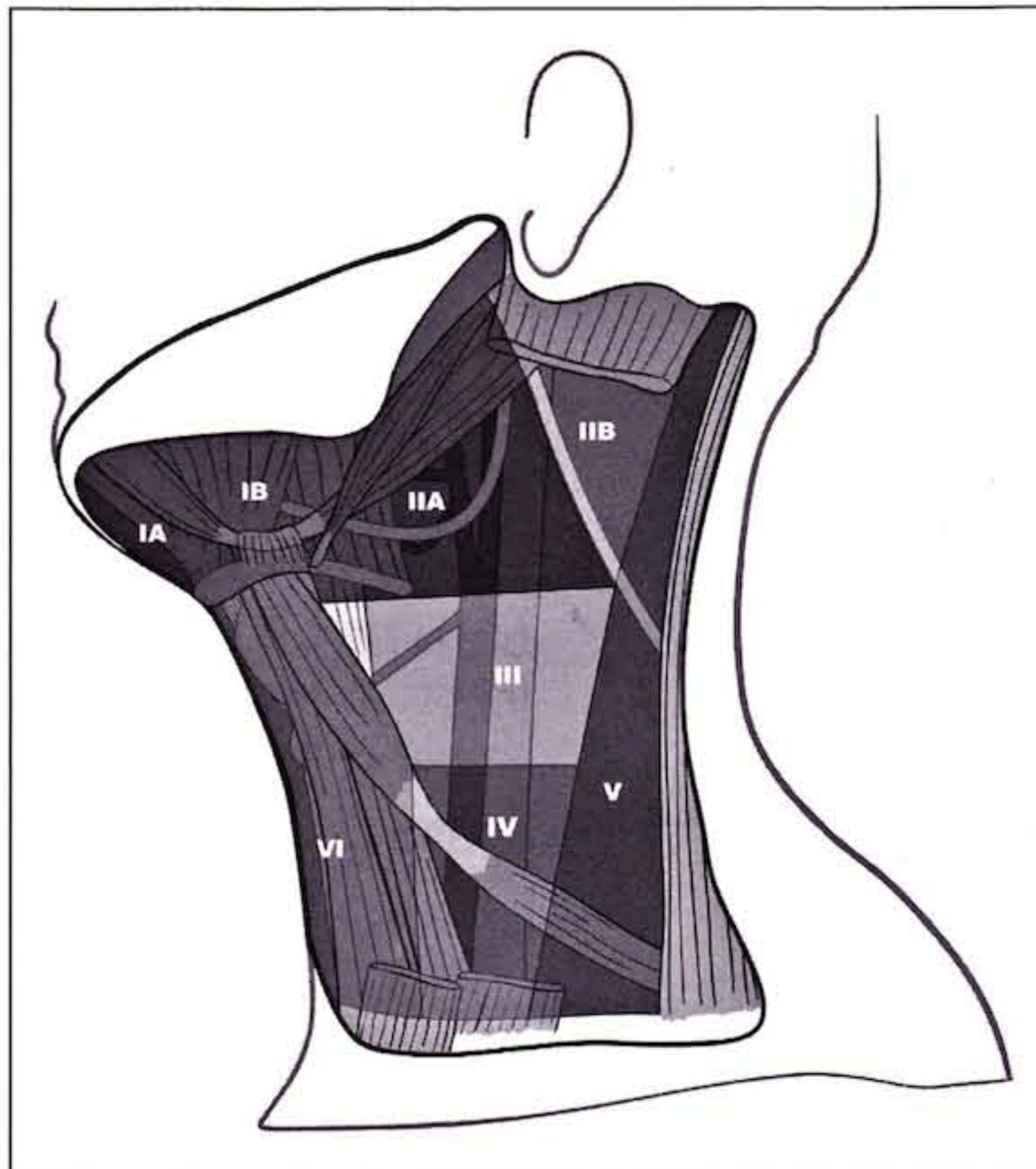
Figure 2.—Levels of lymph nodes. Level IA and IB, the submental and submandibular nodes; Level IIA and IIB (separated by the spinal accessory nerve), the upper jugular nodes; Level III, middle jugular nodes; Level IV, lower jugular nodes; Level V, posterior triangle nodes; Level VI, central compartment or anterior nodes.

Level II is found in the area of the upper third of the internal jugular vein near the spinal accessory nerve. This area extends superiorly toward the skull base and inferiorly to the level of the hyoid. It is divided into two sublevels (IIA and IIB). IIA is located anterior to the plane created by the spinal accessory nerve while IIB can be found posterior to the same plane.

Level III is known as the midjugular group and can be found at the level of the middle third of the IJV. It extends superiorly to the level of the hyoid and inferiorly to the level of the cricoid cartilage.

Level IV includes the lymph nodes around the lower third of the IJV extending from the cricoid cartilage superiorly to the clavicle below.

Level V makes up the posterior triangle nodal group. This includes the supraclavicular nodes. The superior border is the apex of the sternocleidomastoid and the trapezius muscle. The inferior border is the clavicle, the anterior border is the SCM and the pos-

terior border is the trapezius muscle. Level V can be divided into sublevels A and B based on a horizontal plane extending from the cricoid arch laterally.

Level VI nodes make up the pretracheal, paratracheal, and precricoid lymph nodes. This group includes any perithyroidal nodes. Level VI is bounded superiorly by the hyoid bone, inferiorly by the suprasternal notch, and laterally by the carotid artery.

Patterns of lymph node spread

The basis of selective neck dissection and modifications of the RND are centered on the belief that neck metastasis occur in a predictable manner; that is, tumors originating from certain sites have a predeliction for certain lymph node groups. Studies from the 1960s revealed that dyes traveled through the lymphatics in an orderly and progressive manner; however, it was observed that lymphatics occasionally jumped/skipped levels. In addition previous surgery disrupted the predictable spread.

Squamous cell carcinoma is the most common type of cancer of the head and neck; however, its propensity to metastasize is elusive and there is no clinical measure or pathologic feature that predicts with certainty which cancer will metastasize and which will not. This being said, cancers from certain sites do follow general patterns.[8] One of the first studies to delineate patterns of spread came from Robert Lindberg in 1972. He reviewed 2 044 charts of patients with squamous cell carcinoma and defined the incidence and distribution of clinically positive lymphadenopathy of seven primary tumor sites. He noted that the incidence of nodal metastasis increased in proportion to the size of the primary for the oral tongue, floor of mouth, and retromolar trigone cancer; however, metastatic nodal disease of the tonsil, base of tongue, supraglottic larynx, and hypopharynx did not correlate. In addition, he further characterized which nodal groups were most commonly involved with certain primary tumors.[9] Later studies reviewed prevalence of neck node metastasis with pathologic data from RNDs,

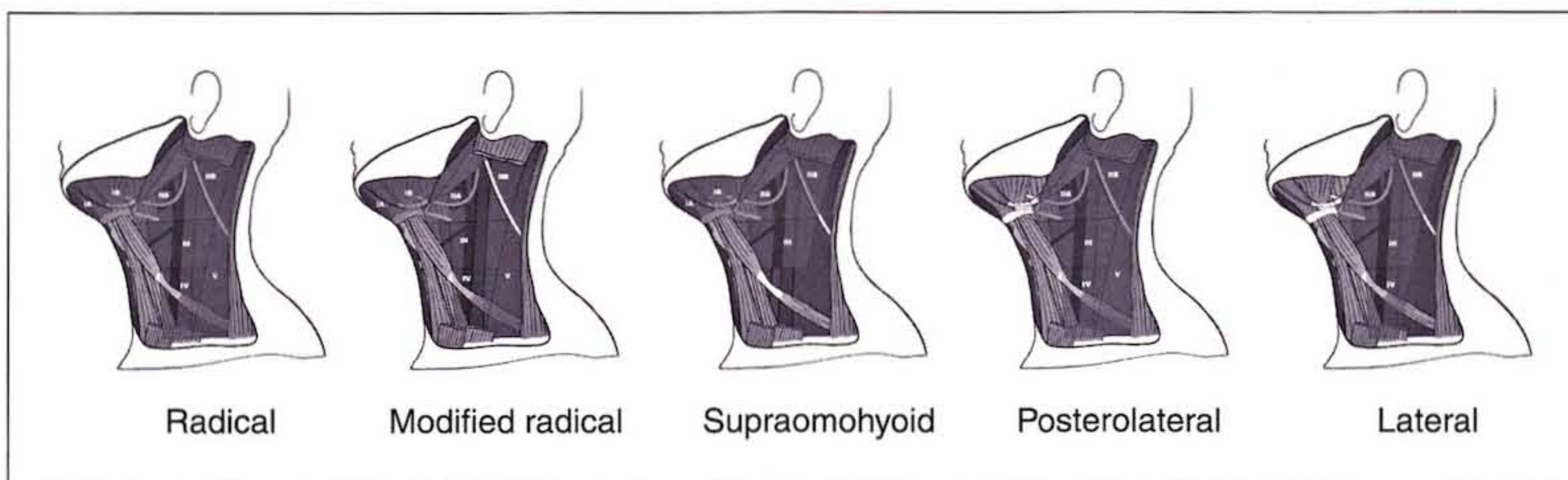| Radical | Modified radical | Supraomohyoid | Posterolateral | Lateral |

Figure 3.—Illustation depicting different types of neck dissection: 1) radical neck dissection, 2) modified radical neck dissection, 3) selective neck dissection, including (3A) supraomohyoid, (3B) posterolateral, (3C) lateral.

again correlating common levels of lymph node with primary site and stage.[10, 11] Data from these studies reveal the following patterns of spread.

Cancers from the oral cavity tend to spread to the submandibular and upper jugular nodes first. Oropharyngeal tumors have a propensity for levels II-IV, and are only rarely found in levels I, V. Hypopharyngeal cancers most often spread to levels II, III. Pharyngeal tumors may also spread to retropharyngeal lymph nodes (Rouviere). Supraglottic carcinoma metastasis are found in levels II-IV, occasionally in level I, and rarely in level V. Glottic cancers have similar patterns of spread, with V being more often involved when other levels have nodal disease. Subglottic extension and hypopharyngeal tumors may involve spread to lymph nodes in the tracheoesophageal groove and upper mediastinum.[8]

Another way of understanding patterns of spread is by knowing which primary sites go to a group of lymph nodes. Submental (level IA) lymph nodes harbor metastatic disease most commonly from the floor of mouth, anterior tongue, anterior mandibular alveolar ridge, and lower lip. Submandibular (level IB) lymph nodes are often metastatic from the oral cavity, anterior nasal cavity, soft tissues of the midface, and submandibular gland. Upper jugular (level IIA, IIB) lymph nodes involve cancer from the oral cavity, nasal cavity, nasopharynx, oropharynx, hypopharynx, larynx, and parotid gland. Middle jugular (level III) lymph node disease comes from cancer

from the oral cavity, nasopharynx, oropharynx, hypopharynx, and larynx. Lower jugular (level IV) lymph nodes receive metastasis from the hypopharyx, the thyroid, cervical esophagus, and the larynx. Posterior triangle group (level VA, VB) may harbor cancer from the nasopharynx, oropharynx, and cutaneous cancers from the posterior scalp and neck. Supraclavicular nodes are included in level V, with the exception of Virchow's node which is included in level IV.[12] Virchow's node (supraclavicular) often receives metastasis from infraclavicular cancers.[13] Anterior compartment (level VI) lymph nodes may receive spread from the thyroid gland, glottic and subglottic larynx, apex of the pyriform sinuses, and the cervical esophagus.[12]

Types of neck dissection

Multiple techniques and modifications of the neck dissection have emerged over the past century. As such, the nomenclature of different types of neck dissection has evolved and changed. To avoid confusion, Robbins *et al.* published "Standardizing Neck Dissection," an official report of the Academy's Committee for Head and Neck Surgery and Oncology; this article established the system of classification used today (Figure 3).[14]

Radical neck dissection

First described by George Crile in the early 20th century, the RND procedure is the

standard from which all other neck dissections are compared. The procedure involves removing all of the lymph node bearing tissue from the clavicle inferiorly to the mandible superiorly, the anterior border of the trapezius to the lateral border of the sternohyoid muscle (levels I-V). This also involves removal of the submandibular gland, tail of the parotid gland, sternocleidomastoid muscle, omohyoid muscle, internal jugular vein, cervical plexus, and the spinal accessory nerve.[13] It does not include the removal of the postauricular, suboccipital, periparotid, perifacial, buccinator, retropharyngeal, or paratracheal nodes.[12] The rationale for performing this procedure is that when metastasis is present in one node, it is likely that there is undetectable spread in surrounding nodes and performing a lesser surgery may leave these micrometastasis behind. Indications typically include nodal disease present when surgery is the only treatment planned, and positive nodes after previous radiation or previous neck dissection .[13] The RND is also indicated when extensive extra-capsular spread or with involvement of the spinal accessory nerve or internal jugular vein.[12] Contraindications include uncontrollable cancer at the primary site, distant metastatic disease, fixed nodes unchanged by radiotherapy or chemotherapy, or life expectancy less than three months. Advantages include the short operative time (less time consuming than modified RND), and low chance of leaving lymph node bearing tissue behind. Disadvantages include shoulder drop, neck deformity, facial swelling, numbness, neuromas, and severe postirradiation complications such as carotid rupture.[13]

The technique of the RND will be briefly discussed. Correct positioning (shoulder roll, neck extension), and draping (to expose landmarks) is important. Common incisions used are the hockey stick, boomerang, or apron (for bilateral neck dissection). Subplatysmal flaps are raised superiorly and inferiorly, and the submandibular fascia is incised and raised to protect the marginal mandibular branch of the facial nerve. Next, the dissection is begun; however, the order of dissection varies based on surgeons prefer-

ence. To begin with the posterior triangle, the anterior border of the trapezius is exposed; the fibrofatty tissue is elevated from superior to inferior, and the accessory nerve is cut where it enters the trapezius. The inferior belly of the omohyoid is also incised to complete the dissection. Care is taken to preserve the transverse cervical artery and to stay superficial to the prevertebral fascia to avoid injury of the phrenic nerve and brachial plexus. The fibrofatty tissue is released off of the posterior triangle floor and mobilized anteriorly. Next, dissection of the anterior triangle begins. The SCM is incised at its superior and inferior attachments, and the carotid sheath is exposed. The internal jugular vein is ligated superiorly and inferiorly, and the soft tissues are further mobilized. Care is taken to avoid the thoracic duct on the left. The lymph node bearing tissues are further elevated. Dissection of the submandibular triangle involves ligating the facial artery and vein and the submandibular duct, and avoiding injury to the lingual and hypoglossal nerves. The remaining lymph node bearing tissue is dissected off and the specimen is removed.[12]

Modified radical neck dissection

This type of neck dissection involves preserving certain non-lymphatic structures in the neck, while removing all nodal groups (I-V). Type I modified RND (MRND) preserves only the spinal accessory nerve, type II preserves the accessory nerve and the internal jugular vein, and type III preserves these structures as well as the sternocleidomastoid muscle (Figure 4). MRND III is also called the functional neck dissection. MRND should be performed when there evidence of nodal disease or there is a risk of probable nodal metastasis and surgery is being performed for the primary cancer. Some references state that contraindications include clinically positive nodes when surgery is the only treatment modality, or there are clinically positive nodes after radiotherapy, or previous neck dissection. Advantages include improved shoulder function, lower morbidity and mortality for bilateral neck dissec-
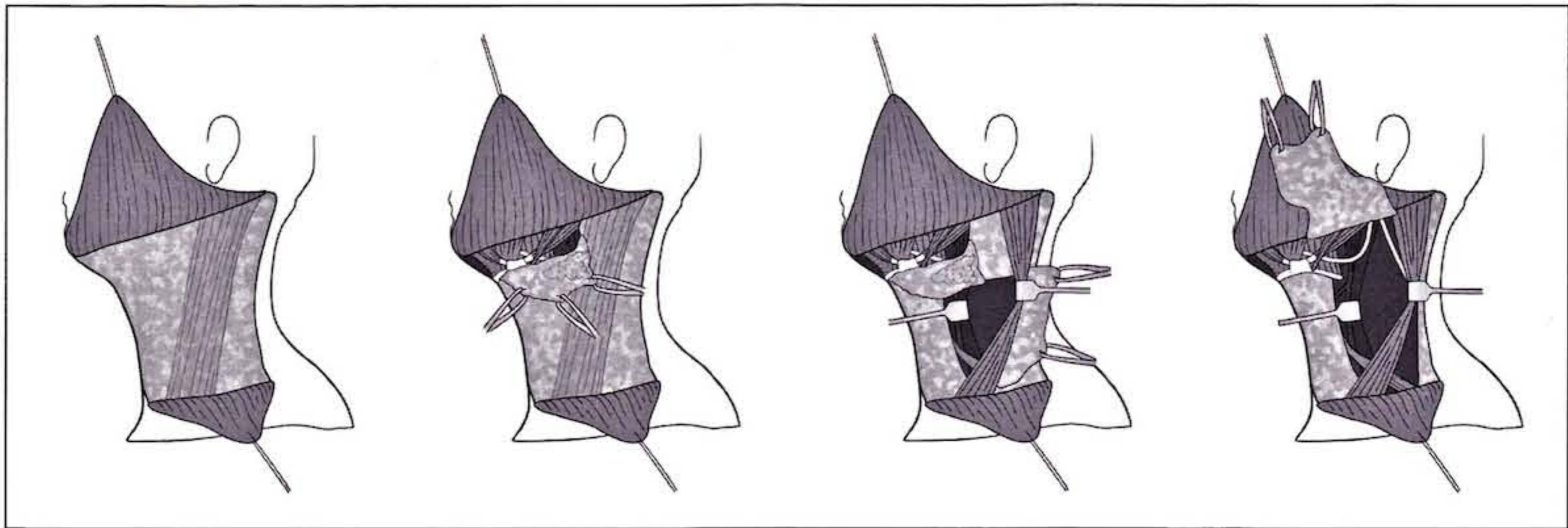
Figure 4.—Artistic depiction of a modified radical neck dissection. Step 1: elevation of subplaysmal flaps superiorly and inferiorly, with fibrofatty, lymph-node bearing tissue seen below; step 2: dissection of level IA, and IB, being pulled inferiorly, with the submandibular gland included in the specimen; step 3: fibrofatty tissue being removed off of the internal jugular vein and floor of the neck, starting inferiorly with level IV, and level III. The cervical rootlets mark the depth of dissection (not seen here). Level IIA and IIB have not yet been dissected out; step 4: lymph node bearing tissue removed from the neck as one specimen.

tions, protection for the carotid artery, staging for prognosis and or use of adjuvant therapy, less cosmetic deformity, and less facial edema. Disadvantages include possibly leaving nodal disease behind, or cutting into positive nodes and seeding cancer.[13]

The surgical technique of the MRND is similar to the RND; however, it first involves isolating and preserving the spinal accessory nerve. This is done at Erb's point, where the nerve exits the posterior SCM and the greater auricular nerve arises from under it. This is dissected out of the fibrofatty tissue until it enters the trapezius, 2 cm above the clavicle. Next, the superior portion of the nerve is found. The fibrofatty tissue is dissected off the anterior aspect of the SCM, and the nerve is found deep to the digastric, entering the medial surface of the SCM near the junction of the superior and middle third of the muscle. Once the nerve is isolated, the SCM is completely mobilized and the fibrofatty tissue from level V is dissected, brought under the SCM, and continued to be separated off of the carotid and IJ. The procedure then continues to proceed in similar fashion the RND.[12]

Selective neck dissection

Selective neck dissection (SND) is defined as a modification of the RND, in which one or more lymph node groups are preserved.[12]

The SND can be broken down into subtypes: the supraomohyoid neck dissection, the posterolateral neck dissection, the lateral neck dissection, and the anterior compartment neck dissection.[13] The goal of the SND is to perform an oncologically sound procedure while minimizing the morbidity of it. In an effort to define indications of SND, Robert Byers reviewed records of 967 patients from 1970 to 1980 at M.D. Anderson Hospital in Houston, Texas, treated with a SND (which he calls a modified neck dissection). He elegantly reviewed recurrence rates of various subsites with different types of SND with or without pre- or postoperative radiation therapy, and he provided data supporting the efficacy of the SND, and provided indications for its use.[15]

The supraomohyoid ND removes nodes in levels I, II, III, and it is commonly used for cancer of the oral cavity and oropharynx.[13] Shah and Candela performed a retrospective review of 501 oral cavity cancer patients who underwent RND at Memoral Sloan-Kettering from 1965-1986. They found that neck metastasis were found in 34% of patients of elective neck dissections (clinically N0), and only 3% of these patients had involvement of level IV. Patients with clinically positive necks had neck metastasis in 69% of patients who had immediate therapeutic dissections, and 90% of patients with subsequent therapeutic dis-

sections (who became clinically positive after a period of observation). Of these patients, 17% had involvement of level IV. This study illustrates that elective neck dissection is indicated in the N0 neck of oral cavity carcinomas and that level I-III is adequate for the clinically negative neck, while level IV should be included in the clinically positive neck.[16] The Brazilian Head and Neck Cancer Study Group performed a prospective randomized trial comparing recurrence and survival rates of patients with oral cavity cancer who underwent MRND vs SOH ND. Both recurrence and survival rates were similar, further proving oncologic efficacy.[17]

The posterolateral neck dissection removes nodes in levels II, III, IV, and V and retroauricular/suboccipital nodes. This type of neck dissection is commonly used for scalp or postauricular skin cancer. When used, regional disease can be controlled in up to 93% of patients as noted in a case series of 58 posterolateral neck dissections.[18]

The lateral ND removes levels II, III, IV, is used for cancer of the larynx, hypopharynx, and oropharynx, and is usually done bilaterally.[13] Candela and Shah evaluated prevalence of neck node metastasis from 262 RND specimens in patients with supraglottic or glottic cancer from 1965-1986. They found that level V was only involved in patients with N2 disease (metastasis in II, III, or IV), and level I was involved with T3 or T4 lesions with extralaryngeal spread with neck nodes present in II, III, and IV. This data supports the SND for laryngeal cancer in the N0 or N1 neck.[10] Level IIB is sometimes excluded for laryngeal and hypopharyngeal cancers; this would be a SND, involving level IIA, III, IV.[12] Rinaldo *et al.* reviewed prospective studies that evaluated neck dissection specimens of laryngeal cancer patients with N0 neck in 2006. They concluded that dissecting level IIB is not indicated due to the low level of occult metastasis in this level (3/211) and the un-necessary risk of shoulder dysfunction in this population of patients.[19]

The anterior compartment ND removes only group VI and is used for thyroid cancer when there is no clinical evidence of lateral disease.[13] It also is included for patients with advanced glottic, subglottic, piriform sinus, and cervical esophageal/tracheal cancers. The lymph nodes removed include the paratracheal, precricoid (Delphian), and perithyroidal nodes. The dissection is from the suprasternal notch to the hyoid bone, extending laterally to the carotid sheaths.[12]

Extended radical neck dissection

The extended neck dissection (END) involves removing additional lymph nodes groups or other non-lymphatic structures that are not routinely dissected during a RND.[12] These structures include (but are not limited to) the retropharyngeal or parapharyngeal nodes, the skull base, the mediastinum, the carotid artery, the hypoglossal nerve, vagus nerve, sympathetic chain, and the paraspinal muscles.[13] Lymph node groups outside the boundaries of the neck are denoted by the anatomic name used for the group, with the exception of level VII, also known as the superior mediastinal lymph nodes.[20] END is indicated for patients with advanced neck disease (N2 or N3) and involvement of these lymphatic or non-lymphatic structures, with the goal of improved local control, and ultimately survival. One study evaluating success of the various types of extended neck dissection achieved local control in 70% of patients, suggesting the efficacy of the procedure.[21] It is important to note, however, that the extended neck dissection has great variability of local control, ultimate survival benefits, morbidity, and mortality, depending on the stage of disease and which structures are involved.

Retropharyngeal nodes are difficult to access due to their close proximity to multiple important structures. Dissection puts the carotid artery, sympathetic chain, vagus nerve, hypoglossal nerve, lingual artery, and jugular vein at risk. Due to the technical difficulty, some studies have looked at the significance of retropharyngeal node dissection and its role in neck dissection. One in particular found that this procedure did not improve five-year survival; however, it decreased the number of patients who died from retropharyngeal lymph node metastasis for patients

with hypopharyngeal or cervical esophageal cancer.[22] Some surgeons advocate this dissection in all resectable tumors of the oropharynx and hypopharynx as these are early levels of metastasis.[13]

Skull base surgery is also technically demanding, and cervical metastasis here are often considered un-resectable and incurable. Difficult exposure puts the great vessels at risk and increases the likelihood of positive margins – this results in an 80% recurrence rate. In addition, intracranial extension is a contraindication. Despite the high potential for morbidity from cranial nerve resections and/or carotid ligation, surgeons may provide palliation as well as potential cures with dissection of the mastoid tip or middle fossa floor. Few case series and oncologic outcomes data on this type of resection exist.[23]

Mediastinal extension of cervical metastasis is a poor prognostic indicator. No palliative or curative benefit comes from resecting adenopathy that extends into the mediastinum lateral to the carotid sheaths. However, both palliative and survival benefits may come from resecting midline lymphadenopathy while protecting the vessels with a muscular flap. Most often, resection in the midline is for stomal recurrence from laryngeal cancer, metastasis from thyroid cancer, cervical tracheal cancer, or cervical esophageal cancer.[23]

Involvement of the internal/common carotid artery

The presence of carotid artery invasion in patients with head and neck cancer poses a complicated and controversial problem for the head and neck surgeon. Initial estimates reported very poor outcomes with approximately 50% morbidity and mortality. More recent studies have suggested better outcomes, however much debate still exists regarding the long-term benefits to the patient.

In a study by Freeman et al., 58 patients who were noted to have recurrent or residual cancer involving the internal carotid were examined retrospectively. Patients were examined angiographically, followed by balloon occlusion and single photon emission computer tomography (SPECT) prior to surgery. Of the 58 patients, 41 underwent carotid sacrifice and immediate reconstruction. The remainder had permanent occlusion. Cerebrovascular accidents occurred in 11 patients and the median disease specific survival was 12 months with 24% dying from distant metastasis.[24] Several other papers suggest a disease specific survival of 12 months with rates between 20-44%.[24, 25] As such there is much debate regarding the efficacy of resecting the carotid artery in patients with extensive neck disease.

If resection is to be attempted several considerations should be taken. Preoperative evaluation should determine the extent of carotid artery involvement and the feasibility of resection by determining cerebral collateral blood flow. Several studies are available to aid in this evaluation. Transcranial Doppler, SPECT, xenon inhalation, and electro-encephalogram can all be used with balloon occlusion to determine the liklihood that the patient can tolerate carotid sacrifice. If the test reveals intolerance of occlusion, the carotid should be reconstructed at the time of resection. The saphenous vein and prosthetic grafts may be used for reconstruction. Postoperatively, delayed strokes may still occur (up to 25%) in patients who have undergone carotid sacrifice, despite passing trial balloon occlusion.[26] This is thought to arise from clot propagation or thromboembolic phenomenon. As a result, many recommend postoperative heparin therapy.

Complications of neck dissection

During the postoperative course following neck dissection, multiple complications can become evident. The early identification and prevention of these complications is essential to any surgeon performing neck dissections.

Air leak

The presence of air circulating through a drain shortly after surgery is not an uncom-

mon event. Typically, this phenomenon is the result of a simply skin defect. For example, the air leak may be present due to incomplete closure of the surgical incision. Another possibility is the presence of an improperly secured drain, which becomes displaced, exposing one or more drain vents. Air leaks can, however, be associated with more serious consequences. For example, those air leaks that may result from communication with a tracheotomy site or a mucosal suture line can create further complications. In addition to the air, contaminated secretions may leak into the wound bed resulting in fistulous tracts and wound infections. Early identification of the site of leakage may be difficult and correcting the leak may require revision of the wound closure in the operating room.

Bleeding

Bleeding from the operative site typically occurs in the immediate postoperative phase. When assessing the presence of bleeding, it is important to note the presence of distortion of the skin flaps. If there is simple external bleeding, without the presence of distortion of the skin flaps, the bleeding is likely originating from a subcutaneous vessel. Hemostasis can typically be achieved by pressure to the area or infiltration of the surrounding tissue with a local anesthetic with epinephrine.

If there is notable swelling or ballooning of the skin flaps with or without external bleeding, the patient has likely developed a hematoma. Management may include simply milking the drains from the site or placing the drains to low wall suction. Other options include simple needle aspiration or release of several sutures to allow external drainage. This can typically be followed with a pressure dressing to prevent reaccumulation. If these measures fail, or if the blood reaccumulates quickly, the best option is to return to the operating room for evacuation and control of hemorrhage. Failure to recognize postoperative hematomas may result in increase wound infections and more seriously airway obstruction.

Chylous fistula

The reported incidence of chylous fistula following neck dissection is between 1% and 2.5%.[27] Most patients that develop a chylous fistula postoperatively were noted to have a chylous leak during the procedure. Therefore thorough investigation of the area believed to be involved and meticulous ligation should be performed. Management of a leak identified postoperatively depends are several factors: 1) time of onset; 2) amount of chyle drainage in a 24 hour period; 3) presence of chyle accumulation under the skin flaps. If the daily chyle output is greater than 600 mL conservative management is unlikely to be successful. As a result surgical exploration is the treatment of choice. If a chyle leak becomes apparent in the later postoperative period after enteral feeds are resumed, or when the drainage is less than 600 mL in 24 hours, conservative treatment may be initiated. This usually involves management with drains, pressure dressings, repeated aspirations, and diet modifications. The diet should consist of medium chain triglycerides with are absorbed directly into the portal circulation, bypassing the lymphatic system. Any failure of these conservative measures should prompt surgical management.

Facial/cerebral edema

Bilateral RND performed in which both internal jugular veins are ligated, may result in facial and/or cerebral edema. The etiology is due to inadequate venous drainage. This typically resolves with time as collateral circulation is established. Facial edema appears more commonly in those patients with a history of previous radiation therapy. The facial edema may be prevented by preserving at least one external jugular vein when bilateral neck dissection is performed. Cerebral edema may lead to increased intracranial pressure, which may also be associated with syndrome of inappropriate antidiuretic hormone. If ligation of both internal jugular veins is anticipated, intraoperative and perioperative fluid administration should be closely monitored.

Carotid artery rupture

The most commonly lethal complication after neck dissection is the exposure and rupture of the carotid artery. Rarely does the carotid artery become exposed if the skin incisions/flaps have been adequately designed. However, in the presence of fistula formation and flap breakdown, the carotid artery is at much greater risk of exposure. These situations are much more common in the presence of malnutrition, diabetes, infection, or any process that disrupts vascular supply to the healing wound bed. All efforts should be made to prevent the mentioned predisposing factors. If an oral or pharyngeal defect is present, meticulous closure and the use of free or pedicled flaps should be used to prevent fistula formation.

Once an exposed carotid artery is identified, the likelihood of rupture is dependent on the condition of the surrounding tissue, the length of the exposed segment, and the size of the fistula. Large, high output fistulas are not likely to heal with conservative measures and in these patients incidence of carotid rupture is high. In these situations, well vascularized tissue should be used to cover the defect.

If carotid rupture does occur, it is usually controlled with manual pressure while blood and fluid are administered to the patient. The patient can then be expedited to the operating room for further control and repair.[28]

Management of the clinically N0 neck

The presence of cervical lymph node metastasis is a very important aspect in predicting patient outcome and directing further treatment modalities. The clinically negative neck (N0) is defined as the absence of palpable and/or radiographically enlarged lymph nodes.[27] Despite the presence of a clinically N0 neck, a patient may have subclinical or occult metastases in the cervical lymph nodes. This discrepancy presents a very important and debatable management decision to the head and neck surgeon. Should a patient with a cN0 neck simply be observed? Should

the patient receive an elective neck dissection or should they be treated with elective neck radiation? Proponents of elective neck dissection suggest that the pathological presence of metastatic disease allows one to better determine the need adjuvant therapy. Opponents of elective neck dissection cite the costs associated with performing a neck dissection on all N0 patients. The answer is continuously debated, but surgeons believe management decisions should rely on the incidence of occult metastatic disease for a given tumor and its subsite.

Finally, the decisions to electively treat a clinically negative neck should be based on the risk- benefits of the morbidity associated with treatment and the incidence of occult metastases for a given primary. Most surgeons use an occult metastatic potential of 20% or greater to determine need for elective treatment of the N0 neck. Based on the paper by Mendenhall *et al.*, the occult metastatic rate for given subsites is as follows:
— 15-20% T1 – glottis, retromolar trigone (RMT), gingiva, hard palate, buccal mucosa;[29]
— >20% T1 – oral tongue, soft palate, pharyngeal wall, supraglottis, tonsil;
— T2 - floor of the mouth, oral tongue, RMT, gingiva, hard palate, buccal mucosa;
— T1-T4 – nasopharynx, piriform sinus, base of the tongue;
— T2-T4 - soft palate, pharyngeal wall, supraglottis, tonsil;
— T3-T4 - floor of the mouth, oral tongue, RMT, gingiva, hard palate, buccal mucosa.[29]

If elective treatment of the neck is the chosen in the patient with a clinically N0 neck, many surgeons advocate the use of selective neck dissection. The specific nodal groups to be dissected have not been determined, but many remove levels I-III or I-IV for oral cavity primaries and II-IV for laryngeal, hypopharyngeal, and oropharyngeal. It is important to note that elective neck dissection does have a regional recurrence rate of 3-6%. Multiple studies have shown improved rates of regional recurrence when comparing elective neck dissection vs. observation. Several of these studies also showed a statistically significant difference (improvement) in terms of disease related survival. Ultimately,

management of the clinically N0 neck is a decision that must be decided between the patient and the surgeon based on the rates of occult metastasis *vs.* the morbidity associated with treatment.[30]

Role of radiation therapy

Multiple studies have shown that patients with clinically positive nodes have improved locoregional control when surgery and radiation therapy are combined.[31] There has been some debate regarding the value of postoperative radiation in patients with N1 disease, however several papers suggest benefits in local control for all stages. In a study by Jackel *et al.*, 118 patients with head and neck cancer and pathologic N1 disease were reviewed. The authors examined recurrences for those patients treated with surgery alone and those treated with surgery and postoperative radiation. The three-year recurrence rates were 11.2% and 2.9%, respectively.[31] In another study by Kao *et al.*, 5 297 patients with head and neck cancer and positive nodal disease (N1-N3) were treated with definitive surgery with or without radiation. This study showed improved five-year survival for all nodal groups when surgery and radiation therapy was compared to surgery alone.[32]

For patients with resectable N2 or N3 disease, neck dissection followed by postoperative irradiation is indicated. The Radiation Therapy Oncology group (RTOG) created one of the first randomized studies in 1973 comparing locoregional control and survival rates with preoperative *versus* postoperative irradiation. This study showed a statistically significant benefit for locoregional control for postoperative irradiation, as well as a trend towards improved survival (though this was not statistically significant).[33] Timing of postoperative radiotherapy is usually within six weeks, based on studies from the 1970s that showed increased locoregional failure with delay. Other studies have shown that an increased dose may compensate for the delay; however, this is not the standard of care. Dosing for postoperative treatment is 60 Gy given at 180 cGY/fraction once daily;

however, an increased dose of 65-70 Gy may be indicated for extracapsular spread. If the primary site is to be treated with irradiation, response is monitored, and incomplete response should be followed by a MRND.[34] Dosing of 45-50 Gy at 1.8-2.0 Gy/fraction is delivered for this.

Patients with inoperable cervical nodal metastasis can be treated with primary irradiation and chemotherapy (often 5-FU, ciplatin). Doses are higher (60-70 Gy) with the goal of regression and potential surgical salvage.[34]

Planned neck dissection after definitive radiotherapy or combination chemotherapy and irradiation for patients with N2/N3 disease improves regional control. Narayan and colleagues found that in-field neck control was achieved in 88% of patients with N2/N3 disease who underwent definitive radiotherapy with a planned neck dissection postoperatively. Only 8% of patients had isolated neck failures.[35] Performing a planned neck dissection on patients who obtain complete clinical and radiological response, on the other hand, is controversial. In Narayan's study, 54% of neck dissection specimens were pathologically negative; however, he did not correlate these patients with their clinical or radiologic response.[35] The Trans Tasman Radiation Oncology study group found that patients who obtained a complete clinical and radiologic response never had isolated neck failures and argue a planned neck dissection is not justified.[36] Forest *et al.* evaluated patients with complete response *vs.* partial response and subsequent recurrence rates based on initial nodal size. They found a total neck recurrence rate of 5% after complete response with no neck dissection, and a recurrence rate of 7% after partial response with a planned neck dissection. They recommended not performing a planned neck dissection for patients with complete response and initial cervical nodes <6 cm. They did not have adequate numbers to make recommendations concerning N3 disease.[37] Others advocate planned neck dissection for those with a complete clinical response as some of these patients have persistent disease, and the morbidity of a neck

dissection within 12 weeks of radiation is low. Ducic *et al.* performed a retrospective case series of patients with planned neck dissection. Seven patients of 26 had a complete clinical response-of those, two had pathologic disease in their neck specimens. This data suggests that these patients would have failed locally had a planned neck dissection not been performed.[38]

Riassunto

Dissezione cervicale: passato e presente

La presenza di metastasi linfonodali al collo è considerata uno dei più importanti fattori prognostici negativi per quanto riguarda la sopravvivenza dei pazienti affetti da carcinoma a cellule squamose del distretto capo-collo. La dissezione cervicale nelle sue diverse forme rappresenta il trattamento chirurgico standard del carcinoma metastatico al collo, clinico e subclinico. Questo articolo costituisce una revisione dell'anatomia del collo, della storia e della tecnica delle diverse tipologie di dissezione cervicale, delle indicazioni, delle opzioni terapeutiche, e degli aspetti ancora attualmente da definire nel trattamento del carcinoma metastatico a livello cervicale.

Parole chiave: Neoplaisie del collo e della testa, chirurgia - Collo, dissezione - Linfonodi, escissione.

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