Paparella: Volume III: Head and Neck

Section 2: Disorders of the Head and Neck

Part 7: The Neck

Chapter 44: Cervical Metastasis

Loren W. Savoury, Jack L. Gluckman

The development of metastatic nodal disease represents a firm statement, by the tumor, of its aggressive malignant nature.

Nothing provokes greater controversy than the management of cervical metastases. This is not surprising given our current inadequate knowledge of carcinogenesis, the pathogenesis of metastases, and the implications of tumor spread. We have, of course, come a long way in out understanding of cervical node metastases; however, personal prejudice and emotion continue to dominate our therapeutic approach to metastatic cancer.

Anatomy

The lymphatic system consists of three components: capillaries, vessels, and nodes. The *lymphatic capillaries* consist of an endothelial lining only and are wider than blood capillaries. They are prominent throughout the gastrointestinal and upper respiratory tracts. They then drain into the *lymphatic vessels*, which consist of an outer longitudinal connective tissue layer, a middle circular smooth muscle layer, and an inner longitudinal elastic layer, as well as an endothelial lining. They contain many more valves than does the venous system, with the lymph being propelled solely by compression of surrounding muscles.

The lymphatic vessels drain into *lymph nodes*. These nodes contain a subcapsular sinus below a prominent capsule, into which the lymphatic fluid drains. This is often the first site of metastatic growth. The fluid then permeates through the substance of the node, consisting of a cortex and a medulla, and exits through the hilum to enter more lymphatic vessels. The head and neck region contains approximately 30 per cent of all lymph nodes in the body. These lymph nodes are located between the superficial cervical and prevertebral fascia and, as such, are very amenable to surgical removal.

The lymphatic fluid eventually enters the venous system at the junction of the internal jugular and subclavian veins. Rouvière's classification of neck nodes is still valid today. The various lymph node groups will be discussed.

Occipital Nodes

Occipital nodes are divided into a superficial and a deep group. The *superficial* group consists of two to five nodes that are located between the sternocleidomastoid and trapezius muscles at the apex of the posterior triangle. They are located superficial to the splenius muscle of the head and just deep to the superficial investing fascia. The *deep* group of one to three occipital nodes is located deep to the splenius muscle and follows the course of the

occipital artery. The superficial nodes drain the occipital scalp and posterior portion of the neck and then drain into the deeper group as well as into the upper spinal accessory nodes. The deep group of nodes in addition drain the deep muscular layers of the neck in the occipital region.

Postauricular Nodes

The postauricular nodes vary from one to four in number and are situated over the dense fibrous portion of the anterior border of the sternocleidomastoid muscle overlying the mastoid bone. They drain the posterior parietal region of the scalp, as well as the skin of the mastoid region and posterior auricle. The efferent vessels drain into the infra-auricular parotid nodes and also into the internal jugular and spinal accessory nodes.

Parotid Nodes

The parotid nodes are divided into an extraglandular and an intraglandular group. The *extraglandular* group is further divided into *preauricular* and *infra-auricular* nodes. They drain the lateral and frontal aspects of the scalp, as well as the anterior portion of the auricle, the external auditory canal, the lateral aspect of the face, and the buccal mucosa of the oral cavity. The *intraglandular* nodes drain the same regions and are also connected with the extraglandular nodes. Embryologically, the lymphatic system develops before the parotid gland, which surrounds the nodes as it develops. The efferent vessels of both groups then drain into the internal jugular or external jugular chain of lymph nodes. There may be up to 20 parotid lymph nodes.

Submandibular Nodes

The submandibular lymph nodes are divided into five groups: (1) preglandular, (2) postglandular, (3) prevascular, (4) postvascular, and (5) intracapsular.

The preglandular and prevascular groups are located anterior to the submandibular gland and facial artery, respectively, whereas the postglandular and postvascular groups are posterior to these structures. The submandibular gland differs from the parotid gland in that there are no true intraglandular nodes; however, an occasional node located inside the capsule of the gland has been identified. The submandibular nodes drain the ipsilateral lower and upper lip, cheek, nose, mucosa of the nasal fossa, medial canthus, anterior gingiva, anterior tonsillar pillar, soft palate, anterior two thirds of the tongue, and submandibular salivary gland. The efferent lymphatic vessels empty into the internal jugular group of nodes in the subdigastric region. An accessory route, however, exists from the preglandular and prevascular nodes into the deep internal jugular nodes via a lymphatic vessel running along the posterior edge of the omohyoid muscle. This explains the multiple-level involvement often noted with lesions of anterior oral cavity.

Submental Nodes

There are usually two to eight nodes in the submental node group. They are located in the soft tissue of the submental triangle between the platysma and mylohyoid muscles. They drain the mentum, the middle 60 to 70 per cent of the lower lip, the anterior gingiva,

and the anterior one third of the tongue. The efferent vessels usually drain into the ipsilateral and contralateral preglandular and prevascular submandibular nodes or into the internal jugular group via a lymphatic vessel following the hypoglossal nerve.

Sublingual Nodes

The sublingual nodes are located along the collecting trunk of the tongue and sublingual gland and drain the anterior floor of the mouth and ventral surface of the tongue. They are occasionally lacking. They subsequently drain into the submandibular group of nodes, or they can follow the hypoglossal nerve or lingual artery and empty directly into the internal jugular group by passing behind the stylohyoid and digastric muscles or may even enter the jugular chain lower down.

It should be appreciated from the preceding discussion that the lymphatic vessels from the submental, submandibular, and sublingual regions do not have a simple drainage pattern and can empty into the internal jugular system at multiple levels.

Retropharyngeal Nodes

The retropharyngeal nodes are divided into a lateral and a medial group. The *lateral* group consists of one to three nodes, which are located at the level of the atlas, in close relationship to the internal carotid artery, and may extend to the base of the skull. The *medial* group is located near the midline and is more inferior. These nodes are more numerous and can extend inferiorly down to the postcricoid area. Both groups are located between the pharynx and the prevertebral fascia. They drain the posterior region of the nasal cavity, sphenoid sinus, ethmoid sinus, hard and soft palate, nasopharynx, and posterior pharynx wall down to the level of the postcricoid region. The efferents usually drain into the upper internal jugular group. The management of these nodes must be taken into consideration when dealing with malignancies in any of the drainage areas mentioned, particularly oropharyngeal and hypopharyngeal cancers.

Anterior Cervical Nodes

The anterior cervical nodes are divided into two groups: (1) the anterior jugular chain and (2) the juxtavisceral chain.

The *anterior jugular group* follows the anterior jugular vein and is located superficial to the strap muscles. Although the nodes are not consistently present, the collecting vessels are always present. They drain the skin and muscles of the anterior portion of the neck, and the efferent vessels empty into the lower internal jugular nodes. The *juxtavisceral chain* is separated into the prelaryngeal, prethyroid, pretracheal, and paratracheal nodes. The *prelaryngeal nodes* are located over the thyrohyoid membrane, the thyroid cartilage, and the cricothyroid membrane. The *upper* nodes drain mainly the supraglottic larynx, whereas the *lower* nodes drain the infraglottic larynx, the thyroid isthmus, and the anteromedial aspects of the thyroid lobes. The single lymph node overlying the thyroid cartilage is often referred to as the Delphian node. The *pretracheal* group consists of nodes lying between the isthmus of the thyroid gland down to the level of the innominate vein. They are continuous with the pretracheal lymph nodes of the anterior superior mediastinum. They vary from 2 to 12 in

number and drain the region of the thyroid gland and trachea, as well as receive vessels from the prelaryngeal group. The efferent vessels empty into the paratracheal chain and into the internal jugular group. They also communicate with the anterior superior mediastinal nodes.

The *paratracheal* group is often referred to as the recurrent nerve chain, as the nodes characteristically follow this nerve. They may extend as high as the retropharyngeal region. They drain the lateral aspects of the thyroid lobes, the parathyroid glands, the posterior infraglottic region of the larynx, the trachea, and the esophagus. They also receive vessels from the pretracheal and retropharyngeal nodes. The efferent vessels drain into the lower jugular group or directly into the internal jugular-subclavian vein junction. There may also be communication with the anterior superior mediastinal nodes.

It is important to remember that in the anterior portion of the neck there is no division in the midline between the lymphatics, with cancer easily spreading to the contralateral side.

Lateral Cervical Nodes

The lateral cervical nodes are divided into a superficial and a deep group. The superficial group follows the external jugular vein and drains into either the internal jugular or the transverse cervical nodes of the deep group. The deep group consists of (1) the spinal accessory chain, (2) the transverse cervical chain, and (3) the internal jugular chain.

These nodes form a triangle, with the base formed by the transverse cervical group, the posterior limb by the spinal accessory group, and the anterior limb by the internal jugular group. The *spinal accessory chain* follows the course of the spinal accessory nerve and may consist of up to 20 nodes. These nodes receive drainage from the occipital, postauricular, and suprascapular nodes, as well as from the posterior part of the scalp, the supraspinous fossa, the nape of the neck, the lateral aspect of the neck, and the shoulder. The upper nodes in this group coalesce with the upper internal jugular chain nodes. These junctional nodes drain a large portion of the upper aerodigestive tract. The *transverse cervical group* follows the transverse cervical vessels and consists of up to 12 nodes. The medial nodes of this chain overlie the scalene muscles and are, therefore, referred to as the scalene nodes. These nodes receive drainage from the spinal accessory group and the transverse cervical group, as well as the collecting trunks from the skin of the upper chest and lower lateral neck. The most medial nodes also coalesce with the low internal jugular nodes. The *internal jugular chain* consists of a large system of nodes covering the anterior and lateral aspects of the internal jugular vein and extending from beneath the digastric muscle superiorly to the junction of the internal jugular and the subclavian vein inferiorly. They have been arbitrarily divided into an upper, middle, and lower group. There may be as many as 30 nodes in this chain. The final efferent vessels from this chain empty into the venous system via the thoracic duct on the left and multiple lymphatic channels on the right. This group of nodes drains all of the previously discussed groups. In addition, this chain may receive direct input from the entire nasal fossa, the pharynx, tonsils, external and middle ear, eustachian tube, tongue, hard and soft palate, laryngopharynx, major salivary glands, and thyroid and parathyroid glands.

As is apparent, this lateral cervical group of nodes constitutes a major and important aspect of lymphatic drainage in the head and neck.

Although these patterns of drainage are fairly constant, alteration in this pattern may occur with malignant involvement or after radiotherapy. In these situations, rerouting can occur, and metastases can arise in unusual sites. Metastases have also been shown to skip first-echelon nodes and present in the lower internal jugular nodes.

Biology

A common denominator to all malignancies is their ability to metastasize. Why and how this phenomenon occurs has been the subject of much research and investigation. We do know, however, that metastasis is not a random event. Some tumors have the propensity to extensive local invasion without metastasis, whereas others produce organ-specific metastasis early on in their development. It has been stated that approximately 4 million tumor cells/gm of tumor are released into the bloodstream on a daily basis. Yet less than 1 per cent of malignant cells entering the bloodstream go on to survive. Why then does metastasis not occur more frequently? The exact reasons are not fully understood. We do know, however, that there are factors involving both the tumor and the environment to which it metastasizes that determine its inevitable course.

By the process of random mutations, tumors cells are generated that are not inhibited by the host and are responsive to microenvironmental signals. These cells will eventually become the dominant cell type. This rate of phenotypic diversification determines how quickly these resistant cells develop and thus allow successful metastasis. The metastatic cells, by their nature, are thus superselected clones and are more likely to survive.

These cells penetrate the basement lamina of the epithelium into the connective tissue spaces and are forced into the lymphatic capillaries by the high interstitial pressure created by the tumor. The cells enter the lymphatics and spread to the regional lymph nodes. The successful metastatic cell is required to adhere to the microvasculature of the organ, extravasate, establish a microenvironment, and then proliferate.

Invasion and metastasis by a tumor is almost certainly related to the elaboration of certain enzymes and growth factors. The isolation of an epidermal growth factor receptor on the surface of malignant cells has been a major advance in tumor biology. Expression of this receptor occurs in squamous cell carcinoma and its presence has been associated with more aggressive tumors. Many tumors produce enzymes that destroy basement membranes, the most important of which is a type IV collagenase. Tumors have also been shown to produce in vitro an angiogenesis factor, which allows for tumor neovascularization and growth.

It has been traditionally regarded that tumors first spread to regional lymphaticus and only then to distant sites. Many investigators now suggest the possibility of distant spread without a regional way station so that there is a local-systemic spread rather than a local-regional-systemic spread. In fact, some tumors have been shown to be site-specific in their metastasis. This is classically demonstrated experimentally using B-16 melanoma cells with lung-colonizing properties. They not only will metastasize to the lung when injected but also will metastasize to a lung that has been grafted to a distant site. Distant spread with head and neck malignancies has always been viewed as being uncommon; however, as the disease progresses, this incidence increases dramatically.

Traditionally it was believed that carcinomas metastasized via the lymphatic system, whereas sarcomas took a hematogenous route. Today, such a view is felt to be naive, as both systems have multiple interconnections. Most tumors can produce distant metastasis by either a lymphatic or a hematogenous route. Once in the lymphatic system, the cells travel to a lymph nodes, in which they can proliferate, or they bypass the node. Whether or not these cells will survive at their termination site depends on the environment and the immune status of the host. Obviously, regions with extensive lymphatic drainage and high lymphatic flow have a higher propensity to metastasis. Conversely, hematogenous spread can occur by direct vessel invasion, following invasion of blood vessels in a lymph node (which is most likely) or by spread from the lymphatic system into the venous system via the thoracic duct.

The preceding concepts support the hypothesis that early excision of the primary tumor and lymph nodes should lead to a decreased incidence of distant metastasis and improved survival. Concrete clinical evidence to substantiate this theory is, however, lacking.

Finally, different tumor types and even tumor sites appear to have different rates of metastasis. Tables 1, 2, and 3 show the various rates of nodal metastasis for squamous cell carcinoma, melanoma, and thyroid and salivary gland tumors. The histologic features of squamous cell carcinoma that predispose to an increased incidence of metastasis are the depth of invasion, presence of perineural invasion, and an infiltrating, as opposed to a pushing, pattern of invasion.

Table 1. Incidence of Nodal Metastasis of Squamous Cell Carcinomas by Site

	N1 or Greater (%)	**N0 Becoming N1 or Greater (%)**
Hard palate	20	20
Floor of the mouth	40	30
Gingiva	30	15
Retromolar trigone	45	15
Tongue	50	18
Buccal mucosa	20	15
Supraglottic larynx	45	30
Oropharynx	50	18
Nasopharynx	85	30.

Table 2. Incidence of Nodal Metastasis of Malignant Melanoma by Depth of Invasion

Level (mm)	**Rate (%)**
< 0.75	0
0.75 - 1.5	25
1.5 - 4.0	57
> 4.0	62.

Table 3. Rate of Nodal Metastasis of Salivary Gland and Thyroid Gland Tumors

Salivary Gland Tumors

	Parotid	Submandibular	Minor
Squamous cell	70	60	-
Mucoepidermoid	44	58	30
Adenocarcinoma	36	-	26
Malignant mixed	21	22	38
Adenoid cystic	10	21	13
Acinic cell	18	-	-.

Thyroid Gland Tumors

Papillary	55%
Follicular	26%
Hürthle cell	9%
Medullary	50%.

Clinical Evaluation

Evaluation of the neck for metastasis must be systematic and thorough. Omission of this part of the examination in evaluating any head and neck malignancy is a grave error. Physical examination begins with inspection, looking for overt asymmetry, and then proceeds to palpation. It is imperative that a system be used to ensure palpation of all node groups.

Clinical evaluation of the neck is far from infallible. The detection of nodal metastases is associated with a 15 to 35 per cent rate of error. Ali and co-workers, in their review of 266 specimens from radical neck dissections found a false-positive rate of 20 per cent and a false-negative rate of 21 per cent. Decroix and colleagues detected a 34 per cent false-negative rate; in addition, of those who were subsequently determined to be histologically positive, almost one third had advanced cervical metastases with more than three positive nodes and extracapsular spread. Floor of the mouth cancers present a unique problem in that obstruction of the submandibular duct by tumor makes assessment of the neck difficult. Crissman and Gluckman noted a 56 per cent false-positive rate in this situation. Likewise, it may sometimes be difficult to differentiate between direct tumor extension into the neck and nodal metastases, most commonly with pyriform sinus cancers.

The use of computer tomography (CT) for assessment of the neck has been advocated. Although the scans are accurate in detecting the presence of nodal enlargement, they are not able to determine whether this represents tumor involvement. In our experience, extracapsular spread with fixation to surrounding structures is often falsely suggested on CT scan and is not confirmed on surgical exploration. Friedman and associates compared the CT and clinical findings with the pathologic results in 50 patients and determined the scan results to have an accuracy rate of 90 per cent, with a false-positive rate of 6 per cent and a false-negative rate of 4 per cent. An accurate assessment of tumor involvement of the carotid system could not be obtained. Conversely, Feinmesser and co-workers, in evaluating 100 neck dissections

comparing CT findings and physical examinations with pathologic results, found similar sensitivity rates for both physical examinations and CT (61.5 and 59.6 per cent, respectively), but there was a slight superiority of the positive predictive value of physical examination (91.4 per cent) over that of CT scanning (81.6 per cent). Their conclusion was that CT scanning offered no advantage over physical examination.

Certainly, CT scanning is useful in evaluating cervical metastases, but like all tests it should be interpreted only in conjunction with the physical findings.

Staging

The status of the cervical nodes constitutes the N portion of the TNM classification system for head and neck tumors. Table 4 shows the classification used by both the International Union Against Cancer (UICC) and the American Joint Committee on Cancer systems (AJC). The criteria for classification of nodal status are completely different in the two systems. The significance of cervical node involvement is recognized in both, but the AJC attaches importance to the size and number of homolateral nodes, whereas the UICC puts emphasis on mobility versus fixation. Both attach importance to contralateral or bilateral node disease, but not in the same way.

Table 4. Staging of Regional Cervical Lymph Nodes

UICC	AJC
N0: No evidence	N0: No evidence
N1: Mobile ipsilateral nodes	N1: Single positive ipsilateral nodes 3 cm or less in diameter
N2: Mobile contralateral or	N2: Single ipsilateral node more than bilateral nodes 3 cm but not more than 6 cm (N2a) or multiple ipsilateral nodes, none greater than 6 cm (N2b)
N3: Fixed regional lymph nodes	N3: Ipsilateral nodes, greater than 6 cm (N3a), bilateral nodes (N3b), or contralateral nodes (N3c).

Prognostic Factors Associated With Cervical Metastasis

In attempting to evaluate those characteristics of nodal metastasis that affect prognosis, one theme is dominant: the more a tumor is allowed to progress, the worse is prognosis. Staging systems are merely an attempt to objectively document the progression of the disease. Some of the more notable prognostic features will be discussed.

Clinical Features

Number of Nodes

It stands to reason that the more lymph nodes that are involved, the more advanced the disease process, and therefore the worse the prognosis. The more nodes involved, the greater the possibility for hematogenous spread with distant metastases. Kalnins and colleagues clearly demonstrated this fact in their review of 340 radical neck dissections. The

5-year survival rate was 75 per cent when no nodes were involved in the neck, 49 per cent when one node was involved, 30 per cent when two nodes were involved, and 13 per cent when three or more nodes were involved. Also, when three or more nodes were involved, the local recurrence rate was an alarming 72 per cent and the rate of distant metastases was 70 per cent!

Level of Involvement

The level of involvement remains controversial. Stell and colleagues, in a review of 569 neck specimens, illustrated the significance of the level of involvement. The neck specimens were divided into four levels: (1) submandibular triangle nodes, (2) upper jugular nodes, (3) lower jugular nodes, and (4) posterior triangle nodes.

The 5-year survival rate dropped precipitously with lower level involvement. The 5-year survival rates produced were (1) 34 per cent with level 1 involvement, (2) 25 per cent with level 2 involvement, 12 per cent with level 3 involvement, and 4 per cent with level 4 involvement.

Node Fixation

The fixation of cervical nodes to surrounding structures, particularly muscle and the carotid system, is an ominous finding. It is indicative of advanced tumor with extracapsular extension into the local tissue. In a review of fixed nodes, Stell and co-workers noted a 5-year survival rate of 7 per cent with unilateral node fixation and 0 per cent with bilateral fixed nodes.

Recurrent Disease

Recurrence of neck disease in a neck that previously underwent surgery is ominous and is for practical purposes incurable.

Size

The size of a node is an indicator of prognosis only in that it reflects a high incidence of extracapsular extension with multiple nodes being matter together. Nodes larger than 3 cm have a 75 per cent incidence of extracapsular spread.

The staging of cervical disease (N stage) is merely a documentation of the clinical findings of these prognostic factors. As the stage increases from N0 to N3, the survival rate decreases, and the incidence of distant metastases increases.

Histologic Features

Pathologically Confirmed Nodal Metastasis

A report by Spiro and associated demonstrated that in clinically N0 necks, there is a 50 per cent decrease in survival with histologically positive nodes as compared with histologically negative nodes. Unfortunately, in this frequently quoted series, the status of the

primary tumor and the extent of cervical metastases was not commented on. In contrast, a more recent report documented no difference in survival between histologically negative and histologically positive nodes. Certainly, it is the impression of the authors that the presence of histologically confirmed metastases significantly diminishes the prognosis.

Extracapsular Spread

The adverse impact of extracapsular extension has been well documented. Clinically, necks with N3 disease have a 75 per cent incidence of extracapsular spread, but of great interest is the documentation that 13 per cent of necks with no clinical evidence of disease (N0) may also have extracapsular spread. The pathologist should be encouraged to look for this finding, as it remains a very important prognostic indicator.

Lymph Node Reaction

The histologic reaction of a node draining a cancer has been correlated with prognosis, although the evidence is conflicting. These nodes may show a T-cell response characterized by prominence of the paracortical areas, a B-cell response characterized by germinal center enlargement, and a histiocytic response characterized by prominence of sinus macrophages. This response may be nonspecific to necrosis and infection; however, the presence of lymphocyte predominance has been associated with a good prognosis, and lymphatic depletion has been associated with a poor prognosis.

Management

No issue in head and neck oncology is more controversial than the management of the cervical lymphatics, with the two conventional treatment options offered being surgery and radiotherapy. Regardless of the therapy used, the basic premise is that control of regional disease will prevent distant metastasis and prolong survival. The ultimate criterion for success, therefore, is not local control of disease but patient survival.

Surgery

The surgical treatment of neck metastasis is dependent on the concept that the cervical lymphatics are amenable to an en bloc resection because they are contained between the superficial and deep fascial layers. Since the original description by Crile, many modifications have been made to the classic neck dissection, with a view to optimizing the oncologic concepts of the procedure but minimizing the morbidity. Current terminology and descriptions are discussed in the following sections.

Radical Neck Dissection

Radical neck dissection refers to the classic neck dissection, which consists of total exenteration of the cervical lymphatic vessels and nodes, with sacrifice of most structures within the anterior and lateral triangles, including the spinal accessory nerve, sternocleidomastoid muscle, and internal jugular vein.

The technique for radical neck dissection has changed little since it was first described by Crile at the turn of the century. It remains an outstanding oncologic operation in its ability to accomplish complete removal of the cervical lymphatic chain with a minimum of morbidity. It may be performed *electively* in a neck with no clinical evidence of disease in the hope of removing early, occult lymphatic spread before it can affect survival. *Therapeutic* dissections are for clinically obvious disease in the hope of preventing distant metastasis and controlling local disease.

Technique. The basic technique of radical neck dissection involves removing the contents of the neck located between the superficial and deep fascial layers and extending from the anterior border of the trapezius to the strap muscles and from the lower border of the mandible and the mastoid tip down to the supraclavicular region. In so doing, the carotid artery, vagus nerve, phrenic nerve, sympathetic chain, and hypoglossal nerves are preserved.

Details of the technique are available in many fine surgical atlases and do not bear repeating.

Advantages. The major advantage of the radical neck dissection is that it allows the most complete removal of the cervical lymphatics possible. In addition, it is simple in its execution and is easily taught and learned; therefore, it remains a superb oncologic procedure.

Disadvantages. The obvious disadvantage of this procedure is the perceived morbidity resulting from removal of the structures. Sacrifice of the accessory nerve may result in loss of function of the trapezius muscle and the winged scapula, with impaired shoulder function. The degree of functional loss varies from minimal to severe and is difficult to predict in an individual patient.

Although resection of the sternocleidomastoid muscle results in an obvious cosmetic defect, it is masked if a myocutaneous flap is used in reconstruction of the site of the primary tumor resection.

Resection of the internal jugular vein causes insignificant edema when a unilateral dissection is performed. When bilateral radical neck dissections are necessary, however, there is significant facial edema. Cerebral edema may occur and should be carefully watched for in the postoperative period. This edema may also develop following a staged or delayed contralateral neck dissection. As significant glottic edema may result, a tracheostomy (if not already present) should always be performed prophylactically in the case of delayed contralateral radical neck dissection.

Indications. This procedure may be indicated in any situation in which the neck is felt to harbor metastatic carcinoma. Although its use in the neck with no clinical evidence of disease is controversial, certainly it is an excellent procedure when there is a high likelihood of occult metastasis and surgical treatment is required for the primary tumor.

Results. Radical neck dissection is unquestionably the most thorough method of removing the cervical lymphatics, with recurrence in the neck after this procedure being extremely low. Whether the advantages outweigh the disadvantages in any given situation will depend on the philosophy and experience of the attending surgical oncologist.

Functional Neck Dissection

Functional neck dissection results in en bloc removal of the cervical lymphatic chain by stripping the fascia off the muscles, nerves, and vessels, thereby preserving the spinal accessory nerve, sternocleidomastoid muscle, and internal jugular vein. Proponents of this procedure claim that the lymphatic dissection is not compromised by such an approach.

The functional neck dissection, as originally described by Bocca and Pignataro, represents a more conservative surgical approach to removal of the cervical lymphatics. Proponents of this technique argue that oncologically, adequate resection of the lymphatics can be achieved without the morbidity associated with a radical neck dissection.

Technique. The principle of this operation is to remove the relevant cervical lymphatics and, at the same time, preserve the spinal accessory nerve, internal jugular vein, sternocleidomastoid muscle, submandibular gland, and cervical nerve plexus.

This procedure is documented in many publications which require careful perusal prior to performing such a procedure.

Advantages. The perceived advantages of this procedure are the functional and cosmetic improvement obtained by preserving the spinal accessory nerve, internal jugular vein, sternocleidomastoid muscle, and cervical nerve plexus.

Disadvantages. This procedure is significantly more difficult to perform than a radical neck dissection. This, in itself, however, is not a problem. The major source of controversy lies in establishing whether this procedure can adequately remove all potentially malignant nodes, particularly those related to the upper end of the accessory nerve and jugular vein. This is almost certainly feasible in very skilled hands, but in less experienced hands it is less likely to be successfully accomplished.

Indications. There is general agreement that this procedure can, in skilled hands, be used satisfactorily for the neck with no clinical evidence of disease and for the neck with N1 disease with results comparable to radical neck dissection. Likewise, it is an excellent procedure for managing the neck in well-differentiated thyroid cancer. It is also agreed that it is contraindicated in advanced nodal disease with fixation to the surrounding structures and extracapsular extension. The major issue is whether in less experienced hands it is an adequate oncologic procedure if there truly is metastatic disease in the neck. Once again, the choice of procedure will depend on the philosophy and experience of the surgeon.

Results. Despite the controversy surrounding this operation, excellent results have been reported in the management of early neck disease, with neck recurrence rates described as comparable to those with radical neck dissection.

Modified Neck Dissection

Modified neck dissection is used to describe many variants of the radical neck dissection. Classically this consists of a radical neck dissection preserving the accessory nerve or the internal jugular vein, or both. By definition, the functional neck dissection represents

the ultimate modified neck dissection.

If the radical and functional dissections are considered extremes in the surgical approach to cervical lymphatics, the modified dissection represents a compromise that maintains both sound oncologic principles and functional considerations.

Technique. This procedure is performed in a manner identical to that of the radical neck dissection except that the spinal accessory nerve or the internal jugular vein, or both, are preserved. Great care is taken to first isolate the accessory nerve in the posterior triangle and then dissect it superiorly and inferiorly to ensure its integrity. A radical lymphadenectomy is then performed in the routine manner, paying particular attention to adequately excising the upper deep cervical lymph nodes. If the internal jugular vein is to be preserved, the fascia of the vein is dissected with the specimen, particularly in the presence of overt metastases surrounding the vein.

Advantages. This procedure is technically easier to perform than a functional dissection, yet allows preservation of shoulder function by maintaining intact the accessory nerve.

Disadvantages. The controversial aspect of this procedure again centers around whether an adequate oncologic procedure can be performed while preserving the accessory nerve. Certainly, in most cases, this is certainly possible, but if a metastatic node is closely related to the nerve, this procedure is probably contraindicated.

Indications. If simultaneous bilateral neck dissections are to be performed, it is imperative to preserve one internal jugular vein to prevent the facial and even cerebral edema that may result if both veins are sacrificed. The accessory nerve can certainly be preserved in all cases in which it is perceived that an adequate lymphadenectomy can be performed without compromising the oncologic resection. The experience and philosophy of each surgeon will dictate the operation used.

Limited Neck Dissection

Limited neck dissections consist of removing only selected portions of the cervical lymphatics, with the areas removed depending on the site of the primary tumor. Examples of these include the suprahyoid dissection, the anterior neck dissection, and the paratracheal node dissection.

These operations are characterized by removal of only those lymphatics that are perceived to be at risk in dealing with a particular cancer, with the following being the most accepted of these operations: (1) the *suprahyoid* neck dissection, (2) the *anterior* neck dissection, and (3) the *paratracheal* neck dissection.

Although it remains an attractive concept to remove only a small number of nodes, with theoretically lower morbidity, it is a somewhat flawed concept because of the unpredictable spread of metastases in the neck lymphatics.

Suprahyoid Neck Dissection. This controversial procedure essentially consists of removing the contents of the submandibular triangle, including all the lymph nodes in this area. Although the dissection may or may not include the digastric muscle, every effort should be made to incorporate the upper deep jugular nodes. This limited lymphadenectomy is classically used in the following situations:

1. When removing an infiltrating anterior oral cavity cancer (together with a unilateral complete neck dissection), a contralateral suprahyoid dissection is performed to ensure wide en bloc resection of the tumor plus removal of the submandibular gland and surrounding structures.

2. It may be performed as an intraoperative staging procedure. If histologically positive nodes are encountered, a complete neck dissection is performed. This, unfortunately, is a fallacious concept, as oral cavity lesions do not metastasize in an orderly and predictable pattern, with the capability of isolated metastases occurring in any region of the neck without first appearing in the suprahyoid region.

Anterior Neck Dissection. This procedure consists of removing all the anterior jugular lymphatic chain, together with the juxtavisceral chain, including, of course, the paratracheal nodes. It should, in fact, be part of any wide-field laryngectomy, particularly for transglottic tumors. Unfortunately, it is not adequate if there is a strong suspicion of occult metastases in the neck.

Paratracheal Neck Dissection. This may be performed as part of a wide-field laryngectomy or alone when dealing with thyroid cancer, cervical cancer, or tracheal cancer. It may be performed in conjunction with a superior mediastinal lymphadenectomy.

Extended Neck Dissection

Extended neck dissection applies to neck dissections that extend outside the usual confines of the classic neck dissection and include removal or parotid, parapharyngeal, posterior cervical, or superior mediastinal nodes in addition to the nodes removed during a routine neck dissection.

Parotid Node Dissection. As already stated, there are intra- and extraglandular lymph nodes that may be the site of metastases from skin cancers arising particularly in the ipsilateral eyelid; the frontal, temporal, and posterior cheek and anterior ear regions; and the posterior oral cavity and buccal mucosa. In order to accomplish an adequate lymphadenectomy with preservation of the facial nerve, the classic neck dissection is performed, followed by a superficial parotidectomy and the piecemeal removal of the deep lobe, including all obvious parotid lymph nodes. If parotid metastasis are identified, postoperative radiation to this area is recommended.

Parapharyngeal Node Dissection. These nodes lying at the base of the skull should be actively sought during all resections for pharyngeal cancer. The internal carotid artery should be dissected to the base of the skull, the pharynx rotated medially, and any overt lymph nodes dissected between these two structures.

Superior Mediastinal Node Dissection. This procedure is usually employed together with paratracheal dissection in dealing with over metastases from thyroid malignancy. With the neck in hyperextension, it is relatively simple to sweep any overt metastases out of the superior mediastinum without splitting the sternum.

Conversely, it can also be performed as part of the management of squamous cell cancer of the subglottis, trachea, and cervical esophagus. However, our own inclination in this situation is to treat this area with postoperative radiation.

Superior mediastinal resection, in addition, is an integral part of the wide composite resection for stomal recurrence and, in this scenario, is performed after removing varying portions of the sternum to allow access.

Posterior Cervical Node Dissection. Skin cancers of the posterior portion of the scalp may metastasize to the occipital lymph nodes, which are not routinely addressed by a standard radical neck dissection. This procedure is performed by separating the trapezius muscle from the nuchal line and reflecting it inferiorly. The splenius muscle of the head is then reflected anteriorly to gain exposure to the deep occipital nodes, which are then dissected in continuity with the primary tumor.

Radiotherapy

The use of radiotherapy in the treatment of cervical metastases is likewise mired in controversy. For cancer in other areas, radiation is most effective in managing early disease, particularly microscopic metastases. Certainly it appears that for early disease, local control rate equal those obtained using surgery. Obviously there is less morbidity than with surgery.

It is not, however, without its problems and should not be used indiscriminately. It involves a considerable investment in time, and complications include skin and mucosal reactions, which though usually mild may be severe. The main indications would, therefore, be for the management of the neck with no clinical evidence of disease and the neck with N1 disease. Any more advanced disease should be treated with either surgery or combination surgery and radiation.

Combined Therapy

The use of combined surgery and radiation therapy should be reserved for more advanced cervical metastasis. The issue at stake is what, in fact, constitutes advanced disease. As already stated, the size of the node, the number of nodes, the level of involvement, clinical evidence of fixation, and histologic evidence of extracapsular extension are all associated with a poor prognosis, and in these situations combined therapy is probably indicated.

Although conceptually it would seem that combined therapy would offer improved cure rate, this has never been conclusively proved. Bartelink and colleagues reviewed 405 patients undergoing radical neck dissection, 140 of whom received preoperative or postoperative radiotherapy. They noted no improvement in survival rate in the combined therapy group when compared with those treated with surgery alone. Likewise, DeSanto and Beahrs evaluated 1192 patients; 837 patients received surgery alone, and the remainder

received preoperative or postoperative radiotherapy. These investigators noted no difference in the rates of recurrence between the two groups. Terz and Lawrence analyzed 22 reports of combined therapy and noted no difference in the 2- and 3-year survival rates between the combined therapy groups and those treated with surgery alone. In contrast, results from El Badawi and Goepfert suggest a decrease in local recurrence rates when postoperative radiotherapy is used in combination with surgery, especially in those patients having multiple positive nodes larger than 3 cm.

Even though the issue is not fully resolved, most oncologists employ postoperative radiotherapy for those pathologic specimens demonstrating extracapsular spread, multiple levels of involvement, or nodes larger than 3 cm, as well as employing it prophylactically to the neck when combination therapy is deemed necessary to treat the primary tumor.

Management of the Neck with no Clinical Evidence of Disease (N_0)

A major dilemma in head and neck oncology is management of the neck when there is no *clinically* identifiable disease. The first issue that needs to be addressed is whether the neck with no clinical evidence of disease should be treated at all, that is, whether there is any microscopic disease within the cervical nodes that would justify treatment. Patently, if no metastases are present or are likely to develop, no treatment is indicated. To help make that decision, the primary tumor needs to be carefully assessed with regard to size, site, and histologic differentiation. As has already been demonstrated in Tables 1, 2, and 3, the site and histologic differentiation have a significant bearing on the likelihood of the tumor metastasizing. The more advanced the primary tumor, the more likely it is to metastasize. In the case of squamous cell carcinoma, the degree of differentiation and the pattern of invasion may also help make this decision.

Two management options exist: (1) to observe and wait and treat only if clinically obvious disease should become apparent or (2) to electively treat the neck prophylactically. Unfortunately, as already stated, clinical evaluation of the neck is notoriously difficult, with a high percentage of examinations that miss evidence of involvement. In fact, in one series, 13 per cent of necks with no clinical evidence of disease had advanced nodal disease (more than three involved nodes or capsular invasion) pathologically, and this group had a concomitant higher recurrence rate and a worse survival rate.

Those who choose to perform elective treatment to the neck do so in the hope that removing undetected occult disease before it has become more advanced, will improve survival. Elective treatment should, therefore, be employed in those situations in which a high yield of occult metastases would be expected. Certainly it is always better to overtreat than to undertreat provided that the morbidity from the therapeutic modality used is not too significant. As to whether the prophylactic treatment of the neck with no clinical evidence of disease is better than waiting for disease to appear and then treating, unfortunately remains unclear at this time.

Surgery

As already stated, the exact role of the prophylactic neck dissection is unclear. The prospective randomized study of Vandenbrouck and colleagues is noteworthy. They evaluated

75 patients who had squamous cell carcinoma of the oral cavity and no clinical evidence of neck disease (N0). One group of 37 patients underwent elective radical neck dissection, whereas the second group of 36 patients was observed and underwent neck dissection only when nodal disease became clinically evident. This resulted in no difference in survival between the two groups. There was, however, a significant increase in the incidence of extracapsular spread in those who underwent secondary neck dissection, but this apparently had no effect on survival. Likewise, a study by Beaver and co-workers also supports the fact that elective neck dissection does not improve survival. In contrast, the review by Lee and Krause suggested that elective prophylactic neck dissection is beneficial.

Once the decision to surgically treat the neck has been made, one must decide on the type of neck dissection. Many types of neck dissections have been advocated, varying from the radical dissection to the functional dissection, with various modifications in between. The ideal procedure in any given situation depends on the experience and philosophy of the surgeon. Multiple large series have shown equal effectiveness of functional dissections versus radical dissections in the management of the neck with no clinical evidence of disease, with a 7 to 10 per cent recurrence rate in that situation.

Radiotherapy

The use of radiotherapy in the treatment of the neck with no clinical evidence of disease has been sanctioned by many and is apparently as effective as surgery in controlling microscopic and early metastases. It appears that a minimum dose of 5000 rad is necessary. The radiation may be given as part of the therapy to the primary tumor or following surgical excision of the primary tumor.

Once again, the question as to whether elective radiotherapy affects survival needs to be addressed. A report by LeBorgne and associates evaluated 50 patients with no clinical evidence of neck disease with the primary tumor controlled. Twenty-five patients received elective radiation, and another 25 patients were observed. Recurrences in the irradiated group were half as frequent as in the nonirradiated group and were usually outside the irradiated field. The survival over 5 years in both groups, however, was identical, although the development of second primary lesions contributed significantly to survival.

Management of the Neck with N_1 Disease

Management of the clinically positive neck is somewhat less controversial, as these necks patently have to be treated. Nodes less than 3 cm, however, are still considered early disease, and reports claim equal success with either radiotherapy or surgery.

Surgery

The type of neck dissection best employed in N_1 disease remains subject to debate. Many advocate only a radical neck dissection in this situation, because the procedure is easier to perform and one is able to ensure a more complete clearance of the lymphatics, particularly in less experienced hands. This is particularly pertinent in clearing the upper jugular nodes. Others point to the excellent results obtained by a functional or modified neck dissection, with the concomitant increased morbidity associated with the radical procedure.

Radiotherapy

The use of radiotherapy as the sole therapeutic modality for N_1 neck disease is questionable. Radiotherapy and surgery are considered equally effective for N_1 disease; however, as the size of the node increases, the dose of radiotherapy needed for control increases considerably. Mendenhall and co-workers noted a 100 per cent control rate for nodes less than 1 cm and a 0 per center control rate for those greater than 7 cm. In addition, there is a possible advantage to having a surgical specimen to quantify the state of cervical disease, which may help to determine the prognosis and need for adjunctive radiotherapy.

Management of the Neck with N_2 or Greater Disease

Most centers employ combined surgery and radiation for advanced disease. The classic radical neck dissection is the surgical treatment of choice for this advanced disease, although Bocca considers the only contraindication to functional neck dissection to be the presence of fixed nodes, fixed nodes that become mobile following radiation, or the recurrence of lymph node metastasis after radiation or previous surgery. The radiation can be given pre- or postoperatively, depending on the experience and philosophy of the oncologist, although the trend today is to treat with postoperative radiation.

Management of the Inoperable Neck

The decision as to what constitutes an inoperable cervical metastasis varies considerably. It is our personal belief that fixation to prevertebral musculature, fixation to the base of the skull, and fixation to the common or internal carotid artery all constitute an incurable situation. The fact that these lesions can be resected is not denied, but in our experience, surgery has never resulted in cure and, therefore, the procedure should probably be aborted. Others feel that subtotal resection followed by postoperative radiation or chemotherapy, or both, may offer long-term palliation and is worthy of consideration. Several reports on carotid artery sacrifice all show dismal results, with great potential for significant morbidity.

Some authorities have suggested the use of preoperative radiotherapy to convert an inoperable fixed node into an operable one. This is, in fact, occasionally possible but does not have any effect on altering survival. Stell and colleagues, in their review of the fixed cervical node, noted that radiotherapy alone produced an insignificant effect on survival and that salvage surgery did not affect outcome. The best results followed surgery alone. Certainly if the metastasis is adherent to skin, mandible, or external carotid artery, resection is easily accomplished with approximately a 15 per cent 5-year survival rate.

Management of the Occult Primary Tumor with Cervical Metastases

Less than 10 per cent of squamous cell carcinomas that are metastatic to the neck arise from an unknown primary tumor. When a neck mass that is suspicious for metastasis is present in the neck, and the primary tumor is not apparent, an exhaustive search should be undertaken to look for the primary tumor. A fine needle aspiration biopsy should be used to confirm the histologic appearance of the cervical metastasis, which will narrow the search. Eighty per cent of all occult primary tumors arise above the clavicles. If the metastasis is a

squamous cell cancer, panendoscopy and x-ray sinus studies should always be performed. If the metastasis is an adenocarcinoma or is undifferentiated, the investigation obviously will have to be widened. Endoscopy should include blind biopsies of the nasopharynx, tonsil, and base of the tongue if no over tumor is identified. Although multiple therapeutic regimens are postulated, it is our approach to perform an open exploration of the neck with frozen section examination of the node and proceed to a neck dissection if the results of the section are positive. Postoperative radiation is administered to both sides of the neck and from the nasopharynx down to and including the hypopharynx in an attempt to include all potential likely sites of origin. Every 3 to 6 months, for the first 2 years, the patient is subjected to a repeat examination under anesthetic in addition to the routine follow-up for the primary tumor. The occult primary tumor only rarely becomes apparent.

Management of Nonsquamous Metastasis

It is not uncommon for malignant *thyroid* disease to present with neck metastasis. In children with papillary carcinoma of the thyroid gland, 80 per cent has clinically palpable neck disease at the time of presentation. In adults, this figure is closer to 30 per cent. It is unclear whether these nodes truly have an adverse effect on the prognosis of the patient. Papillary and follicular carcinoma metastatic to the neck should be treated with a therapeutic functional neck dissection or a modification thereof. Radical neck dissection is not indicated. Medullary thyroid carcinoma, in contrast, is more aggressive, with a tendency to extracapsular extension. A therapeutic radical neck dissection is recommended in this case, and likewise when dealing with metastasis from an anaplastic cancer.

Superior mediastinal nodes may also need to be addressed in dealing with thyroid malignancy. They can usually be dissected out during the thyroidectomy without needing to split the sternum.

The usefulness of prophylactic neck dissection for *malignant melanoma* in the head and neck has been the subject of heated debate in the literature. A recent report by Urist and Soong of 535 head and neck melanomas from Birmingham, Alabama and Sydney, Australia showed a definite improvement in survival when neck dissection was used in combination with wide local excision for lesions with a tumor thickness between 1.5 and 3.99 mm. Neck dissection was not useful for tumors less than and greater than this depth of invasion.

Malignant *salivary* neoplasms also have a propensity for cervical lymph node metastases. For advanced high-grade malignancies (squamous cell carcinoma, high-grade mucoepidermoid carcinoma, and undifferentiated cancers), a prophylactic neck dissection is advocated because of the high incidence of nodal metastasis. For other malignancies, neck dissection is indicated only for clinically obvious metastases.

Conclusion

Cervical metastatic disease is obviously a complex topic, with many factors ill understood. Basic research has done much to clarify mechanisms of tumor advancement and spread and will, hopefully, ultimately lead to improvements in our therapeutic approach. Until such time, oncologists will continue to do what appears appropriate for managing the patients under their care, irrespective of the confusing literature that we now have before us.

Definitive management awaits large, multicenter, prospective, randomized trials to enlighten the debate. Until that time, our current knowledge of the biology of cancer suggests that improved results can be obtained by treating this disease at its earliest stage.