# Imaging-Based Nodal Classification for Evaluation of Neck Metastatic Adenopathy

Peter M. Som[1]
Hugh D. Curtin[2]
Anthony A. Mancuso[3]

**OBJECTIVE.** This study was undertaken to create an imaging-based classification for the lymph nodes of the neck that will be readily accepted by clinicians, result in consistent nodal classification, and be easily used by radiologists.

**SUBJECTS AND METHODS.** Over an 18-month period, the necks of 50 patients with cervical lymphadenopathy were scanned with CT, MR imaging, or both. Imaging anatomic landmarks were sought that would create a nodal classification of these necks similar to the clinically based nodal classifications of the American Joint Committee on Cancer and the American Academy of Otolaryngology–Head and Neck Surgery. Each nodal level was defined to ensure consistent nodal classification and eliminate areas of confusion existing in the clinically based classifications.

**RESULTS.** Necks were classified using the imaging-based classification and then compared with the classification of the same necks using the most common clinically based classifications. The imaging-based nodal classifications of the superficial nodes were the same as the clinically based classifications; however, the deep nodes of eight patients were found only by imaging. The anatomic precision and the level definition afforded by sectional imaging allowed the radiologists to use the imaging-based classification in a consistent manner.

**CONCLUSION.** This imaging-based classification has been endorsed by clinicians who specialize in head and neck cancer. The boundaries of the nodal levels were easily discerned by radiologists and yielded consistent nodal classifications. The reproducibility of this classification will allow it to become an essential component of future classifications of metastatic neck disease.

For nearly four decades, the most commonly used classification for the cervical lymph nodes was that developed by Rouvière [1] in 1938. His work, and earlier works, precisely defined the anatomic location of the lymph nodes and mapped their drainage areas [2, 3]. The landmarks used in those early classifications were those identified by palpation and those noted only at surgery or dissection.

In 1981, Shah et al. [4] suggested that the anatomically based terminology be replaced with a simpler classification based on levels. Since then, a number of classifications have been proposed that use such level, region, or zone terminology [5–13]. The purpose of these newer classifications was not to change terminology, but to group the cervical nodes on the basis of the clinical and pathophysiologic information gleaned in the intervening 60 years [8, 14, 15]. The direction of nodal classification changed from that of a pure anatomic study to a nodal mapping guide for selecting the most appropriate surgical procedure among the various types of neck dissections [15]. The latest and most used of these classifications are the ones of the American Joint Committee on Cancer and the American Academy of Otolaryngology–Head and Neck Surgery [10, 11, 15]. The imaging-based classification created in our study was designed to be compatible with these widely accepted clinically based classifications [16].

Imaging was chosen as the basis of this new classification for several reasons: at least 80% of patients with head and neck cancer undergo CT or MR imaging before treatment and, in general, only those patients with small superficial tumors do not receive such pretreatment imaging; imaging can reveal clinically silent nodes [5, 17–24]; imaging, if properly performed, has the potential to best

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[1]Department of Radiology, Mount Sinai School of Medicine, City University of New York, One Gustave Levy Pl., New York, NY 10029. Address correspondence to P. M. Som.

[2]Department of Radiology, Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston, MA 02114.

[3]Department of Radiology, Shands Hospital, University of Florida College of Medicine, 1600 Southwest Archer Rd., Gainesville, FL 32610.

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show precise anatomic landmarks that make the nodal levels reproducible; and nodal information to classify nodes in the neck is no longer obtainable only at surgery.

Although both the imaging-based and clinically based classifications are designed as independent classifications, the best possible classification of cervical nodal disease may be accomplished by using both clinical palpation and information provided by imaging. For example, because of the slope of the shoulders, the supraclavicular fossa is not as well defined on axial CT and MR imaging as it is on palpation, especially when Ho's triangle is used as the defining anatomic plane [11]. Classifying some lymph nodes located at the junction between levels may be difficult with imaging; however, when combined with clinical assessment, such classification problems are easily resolved. This article presents the imaging-based nodal classification and explains how to use it.

## Subjects and Methods

Prospectively, over an 18-month period, the necks of 50 patients with cervical lymphadenopathy were scanned with CT, MR imaging, or both.

The anatomic landmarks of the two most common clinically based classifications were used as initial guidelines for assessing the boundaries of nodal levels. This was done to create imaging definitions that would be consistent with those of the clinically based classifications. Areas of difficulty in both the clinically based and imaging-based classifications were then prospectively evaluated and new imaging anatomic landmarks were sought to resolve any confusion among sites. Radiologists independently classified the cervical lymphadenopathy on the CT and MR imaging studies using the imaging-based classification. The same patients were independently classified by otolaryngologists using the clinically based classifications. Comparison between these neck assessments was then made. The aim of the study was to have each neck similarly classified using the clinically and imaging-based classifications so that clinicians would accept the imaging-based classification.

When using the imaging-based classification, a consistent scanning technique must be used to provide reproducible nodal levels. For CT, such consistency includes patient positioning and gantry angulation. Although there is no single method of performing CT of the neck, the following technique is used by many head and neck radiologists, and

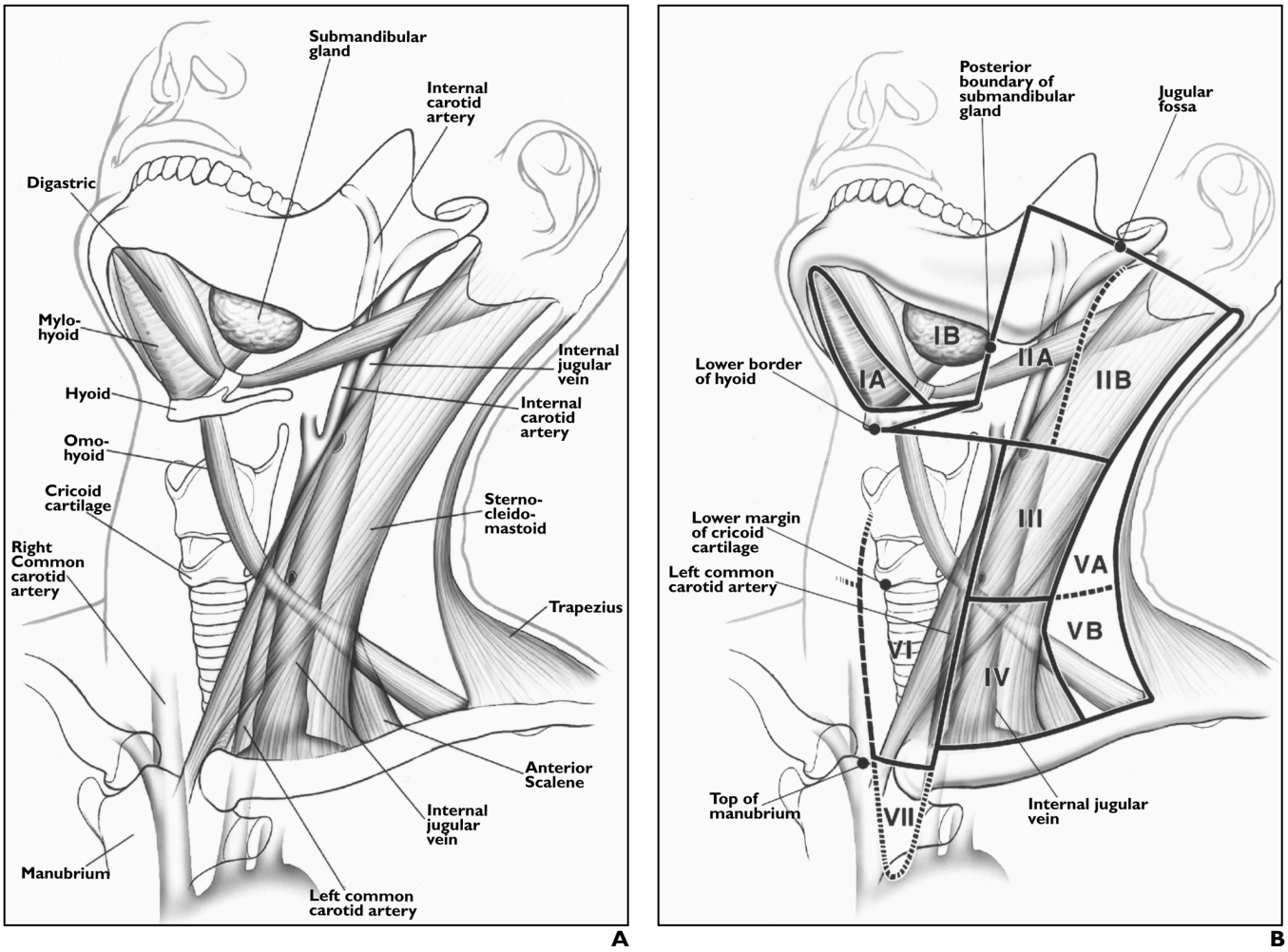



**Fig. 1.**—Neck as seen from left anterior view.
**A**, Drawing shows anatomy pertinent to nodal classification.
**B**, Drawing shows specific margins of anatomy seen in **A** that relate to definitions of classification levels. Note that line of separation between levels I and II is posterior margin of submandibular gland. Separation between levels II and III and level V is posterior edge of sternocleidomastoid muscle. Line of separation between levels IV and V is oblique line extending from posterior edge of sternocleidomastoid muscle to posterior edge of anterior scalene muscle. Posterior edge of internal jugular vein separates level IIA and IIB nodes. Carotid arteries separate levels III and IV from level VI. Top of manubrium separates levels VI and VII. (Reprinted with permission from [16])

slight variations from this approach do not change the nodal levels. The axial plane referred to in this classification is obtained with the patient's head in a comfortable neutral position with the hard palate perpendicular to the tabletop and the shoulders down as far as possible. The scanner gantry is aligned along the inferior orbitomeatal plane and, if possible, the examination is performed with the administration of IV contrast material to allow the best possible differentiation of nodes from vessels. The recommended field of view is 16 × 18 cm. The CT examination is performed as contiguous 3-mm scans from the skull base to the manubrium or as a helical study reconstructed as contiguous 2- or 3-mm slices. The helical technique uses 3-mm thick scans with a 3-mm gap and a pitch of 1:1. MR images should be no thicker than 5 mm (preferably 3–4 mm) with a 1-mm interslice gap. If the patient has a history of thyroid or cervical esophageal cancer, the caudal margin of the studies should extend to the level of the carina to ensure inclusion of the superior mediastinum.

The pertinent anatomic landmarks used for classification are depicted in the diagrams in Figure 1. The radiologist must be able to identify the essential anatomic landmarks of the classification: the skull base at the jugular fossa, the bottom of the body of the hyoid bone, the bottom of the cricoid arch, the top of the manubrium, the back edge of the submandibular gland, the back edge of the sternocleidomastoid muscle, the lateral posterior edge of the anterior scalene muscle, the anterior edge of the trapezius muscle, both the internal carotid and common carotid arteries, the internal jugular vein, the clavicle, the medial margin of the anterior belly of the digastric muscle, and the mylohyoid muscle. For consistency, all figure images in this article are CT scans that illustrate the use of the new classification. MR images could have been used. The final imaging-based classification is the result of continual use and refining of the classification by both radiologists and consulting clinicians during this 18-month period.

## Results

The clinically and imaging-based classifications of the cervical lymphadenopathy were the same for superficial nodal disease in all 50 patients. There were five patients with retropharyngeal lymphadenopathy identified only by imaging. There were also three patients with low visceral nodes identified only by imaging. Using the imaging-based classification (Appendix), the radiologists classified all necks the same.

## Discussion

### *How to Use the Classification*

The classification was designed to be easy to use. Each side of the neck should be evaluated separately; the lines that are used to define the boundaries of the levels should be drawn separately for each side of the neck. The lines need not actually be drawn; when one becomes familiar with the classification, one can visually approximate the lines or place a straight-line guide or ruler on the image or monitor. When a lymph node is transected by one of the lines that define the levels, the side of the line on which most of the nodal cross-sectional area lies is the level in which the lymph node should be classified. The supraclavicular fossa is defined on each axial scan when any portion of the clavicle is identified on one side of the neck; if the scan level is cranial to any portion of the clavicle, the nodes in the lower lateral neck should be classified as either level IV or level VB. Once any portion of the clavicle is seen on the scan, such nodes are classified as supraclavicular nodes. If nodes are seen below the level of the

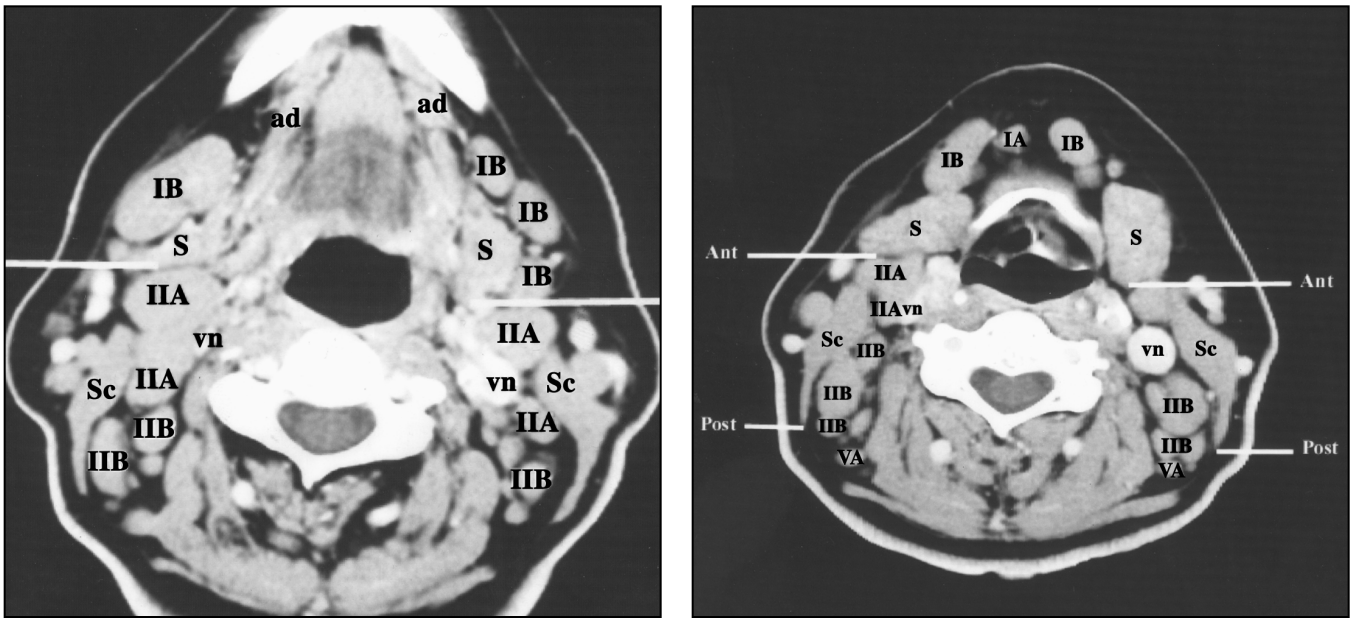



**Fig. 2.**—44-year-old man with lymphoma. ad = anterior belly of digastric muscle, S = submandibular gland, vn = internal jugular vein, Sc = sternocleidomastoid muscle.
**A**, Axial contrast-enhanced CT scan of neck through floor of mouth and above level of hyoid bone. White line is drawn through back of each submandibular gland. Nodes anterior to lines are level I nodes and, because they are lateral to medial margin of each anterior belly of the digastric muscle, they can be subclassified as level IB nodes. Level II nodes are posterior to white lines, but anterior to posterior edge of sternocleidomastoid muscle. Level II nodes, either anterior to the internal jugular vein or posterior to it but touching it, are subclassified as level IIA nodes. Nodes posterior to internal jugular vein and not touching it are subclassified as level IIB nodes.
**B**, Axial contrast-enhanced CT scan of neck through floor of mouth and at level of hyoid bone. Because level is cranial to that of bottom of body of hyoid bone, internal jugular nodes are classified as level II, not level III. On each side of neck, transverse white line (Ant) has been drawn through posterior edge of each submandibular gland. Second white line (Post) has been drawn through posterior edge of each sternocleidomastoid muscle. Nodes anterior to line (Ant) are level I nodes. Nodes between line (Ant) and line (Post) are level II nodes. Nodes posterior to line (Post) are level V nodes. Because level V nodes are cranial to level of bottom of body of cricoid cartilage arch, they are subclassified as level VA nodes.

clavicle and lateral to the ribs, they are axillary nodes. The clinically important internal jugular nodes described by Rouvière [1] are now classified as level II, III, or IV nodes, depending on their locations with reference to the axial scan levels of the bottom of the body of the hyoid bone and the bottom of the arch (anterior rim) of the cricoid cartilage.

*The Imaging-Based Classification*

Level I includes all nodes above the hyoid bone, below the mylohyoid muscle, and anterior to a transverse line drawn on each axial image through the posterior edge of the submandibular gland (Figs. 2 and 3). Thus, level I nodes include the previously classified submental and submandibular nodes, and they can be subclassified into levels IA and IB.

Level IA represents the nodes that lie between the medial margins of the anterior bellies of the digastric muscles, above the hyoid bone, and below the mylohyoid muscle (previously classified as submental nodes) (Figs. 2 and 3).

Level IB represents the nodes that lie below the mylohyoid muscle, above the hyoid bone, posterior and lateral to the medial edge of the anterior belly of the digastric muscle, and anterior to a transverse line drawn on each axial image tangent to the posterior surface of the submandibular gland on each side of the neck (previously classified as submandibular nodes) (Figs. 2 and 3).

Level II extends from the skull base, at the lower level of the bony margin of the jugular fossa, to the level of the lower body of the hyoid bone (Figs. 2–5). Level II nodes lie anterior to a transverse line drawn on each axial image through the posterior edge of the sternocleidomastoid muscle and lie posterior to a transverse line drawn on each axial scan through the posterior edge of the submandibular gland. If a node situated within 2 cm of the skull base lies anterior, lateral, or posterior to the carotid sheath, it is classified as a level II node. If the node lies medial to the internal carotid artery, it is classified as a retropharyngeal node (Fig. 5). Caudal to 2 cm below the skull base, level II nodes can lie anterior, lateral, medial, and posterior to the internal jugular vein. Level II nodes can be subclassified into levels IIA and IIB.

Level IIA nodes are level II nodes that lie posterior to the internal jugular vein and are inseparable from the vein or that lie anterior, lateral, or medial to the vein (previously classified as upper internal jugular nodes) (Figs. 2–5).

Level IIB nodes are level II nodes (previously classified as upper spinal accessory nodes) that lie posterior to the internal jugular vein and have a fat plane separating the nodes and the vein (Figs. 2 and 3).

Level III nodes lie between the level of the lower body of the hyoid bone and the level of the lower margin of the cricoid cartilage arch (Figs. 6 and 7). These nodes lie anterior to a transverse line drawn on each axial image through the posterior edge of the sternocleidomastoid muscle. Level III nodes also lie lateral to the medial margin of either the common carotid artery or the internal carotid artery. On each side of the neck, the medial margin of these arteries separates level III (lateral) nodes from level VI (medial) nodes. Level III nodes were previously known as the mid jugular nodes.

Level IV nodes lie between the level of the lower margin of the cricoid cartilage arch and the level of the clavicle on each side as seen on each axial scan. These nodes lie anterior and medial to an oblique line drawn through the posterior edge of the sternocleidomastoid muscle and the posterolateral edge of the anterior scalene muscle on each axial image (Figs. 7–10). The medial aspect of the common carotid artery is the landmark that separates level IV

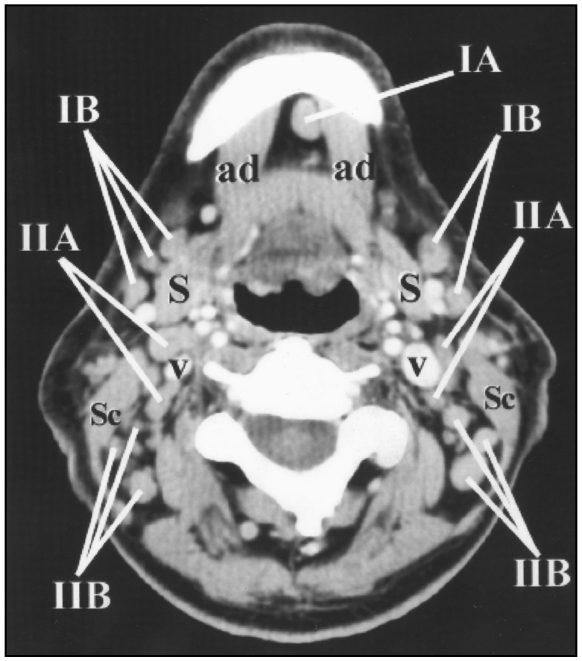



**Fig. 3.**—36-year-old HIV-positive man. Axial contrast-enhanced CT scan of neck through level of lower mandible and above hyoid bone shows level IA node between medial margins of anterior bellies of digastric muscles (ad). Level IB nodes are lateral to level IA nodes and anterior to back of submandibular glands (S). Levels IIA and IIB nodes are seen bilaterally. v = internal jugular veins, Sc = sternocleidomastoid muscles.

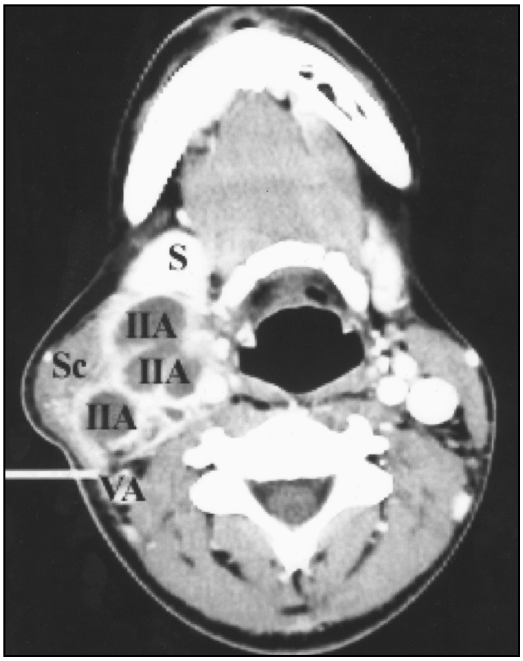



**Fig. 4.**—Axial contrast-enhanced CT scan of neck through level of hyoid bone in 57-year-old man with squamous cell carcinoma of pharynx. White line has been drawn through posterior edge of right sternocleidomastoid muscle (Sc). Note conglomerate mass of necrotic level IIA nodes in right neck posterior to submandibular gland (S). Small necrotic level VA nodes are also present on right side.

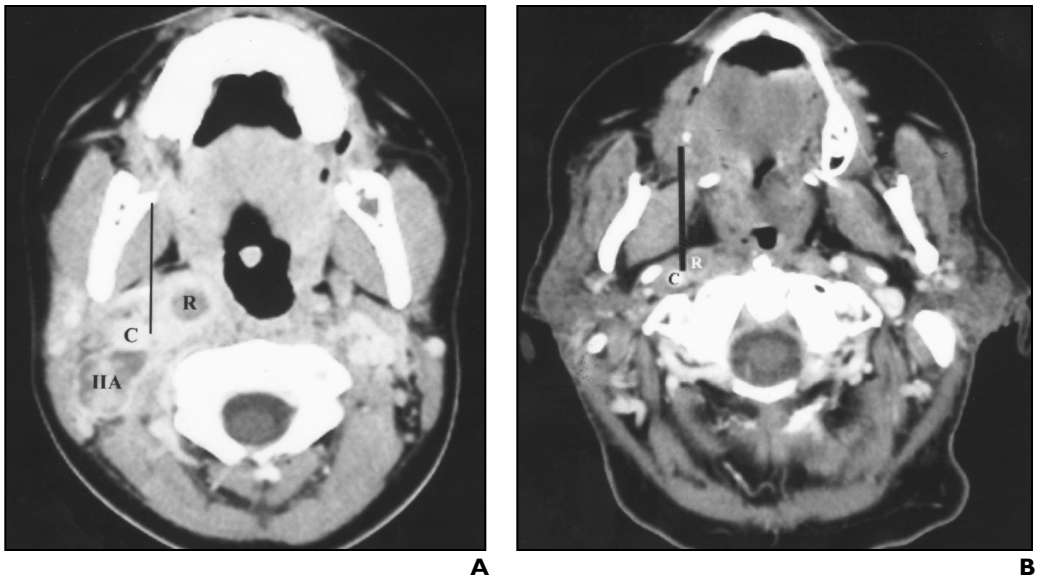



**Fig. 5.**—14-year-old boy (**A**) and 46-year-old man (**B**) with nasopharyngeal carcinomas.
**A** and **B**, Axial contrast-enhanced CT scans show neck at level just below skull base. Sagittal black line has been drawn along medial aspect of right internal carotid artery (C). Note retropharyngeal necrotic node (R) medial to this line. Also note necrotic high level II node (**A**), which can be subclassified as level IIA node because it is inseparable from carotid sheath.

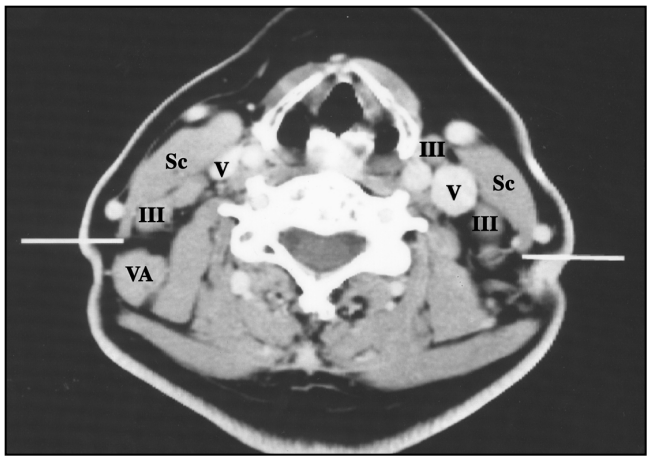



**Fig. 6.**—47-year-old woman with lymphoma. Axial contrast-enhanced CT scan of neck at level of supraglottic larynx shows transverse white line drawn on each side at posterior edge of sternocleidomastoid muscle (Sc). Bilateral level III nodes and right-sided level VA node are seen. V = internal jugular vein.

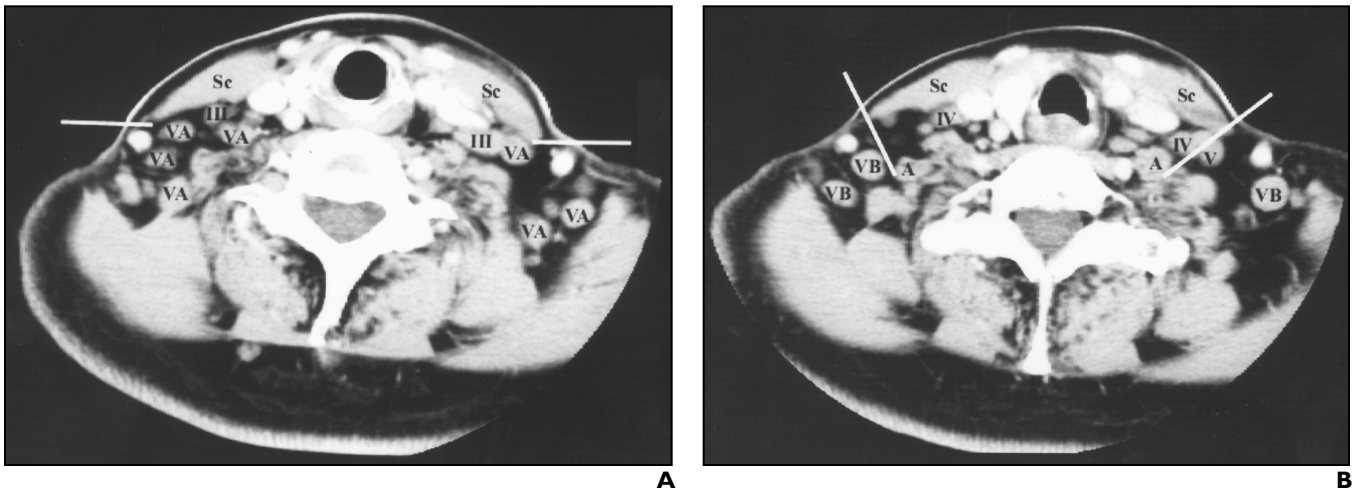



**Fig. 7.**—46-year-old woman with lymphoma.
**A**, Axial contrast-enhanced CT scans of neck at level of cricoid cartilage. On each side of neck, transverse white line has been drawn at posterior edge of sternocleidomastoid muscle (Sc). Because scan level is above bottom of cricoid arch, internal jugular nodes are classified as level III and not level IV. Level VA nodes are posterior to lines.
**B**, Axial contrast-enhanced CT scans of neck through thyroid gland shows oblique white line drawn on each side of neck through posterolateral margin of anterior scalene muscle (A) and posterior margin of sternocleidomastoid muscle (Sc). Levels IV and VB nodes are seen. No portion of clavicle is present on either side so supraclavicular nodes cannot be diagnosed.

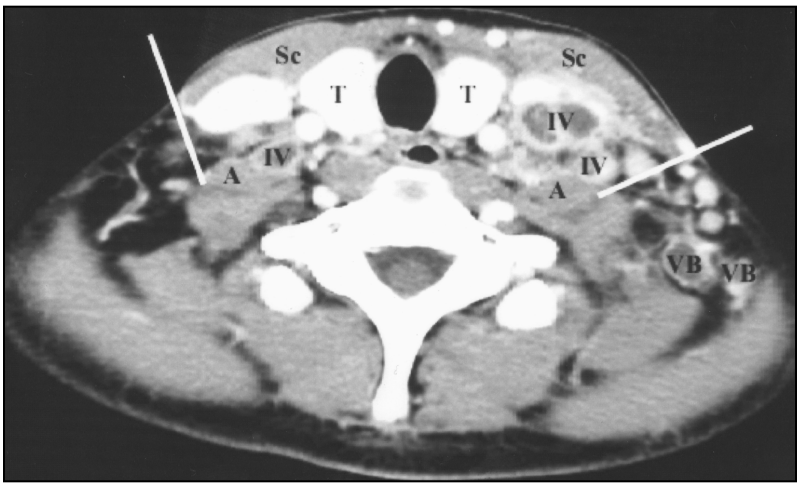



**Fig. 8.**—48-year-old man with nasopharyngeal carcinoma. Axial contrast-enhanced CT scan of neck through level of thyroid gland (T) shows oblique white line drawn on each side of neck through posterolateral margins of anterior scalene muscle (A) and posterior margin of sternocleidomastoid muscle (Sc). Necrotic nodes are seen at level IV and VB .

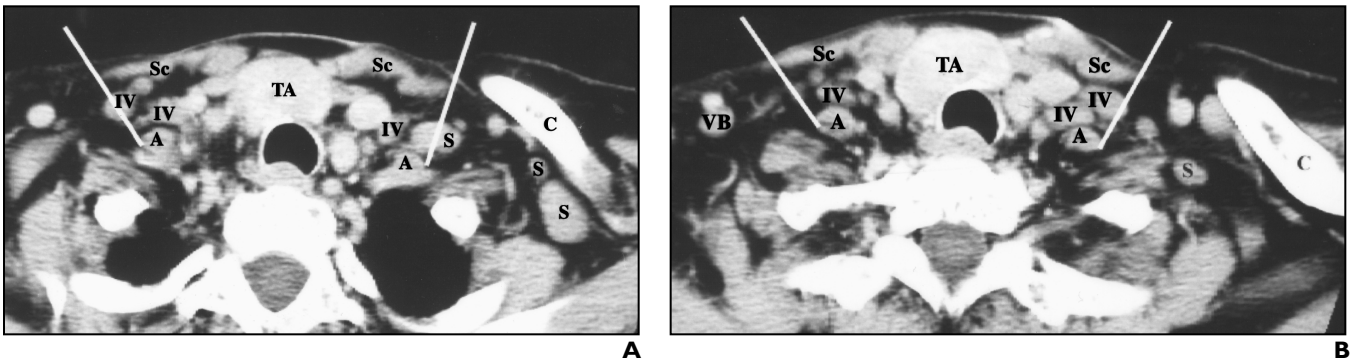



**Fig. 9.**—54-year-old woman with lymphoma.
**A** and **B**, Axial contrast-enhanced CT scans of neck through level of lower thyroid gland show incidental thyroid adenoma (TA). **A** is slightly more cranial than **B**. On each side of neck oblique white line has been drawn through posterolateral margins of anterior scalene muscles (A) and posterior margin of sternocleidomastoid muscles (Sc). Level IV and VB nodes are seen. On left side, portion of clavicle (C) is seen on both images; thus, left level V nodes are classified as supraclavicular nodes (S).

nodes (lateral to this artery) from level VI nodes (medial to this artery) (Fig.10). Level IV nodes were previously known as the low jugular nodes.

Level V nodes extend from the skull base, at the posterior border of the attachment of the sternocleidomastoid muscle, to the level of the clavicle as seen on each axial scan (Figs. 2, 4, 6–8, 10). Level V nodes all lie anterior to a transverse line drawn on each axial scan through the anterior edge of the trapezius muscle. Between the levels of the skull base and the bottom of the cricoid arch, these nodes are situated posterior to a transverse line drawn on each axial scan through the posterior edge of the sternocleidomastoid muscle (Figs. 4, 6, 7). Between the axial level of the bottom of the cricoid arch and the level of the clavicle, level V nodes lie posterior and lateral to an oblique line through the posterior edge of the sternocleidomastoid muscle and the posterolateral edge of the anterior scalene muscle (Figs. 7, 8–10). The level V nodes can be subdivided into VA and VB nodes.

Level VA (upper level V) nodes lie between the skull base and the level of the lower margin of the cricoid cartilage arch, behind the posterior edge of the sternocleidomastoid muscle (Figs. 2, 4, 6, 7).

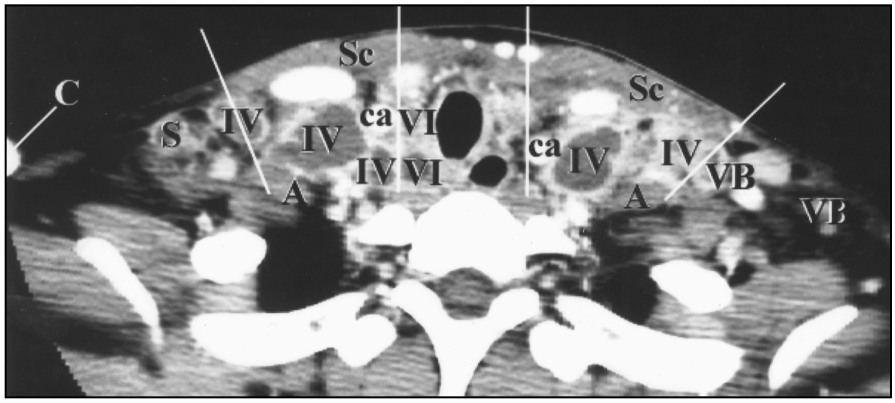
Level VB (lower level V) nodes on each side lie between the level of the lower margin of the cricoid cartilage arch and the level of the clavicle as seen on each axial scan. They are behind an oblique line through the posterior edge of the sternocleidomastoid muscle and the posterolateral edge of the anterior scalene muscle (Figs. 7–10).

Level VI nodes lie inferior to the lower body of the hyoid bone, superior to the top of the manubrium, and between the medial margins of the left and right common carotid arteries or the internal carotid arteries. They are the visceral nodes (Fig.10).

Level VII nodes lie caudal to the top of the manubrium in the superior mediastinum, between the medial margins of the left and right common carotid arteries (Fig.11). These superior mediastinal nodes extend caudally to the level of the innominate vein.

To be consistent with the earlier classifications, most nodal groups continue to be referred to by their anatomic names: supraclavicular, retropharyngeal, parotid, facial, occipital, postauricular, and the other superficial nodes.

In conclusion, CT and MR imaging form an integral part of the assessment of most head and neck cancer patients. The imaging findings complement the physical examination, and the imaging-based classification provides the radiologist with clinically acceptable guidelines for classifying the cervical nodes and communicating these findings to clinicians. This new classification provides precision and reproducibility to nodal localization; we hope that imaging will now become a necessary component of patient classification and staging.

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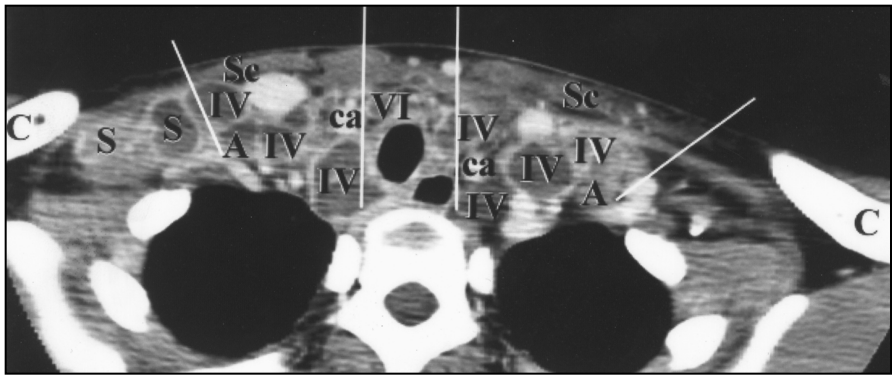


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**Fig. 10.**—28-year-old woman with lymphoma.
**A** and **B**, Axial contrast-enhanced CT scans through level of lower neck. **A** is slightly more cranial than **B**. On each side of neck oblique white line has been drawn through posterior and lateral margins of anterior scalene muscles (A) and posterior margins of sternocleidomastoid muscles (Sc). Sagittal white line is drawn through medial margin of each carotid artery (ca). Necrotic levels IV and VI nodes, right supraclavicular nodes (S), and level VB nodes are seen. C = clavicle.

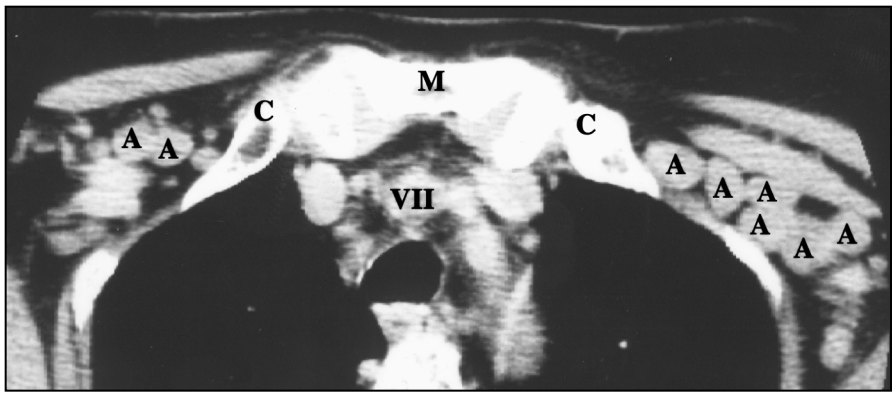


**Fig. 11.**—67-year-old man with lymphoma. Axial contrast-enhanced CT scan of neck through level just below top of manubrium (M) shows medial clavicle (C) on each side. Level VII node is seen in superior mediastinum. Multiple axillary nodes (A) lie lateral to ribs on each side of upper chest.

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**APPENDIX: Summary of the Imaging-Based Nodal Classification**

| Nodes | Definition |
|---|---|
| **Level I:** | • Above hyoid bone<br>• Below mylohyoid muscle<br>• Anterior to back of submandibular gland<br>• Previously classified as submental and submandibular nodes |
| **Level IA:** | • Between medial margins of anterior bellies of digastric muscles<br>• Previously classified as submental nodes |
| **Level IB:** | • Posterolateral to level IA nodes<br>• Previously classified as submandibular nodes |
| **Level II:** | • From skull base to level of lower body of hyoid bone<br>• Posterior to back of submandibular gland<br>• Anterior to back of sternocleidomastoid muscle |
| **Level IIA:** | • Anterior, lateral, medial, or posterior to internal jugular vein<br>• Inseparable from internal jugular vein (if posterior to vein)<br>• Previously classified as upper internal jugular nodes |
| **Level IIB:** | • Posterior to internal jugular vein with fat plane separating nodes and vein<br>• Previously classified as upper spinal accessory nodes |
| **Level III:** | • From level of lower body of hyoid bone to level of lower cricoid cartilage arch<br>• Anterior to back of sternocleidomastoid muscle<br>• Previously known as mid jugular nodes |
| **Level IV:** | • From level of lower cricoid cartilage arch to level of clavicle<br>• Anterior to line connecting back of sternocleidomastoid muscle and posterolateral margin of anterior scalene muscle<br>• Lateral to carotid arteries<br>• Previously known as low jugular nodes |
| **Level V:** | • Posterior to back of sternocleidomastoid muscle from skull base to level of lower cricoid arch<br>• From level of lower cricoid arch to level of clavicle as seen on each axial scan<br>• Posterior to line connecting back of sternocleidomastoid muscle and posterolateral margin of anterior scalene muscle<br>• Anterior to anterior edge of trapezius muscle |
| **Level VA:** | • From skull base to level of bottom of cricoid cartilage arch<br>• Posterior to back of sternocleidomastoid muscle<br>• Previously known as upper level V nodes |
| **Level VB:** | • From level of lower cricoid arch to level of clavicle as seen on each axial scan<br>• Posterior to line connecting back of sternocleidomastoid muscle and posterolateral margin of anterior scalene muscle<br>• Previously known as lower level V nodes |
| **Level VI:** | • Between carotid arteries from level of lower body of hyoid bone to level superior to top of manubrium<br>• Previously known as visceral nodes |
| **Level VII:** | • Between carotid arteries below level of top of manubrium<br>• Caudal to level of innominate vein<br>• Previously known as superior mediastinal nodes |
| **Supraclavicular:** | • At or caudal to level of clavicle as seen on each axial scan<br>• Lateral to carotid artery on each side of neck<br>• Above and medial to ribs |
| **Retropharyngeal:** | • Within 2 cm of skull base and medial to internal carotid arteries |

**Note.—**For levels I–V, the nodes are classified for each side of the neck. The parotid nodes and other superficial nodes are referred to by their anatomic names. (Appendix modified and reprinted with permission from [16])