Selective Neck Dissection: CT and MR Imaging Findings

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AJNR Am J Neuroradiol 2005, 26 (5) 1174-1177
http://www.ajnr.org/content/26/5/1174

AJNR Am J Neuroradiol 26:1174–1177, May 2005

Selective Neck Dissection: CT and MR Imaging Findings

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BACKGROUND AND PURPOSE: **Selective neck dissection (SND) has become a common surgical procedure for selectively treating known or potential metastatic nodal disease from head and neck cancer while preserving functional structures. The purpose of this article is to describe the expected CT and MR findings after SND.**

METHODS: **CT (26/27) or MR images (1/27) from 27 consecutive patients treated with SND for either staging or nodal control of head and neck malignancy were retrospectively reviewed by two experienced head and neck radiologists. One patient had bilateral SND. The quantity of deep cervical fat was subjectively assessed, as was patency of the ipsilateral internal jugular vein (IJV) and asymmetry in size and contour of the sternocleidomastoid (SCM), trapezius, and infrahyoid strap muscles. The presence of the submandibular gland was noted.**

RESULTS: **Twenty-seven of 28 necks had marked decrease in fat beneath the SCM muscle. This resulted in the muscle directly abutting the paraspinal muscles in most cases. The SCM muscle contour and size was asymmetric or flattened and atrophic in 16/28 necks. Atrophy of the infrahyoid strap muscles was seen in 8/28 necks. Six of 28 had no detectable IJV, and it was presumably thrombosed. Submandibular gland was not present in 17/28 cases.**

CONCLUSION: **The imaging findings after SND are characteristic and reflect the type of surgery performed. If level I nodes are removed, the submandibular gland is absent. Marked decrease in deep cervical fat is common. Changes in and around the SCM muscle are routinely seen and include posterior and medial displacement of the muscle, distortion and flattening of the muscle, or atrophy, despite surgical preservation of spinal accessory nerve. Finally, although the IJV is not resected in SND, nonvisualization of the vein on postoperative images may reflect thrombosis.**

Extirpation of cervical lymph nodes at risk for harboring metastatic disease in a patient with head and neck malignancy has two goals: first, to stage disease at time of presentation; and, second, to control nodal metastases (1–3). The cervical nodes are contained in the areolar tissue of the neck, along with functionally significant structures: internal jugular vein (IJV), spinal accessory nerve (SAN), and the cervical muscles. The traditional radical neck dissection (RND) involves removal of lymph node groups I–V, as well as the IJV, SAN, and sternocleidomastoid (SCM) muscle. A disadvantage of the RND is the "shoulder syndrome," consisting of pain and reduced function following sacrifice of the SAN (1, 4–6). The modified neck dissection (MND) preserves one or more of the functional structures in an attempt to avoid shoulder pain, cosmetic deformity, and potential venous obstruction. Selective neck dissection (SND) is a procedure that resects the nodal chains commonly involved in head and neck cancer, levels I–V, but leaves functional structures (the IJV, SCM muscle, and SAN) intact. It has become a surgically and oncologically acceptable alternative to RND and MND in patients with head and neck cancer (7).

The nodal levels resected during SND depend on the lymph node groups at risk for a particular tumor. For example, squamous cell carcinoma of the oral cavity commonly metastasizes to level I–III nodal groups (submandibular and submental, and high and midjugular chain nodes), which are resected during SND. On the other hand, laryngeal carcinoma usually spares level I, so that only nodal groups II–IV are included in SND. In the 1990s, SNDs were grouped into one of four types (supraomohyoid, lateral, pos-

Received October 2, 2002; accepted after revision October 14, 2004.

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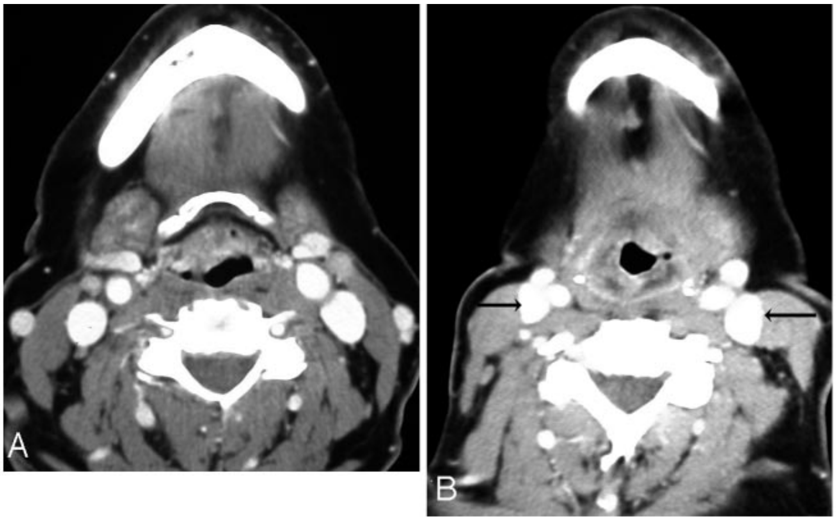

FIG 1. Squamous cell carcinoma, supraglottic larynx, treated with bilateral SND.

A, Preoperative axial postcontrast enhanced 3-mm-thick CT image. Note the mass on the laryngeal surface of the suprahyoid epiglottis, and the small bilateral level IIA nodes. Both were positive on pathologic examination, despite the small size. The SCM muscles are normal in contour and symmetric.

B, Postoperative 3-mm-thick CT image, same patient, following supraglottic laryngectomy and bilateral SND (levels II, III, and IV on the left and I–IV on the right). There is marked decrease, bilaterally, in the fat about the carotid sheath, and the SCM muscles appear short and thick. On the right side, the undersurface of the SCM abuts the lateral aspect of the paraspinal muscles. Both internal jugular veins are patent and are flattened laterally (*arrows*) when in direct contact with the undersurface of the sternocleidomastoid muscles.

terolateral, or anterior) depending on the nodal levels resected (7, 8). An updated classification, proposed in 2001 (7), has replaced the older one. This classification refers to SND, and in parentheses the nodal levels are included in the resection. For example, if levels I, II, and III were resected, it is termed "SND (I, II, III)."

Although many radiologists are familiar with the CT and MR imaging appearance after RND, the imaging findings after SND are less well known. The purpose of this work is to describe the expected postoperative findings after SND on cross-sectional images.

Methods

CT (26/27) or MR images (1/27) from 27 consecutive patients treated with SND for either staging or nodal control of head and neck malignancy were retrospectively reviewed by two experienced head and neck radiologists (P.A.H., S.K.M.). CT was performed following administration of 100 mL of iodinated contrast medium at 2 mL/s then 1.0 mL/s for 50 mL for a total of 150 mL. Image acquisition began after a 40-second delay. Axial imaging began at the roof of the frontal sinus, or at the skull base, and 3-mm section increments were obtained by using a spiral technique, pitch of 1, 140 kVp, 220 mAs, and reconstruction interval of 3 mm. Standard soft tissue and bone windows were photographed and were available for review. In a single patient, high-resolution multiplanar MR images were obtained with a neck coil, both before and after intravenous Gadolinium administration.

Imaging findings that were reviewed included primary tumor resection site, contrast enhancement within the ipsilateral IJV (considered confirmation of patency), contour of the ipsilateral SCM and infrahyoid strap muscles, asymmetry in size of the SCM or infrahyoid strap muscles, presence of the ipsilateral submandibular gland, and amount of fat beneath the SCM and around the carotid sheath. If surgery had not been performed on the contralateral neck, the appearances of the muscles and fat were compared with the patient's normal side. If surgery was performed on the contralateral neck, the fat and muscles were compared with preoperative films. Clinical charts or operative notes were reviewed to determine the interval between surgery and imaging and to confirm nodal levels resected during SND.

Results

The study population consisted of 27 patients (14 female, 13 male; mean age, 57 years; age range, 40–78 years). Histologic results of primary lesions included 25 cases of squamous cell carcinoma of head and neck origin, one case of thyroid primary, and one case of melanoma. Primary sites included 10 of the oral cavity, 8 of the oropharynx, 5 of the larynx, 3 cutaneous, and 1 thyroid. Time since surgery ranged from 4 to 50 months, with an average time of 20 months.

Twenty-eight cases of SND were evaluated. One patient had bilateral SND. Three of 27 patients had bilateral neck dissections that included a radical dissection on one side and SND on the other. The RND and MND were not evaluated for the purposes of this study.

Seventeen of 28 SNDs showed absence of the ipsilateral submandibular gland. Only 1/28 that had undergone SND had a normal appearance to the fat beneath the SCM and around the carotid sheath. In most cases, there was a decrease in deep cervical fat and fibroadipose tissue (Figs 1 and 2), and as a result, the IJV and carotid artery were located directly between the undersurface of the SCM and paraspinal muscles. Posterior to the carotid artery and IJV, the SCM muscle directly abutted the paraspinal muscles. There was no obvious trend between the postoperative changes and the time since surgery.

The appearance of the SCM was variable, ranging from normal in 12/28, to flattened, thicker, smaller and/or atrophic compared with the contralateral muscle in 16/28 (Figs 1B, 2, and 3). The infrahyoid strap muscles on the side of the SND were also variable in appearance (Fig 3) and were so atrophic in 8/28 that they were initially thought to have been resected.

Six of 28 cases had no detectable ipsilateral IJV, with no discernible contrast enhancement within the IJV (Fig 3), whereas 22/28 had contrast enhancement within the IJV. All patients with no enhancement within the IJV were >3 months from surgery.

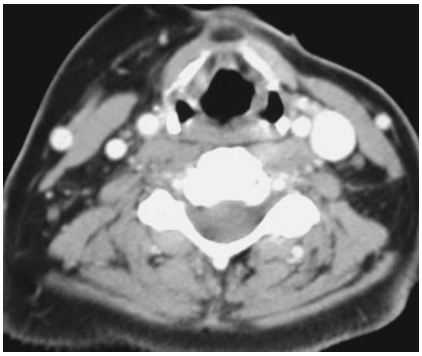

FIG 2. Patient has undergone resection of oropharyngeal squamous cell carcinoma, and left SND (levels I, II, and III). Postoperative CT scan of 3-mm-section thickness was obtained several months following surgery. There is marked paucity of fat beneath the left SCM muscle, and the muscle lies directly on top of the internal jugular vein.

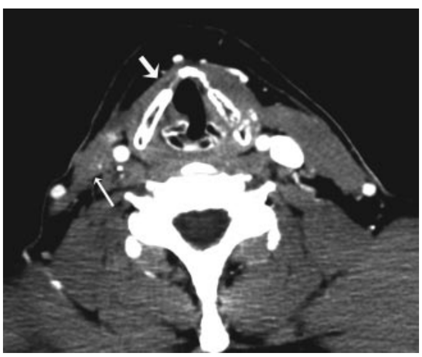

FIG 3. Patient treated for right tonsillar cancer with right SND (levels II, III, and IV). The right SCM muscle (*thin arrow*) is atrophic, thinned and flat compared with the left side, and there is decreased fat beneath the muscle. There is marked atrophy of the right infrahyoid strap muscles (*thick arrow*). Note lack of opacification of the right IJV, presumably due to thrombosis. The right true vocal cord palsy is unrelated to the surgery.

Discussion

Extirpation of cervical lymph nodes at risk for harboring metastatic disease in a patient with head and neck malignancy has two goals: first, to determine the stage of disease at time of presentation; and, second, for loco-regional control of nodal metastases. Until recently, the RND and the MND were the most frequently performed procedures for control of local nodal disease. Since the early 1980s, there has been considerable controversy among head and neck surgeons regarding the surgical procedure of choice. It has been argued that the role of a neck dissection is to remove fibroadipose tissue in which cervical nodes are embedded, and the removal of muscles, veins, and nerves occurs simply because they are in close proximity to the nodal groups and for no sound oncologic reason (1). A procedure that spares the functionally important structures (SAN, SCM muscle, IJV) made oncologic sense, and the MND was developed.

The main surgical procedures traditionally performed for regional control of nodal metastatic disease are the two comprehensive procedures, the RND and the MND. The RND included removal of level I–V nodes, the fibroadipose tissue surrounding the nodes, the SCM muscle, IJV, and the SAN (8). The submandibular gland is also routinely resected when level I nodes are removed. The MND is a modification of the RND, and preserves one or more of the functional, or nonlymphatic, structures, including the SCM muscle, SAN, or IJV.

Removal of each of the functional structures may result in a distinct clinical syndrome. Pain in the shoulder, a winged scapula, and weak abduction, termed "shoulder syndrome," due to adhesive capsulitis, often results from trapezius muscle denervation after SAN sacrifice (5, 6). Although shoulder rehabilitation exercises are begun as soon as possible after surgery, this syndrome adversely affects quality of life for patients (4, 5, 9). Modifications of the RND were developed expressly to avoid loss of the SAN, while still removing nodes at risk for metastases. Clinical results have shown that, if the SAN is spared, the shoulder syndrome is less common, with less pain and functional disability and improved strength and range of motion (4, 6, 9). Unfortunately, adequate postoperative function of the trapezius muscle is not always seen, even with preservation of the SAN (9). This may explain why, even after SAN-sparing surgery, atrophy of the trapezius muscle may be seen on cross-sectional images. Future work could address whether the appearance of trapezius muscle atrophy or flattened contour correlates with shoulder pain. Even with SAN preservation, atrophy or asymmetry in the SCM muscle may be seen. Infrahyoid strap muscle atrophy may reflect inadvertent surgical injury to that muscle group innervation.

After IJV resection, and especially if both IJVs are removed, there may be clinically significant adverse effects such as chronic face and neck edema and skin discoloration (10). Bilateral IJV resection, which may be required if there is bilateral nodal disease, carries significant morbidity and may result in venous hypertension and cerebral edema (10, 11). IJV thrombosis following SND has been reported, and is important to note, especially if further surgery is planned (10–13). IJV occlusion after SND, based on sonography or venography findings, ranges from 0% to 30% and appears to be more common after wound infection, fistula, or radiation treatment (11, 12). Explanations for IJV thrombosis following SND include endothelial venous injury or increased coagulability. Approximately 20% of patients in our series had no visible jugular vein ipsilateral to the SND. We speculate that sonography may be a more sensitive technique for assessing IJV patency, because maneuvers that increase jugular venous pressure, such as the Valsalva maneuver, can dynamically assess flow.

The MND is considered a modification of the RND and was developed to minimize the morbidity of resecting the functional or nonlymphatic structures (14). More recently, it was realized that the cervical lymph node groups are not all at equal risk for metastases, and selective removal of groups at risk was undertaken as SND. This procedure preserves all three of the functional structures, the SAN, IJV, and SCM muscle as well as some of the lymph node groups within the neck. It has been recommended that the nomenclature be changed to simply state that the procedure was "selective" and then list the nodal groups that were dissected (7). Therefore, all SNDs spare the SCM muscle, IJV, and SAN and differ only in the nodal regions resected. The specific nodal levels included in SND differ on the basis of the primary tumor and the predicted pattern of nodal spread particular for a malignancy in that location or if a metastatic node is encountered during the dissection. A standard nomenclature describing the various SNDs has been proposed (7).

Our hypothesis was that the imaging findings would reflect the respective surgical procedures. We expected no muscular atrophy, as the innervation was spared, a patent IJV with robust enhancement within the vessel, and a marked loss of fat beneath the SCM muscle and about the carotid sheath, as the fibroadipose tissue around the internal jugular nodal chains is routinely resected. The deep cervical fat manifests a natural CT and MR contrast around the nodal groups, and with the resection of this fat, the SCM directly abuts the carotid sheath and the paraspinal musculature.

Conclusion

SND has become a popular surgical procedure for selectively treating known or potential metastatic disease from head and neck cancer while preserving functional structures. The postoperative imaging findings reflect the selective surgery. There is almost always loss of pericarotid and deep cervical fibroadipose tissue. Even with SAN preservation, atrophy or asymmetry in the SCM may be seen. Infrahyoid strap muscle atrophy is also a common finding. Patency of the ipsilateral IJV should be noted by the radiologist, as thrombosis of the vein may occur. This may affect future surgery, because the contralateral IJV will need to be preserved.

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