Surgical Anatomy of the Neck

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The radical neck dissection is a safe, effective therapeutic procedure for eradication of metastatic neoplasia originating in the head and neck region. Utilizing the steps of the radical neck dissections as an outline, we will present specific aspects of neck anatomy requisite to a complete and safe dissection.

Lymphatics

The purpose of the radical neck dissection is to remove the lymphatics and the drainage areas of primary cancers originating in the head and neck. Applying this principle of regional lymphatic excision (radical dissection), all cervical lymphatics and, in addition, certain adjacent muscles, nerves, and glands must be sacrificed to facilitate complete extirpation of the disease. A "partial" or upper neck dissection for carcinoma violates the lymph node bearing fields and negates the tenets of the en bloc dissection of cervical lymphatics.

Rouviere has classified the cervical lymph nodes into ten principal groups. They may be further recognized conceptually as a superior horizontal chain arranged about the base of the head and jaw, leading to a vertical chain in the midportion of the neck and another horizontally oriented chain in the supraclavicular region. The groups of nodes in the superior horizontal chain are the submental, submandibular, preauricular (parotid), postauricular (mastoid), and occipital. These nodes receive afferents from the integument of the head and mucous membranes of the nasal and oral cavities and the adjacent nasopharynx, oropharynx, tonsil region, and the salivary glands. Their efferents drain into the vertically oriented deep jugular nodes. This jugular chain, in addition, receives major afferents to its important subdigastric nodes from the deep parotid region, the nasopharynx, and the tonsil. A posteriorly and more superficially oriented vertical group is in relation to the spinal accessory nerve and the external jugular vein. An anteriorly oriented chain drains the cervical viscera and the thyroid gland. The supraclavicular horizontal chain receives afferents from the vertical chains immediately superior, the upper thoracic wall, and the upper extremity.

The primary lymphatic ducts deliver large volumes of lymph and chyle into the venous system, and if injured surgically should be securely ligated. On the right, three terminal lymphatic trunks empty into the junction of the right subclavian and the right internal jugular vein, either directly or indirectly. These trunks are the subclavian trunk from the supraclavicular nodes, the jugular trunk, and the bronchomediastinal trunk. It is unusual for these three trunks to coalesce to form a true right lymphatic duct. On the left, the chief collecting channel of the lymphatic system which drains all lymphatics from below the diaphragm, the left half of the thorax, the left side of the head and neck, and the left upper extremity is the thoracic duct. It may receive the jugular, subclavian, and bronchomediastinal trunks on the left side. Occasionally, however, one or more of these trunks may enter separately.
An en bloc resection of all the lymphatic bearing tissues will therefore require dissection from the inferior margin of the mandible to the clavicle and from the anterior aspect of the trapezius muscle to the muscles covering the cervical viscera. These tissues also lie between the deep investing cervical fascia and the prevertebral lamina of the deep cervical fascia. Of necessity, this en bloc resection includes the sternocleidomastoid muscle, the jugular vein, submaxillary gland, omohyoid muscle, spinal accessory nerve, the external jugular vein, and the tail of the parotid. Usually, the posterior belly of the digastric and the sternohyoid muscles are also included in the resection. If there is involvement in the submental region, the anterior belly of the digastric is taken.

Incisions

Cervical incisions should be designed to provide adequate exposure, avoid superimposition of intraoral, pharyngeal, or laryngeal incisions, and follow the natural transverse skin lines of the neck, thus favoring optimum healing and appearance. Particularly in cases which follow upon preoperative irradiation, these incisions should be adequately vascularized and so designed that the flaps are safe from necrosis or delayed healing over the carotid artery. The double transverse incision as described by MacFee is quite safe and meets these criteria admirably. Its upper limb extends at the level of the hyoid in a slight curve from the trapezius anteriorly to approximately midline. The lower incision is transverse 2.5 cm above the clavicle. An alternative incision has a vertical limb along the anterior trapezius and a single transverse limb extending anteriorly in the midportion of the neck. These incisions both avoid the oft used trifurcate incision of Crile and Martin which is so vulnerable to necrosis over the carotid artery. In order to gain access to the intraoral structures, the upper transverse limb of these incisions may be curved and extended to the midline of the lower lip, thus providing a well vascularized flap which can be rotated posteriorly.

The cervical nodes all lie deep to the investing layer of the deep cervical fascia. Therefore, the skin flaps are elevated immediately beneath the thin platysma muscle and just above the investing layer. The primary superficial veins - external jugular, anterior jugular, and facial - lie just beneath the platysma and superficial to the investing layer of the deep cervical fascia.

During elevation of the flaps, the sensory branches of the cervical plexus are divided as they emerge from the posterior aspect of the sternocleidomastoid muscle and penetrate the investing layer of the deep cervical fascia. These include the greater auricular nerve and branches C-2 through C-4. These cutaneous nerves will be divided again as they penetrate at the prevertebral lamina of the cervical fascia at the deep extent of the surgical field. Thus, a segment of them is included in the specimen. These nerves, particularly the greater auricular, are excellent for interposition donor grafts for nerve repairs such as the seventh.

Root of the Neck

Removal of the specimen always proceeds in centripetal fashion; in the manner the potential cancer-bearing lymphatics are not violated. The dissection usually beings in the supraclavicular area where the superficial or investing lamina of the deep cervical fascia over the sternocleidomastoid muscle is divided approximately 2 to 3 cm above the clavicle. This layer of fascia completely encompasses the neck and invests the sternocleidomastoid,
omohyoid, and trapezius muscles. It continues upward as the fascia of the parotid and submaxillary gland. The sternal and clavicular heads of the sternocleidomastoid muscle are divided at this level parallel to the clavicle. The carotid sheath, a condensation of the cervical fascia, is entered 2 to 3 cm above the clavicle and the jugular vein is isolated, carefully ligated, and divided after absolute identification of the adjacent vagus nerve and protection of the common carotid artery. The vagus nerve may inadvertently be lifted up with the jugular vein and carelessly included in the ligating sutures. Injury at this level will include those fibers which make up the recurrent laryngeal nerve.

The dissection then continues posterior in the supraclavicular triangle to the anterior border trapezius and down to the level of the prevertebral lamina. The main lymphatic trunks emptying into the junction of the subclavian and jugular veins are preserved; however, if injured they should be securely ligated. The external jugular vein, coursing to the subclavian vein, is ligated and divided and will be reflected upward with the specimen. The transverse cervical artery, a terminal branch of the thyrocervical trunk from the first portion of the subclavian artery, must be divided and included in the specimen along with the accompanying veins and lymph nodes about these vessels. The node-bearing fatty areolar tissue in the posteroinferior aspect of the supraclavicular triangle is included in the en bloc dissection. This posterior inferior limit of the dissection is the junction of the omohyoid and trapezius muscle.

The prevertebral lamina of the deep cervical fascia is well-defined and the specimen is dissected upward based on this fascia. It is important to remember that the brachial plexus, phrenic nerve, subclavian vessels, scalene muscles, and dome of the pleura are all just beneath this lamina. The spinal accessory nerve, the only major nerve that lies above the superficial lamina of the deep cervical fascia, is divided at its entrance to the trapezius muscle and is reflected upward with the specimen along with its accompanying chain of lymph nodes. On occasion the spinal accessory nerve may be preserved if there is no gross metastatic disease in the neck. The vessels not remaining with the specimen are ligated with fine permanent ligatures and are not cauterized because sudden increase in venous pressure from straining or a Valsalva maneuver tends to dislodge the cauterized thrombus leading to bleeding beneath the flaps.

As the dissection proceeds cephalad, the roots of the cervical plexus which emerge from the prevertebral lamina are identified. The phrenic nerve which is the only structure coursing from lateral to medial just beneath the prevertebral lamina is identified along the anterior aspect of the anterior scalene muscle. Its contribution from roots C-3 and C-5 must be accurately identified, and these cervical branches, which are quite substantial, are divided distal to their phrenic nerve contributions. The ansa hypoglossi, composed of the descendens hypoglossi from C-1 and the descendens cervicalis from C-2 and C-3. courses superficial to the carotid sheath to supply the sternohyoid, sternothyroid, and omohyoid muscles and must be divided to gain access to the deeper structures. The posterior aspect of the dissection is carried superiorly on the prevertebral fascia covering the splenius capitis and levator scapulae. Medially the jugular vein and its accompanying nodes are cleared from the carotid artery, vagus nerve, and posteriorly situated sympathetic trunk. The investing tissue over the carotid bulb is infiltrated with local anesthetic to preclude bradycardia and hypotension. Care must be taken lest undue traction be placed on the carotid artery during any of the dissection particularly in the elderly patient. An atheromatous plaque may fracture and loose microemboli of atheromatous material into the cerebral circulation.
The hypoglossal nerve is identified as looping over the external carotid artery beneath the posterior belly of the digastric muscle and the mylohyoid muscle to provide motor supply to the intrinsic and extrinsic tongue musculature, including the styloglossus and hyoglossus muscles.

The superior thyroid and external maxillary arteries are divided, care being taken to preserve the external laryngeal nerve which is just deep to the superior thyroid artery. This nerve originates at the nodose ganglion of the vagus and provides sensory innervation to the mucosa of the larynx and to the cricothyroid muscle. The ranine plexus of veins is in close relationship to the hypoglossal nerve. These veins are ordinarily quite small and inconspicuous. After distal ligation of the internal jugular vein, these ranine veins become engorged and distended. They must be handled carefully and securely lest undue bleeding obscure the field of dissection and lead to inadvertent injury of underlying structures. The external maxillary artery is divided as it approaches the submandibular triangle just beneath the posterior belly of the digastric. The omohyoid muscle is also divided from its origin on the hyoid; thus both bellies of the omohyoid are divided and it is included in the specimen in its entirety.

**Superior Aspect of the Dissection**

The en bloc specimen must be separated from the upper neck and mandible unless additional tissue is to be resected in continuity, such as primary tumors of the tongue, jaw, floor of mouth, or pharynx. The platysma, which is innervated by the lowermost fibers of the facial nerve, is divided along the inferior aspect of the mandible. In the absence of adjacent metastatic disease, the mandibular ramus of the 7th nerve, which supplies motor innervation to the lateral aspect of the lower lip, is identified and preserved. This branch of the facial nerve usually crosses above the posterior facial vein and its course is deep to the platysma. It usually crosses the external maxillary artery and anterior facial vein at or above the inferior border of the mandible. However, on occasion it may be up to 1 cm below the inferior border in relationship to these vessels. Nerve fibers to the platysma are frequently mistaken for the ramus mandibularis but are at a lower level in the neck.

The submandibular triangle is cleaned down to the anterior belly of the digastric muscle. If there is gross clinical disease in this region, the anterior belly of the digastric is divided at its mandibular insertion and reflected with the specimen. The floor of this dissection is the mylohyoid muscle. At the posterior border of the mylohyoid muscle, the external maxillary artery and vein are divided at the level of the lower border of the mandible. The mylohyoid muscle is retracted anteriorly and the lingual nerve, a terminal branch of the mandibular portion of the trigeminal, is identified high under the mandible while the submaxillary gland is retracted downward. Its two small branches to the submaxillary ganglion are divided, which permits removal of the submaxillary gland and the nodes within the submaxillary triangle. These tissues are cleaned down to the hyoglossus muscle and Wharton's duct is ligated and divided. The hypoglossal nerve posterior and inferior to the submaxillary gland is carefully preserved, unless the major portion of the tongue is to be removed to include a primary carcinoma.

Posteriorly the inferior pole of the parotid is divided in line with the lower mandible. The adjacent nodes are reflected downward to be included in the specimen. The posterior
facial vein within the parotid is identified and ligated at this time. The main trunk of the facial nerve is above this level and is not usually encountered. The sternocleidomastoid muscle is divided at its origin from the mastoid process and reflected downward. The posterior belly of the digastric and the stylohyoid, originating from the styloid process, are divided and reflected downward. This gives good access to the jugular vein near its exit from the base of the skull and also makes it possible to clear adequately the high jugular nodes and the subdigastric nodes which are frequently the site of metastatic disease. Prior to division of the jugular vein high in the neck, the spinal accessory nerve is again divided and the vagus and hypoglossal nerves, which also exist the jugular foramen and hypoglossal canals respectively, are carefully identified and preserved. At this point the dissection is complete.

It must be stressed that the specific type of en bloc procedure depends upon the type, location, and histology of the primary tumor. The basic principle, however, is extirpation of the gross regional lymphatic drainage system of a tumor at the time of operation.