Surgical Technique

This chapter describes the surgical technique for a complete functional approach to the neck in which all cervical nodal groups are removed. For teaching purposes, the surgical steps are sequentially detailed. However, not every single surgical step of those mentioned must be considered mandatory for every malignant head and neck tumor. As previously emphasized in this book, the preservation of selected nodal groups is a valid option that does not modify the basic principle of the functional approach to the neck (i.e., the removal of lymphatic tissue by means of fascial dissection). Surgeons must be able to decide, according to their own personal experience, which nodal groups should be included in the dissection and which can be preserved, then proceed accordingly, skipping the surgical steps that are not considered necessary.

PREOPERATIVE PREPARATION AND OPERATING ROOM SETUP

The patient should be prepared as for any major operation. All routine laboratory tests must be performed, including electrocardiogram and chest radiographs. Preoperative evaluation is accomplished by the anesthesiologist prior to surgery. Premedication is used according to the anesthesiologist’s choice. Prophylactic antibiotics are given according to the usual protocol. The patient’s neck and upper chest are shaved and prepared for the operation.

The patient is placed supine on the operating table with a pillow or inflatable rubber bag under the shoulders to obtain the proper angle for surgery (Fig. 4-1). This is generally obtained when the occiput rests against the upper end of the table. Elevating the upper half of the operating table to approximately 30 degrees will decrease the amount of bleeding during surgery. The patient’s lower face, ears, neck, shoulders, and upper chest are prepared with surgical solution, and the patient is draped in layers (Fig. 4-2). Four towels are placed and affixed to the skin. Two of the towels are placed horizontally, one from the chin to the mastoid over the body of the mandible and the other across the upper chest from the shoulder to the midline. The remaining two towels are placed vertically, from the mastoid tip to the shoulder, except for unilateral procedures where the second vertical towel is placed in the midline. A sheet is placed over the patient’s chest and legs, and an open sheet covers the entire patient except for the field of operation. The Mayo stand is prepared with the suction tubing and cautery cords secured in place (Fig. 4-3).

Two assistants are usually present: one in front of the surgeon and the second at the patient’s head. The scrub nurse stands on the right side of the patient facing the head of the table (Figs. 4-4A,
4-4B). The anesthetist sits at the patient’s head with the machine to the opposite side of the surgery. Few general instruments are needed for the operation (Fig. 4-5).

General endotracheal anesthesia is always used. Muscular relaxation is not a priority but the surgeon must be aware of the patient’s condition to know the degree of contraction that can be expected when approaching the main nerves in the neck. A bloodless field will decrease the operating time and help the identification of neck structures. We do not routinely use infiltration of local anesthetics.
Figure 4-4  (A) Picture showing the surgical team for a right-side functional neck dissection. (B) Operating room setup for the operation.
FUNCTIONAL AND SELECTIVE NECK DISSECTION
INCISION AND FLAPS

The exact location and type of skin incision will depend on the site of the primary tumor and whether a unilateral or bilateral neck dissection is planned. The following are the main goals to be achieved by the skin incision:

- Allow adequate exposure of the surgical field.
- Assure adequate vascularization of the skin flaps.

Figure 4-5  General instruments used in functional and selective neck dissection. (A) 1, scissors; 2, knives (#10, #15); 3, needle holders. (B) 1, atraumatic and toothed tissue forceps; 2, suction tips; 3, monopolar forceps. (C) 1, Volkmann retractors; 2, Howarth raspatory; 3, Desmarres vascular retractor; 4, Deschamps ligature needle; 5, skin hooks; 6, Farabeuf retractors; 7, Langenbeck retractors. (D) 1, straight Péan’s forceps; 2, large and small Duval forceps; 3, large and small Allis forceps. (E) 1, right-angle forceps; 2, large and small curved Péan’s forceps; 3, Dandy hemostatic forceps; 4, mosquito forceps.
Protect the carotid artery if the sternocleidomastoid muscle has to be sacrificed.
Include scars from previous procedures (e.g., surgery, biopsy, etc.).
Consider the location of the primary tumor.
Facilitate the use of reconstructive techniques.
Contemplate the potential need of postoperative radiotherapy.
Produce acceptable cosmetic results.

A number of skin incisions may be used for neck dissection (Fig. 4-6). A popular incision in our practice is the classic Gluck incision (Fig. 4-6A), which is basically an apron flap incision, with a vertical postero-lateral arm to approach the supraclavicular area. For a bilateral functional neck dissection the incision extends between both mastoid tips, crossing the midline at the level of the cricoid arch. This incision allows good exposure when the neck dissection is to be combined with total or partial laryngectomy. Sometimes the vertical arm can be avoided by prolonging the apron flap in a postero-inferior direction, thus producing a better cosmetic result. When the operation includes a total laryngectomy the tracheostomy is usually incorporated in the incision. On the other hand, for partial laryngectomies and other tumors requiring temporary tracheostomy, a small independent horizontal incision is made at the level of the second tracheal ring for the tracheostomy.

The double-Y incision of Martin (Fig. 4-6B) is also popular for functional and selective neck dissection. A chin extension may be used when the removal of the primary tumor requires an intraoral approach. A well-known disadvantage of this incision is the compromise to the blood supply, especially in the two crossings of the incision. Thus, the vertical arm of the incision should
be placed posterior to the carotid artery. The cosmetic result is improved by giving the vertical arm a slightly S-shaped curve.

The single-Y incision (Fig. 4-6C) avoids one of the crossings of the double-Y incision but makes the dissection of the supraclavicular fossa difficult.

The Schobinger flap (Fig. 4-6D) is also designed to protect the carotid artery by means of a large anteriorly based skin flap. However, the blood supply to the posterosuperior part of the flap is not good and, occasionally, this area becomes devitalized.

The Conley modification (Fig. 4-6E) of the Schobinger flap brings the posterosuperior arm of the incision a little further anteriorly. The vertical arm of the incision is extended more posteriorly, toward the lateral third of the clavicle.

The incisions commonly used for radical neck dissection in previously irradiated patients may also be used for functional neck dissection. These include the Mac Fee parallel transverse incision (Fig. 4-6F) and the H incision (Fig. 4-6G). They both allow a good preservation of the blood supply to the skin flaps. The Mac Fee incision has excellent cosmetic results. However, the approach to the neck is not as good as with other incisions. Because a functional approach to the neck is not possible in previously irradiated patients where no fascial spaces remain after radiation, this incision is not commonly used for functional procedures. However, it may be useful for modified radical neck dissection when the extension of nodal disease allows preservation of some neck structures. Many other skin incisions may be used depending on the clinical characteristics of the lesion and the personal preference of the surgeon.

After the incision is completed, the skin flaps are elevated deep to the platysma muscle, preserving the superficial layer of the cervical fascia (Fig. 4-7). Preservation of the external lymphatic envelope allows further fulfillment of the basic anatomical principle of the functional approach (i.e., removal of the fascial walls of the lymphatic container along with the lymphatic tissue of the neck).
The limits for a complete functional neck dissection are similar to those of the classic radical neck dissection (Fig. 4-8). The surgical field should expose superiorly the inferior border of the mandible and the tail of the parotid gland. Inferiorly, the flap should be raised up to the level of the clavicle and the sternal notch. The midline of the neck will be the anterior border of the surgical field for a unilateral neck dissection. Finally, the posterior border of the sternocleidomastoid muscle in the upper part of the surgical field, and the anterior border of the trapezius muscle in the lower half of the neck, constitute the posterior boundary of the dissection. After the flaps have been raised, the underlying neck structures can be seen shining through the superficial layer of the cervical fascia (Figs. 4-7, 4-8).

The flaps must be protected by means of wet surgical sponges. Frequent moistening of the sponges will help to keep the skin flaps in good condition throughout the operation. It should be remembered that this may be a long operation since neck dissection is often performed in conjunction with removal of the primary tumor and, in some instances, reconstructive procedures. Thus, all efforts should be made to preserve the skin in good condition until the end of the procedure.

**DISSECTION OF THE STERNOCLEIDOMASTOID MUSCLE**

Usually, the first step of the operation is the dissection of the fascia that covers the sternocleidomastoid muscle. The goal of this maneuver is to completely unwrap the muscle from its surrounding fascia.

Prior to approaching the fascia of the sternocleidomastoid muscle, the external jugular vein must be ligated and divided. Usually, three sections of the external jugular vein are required in functional and selective neck dissection (Fig. 4-9): (1) at the tail of the parotid gland, where the
Figure 4-8  Boundaries of a complete functional neck dissection on the right side of the neck. ML, midline; BM, inferior border of the mandible; C, clavicle; TM, trapezius muscle; ga, great auricular nerve; SC, sternocleidomastoid muscle; sm, strap muscles; pm, platysma muscle; ej, external jugular vein; aj, anterior jugular vein; SG, submandibular gland.

Figure 4-9  Points of division of the external jugular vein on a right functional neck dissection. 1, tail of the parotid gland; 2, posterior border of the sternocleidomastoid muscle; 3, supradyaviular fossa; SC, sternocleidomastoid muscle; ga, great auricular nerve.
external jugular vein begins by the union of the retromandibular and posterior auricular veins; (2) at the external surface of the sternocleidomastoid muscle; and (3) at a later step of the operation, within the posterior triangle of the neck when this nodal region is included in the dissection.

The dissection of the sternocleidomastoid muscle begins with a longitudinal incision over the fascia, along the entire length of the muscle. This cut is made with a number 10 knife blade and must be placed near the posterior border of the muscle (Fig. 4-10). This facilitates the dissection of the sternocleidomastoid muscle because the cleavage plane between the fascia and the muscle is much easier to identify in a forward direction. The external jugular vein should be thus transected as close to the posterior border of the sternocleidomastoid muscle as possible. The vein is then included in the specimen and dissected forward with the fascia of the sternocleidomastoid muscle (Fig. 4-11).

Using several hemostats, one of the assistants retracts the fascia medially while the surgeon carries the dissection toward the anterior margin of the muscle (Fig. 4-11). Fascial retraction should be done with extreme care because the thin superficial layer of the cervical fascia is the only tissue now included in the specimen.

We strongly recommend performing this, as well as most other parts of the operation, using knife dissection. The fascial planes of the neck are mainly avascular and can be easily followed with the scalpel. For knife dissection to be most effective the tissue must be under traction. An important task of the assistants throughout the operation is to apply adequate pressure to the dissected tissue.

When the dissection reaches the anterior border of the sternocleidomastoid muscle the hemostats that have been used to retract the fascia may be left lying on the medial part of the surgical field hanging toward the opposite side. This will maintain the required amount of traction while freeing the assistants’ hands. Then the muscle is retracted posteriorly to continue the dissection over its medial face. Retraction is performed initially by one of the assistants, who holds the muscle posteriorly by means of a retractor, while the surgeon continues the dissection over the sternocleidomastoid muscle (Fig. 4-12). When the dissection reaches the deep medial face of the muscle

Figure 4-10 Incision of the fascia over the sternocleidomastoid muscle on the right side. Note the posterior placement of the incision with respect to the muscle. SC, sternocleidomastoid muscle; SG, submandibular gland; ej, external jugular vein; ga, great auricular nerve.
Figure 4-11  The fascia of the sternocleidomastoid muscle is dissected medially. The external jugular vein is included in the fascia (right side). ej, external jugular vein; F, fascia; SC, sternocleidomastoid muscle.

Figure 4-12  Lateral retraction of the sternocleidomastoid muscle allows the dissection of the medial surface of the muscle. The dissected fascia is carefully pulled medially (right side). IJ, internal jugular vein shining through the fascia; SC, sternocleidomastoid muscle; F, dissected fascia; tm, trapezius muscle; SG, submandibular gland.
(close to the carotid sheath) the retractor is removed and further separation of the sternocleidomastoid muscle is performed by the surgeon using a hand with a gauze pad.

Until this point, the cleavage plane between the muscle and the fascia is avascular. However, when the deep medial face of the muscle is approached, small perforating vessels are found entering the muscle through the fascia (Fig. 4-13). The assistant must now cauterize the vessels while the surgeon continues the dissection over the entire medial surface of the sternocleidomastoid muscle. The surgeon must be extremely careful at the upper half of this region, where the spinal accessory nerve enters the muscle. One or more small vessels usually accompany the spinal accessory nerve, which often divides before entering the muscle. The vessels should be cauterized without injuring the nerve, and all branches of the nerve must be preserved to obtain the best shoulder function. More details concerning the dissection of the spinal accessory nerve are given in a later stage of the operation.

After all the small vessels entering the sternocleidomastoid muscle have been cauterized, a new avascular fascial plane is entered and the dissection continues posteriorly along the entire length of the muscle. The internal jugular vein can now be seen through the fascia of the carotid sheath (Fig. 4-14).

The muscle is now almost completely separated from its covering fascia except for a small portion at the posterior border. This part of the muscle will be dissected in a later stage of the procedure. Wet surgical sponges are now introduced in the lower half of the sternocleidomastoid muscle, between the muscle and its dissected fascia. They will serve two purposes: (1) maintain the desired moisture of the dissected tissues while the attention shifts to the upper part of the surgical field, and (2) serve as a reference for the dissection of the fascia that still covers the posterior border of the sternocleidomastoid muscle, in a later stage of the operation.

The surgeon now moves to the upper part of the surgical field to complete the identification of the spinal accessory nerve. For a better understanding of the following steps of the operation, at this point it may help the reader to take a short pause in the technical details to realize how the surgical approach is made with respect to the sternocleidomastoid muscle when the posterior triangle is included in the resection.

Figure 4-13  Small vessels enter the sternocleidomastoid muscle through its medial face (right side). SC, Sternocleidomastoid muscle retracted laterally; IJ, Internal jugular vein shining through the fascia; V, Vascular pedicle entering the sternocleidomastoid muscle.
MANAGEMENT OF THE STERNOCLEIDOMASTOID MUSCLE

Including the posterior triangle of the neck in the field of dissection requires a combined approach, both posterior and anterior to the sternocleidomastoid muscle (Fig. 4-15). In the upper half of the neck the dissection is performed anterior to the sternocleidomastoid muscle, whereas in the lower half of the neck the supraclavicular fossa is approached posterior to the sternocleidomastoid muscle.

To better understand this, imagine the surgical field divided horizontally in two halves by a line passing through Erb’s point, the place where the superficial branches of the cervical plexus appear at the posterior border of the sternocleidomastoid muscle. This creates an upper and a lower part of the neck.

The upper half of this division includes the submental and submandibular nodes (area I), the upper part of the posterior triangle of the neck (upper part of area V), and part of the lymphatic chain of the internal jugular vein (area II and part of area III). The dissection of the upper half of this division is performed anterior to the sternocleidomastoid muscle. For this purpose, the muscle must be retracted posteriorly throughout the dissection.

The lower half of this imaginary division includes the supraclavicular fossa (lower part of area V), the lower part of the lymphatic chain of the internal jugular vein (area IV and part of area III), and the paratracheal lymph nodes (area VI). These regions will be approached both posterior and anterior to the sternocleidomastoid muscle. The supraclavicular fossa will be dissected from behind the muscle, and the remaining lymph structures of the lower half of the neck will be approached anterior to the sternocleidomastoid muscle.

For the surgical specimen to be removed en bloc, the tissue removed from the supraclavicular fossa will be passed beneath the sternocleidomastoid muscle to meet the remaining part of the specimen. This maneuver, which has always been difficult to understand, is detailed in the following text.
Now we shall resume the dissection at the point where we left it. The sternocleidomastoid muscle was almost completely free of its fascia, except for a small part at the posterior edge of the muscle, and the attention of the surgeon was directed to the upper part of the surgical field to identify the spinal accessory nerve on its course between the jugular foramen and the sternocleidomastoid muscle.
IDENTIFICATION OF THE SPINAL ACCESSORY NERVE

The main goal of this step of the operation is to locate the nerve at the entrance of the sternocleidomastoid muscle. The dissection of the entire course of the nerve between the sternocleidomastoid muscle and the internal jugular vein will be performed in a later step of the procedure.

The spinal accessory nerve enters the sternocleidomastoid muscle approximately at the junction of the upper and middle third of the muscle. The transverse process of the atlas serves as a useful anatomical landmark (Fig. 4-16).

Adequate exposure of the area requires posterior retraction of the sternocleidomastoid muscle. The small vessels that usually go along with the nerve are carefully cauterized and the nerve is examined for divisions that may appear before it enters the muscle. All nerve branches must be preserved to obtain the best shoulder function. Sometimes a branch from the second cervical nerve can be seen joining the spinal accessory nerve before its entrance into the sternocleidomastoid muscle. Although most anatomy books consider this and other branches from the cervical plexus to be mainly sensory, it is our experience that preservation of these branches helps to prevent shoulder dysfunction after the operation.

Once the nerve is identified, wet surgical sponges are introduced between the muscle and the fascia, avoiding excessive pressure and stretching maneuvers that may lead to spinal accessory nerve damage. The dissection now continues along the upper border of the surgical field.

DISSECTION OF THE SUBMANDIBULAR FOSSA

Removal of the submental and submandibular lymph nodes (area I) comes next. From a technical standpoint, this maneuver may be accomplished without removing the submandibular gland. In fact, preservation of the submandibular gland was originally described by Osvaldo Suárez as one of the advantages of the functional approach to the neck. However, the surgical treatment of most primary tumors that require the inclusion of level I as part of the dissection also requires the removal of the submandibular gland. On the other hand, those tumors in which the submandibular gland may be preserved without compromising the oncological safety of the operation, such as cancer of the larynx, hypopharynx, or thyroid gland, usually do not require the dissection of level I. Thus, to avoid centering the controversy where it is less necessary, the following description will present the surgical details of submandibular and submental lymph node removal (area I) including the resection of the submandibular gland (for technical details concerning submandibular gland preservation see Chapter 5).

Dissection of the submandibular and submental triangle starts with a fascial incision along the upper boundary of the surgical field, from the midline to the tail of the parotid gland (Fig. 4-17). Before reaching the deep plane, the anterior jugular vein must be ligated and divided. The fascia is then incised at the submental area and the tissue in the submental region is dissected inferiorly. The incision is continued posteriorly 1 cm below and parallel to the lower border of the mandible to avoid injuring the marginal mandibular branch of the facial nerve.

The marginal nerve runs superficially in the submandibular gland fascia (Fig. 4-18). Most of the times its identification is tedious and unnecessary. Safe preservation of this branch of the facial nerve may be accomplished by using the facial vein as a landmark. This maneuver begins with the identification of the facial vein at the lower border of the submandibular gland (Fig. 4-19A). The vein is then ligated and divided (Fig. 4-19B). The distal ligature is left long, with a hemostat attached, so that it can be reflected superiorly over the body of the mandible (Fig. 4-19C). As the
fascia and the distal stump of the anterior facial vein are retracted superiorly, the marginal mandibular branch of the facial nerve is taken away from the dissection that follows. The dissection is then continued over the anterior border of the submandibular gland. The posterior border of the mylohyoid muscle is dissected free from the submandibular gland and retracted anteriorly. The dissection continues along the superior border of the submandibular
gland.
gland to identify the facial artery which may go superficial to, through, or even posterior to the submandibular gland. The artery is ligated and divided, thus freeing the superior border of the gland. When the facial artery goes superficial to the submandibular gland it may be dissected from the submandibular gland and preserved (Fig. 4-20). At the anterosuperior border of the gland, the lingual nerve must be identified. This is accomplished by retracting the mylohyoid muscle medially and the submandibular gland in a posteroinferior direction. In so doing, the subman-

Figure 4-19  Surgical maneuver to preserve the marginal nerve on the right side of the neck. (A) The facial vein is identified immediately below the submandibular gland. (B) The vein is ligated and divided. (C) The distal ligature is left long and reflected superiorly. SG, submandibular gland; fv, facial vein; SC, sternocleidomastoid muscle; dl, distal ligature reflected superiorly.

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dibular ganglion and its accompanying vein will bring the lingual nerve into the field (Fig. 4-21). The submandibular duct is identified inferior to the lingual nerve. A hemostat is placed across the submandibular ganglion and vein, and both structures are ligated and divided. This frees the lingual nerve, which retracts superiorly, out of the field. After it has been ligated and divided, the gland is retracted inferiorly to identify the genioglossus and hyoglossal muscles. The dissection is continued inferiorly on the medial side of the submandibular gland to identify the digastric muscle and the proximal end of the facial artery. If it was not previously preserved, the artery is ligated again immediately above the digastric muscle. The hypoglossal nerve is identified coursing in an

Figure 4-19 (continued)

Figure 4-20  Facial artery running superficial to the right submandibular gland. SG, submandibular gland; FA, facial artery.
anterosuperior direction just above and medial to the anterior belly of the digastric muscle. This completely frees the submandibular gland (Fig. 4-22), which is included in the specimen along with the fibrofatty tissue containing the lymph nodes from the submandibular and submental regions (area I).

Figure 4-21  Lingual nerve in the submandibular fossa (right side). LN, lingual nerve; SG, submandibular gland; wd, Whartons's duct; gv, submandibular ganglion and accompanying vein.

Figure 4-22  Right submandibular fossa after removal of the submandibular gland. DM, digastric muscle; fa, facial artery; ln, lingual nerve; hn, hypoglossal nerve; S, specimen including the submandibular gland and the lymphatic tissue from the submandibular region.
The specimen is reflected inferiorly, and the fascia over the digastric and stylohyoid muscles is incised from the midline to the tail of the parotid gland (Fig. 4-23). Following the posterior belly of the digastric muscle the stylomandibular ligament is transected (Fig. 4-24). At this level, the retromandibular vein, the posterior auricular vein, and the external jugular vein are identified.
They should be ligated and divided according to their anatomical distribution. Depending on the lower extension of the tail of the parotid gland, part of the gland may also be included in the resection. This will facilitate the visualization of the upper jugular nodes (upper part of area II) as well as include in the specimen the infraparotid lymph nodes.

The digastric and stylohyoid muscles are retracted superiorly, exposing the hypoglossal nerve as well as the lingual veins that follow and cross the nerve in this area (Fig. 4-25). The lingual veins...
should be carefully ligated because they may be a source of troublesome bleeding. When bleeding occurs in this area, bipolar coagulation may be used instead of clamps and ligatures to avoid injury to the hypoglossal nerve.

The dissected tissue is finally pulled inferiorly and dissected free from the subdigastic and upper jugular spaces. At this moment, the specimen includes the submandibular and submental lymph nodes (area I), the uppermost jugular nodes (upper part of area II), and (optionally) the submandibular gland.

**DISSECTION OF THE SPINAL ACCESSORY NERVE**

The dissection of the spinal accessory nerve is one of the few steps of the operation that we usually perform using scissors instead of scalpel. To approach this area the sternocleidomastoid muscle is retracted posteriorly, and the posterior belly of the digastric muscle is pulled superiorly with a smooth blade retractor (Fig. 4-26). The wet surgical sponges previously left over the nerve at the level of its entrance in the sternocleidomastoid muscle are removed and the nerve is dissected toward the carotid sheath.

At this level the nerve runs within the “lymphatic container” of the neck, thus forcing the surgeon to cut across the fibrofatty tissue instead of following fascial planes as for the rest of the operation. Consequently, the tissue overlying the nerve is divided and the nerve completely exposed from the sternocleidomastoid muscle to the internal jugular vein (Fig. 4-27).

As the dissection approaches the internal jugular vein, the surgeon must be aware of the relations between these two structures. Usually, the internal jugular vein lies immediately behind the proximal portion of the nerve. However, on some occasions the nerve may go behind the

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Figure 4-26  Surgical field prepared for the dissection of the spinal accessory area on the right side of the neck. SC, Sternocleidomastoid muscle; IJ, Internal jugular vein; sa, spinal accessory nerve; hn, hypoglossal nerve; mn, marginal mandibular branch of the facial nerve; fv, facial vein; SG, submandibular gland; pg, tail of the parotid gland; F, fascia dissected form the upper part of the surgical field.
ven or even across it (Fig. 4-28). These anatomical variations should be kept in mind to avoid unintentional damage to the internal jugular vein when following the spinal accessory nerve.

Once the spinal accessory nerve has been completely exposed, the tissue lying superior and posterior to the nerve must be dissected from the splenius capitis and levator scapulae muscles. The tissue is pulled in an anteroinferior direction toward the spinal accessory nerve.

It must be emphasized that the lymph nodes that are now being removed are located between the spinal accessory nerve and the internal jugular vein. This region corresponds to the ill-defined boundary between area II and the upper part of area V, which constitutes one of the weak points of the artificial lymph nodal region classification. The lymph nodes in this region belong to the spinal accessory nerve lymph chain and to the upper jugular lymph chain, and no clear anatomical landmarks can be found here to separate these two lymphatic chains (Fig. 4-29). Thus, the surgeon

Figure 4-27  The spinal accessory nerve is completely exposed in the upper part of the field on the right side of the neck. sa, spinal accessory nerve; IJ, internal jugular vein; oa, occipital artery; SC, Sternocleidomastoid muscle; *, fibrofatty tissue of the upper jugular and upper spinal accessory regions.

Figure 4-28  Anatomic relations between the spinal accessory nerve and the internal jugular vein.
must be especially careful during this step of the operation to avoid missing potentially metastatic lymph nodes behind.

The occipital and sternocleidomastoid arteries are often found at this step of the operation (Fig. 4-27). When seen, they must be ligated and divided. However, most of the time they are inadvertently sectioned during the removal of the lymphatic tissue in this area. If this happens it is usually easier to cauterize them instead of trying to place clamps and ligatures.

Once the dissected tissue reaches the level of the spinal accessory nerve it must be passed underneath the nerve to be removed in continuity with the main part of the specimen. Osvaldo Suárez referred to this step of the operation as "the spinal accessory maneuver" (Figs. 4-30, 4-31). After this maneuver has been completed, the specimen includes the fibrofatty tissue coming from the spinal accessory nerve area along with the tissue removed from the submandibular triangle (area I) and upper jugular region (Fig. 4-32).

Before moving to the next step of the operation, a final cut is made in this area that will help further dissection. Keeping the sternocleidomastoid muscle retracted posteriorly, a number 10 scalpel blade is used to make an incision into the tissue located below the entrance of the spinal accessory nerve into the sternocleidomastoid muscle. This cut is made just anterior to the sternocleidomastoid muscle and goes down to the level of Erb's point following the medial border of the sternocleidomastoid muscle (Fig. 4-33). The underlying levator scapulae muscle is identified and the tissue is slightly dissected forward and medially over its fascia. The rest of the dissection in this area will be completed later.

Again, wet surgical sponges are left around the spinal accessory nerve over the splenius capitis and levator scapulae muscles, and the dissection is taken to the supraclavicular fossa.

**DISSECTION OF THE POSTERIOR TRIANGLE OF THE NECK**

The supraclavicular fossa constitutes the lower part of area V. The need to include this area in the dissection has become one of the most controversial issues concerning functional and selective
neck dissection. We remind the reader that this controversy is beyond the scope of this book. We are not discussing the indications for the inclusion of this region in the dissection. Nor are we suggesting that this should be considered an unavoidable part of functional neck dissection for every single head and neck tumor. As should be clear to those reaching this point of reading, functional is not a surgical technique, but a concept, and the description of a complete approach should mention the removal of all nodal groups in the neck.

Figure 4-30 Spinal accessory maneuver on the right side of the neck. (A) The nerve is exposed between the sternocleidomastoid muscle and the internal jugular vein. (B) The fibrofatty tissue lying posterior and superior to the nerve is passed beneath the nerve. sa, spinal accessory nerve; IJ, internal jugular vein; SG, submandibular gland; dm, digastric muscle; SC, sternocleidomastoid muscle; Is, levator scapulae muscle; S1, specimen from the submandibular and upper jugular area; S2, specimen from the upper spinal accessory and posterosuperior jugular area.
Figure 4-31. Artist’s view of the spinal accessory maneuver on the right side of the neck. sa, spinal accessory nerve; IJ, internal jugular vein; S, specimen; SC, sternocleidomastoid muscle; sp, splenius capitis muscle.

Figure 4-32. Anterior view of the surgical field after dissection of the upper cervical regions on the right side. IJ, internal jugular vein; sa, spinal accessory nerve; Is, levator scapulae muscle; hn, hypoglossal nerve; SG, submandibular gland; dl, distal ligature of the facial vein; ●, divided lingual veins.
To facilitate the exposure of the supraclavicular area, this region is approached posterior to the sternocleidomastoid muscle. The dissection begins with the removal of the fascia that still covers the posterior border of the sternocleidomastoid muscle (Fig. 4-34). It must be remembered that the fascia was dissected off the muscle up to its posterior border in a previous step of the operation (see Figure 4-33).

Figure 4-33 The spinal accessory maneuver has been completed. A final cut is made anterior to the sternocleidomastoid muscle, between the spinal accessory nerve and the level of Erb’s point (right side). SC, sternocleidomastoid muscle retracted posteriorly; sa, spinal accessory nerve; S, specimen from the upper jugular and spinal accessory area.

To facilitate the exposure of the supraclavicular area, this region is approached posterior to the sternocleidomastoid muscle. The dissection begins with the removal of the fascia that still covers the posterior border of the sternocleidomastoid muscle (Fig. 4-34). It must be remembered that the fascia was dissected off the muscle up to its posterior border in a previous step of the operation (see Figure 4-34).

Figure 4-34 Dissection of the remaining fascia of the sternocleidomastoid muscle at the supraventricular fossa (right side). SC, sternocleidomastoid muscle; F, fascia retracted laterally; PT, fibrofatty tissue of the supraventricular fossa.
Dissection of the Sternocleidomastoid Muscle. The wet surgical sponges left between the anteromedial aspect of the muscle and the dissected fascia are used as a reference to complete the fascial isolation of the sternocleidomastoid muscle. Once completed, this maneuver results in a total release of the muscle from its surrounding fascia (Fig. 4-35).

The loose fibrofatty tissue of the supraclavicular fossa and the absence of well-defined dissection planes within this area make knife dissection ineffective here. Thus, for this step of the operation scissors and blunt dissection are preferred.

Some anatomical landmarks define the boundaries of the surgical field in the posterior triangle (Fig. 4-36). The inferior limit is located at the level of the clavicle. The posterior margin is clearly marked by the anterior edge of the trapezius muscle, and the upper boundary is defined by the exit of the spinal accessory nerve toward the trapezius muscle. The transverse cervical vessels and the omohyoid muscle constitute important anatomical landmarks within this area.

The sternocleidomastoid muscle is retracted anteriorly, and the external jugular vein is divided and ligated low in the neck if this was not done at a previous stage of the operation. The dissection then proceeds from the anterior border of the trapezius muscle in a medial direction including the lymphatic contents of the supraclavicular fossa. The upper margin of this area presents the greatest risk of damage to the spinal accessory nerve. The spinal accessory nerve leaves the sternocleidomastoid muscle deep to Erb’s point and descends obliquely downward and backward toward the trapezius muscle. The position of the patient’s head, along with the traction exerted by the surgeon during the dissection may displace the nerve from its original course, creating a slight anterior curvature where the nerve may be inadvertently damaged. Displacement of the nerve is due to its connections with the second, third, and fourth cervical nerves. During the dissection of this region several supraclavicular branches of the cervical plexus may be found. They follow a similar course but are located superficial to the spinal accessory nerve (Fig. 4-37). Although the difference between the eleventh nerve and the supraclavicular branches is easily noticed, the novice surgeon may sometimes find this to be difficult.
Figure 4-36  Boundaries of the dissection and anatomic landmarks in the posterior triangle. C, clavicle; tm, trapezius muscle; sa, spinal accessory nerve; SC, sternocleidomastoid muscle; oh, omohyoid muscle; tc, transverse cervical artery; *, Erb's point.

Figure 4-37  The spinal accessory nerve crossing the posterior triangle of the neck on the right side. Note the supravacicular branch of the cervical plexus following a similar but more superficial course. sa, spinal accessory nerve; sn, supravacicular branch of the cervical plexus; SC, sternocleidomastoid muscle (posterior border).
The omohyoid muscle is then identified, and its fascia is dissected off the muscle to be removed with the contents of the posterior triangle. The muscle may be transected at this moment if this will be required for the removal of the primary tumor; otherwise it is preserved and retracted inferiorly with a smooth blade retractor. The transverse cervical vessels are identified deep to the omohyoid muscle (Fig. 4-38). Usually they are easily dissected free from the surrounding fibrofatty tissue, displaced inferiorly, and preserved. However, the numerous variations in the branches and the exact manner of branching of the thyrocervical trunk restrain the systematization of this step (Fig. 4-39).

The deep layer of the cervical fascia over the levator scapulae and scalene muscles is now visible (Fig. 4-38). The brachial plexus is easily identified as it appears between the anterior and middle scalene. Staying superficial to the scalene fascia prevents injuring the brachial plexus and the phrenic nerve (Fig. 4-40).

The dissection is continued medially until it reaches the level of the anterior border of the sternocleidomastoid muscle. The muscle is then pulled laterally with retractors and the contents of the supraclavicular fossa are passed underneath to meet the tissue previously dissected from the upper half of the neck. The sternocleidomastoid muscle is then retracted posteriorly, and the dissection continues anterior to the muscle toward the carotid sheath.

**DISSECTION OF THE DEEP CERVICAL MUSCLES**

If the previous steps have been properly performed, we will now have two main blocks of the dissection. The upper part includes the submandibular and submental triangles (area I), as well as the upper jugular and spinal accessory regions (upper part of areas II and V). The lower block includes the supraclavicular fossa (remaining part of area V). A small bridge of tissue still separates these two blocks and connects the specimen to the deep cervical muscles (Fig. 4-41). This bridge usually goes from just below the entrance of the spinal accessory nerve into the sternocleidomastoid muscle to a level just below Erb’s point.
Figure 4-39  Variations in the branches of the thyrocervical trunk. tt, thyrocervical trunk; it, inferior thyroid artery; tc, transverse cervical artery; s, superficial cervical artery; ds, descending scapular artery; sc, suprascapular artery; th, internal thoracic artery.

Figure 4-40  Anterior view of the anatomic landmarks on the right supraventricular fossa. BP, Brachial plexus; pn, phrenic nerve; tc, transverse cervical artery; sn, supraventricular branch of the cervical plexus; oh, omohyoid muscle retracted inferomedially.
Using a scalpel, this bridge is transected and the fascia of the levator scapulae muscle is identified. This maneuver creates a single block that must be dissected free from the deep muscles toward the carotid sheath (Fig. 4-42). The dissection that follows will be performed using sharp dissection. Thus, the specimen is grasped with forceps and adequate traction is applied.

As the dissection proceeds medially, several branches of the cervical plexus are found. A thorough knowledge of neck anatomy is essential to combine oncological radicalism with functional surgery. As already mentioned, to achieve optimal shoulder function, the deep branches from the second, third, and fourth cervical nerves that may anastomose with the spinal accessory nerve should be preserved (Fig. 4-43). In the same manner, the contribution to the phrenic nerve from the third, fourth, and fifth cervical nerves should also be preserved. This is best achieved by keeping the dissection superficial to the scalene fascia, where the branches of the cervical plexus usually lie. On the other hand, the superficial or cutaneous branches of the cervical plexus will be transected as the dissection approaches the carotid sheath.

The dissection of the deep cervical muscles must be stopped as soon as the carotid sheath is exposed. Continuing the dissection posterior to the carotid sheath carries a high risk of damage to the sympathetic trunk (Fig. 4-44).

**DISSECTION OF THE CAROTID SHEATH**

The carotid sheath is a fascial envelope surrounding the internal jugular vein, common carotid artery, and vagus nerve (Fig. 2-3). It is interposed between the superficial and prevertebral layers of the cervical fascia. The carotid sheath must be included in the resection, preserving its neurovascular contents.
This part of the dissection needs a new number 10 knife blade and adequate tension. The surgical specimen is grasped with hemostats and retracted medially by the assistant, while the surgeon uses one hand with a gauze pad to pull laterally over the deep cervical muscles. This allows a complete exposure of the carotid sheath along the entire length of the surgical field. To avoid injuring important neurovascular structures, during the next minutes all movements should
be precise and gentle. This includes all activity from the assistants, scrub nurse, and circulating personnel in the operating room.

An incision is made with the scalpel over the vagus nerve along the entire length of the carotid sheath (Fig. 4-45). The nerve can be easily identified between the internal jugular vein and the carotid artery (Fig. 4-46). The dissection then continues, removing the fascia from the internal jugular vein. This is achieved by continuously passing the knife blade along the wall of the internal jugular vein up and down along its entire length (Fig. 4-47). The scalpel must be moved obliquely
Figure 4-46 Dissection of the carotid sheath on the right side. CA, carotid artery; IJ, internal jugular vein; vn, vagus nerve; st, sympathetic trunk; SC, sternocleidomastoid muscle.

Figure 4-47 Dissection of the carotid sheath on the right side. CA, carotid artery; IJ, internal jugular vein; vn, vagus nerve; oh, omohyoid muscle; SC, sternocleidomastoid muscle; uf, upper fold of the internal jugular vein wall; If, lower fold of the internal jugular vein wall; *, deep branches of the cervical plexus.
with respect to the vein, with the blade pointing away from the vein wall. When this is properly
done and the traction exerted on the tissue is adequate, this maneuver is extremely safe and
effective. The fascia can be seen coming apart from the vein after each pass of the knife blade, until
the internal jugular vein is completely released from its fascial covering (Fig. 4-48).

The facial, lingual, and thyroid veins appear as the dissection approaches the medial wall of the
internal jugular vein (Fig. 4-49). They should be clearly identified, ligated, and divided to complete
the isolation of the internal jugular vein. Other smaller branches as well as some vasa vasorum
often found during the dissection of the internal jugular vein can be cauterized, taking care not to
use the cautery too close to the venous wall to avoid troublesome perforations that will require
further repair. Bipolar cautery may be helpful at this stage of the operation.

The dissection of the carotid sheath has two danger points. One at each end—upper and
lower—of the dissection (Fig. 4-47). At these two points the traction exerted to facilitate
the dissection of the fascial envelope produces a folding of the wall of the internal jugular vein
that can be easily sectioned at the touch of the scalpel blade. We refer to these two points as
the initial folds, and they should be freed before further dissection of the internal jugular
vein is attempted. The surgeon must be extremely cautious to avoid injuring the vein at these
points.

Lower in the neck, the terminal portion of the thoracic duct on the left side (Fig. 4-50), and the
right lymphatic duct, when present, are also within the boundaries of the dissection and must be
preserved. They are difficult to identify because of their variable anatomy and, more often than
desired, can only be found after being injured, which is especially likely given their very thin wall
that easily breaks under normal dissection maneuvers. The surgeon must be aware that post-
operative leakage in patients with functional neck dissection is much more difficult to solve than in
patients with radical neck dissection because of the preservation of the sternocleidomastoid
muscle. The pressure maneuvers that usually control chylous fistulae in patients with radical
neck dissection are less effective when the muscle remains in place. Thus, intraoperative recogni-
tion of the problem and appropriate management at the time of operation are essential for a

![Figure 4-48](image)

Figure 4-48  Dissection of the internal jugular vein within the carotid
sheath (right side). ca, carotid artery; IJ, internal jugular vein; vn, vagus
nerve; oh, omohyoid muscle; sh, sternohyoid muscle; SC,
sternocleidomastoid muscle; FC, fascia of the carotid sheath.
successful outcome. Once injured, the thoracic duct must be surrounded by muscle, fascia, or adipose tissue before being sutured. More details about the management of the thoracic duct can be found in Chapter 5.
Once the internal jugular vein is released from its covering fascia, the dissection continues medially over the carotid artery. The specimen is now completely separated from the great vessels and remains attached only to the strap muscles (Fig. 4-51). The dissection of the strap muscles will complete the release of the neck dissection specimen. However, when the strap muscles are to be removed with the primary tumor, an en bloc resection may be performed by leaving the specimen pedicled over the strap muscles in order to resect the primary tumor in-continuity with the neck dissection specimen.

**DISSECTION OF THE STRAP MUSCLES**

Although this is described as the last step of the operation, it may be performed in a different order according to the needs of the surgery and the location of the primary tumor.

The midline constitutes the medial border of the dissection for unilateral operations. Thus, a midline cut is made in the superficial layer of the cervical fascia from the upper border of the surgical field to the sternal notch (Fig. 4-52). If the upper end of the anterior jugular vein was not transected at a previous step of the operation, it is now identified, ligated, and divided. The same is made at the lower boundary of the dissection. After both ends of the anterior jugular vein have been ligated and divided, the fascia is dissected from the underlying strap muscles. The dissection starts at the upper part of the surgical field and continues in a lateral and inferior direction. The sternohyoid and omohyoid muscles are completely freed from their fascial covering (Fig. 4-53).

As the dissection proceeds laterally toward the carotid sheath the superior thyroid artery can be identified coursing in an inferomedial direction toward the thyroid gland (Fig. 4-54). Depending on the resection of the primary tumor, the superior thyroid artery can be preserved or should be ligated and divided. The common facial vein and a variable vein communicating the superficial

![Figure 4-51](image) After dissection of the carotid sheath the specimen remains pedicled over the strap muscles (right side). IJ, internal jugular vein; cb, carotid bifurcation; hn, hypoglossal nerve; ac, ansa cervicalis (superior root); dm, digastric muscle; oh, omohyoid muscle; S, specimen.
and deep venous systems of the neck (Kocher’s vein) are usually ligated and divided before the specimen is completely released from the strap muscles.

**DISSECTION OF THE CENTRAL COMPARTMENT**

The prelaryngeal, pretracheal, and paratracheal lymph nodes constitute the central lymphatic compartment of the neck (area VI). Lymph nodes in this area are mainly located in the
tracheoesophageal groove and around the recurrent laryngeal nerve. The lateral boundaries of this region are the common carotid arteries, the superior boundary is the hyoid bone, and the inferior boundary is the suprasternal notch (Fig. 4-55).

For some tumor locations the central compartment must be included in the dissection. This is the case of tumors of the thyroid gland, subglottic lesions, and some hypopharyngeal cancers. In some cases, it is also important to remove the lymph nodes in the anterior superior mediastinum along with the dissection of the central compartment.
During the dissection of the central compartment, the recurrent laryngeal nerve must be identified and preserved in a patient with normal vocal cord function whose primary tumor does not require the removal of the ipsilateral larynx. Identification of the nerve should be attempted before further removal of lymphatic tissue from the central compartment in order to assure its preservation (Fig. 4-56A). The nerve is then followed upward toward the larynx and downward to the upper mediastinum. The inferior thyroid artery is ligated and divided when total

Figure 4-56  Identification of the recurrent laryngeal nerve and parathyroid glands (right side). (A) The recurrent laryngeal nerve and both parathyroid glands are identified before dissection of the central compartment. (B) The inferior thyroid artery is ligated and divided, and the nerve is completely exposed. TG, thyroid gland; rl, recurrent laryngeal nerve; sp, superior parathyroid gland; ip, inferior parathyroid gland; it, inferior thyroid artery.
lobectomy is planned (Fig. 4-56B), and the lymphatic tissue is removed from the central compartment of the neck.

Adequate management of the parathyroids is also extremely important in all cases. At least one gland should be identified on each side and their blood supply must be preserved (Fig. 4-57). When this is not possible because of the vascular anatomy of the parathyroids or as a consequence

Figure 4-57  Vascular pattern of a parathyroid gland (microphotograph ×25). pt, parathyroid gland; it, inferior thyroid artery ligated.

Figure 4-58  The neck after a right functional neck dissection for supraglottic cancer of the larynx. IJ, internal jugular vein; CA, carotid artery; SG, submandibular gland; oh, omohyoid muscle; sh, sternohyoid muscle; ls, levator scapulae muscle; as, anterior scalene muscle; SC, sternocleidomastoid muscle.
of the extension of the nodal disease, every attempt should be made to autotransplant enough parathyroid gland tissue to a muscle in the neck. In patients with thyroid cancer this is generally performed in the sternocleidomastoid muscle. In all patients undergoing central compartment dissection careful postoperative calcium monitoring is mandatory.

**CLOSURE OF THE WOUND**

Figures 4-58 and 4-59 show the appearance of the neck after functional neck dissection. Once again, we would like to emphasize that it is not the preservation of anatomical structures that makes functional neck dissection different from radical neck dissection, but the approach to the neck through fascial planes.

The neck is carefully inspected for bleeding points and surgical sponges. Careful hemostasis is time consuming but rewarding. The entire field is thoroughly irrigated with normal saline. Finally, the skin is closed in two layers over a large suction catheter. The platysma is sutured with absorbable buried sutures, and the skin with skin clips. A moderately tight dressing is applied with special attention to the supraclavicular fossa because this is the area where most serohematomas develop.