Anatomical Complications in General Surgery

John E. Skandalakis
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DEDICATION

To our Medical Students at Emory and to our House Staff at The Piedmont Hospital who, during their way to Ithaka, taught and stimulated us.

ITHAKA

Setting out on the voyage to Ithaka
You must pray that the way be long,
Full of adventures and experiences.
The Laistrygonians, and the Kyklopes,
Angry Poseidon,—don't be afraid of them;
You will never find such things on your way,
If only your thoughts be high, and a select
Emotion touch your spirit and your body.
The Laistrygonians, the Kyklopes,
Poseidon raging—you will never meet them,
Unless you carry them with you in your soul,
If your soul does not raise them up before you.

* * *

You must always have Ithaka in your mind,
Arrival there is your predestination.
But do not hurry the journey at all.
Better that it should last many years;
Be quite old when you anchor at the island,
Rich with all you have gained on the way,
Not expecting Ithaka to give you riches.

Ithaka has given you your lovely journey.
Without Ithaka you would not have set out.
Ithaka has no more to give you now.

Poor though you find it, Ithaka has not cheated you.
Wise as you have become, with all your experience,
You will have understood the meaning of an Ithaka.

From Poems by C. P. Cavafy
Translated into English by John Maurogordato
Hogarth Press, London
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PREFACE

Our book is intended to serve the following purposes:

We wish to remind the reader that anatomical complications of surgical procedures fall into two broad categories: those complications which arise from failure to achieve the desired anatomical result, and those which arise from injury to surrounding structures.

Failure to achieve the desired result is often caused by an inadequate knowledge of normal anatomy and its possible variations. For this reason, we have sometimes described in detail certain anatomical areas not well covered in standard textbooks.

Injury to surrounding structures may be caused by inadequate anatomical knowledge, or a structure may be injured by too careful avoidance of possible injury to some other structure. In each case, mere recognition of the possibility of an injury will go far in preventing its occurrence.

Through a basic understanding of the anatomical problems, we hope that the surgeon will become more critical of specific surgical procedures and more flexible in their use. Thus, rather than memorizing a procedure, word by word, from a textbook, the surgeon will be able to analyze the procedure critically and adapt it to various anatomical settings.

While the general field of surgery progresses to complex, modern surgical problems, each surgical student must start, almost from the beginning, to learn many of the facts and basic principles that modern surgical research has long since dismissed as already investigated and established truth.

These data are what we wish to resurrect. These data are what are vital to the young surgeon who hopes

to perform established and accepted procedures in his or her future practice. These data, many of which are well known and part of the armamentarium of the practicing surgeon, are what we wish to salvage from the overwhelming mass of surgical literature.

Finally, we wish to remind the surgeon that he or she should be primarily a surgeon and only secondarily an internist, physiologist, or pathologist. In the operating room it is the surgeon, standing alone, who must solve any anatomical or technical problem that may be encountered. Out of the operating room, the surgeon may call upon many other specialists for assistance, but when the abdomen is open and an anatomical problem arises, it is surgical knowledge alone that enables the surgeon to arrive at a solution. It is to help the surgeon with such solutions that we have designed this book.

A few years ago, we saw a letter to the Editor of the New England Journal of Medicine by Dr. George Crile, Jr., entitled Thoughts While Watching a Resident Operate. It expresses our philosophy of surgery so well that we wish to share it with our readers:

To the Editor: Just before assisting a resident in an operation, I chanced to read the following excerpt from a book on Chinese cooking (Hsiang Ju Lin and Tsuiseng Lin: *Chinese Gastronomy.* Hastings House, 1959). It was written by Chuangtse in the fourth century B.C. and emphasized the use of the cleaver. Much of its wording seems applicable to our everyday problems in surgery, particularly the concept of working "with the mind, not the eye."

Prince Huei's cook was cutting up a bullock. Every blow of his hand, every heave of his shoulders, every trend of his foot, every thrust of his knee, every *whshh* of rent flesh, every *chhk* of the chopper, was in perfect rhythm—like the dance of the Mulberry Grove, like the harmonious chords of Ching Shou.

"Well done!" cried the Prince. "Yours is skill indeed!"

"Sire," replied the cook laying down his chopper, "I have always devoted myself to Tao, which is higher than mere skill. When I first began to cut up bullocks, I saw before me whole bullocks. After three years' practice, I no longer saw whole animals. And now I work with my mind and not with my eye. My mind works without control of the senses. Falling back on eternal principles, I glide through such great joints or cavities as there may be, according to the natural constitution of the animal. I do not even touch the convolution of muscle and tendon, still less attempt to cut through large bones.

"A good cook changes his chopper once a year—because he cuts. An ordinary cook once a month—because he hacks. But I have had this chopper for nineteen years, and although I have cut up many thousand bullocks, its edge is as if fresh from the whetstone. For at the joints there are always interstices, and the edge of the chopper being without thickness, it remains only to insert that which is without thickness into such an interstice. Indeed there is plenty of room for the blade to move about. It is thus that I have kept my chopper for nineteen years as though fresh from the whetstone.

Nevertheless, where I come upon a knotty part which is difficult to tackle, I am all caution. Fixing my eye on it, I stay my hand, and gently apply my blade, until with a *hivah* the part yields like earth crumbling to the ground. Then I take out my chopper, stand up, and look around with an air of triumph. Then, wiping my chopper, I put it carefully away."

"Bravo!" cried the Prince. "From the words of this cook I have learnt how to take care of my life."

This quotation from the ancient manuscript is so self-explanatory that no comment is needed. It is strange, however, that in books on surgical technique much space is spent on advice on the gentle handling of tissues and the benefits of sharp dissection, but little or none on how to find the natural tissue planes and separate them by a gentle traction and a minimum of dissection. Perhaps, since the downgrading of anatomy in the medical schools, it will be even more difficult for young surgeons to work with their minds instead of their eyes.

John E. Skandalakis
Stephen W. Gray
Joseph S. Rowe, Jr.

(Reprinted with permission of George Crile, Jr., M.D. and N. Eng. J. Med. *287:826, 1972.)*

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1

THE NECK

The human neck is so designed that the swelling of a normal structure or the presence of an abnormal one is readily apparent. Neoplasms and infections can affect any of the 300 lymph nodes or the more than a dozen fascial spaces in the neck. Persistent embryonic structures may occupy spaces no longer assigned to them. The structures of the neck are packed so tightly that nearly every lesion expresses itself as a visible or palpable bulge. In most cases, even the most perfunctory physical examination will reveal the swelling.

We have examined reports of 7748 neck masses found in 232,256 surgical admissions in Atlanta hospitals from 1954 to 1972 (Skandalakis et al., 1960, 1969, 1975). Among these, 3625 were of thyroid origin (46.8 percent) and 4123 were of nonthyroid origin (53.2 percent).

Diagnosis of the nonthyroid neck masses follows a well-marked pathway. With a little rounding of the figures, an easily remembered rule is apparent:

Rule of 80
80 percent of nonthyroid neck masses are *neoplastic.*
80 percent of neoplastic neck masses are *in males.*
80 percent of neoplastic neck masses are *malignant.*
80 percent of malignant neck masses are *metastatic.*
80 percent of metastatic neck masses are *from primary sites above the clavicle.*

In addition, the probable diagnosis may be based on the average duration of the patient's symptoms:

Rule of 7
Swelling from inflammation has existed for 7 *days.*
Swelling from a neoplasm has existed for 7 *months.*
Swelling from a congenital defect has existed for 7 *years.*

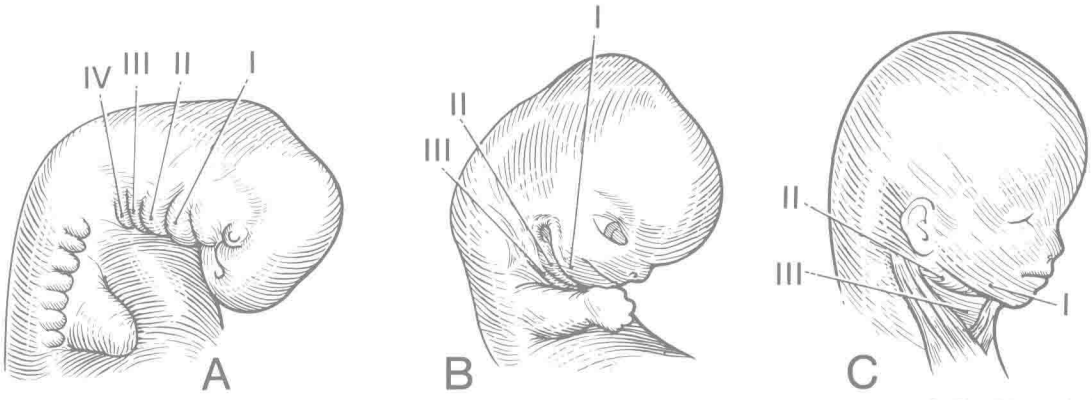


Figure 1-1 The development of the neck. **A.** Fifth week. Prominent branchial arches mark the site of the neck. **B.** Seventh week. Branchial arches are reduced, a constriction appears between head and thorax. **C.** Twelfth week. From this stage on, the true neck is present.

I.

EMBRYOGENESIS OF THE NECK

The neck as seen in the adult human does not exist in the embryo. The history of the region is the history of the organs contained within it, chiefly the pharynx and its derivatives, the thyroid, parathyroid, and thymus glands. In addition, vessels passing through the neck from head to thorax are elongated and modified during the course of development.

Elongation of the pharynx at 5 weeks and later elongation of the esophagus, together with the descent of the diaphragm, separate the head of the developing embryo from the relatively large heart. By 7 weeks, a neck is visible (Figure 1-1). Further details of differentiation and migration will be discussed with specific organs.

II.

TOPOGRAPHIC ANATOMY OF THE NECK

TRIANGLES OF THE NECK

The topography of the neck lends itself to description by a series of natural triangular areas.

The Anterior Cervical Triangle

The boundaries are

Lateral: Sternocleidomastoid muscle
Superior: Inferior border of the mandible
Medial: Anterior midline of neck

This large triangle may be subdivided into four more triangles: submandibular, carotid, muscular, and submental (Figure 1-2).

SUBMANDIBULAR TRIANGLE

The submandibular triangle is demarcated by the inferior border of the mandible above and the anterior and posterior bellies of the digastric muscle below.

The largest structure in the triangle, and the most frequent object of the surgeon's attention, is the submandibular salivary gland. A number of vessels, nerves, and muscles also are found in the triangle.

For the surgeon, the contents of the triangle are best described in four layers, or surgical planes, starting from the skin. It must be noted that severe inflammation of the submandibular gland can destroy all traces of normal anatomy. Identifying and sparing the essential nerves becomes a great challenge. With this warning, we will describe the structures in the triangle at the four surgical planes.

The Roof of the Submandibular Triangle The roof of the submandibular triangle is composed of skin, superficial fascia enclosing platysma muscle and fat, and the mandibular and cervical branches of the facial nerve (VII) (first surgical plane; Figure 1-3).

It is important to remember (1) that the skin should be incised 4 to 5 cm below the mandibular angle; (2) that the platysma and fat compose the

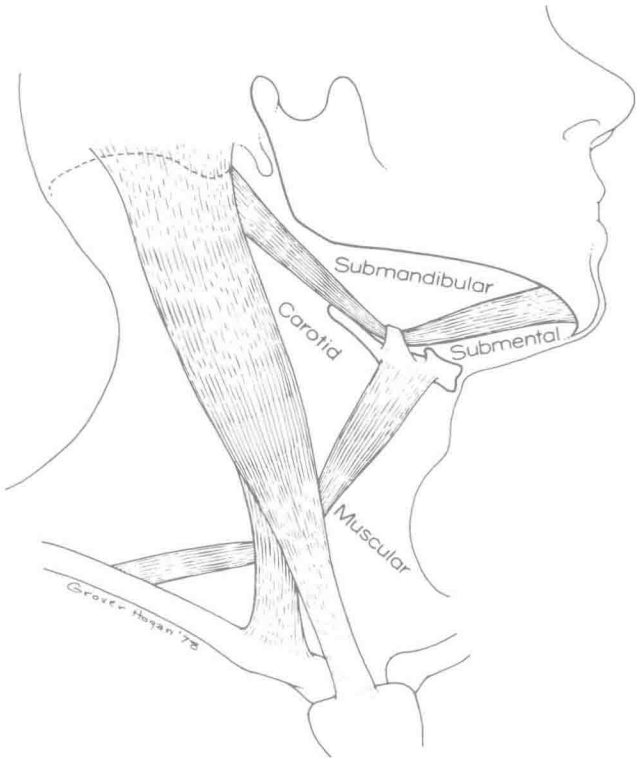


Figure 1-2 The anterior triangle of the neck is divided into four smaller triangles by the digastric and omohyoid muscles. *(From Skandalakis et al., 1979. Used with permission.)*

superficial fascia, and (3) that the cervical branch of the facial nerve (VII) lies just below the angle, superficial to the facial artery.

The nomenclature and topography of the branches of the facial nerve are confusing and variable. The mandibular, or marginal mandibular, nerve is usually the second branch of the cervicofacial division of the facial nerve. It passes approximately 3 cm below the angle of the mandible to supply the muscles of the corner of the mouth and lower lip.

The curved course of this nerve and the similarly shaped courses of other nerves in this region have led to the term *neural hammocks*. The mandibular nerve forms the first of such hammocks of the submandibular triangle. We have seen this hammock hanging so far below the mandible that a high transverse incision would have severed it (Skandalakis et al., 1979).

The cervical branch of the facial nerve divides to form descending and anterior branches. The descending branch innervates the platysma and communicates with the anterior cutaneous nerve of the neck. The anterior branch, the ramus colli mandibularis, crosses the mandible superficial to the facial artery and vein and joins the mandibular branch to contribute to the innervation of the muscles of the lower lip. This anterior branch forms the second neural hammock of the triangle. It is frequently confused with the mandibular hammock.

Injury to the mandibular branch results in severe drooling at the corner of the mouth. Injury to the anterior cervical branch produces minimal drooling that will disappear in 4 to 6 months.

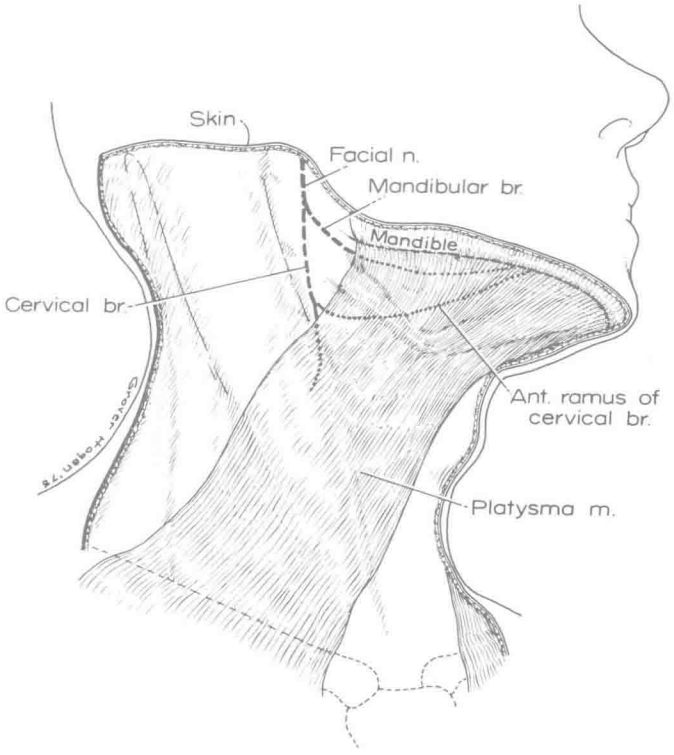
We (Skandalakis et al., 1979) measured the distance between these two neural hammocks and the lower border of the mandible in 40 cadavers (80 cervicofacial dissections). The measurements are shown in Figure 1-4.

In 50 percent of our specimens, the mandibular branch was above the mandibular border and thus outside the boundaries of the submandibular triangle. In a similar study, Dingman and Grabb (1962) found the branch to be above the border in 81 percent of their specimens. If the skin incision is placed at least 4 cm below the border of the mandible, even an exceptionally low cervical branch will not be accidentally cut.

The Contents of the Submandibular Triangle

The structures of the second surgical plane, from superficial to deep, are the anterior and posterior facial vein, part of the facial (external maxillary) ar-

Figure 1-3 The first surgical plane of the submandibular triangle. The platysma lies over the mandibular and cervical branches of the facial nerve. *(From Skandalakis et al., 1979. Used with permission.)*



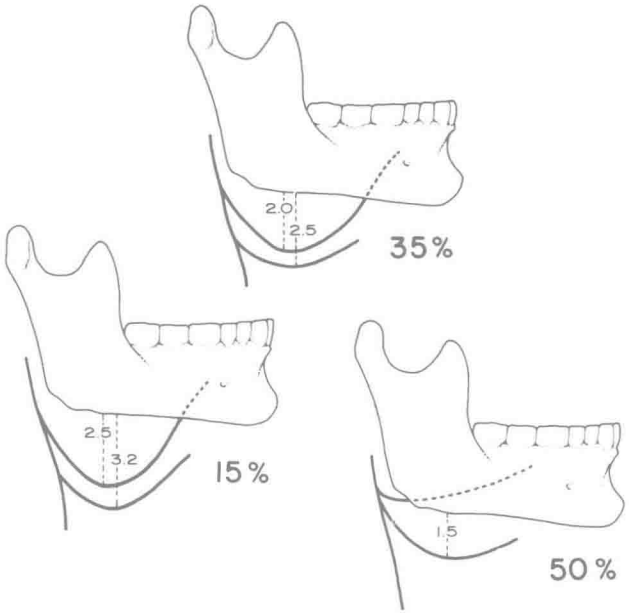


Figure 1-4 The neural "hammocks" formed by mandibular branch (upper) and the anterior ramus of the cervical branch (lower) of the facial nerve. The distance below the mandible is given in centimeters, and percentages indicate the frequency found in 80 dissections of these nerves. *(From Skandalakis et al., 1979. Used with permission.)*

tery, the submental branch of the facial artery, the superficial layer of submaxillary fascia (deep cervical fascia), the lymph nodes, the deep layer of submaxillary fascia (deep cervical fascia), and the hypoglossal nerve (XII) (Figure 1-5).

It is necessary to remember that the facial artery pierces the stylomandibular ligament. Therefore, it must be ligated before it is cut to prevent bleeding after retraction. It also is important to remember that the lymph nodes lie within the envelope of the submandibular fascia in close relationship with the gland. Differentiation between gland and lymph node may be difficult.

The anterior and posterior facial veins cross the triangle in front of the submandibular gland and unite close to the angle of the mandible to form the common facial vein, which empties into the internal jugular vein near the greater cornu of the hyoid bone. It is wise to identify, isolate, clamp, and ligate both these veins.

The facial artery, a branch of the external carotid artery, enters the submandibular triangle under the posterior belly of the digastric muscle and under the stylohyoid muscle. At its entrance into the triangle it is under the submandibular gland. After crossing the gland posteriorly, the artery passes over the mandible, lying always under the platysma. It can be ligated easily.

The Floor of the Submandibular Triangle The structures of the third surgical plane, from superficial to deep, include the mylohyoid muscle with its nerve, the hyoglossus muscle, the middle constrictor muscle covering the lower part of the superior constrictor, and part of the styloglossus muscle (Figure 1-6).

The mylohyoid muscles are considered by DuPlessis (1975) to form a true diaphragm of the floor of the mouth. They arise from the mylohyoid line of the inner surface of the mandible and insert on the body of the hyoid bone into the median raphe. The nerve, a branch of the mandibular di-

Figure 1-5 The second surgical plane of the submandibular triangle. The superficial portion of the gland is exposed. *(From Skandalakis et al., 1979. Used with permission.)*

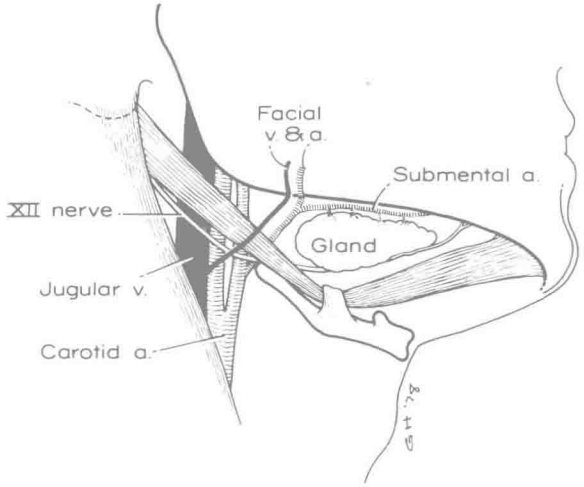
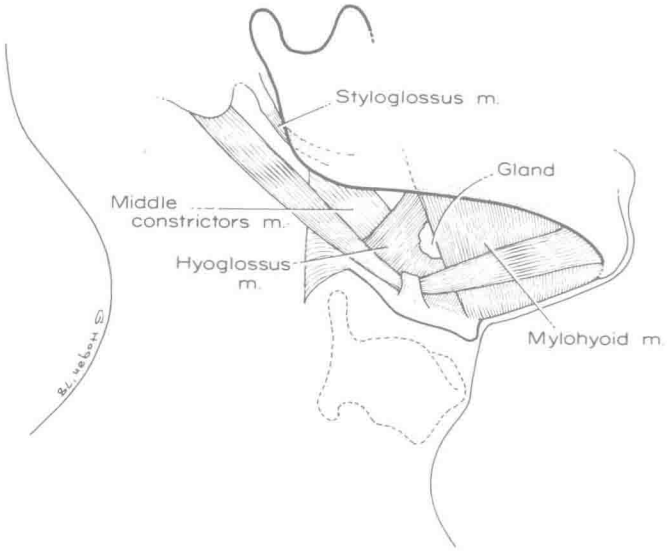


Figure 1-6 The third surgical plane of the submandibular triangle. The superficial portion of the gland has been removed and the deep portion is visible under the edge of the mylohyoid muscle. *(From Skandalakis et al., 1979. Used with permission.)*



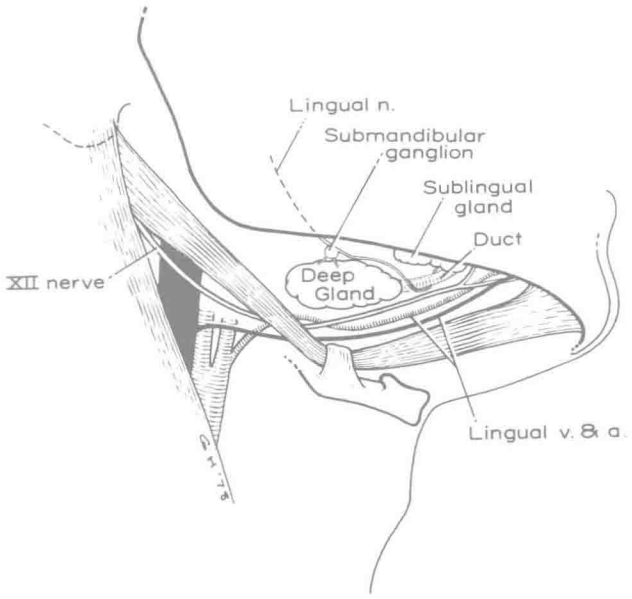


Figure 1-7 The fourth surgical plane of the submandibular triangle. The deep portion of the gland and duct are exposed. *(From Skandalakis et al., 1979. Used with permission.)*

vision of the trigeminal nerve (V), lies on the inferior surface of the muscle. The superior surface is in relationship with the lingual and hypoglossal nerves.

The Basement of the Submandibular Triangle The structures of the fourth surgical plane, or basement of the triangle, include the deep portion of the submandibular gland, the submandibular (Wharton's) duct, the lingual nerve, the sublingual artery, the sublingual vein, the sublingual gland, the hypoglossal nerve (XII), and the submandibular ganglion (Figure 1-7).

The submandibular duct lies below the lingual nerve (except where the nerve passes under it) and above the hypoglossal nerve.

The Lymphatic Drainage of the Submandibular Triangle The submandibular lymph nodes receive afferent channels from the submental nodes, the oral cavity, and the anterior parts of the face. Efferent channels drain primarily into the jugulodigastric, jugulocarotid, and juguloomohyoid nodes of the chain accompanying the internal jugular vein (deep cervical chain). A few channels pass by way of the subparotid nodes to the spinal accessory chain.

SUBMENTAL TRIANGLE

The boundaries of this triangle are

Lateral: Anterior belly of digastric muscle
Inferior: Hyoid bone
Medial: Midline
Floor: Mylohyoid muscle
Roof: Skin and superficial fascia
Contents: Lymph nodes

The lymph nodes of the submental triangle receive lymph from the skin of the chin, the lower lip, the floor of the mouth, and the tip of the tongue. They send lymph to the submandibular and jugular chains of nodes.

CAROTID TRIANGLE

The boundaries are

Posterior: Sternocleidomastoid muscle
Anterior: Anterior belly of omohyoid muscle
Superior: Posterior belly of digastric muscle
Floor: Hyoglossus muscle, inferior constrictor of pharynx, thyrohyoid muscle, longus capitus muscle, and middle constrictor of pharynx
Roof: Investing layer of deep cervical fascia
Contents: Bifurcation of carotid artery; internal carotid artery (no branches in neck); external carotid artery branches, e.g., superior thyroid artery, superficial temporal artery, posterior auricular artery, internal maxillary artery, occipital artery, ascending pharyngeal artery, sternocleidomastoid artery, lingual artery (occasional), external maxillary artery (occasional); jugular vein tributaries, e.g., superior thyroid vein, occipital vein, common facial vein, the pharyngeal vein; and vagus nerve, spinal accessory nerve, hypoglossal nerve, ansa hypoglossi, and sympathetic nerves (partially)

Lymph is received by jugulodigastric, jugulocarotid, juguloomohyoid nodes, and nodes along the internal jugular vein from submandibular and submental nodes, deep parotid nodes, and posterior deep cervical nodes. Lymph passes to supraclavicular nodes.

MUSCULAR TRIANGLE

The boundaries are

Superior lateral: Anterior belly of omohyoid muscle
Inferior lateral: Sternocleidomastoid muscle
Medial: Midline of neck
Floor: Sternohyoid and sternothyroid muscle
Roof: Investing layer of deep fascia, strap muscles, sternohyoid, and cricothyroid muscles
Contents: Thyroid and parathyroid glands, trachea, esophagus, and sympathetic nerve trunk

Lymphatic drainage of the triangle will be discussed with the thyroid gland. Remember that oc-

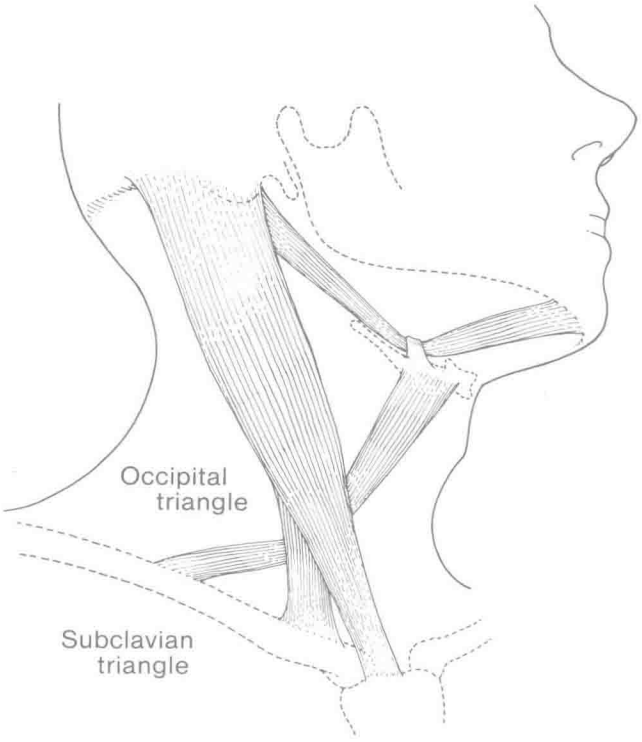


Figure 1-8 The posterior triangle of the neck. The triangle may be divided into two smaller triangles by the omohyoid muscle.

casionally the strap muscles must be cut to facilitate thyroid surgery. They should be cut across the upper third of their length to avoid sacrificing their nerve supply.

The Posterior Cervical Triangle

The posterior cervical triangle is sometimes considered to be two triangles, occipital and subclavian, divided by the posterior belly of the omohyoid muscle (Figure 1-8); we will treat it as one.

The boundaries of the posterior triangle are

Anterior: Sternocleidomastoid muscle
Posterior: Anterior border of trapezius muscle
Inferior: Clavicle
Floor: Splenius capitus muscle, levator scapulae muscle, and three scalene muscles

This muscular floor is covered with investing and prevertebral fascia, between which lie the accessory nerve (XI) and a portion of the external jugular vein.

Deep to the fascia are the cervical nerves, the subclavian vessels and motor nerves to levator scapulae, the rhomboids, the serratus anterior, and the diaphragm.

Roof: Investing layer of the deep cervical fascia
Contents: Subclavian artery, subclavian vein, cervical nerves, brachial plexus, phrenic nerve, accessory phrenic nerve, spinal accessory nerve, and lymph nodes

Superficial occipital lymph nodes receive lymph from the occipital region of the scalp and the back of the neck. Efferent vessels pass to deep occipital lymph nodes (usually only one), which drain into deep cervical nodes along the spinal accessory nerve.

FASCIAE OF THE NECK

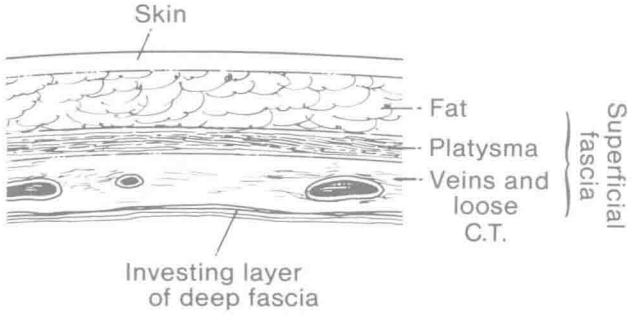
The following classification of the rather complicated fascial planes of the neck follows the work of several investigators:

1. Superficial fascia
2. Deep fascia
   a. Investing layer (anterior or superficial layer)
   b. Middle, or pretracheal, layer (in front and below hyoid bone only)
   c. Prevertebral layer (posterior or deep layer)

Superficial Fascia

The superficial fascia lies beneath the skin and is composed of loose connective tissue, fat, the platysma muscle, and small unnamed nerves and blood vessels (Figure 1-9). The surgeon should remember

Figure 1-9 The superficial fascia of the neck lies between the skin and the investing layer of the deep cervical fascia.



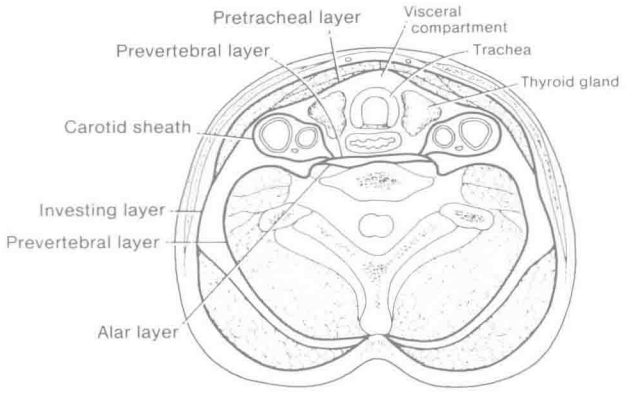


Figure 1-10 Diagrammatic section through the neck below the hyoid bone showing the layers of the deep cervical fascia and the structures which they envelop.

that the cutaneous nerves of the neck and the anterior and external jugular veins are between the platysma and the deep cervical fascia. If these veins are to be cut, they must first be ligated. Because of their attachment to the platysma above and the fascia below, they do not retract; bleeding from them may be serious. For practical purposes, there is no space between this layer and the deep fascia.

Deep Fascia

INVESTING LAYER

This fascia attaches above to the occipital and temporal bones and the mandible, posteriorly to the spines and supraspinous ligaments of the cervical vertebrae, and below to the clavicle, scapula, and manubrium of the sternum (Figure 1-10). It envelops two muscles, the trapezius and the sternocleidomastoid, and two glands, the parotid and the submaxillary. It forms two spaces, the supraclavicular and the suprasternal, and forms the roof of the anterior and posterior cervical triangles.

PRETRACHEAL, OR MIDDLE, LAYER

The middle layer of the deep fascia splits into an anterior portion that envelops the strap muscles and a posterior layer that envelops the thyroid gland, forming the false capsule of the gland (Figure 1-10). This layer is fixed to the thyroid and cricoid cartilages above. The attachment to the cartilages may be thickened to form the suspensory ligament of the thyroid gland (ligament of Berry). Posteriorly the layer becomes ill-defined, permitting an enlarging thyroid gland to extend posteriorly. Anteriorly the middle layer attaches above to the hyoid bone and below to the fibrous pericardium; laterally it contributes to the carotid sheath.

PREVERTEBRAL, OR POSTERIOR, LAYER

This plane lies in front of the prevertebral muscles (Figure 1-10). It originates from the posterior surface of sternocleidomastoid and, together with the pretracheal fascia, forms the carotid sheath. The fascia divides to form a space in front of the vertebral bodies, the anterior layer being the alar fascia, the posterior layer retaining the designation of prevertebral fascia. Lateral to the carotid sheath, the prevertebral fascia covers the scalene muscles, phrenic nerve, and deep cervical muscles; posteriorly it attaches to the ligamentum nuchae.

THE CAROTID SHEATH

Beneath the sternocleidomastoid muscle, the investing fascia, the pretracheal fascia, and the prevertebral fascia contribute to a fascial tube, the carotid sheath. Within this tube lie the common carotid artery, the internal jugular vein, the vagus nerve, and the deep cervical lymph nodes. The sheath extends from the base of the skull to the root of the neck.

BUCCOPHARYNGEAL FASCIA

This layer covers the lateral and posterior surfaces of the pharynx and binds the pharynx to the alar layer of the prevertebral fascia.

AXILLARY FASCIA

This fascia takes its origin from the prevertebral fascia. It is discussed in Chapter 2.

SPACES OF THE NECK

There are many spaces in the neck defined by the fasciae. It is not within the scope of this book to describe these spaces in detail. This book is for the general surgeon, and only those spaces which need special emphasis will be described. Some others, such as the parotid and submaxillary spaces, will be discussed with the organs themselves. The authoritative works on the cervical spaces are those of Grodinsky and Holyoke (1938) and Coller and Yglesias (1937).

Above the hyoid bone,

1. Intrafascial spaces: body of the mandible, submaxillary, masticator, and parotid spaces
2. Peripharyngeal spaces: retropharyngeal, lateral pharyngeal, and submandibular spaces

Below the hyoid bone,