An overview of the topography of the neck

Vishy Mahadevan

Abstract

This article describes in a systematic manner, the basic topographical arrangement of the viscera, muscles and the major neurovascular structures in the neck. It defines the anatomical relationships of these structures to one another and to the various fascial layers in the neck. A clear understanding of this arrangement is fundamental to a proper study of the surgical anatomy of the neck. Detailed anatomical descriptions of individual cervical viscera fall outside the scope and purpose of this article as do detailed accounts of the course and distribution of individual nerves and vessels in the neck.

Keywords Carotid sheaths; cervical lymph nodes; cervical viscera; deep cervical fascia; fascial planes

A thorough appreciation of the manner in which the various fascial layers and muscular planes in the neck are arranged and a detailed knowledge of the relationship of these fascial layers to the major vessels in the neck and to the cervical viscera is crucial to a proper understanding of the surgical anatomy of the neck and is an essential requisite to safety and precision in all neck operations. In addition, such knowledge helps the clinician immeasurably in making accurate diagnoses of clinical conditions involving the neck.

Conceptually, the neck may be divided arbitrarily into two regions: (i) a posterior cervical region and (ii) an anterior cervical region

The posterior region comprises the cervical vertebral column (with the contained cervical portion of the spinal cord), the post-vertebral musculature and other post-vertebral soft tissues. The posterior cervical region may be said to extend from the level of the superior nuchal line, above, to the level of the vertebra prominens, below. The vertebra prominens is usually the seventh cervical vertebra. The post-vertebral muscles are arranged in layers and function collectively as extensors of the cervical part of the vertebral column and/or as extensors of the head on the vertebral column. They are innervated segmentally by the dorsal rami of the cervical spinal nerves.

The anterior region consists of all the anterior and anterolateral cervical muscles, the prevertebral musculature, the cervical viscera and the major blood vessels of the head and neck. For all practical purposes, the anterior region may be said to extend from the skull base (inferior surface of the clivus) above, to the root of the neck below. The root of the neck or cervicothoracic junction is the area circumscribed by the shafts of the

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first ribs on either side, the sternal notch anteriorly and the upper border of the first thoracic vertebra, posteriorly.

It is the anterior cervical region that is the principal subject of this article as it is in this region that most pathological conditions of interest to the head & neck surgeon are encountered.

Surgically relevant surface anatomy

A number of superficial, palpable landmarks provide useful topographical clues to the precise location of deep structures that are not usually palpable or visualized. Additionally, these landmarks bear a fairly constant relationship to specific vertebral levels, and thus aid the spinal surgeon in siting skin incisions at an appropriate level. It is instructive to consider these landmarks in order.

Assuming the subject to be in the anatomical position, with the neck neither hyperextended nor hyperflexed, the important landmarks and their corresponding vertebral levels are as follows:

- The **thyroid notch** is readily palpable and often visible. It lies in the midline at the level of the upper border of C4 vertebra (or disc between C3 and C4). The superior borders of the thyroid laminae can be felt on either side of the thyroid notch.
- The body of the **hyoid bone** lies 2 cm directly superior to the thyroid notch at the level of the body of C3.
- The angle of the mandible is easily felt and lies at the level of C2.
- The hard palate lies at the level of the anterior arch of the atlas (C1).
- The anterior arch of the cricoid cartilage lies 1 cm directly below the lower border of the thyroid cartilage; the interval between the thyroid and cricoid being bridged by the tough median cricothyroid ligament (membrane). The arch of the cricoid lies at the level of C6.
- At this level, on either side of the midline one can palpate the rather prominent transverse processes of C6.
- The sternal notch (i.e. the notched upper border of the manubrium sterni) lies at the level of the upper part of T3 (3rd thoracic vertebra).

Muscles of the neck (Figures 1 and 2)

All the voluntary muscles in the neck, both in the anterior and posterior cervical regions, are bilaterally represented and symmetrically arranged.

The muscles in the anterior cervical region of the neck may be conveniently allocated to the following groups:
- superficial group (comprising the right and left platysma muscles).
- anterolateral group (comprising the sternocleidomastoid and trapezius muscles bilaterally)
- anterior group (made up of two subgroups)
  - a suprahyoid subgroup comprising mylohyoid, anterior and posterior bellies of digastric and stylohyoid
  - an infrahyoid subgroup comprising the strap muscles, i.e. sternohyoid, omohyoid, sternothyroid and thyrohyoid
- prevertebral (made up of two subgroups)

557
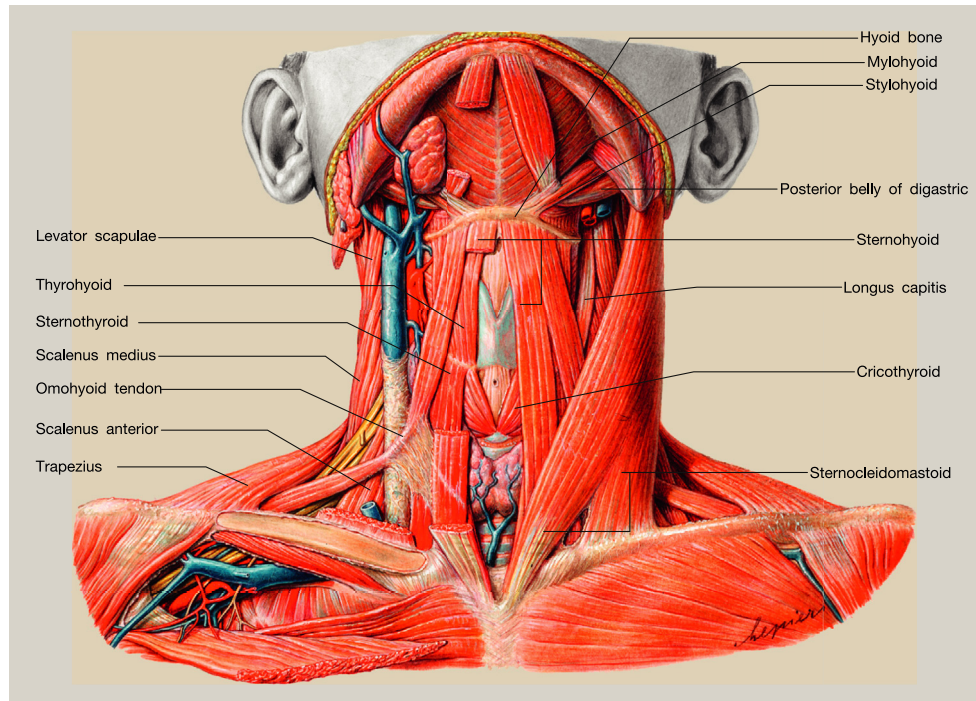
Figure 1 Muscles of the anterior region of neck. Note: right sternocleidomastoid, sternohyoid and anterior belly of digastric have been removed. Observe also that the carotid sheath is largely overlapped by the sternocleidomastoid muscle.

○ anterior prevertebral muscles exemplified by longus colli, longus capitis and a couple of other small muscles, all running longitudinally in line with the cervical vertebral bodies

○ lateral prevertebral muscles comprising scalenus anterior, medius and posterior, and levator scapulae. All of these arise from the transverse processes of cervical vertebrae and run inferolaterally to attach to the upper part of the rib cage or upper border of scapula.

All the muscles in the anterior region of the neck are innervated directly or indirectly by anterior rami of cervical spinal nerves (with the exception of platysma which is, of course, innervated by the facial nerve).

Tissue planes and fascial layers in the anterior part of neck (Figure 3)

The skin is thinner and generally more mobile over the anterior part of the neck than over the posterior part.

Deep to the skin of the neck is the superficial fascia which is essentially a layer of subcutaneous fat arranged circumferentially around the neck. The amount of fat in this layer varies between individuals, and also, to some extent, between the anterior and posterior aspects of the neck in the same individual; being generally somewhat thinner in the front of the neck than in the back. Lying immediately deep to the subcutaneous fat, on either side of the anterior midline is the platysma, a relatively thin but wide sheet of muscle (Figure 4). The platysma is confined to the anterior and anterolateral parts of the neck and does not extend to the back of the neck. Superiorly, platysma crosses superficial to the lower border of the mandible to become continuous with the SMAS (superficial musculo-aponeurotic system) layer of the

face; while inferiorly, it crosses superficial to the clavicle and blends with the fascia overlying pectoralis major, about 1−2 cm below the level of the clavicle. Above the level of the hyoid, the medial borders of the right and left platysma muscles are contiguous, whereas, below the hyoid level they are separated from each other by an interval of 2−3 cm. Subjacent to the platysma is the *investing layer of deep cervical fascia* which invests the neck like a collar. It is the most superficial of the various layers of the deep cervical fascia (the other layers being the prevertebral fascia, the carotid sheaths and the pretracheal fascia) (see Figure 3). Superiorly, the investing layer of deep cervical fascia is attached to the entire length of the lower border of the mandible, from midline to angle on either side. Traced posteriorly from the angle of the mandible, it is seen to be attached to the mastoid processes and superior nuchal lines on either side and to the external occipital protuberance in the posterior midline. In the interval between the angle of the mandible and the mastoid process, the investing layer of deep cervical fascia splits to enclose the parotid salivary gland as the parotid fascia or parotid capsule.

Inferiorly, the line of attachment of the investing layer of deep cervical fascia is to the sternal notch (i.e. the notched, thick upper border of the manubrium sterni), and in continuity, on each side, to the upper surface of the clavicle, the acromion, the spine of the scapula and thus to the posterior midline. Traced laterally from the anterior midline, between its upper and lower attachments, the investing layer of deep cervical fascia meets, on each side, the medial border of the corresponding sternocleidomastoid muscle and splits to enclose the muscle. Thereafter it continues posterolaterally as the fascial roof of the ipsilateral posterior triangle of the neck, and upon reaching the anterior

558

edge of the trapezius muscle, it splits to enclose the trapezius (see Figure 3).

In its descent from the lower border of the mandible, the investing layer of deep cervical fascia is firmly adherent to the front of the hyoid body and to the lateral aspects of the greater horns of the hyoid. Thus all the cervical viscera, major blood vessels and nerves of the neck, and all the cervical muscles (with the sole exception of the platysma) come to lie within the sweep of the investing layer of deep cervical fascia.

The deepest layer of the deep cervical fascia is the prevertebral fascia, a relatively dense layer which covers the anterior aspects of the prevertebral musculature and the cervical vertebral column. The brachial plexus and phrenic nerve lie deep to the prevertebral fascia (Figure 2), a relationship that is of much practical significance in neck surgery. It is also of importance to the anaesthetist when attempting a brachial plexus block using ultrasound-guided regional anaesthesia.

Lying immediately deep to the investing layer of deep cervical fascia and running longitudinally on either side of the anterior midline of the neck are the infrahyoid anterior cervical muscles, also known as the strap muscles. On each side of the vertical midline, the strap muscles are disposed in two layers (see Figure 1). The superficial of the two layers consists of the sternohyoid and omohyoid muscles lying side by side (sternohyoid medial to omohyoid), and the deep layer consists of the sternothyroid muscle, which extends vertically from the posterior surface of the manubrium sterni to the oblique line of the thyroid cartilage. Extending upwards from the oblique line of the thyroid cartilage to the greater horn of the hyoid is the thyrohyoid muscle, often described as the upward continuation of the sternothyroid muscle.
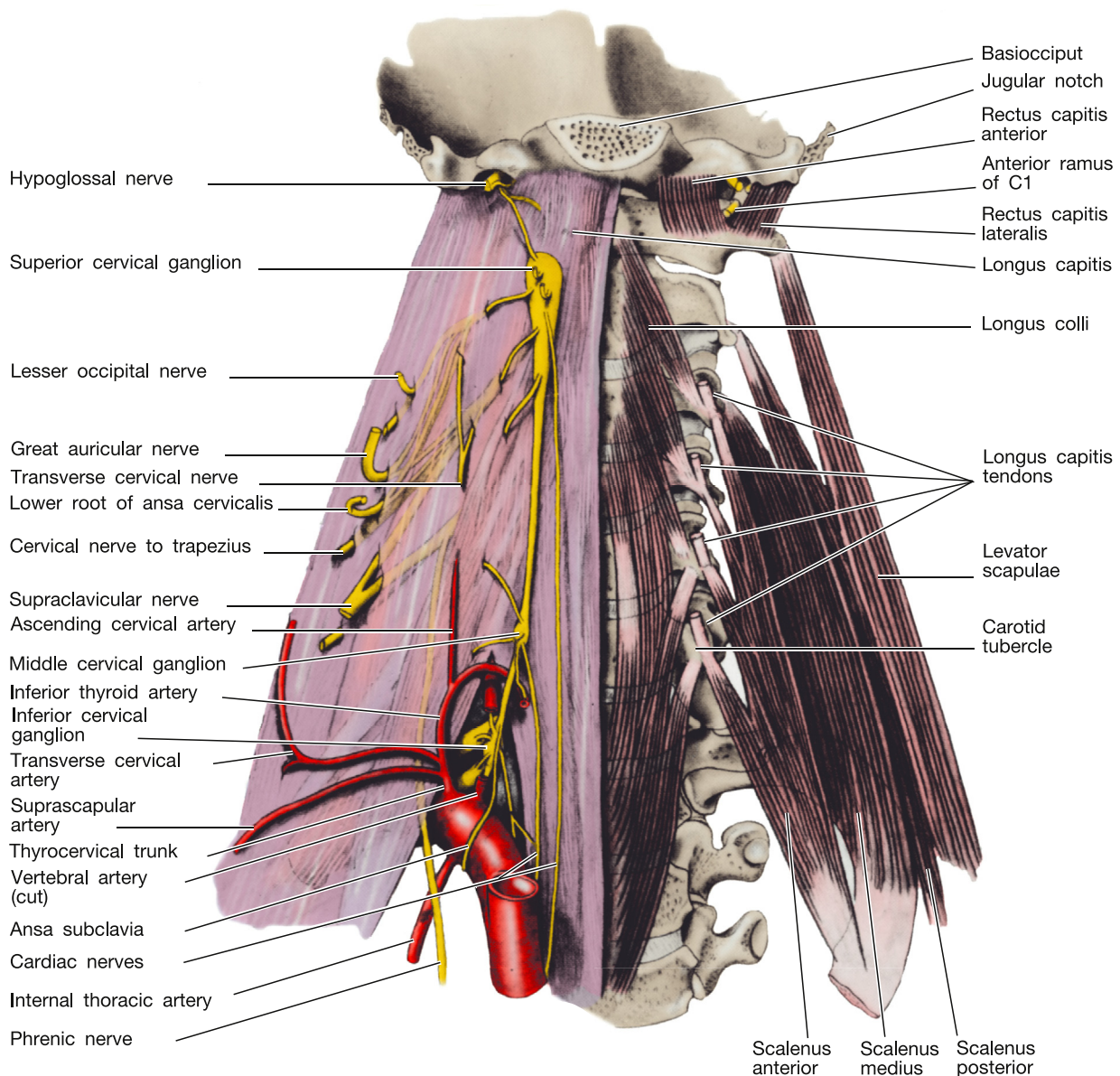

Figure 2 Prevertebral muscles of the neck. Note: the prevertebral fascia is intact on the right side and has been removed on the left side to reveal the anterior and lateral prevertebral muscles. Note also that the prevertebral fascia extends inferiorly as far as the 4th thoracic vertebral body.
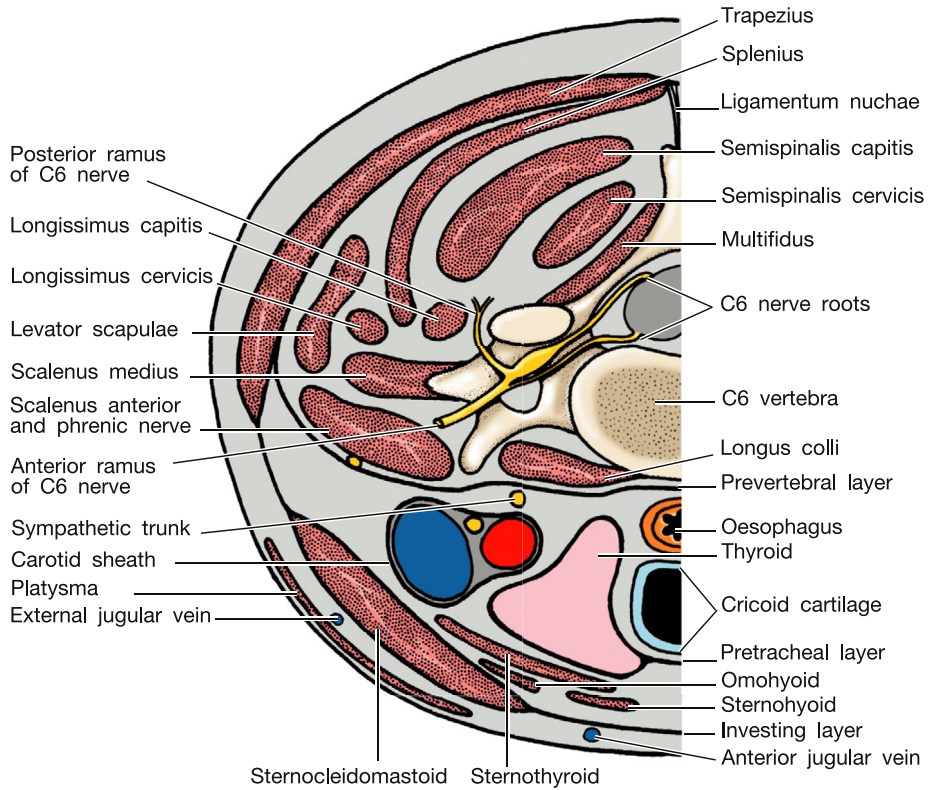
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Figure 3 Schematic depiction of cross sectional view of one half of neck showing the various layers of the deep cervical fascia.
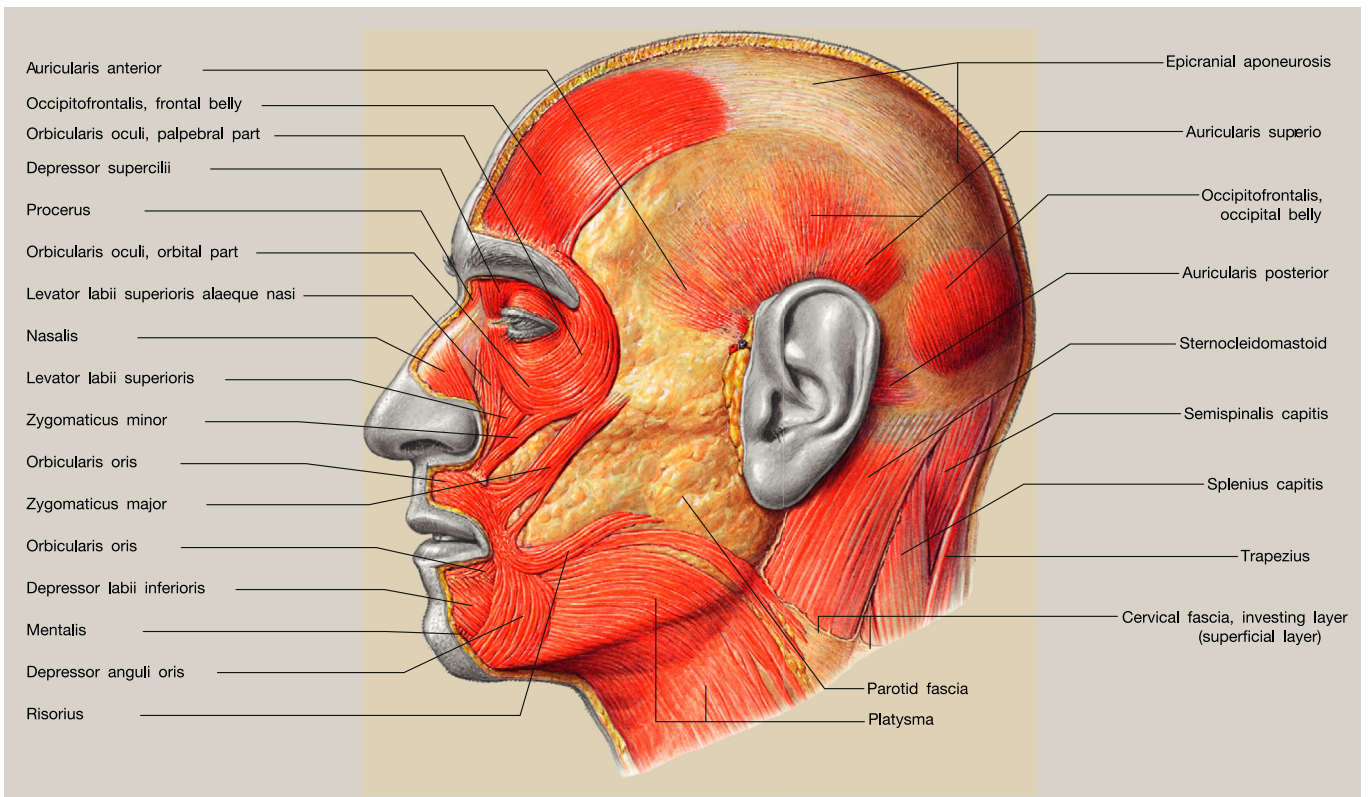

Figure 4 Left side of neck and face showing platysma and the investing layer of deep cervical fascia.

Above the level of the hyoid are the suprahyoid anterior cervical muscles (see Figure 1). These include the right and left mylohyoid muscles which interdigitate in the anterior midline at the mylohyoid raphe to form a mobile muscular sheet extending between the inner aspects of the right and left halves of the mandible. This mylohyoid 'sheet' is an important surgical landmark for it demarcates the neck below from the oral region above. Lying on the neck side of mylohyoid are the stylohyoid and digastric muscles (the latter muscle comprising anterior and posterior bellies). The two bellies of digastric and the lower border of the mandible together form an inverted triangular outline known as the digastric triangle or submandibular triangle (see Figure 1) The floor (or deep limit) of this triangular area is the mylohyoid and the roof (or superficial limit) is the investing layer of deep cervical fascia on its way to the lower border of the mandible. Situated within the submandibular triangle are the submandibular salivary gland and lymph nodes.

Deep to the strap muscles, and anterior to the prevertebral fascial layer is the centrally located visceral column of the neck. The cervical visceral column flanked by the right and left carotid sheaths comprises, most posteriorly, the pharynx and its distal continuation the oesophagus. The pharyngo-oesophageal junction is typically at the level of the lower border of the cricoid cartilage (corresponding to the level of the body of the sixth cervical vertebra).

The pharynx is an elongated chamber that extends from the clivus superiorly to the pharyngo-oesophageal junction inferiorly. From above downwards it lies successively behind the nasal cavity, the oral cavity and the larynx. Accordingly, the pharynx is divided descriptively into three segments: nasopharynx (post-nasal space), oropharynx and laryngopharynx, each with its characteristic features. Suspended from the hyoid by the thyro-hyoid membrane, the larynx lies in front of the lower part of the pharynx and has a skeletal framework made up largely of the thyroid and cricoid cartilages, arytenoids and epiglottis. From a surgical and technical perspective, however, the hyoid bone is regarded as an integral part of the laryngeal skeletal framework. The larynx is continuous with the trachea at the level of the lower border of the cricoid cartilage (i.e. at the level of the lower part of C6 vertebra). Thus the laryngotracheal junction is at the same horizontal level as the pharyngo-oesophageal junction. Lying astride the anterior aspect of the upper trachea is the thyroid isthmus, which on either side of the midline is coextensive with the corresponding thyroid lobe. The entire thyroid gland is enveloped in a further layer of deep cervical fascia termed the pretracheal fascia (see Figure 3). The pretracheal fascia is itself firmly adherent to the front of the upper trachea behind the isthmus, and elsewhere, to the sides of the cricoid and thyroid cartilages. Indeed the encasement of the thyroid by the pretracheal fascia, and the attachment of the latter to the trachea and laryngeal cartilages, is the anatomical basis to the clinical observation that all thyroid swellings move upwards during the second phase of swallowing. During this phase of swallowing, the larynx and trachea ascend. The thyroid gland contained within the pretracheal fascia thus moves upwards obligatorily.

Lying lateral to the centrally located cervical visceral column, and in front of the prevertebral fascia are the right and left carotid sheaths. Situated posteromedial to the carotid sheath (outside the carotid sheath) and anterior to the prevertebral fascia is the ipsilateral ganglionated, cervical sympathetic chain (see Figure 2). Each carotid sheath is in reality a condensation of connective tissue around the major vessels of the neck. It extends from the skull base superiorly to the root of the neck inferiorly, and contains the internal jugular vein and common carotid artery (artery medial to the vein). Above the level of the common carotid bifurcation, the internal carotid artery runs within the carotid sheath. In addition to the major vessels, the carotid sheath contains the vagus nerve which lies between the artery and vein.

For descriptive purposes the anterior region of the neck is subdivided into the following areas (see Figure 1):

- Anterior triangle of neck which is the area between the medial borders of the right and left sternocleidomastoid muscles limited above by the lower border of the mandible.
- Posterior triangle (one on each side of the neck) bounded anteriorly by the lateral border of sternocleidomastoid muscle, and bounded posteriorly by the anterior border of the trapezius. The base of the posterior triangle is the middle third of the clavicle. The floor of the posterior triangle is the prevertebral fascia overlying the scalene muscles, while the roof is the investing layer of deep cervical fascia running from sternocleidomastoid to trapezius.
- Within the upper part of the anterior triangle there lies on each side the corresponding submandibular triangle whose boundaries have already been defined (see above).
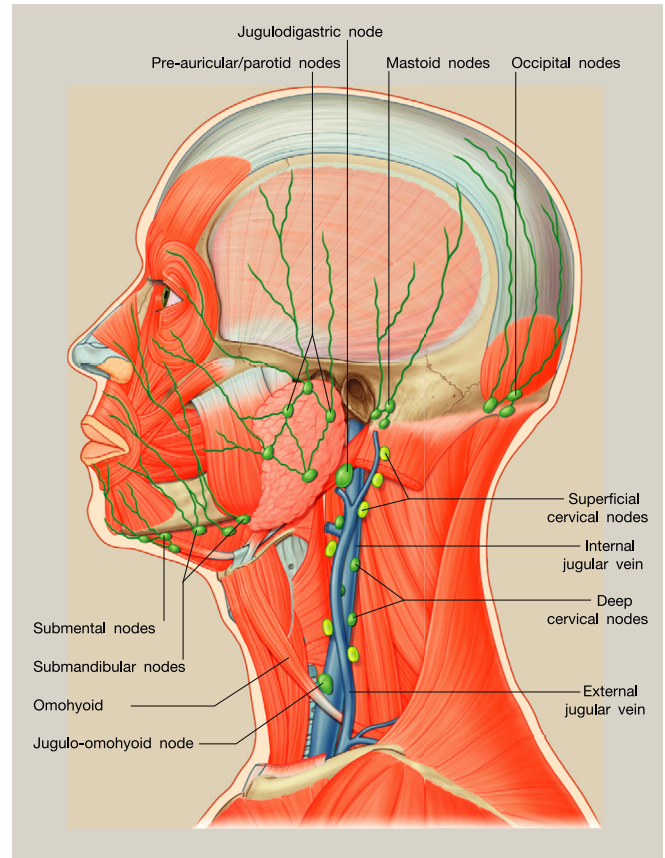

Figure 5 Superficial and deep cervical lymph nodes.

Cervical lymph nodes (Figure 5)

The cervical lymph nodes are of great clinical importance in the context of neoplastic and inflammatory disease involving viscera in the head and neck. The lymph nodes in the neck may be broadly categorized into two sets:

- superficial cervical lymph nodes (i.e. those that are superficial to the investing layer of deep cervical fascia)
- deep cervical lymph nodes (i.e. those that are deep to the investing layer of deep cervical fascia).

Each of these categories is further subdivided into groups on the basis of location and territory of drainage.

It is the deep cervical lymph nodes that are most commonly involved in visceral neoplasia. It is unusual for the superficial lymph nodes to be affected in neoplasia of the cervical viscera.

The traditional system of naming deep cervical lymph nodes is according to topographical location (e.g. submental, jugulodigastric etc) (Figure 5). However, the system favoured by head and neck surgeons and one that reflects actual clinical presentation and pattern of spread in upper aerodigestive tract cancers, is the one that was initially developed in the Memorial Sloan-Kettering Hospital in New York in the 1990s, which has since been refined and enhanced. According to this system deep cervical lymph nodes are classified into eight levels indicated by roman numerals as follows:

- level I − nodes in submandibular and submental triangles
- level II − nodes in relation to upper third of internal jugular vein
- level III − nodes in relation to middle third of internal jugular vein
- level IV − nodes in relation to lower third of internal jugular vein
- level V − nodes in posterior triangle
- level VI − paratracheal (trachea-oesophageal groove) lymph nodes
- level VII − pretracheal/superior mediastinal lymph nodes
- level VIII − parapharyngeal and retropharyngeal lymph nodes
- level VIII − nodes, on account of their very deep location are generally deemed to be surgically inaccessible. ◆

FURTHER READING

Brennan PA, Mahadevan V, Evans BT, eds. Clinical head and neck anatomy for surgeons. CRC Press, 2016.

Ellis H, Mahadevan V, eds. Clinical anatomy. 13th edn. WILEY Blackwell, 2013.

Moore KL, Dalley AF, Agur AMR, eds. Clinically oriented anatomy. 7th edn. Wolters Kluwer/Lippincott Williams & Wilkins, 2014.

Sadler TW, ed. Langman's medical embryology. 13th edn. Wolters Kluwer, 2015.