

CT neck anatomy demystified

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Learning objectives

Discuss the spaces of the deep core tissues of the suprahyoid and infrahyoid neck, as well as the oral cavity. Explore the anatomy of each space, presenting its limits, anatomy relationships and contents.

Background

Previously, the suprahyoid neck was divided into nasopharynx, oropharynx and oral cavity. Those spaces are still useful in the context of squamous cell carcinoma allowing its staging. However, the spaces of the suprahyoid neck as defined by the deep fascia cervical cut across the boundaries of the nasopharynx and oropharynx and some traverse into the infrahyoid neck. Therefore, the involvement of these fascia by diseases other than squamous cell carcinoma is poorly defined using this subdivisions.

Currently, the suprahyoid and infrahyoid spaces are divided by the three layers of the deep cervical fascia (Table 1).

CERVICAL SPACES Defined by the three layers of the deep cervical fascia		
Suprahyoid spaces Exclusively	Both	Infrahyoid spaces Exclusively
1. Parapharyngeal space (PPS)		
2. Pharyngeal mucosal space (PMS)		
3. Masticator space (MS)		
4. Parotid space (PS)		
	5. Carotid space (CS)	
	6. Retropharyngeal space (RPS)	
	7. Perivertebral space (PVS)	
	8. Posterior cervical space (PCS)	
		9. Visceral space (VS)

Table 1: Cervical spaces defined by the three layers of the deep cervical fascia

References: Radiology, Centro Hospitalar e Universitário de Coimbra, Centro Hospitalar e Universitário de Coimbra - Porto/PT

Findings and procedure details

The suprahyoid neck consists in the region of the extracranial head and neck from the skull base to the hyoid bone. The remaining neck from the hyoid bone to the cervicothoracic junction is the infrahyoid neck.

THE DEEP CERVICAL FASCIA

The deep cervical fascia is composed by three layers that separate the supra and infrahyoid neck into fascia-defined spaces.

Superficial (investing) layer of deep cervical fascia

This fascia envelopes the entire extracranial head and neck region from the skull base to the clavicles. In the suprahyoid neck it splits to enclose the parotid, masticator, and submandibular spaces.

In the infrahyoid neck the superficial layer of deep cervical fascia invests the neck completely and splits as it runs posteriorly to encircle the sternocleidomastoid and trapezius muscles.

A slip of this fascia also contributes to the carotid sheath.

Middle layer of deep cervical fascia

The middle layer runs on the deep surface of the strap muscles, but it merges anteriorly with the superficial layer of deep cervical fascia. It splits to encapsulate the thyroid gland.

The posterior margin of the middle layer constitutes the anterior border of the retropharyngeal space.

Other significant attachments of the visceral fascia include superiorly to the skull base and inferiorly with the deep layer of deep cervical fascia to the pericardium.

A slip of the middle layer also contributes to the carotid sheath.

Deep layer of deep cervical fascia

The deep layer circumscribes and defines the perivertebral space, enveloping the prevertebral and paraspinal muscles, scalene muscles, vertebrae, vertebral artery and vein, phrenic nerve, and trunks of the brachial plexus.

The deep layer of the deep cervical fascia attaches to the transverse process, subdividing the perivertebral space into anterior and posterior areas.

- Anterior: The *prevertebral aspect of the perivertebral space*
- Posterior: The *paraspinal aspect of the perivertebral space*

Other significant attachments of the deep layer of deep cervical fascia include superiorly to the skull base and inferiorly with the middle layer of the deep cervical fascia to the pericardium of the mediastinum.

A slip of the deep layer (alar fascia) contributes to the carotid sheath.

All three layers of the deep cervical fascia contribute to the carotid sheath. The alar fascia also flares anteriorly to form the lateral wall of the retropharyngeal space.

THE SUPRAHYOID NECK SPACES

1 - PARAPHARYNGEAL SPACE (PPS)

The parapharyngeal space (PPS) is the central space of the deep face and is surrounded by the pharyngeal mucosal, masticator, parotid, carotid, and lateral retropharyngeal spaces.

Limits:

The medial fascial margin of the PPS is made up of the middle layer of deep cervical fascia and the lateral fascial margin is formed by the medial slip of the superficial layer of deep cervical fascia. Posteriorly the PPS fascia is made up of the anterior part of the carotid sheath.

The PPS is crescent-shaped in the craniocaudal dimension and extends from the skull base to the hyoid bone.

Contents:

- Fat
- Branches of cranial nerve V
- Internal maxillary artery
- Ascending pharyngeal artery
- Pharyngeal venous plexus

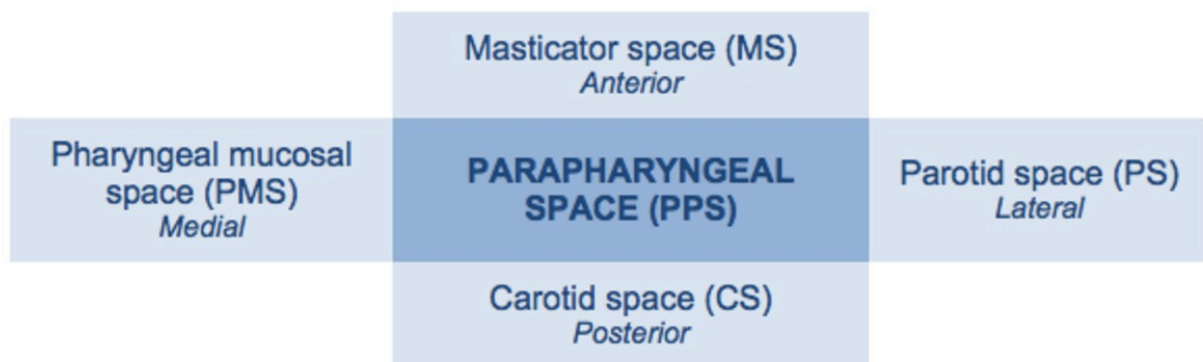


Fig. 1: Parapharyngeal space boundaries

References: Radiology, Centro Hospitalar e Universitário de Coimbra, Centro Hospitalar e Universitário de Coimbra - Porto/PT

2 - PHARYNGEAL MUCOSAL SPACE (PMS)

The PMS is the area of the nasopharynx and oropharynx on the airway side of the middle layer of deep cervical fascia (buccopharyngeal fascia).

Limits:

Near the skull base the middle layer of deep cervical fascia (buccopharyngeal fascia) encircles the lateral and posterior margins of the pharyngobasilar fascia, the tough aponeurosis of the superior constrictor muscle that attaches it to the skull. More caudal in the nasopharynx and oropharynx, this middle layer surrounds the superior and middle constrictor muscles.

The PMS is not completely fascia enclosed. Its posterior and lateral margins are defined by the middle layer of deep cervical fascia, but its airway side has no fascial margin. The bordering spaces of the PMS include the retropharyngeal space posteriorly and the PPS laterally.

Contents:

- Lymphoid tissue (adenoids, faucial and lingual tonsils)
- Superior and middle constrictor muscles
- Salpingopharyngeus muscle
- Pharyngobasilar fascia
- Levator palatini muscle
- *Torus tubarius*

3 - THE MASTICATOR SPACE (MS)

The superficial layer of deep cervical fascia splits along the inferior mandible, creating a sling that encloses the masticator space (MS).

Limits:

- Anterior: The buccal space (BS)
- Posteromedial: parapharyngeal space (PPS)
- Posterior: Parotid space (PS)

The lateral slip of the superficial layer of deep cervical fascia runs over the superficial masseter muscle to the zygomatic arch and then cephalad over the temporalis muscle.

The medial slip runs along the deep edge of the pterygoid muscles from the inferior mandible and attaches to the skull base. Its insertion on the skull base is medial to the

foramen ovale, so lesions extending cephalad in the MS can enter the skull base through the foramen ovale.

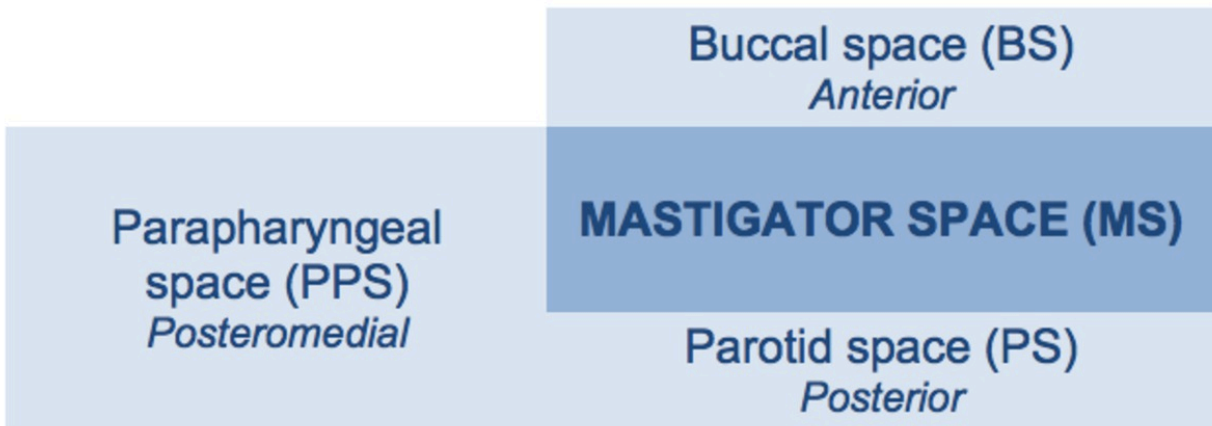


Fig. 2: Masticator space boundaries

References: Radiology, Centro Hospitalar e Universitário de Coimbra, Centro Hospitalar e Universitário de Coimbra - Porto/PT

Contents:

- Muscles of mastication (Lateral pterygoid; Medial pterygoid; Masseter; Temporalis)
- Inferior alveolar nerve
- Ramus and body of mandible

The parotid duct is not in the MS, but it passes just superficial to it as it courses over the masseter muscle. Lesions of the MS can involve the parotid duct by direct lateral invasion and mutually, lesions of the parotid duct may appear clinically as arising from the MS.

The **Buccal space (BS)** has no true fascia boundaries. It is a region in close proximity to the MS and is often involved simultaneously with the MS when infection or malignancy is present.

Contents:

- Buccal fat pad
- Facial artery and vein
- Parotid duct (distal portion).
- Buccinator muscle.

4 - THE PAROTID SPACE (PS)

The superficial layer of the deep cervical fascia splits to envelope the parotid space (PS).

Limits:

The PS is the most lateral space in the suprahyoid neck, extending from the external auditory canal above to the level of the mandibular angle below.

The posteromedial limit of the PS is the posterior belly of the digastric muscle and its fascia, which separates the PS from the carotid space.

Directly medial to the PS is the parapharyngeal space.

Contents:

- Parotid gland
- Facial nerve
- Retromandibular vein
- External carotid and internal maxillary arteries
- Intraparotid lymph nodes

5 - THE CAROTID SPACE

All three layers of deep cervical fascia condense to form the carotid sheath. It is a more substantive fascia in the extracranial head and neck that prevents disease outside the CS from entering and disease within the CS from spreading into the surrounding deep spaces.

The carotid sheath is a well-defined structure below the carotid bifurcation, but it is often incomplete or absent in the area of the oropharynx and nasopharynx.

Limits:

The CS extends from the skull base to the aortic arch. Subdividing the CS into segments (nasopharyngeal, oropharyngeal, cervical and mediastinal) helps to localize an abnormality.

It is important to recognize that the cephalad margin is the jugular foramen. This critical anatomic relationship creates the potential for extracranial spread of cisternal and skull base lesions and intracranial spread of nasopharyngeal CS lesions.

The posterior belly of the digastric muscle and its associated superficial layer of deep cervical fascia separate the CS from the parotid space, which is laterally located. Anterior to the CS is the parapharyngeal space fat and medial to the CS is the lateral margin of the retropharyngeal space.

Corresponding infrahyoid neck triangles: Carotid triangle.

Contents:

- Internal carotid artery
- Internal jugular vein
- Cranial nerves (IX; X; XI and XII)
- Sympathetic plexus
- Deep cervical chain lymph nodes



Fig. 3: Carotid space boundaries

References: Radiology, Centro Hospitalar e Universitário de Coimbra, Centro Hospitalar e Universitário de Coimbra - Porto/PT

6 - THE RETROPHARYNGEAL SPACE (RPS)

The retropharyngeal space (RPS) is the potential space formed between the middle layer and the deep layer of deep cervical fascia.

Limits:

- Anterior: Pharyngeal constrictor muscles - Pharyngeal mucosal space (PMS)
- Posterior: Prevertebral muscles - Perivertebral space (PVS)
- Lateral: Parotid space (CS)
- Medial: Median raphe

The lateral walls of the RPS are comprised of a slip of deep cervical fascia called the alar fascia.

In the normal patient the RPS is seen as a thin line of fat, which may be more prominent in patients with obesity.

The RPS extends as a potential space from the skull base above to approximately the level of the T4 vertebral body and serves as a conduit through which infection spreads from the neck to the mediastinum.

A median raphe divides the RPS into two halves. The median raphe is often difficult to identify with imaging when the RPS is normal.

A second slip of deep cervical fascia separates the RPS from the danger space (DS). The danger space serves as the caudal conduit for retropharyngeal disease to access the mediastinum.

Lesions of the RPS and DS are radiologically indistinguishable from one another.

Contents:

- Fat
- Lateral and medial retropharyngeal lymph nodes

Danger space (DS):

It corresponds to a midline posterior space, which is found between the RPS and the PVS, located between two leaves of the deep layer of deep cervical fascia. It can be grouped with the RPS as both spaces traverse the neck into the mediastinum, and both are posterior, in the midline, and anterior to the PVS. An inflammatory or neoplastic mass in either the danger space or RPS cannot be differentiated by CT or MRI.

Important notes:

When a lesion is found within the RPS, be sure that the nasopharynx is imaged when the lesion appears nodal, because the nasopharynx is the most common primary site of squamous cell carcinoma that spreads into the nodes of the RPS. Be also sure that the entire lower extent of the lesion is imaged to exclude mediastinal spread.

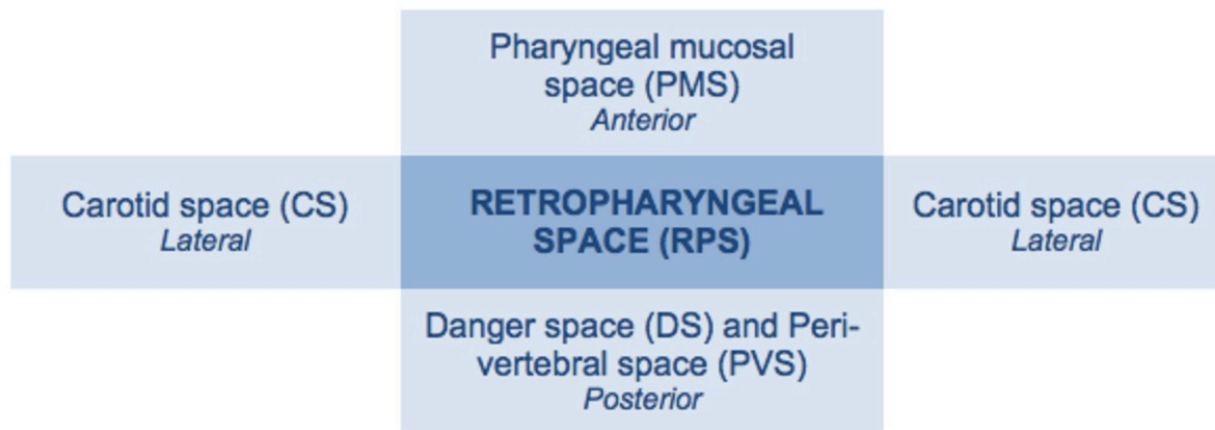


Fig. 4: Retropharyngeal space boundaries

References: Radiology, Centro Hospitalar e Universitário de Coimbra, Centro Hospitalar e Universitário de Coimbra - Porto/PT

7 - THE PERIVERTEBRAL SPACE

The deep layer of deep cervical fascia arches anteriorly from the cervical spine transverse process to the opposite transverse process.

This fascia continues posteriorly to completely enclose the paraspinal muscles and attach to the nuchal ligament.

The attachment of the deep layer of deep cervical fascia to the transverse process of the vertebral body divides the PVS into the anterior (prevertebral) and posterior (paraspinal) portions.

The deep layer of deep cervical fascia involves the PVS. Therefore, when disease begins in the PVS it usually remains confined to it.

Limits:

- Anterior: Retropharyngeal space/danger space
- Anterolateral: Carotid space
- Lateral: Posterior cervical space (PCS)

The prevertebral portion of the PVS is located directly behind the retropharyngeal space/danger space. Infection or tumor of the RPS/DS can violate the deep layer of deep cervical fascia and enter the PVS, but this occurs very rarely, because this fascia is sufficiently tough.

The PVS extends from the skull base to the level of T4 in the posterior mediastinum.

Contents:

- Prevertebral muscles
- Vertebral artery
- Vertebral vein
- Scalene muscles
- Brachial plexus
- Phrenic nerve
- Paraspinal muscles

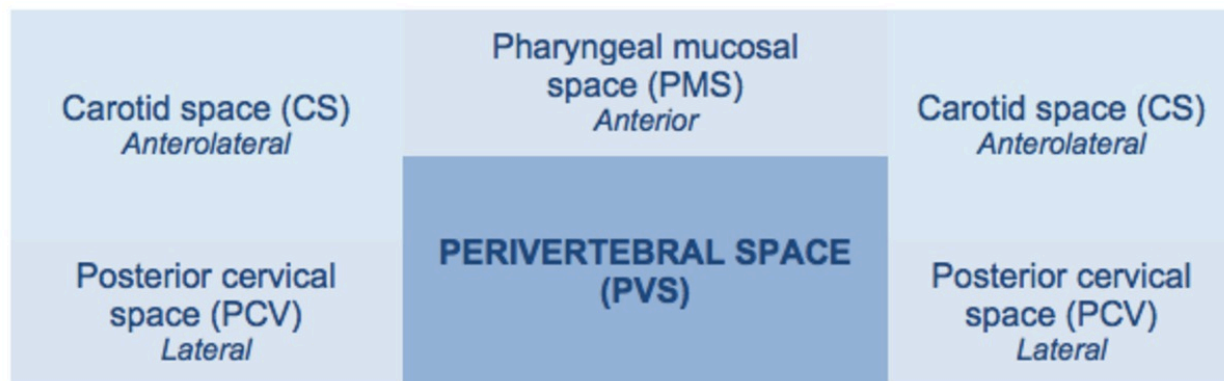


Fig. 5: Perivertebral space boundaries

References: Radiology, Centro Hospitalar e Universitário de Coimbra, Centro Hospitalar e Universitário de Coimbra - Porto/PT

8 - THE POSTERIOR CERVICAL SPACE

Limits:

- Superficial: Superficial layer of deep cervical fascia
- Deep: Deep layer of the deep cervical fascia
- Anterior: Carotid sheath

This space extends from a small superior tip at the skull base to the clavicle.

Corresponding infrahyoid neck triangles: Occipital and subclavian triangles.

Contents:

- Fat
- Spinal accessory nerve (XI)
- Spinal accessory lymph node chain

- Brachial plexus
- Dorsal scapular nerve

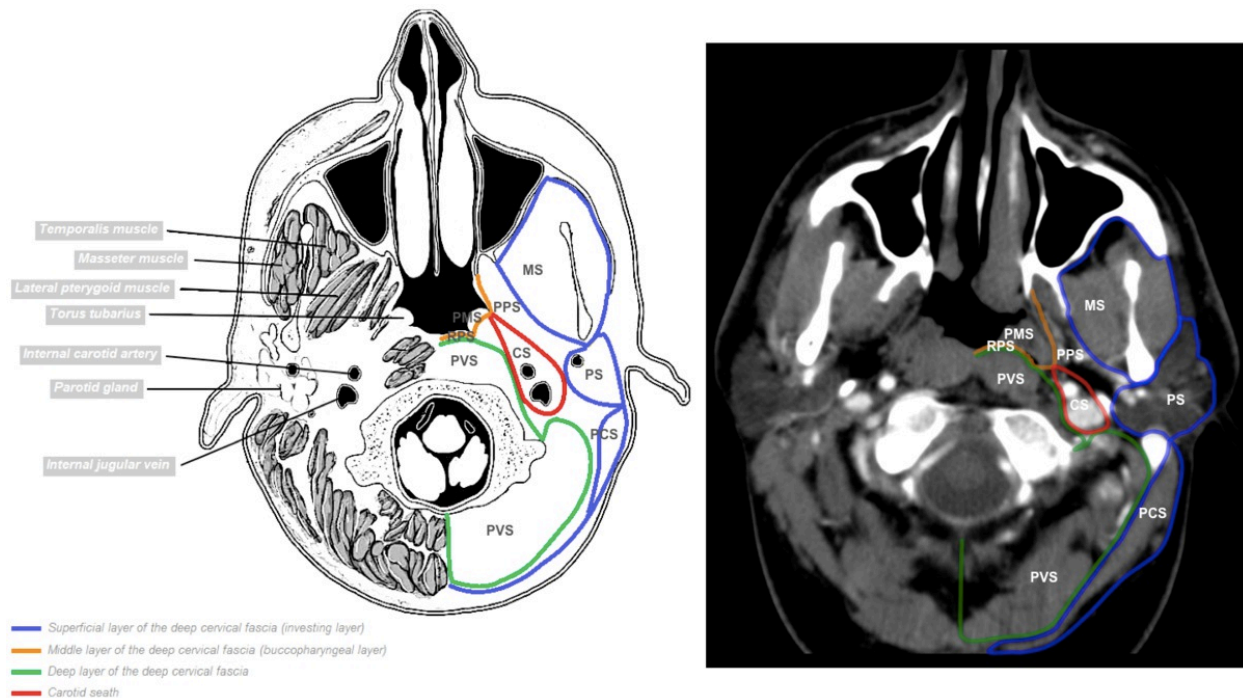


Fig. 6: Sectional anatomy of the suprahyoid neck at the level of the nasopharynx
 PPS - Parapharyngeal space; PMS - Pharyngeal mucosal space; MS - Masticator space; PS - Parotid space; CS - Carotid space; RPS - Retropharyngeal space; PVS - Perivertebral space; PCS - Posterior cervical space. Adapted from: NETTER'S Correlative Imaging: Neuroanatomy. Elsevier 2015

References: Radiology, Centro Hospitalar e Universitário de Coimbra, Centro Hospitalar e Universitário de Coimbra - Porto/PT

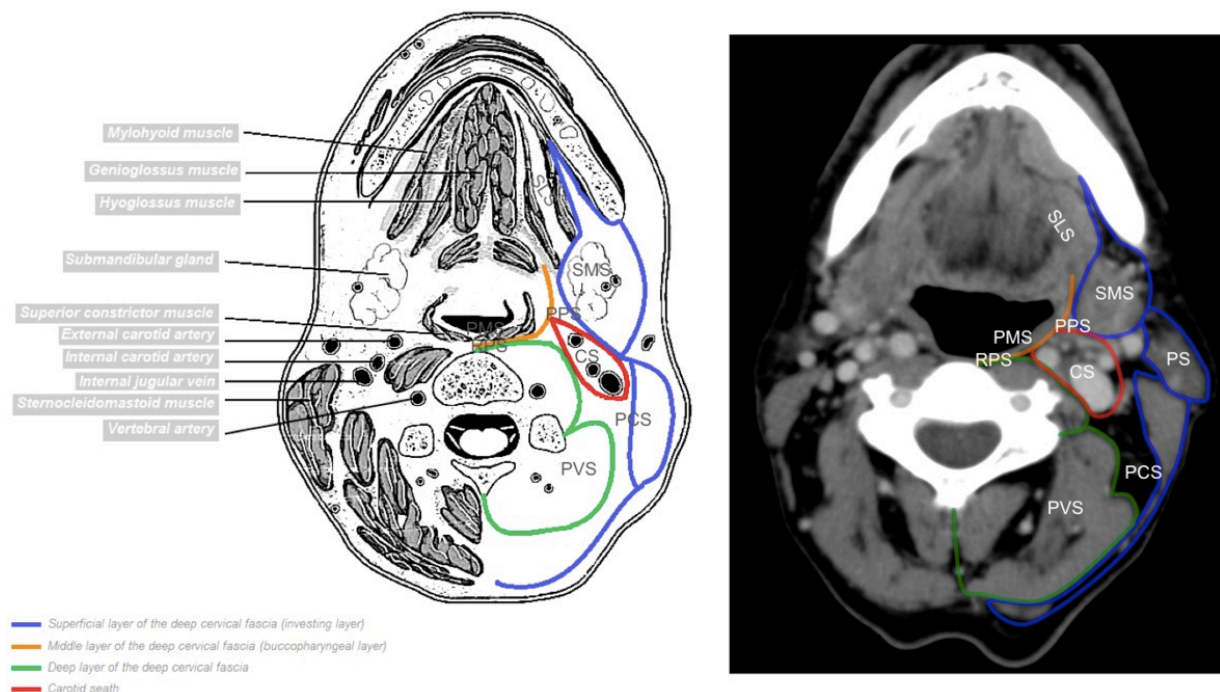


Fig. 7: Sectional anatomy of the suprahyoid neck at the level of the oropharynx PPS - Parapharyngeal space; PMS - Pharyngeal mucosal space; PS - Parotid space; CS - Carotid space; RPS - Retropharyngeal space; PVS - Perivertebral space; SLS - Sublingual space; SMS - Submandibular space; PCS - Posterior cervical space.

Adapted from: NETTER'S Correlative Imaging: Neuroanatomy. Elsevier 2015

References: Radiology, Centro Hospitalar e Universitário de Coimbra, Centro Hospitalar e Universitário de Coimbra - Porto/PT

THE INFRAHYOID NECK

Traditionally, the infrahyoid neck has been taught from the perspective of anatomic triangles. However, in the transaxial plane, the triangular orientation does not easily translate into the CT or MRI axial images. The spaces method permits a more direct imaging approach to the anatomy of this region.

THE CERVICAL TRIANGLES

The cervical neck from the mandible to the clavicles is divided by the sternocleidomastoid muscle into two large triangles: the anterior and posterior triangles. Thereafter, these two triangles are subdivided into six

smaller triangles.

Anterior triangle:

1. Submandibular #
2. Submental #
3. Carotid #
4. Muscular #

Posterior triangle:

5. Occipital #
6. Subclavian #

The anterior triangle is anteromedial to the sternocleidomastoid muscle and is subdivided at the hyoid bone into the suprahyoid and infrahyoid components.

The suprahyoid portion is subdivided by the anterior belly of the digastric muscle into the submental and submandibular triangles.

The infrahyoid component is subdivided by the superior belly of the omohyoid muscle into muscular and carotid triangles.

The posterior triangle corresponds to the region of the cervical neck posterolateral to the sternocleidomastoid muscle and anteromedial to the trapezius muscle and is subdivided by the inferior belly of the omohyoid muscle into the occipital and subclavian triangles.

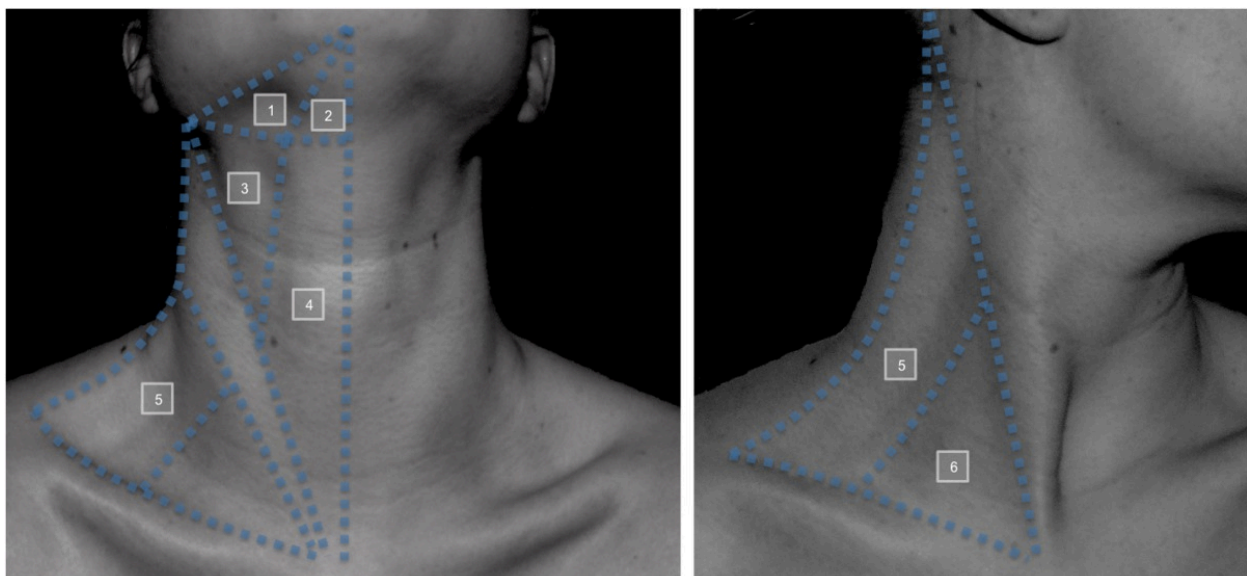


Fig. 10: The cervical triangles. 1 - Submandibular; 2 - Submental; 3 - Carotid; 4 - Muscular; 5 - Occipital; 6 - Subclavian.

References: Radiology, Centro Hospitalar e Universitário de Coimbra, Centro Hospitalar e Universitário de Coimbra - Porto/PT

As described to the suprahyoid neck, the three layers of deep cervical fascia divide the infrahyoid neck into spaces.

Five major spaces are easily identified in the infrahyoid neck:

1. Visceral space (VS)
2. Carotid space (CS)
3. Retropharyngeal space (RPS)
4. Posterior cervical space (PCS)
5. Perivertebral space (PVS)

Only the visceral space is exclusive to the infrahyoid neck.

9 - THE VISCERAL SPACE

Limits:

Completely enclosed by the middle layer of deep cervical fascia.

Extends from the Hyoid bone to the mediastinum.

Corresponding infrahyoid neck triangle: Muscular triangle.

Contents:

- Thyroid gland
- Parathyroid glands
- Hypopharynx, larynx and trachea
- Esophagus
- Recurrent laryngeal nerve
- Paratracheal lymph nodes.

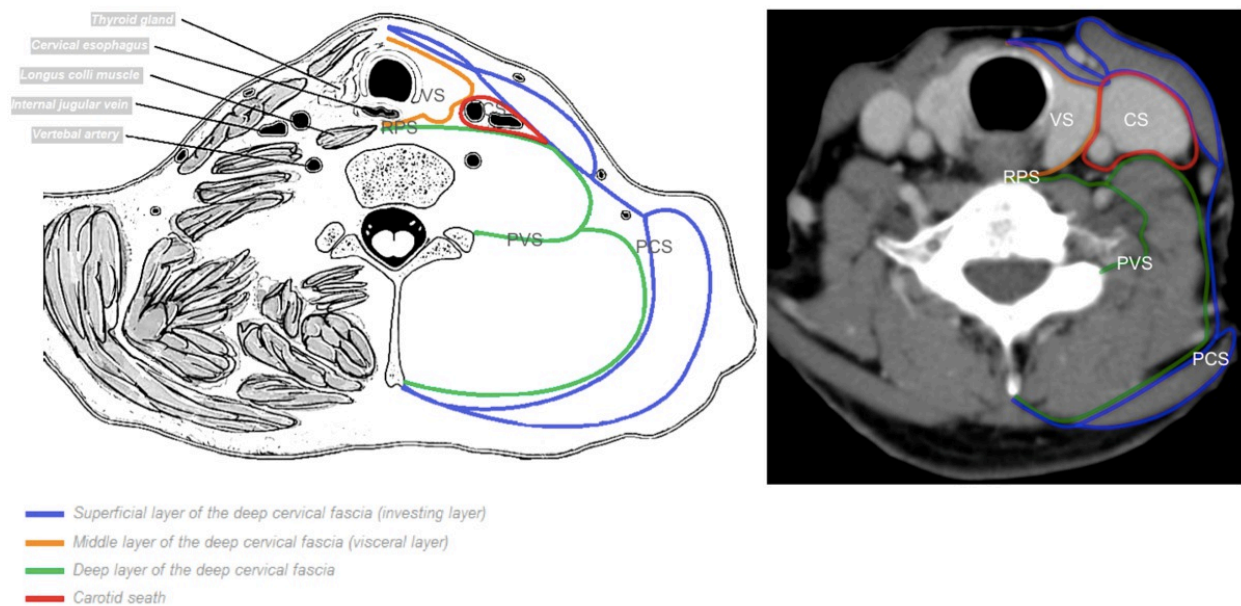


Fig. 8: Sectional anatomy of the infrahyoid neck at the level of the thyroid gland VS - Visceral space; CS - Carotid space; RPS - Retropharyngeal space; PVS - Perivertebral space; PCS - Posterior cervical space. Adapted from: NETTER'S Correlative Imaging: Neuroanatomy. Elsevier 2015

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THE ORAL CAVITY (OC)

Limits:

- Superior: hard palate, superior alveolar ridge and teeth.
- Lateral: cheek.
- Posterior: anterior tonsillar pillars and circumvallate papillae.
- Inferior: mylohyoid muscle and inferior alveolar ridge.

The circumvallate papillae divide the tongue into the anterior two thirds, called the oral tongue, and the posterior third, called the tongue base (*Note: the oral tongue is in the OC and the tongue base is in the oropharynx*).

Within the OC are two major spaces and a third major area:

1. Sublingual space (SLS)
2. Submandibular space (SMS)

3. Mucosal area

The mylohyoid muscle cleaves the lower OC into the two spaces.

Lesions of the OC often can be located to one of the two spaces based on the center of the lesion relative to the mylohyoid muscle.

1. THE SUBLINGUAL SPACE (SLS)

There is no true fascial lining of the SLS. It is a potential space, with critical contents found within the oral tongue. No fascia separates the posterior SLS from the SMS. As a result, lesions of the SLS readily spread to involve the adjacent SMS.

Limits:

- Superior: intrinsic tongue muscles
- Medial: genioglossus-geniohyoid complex
- Lateral: mylohyoid muscle

Contents:

- Hyoglossus muscle
- Lingual nerve
- Cranial nerves (IX and XII)
- Lingual artery and vein
- Sublingual glands
- Deep portion of the submandibular gland
- Submandibular gland duct (Wharton's duct)

2. THE SUBMANDIBULAR SPACE (SMS)

The superficial layer of deep cervical fascia splits to encircle the SMS, with the deeper slip of fascia running along the external surface of the mylohyoid muscle and the more shallow slip paralleling the deep margin of the platysma. No fascial margin separates the posterior SMS and SLS from the inferior parapharyngeal space.

Limits:

- Superior: mylohyoid muscle
- Inferior: hyoid bone

The SMS is a horseshoe-shaped space found between the mylohyoid muscle and the hyoid bone and runs posteriorly into the inferior parapharyngeal space and the posterior portion of the SLS, communicating with them.

Contents:

- Anterior belly of digastric muscle
- Superficial portion of submandibular gland
- Submandibular and submental lymph nodes
- Facial vein and artery
- Inferior loop of the XII nerve
- Fat

3. THE MUCOSAL AREA

Lesions of the mucosal area usually are clinically obvious. The imaging role is to evaluate the deep tissue extent of a known lesion.

The mucosal area of the OC coats the entire cavity (buccal, gingival, palatal, sublingual and lingual surfaces) and is not defined by fascial margins.

The normal depth of the mucosal area of the OC is only a few millimeters.

Contents:

- Nonkeratinized, stratified, squamous epithelium
- Subepithelial minor salivary glands (most common locations: inner lip, buccal mucosa and the palate).

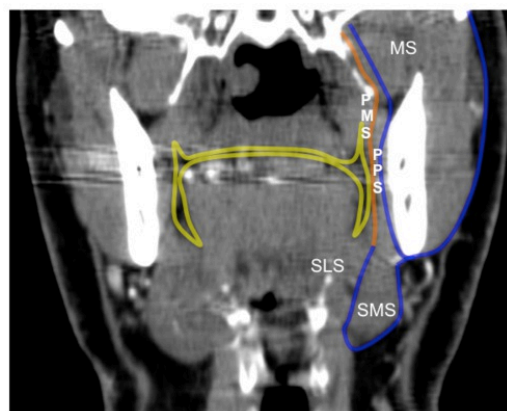
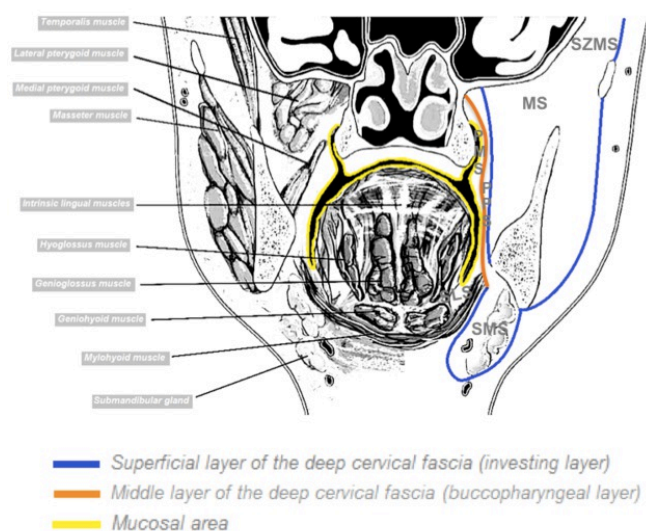


Fig. 9: Coronal anatomy of the oral cavity. SZMS - Suprazygomatic masticator space; MS - Masticator space; PPS - Parapharyngeal space; PMS - Pharyngeal mucosal space; SMS - Submandibular space; SLS - Sublingual space. Adapted from: NETTER'S Correlative Imaging: Neuroanatomy. Elsevier 2015

References: Radiology, Centro Hospitalar e Universitário de Coimbra, Centro Hospitalar e Universitário de Coimbra - Porto/PT

Images for this section:

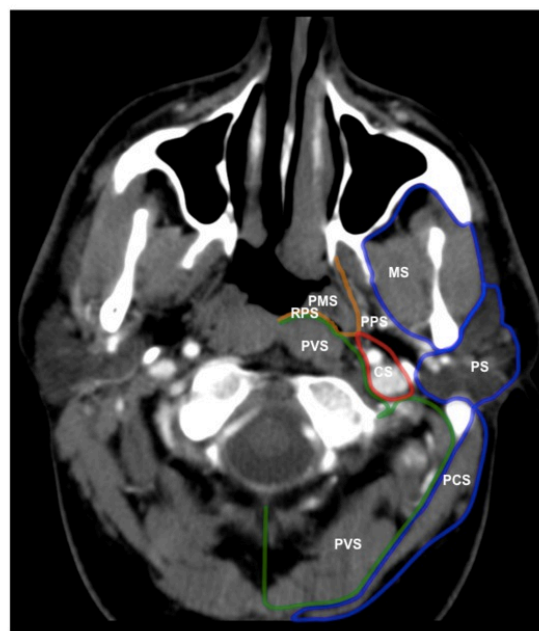
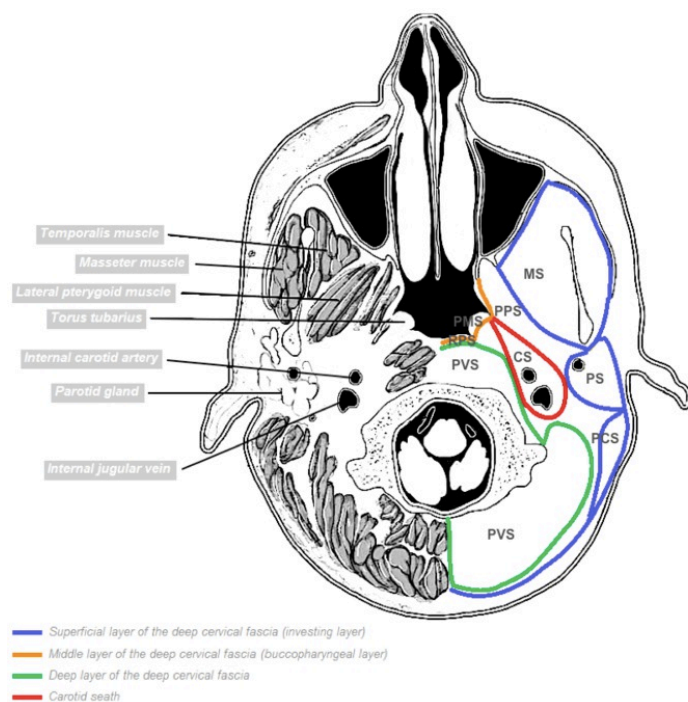


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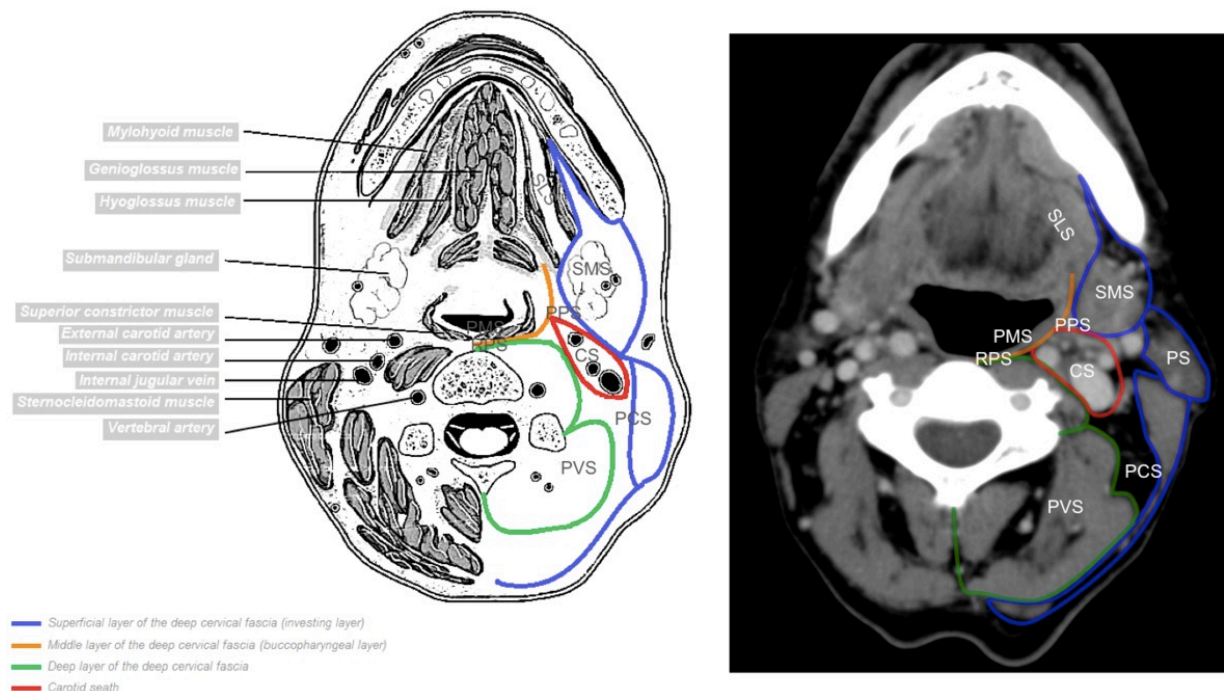


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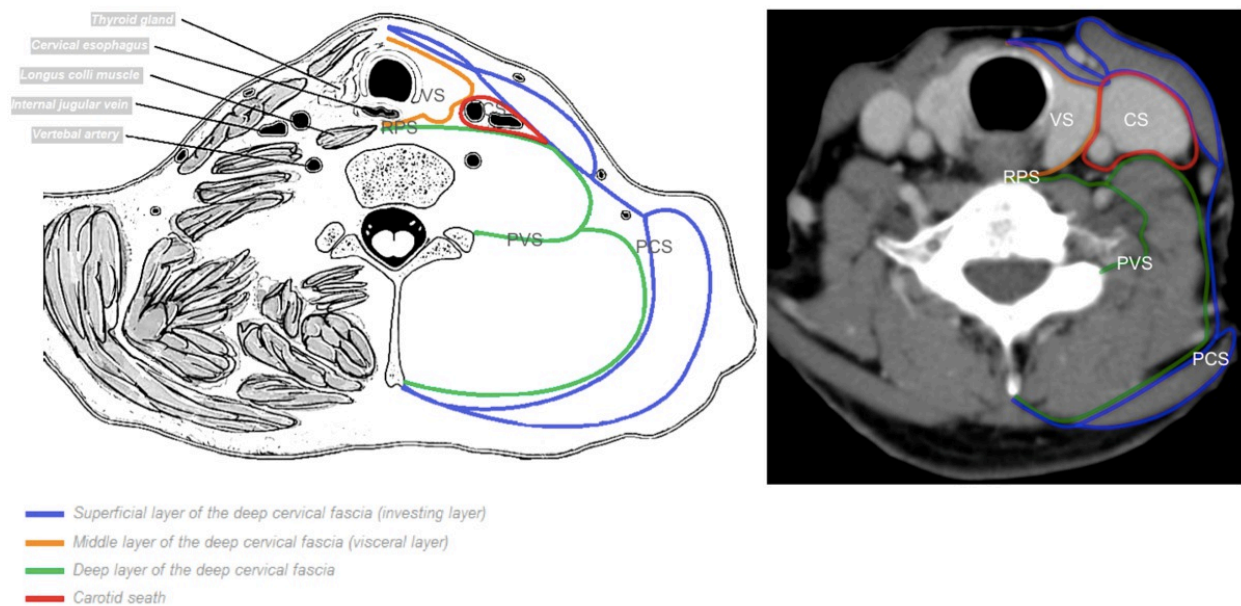


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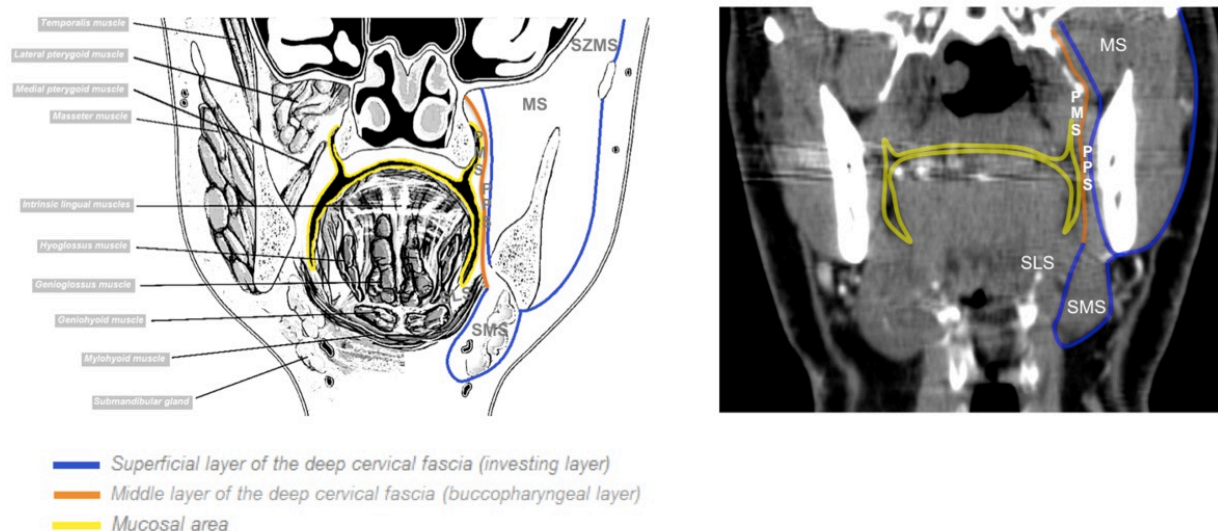


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CERVICAL SPACES AND CONTENTS

Parapharyngeal space (PPS)	<ul style="list-style-type: none"> Fat Branches of cranial nerve V Internal maxillary artery Ascending pharyngeal artery Pharyngeal venous plexus
Pharyngeal mucosal space (PMS)	<ul style="list-style-type: none"> Lymphoid tissue (adenoids, faucial and lingual tonsils) Superior and middle constrictor muscles Salpingopharyngeus muscle Pharyngobasilar fascia <i>Levator palatini</i> muscle <i>Torus tubarius</i>
Masticator space (MS)	<ul style="list-style-type: none"> Muscles of mastication (Lateral pterygoid; Medial pterygoid; Masseter; Temporalis) Inferior alveolar nerve Ramus and body of mandible
Parotid space (PS)	<ul style="list-style-type: none"> Parotid gland Facial nerve Retromandibular vein External carotid and internal maxillary arteries Intraparotid lymph nodes
Carotid space (CS)	<ul style="list-style-type: none"> Internal carotid artery Internal jugular vein Cranial nerves (IX; X; XI and XII) Sympathetic plexus Deep cervical chain lymph nodes
Retropharyngeal space (RPS)	<ul style="list-style-type: none"> Fat Lateral and medial retropharyngeal lymph nodes
Perivertebral space (PVS)	<ul style="list-style-type: none"> Prevertebral muscles Vertebral artery Vertebral vein Scalene muscles Brachial plexus Phrenic nerve Paraspinal muscles
Posterior cervical space (PCS)	<ul style="list-style-type: none"> Fat Spinal accessory nerve (XI) Spinal accessory lymph node chain Brachial plexus Dorsal scapular nerve
Visceral space (VS)	<ul style="list-style-type: none"> Thyroid gland Parathyroid glands Hypopharynx, larynx and trachea Esophagus Recurrent laryngeal nerve Paratracheal lymph nodes.
Sublingual space (SLS)	<ul style="list-style-type: none"> Hyoglossus muscle Lingual nerve Cranial nerves (IX and XII) Lingual artery and vein Sublingual glands Deep portion of the submandibular gland Submandibular gland duct (Wharton's duct)
	<ul style="list-style-type: none"> Anterior belly of digastric muscle Superficial portion of submandibular gland

Table 2: Cervical spaces and contents

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Conclusion

The best way to correctly evaluate the head and neck regions starts with the analysis of the anatomy. Once the space of origin of a mass is identified, the spectrum of differential diagnoses becomes shorter. With this approach, the radiologic evaluation of lesions in the deep spaces of the neck becomes easier and more accurate.

Personal information

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