Neck muscles and deep spaces made simple.

Poster No.: C-1862
Congress: ECR 2017
Type: Educational Exhibit
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Keywords: MR, CT, Head and neck, Anatomy, Education, Abscess, Neoplasia, Inflammation
DOI: 10.1594/ecr2017/C-1862

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Learning objectives

1. Anatomic review of cervical spaces; demarcating their contents, muscles and adjacent structures.

2. To describe the role of MRI imaging of the neck and the main features of some pathologies.

3. Case-based review of a variety of pathologic findings within these spaces.
Background

At the neck the fascia are classified into two major divisions; superficial and deep. The deep cervical fascia has three layers that converge on the hyoid bone and they divide the neck into two different regions: the suprathyoid and infrathyoid.

The suprathyoid area encompasses the deep spaces between the skull base to hyoid bone, and the infrathyoid inclues spaces from hyoid bone to cervicothoracic junction.

The superficial cervical fascia is composed by fatty and connective tissue that encloses the voluntary muscles of the face, platysma muscles, nerves, lymphatics and vessels. Its primary function is to allow the skin to glide easily over deeper structures.

The main pathologies are keloids, subcutaneous fat necrosis, lipomas, cellulitis, neurofibromas, squamous cell and basal cell carcinomas.

The deep cervical fascia made up of denser and better defined layers encloses the musculature of the neck, mandible and muscles of mastication and deglutition and it is subdivided into 3 layers that meet to form the carotid sheet.

1) Superficial layer fibrous tissue that encircles the neck including sternocleidomastoid and trapezius muscles, it extends into de face and caudally to the pectoral and axillary regions.

2) Middle layer it extends from hyoid bone to fibrous pericardium and contains strap muscles, thyroid gland, trachea, larynx and esophagus.

3) Deep layer from skull base to the endothoracic fascia and extends laterally below clavicle to form de axillary sheath, it contents the axillary vessels, brachial plexus, vertebral column and paravertebral muscles.

The importante of these fascial layers is that they help for surgical planning and are vital in limiting the spread of diseases.

-Suprathyoid neck includes:

Parapharyngeal, pharyngeal mucosal, masticator, parotid, buccal, submandibular, carotid, retropharyngeal, danger and perivertebral spaces.

-Infrahyoid neck includes:
Visceral, posterior cervical, anterior cervical, carotid, retropharyngeal and perivertebral spaces.

**Supra and infrahyoid spaces:**

Carotid, retropharyngeal, perivertebral and posterior cervical spaces.

**Suprathyroid space includes:**

**Parapharyngeal space (PPS)**

It lies in a central location and extends from the skull base to the hyoid bone, containing only fat, branches of trigeminal nerve and pterygoid venous plexus.

Main diseases in this space are deep portion of parotid gland tumors, minor salivary gland tumors, paragangliomas, phlegm and abscess.

**Pharyngeal mucosal space (PMS)**

It is delimited by the middle layer of the deep cervical fascia and is medial to the PPS. It mainly contains mucosa, lymphoid tissues of Waldeyer ring, eustachian tube, minor salivary glands, foramen lacerum, muscle levator veli palatine and constrictor muscles.

**Masticator space (MS)**

Anterior to parotid space, anterolateral to PPS and posterior to buccal space. It has a suprazygomatic component and extends to the inferior margin of the mandible. Surrounded by two slips of the superficial layer of deep cervical fascia.

Includes ramus and posterior body of mandible, muscles of mastication, inferior alveolar nerves, vein and artery.

Lesions in this space may spread along the mandibular division of trigeminal nerve into middle cranial fossa.

Main diseases are medial and lateral pterygoid, masseter muscle inflammatory disease or tumors, mandibular disease, V3 retrograde tumor or schwannoma, abscess, etc.

**Parotid space (PS)**

It is located lateral to PPS, and is circumscribed by the superficial layer of deep cervical fascia. The superior margin borders the external auditory canal and the inferior lobe of
parotid extends below inferior mandibular margin. It contains parotid gland, intraparotid facial nerve, retromandibular vein, external carotid artery and lymph nodes.

Malignancy in this space may follow the facial nerve into temporal bone.

Parotid gland disease, facial nerve schwannoma, external carotid artery aneurisma and retromandibular vein thrombosis.

**Buccal space (BS)**

Is not a true fascially defined space. They are fat contained spaces on each side of the face between the buccinators and platysma muscles.

It contains fat, parotid duct, facial arteries, veins and nerve, trigeminal nerve (bucal branch of mandibular division).

Main pathology are parotid duct calculi, odontogenic infection or minor salivary gland tumours.

**Submandibular space (SMS)**

Inferolateral to mylohyoid muscle and above hyoid bone. The upper portion is called the sublingual space and its filled with connective tissue and surrounds both sublingual glands and ducts. The lower portion is referred to as submaxillary space the larger superficial portion of submandibular gland lies within its connective tissue.

Diseases that affect this space; sublingual gland disease especially ranula, dermoid, lingual nerve or cranial nerves XI-XII schwannomas.

**Supra and infrathyoid spaces include:**

**Carotid space (CS)**

Located posterior to the parapharyngeal space. Extends from skull base to aortic arch. All three layers of deep cervical fascia contribute to carotid sheath that circumscribes this space.

Includes internal carotid artery, jugular vein, cranial nerves IX-XII, and deep cervical lymph node chain.

Common diseases include carotid body paragangliomas, carotid aneurism/dissection, neurogenic tumors, vascular pseudotumors and isolated nodal disease.
Retropharyngeal space (RPS)

Posterior midline space that extends from skull base to the level of T3 vertebral body. It has the middle layer of deep cervical fascia as anterior margin and the deep layer as posterior and lateral margin.

Contains only fat and lymph nodes.

· Danger space

Potential space behind the true retropharyngeal space. It connects the deep cervical spaces to mediastinum. In healthy patients it is indistinguishable from retropharyngeal space, Only visible when distended by fluid or pus.

Main disease affecting this spaces are infections, hematomata, metastatic disease, lipomas, etc.

Perivertebral space (PVS)

Located posterior to RPS and danger space surrounded by prevertebral layer of the deep cervical fascia, it extends from skull base to upper mediastinum.

Contains prevertebral and paraspinal muscles, vertebral body, artery and vein, spinal cord, phrenic nerve and brachial plexus.

Involved by infection (osteomyelitis/diskitis), chordomas, pseudotumors, osteoblastoma, lymphomas, neurogenic tumors.

Posterior cervical space (PCS)

Posterolateral part of suprathyoid and infrathyoid neck. The deep layer of deep cervical fascia separates it from perivertebral space.

It contains the spinal accessory nerve and lymph node chain, dorsal scapular nerve and fat.

Cystic hygromas, lymphangiomas, inflammatory/malignant nodal disease, lipomas and liposarcomas occur in this space.

Infrahyoid region:

Visceral space (VS)
Delimited by the middle layer of deep cervical fascia, it contains thyroid and parathyroid glands, trachea, esophagus, recurrent laryngeal nerves.

It is divided into anterior pretracheal space and a retrovisceral space, which communicate freely around the sides of the larynx.

Thyroid gland disease predominates; carcinomas, adenomas goiter. Other disease are thyroglossal duct cysts, parathyroid and esophageal disease.

**Anterior cervical space (ACS)**

Anterolateral region of infrahyoid neck. Located lateral to visceral space superiorly it continues with submandibular space. Main content is fat.

Most common disease are lipomas and branchial cleft cysts.
Fig. 1: T1 weighted MRI in axial plan of suprahyoid neck demonstrating the three deep cervical fascia layers; superficial (red); middle (orange) and deep layer (blue).

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**Fig. 2:** T1 weighted MRI in axial plan of infrahyoid neck demonstrating the three deep cervical fascia layers; superficial (red), middle (orange) and deep (blue), and carotid sheath (green).

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**Fig. 3:** T1 weighted MRI in axial plan of the spaces of suprathyroid region demonstrating pharyngeal mucosal space (pink), parapharyngeal space (orange), masticator space (green), parotid space (yellow), buccal space (light blue), carotid (red) and perivertebral space (dark blue).

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Fig. 4: T1 weighted axial plan of an inferior part of suprhyoid region demonstrating submandibular space (light orange), carotid space (red), retropharyngeal space (purple), perivertebral space (dark blue) and posterior cervical space (green).

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Fig. 5: T1 weighted axial plan image of infrahyoid neck demonstrating anterior cervical space (yellow), visceral space (light blue), carotid (red), posterior cervical space (green) and perivertebral space (dark blue).

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Fig. 6: T1 weighted axial plan image of an inferior region of infrahyoid neck demonstrating visceral space (light blue), carotid space (red), retropharyngeal space (purple) and perivertebral space (dark blue).

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Findings and procedure details

There are various imaging techniques used in the evaluation of the neck and each of these modalities has its own advantages or disadvantages.

CT and MRI are the primary imaging modalities, and the decision mainly depends on the institution.

The relative low cost of CT, availability, short time of acquisition and the high-quality multiplanar images provided are some of the advantages over MRI. Some of the disadvantages are the relatively low soft tissue contrast, the need of iodinated contrast agents and the image degradation caused by dental fillings or foreign objects.

MRI has the benefit of not using ionizing radiation, it has a better resolution and anatomic detail specially in the upper neck.

MRI of the neck is routinely performed at magnetic fields of 1.0 or 1.5 T, recently 3.0 T units.

The choice of the right surface coils and their optimal positioning along with good instructions and positioning of the patient are some of the most important factors. The combined head and neck coil should be used.

The axial plane is obtained with patient’s hard palate perpendicular to tabletop and the axial plane aligned along the inferior orbital meatal.

Slices of 4mm with either no interslice gap or 10% gap.

Inversion recovery fast-spin echo (FSE) sequences with fat saturation is useful in node imaging. Followed by an FSE T2 weighted sequence as complementary.

Subsequently, axial and coronal spin echo T1 weighted images are performed before and after IV gadolinium containing contrast agent with fat saturation in postcontrast images.

Diffusion weighted imaging is performed, obtained with a single shot echo planar imaging sequence using the same coil. The sequence can be repeated for three values (b=0, 500 and 1000 sec/mm2). The thickness suggested is 4-5mm with intersection gap of 1mm. Posterior quantification of diffusion abnormalities requires calculation of the ADC (apparent diffusion coefficient).

Neck masses can be grouped into two major types: nodal masses and nonnodal masses and this two types can appear as benign or malignant lesions.
When approaching a neck lesion we need to define the mass center, in suprahyoid lesions in relation to PPS and how does the mass displace it, so we can define the space of origin and then review the specific differential diagnosis.

In this review we present some of the most significative neck pathologies of these spaces.

**Parapharyngeal space (PPS)**

Most lesions occur from secondary extension originating in neighboring spaces. A primary lesion of this space must have be suspected if a whole circumference of surrounding fat is preserved.

Some of the most common lesions are: inflammatory/infectious (abscess from adenoids tonsils, odontogenic or parotid), lipoma, pleomorphic adenoma from salivary gland, or direct spread of tumour from adjacent spaces (squamous cell carcinoma, NHL, sarcoma or mucoepidermoid or adenoide cystic carcinoma).

**Pharyngeal mucosal space (PMS)**

A mass is designated primary to PMS if mass center is medial to PPS, it pushes PPS fat from medial to lateral and it disrupts normal mucosal and submucosal architecture.

Some common pitfalls are labeling normal asymmetry as tumor, lateral pharyngeal recess is asymmetric and may have fluid within it, lymphoid tissue can cause misimpression of tumor.

In table 1 we mention some of the lesions in PMS, by far the most common lesion is squamous cell carcinoma.

<table>
<thead>
<tr>
<th>Type</th>
<th>Main lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflammatory</td>
<td>Pharyngitis, post-radiation, postinflammatory retention cyst.</td>
</tr>
<tr>
<td>Infectious</td>
<td>Tonsillar abscess,</td>
</tr>
<tr>
<td>Benign tumor</td>
<td>Minor salivary gland origin, Benign mixed tumor.</td>
</tr>
<tr>
<td>Malignant tumor</td>
<td>Squamous cell carcinoma (naso/oropharynx), Non-Hodgkin lymphoma, minor salivary gland malignancy, rhabdomyosarcoma.</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Tornwaldt cyst.</td>
</tr>
</tbody>
</table>
**Table 1. Differential diagnosis of Pharyngeal mucosal space.**

- **Squamous cell carcinoma (Nasopharynx)**

  The best diagnostic clue is a mass centered in lateral pharyngeal recess of nasopharynx with deep extension and cervical adenopathy. It usually spreads into nasal cavity, pterygopalatine fossa, parapharyngeal space, through RPS or into oropharyngeal soft palate. The main clinical presentation is triad of neck mass, Serous otitis media and bloody nasal discharge.

  * **CT**: destruction of clival cortex or posterior skull base. Mildly enhancing mass in CECT.
  
  * **MRI**: T1WI mass hypo to isointense to muscle. T2WI moderate hyperintensity. T1 C+ mild homogeneous enhancement.

- **Non Hodgkin lymphoma**

  Large infiltrative mass with associated cervical adenopathy, imaging findings may be identical to SCCa. Main locations are adenoids, faucial or lingual tonsils.

  * **CT**: minimally enhancing bulky mass filling PMS often without deep extension. Nodes are usually large and may be centrally necrotic.
  
  * **MRI**: T1WI large mass isointense to muscle. T2WI varies in signal intensity, usually homogeneously hyperintense. T1C+ enhancing mass.

**Masticator space**

The features that define a lesion primary to this space are; A mass centered in muscles of mastication-mandible ramus and pushes on PPS from anterior to posterior. Primary symptoms of MS tumor or infection is trismus.

Infection is the most common mass in this space and sarcoma is the principal primary tumor. Tumors usually spread perineurally along V3 trunk.

<table>
<thead>
<tr>
<th>Type</th>
<th>Main lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital</td>
<td>Infantile hemangioma, venous vascular malformation.</td>
</tr>
</tbody>
</table>
Infectious | Odontogenic abscess.
---|---
Benign tumor | Schwannoma, Neurofibroma
Malignant tumor | Osteosarcoma, Chondrosarcoma, Rhabdomyosarcoma, Non-Hodgkin lymphoma, systemic metastasis.
Miscellaneous | Masticator muscle hypertrophy.

Table 2. Differential diagnosis of masticator space.

- **Odontogenic abscess**

Usually located in lower masticator space adjacent to posterior body of mandible.

* **CT**: lesion with compression of parapharyngeal space from anterolateral to posteromedial, shows focal fluid density with thick enhancing rim. Adjacent muscles are swollen and enhance. Osteomyelitis may be seen.

* **MRI**: T1WI low signal perimandibular area. T2WI focal high signal foci. T1C+ focal low signal area surrounded by enhancing wall.

- **Sarcoma (Chondrosarcoma, rhabdomyosarcoma, leiomyosarcoma)**

Malignant tumor of soft tissue origin. Poorly margined mass with bone destruction and invasión of adjacent fascial planes.

- **CT**: heterogeneous lesion with ill-defined borders and areas of calcification with erosion of bone of origin. Heterogeneous enhancement. Allows assessment of matrix and bone destructive changes.

- **MRI**: T1WI iso to hypointense to muscle, often heterogeneous. Mandible involvement shows replacement of normal marrow signal. T2WI heterogeneous hyperintense to muscle. Marrow soft tissue edema. T1C+ heterogeneous enhancement.

**Parotid space**

Lesions in this space can be intra or extraparotid, they displace PPS medially. It is important to designate a mass as superficial, deep or in same plane as intraparotid facial nerve. They can extend through stylomandibular túnel.

Parotid gland masses are the most common finding.
The most common parotid space tumor (80%) is benign mixed tumor.

<table>
<thead>
<tr>
<th>Type</th>
<th>Main lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital</td>
<td>1st branchial cleft cyst, hemangioma, lymphangioma</td>
</tr>
<tr>
<td>Infectious/inflammatory</td>
<td>Parotiditis, sarcoidosis.</td>
</tr>
<tr>
<td>Benign tumor</td>
<td>Pleomorphic adenoma, warthin tumor, lipoma, schwannoma.</td>
</tr>
<tr>
<td>Malignant tumor</td>
<td>Mucoepidermoid carcinoma, adenoide cystic carcinoma, malignant mixed tumor, squamous cell carcinoma.</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Systemic metastases. Facial nerve neuroma.</td>
</tr>
</tbody>
</table>

Table 3. Differential diagnosis of parotid space.

- **Acute parotiditis**

  Unilateral diffuse inflammation-infection of parotid gland and adjacent tissues. Bacterial usually unilateral, viral 75% bilateral. Sometimes calculus-induced.

  - **CT:** Hyperdense enlarged gland with ill-defined margins with diffuse enhancement.
  
  - **MRI:** T2WI diffuse high signal and focal areas of high signal (abscesses). T1C+ diffusely enhancement, and if abscess; rim enhancing low signal fluid collections.

- **Benign mixed tumor (also called pleomorphic adenoma)**

  Heterogeneous tumor of parotid gland made up of an admixture of epithelial, myoepithelial and stromal components. They can be sharply circumscribe with homogeneous parenchyma or multilobular inhomogeneous mass.

  - **CT:** Smoothly marginated with homo/heterogeneous enhancement. Depending on the size. Necrosis, hemorrhage or calcifications may be present.
  
  - **MRI:** T1WI hypointensity, if big heterogeneous signal. T2WI intermediate to high signal. T1C+ variable mild to moderate enhancement.

- **Mucoepidermoid carcinoma**
Is a tumor that usually occurs in the salivary glands, and are more common in middle ages. This tumors account for 2.8-15.5% of all salivary gland tumours. In parotid gland they are the most common malignant primary neoplasma. They can involve the facial nerve.

* CT: Low grade tumours appear as well-circumscribe masses with cystic components. Enhancement of solid components and sometimes calcifications are seen. High grade tumours have poorly defined margins and infiltrate adjacent structures.

* MRI: *low grade tumors*; T1 low to intermediate signal; low signal cystic spaces. T2 intermediate to high signal; cystic areas will be high signal.

T1 C+ heterogeneous enhancement of solid components.

High grade tumours; T1 low to intermediate. T2 intermediate to low.

It is Essentials to image cranial nerves with fat saturated post contrast T1 sequences and evaluate cavernous sinus and inner ear.

- **Warthin tumour**

Benign sharply demarcated tumour from salivary-lymphoid origin most common from parotid gland. Bilateral or multifocal in 20% of the cases and are the most common benign parotid tumour alter pleomorphic adenoma. Typically heterogeneous on all Imaging modalities and often hypervascular. Cystic components in 30%. Associated with smoking.

*CT: well defined heterogeneous solid cystic lesion with enhancement of solid portions. A mural nodule is strongly suggestive.

*MRI: T1 low to intermediate signal with cystic portions or colesterol components with focal high signal.

T2 heterogeneous and variable. T1 C+ usually no enhancement.

- **Buccal space**

The most common lesions in this space occur secondary to spread from masticator and submandibular space.

Metastasic nodes from squamous carcinoma are often found. Other pathologies are hemangioma, lipoma, sebaceous cyst, carcinoma from minor glands and soft tissue sarcomas by secondary invasion.

- **Submandibular space**
Many different pathologic processes may occur in this space.

The most common pathologies are referred in table 4.

<table>
<thead>
<tr>
<th>Type</th>
<th>Main lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cystic</td>
<td>Ranulas, dermoid and epidermoid cyst.</td>
</tr>
<tr>
<td>Inflammatory</td>
<td>Non specific inflammatory infectious or non infectious processes.</td>
</tr>
<tr>
<td>Vascular</td>
<td>High flow arteriovenous malformations, hemangiomas.</td>
</tr>
<tr>
<td>Malignant tumor</td>
<td>Squamous cell carcinoma or salivary gland tumors.</td>
</tr>
<tr>
<td>Benign tumors</td>
<td>Lipoma.</td>
</tr>
</tbody>
</table>

* **Ranula**

Is a benign acquired or congenital mucous retention cyst that arises from sublingual gland or minor salivary gland. Result from trauma or inflammation of glands. They can be simple or plunging; this one occurs in ruptured ranula that extend into submandibular space.

* **CT**: Uncomplicated ranulas appear as thin-walled cystic lesions with fluid attenuation, if they are infected the walls are typically thicker and enhance with contrast.

* **MRI**: T1 low signal. T2 high signal. T1C+ wall with enhancement best seen with fat saturation.

**Carotid space**

A lesion in this space displaces parapharyngeal space fat anteriorly, pushes posterior belly of digastric muscle laterally, and if it begins posteroirly internal carotid artery is pushed anteriorly.

<table>
<thead>
<tr>
<th>Type</th>
<th>Main lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital</td>
<td>2nd branchial cleft cyst.</td>
</tr>
<tr>
<td>Infectious</td>
<td>Cellulitis, abscess.</td>
</tr>
</tbody>
</table>
**Table 5. Differential diagnosis of carotid space.**

<table>
<thead>
<tr>
<th>Type</th>
<th>Main lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign tumor</td>
<td>Glomus jugulare paraganglioma, carotid paraganglioma, CN9-11 schwannoma/neurofibroma, jugular foramen meningioma.</td>
</tr>
<tr>
<td>Malignant tumor</td>
<td>Squamous carcinoma primary tumor invasión or extranodal invasión, entranodal NHL.</td>
</tr>
<tr>
<td>Vascular/pseudolesion</td>
<td>IJV thrombophlebitis/trombosis, CCA/ICA trombosis, dissection, aneurisma, ectatic CCA/ICA, asymmetric IJV.</td>
</tr>
</tbody>
</table>

- **Carotid body paraganglioma**

Benign vascular tumor arising in glomus bodies in carotid body found in crotch of ECA and ICA at carotid bifurcation. The mass displaces ECA anteromedially and ICA posterolaterally.

- **CT**: density similar to muscles, avidly rapid enhancement.

- **MRI**: T1WI isointense to muscles, with `Salt and pepper` appearance if bigger than 1.5cm. (Salt= secondary to subacute hemorrhage, pepper= hypointense serpentine flow channels due to high vascularity in fibrous matrix). T2WI mass signal above of muscle. T1C+ intense enhancement.

**Retropharyngeal space**

Mass in this space are centered posteromedial to parapharyngeal space and medial to carotid space. This space is route of Spreads for tumor or inflammatory processes in to Skull and mediastinum.

<table>
<thead>
<tr>
<th>Type</th>
<th>Main lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital</td>
<td>Infantile hemangioma, lymphangioma.</td>
</tr>
<tr>
<td>Infectious/inflammatory</td>
<td>Reactive nodes, cellulitis, abscess.</td>
</tr>
<tr>
<td>Benign tumor</td>
<td>Lipoma.</td>
</tr>
<tr>
<td>Malignant tumor</td>
<td>Squamous carcinoma posterior oro/hypopharynx invasion, nodal metastasis (NHL, Thyroid, other systemic metastases)</td>
</tr>
</tbody>
</table>
Vascular/pseudolesion

| IJV thrombophlebitis/trombosis, CCA/ICA trombosis, dissection, aneurisma, ectatic CCA/ICA, asymmetric IJV. |

Table 6. Differential diagnosis of Retropharyngeal space.

- **Retropharyngeal abscess**

Tense fluid Collection distending the space with variable wall enhancement. Posterior to PMS and anterior to perivertebral space. It can extend to mediastinum through danger space. CT more available and allows rapid diagnosis. MRI rarely used in septic patient.

**Perivertebral space**

A mass in this space is centered within prevertebral muscles or corpus of vertebral body and lifts prevertebral muscles anteriorly. Most lesions originate in vertebral body.

<table>
<thead>
<tr>
<th>Type</th>
<th>Main lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degenerative</td>
<td>Anterior disc herniation, hypertrophic facet Joint, osteophyte.</td>
</tr>
<tr>
<td>Infectious/inflammatory</td>
<td>Vertebral body osteomielitis.</td>
</tr>
<tr>
<td>Benign tumor</td>
<td>Brachial Plexus schwannoma/ neurofibroma, vertebral body benign bony tumors.</td>
</tr>
<tr>
<td>Malignant tumor</td>
<td>Chordoma, epidural metastasis, NHL, Squamous carcinoma invasion, vertebral body primary tumors.</td>
</tr>
<tr>
<td>Vascular</td>
<td>Vertebral artery dissection/aneurisma.</td>
</tr>
</tbody>
</table>

Table 7. Differential diagnosis of Perivertebral space.

**Visceral space**

Lesions in this space are better divided based on their organ of origin. Thyroid and parathyroid lesions are the most common. Squamous cell carcinomas of larynx and hypopharynx are also important. The most common cystic lesion is a thyroglossal duct cyst.
### Table 8. Differential diagnosis of visceral space.

<table>
<thead>
<tr>
<th>Type</th>
<th>Main lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degenerative</td>
<td>Colloid cyst, zenker diverticulum.</td>
</tr>
<tr>
<td>Infectious/inflammatory</td>
<td>Suppurative or hashimoto tiroiditis, reactive adenopathy.</td>
</tr>
<tr>
<td>Laryngeal lesions</td>
<td>Laryngocele, squamous cell carcinoma.</td>
</tr>
<tr>
<td>Thyroid lesions</td>
<td>Goiter, thyroid adenoma, carcinoma (papillary, follicular, medullary, anaplastic. Extranodal NHL.</td>
</tr>
<tr>
<td>Parathyroid</td>
<td>Cyst or adenoma.</td>
</tr>
<tr>
<td>Esophageal</td>
<td>Zenker diverticulum, carcinoma.</td>
</tr>
<tr>
<td>Other</td>
<td>Thyroglossal duct cyst, Nodal metastases.</td>
</tr>
</tbody>
</table>

### Posterior cervical space

The criteria for defining a neck mass as primary to PCS are; mass centered within fat of PCS, that displaces carotid space anteromedially, elevates sternocleidomastoid muscle and flattens deeper prevertebral and paraespinlal structures.

<table>
<thead>
<tr>
<th>Type</th>
<th>Main lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital</td>
<td>Lymphangioma, 3erd branchial cleft cyst.</td>
</tr>
<tr>
<td>Infectious/inflammatory</td>
<td>Suppurative/reactive adenopathy, tuberculous adenitis, abscess.</td>
</tr>
<tr>
<td>Malignant tumor</td>
<td>Liposarcoma.</td>
</tr>
<tr>
<td>Benign tumor</td>
<td>Lipoma, schwannoma/neurofibroma of brachial Plexus or CN11.</td>
</tr>
<tr>
<td>Other</td>
<td>Nodal metastases.</td>
</tr>
</tbody>
</table>

* **Schwannoma**

Benign tumor arising from CN11, distal brachial Plexus or cervical sensory nerve. Displaces jugular vein anteriorly and medially. If suprasyoid is located between paraspinoous and sternocleidomastoid muscles and posterior to JV, when infrasyoid located between scalene ans sternocleidomastoid muscles, lateral to JV.
* **CT:** Well delineated solitary fusiform iso/hypodense mass to soft tissue, with homogeneous enhancement, with cystic component.

* **MRI:** T1WI Homogeneous isointense to muscle. T2WI Hyperintense. T1C+ Homogeneous enhancement.

**Anterior cervical space**

Mostly all lesions in this space are transspatial disease from adjacent spaces.

The most common lesions are inflammatory (cellulitis or abscess), benign tumors as lipoma, or spread of carcinoma from adjacent spaces (thyroid).
Fig. 7: 26 year male patient with HIV and left periphery facial palsy, that was diagnose with extranodal NK/T cell lymphoma. A) T1 weighted axial image, b), c) and d) T1 C+ in axial, coronal and sagital plane images respectively showing involvement of pharyngeal mucosal space.

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Fig. 8: 72 year male patient that presents with increased volume in left preauricular region. A) Contrast enhanced CT in axial and b) coronal plane, that show in parotid left space a well-circumscribe round hypodense lesion with discrete inflammatory changes in adjacent fat.

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Fig. 9: Same patient, a) T1 weighted image with contrast that shows the same round well-circumscribe lesion with discrete enhancement in periphery and central hypointensity that in b) T2 FSE weighted image is hyperintense indicating cystic changes. C) Diffusion weighted axial image showing restricted diffusion. Diagnosis of mucoepidermoid carcinoma of left parotid gland was made.

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**Fig. 10:** 63 year old male patient that presented with increased volume in right neck region that refers being an intense smoker. A) Gray scale and b) color Doppler ultrasound showed a well circumscribe oval heterogeneous lesion in right parotid space with increased vascularity.

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Fig. 11: Same patient. A) non contrast CT in axial image that shows in right parotid space a well demarcated hypodense solid lesion that in b) and c) contrast enhanced CT in axial and coronal images respectively showed heterogeneous enhancement of solid regions, showing another lesion of the same characteristics in the contralateral parotid space, diagnosis of Warthin tumour was made.

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Fig. 14: 73 year old female that presented with fever and increased volume in the chin region. A) Non contrast CT showing nonspecific inflammatory changes in buccal space.

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**Fig. 15:** 47 year old female with previous diagnosis of Antiphospholipid syndrome that presents increased volume of sublingual region since 4 months and fever during one week. A) Non contrast enhanced CT that shows in right submandibular space a well-demarcated walled homogeneous cystic lesion that in b) and c) contrast enhanced CT in axial and coronal plane images show peripheral enhancement in relation of a thick wall, this findings suggestive of infected Ranula that involves sublingual and submandibular right space.

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Fig. 16: 55 years old female. A) and b) T1 weighted coronal and sagital images respectively that show in left carotid space an oval well-demarcated isointense lesion with salt and pepper aspect located at the carotid bifurcation with splaying of ICA and ECA, that in c) STIR and d) T2 weighted images increased signal. E) and F) T1C+ axial and coronal images respectively show intense enhancement. These findings compatible with carotid body paraganglioma.

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**Fig. 17:** 43 years old male patient with previous diagnosis of inflammatory bowel disease that presents with fever, a) and b) contrast enhanced CT axial plane images as c) and d) coronal and sagital images that show a well-demarcated thick walled collection in retropharyngeal space that extends to visceral and perivertebral spaces. Diagnosis of retropharyngeal abscess was made.

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**Fig. 18:** 20 year old female patient with previous diagnosis of neurofibromatosis type 2. A) STIR weighted axial plane image that shows a hyperintense lesion arising from spinal nerve root at the level of C2-C3, b) in axial T1 weighted image and e) coronal plane has isointense signal. In c) T1C+ weighted image shows intense enhancement. In d) and f) T2 weighted images in coronal and sagittal planes images respectively shows increased signal. Diagnosis of Schwannoma that involves perivertebral space was made.

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Fig. 19: Female patient with thyroid papilar carcinoma to represent a common pathology affecting the visceral space.

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Fig. 20: 57 years old female patient that refers a mass in posterior right neck. In a) and b) Non contrast enhanced Ct in axial and sagital plan images respectively show a welldemarcated hypodense lesion in right posterior cervical space. Contrast enhanced CT wasn’t able to obtain because of renal function. Diagnosis of Schwannoma was made during surgery.

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**Fig. 13:** Same patient. A) T1 weighted image with a lobulated well demarcated heterogeneous isointense mass in right parotid and parapharyngeal space that includes part of parotid gland, in b) T2 FSE and c) STIR weighted axial images has heterogeneous increased signal. D) to f) Diffusion weighted images the mass show restriction. Diagnosis of benign mixed tumour in right parapharyngeal and parotid spaces.

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**Fig. 12:** 25 years old female patient. A) Non contrast CT axial imagen that shows a hypodense well demarcated lesion in right parotid and parapharyngeal spaces that in b) contrast CT axial image doesn´t present enhancement.

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Conclusion

Knowledge of the neck anatomy and the different abnormalities that can affect each space and how they behave on the different imaging techniques allows the radiologist to have a more organized approach to neck lesions and gives him the tools for a better diagnostic and characterization of each lesion.

Given the varied appearance of neck lesions, the radiologist should avoid being dogmatic about the final diagnosis, because of the important therapeutic implications, which may change the management and outcome of the patient.

Clinical presentation combined with imaging findings can help the radiologist to establish a better diagnosis or to limit the differential diagnosis.
References


