CT and MR imaging of the neck - a practical approach

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Learning objectives

- Provide an anatomic review of cervical spaces and their components.
- Present a simplified approach to evaluation of neck disorders.
- Describe the role of CT and MR imaging of the neck in clinical practice and imaging features of the commonest pathologic conditions.

Background

The neck has a complex anatomical structure, and is divided in several spaces based in fascial boundaries. There are two main cervical fasciae: the superficial cervical fascia (SCF) and deep cervical fascia (DCF).

Superficial cervical fascia

The SCF is a fat-filled layer of connective tissue that surrounds the neck and contains the platysma, superficial lymph nodes, nerves and vessels.

Deep cervical fascia

The DCF is divided in three parts (Fig. 1 on page 7, Fig. 2 on page 7, Fig. 3 on page 8, Fig. 4 on page 9, Fig. 5 on page 10 and Fig. 6 on page 11):

- The superficial layer (*investing fascia*) - it completely encircles the neck, running from the skull base to the sternum, clavicles, and scapulae. It encloses the trapezius, the sternocleidomastoid and the inferior belly of the omohyoid muscles and also the parotid and masticator spaces. Anterolaterally contributes to the carotid sheath.
- The middle layer (*buccopharyngeal fascia)* - runs from skull base and continuous inferiorly with the pericardium. It envelops the infrahyoid strap muscles (muscular part), the thyroid and parathyroid glands, larynx and the trachea (visceral space). It is the anterior boundary of the retropharyngeal space and a part of the carotid sheath laterally.
- The deep layer *(perivertebral fascia)* - runs from the base of the skull, merges inferiorly with the middle layer and then continues into the mediastinum. It encircles the prevertebral and paraspinous muscles as well as the trunks of the brachial plexus, phrenic nerve and vertebral vessels. It attaches to the transverse processes of the vertebrae and forms the anterior

boundary of the prevertebral space; it also contributes to the margins of the retropharyngeal space and carotid sheath.

Anatomically the extracranial portion of the head and neck, excluding the more anterior parts of the orbit, sinonasal region and oral cavity, can be divided at the hyoid bone into two distinct regions: the suprahyoid and infrahyoid regions. The majority of neck spaces are located in the suprahyoid region, others belong to the infrahyoid region and some of them are common to both supra and infrahyoid regions:

Suprahyoid region (Fig. 7 on page 12, Fig. 8 on page 13, Fig. 9 on page 14 and Fig. 10 on page 15)

Parapharyngeal space (PPS):

It has an inverted pyramidal shape, extending from the basis of the skull to the hyoid bone. An important anatomical relation is that this space is continuous anteriorly with the submandibular space in the inferior portion.

Contents: fat, internal maxillary and ascending pharyngeal arteries, branches of the submandibular nerve, pharyngeal venous plexus, minor salivary glands rests and salpingoparyngeus muscle.

Pharyngeal mucosal space (PMS):

It is surrounded posteriolaterally by the middle layer of the *DCF*, which superiorly encloses the posterior aspect of the pharyngobasilar fascia. This fascia attaches the pharynx and superior constrictor muscle to the skull base. The *levator veli palatine* muscle and the eustachian tube pass through it superolaterally via the sinus of Morgagni, providing a route of spread for nasopharyngeal tumors to the skull base.

Contents: mucosal surfaces and submucosa of the nasopharynx, oral cavity,oropharynx and hypopharynx, lymphoid tissue (tonsils, adenoids), minor salivary glands, torus tubarius, superior and middle constrictor muscles, palatoglossus muscle, palatopharyngeus, muscle *levator veli palatine* muscle and pharyngobasilar fascia.

Parotid space (PS):

It is located posterior to the masseter muscle and mandible and lateral to the PPS. The superior margin of the PS abuts the external auditory canal, and the inferior lobe of parotid often extends inferiorly below the inferior mandibular margin. The posterior belly of the digastric muscle can indent the parotid from a posteromedial direction and can help in differentiating superficial lobe lesions from deep lobe lesions of the parotid.

Contents: parotid gland, facial nerve (lateral to the retromandibular vein), retromandibular vein, intra parotid lymph nodes, external carotid artery, parotid duct (Stensen's duct).

Masticator space (MS):

The masticator space (MS) is anterior to the PS, anterolateral to the PPS, and posterior to the buccal space. It is most extensive in the craniocaudal direction and reaches from the superior border of the temporalis muscle to the inferior edge of the mandible. It can be thought of as two continuous parts: the*suprazygomatic MS* and the *naso-oropharyngeal MS*. This is important for sectioned imaging, as slices should always continue above the zygomatic arch when delineating this space. The MS is surrounded by two slips of the superficial layer of the DCF, which ends superiorly at the skull base medial to the foramen ovale. Through this elevator shaft, MS lesions can communicate with the intracranial structures (cavernous sinus). There is also a possibility of communicating with the pterygopalatine fossa through the pterygomaxillary fissure superomedially.

Contents: ramus and posterior body of mandible, masseter muscle, medial and lateral pterygoid muscles, temporalis muscle, inferior alveolar artery and vein, masticator nerve branches and inferior alveolar nerve branches.

Buccal space (BS):

It is a horizontal elongated space along the anterior part of the parotid duct, and is not a true fascially defined space. It lies between the buccinator muscle medially and the superficial muscles of facial expression laterally. This space is almost entirely filled with fat that has some finger-like projections: laterally along the parotid gland, medially along the medial side of the mandible and superiorly along the both sides of the temporalis muscle.

Contents: buccal fat pad, minor salivary glands, parotid duct (Stensen's duct), facial artery and vein, buccal branches of facial and mandibular nerves, buccal lymph nodes.

Sublingual space (SLS):

The teacup-shaped SLS is located deep in theoral tongue, superomedial to the mylohyoid muscle and lateral to the genioglossus-geniohyoid muscles. The space is not bounded by fascial structures and is posteroinferiorly continuous with the posterosuperior part of the submandibular space, for this reason lesions can easily spread out to the submandibular region.

Contents: anterior hyoglossus muscle, lingual artery and vein, cranial nerves IX, XII, lingual nerve, deep lobe of submandibular gland submandibular gland duct (Wharton's duct), sublingual glands and ducts and sublingual lymph nodes.

Submandibular space (SMS):

The SMS has a horseshoe-shaped configuration (Fig. 11 on page 16 and Fig. 12 on page 18) and lies above the hyoid bone and inferolateral to the mylohyoid muscle. The anterior part is bounded by fascial slips from the superficial layer of the DCF. In the posterior part there are no fascial boundaries and the SMS is continuous with the SLS and with the inferior PPS, creating a potential route from the submandibular region to the skull base. At the level of the hyoid bone the SMS is continuous with the anterior cervical spaces (infrahyoid region).

Contents: anterior belly of the digastric muscle, facial artery and vein, inferior loop of hypoglossal nerve, superficial lobe of the submandibular gland, submandibular and submental lymph nodes and fat.

Infrahyoid region (Fig. 13 on page 19 and Fig. 14 on page 19)

Visceral space (VS):

The VS extends from the hyoid bone to the anterior mediastinum. It lies anterior to the retropharyngeal space and superomedial to both carotid spaces. For practical purposes, the space can be further subdivided in four areas: laryngeal, thyroid, parathyroid and esophageal areas.

Contents: hypopharynx, larynx, cervical esophagus, trachea, thyroid and parathyroid glands, paratracheal lymph nodes and recurrent laryngeal nerves.

Anterior cervical space (ACS):

These small paired spaces lie in the anterolateral part of the infrahyoid neck. They are located lateral to the visceral space, medial to the lateral strap of the sternocleidomastoid muscles and anterior to the carotid spaces. Superiorly they are continuous with the SMS and, as no fascia separates the two, SMS lesions can spread into the fat-filled ACS as well.

Contents: fat.

Supra and infrahyoid regions:(Fig. 15 on page 20, Fig. 16 on page 21, Fig. 17 on page 23 and Fig. 18 on page 24)

Carotid space (CS):

The two carotid spaces extend from the jugular foramen at the skull base to the aortic arch (suprahyoid and infrahyoid neck spaces). They are located posteromedial to thePPS

and lateral to the retropharyngeal space. All three layers of the DCF condense into the thick carotid sheath, which prevents spreading of disease.

Contents: carotid artery, internal jugular vein, cranial nerves IX, XI, XII (upper part), cranial nerve X (upper and lower parts), sympathetic plexus and deep cervical lymph nodes.

Retropharyngeal space (RPS):

The RPS is a midline space that runs from the base of the skull to theupper mediastinum. In normal circumstances this is a virtual space between the PMS and the perivertebral space. Its lateral walls are made of slips of the DCF and are called the *alar fasciae*. The anterior extension of the alar fasciae divides this space in two parallel subspaces: the posterior of which has been referred to as the "danger space". This "danger space" continues even further downward to the diaphragm. Both these spaces form natural conduits for spread of infection or tumors from the neck region into the mediastinum or skull base.

Contents: lymph nodes (suprahyoid) and fat.

Perivertebral space (PVS):

It is a midline space from skull base to coccyx that lies posterior to the RPS. It is bounded anteriorly and posteriorly by the deep layer of the DCF which is attached to the transverse and spinous processes of the cervical vertebrae forming two compartments: the anterior compartment (prevertebral space) and the posterior compartment (paraspinal space). The corpus and pedicles of the vertebrae as well as the intervertebraldisks are part of the anterior compartment, while the spinous process and laminae are part of the posterior one.

Contents:prevertebral muscles, vertebral artery and vein, scalene muscles, proximal brachial plexus, cervical vertebrae and disks (posterior), paraspinous muscles (posterior), phrenic nerve (posterior) and muscle motor nerve branches (posterior).

Posterior cervical space (PCS):

They are also paired spaces and lie in the posterolateral part of the suprahyoid and infrahyoid neck. The deep layer of the DCF separates it from the perivertebral space and superficially the superficial layer of the DCF forms a boundary to the subcutis and sternocleidomastoid muscles.

Contents: fat, preaxillary brachial plexus, spinal accessory nerve (XI), dorsal scapular nerve and spinal accessory lymph nodes.

Images for this section:

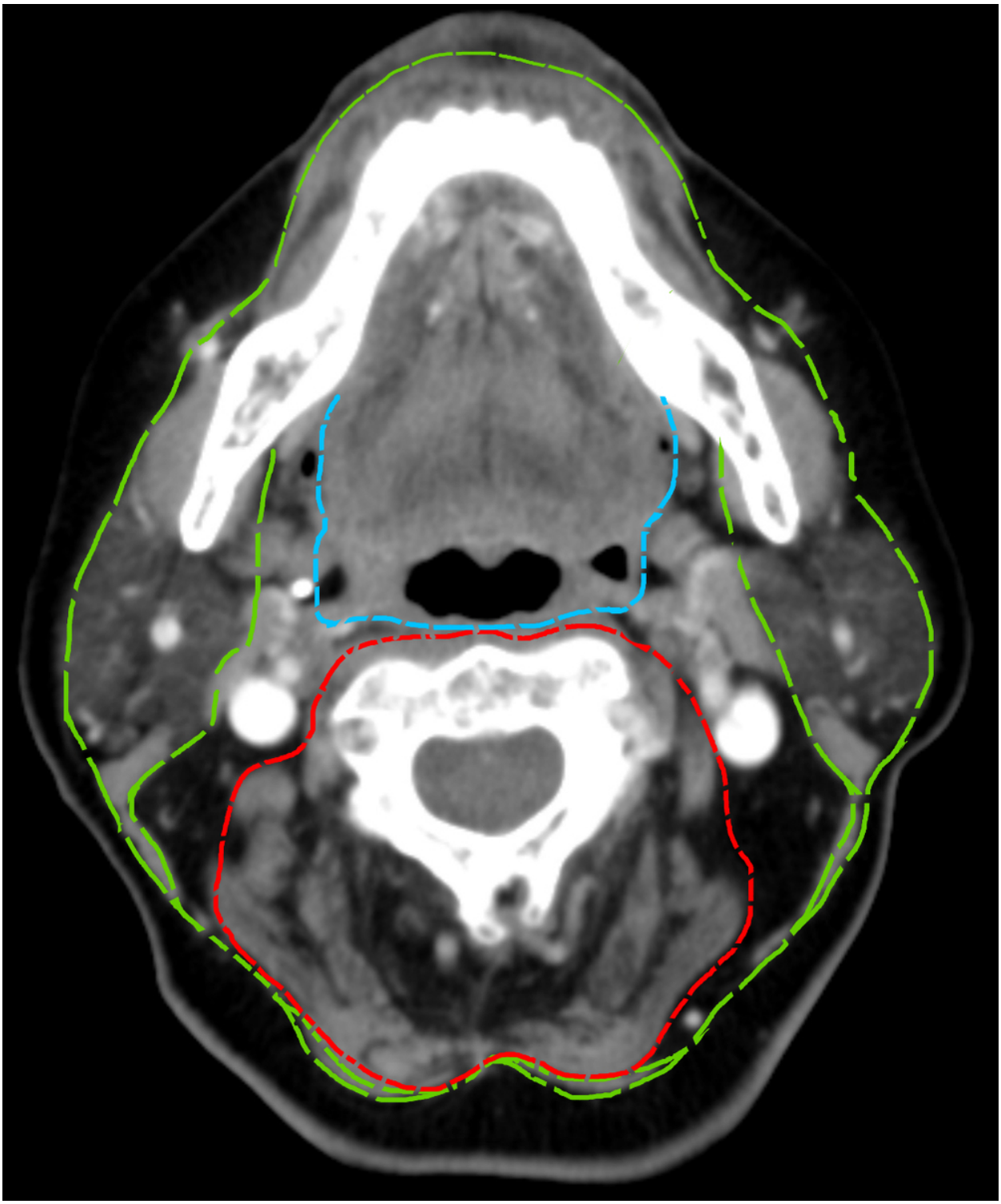

Fig. 1: Contrast enhanced CT scan in the axial plan of the suprahyoid region demonstrating the three layers of the deep cervical fascia (superficial layer - green dash line; middle layer - blue dash line; deep layer - red dash line).

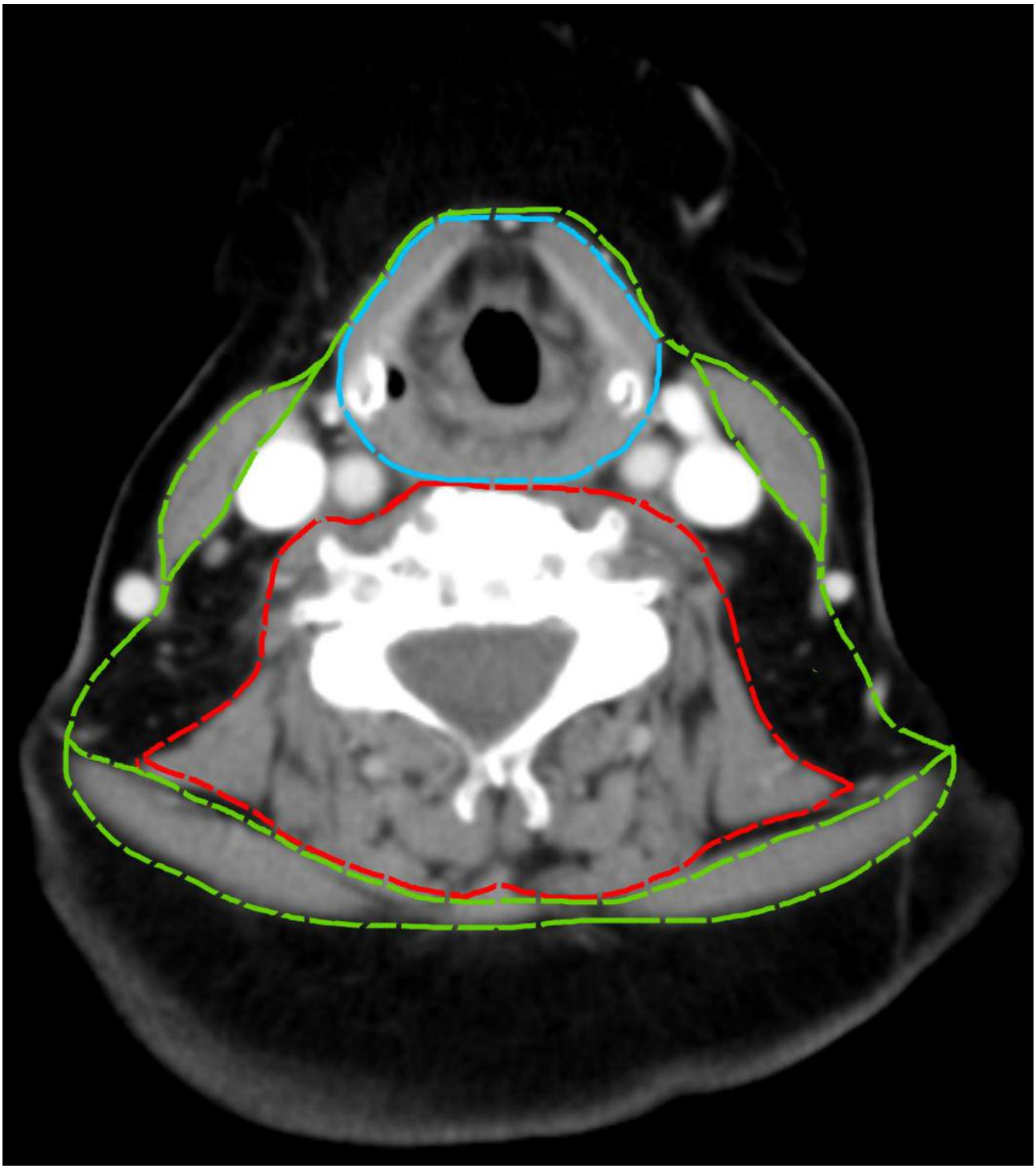

Fig. 2: Contrast enhanced CT scan in the axial plan of the infrahyoid region demonstrating the three layers of the deep cervical fascia (superficial layer - green dash line; middle layer - blue dash line; deep layer - red dash line).

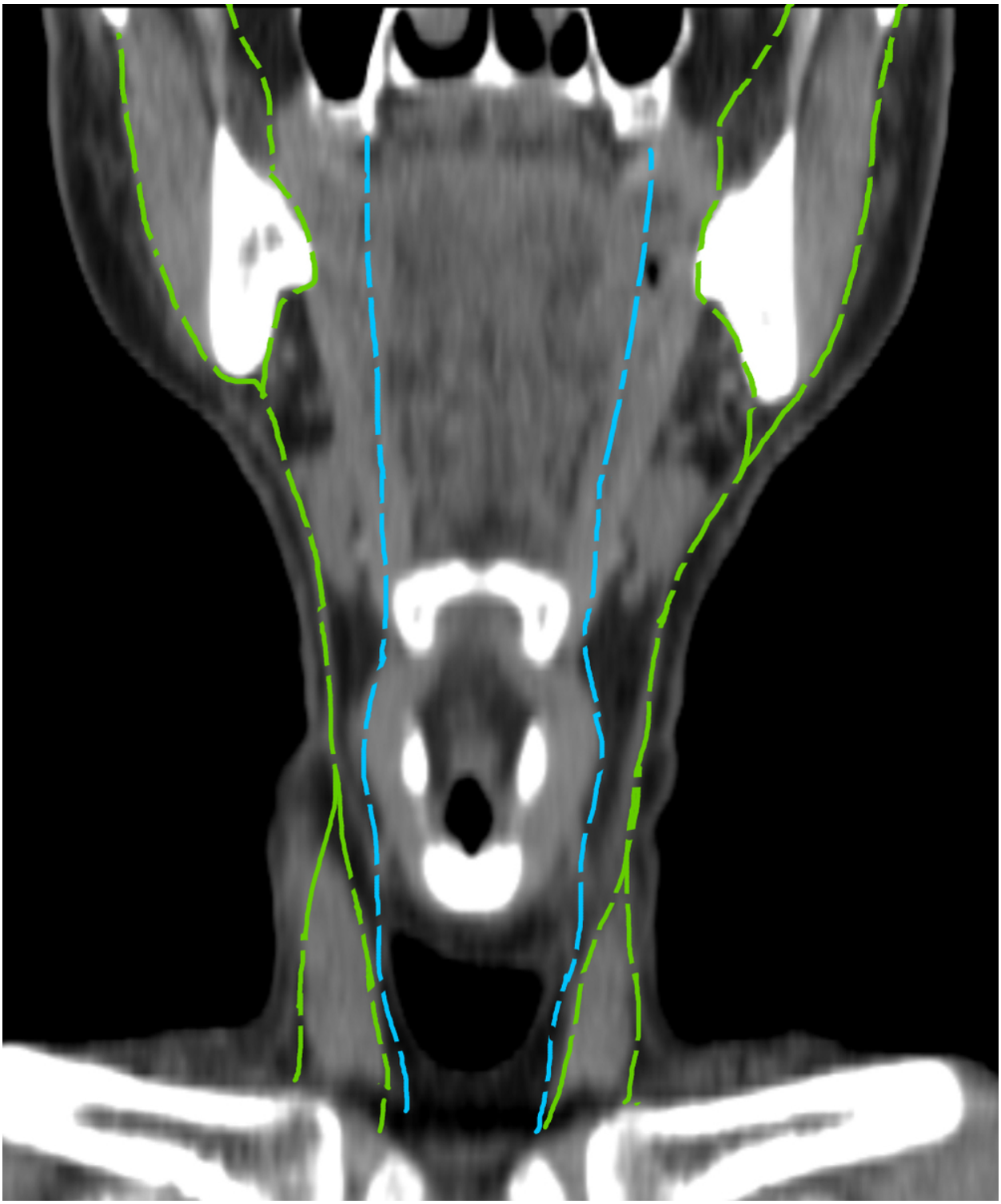

Fig. 3: Multiplanar reconstruction of a contrast enhanced CT scan in the coronal plan of anterior part of the neck demonstrating the superficial layer (green dash line) and middle layer (blue dash line) of the deep cervical fascia.

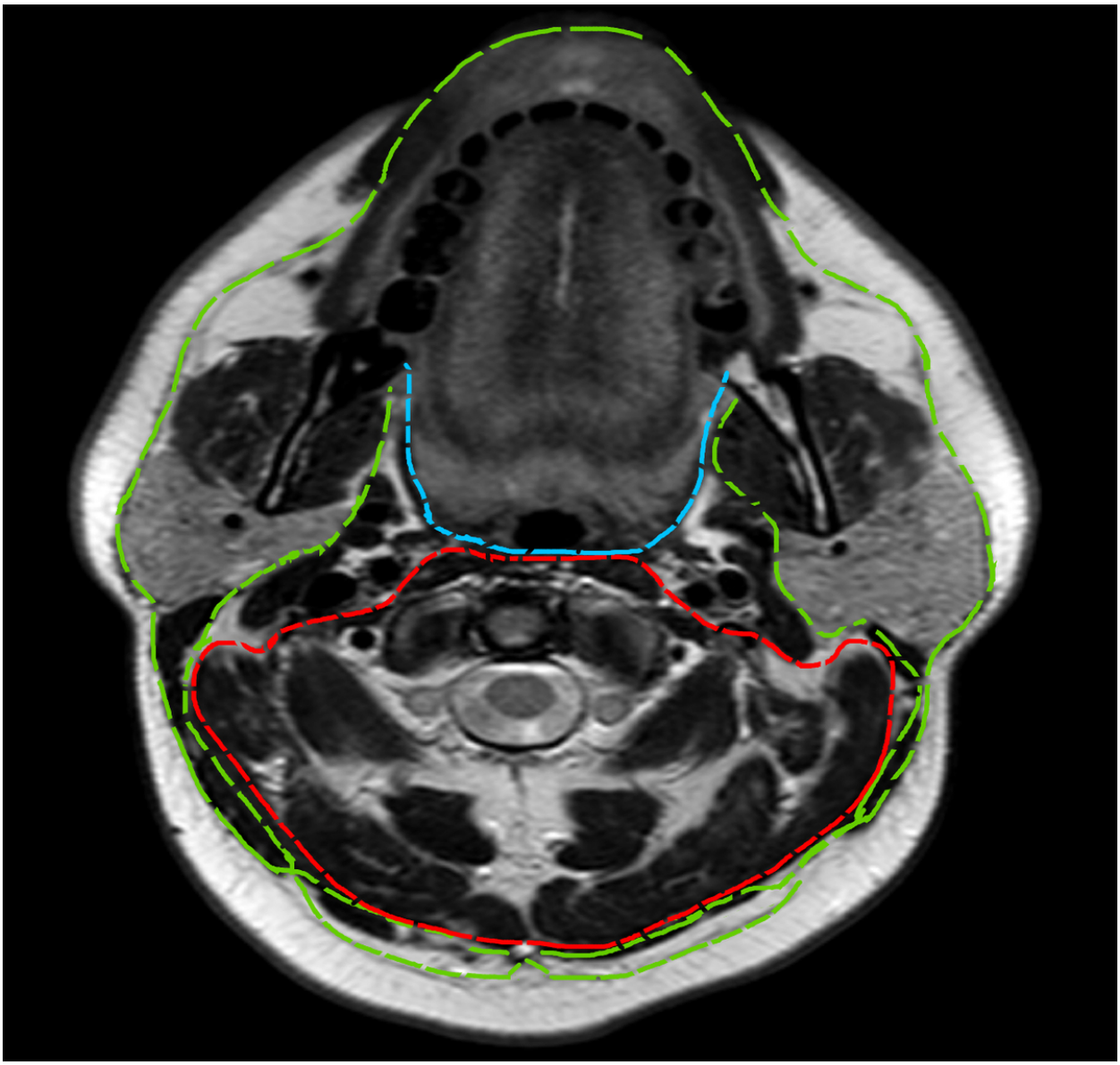

Fig. 4: T2 weighted imaging (TR 2621/TE 60) in the axial plan of the suprahyoid region demonstrating the three layers of the deep cervical fascia (superficial layer - green dash line; middle layer - blue dash line; deep layer - red dash line).

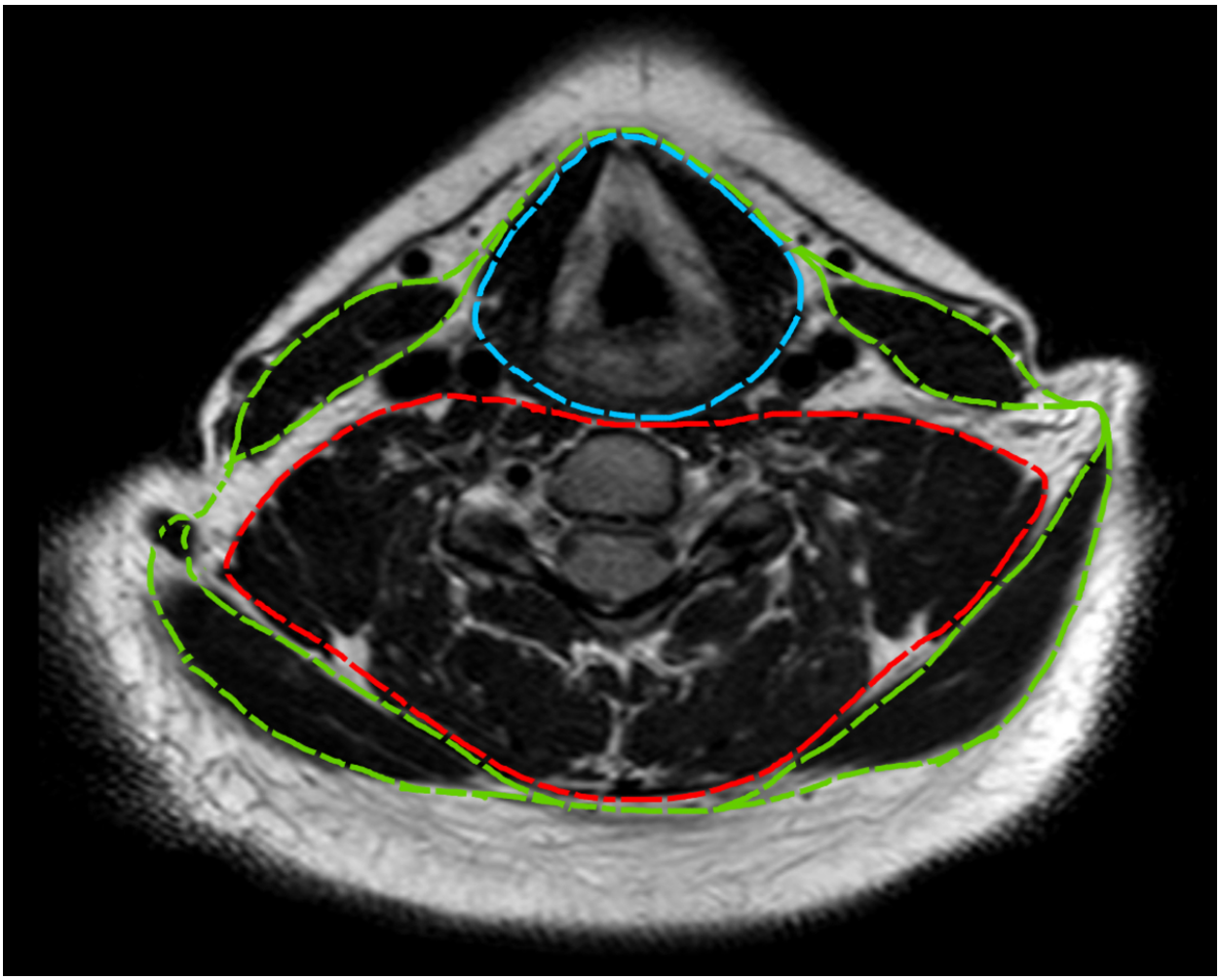

Fig. 5: T2 weighted imaging (TR 2621/TE 60) in the axial plan of the infrahyoid region demonstrating the three layers of the deep cervical fascia (superficial layer - green dash line; middle layer - blue dash line; deep layer - red dash line).

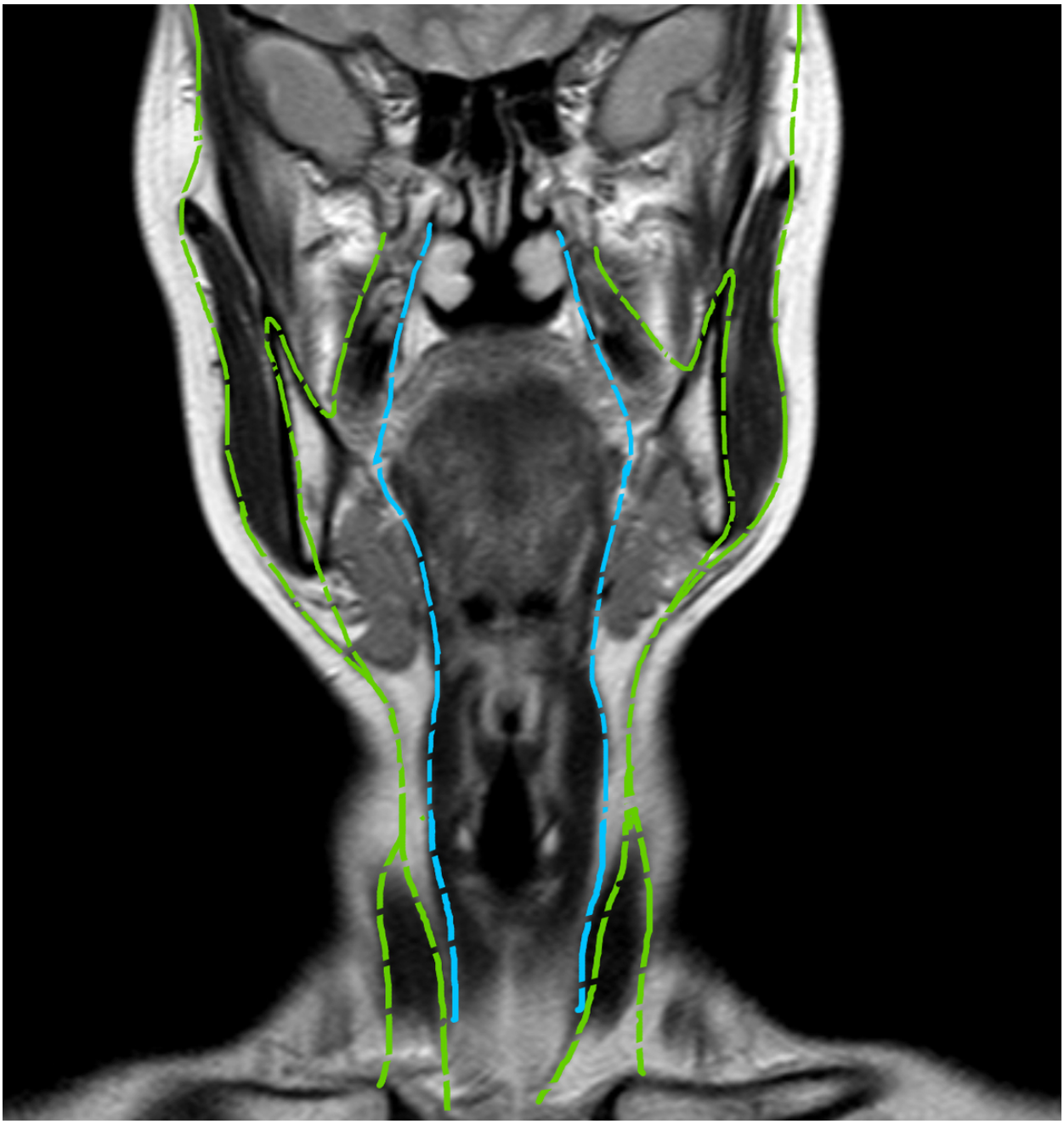

Fig. 6: T2 weighted imaging (TR 2621/TE 60) in the coronal plan of anterior part of the neck demonstrating the superficial layer (green dash line) and middle layer (blue dash line) of the deep cervical fascia.

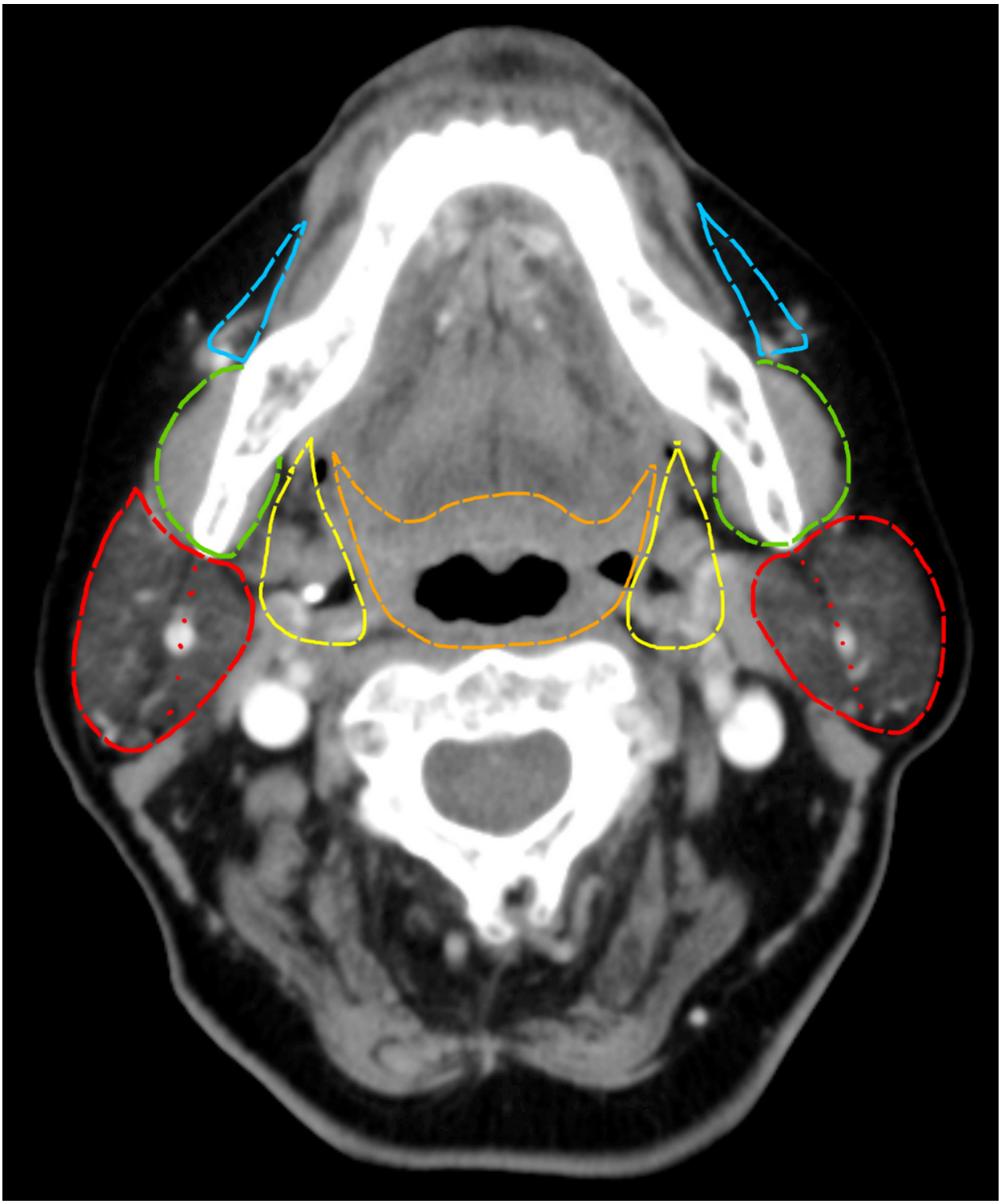

Fig. 7: Contrast enhanced CT scan in the axial plan of the suprahyoid region demonstrating the parapharyngeal space (yellow dash line), pharyngeal mucosal space (orange dash line), parotid space (red dash line), masticator space (green dash line) and buccal space (blue dash line).

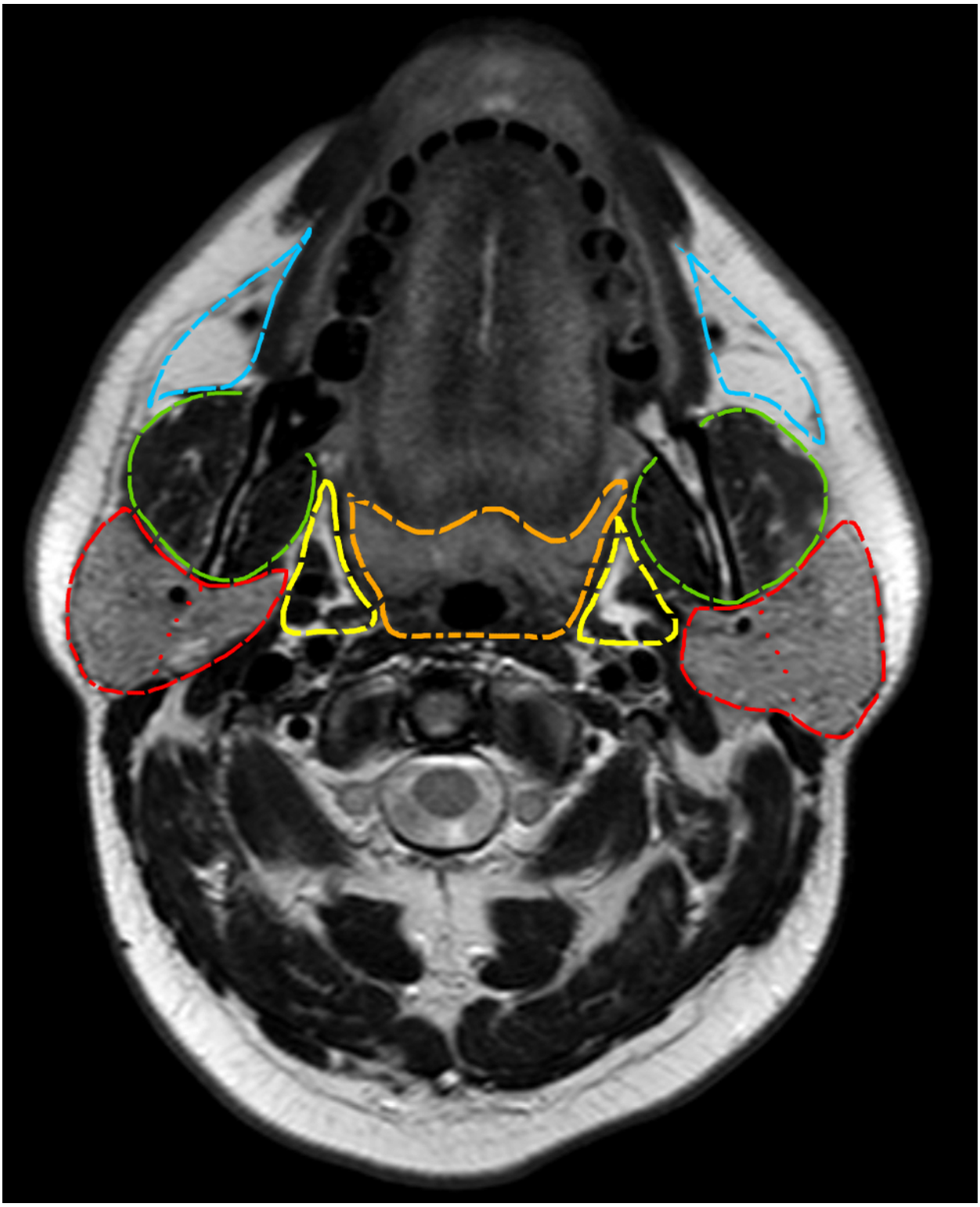

Fig. 8: T2 weighted imaging (TR 2621/TE 60) in the axial plan of the suprahyoid region demonstrating the parapharyngeal space (yellow dash line), pharyngeal mucosal space (orange dash line), parotid space (red dash line), masticator space (green dash line) and buccal space (blue dash line).

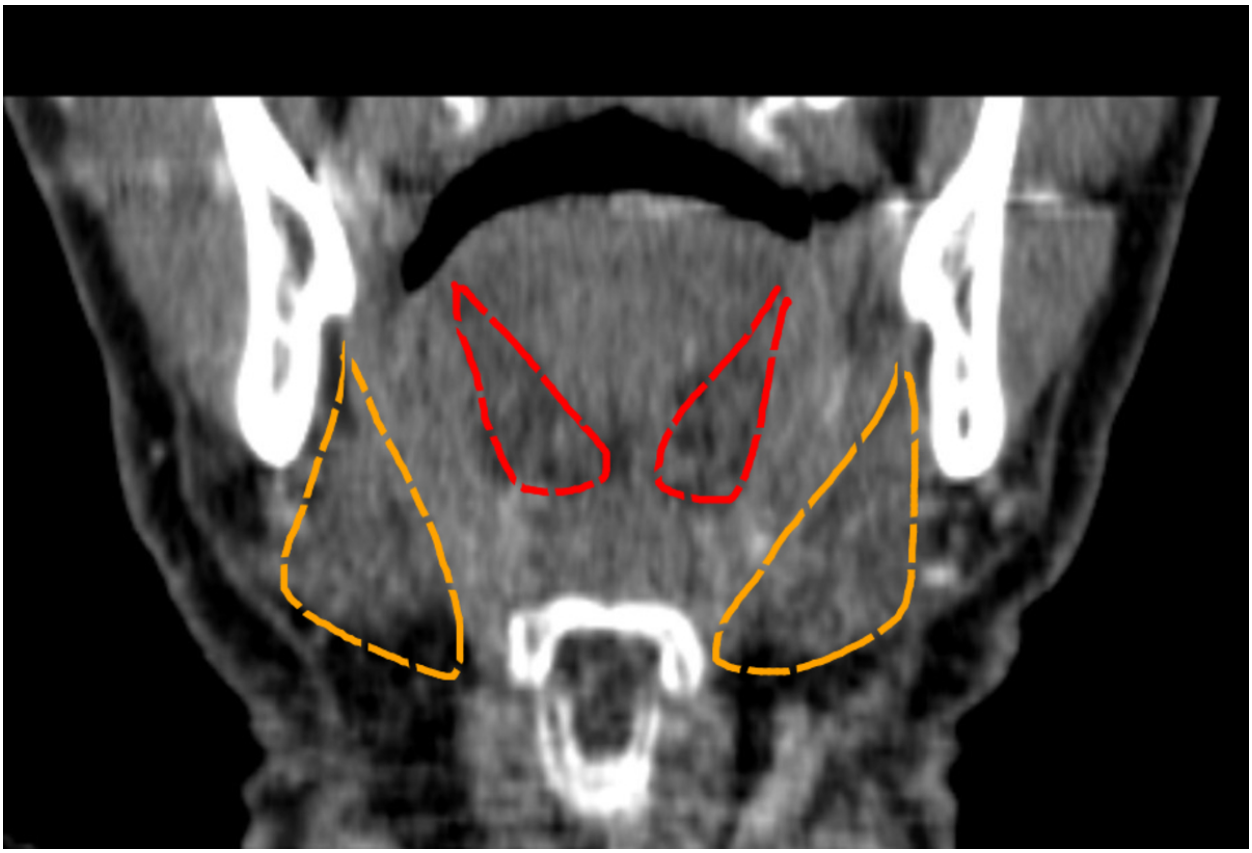

Fig. 9: Multiplanar reconstruction of a contrast enhanced CT scan in the coronal plan of suprahyoid region of the neck demonstrating the sublingual space (red dash line) and submandibular space (orange dash line).

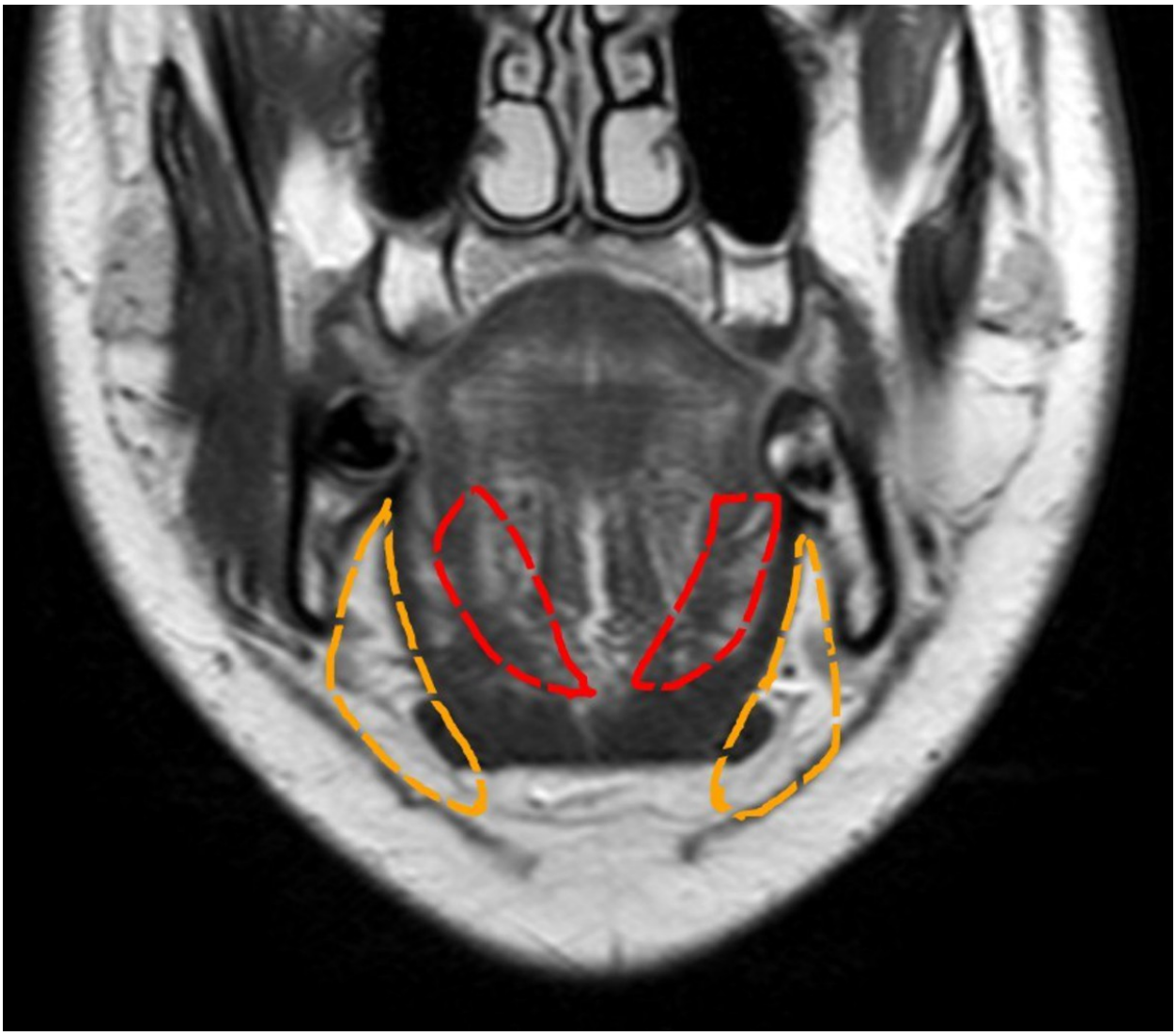

Fig. 10: T2 weighted imaging (TR 2621/TE 60) in the coronal plan of the suprahyoid region demonstrating the sublingual space (red dash line) and submandibular space (orange dash line).

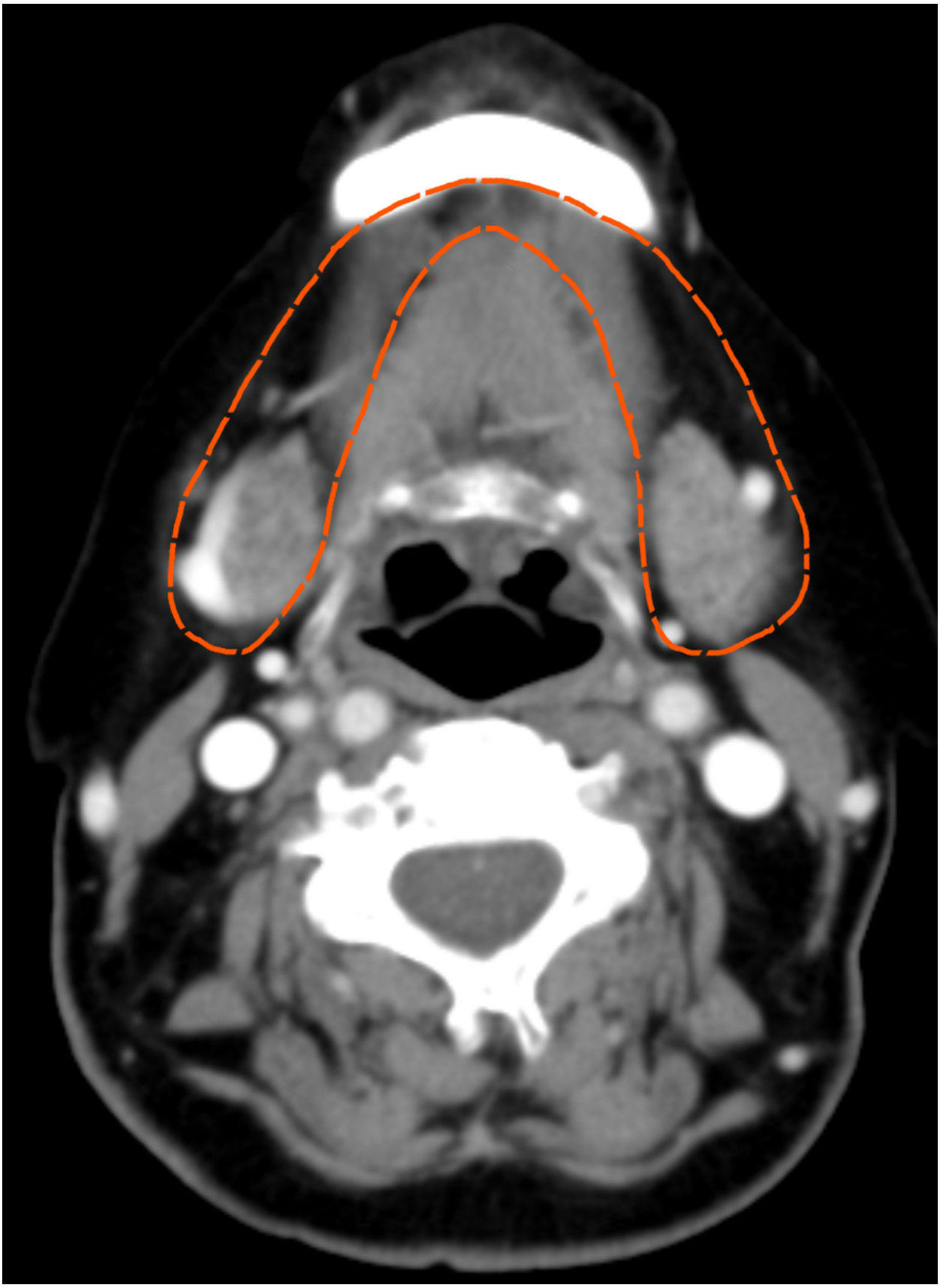

Fig. 11: Contrast enhanced CT scan in the axial plan of suprahyoid region of the neck demonstrating submandibular space (orange dash line).

Fig. 12: T2 weighted imaging (TR 2621/TE 60) in the axial plan of the suprahyoid region demonstrating the submandibular space (orange dash line).

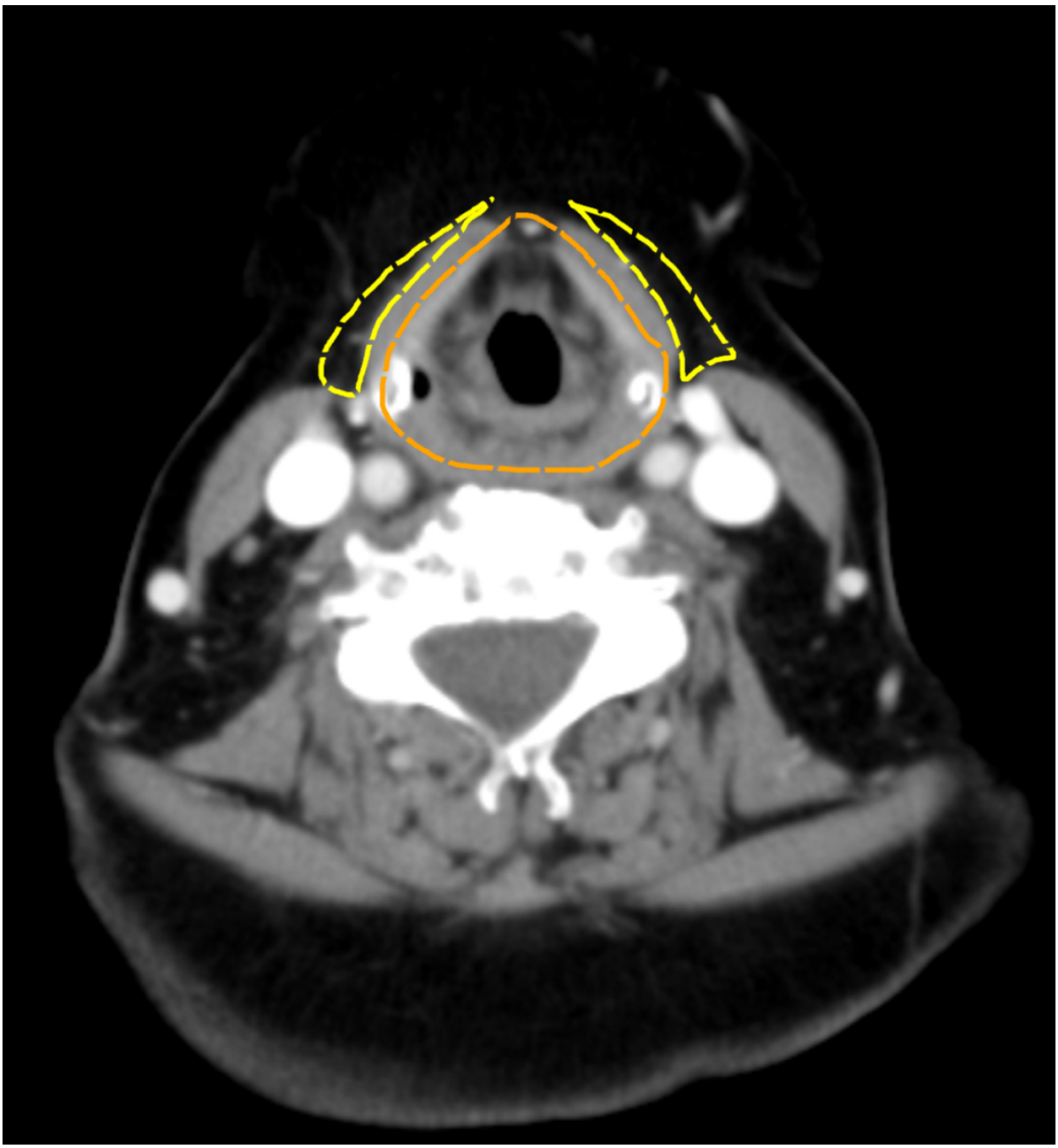

Fig. 13: Contrast enhanced CT scan in the axial plan of infrahyoid region of the neck demonstrating visceral space (orange dash line) and anterior cervical space (yellow dash line).

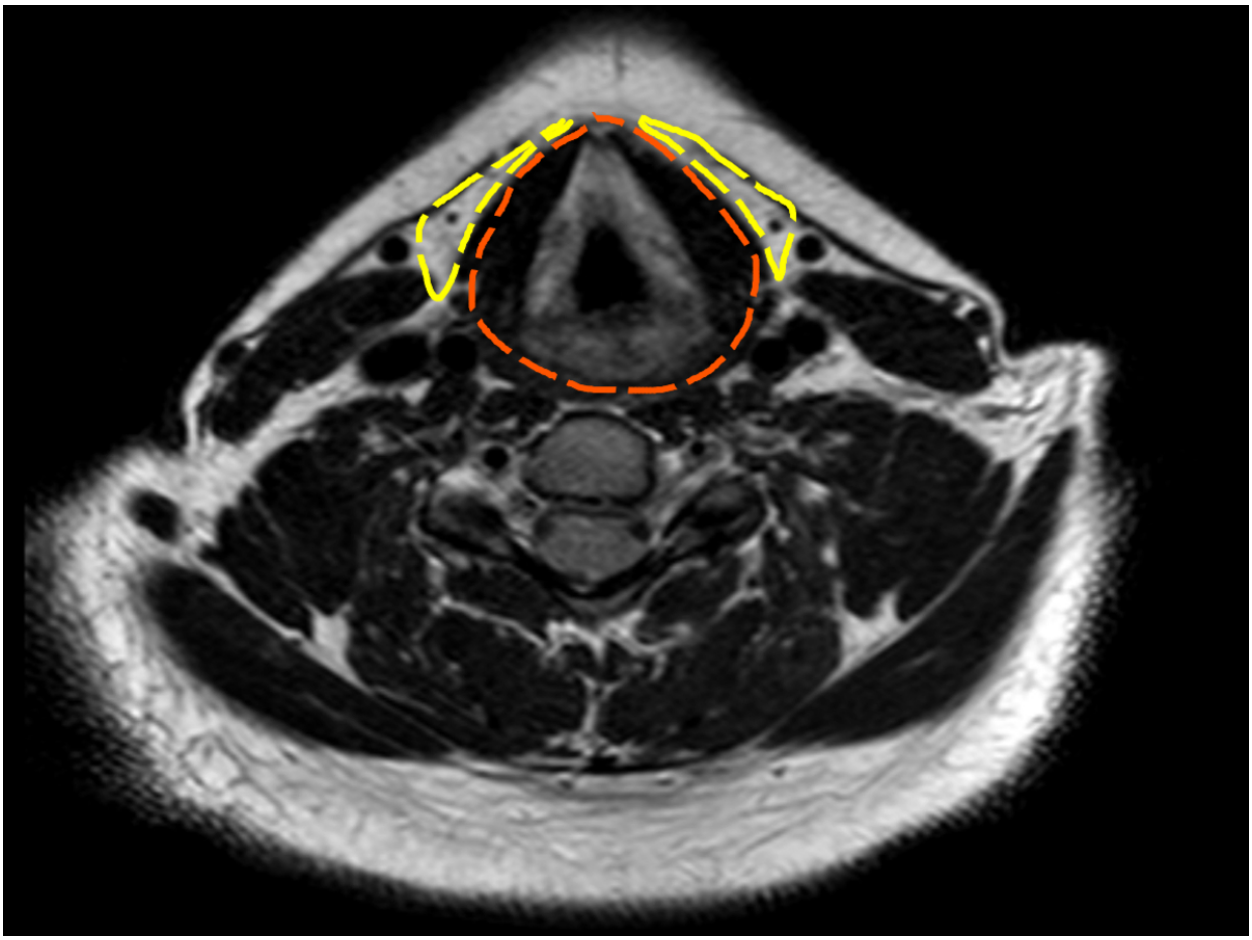

Fig. 14: T2 weighted imaging (TR 2621/TE 60; thickness 2,5 AC 6) in the axial plan of the infrahyoid region demonstrating the visceral space (orange dash line) and anterior cervical space (yellow dash line).

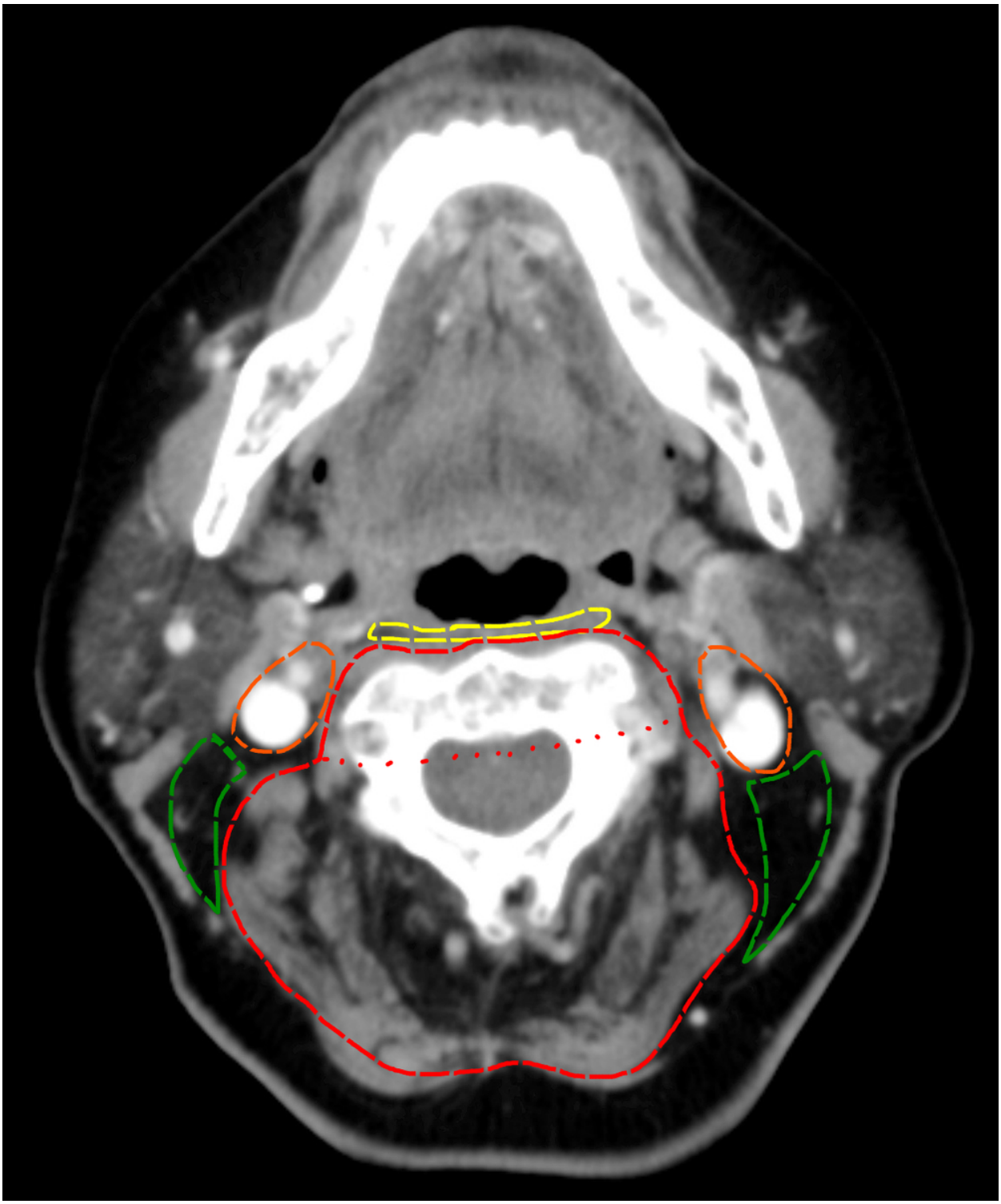

Fig. 15: Contrast enhanced CT scan in the axial plan of suprahyoid region of the neck demonstrating carotid space (orange dash line), retropharyngeal space (yellow dash line), perivertebral space (red dash line) and cervical posterior space (green dash line).

Fig. 16: T2 weighted imaging (TR 2621/TE 60) in the axial plan of the suprahyoid region of the neck demonstrating carotid space (orange dash line), retropharyngeal space (yellow

dash line), perivertebral space (red dash line) and cervical posterior space (green dash line).

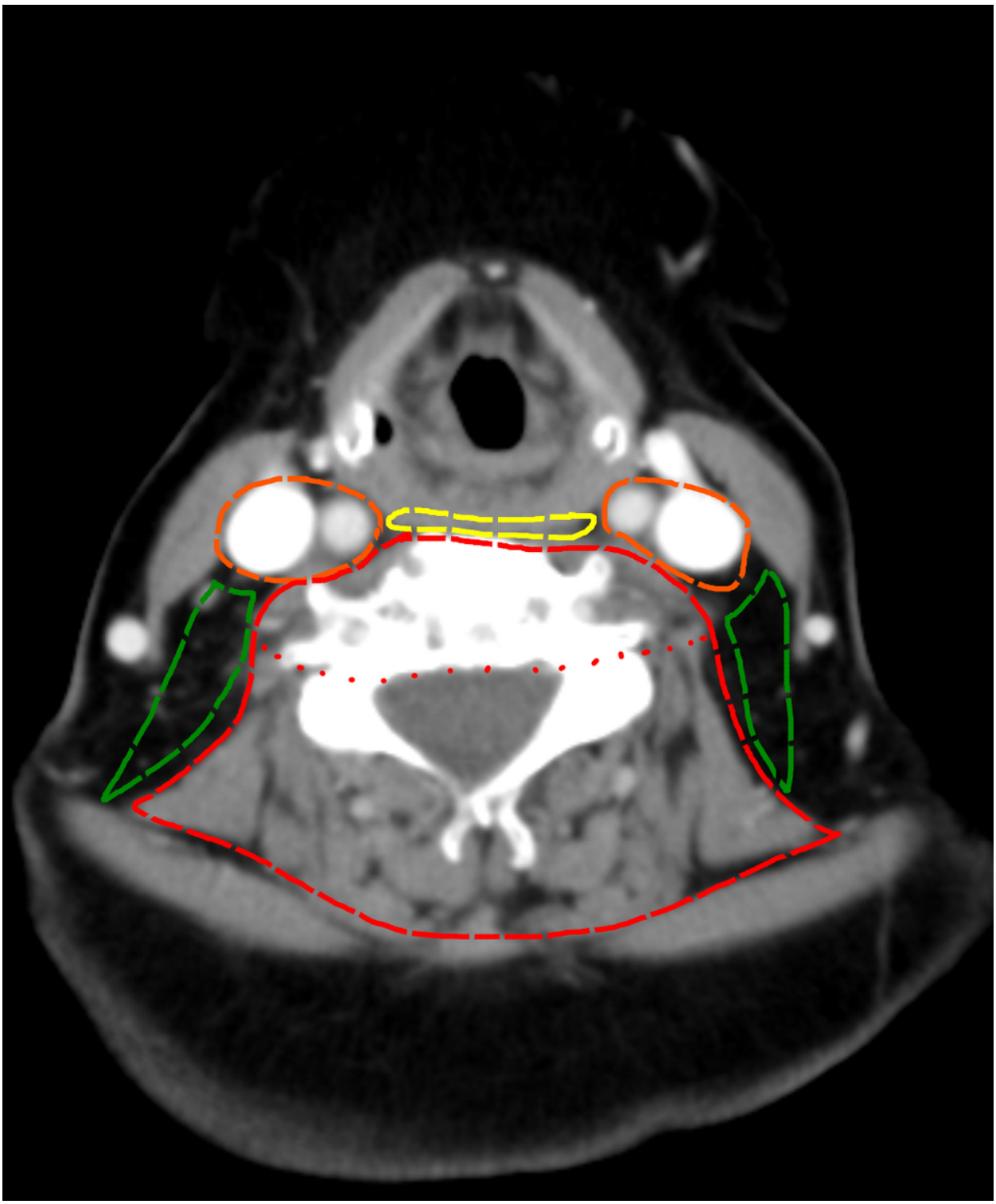

Fig. 17: Contrast enhanced CT scan in the axial plan of infrahyoid region of the neck demonstrating carotid space (orange dash line), retropharyngeal space (yellow dash line), perivertebral space (red dash line) and cervical posterior space (green dash line).

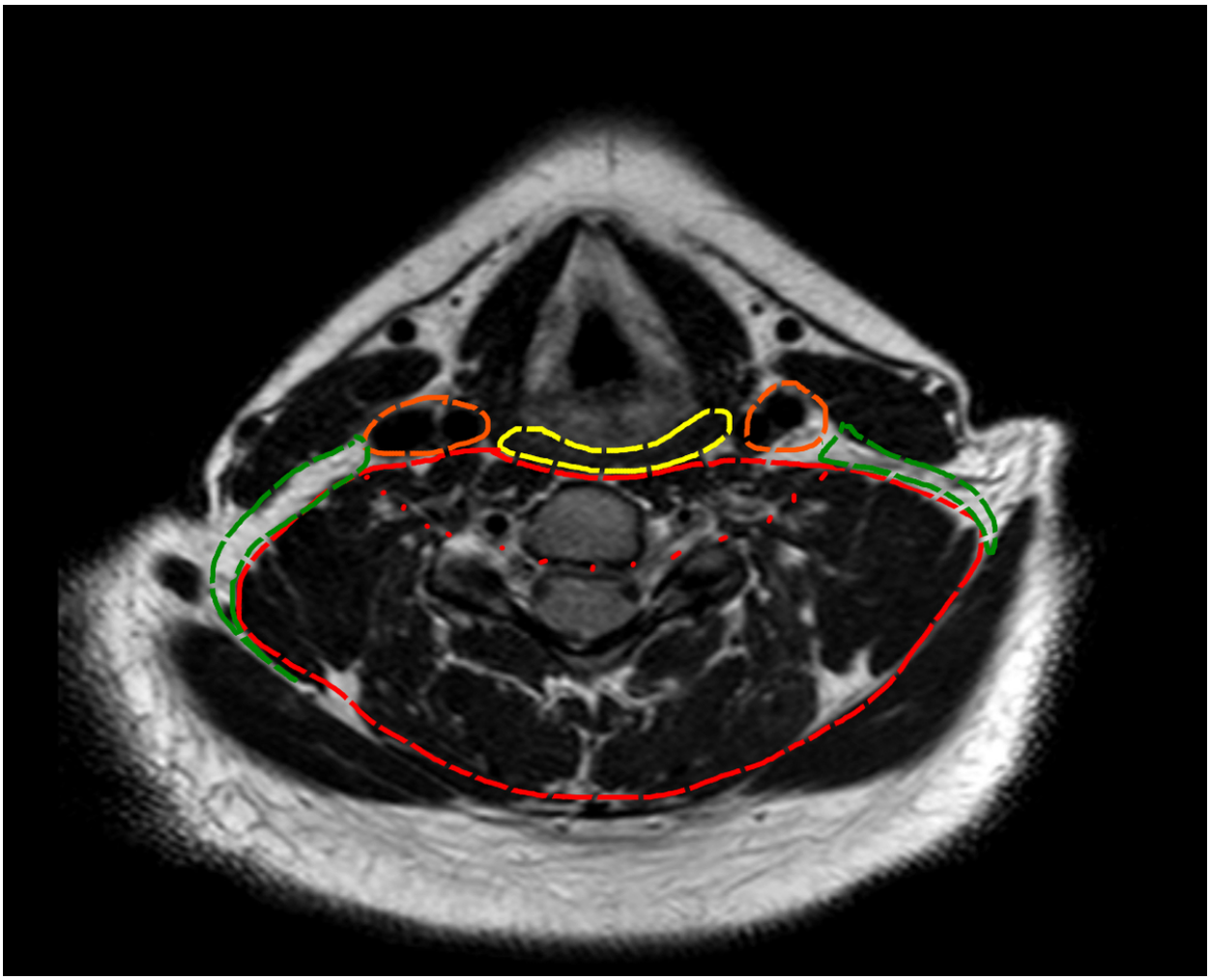

Fig. 18: T2 weighted imaging (TR 2621/TE 6) in the axial plan of the infrahyoid region of the neck demonstrating carotid space (orange dash line), retropharyngeal space (yellow dash line), perivertebral space (red dash line) and cervical posterior space (green dash line).

Imaging findings OR Procedure details

CT and MR imaging

CT and MR imaging allow a good visualization and examination of the complex neck's spatial anatomy and their components.

In general, MR imaging (MRI) has the benefit of not using ionizing radiation, and having a much better resolution, with a better anatomical detail. MRI is also the primary modality for tumor imaging, especially in the upper neck.

CT is a more available resource and is less time consuming. Meanwhile new developments in technology, cost and availability have led to an increased use of MRI. Despite that, CT still has advantages and should be used as the primary modality in several circumstances:

- Intensive care patients and severely debilitated patients: shorter examination time, better monitoring and less motion artifact;
- Patients with suspected destructive bone lesions or bone erosion.

In fact, CT and MRI should be face as complementary imaging modalities rather than competitive ones.

Practical approach

Approach to radiographic evaluation of pathology should include the following stepwise approach (Fig. 19 on page) .

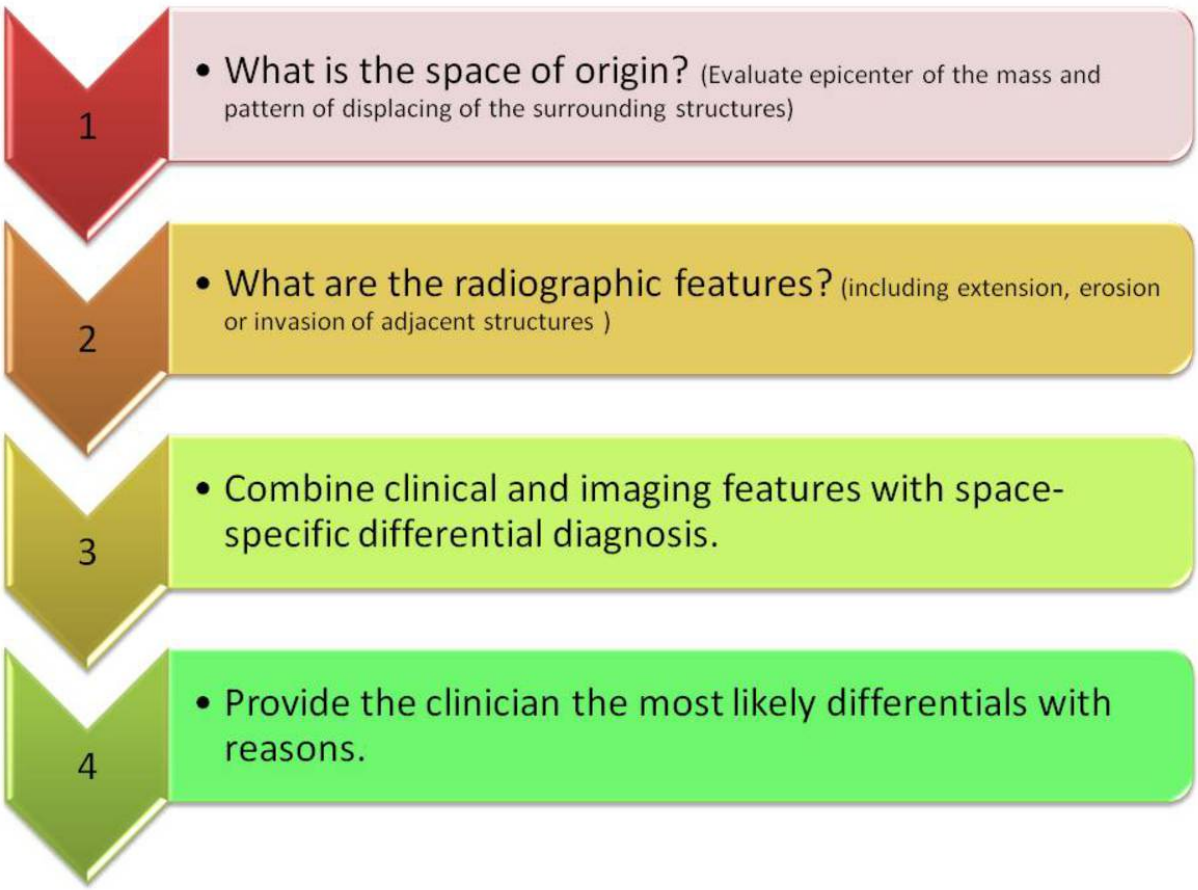

Fig. 19: Schematic stepwise approach to radiographic evaluation of neck pathology based in anatomical space differential diagnosis.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Each neck space will know be discussed, accompanied by a list of pathologic differential diagnosis.

Suprahyoid region

Parapharyngeal space (PPS):

Most lesions in the PPS occur from a secondary extension of lesions originating in the neighboring spaces (Table 1). Establishing the center of the lesion and its displacement pattern of the PPS fat can be used to assign the space of origin, particularly in lesions occurring in the four spaces surrounding PPS (pharyngeal mucosal, masticator, parotid and carotid spaces) (Fig. 20 on page 36). A primary lesion of the PPS must have be suspected if a whole circumference of surrounding fat is preserved (Fig. 21 on page 37).

Table 1 - Differential diagnosis of parapharyngeal space lesions.	
Pseudotumor:	• Asymmetric pterygoid venous plexus
Inflamatory lesions:	• Inflammatory abscess spread from adjacent deep cervical spaces: adenoids tonsils (PMS), odontogenic (SMS), parotid (PS)
Cystic lesions:	• Second branchial cleft cyst
Benign tumors:	• Lipoma • Pleomorphic adenoma from savilary gland rests
Malignant tumors:	• Mucoepidermoid and adenoid cystic carcinoma of salivary gland rests • Direct spread of tumor from adjacent spaces: squamous cell carcinoma, non-Hodgkin's lymphoma (PMS), sarcoma (MS), mucoepidermoid or adenoid cystic carcinoma (PMS, PS)

Table 1: Differential diagnosis of parapharyngeal space lesions.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Pharyngeal mucosal space (PMS):

The most important intrinsic masses in the PMS are the squamous cell carcinomas (SCCa) arising from the mucosal surfaces of the nasopharynx, oropharynx and hypopharynx (Fig. 22 on page 38). Inflammatory lesions are also a frequent finding (Table 2).

Table 2 - Differential diagnosis of pharyngeal mucosal space lesions.	
Pseudotumor:	• Asymmetric fossa of Rosenmüller
Inflamatory lesions:	• Infectious or radiation-induced pharyngitis • Inflammatory adenoidal, faucial tonsillitis or abscess • Postinflammatory retention cyst
Cystic lesions:	• Tomwaldt's cyst
Benign tumors:	• Pleomorphic adenoma from minor salivary glands
Malignant tumors:	• SCCa of the pharyngeal mucosa • Non-Hodgkin's lymphoma • Mucoepidermoid or adenoid cystic carcinoma

Table 2: Differential diagnosis of pharyngeal mucosal space lesions.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Parotid space (PS):

Parotid gland masses are the most common finding in this space (Fig. 23 on page 39 and Fig. 24 on page 40). They are termed intra parotid masses if more than 50% of the circumference of the lesion is surrounded by normal parotid gland tissue (Table 3). Note that these lesions can extend through the stylomandibular tunnel, which can be widened by the mass.

Table 3 - Differential diagnosis of parotid space lesions.	
Pseudotumor:	• Masseter hypertrophy • Accessory parotid gland
Inflamatory lesions:	• Parotitis or parotid gland abscess • Reactive adenopathy • Sjogren's syndrome
Cystic lesions:	• First branchial cleft cyst • Benign lymphoepithelial cyst (AIDS) • Lymphangioma (children)
Benign tumors:	• Hemangioma (children) • Pleomorphic adenoma • Warthin's tumor • Facial nerve neuroma
Malignant tumors:	• Mucoepidermoid carcinoma • Adenoid cystic carcinoma • Adenocarcinoma • Non-Hodgkin's lymphoma - primary and metastatic • Lymph node metastases from SCCa, skin, breast or lung cancers • Perineural tumor spread along facial nerve

Table 3: Differential diagnosis of parotid space lesions.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Masticator space (MS):

Sarcomas (soft tissue), chondrossarcomas and osteosarcomas are the most dangerous lesions (Table 4). They can spread perineurally to the skull base via the masticator and inferior alveolar nerves. Osseous tumors of the posterior mandible can also occur (Fig. 25 on page 41 and Fig. 26 on page 42).

Table 4 - Differential diagnosis of masticator space lesions.	
Pseudotumor:	• Accessory parotid gland • Hypertrophic masseter muscle • Atrophy of mastication muscles
Inflamatory lesions:	• Odontogenic abscess • Osteomyelitis of the mandible
Benign tumors:	• Hemangioma • Lymphangioma • Leiomyoma • Myositis ossificans • Schwannoma, neurofibroma
Malignant tumors:	• Malignant fibrous histiocytoma, • Rhabdomyosarcoma, leiomyosarcoma • Chondrosarcoma, osteosarcoma • Malignant schwannoma • Non-Hodgkin's lymphoma • Squamous cell carcinoma of oropharynx (retromolar trigone)

Table 4: Differential diagnosis of masticador space lesions.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Buccal space (BS):

The commonest lesions in the buccal space occur secondary to spread from other spaces such as the MS and submandibular space (Fig. 26 on page 42). Metastatic lymph nodes from squamous cell carcinomas are also frequently found. Minor salivary gland tumors occur less often (Table 5).

Table 5 - Differential diagnosis of buccal space lesions.	
Pseudotumor:	• Accessory parotid gland
Inflamatory lesions:	• Spread of infection from adjacent spaces (MS) • Reactive lymphadenopathy
Cystic lesions:	• Sebaceous cyst
Benign tumors:	• Hemangioma • Lipoma • Fibromatosis
Malignant tumors:	• SCCa (direct invasion or lymph mode metastases) • Non-Hodgkin's lymphoma • Mucoepidermoid or adenoid cystic carcinoma from minor glands • Soft tissue sarcomas (secondary invasion)

Table 5: Differential diagnosis of buccal space lesions.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Sublingual space (SLS):

Most important mass in the SLS is the SCCa of the tongue (Fig. 27 on page 43). The tumors of the anterior tongue invade the SLS from superior to inferior and those of the tongue base from posterior to anterior. Spreading odontogenic infections also commonly involve this space (Table 6).

Table 6 - Differential diagnosis of sublingual space lesions.	
Pseudotumor:	• Tongue muscle atrophy • Lingual thyroid tissue
Inflammatory lesions:	• Cellulitis or abscess from odontogenic focus • Ludwig's angina • Dilated submandibular gland duct from calculi
Cystic lesions:	• Lymphangioma- cystic hygroma • Ranula or diving ranula • Dermoid-epidermoid cyst
Benign tumors:	• Hemangioma • Pleomorphic adenoma (sublingual gland)
Malignant tumors:	• Invading SSCa from anterior tongue or tongue base • Mucoepidermoid or adenoid cystic carcinoma (sublingual gland)

Table 6: Differential diagnosis of sublingual space lesions.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Submandibular space (SMS):

Congenital cystic and submandibular gland lesions, as well as nodal metastases represent the commonest lesions in this area, depending on the age of the patient (Table 7) (Fig. 28 on page 44). Lesions in the SMS can extend up into the SLS. or inferiorly to the anterior cervical space.

Table 7 - Differential diagnosis of submandibular space lesions.	
Pseudotumor:	• Atrophy of digastric and mylohyoid muscle
Inflammatory lesions:	• Cellulitis or abscess • Reactive adenopathy • Submandibular gland inflammation duct from calculi
Cystic lesions:	• Second branchial cleft cyst • Suprahyoid thyroglossal duct cyst • Cystic hygroma/lymphangioma • Diving ranula (children) • Epidermoid-dermoid
Benign tumors:	• Hemangioma • Lipoma • Pleomorphic adenoma (submandibular gland, parotid tail)
Malignant tumors:	• Lymph node metastasis from SCCa of face or oral cavity • Lymphoma • Mucoepidermoid or adenoid cystic carcinoma (submandibular)

Table 7: Differential diagnosis of submandibular space lesions.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Infrahyoid region

Visceral space:

The visceral space is clinically important for thyroid and parathyroid lesions, but also for squamous cell carcinomas of the larynx and hypopharynx (Fig. 29 on page 46). If a median cystic lesions is found, a thyroglossal duct cyst is the most probable diagnosis, if that is this case always confirm the normal location of the thyroid gland. If a laryngocele is suspected, always search carefully for underlying cause such as squamous carcinoma cell, as they may have a primary or secondary origin. Lesions in this space are better dived based in their organ/tissue origin (Table 8).

Table 8 - Differential diagnosis of visceral space lesions.	
Pseudotumor:	• Pyramidal lobe of thyroid gland • Prominent thyroid isthmus • Patulous esophagus in tracheoesophageal groove
Inflammatory lesions:	• Cellulitis or abscess lesions • Reactive adenopathy
Laryngeal lesions:	• Laryngocele • Squamous cell carcioma • Chondrosarcoma
Thyroid lesions:	• Goiter/Colloid cyst • Acute/chronic thyroiditis • Thyroid adenoma • Thyroid carcinoma: papillary, follicular, medullary • Extranodal non-Hodgkin's lymphoma- primary or metastatic
Parathyroid lesions:	• Parathyroid cyst • Adenoma
Esophageal lesions:	• Zenker's diverticulum • Esophageal carcinoma
Embryological remnants	• Infrahyoid thyroglossal duct cyst • Third branchial cyst
Other malignant lesions:	• Nodal metatasis (SCCa) • Nodal lymphoma

Table 8: Differential diagnosis of visceral space lesions.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Anterior cervical space (ACS):

The most important lesions in the ACS are transspatial diseases from the neighboring spaces, such as tumors or infections (Table 9) (Fig. 30 on page 47).

Table 9 - Differential diagnosis of anterior cervical space lesions.	
Pseudotumor:	• Enlarged anterior jugular vein
Inflammatory lesions:	• Cellulitis or abscess
Cystic lesions:	• Second branchial cleft cyst • Cystic hygroma/lymphangioma
Benign tumors:	• Lipoma
Malignant tumors:	• Spread of thyroid carcinoma, lymphoma (adjacent spaces)

Table 9: Differential diagnosis of anterior cervical space lesions.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Supra and infrahyoid regions:

Carotid space (CS):

Lesions in the CS typically abut the carotid artery or jugular vein and are tubular or fusiform in shape (Fig. 31 on page 49). Important lesions in adults are the lymph node metastases of the deep cervical chain (levels II-IV) and neurogenic tumors in children (Table 10). Thrombophlebitis of the jugular vein due to an infection of the head or neck, complicated by sepsis and metastatic infections (Lemierre's Syndrome) is also an important differential diagnosis especially in pediatric age (Fig. 32 on page 49).

Table 10 - Differential diagnosis of carotid space lesions.

Pseudotumor:	• Asymmetric carotid bulb or ectatic carotid artery • Asymmetric jugular vein
Vascular lesions:	• Carotid artery thrombosis, dissection, (pseudo)aneurysm • Internal jugular vein thrombosis or thrombophlebitis
Inflammatory lesions:	• Cellulitis or abscess • Reactive or suppurative adenopathy • Tuberculous adenitis
Cystic lesions:	• Second branchial cleft cyst
Benign tumors:	• Paraganglioma: carotid body, glomus vagale or glomus jugulare • Cranial or sympathetic nerve schwannoma, neurofibroma • Neuroblastoma • Meningeoma (via jugular foramen)
Malignant tumors:	• Encasement from direct infiltration by SCCa • Lymph node metastases from SCCa, thyroid, melanoma, lung and abdominal carcinoma • Hodgkin's and non-Hodgkin's lymphoma

Table 10: Differential diagnosis of carotid space lesions.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Retropharyngeal space:

The retropharyngeal space is a route of spread for tumor and inflammatory processes in to the skull and mediastinum Attention should be paid to include a wide body section when studies this space (always included until tracheal bifurcation). Remember that the suprahyoid RPS include some lymph nodes, which are important in staging SCCa. Edema following radiation therapy or air following trauma can also be found in the in the RPS (Table 11) (Fig. 33 on page 51).

Table 11 - Differential diagnosis of retropharyngeal space lesions.	
Pseudotumor:	• Ectatic carotid artery • Edema secondary to radiation or (internal jugular) venous obstruction
Inflammatory lesions:	• Cellulites or abscess (from tonsils lesions: and adenoids) • Reactive or suppurative adenopathy
Benign tumors:	• Hernangioma • Lipoma
Malignant tumors:	• Direct extension of SCCa from neighbouring spaces (PMS) • Lymph node metastases from (nasopharyngeal) SCCa • Lymph node metastases from melanoma, thyroid carcinoma • Lymphoma, leukemia
Post-traumatic lesions:	• Air, edema, hematoma

Table 11: Differential diagnosis of retropharyngeal space lesions.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Perivertebral space (PVS):

In the anterior compartment (prevertebral) of the PVS, lesions typically displace the prevertebral muscles anteriorly; a sign that can differentiate them from the lesions arising from the RPS (displaces them posteriorly). In the posterior compartment the fat of the posterior cervical space is displaced posterolaterally. Bony lesions of the vertebrae are a common and clinically important finding (Table 12) (Fig. 34 on page 52).

Table 12 - Differential diagnosis of perivertebral space lesions.	
Pseudotumor:	• Degenerative lesions of the vertebrae and facet joints • Cervical disk herniation
Inflammatory lesions:	• Vertebral body osteomyelitis or diskitis (pyogenic, TB) • Longus colli tendinitis
Benign tumors:	• Chordoma • Osteoblastoma, osteochondroma • ABC, giant cell tumor • Brachial plexus schwannoma/neurofibroma
Malignant tumors:	• Malignant bone tumors of the cervical spine • Vertebral body or epidural metastasis: Lung, breast, prostate, thyroid and renal cell neoplasm • Direct extension of SCCa • Non-Hodgkin's lymphoma-secondary • Rhabdomyosarcoma (paediatric)
Post-traumatic lesions:	• Edema, hematoma

Table 12: Differential diagnosis of perivertebral space lesions.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Posterior cervical space (PCS):

Lesions specific to the PCS should be centered in the fat and have a thin fat stripe that surrounding them. This can be difficult to access in the suprahyoid region where the PCS is very small. Most clinically important pathologies in this space are lymphoma or metastases from SCCa (Fig. 35 on page 52). Cystic hygroma-lymphangioma are also frequent is this space (Table 13).

Table 13 - Differential diagnosis of posterior cervical space lesions.	
Pseudotumor:	• Hypertrophied levator scapulae muscle
Inflammatory lesions:	• Cellulitis or abscess • Reactive or suppurative adenopathy • Tuberculous adenitis
Cystic lesions:	• Cystic hygroma-lymphangioma • Third branchial cleft cyst
Benign tumors:	• Lipoma • Hemangioma • Schwannoma, neurofibroma
Malignant tumors:	• Nodal metastasis from SCCa (nasopharynx) • Hodgkin's or non-Hodgkin's lymphoma • Liposarcoma (rare)

Table 13: Differential diagnosis of posterior cervical space lesions.
References: Radiologia, Hospital Geral, Centro Hospitalar e Universitário de Coimbra - Coimbra/PT

Images for this section:

Fig. 20: Contrast enhanced CT scan in the axial plan of the suprahyoid region in a 47-years old male with a squamous cell carcinoma of de right tonsil with direct spread to the adjacent parapharyngeal space (red dash line and asterisk). Note that the center of the lesion is in the PMS and the PPS is displaced latero posteriorly (green dash line).

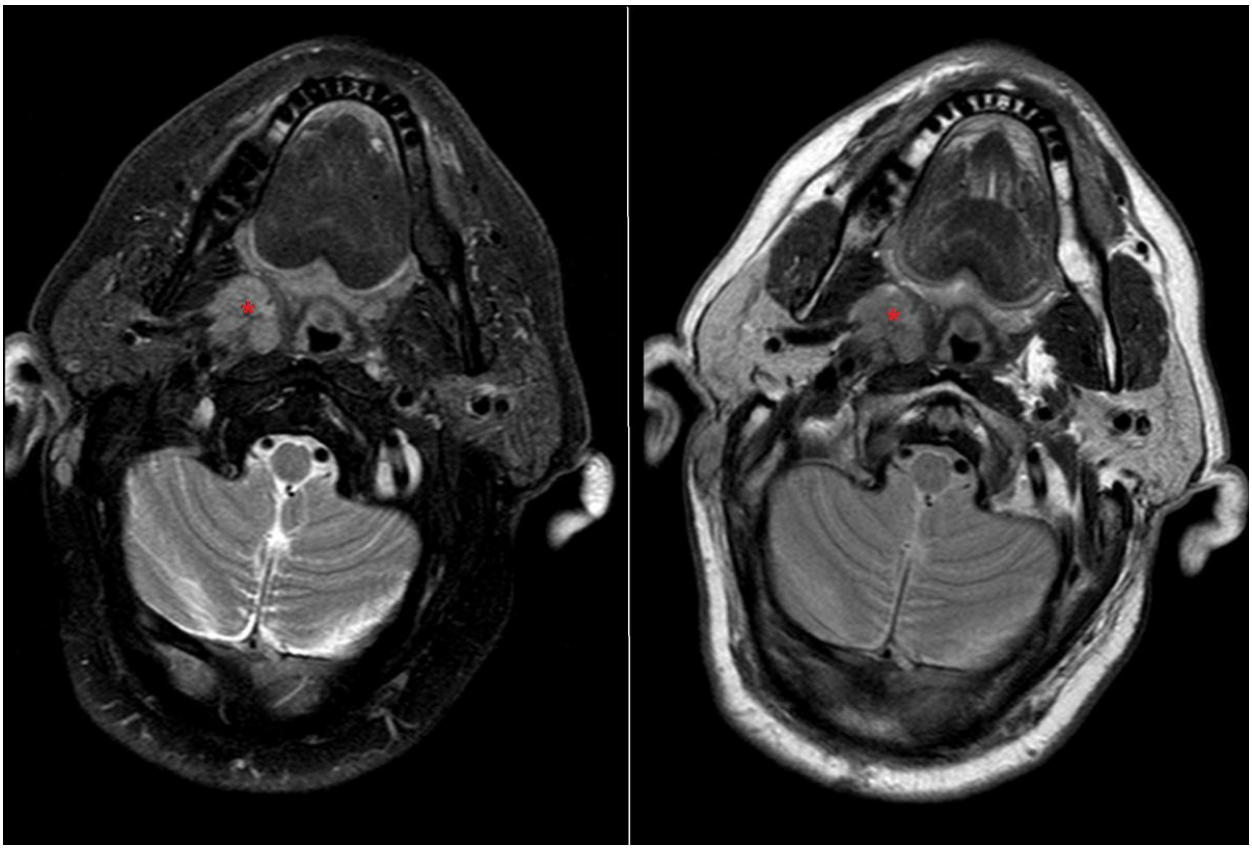

Fig. 21: T2 fat saturation weighted image (TR 4141/TE 60)(right side picture)and T1 weighted image (TR 500/TE 15)(left side picture) in the axial plan of the suprahyoid region in a 58-years old male with a minor salivary gland carcinoma in the rigth parapharyngeal space (asterisk). The mass is ill-defined but encircled by fat, sugesting primary origin in the PPS; it has a medium/high signal intensity in T2 and a medium/low intensity signal in T1.

Fig. 22: Contrast enhanced CT scan in the axial plan of the suprahyoid region in a 77-years old female with a squamous cell carcinoma of the pharynx. Note the circumferential widening of the pharyngeal mucosa (asterisks).

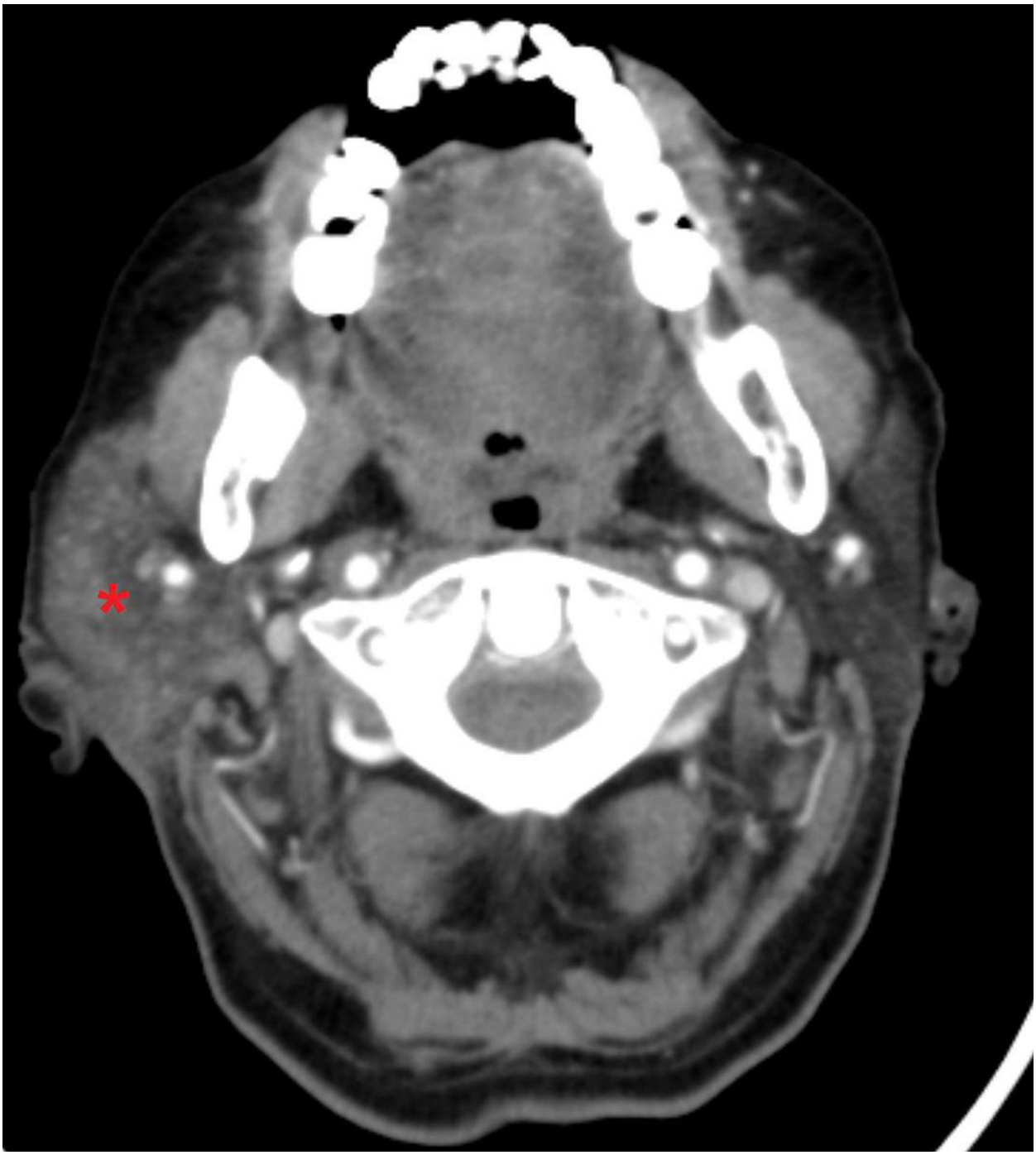

Fig. 23: Contrast enhanced CT scan in the axial plan of the suprahyoid region in a 80-years old female with a enlargement of the right parotid (asterisk), no mass or obstruction was found - unilateral parotitis.

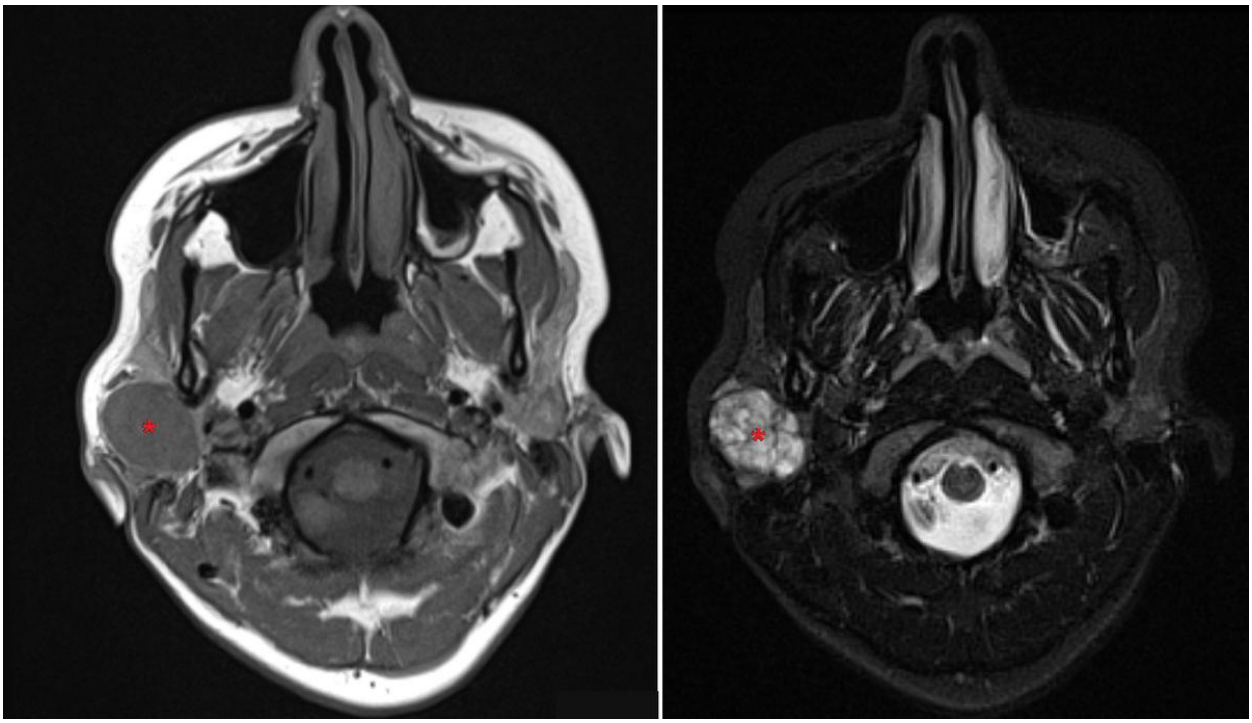

Fig. 24: T1 weighted image (TR 760/TE 11) (right side picture) and T2 STIR weighted image (TR 8160/TE 99/TI 150) (left side picture) in the axial plan of the suprahyoid region in a 15-years old female with pleomorphic adenoma of the right parotid gland (asterisk). The mass is almost totally encircled by the salivary gland, and has a typical very high signal intensity in T2 with a rim of decreases signal intensity due to the surrounding fibrous capsule and a low intensity signal in T1.

Fig. 25: Plain CT scan in the axial plan of the suprahyoid region in a 16-years old male with a lytic lesion in right the posterior ramus of the mandible (asterisk), occupying the ipsilateral MS; further surgery revealed that it was an eosinophilic granuloma.

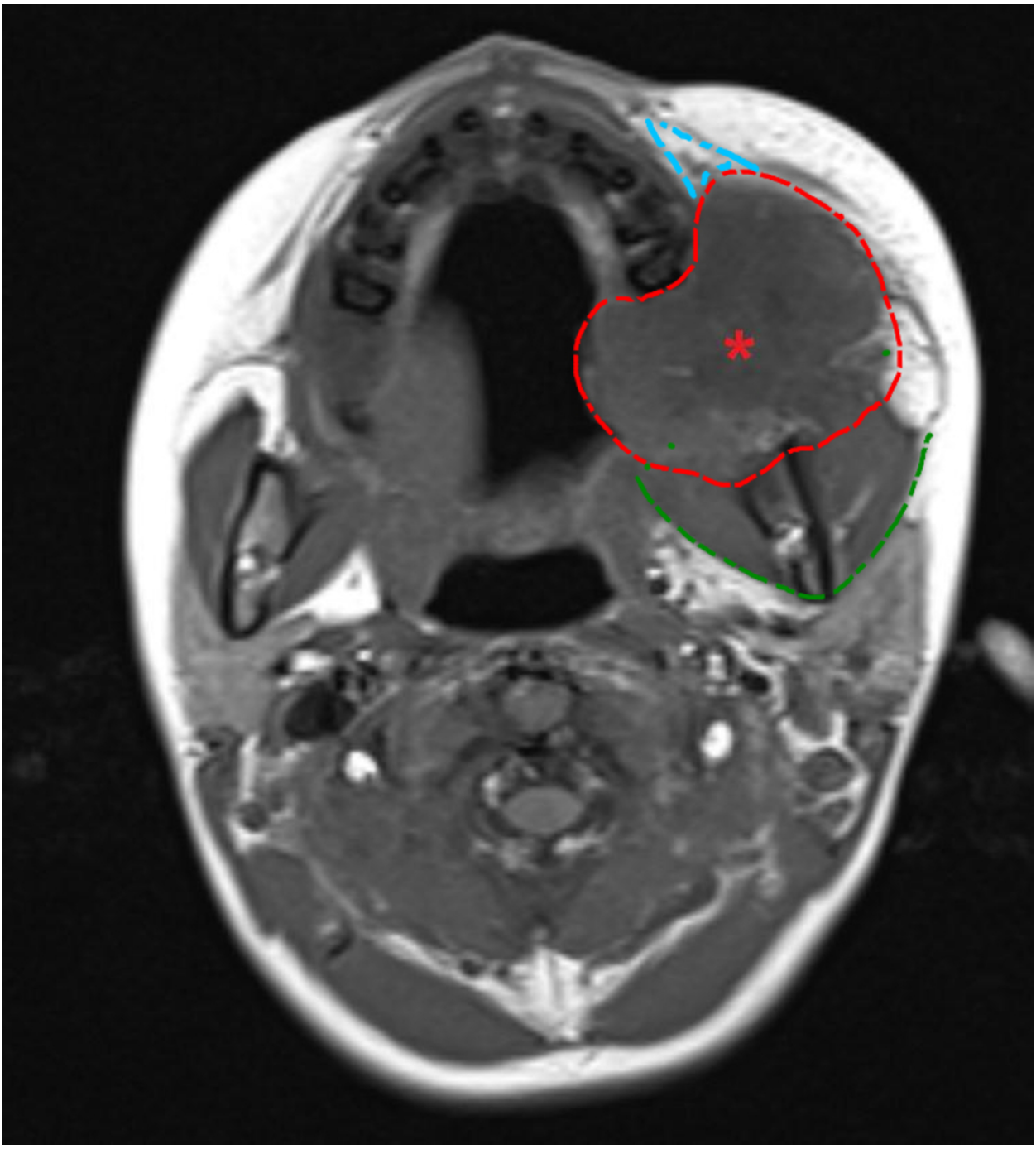

Fig. 26: T1 weighted image (TR 483/ TE 8,8) in the axial plan of the suprahyoid region in a 4-years old female with rabdomyossarcoma. Note the low intensity in T1 mass (red dash line) involving the muscles of the left MS (green dash line) and spreading into the adjacent buccal space (blue dash line).

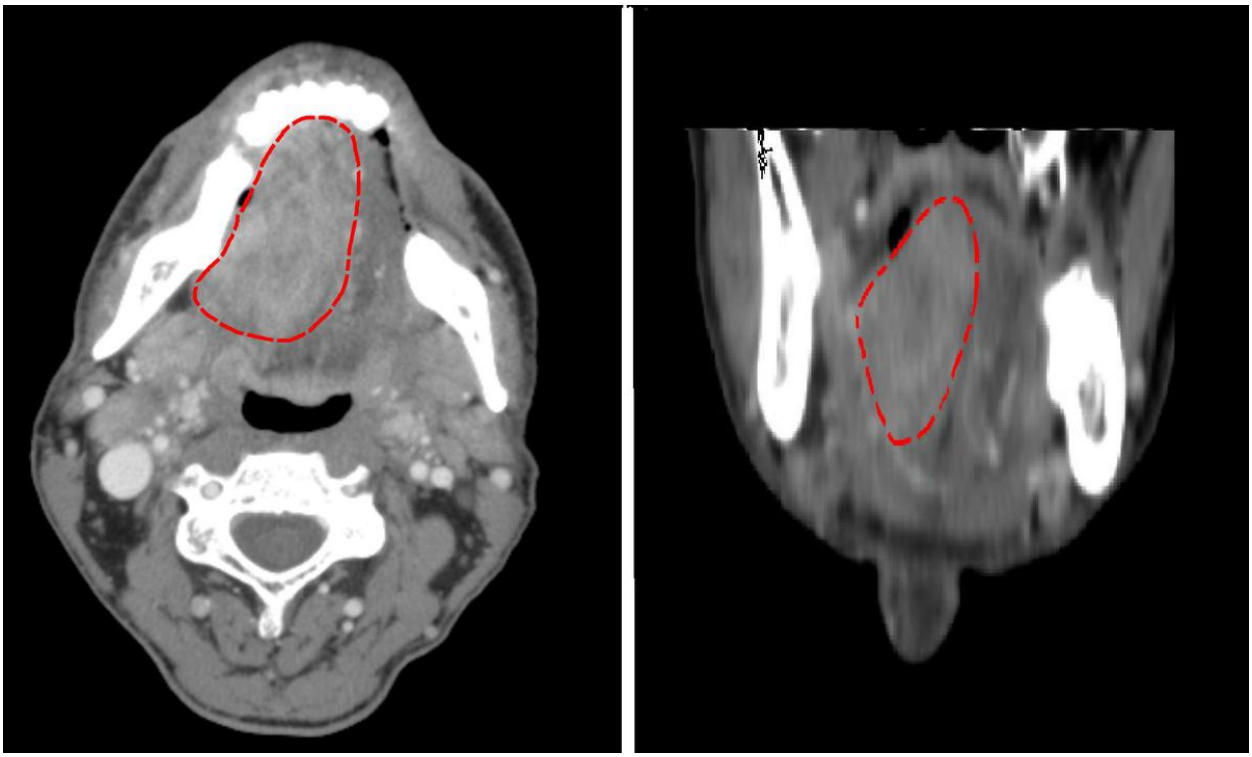

Fig. 27: Contrast enhanced CT scan in the axial and multiplanar reconstruction in the coronal plan of the suprahyoid region in a 46-years old male with a carcinoma of the anterior tongue invading the sublingual space (red dash line). Note the superior to inferior direction of the invasion.

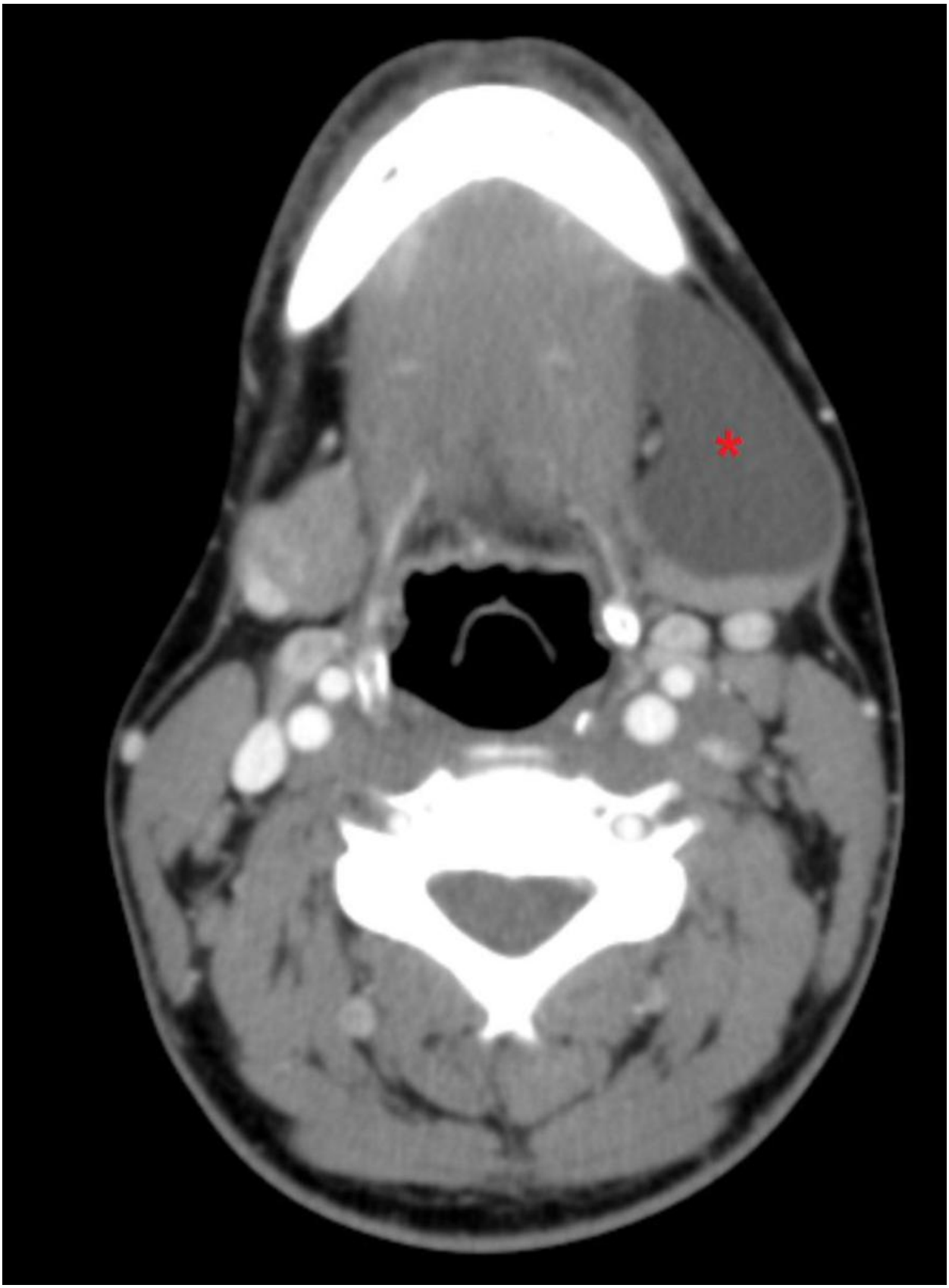

Fig. 28: Contrast enhanced CT scan in the axial plan of the suprahyoid region in a 33-years old male with a suprahyoid thyroglossal duct cyst in the submandibular space (asterisk); This is not a typical case: thyroglossal duct cyst occur more frequent in the midline and in the infrahyoid region.

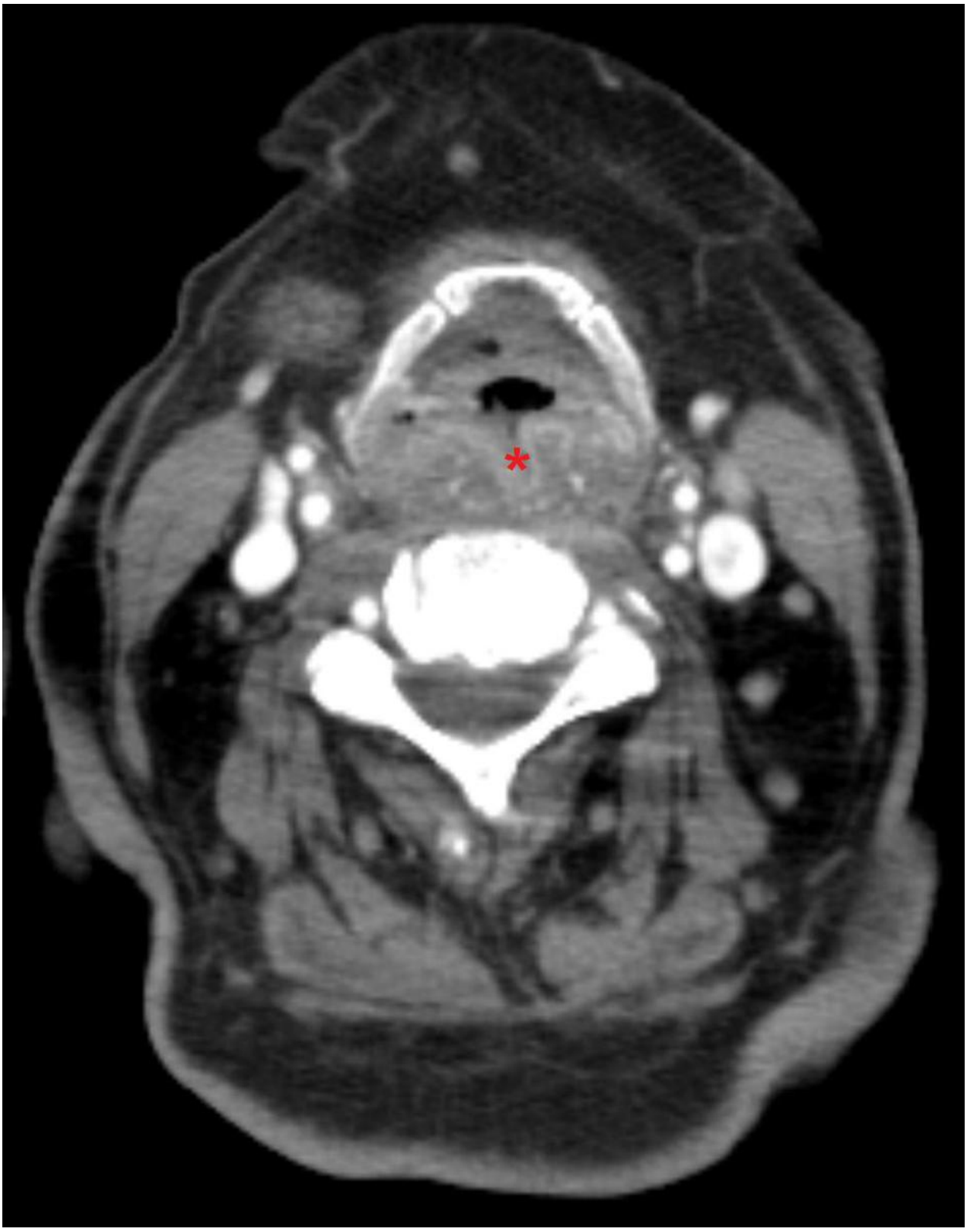

Fig. 29: Contrast enhanced CT scan in the axial plan of the infrahyoid region in a 77-years old female with a squamous cell carcinoma of de larynx. Note the circumferential exuberant widening of the laryngeal mucosa (asterisks).

Fig. 30: Contrast enhanced CT scan in the axial plan of the infrahyoid region in an 81-years old female with cellulitis, complicated with abscess in the anterior cervical space (asterisks).

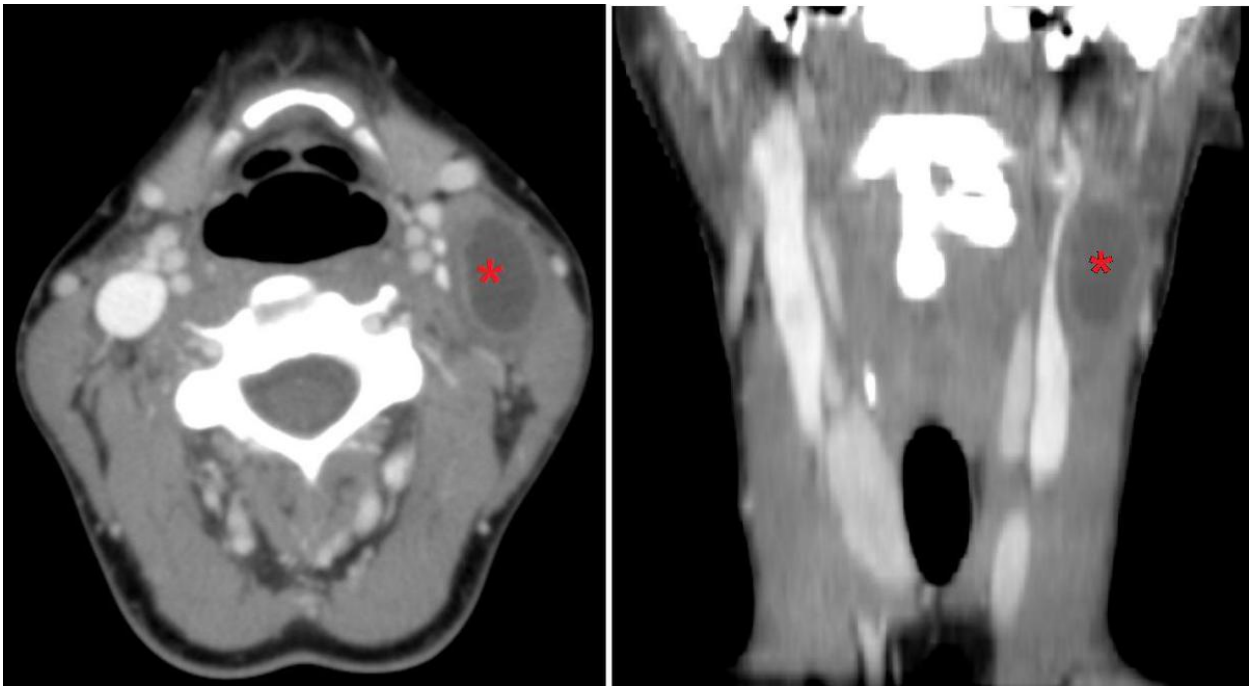

Fig. 31: Contrast enhanced CT scan in the axial plan (left side picture) and multiplanar reconstruction in the coronal plan (right side picture) of the infrahyoid region in a 27-years old female with a second branchial cleft cyst in the left carotid space (asterisk). Note the fusiform morphology of the cystic lesion how it compresses the vessels in the CS.

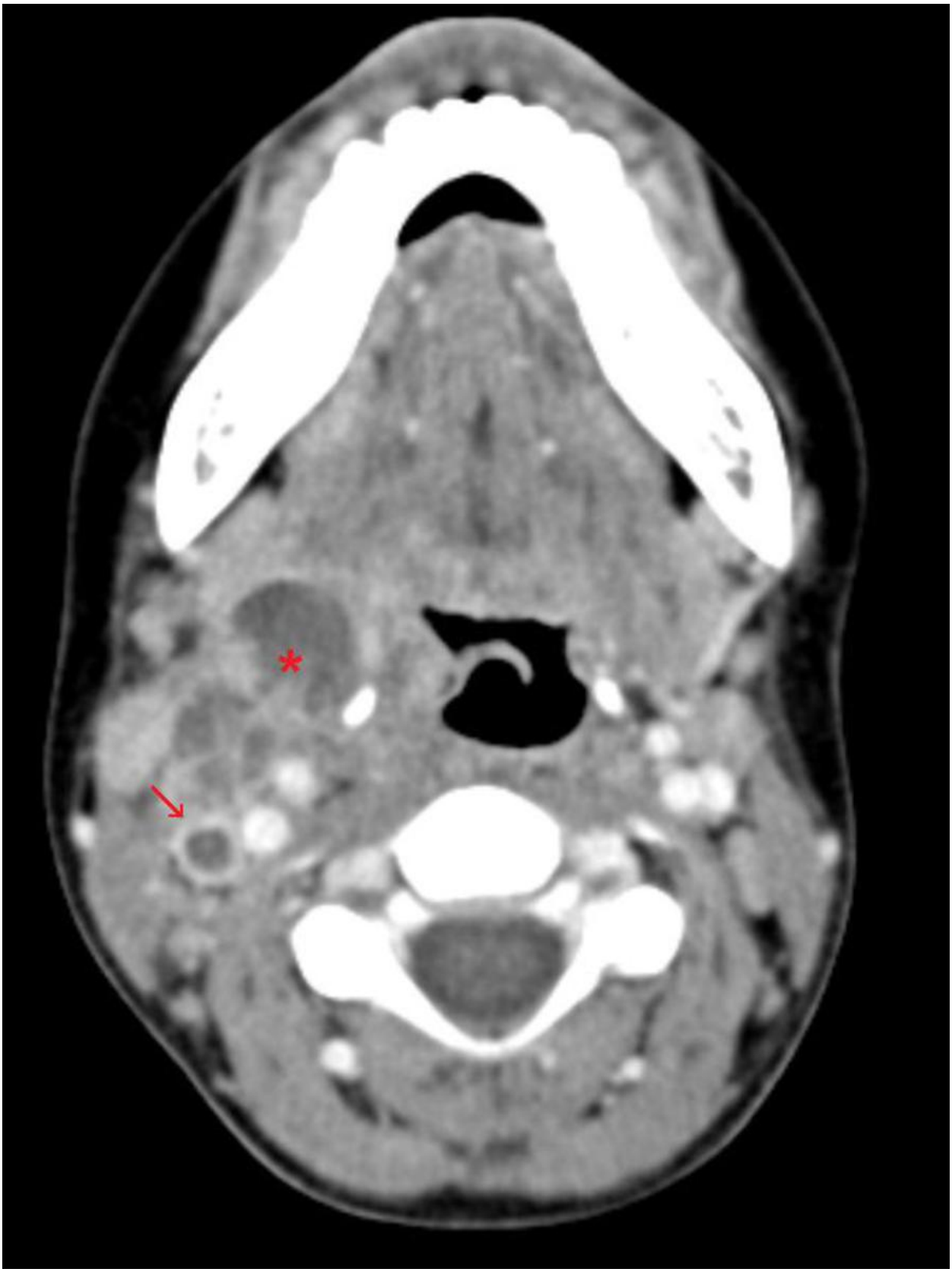

Fig. 32: Contrast enhanced CT scan in the axial plan of the suprahyoid region in a 11-years old boy with Lemierre's Syndrome. Note the thrombophlebitis of the right jugular vein (arrow) and adjacent infectious process (asterisk).

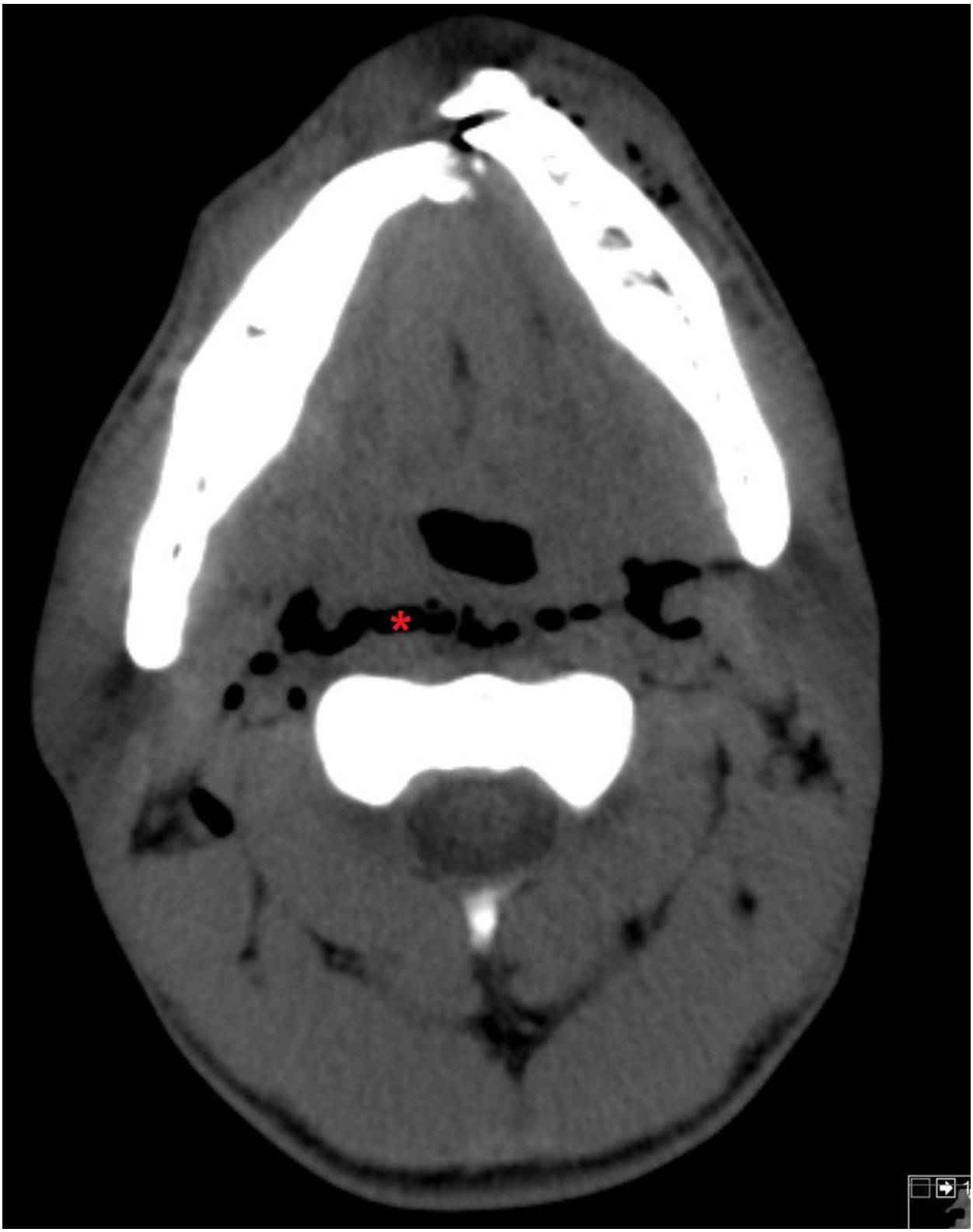

Fig. 33: Plain CT scan in the axial plan of the suprahyoid region in a 40-years old male after a motor vehicle accident. The retropharyngeal space is filled with air (asterisk). Note the fracture in the mandible.

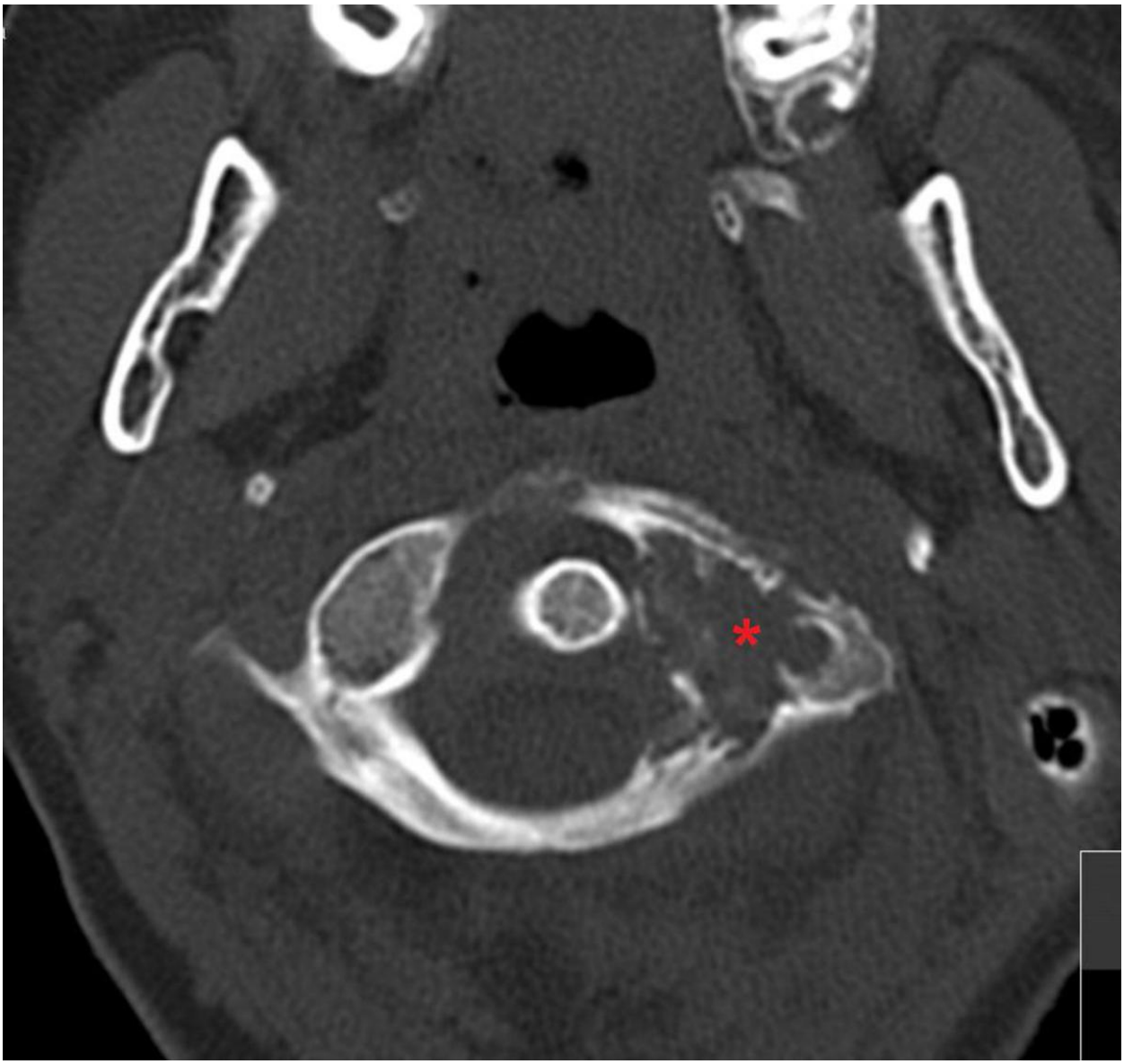

Fig. 34: Plain CT scan in the axial plan of the suprahyoid region of the neck in a 10 years-old boy with a cervical eosinophilic granuloma.(asterisk). Note the lytic lesion, eroding the bone cortical, in the anterior arc of the atlas.

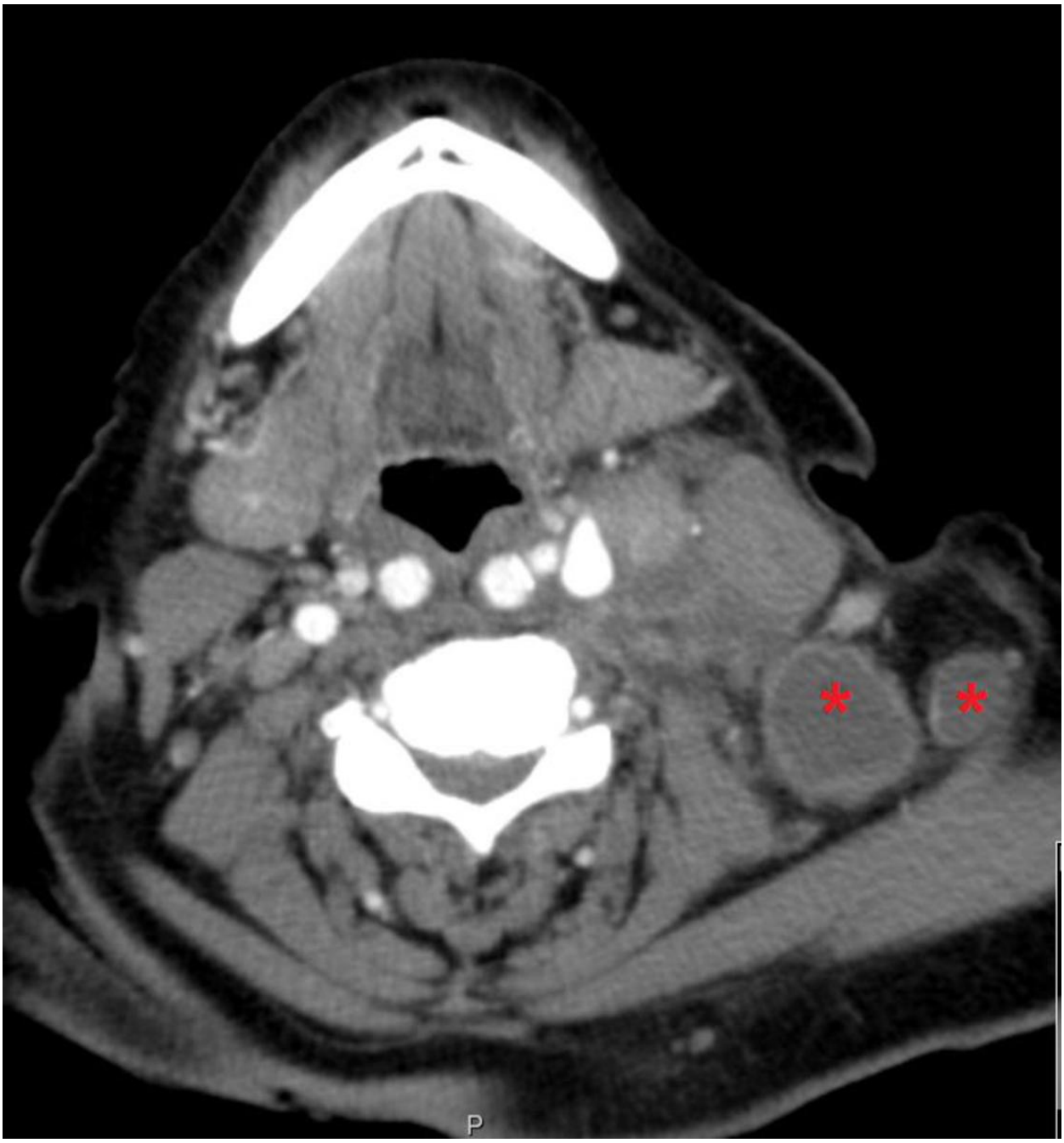

Fig. 35: Contrast enhanced CT scan in the axial plan of the infrahyoid region in an 80-years old female with a pharyngeal squamous cell carcinoma. Note the lymph nodes metastases in the left posterior cervical space (asterisks), they have a typical central necrosis, very common in squamous cell carcinoma.

Conclusion

- Knowing the anatomy and the spectrum of potential findings and their etiologies is essential for the radiologist have a comprehensive knowledge of neck.
- CT and MRI are important tools for the diagnostic, characterization and definition of the extension of neck pathological processes.
- The correct evaluation has important therapeutic implications, which may change patient's management and outcome.

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Personal Information