Visceral space anatomy and neuroanatomy: anatomical-CT correlation with emphasis on neural pathways

<table>
<thead>
<tr>
<th>Poster No.:</th>
<th>C-0757</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congress:</td>
<td>ECR 2016</td>
</tr>
<tr>
<td>Type:</td>
<td>Educational Exhibit</td>
</tr>
<tr>
<td>Authors:</td>
<td>M. Huertas Moreno, A. P. Solano Romero, C. Botía González, R. Vergel Eleuterio, M. A. Fernandez-villacañas Marin, M. Moreno Cascales, J. M. Garcia Santos; Murcia/ES</td>
</tr>
<tr>
<td>Keywords:</td>
<td>Anatomy, Head and neck, Neuroradiology peripheral nerve, CT, Education, Education and training</td>
</tr>
<tr>
<td>DOI:</td>
<td>10.1594/ecr2016/C-0757</td>
</tr>
</tbody>
</table>

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

Given the great amount of muscles and a reduced space, the neck is a complex anatomical space. Regarding the visceral space, CT images provide excellent anatomic detail of viscera, muscles, glands and vessel, however, the majority of nerves involved in their function are beyond the clinical cross-sectional imaging resolution. Throughout this electronic presentation we will identify visible and anatomic references for non-visible structures, from cadaveric dissections and schematic illustrations, to CT correlation.

This way, the objectives of our presentation are:

1. To remember the anatomy of the visceral space.
2. To identify anatomical landmarks of the innervation pathways.
3. To transfer that information to CT images.
Visceral space anatomy and neuroanatomy: anatomical-CT correlation with emphasis on neural pathways

M. Huertas Moreno¹, A.P. Solano Romero¹, C. Botia González¹, R. Vergel Eleuterio², M.A. Fernández-Villacañas Marín³, M. Moreno Cascales⁴, J.M. García Santos¹

¹ Servicio de Radiodiagnóstico. HU Morales Meseguer. Murcia, Spain
² Servicio de Anestesia. HU Virgen de la Arrixaca. Murcia, Spain
³ Departamento de Anatomia. Universidad de Murcia. Murcia, Spain

Fig. 1

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
Background

The visceral space is a neck area spanning from the hyoid bone level to the mediastinum, within the middle layer of the deep cervical fascia, and containing the thyroid and parathyroid glands, hypopharynx, larynx, trachea, oesophagus and paraesophageal lymph nodes (Fig. 2 on page 6, Fig. 3 on page 6).

Extrinsic larynx (strap) muscles are innervated by the ansa cervicalis of the cervical plexus, which results from the anastomosis between the ventral branches of the first three cervical nerves, gathered together after they exit through the intervertebral foramen, between the origins of the anterior and middle scalene, and the hypoglossal nerve (Fig. 4 on page 7).

The descendent branch of the hypoglossal nerve (anterior or superior branch of the ansa cervicalis) runs down anterior to the great vessels, along the anterior diehedral angle formed by the common carotid artery and the internal jugular vein. When arriving to the level of the intermediate tendon of the omohyoid muscle, it meets with the descendent branch of the cervical plexus (posterior or inferior branch of the ansa cervicalis) in front of the internal jugular vein (Fig. 5 on page 8, Fig. 6 on page 8, Fig. 7 on page 9, Fig. 8 on page 10, Fig. 9 on page 10). They create a U-shaped handle leaving the nerves for the sternohyoid and sternothyroid muscles and the upper belly of the omohyoid from the anterior branch, and the nerves for the lower belly of the omohyoid and the sternothyroid muscle from the convexity. The nerve for the thyrohyoid muscle comes directly from the hypoglossal (Fig. 10 on page 11).

Taking into account these characteristics, the anatomic reference to identify the anterior branch of the ansa cervicalis is the anterior diehedral angle between the internal jugular vein and the common carotid artery, posterior to the sternocleidomastoid muscle in superior segments, and posterior to the omohyoid in the inferior segments.

The vagus nerve goes through the neck to the abdomen. Even though it doesn’t run through the visceral space, it is an important nerve as it innervates some related muscles, such as the inferior constrictor muscle of the pharynx, the thyroid and parathyroid glands, the trachea and the oesophagus. The nerve’s origin is located in the nucleus ambiguous, emerges through the posterolateral sulcus of the bulb to, later on, leave out the skull through the jugular foramen. Once out the skull, the vagus descends within the carotid space (Fig. 2 on page 6, Fig. 3 on page 6) through the posterior diehedral angle formed by the internal jugular vein and the internal carotid artery (superiorly) and the common carotid artery (inferiorly).
The vagus gives multiple branches, even though we will just name those relevant in the visceral space. Within the cervical branches, we will emphasize the pharyngeal branches and the superior laryngeal nerve. The first branches run ahead the common carotid artery and finish in the anterior wall of the pharynx, where they innervate its muscles, as the inferior constrictor of the pharynx.

On the other hand, the superior laryngeal nerve, which innervates the cricothyroid muscle, begins in the inferior part of the inferior vagus node, and runs inferiorly, anterior and medially to the pharynx wall, posterior and medial to the internal carotid artery. Later on, the nerve descends over the lateral wall of the pharynx, crosses the medial wall of the external carotid artery, under the lingual artery, to be divided between the origin of this artery and the greater horn of the hyoid into two terminal branches: superior (internal) and inferior (external). The superior branch runs inferior to the lesser horn of the hyoid and runs over the thyrohyoid membrane, which crosses through the same foramen than the superior laryngeal artery. Finally, it is divided into terminal branches for the pharyngeal and laryngeal mucosa, among which stands out the communicating branch with the recurrent laryngeal nerve, making up the ansa of Galen. The inferior branch, however, descends anterior to the inferior pharyngeal constrictor muscle to innervate the cricothyroid muscle and, finally, the laryngeal mucosa, passing through the cricothyroid membrane (Fig. 11 on page 12).

Regarding the thoracic branches of the vagus nerve, the recurrent laryngeal nerve is relevant since it innervates the intrinsic muscles of the larynx, except for the cricothyroid. It is important to outline that the origin of both recurrent laryngeal nerves is different. On the right side, the recurrent laryngeal nerve leaves the vagus anterior to the subclavian artery, surrounds the vessel and ascend to the larynx through the sulcus between the oesophagus and the trachea. On the left side, the nerve leaves the vagus at the level of the aortic arc. Then surrounds the vessel and reaches the larynx lying on the left anterolateral wall of the oesophagus (Fig. 12 on page 12, Fig. 13 on page 13, Fig. 14 on page 14). When reaching the superior portion of the trachea, both nerves are located deep to the inferior pharyngeal constrictor, and go down the mucosa of the pyriform sinus (Fig. 15 on page 14). They finally give branches to all the intrinsic muscles of the larynx (except to the cricothyroid) and a communicating branch that forms the ansa of Galen.

For the cervical assessment of the vagus, the anatomic reference that must be considered is the posterior dihedral angle between the common carotid artery and the internal jugular vein, anterior to the scalene muscles. Regarding the recurrent laryngeal nerve, it can be located lateral to the wall of the oesophagus, posterior and medial to the lateral lobes of the thyroid gland, while at superior levels, it is located anterior to the pyriform sinus.
**Fig. 2:** Visceral space anatomic relationships. A) Sagittal plane sketch of the neck, showing the visceral space surrounded by the middle layer of the deep cervical fascia (dot line) and its limits. B) Axial plane sketch of the neck, through the red line at image A.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
Fig. 3: Visceral space axial plane sketch.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES

Fig. 4: Cervical plexus sketch.
**Fig. 5:** Anterior view of the neck in different planes, from surface to depth (Figs. 5-9). A) 1: Sternocleidomastoid muscle (sectioned). 2: Platysma colli muscle.
Fig. 6: Anterior view of the neck in different planes, from surface to depth (Figs. 5-9). B) 1: Sternocleidomastoid muscle (sectioned). 2: Platisma colli muscle (removed superiorly).

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
Fig. 7: Anterior view of the neck in different planes, from surface to depth (Figs. 5-9). C) 1: Sternocleidomastoid muscle (removed and cut). 2: Platisma colli muscle (removed superiorly). 3: Omohyoid muscle.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES

Fig. 8: Anterior view of the neck in different planes, from surface to depth (Figs. 5-9). D) Ansa cervicalis (White arrow: anterior branch. Red arrow: posterior branch). Omohyoid (3) and sternocleidomastoid(1) muscles are removed. E) Ansa cervicalis (detail). F) Ansa cervicalis and omohyoid muscle relationship.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
Fig. 9: Anterior view of the neck in different planes, from surface to depth (Figs. 5-9). G) Vagus nerve relationship (Green thread, Green arrow) with the anterior (white arrow) and posterior (red arrow) branches of the ansa cervicalis, common carotid artery (4) and internal jugular vein (5).

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
Fig. 10: Anatomic relationships of the ansa cervicalis. ICA: Internal carotid artery. ECA: External carotid artery. IJV: Internal jugular vein.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES

Fig. 11: A) Right lateral view of the larynx and its innervation. B) Sagittal plane view of the larynx.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
**Fig. 12**: Anatomic relationships of the recurrent laryngeal nerves.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
**Fig. 13:** Right recurrent laryngeal nerve. A) Superior-anterior view. B) Superior-posterior view. 1: Right vagus nerve. 2: Right recurrent laryngeal nerve. 3: Right subclavian artery. 4: Right common carotid artery. A: anterior. P: posterior. R: Right. L: Left.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES

**Fig. 14:** Left recurrent laryngeal nerve. A) Postero-superior view (Aorta pushed to the right) B) Postero-superior view (Aorta pushed to the left, oesophagus pushed to the right with a pin (asterisk) 1: Left vagus nerve. 2: Left recurrent laryngeal nerve. 3: Oesophagus. 4: Aorta. 5: Left lung (superior lobe). 6: Right lung (superior lobe). 7: Left subclavian artery (resected). 8: Left common carotid artery. P: Posterior. A: Anterior. R: Right. L: Left.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
**Fig. 15:** Posterior view of the larynx with the pyriform sinus open to identify the left recurrent laryngeal nerve (black arrow). Epiglottis (asterisk).

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES

**Visceral space anatomy and neuroanatomy: anatomical-CT correlation with emphasis on neural pathways**

M. Huertas Moreno¹, A.P. Solano Romero¹, C. Botia González¹, R. Vergel Eleuterio², M.A. Fernández-Villacañas Marín³, M. Moreno Cascales⁴, J.M. García Santos⁵

¹ Servicio de Radiodiagnóstico. HU Morales Meseguer. Murcia, Spain
² Servicio de Anestesia. HU Virgen de la Arrixaca. Murcia, Spain
³ Departamento de Anatomía. Universidad de Murcia. Murcia, Spain

**Fig. 1**
Findings and procedure details

As the neural structures are not visible in CT and aiming to make and anatomical-radiological correlation, we performed a CT scan of an anatomical piece from the nasal bone to the sternal manubrium. The piece was later converted into axial sections of about 1,5 cm gross parallel to the hard palate, in which we identify the neural structures to, after that, locate them in the respective CT images (Fig. 16 on page 18). We also compare the cross-section images with the CT images (Figs. 17-27) and cervical ultrasound (Fig. 28 on page 27) in living subjects.

Ansa cervicalis (anterior or superior branch)

Anatomic reference: the anterior dihedral angle between the internal jugular vein and the common carotid artery, posterior to the sternocleidomastoid muscle in the upper segments (Fig. 18 on page 19, Fig. 20 on page 20) and posterior to the omohyoid in the lower ones (Fig. 22 on page 22, Fig. 24 on page 24).

Vagus nerve

Anatomic reference: Posterior dihedral angle between the internal jugular vein and the common carotid artery, anterior to the scalene muscles (Fig. 18 on page 19, Fig. 20 on page 20, Fig. 22 on page 22, Fig. 24 on page 24).

Recurrent laryngeal nerve

Anatomic reference: Lateral to the oesophageal wall, posterior and medial to the lateral lobes of the thyroid gland in the lower segments (Fig. 27 on page 27) and anterior to the pyriform sinus in the upper segments (Fig. 20 on page 20).
Fig. 16: Sagittal CT image. Red line signaling the plane used for the parallel planes of the neck.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
**Fig. 17:** Axial cross-section images correlation. A) Cadaveric section, axial slice. B) Cadaveric axial CT image. 1: Hyoid bone. 2: Submandibular gland. 3: Sternocleidomastoid muscle. 4: Epiglottis. 5: Piriform sinus. 6: Inferior pharyngeal constrictor muscle. 7: Common carotid artery. 8: Internal jugular vein. 9: Vagus nerve. 10: Levator scapulae muscle.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES

**Fig. 18:** A) Cadaveric section, axial slice (previous image detail). B) Axial contrast-enhanced CT image (alive subject). C) Cadaveric axial CT image. Black arrow: Vagus nerve. Red arrow: Ansa cervicalis (anterior branch). 1: Hyoid bone. 2: Submandibular gland. 3: Sternocleidomastoid muscle. 4: Piriform sinus. 5: Inferior pharyngeal constrictor muscle. 6: Common carotid artery. 7: Internal jugular vein. 8: Superior thyroid artery. 9: Vertebral artery.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
**Fig. 19:** Axial cross-section images correlation. A) Cadaveric section, axial slice. B) Cadaveric axial CT image. 1: Laryngeal vestibule. 2: Epiglottis. 3: Piriform sinus. 4: Thyroid cartilage. 5: Sternohyoid muscle. 6: Thyrohyoid muscle. 7: Inferior laryngeal constrictor muscle. 8: Common carotid artery. 9: Internal jugular vein. 10: Sternocleidomastoid muscle. 11: Scalene muscles. 12: Levator scapulae muscle.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
**Fig. 20:** A) Cadaveric section, axial slice (previous image detail). B) Image A with closed pyriform sinus. C) Axial contrast-enhanced CT image (alive subject). D) Cadaveric axial CT image. Black arrow: Laryngeal recurrent nerve. Red arrow: Ansa cervicalis (anterior branch). White arrow: Vagus nerve. 1: Pyriform sinus. 2: Thyroid cartilage. 3: Sternohyoid muscle. 4: Thyrohyoid muscle. 5: Inferior laryngeal constrictor muscle. 6: Common carotid artery. 7: Internal jugular vein. 8: Sternocleidomastoid muscle.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
**Fig. 21:** Axial cross-section images correlation. A) Cadaveric section, axial slice. B) Cadaveric axial CT image. 1: Glottis. 2: Vocal muscle. 3: Sternohyoid muscle. 4: Omohyoid muscle. 5: Thyrohyoid muscle. 6: Thyroid cartilage. 7: Cricoid cartilage. 8: Hypopharynx. 9: Inferior laryngeal constrictor muscle. 10: Sternocleidomastoid muscle. 11: Internal jugular vein. 12: Common carotid artery. 13: Scalene muscles. 14: Levator scapulae muscle.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
**Fig. 22:** A) Cadaveric section, axial slice (previous image detail, nerves dissected). B) Axial contrast-enhanced CT image (alive subject). C) Cadaveric axial CT image. Black arrow: ansa cervicalis (anterior branch). White arrow: vagus nerve. 1: Glottis. 2: Vocal muscle. 3: Sternohyoid muscle. 4: Omohyoid muscle. 5: Thyrohyoid muscle. 6: Thyroid cartilage. 7: Cricoid cartilage. 8: Hypopharynx. 9: Inferior laryngeal constrictor muscle. 10: Sternocephaloidomastoid muscle. 11: Internal jugular vein. 12: Common carotid artery. 13: Thyroid gland. 14: Superior carotid artery.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
Fig. 23: Axial cross-section images correlation. A) Cadaveric section, axial slice. B) Cadaveric axial CT image. 1: Sternohyoid muscle 2: Sternothyroid muscle. 3: Larynx. 4: Cricoid cartilage. 5: Hypopharynx. 6: Inferior laryngeal constrictor muscle. 7: Thyroid cartilage. 8: Omohyoid muscle. 9: Sternocleidomastoid muscle. 10: Thyroid gland. 11: Internal jugular vein. 12: Common carotid artery. 13: Posterior cricoarytenoid muscle. 14: Scalene muscles. 15: Levator Scapulae muscle.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
Fig. 24: A) Cadaveric section, axial slice (previous image detail, omohyoid muscle separated). B) Axial contrast-enhanced CT image (alive subject). C) Cadaveric axial CT image. White arrow: Ansa cervicalis (anterior branch). Black arrow: Vagus nerve. 1: Larynx. 2: Cricoid cartilage. 3: Inferior laryngeal constrictor muscle. 4: Posterior cricoarytenoid muscle. 5: Thyroid cartilage. 6: Omohyoid muscle. 7: Sternocleidomastoid muscle. 8: Thyroid gland. 9: Internal jugular vein. 10: Common carotid artery.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
Fig. 25: Posterior view of previous image where the anterior (red arrow) and posterior (black arrow) branches of the ansa cervicalis can be seen. S: Superior. I: Inferior. L: Left. R: Right.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
**Fig. 26:** Axial cross-section images correlation. A) Cadaveric section, axial slice. B) Cadaveric axial CT image. 1: Sternohyoid muscle. 2: Sternothyroid muscle. 3: Thyroid gland. 4: Internal jugular vein. 5: Common carotid artery. 6: Oesophagus. 7: Sternocleidomastoid muscle. 8: Trachea. 9: Anterior scalene muscle. 10: Middle scalene muscle. 11: Posterior scalene muscle. 12: Levator scapulae muscle.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES

**Fig. 27:** A) Cadaveric section, axial slice (previous image detail, sternohyoid and sternothyroid muscles separated). B) Axial contrast-enhanced CT image (alive subject). C) Cadaveric axial CT image. Anterior branch of the ansa cervicalis (White arrow). Recurrent laryngeal nerve (red arrow). 1: Sternohyoid muscle. 2: Sternothyroid muscle. 3: Thyroid gland. 4: Internal jugular vein. 5: Common carotid artery. 6: Oesophagus. 7: Sternocleidomastoid muscle. 8: Trachea. 9: Anterior scalene muscle.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
**Fig. 28:** Video. Ultrasound anatomy of the visceral space. CCA: common carotid artery. IJV: internal jugular vein.

© Radiodiagnóstico, Hospital General Universitario Morales Meseguer, Hospital General Universitario Morales Meseguer - Murcia/ES
Conclusion

Visible anatomical references in the neck are crucial for evaluating function and dysfunction of visceral space related nerves. In this electronic presentation we have made an anatomical review and an anatomical-radiological correlations to help radiologists to be more familiar to this complex anatomy and relationships.
References


