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Laryngeal Radioanatomy

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Abstract **Original Research Article**

The larynx, a specialized segment of the airways, is the essential organ of phonation, breathing and protection of the lower airways when swallowing by a complex anatomic structures organized around a cartilaginous skeleton. We realized a prospective study on three months, ranging from March 01 to May 31 2020, of patients referred to our service for cervical CT scan or MRI exploration in different contextes. We retained the normal exams. For scanographic exploration we used a multi-slice CT scan consisting of 64 rows of detectors. Helical acquisition in native axial slices 0.627 mm thick from the base of the skull to the arch of the aorta was performed in indifferent breathing after asking the patient not to swallow. Iodinated contrast product was injected according to the administration protocol in a single bolus of 90 ml at an average flow rate of 1.5 ml / s and to perform the acquisition with 50 second delay. A dynamic phonation maneuver (saying "eee" continuously and evenly) was used to analyse the true and false vocal cords. On MRI exploration of the larynx, we used a high-field device (1.5Tesla) with a semi-circular specific surface antenna, the phase oriented in an anteroposterior direction, the 3DT1 spin echo sequence without fat signal saturation was performed. In ultrasound, we used literature data. Knowledge of laryngeal radioanatomy contributes to the diagnosis of laryngeal cancers which occupy an important place in all cancers of the upper aerodigestive tract. They can be diagnosed early and the refinement of their endoscopic exploration and imaging allows them to make a precise extension assessment.

Keywords: Larynx, radioanatomy, Cross-sectionnal, imaging.

I. INTRODUCTION

The larynx, a specialized segment of the respiratory tract, is the essential organ of phonation by the production of a laryngeal sound. It also participates in breathing and ensures the protection of the lower respiratory tract during swallowing. These functions are performed by complex anatomical structures organized around a cartilaginous skeleton.

The aim of our work is to describe the radioanatomy of the larynx on cross-sectional imaging.

II. PATIENTS AND METHODS

Our study concerned patients referred to our service for cervical CT scan or MRI exploration in different contextes. We retained the normal exams during three months, from March 01 to May 31 2020.

For scanographic exploration we used a multi-slice CT scan consisting of 64 rows of detectors.

Helical acquisition in native axial slices 0.627 mm thick from the base of the skull to the arch of the aorta was performed in indifferent breathing after asking the patient not to swallow.

The slices are then reconstructed with a standard filter for good quality multiplanar reconstructions.

To allow good tissue impregnation and excellent vascular contrast, the iodinated contrast product was injected according to the administration protocol in a single bolus of 90 ml at an average flow rate of 1.5 ml / s and to perform the acquisition with 50 second delay (alternative to biphasic injection) [4].

A Smartprep pre-delay system is used to automatically trigger the injection of contrast product (Fig 4, A, B, C and D).

A dynamic phonation maneuver (saying "eee" continuously and evenly) that causes the true and false vocal cords to open and provides excellent visualization of these structures and the laryngeal ventricle was performed. It is also useful for confirming suspected vocal cord paralysis (Fig 4, E, F and G).

On MRI exploration of the larynx, we used a high-field device (1.5Tesla) with a semi-circular specific surface antenna, the phase oriented in an anteroposterior direction in order to limit the artifacts, the 3DT1 spin echo sequence without fat signal saturation provides good spatial resolution and excellent anatomical definition (good analysis of fat spaces (Fig 5).

The limits of this technique lie in the significant duration of the examination, the spatial resolution (lower than that of the scanner) and the sensitivity to kinetic artefacts (movements, swallowing). In daily practice, MRI is therefore a second-line examination, complementary to CT in certain indications.

In ultrasound, we used literature data which say that examination of the larynx should be performed with a linear (7–18 MHz) and sectoral (6.5–8 MHz) probe (the latter for assessment of the base of the tongue and the preepiglottic space). Routine ultrasound of the larynx should include midline transverse, paramedian transverse, and longitudinal views (or scans) obtained from a patient in the supine position, although a seated position may also be used in patients who have difficulty breathing (Fig 6 and 7).

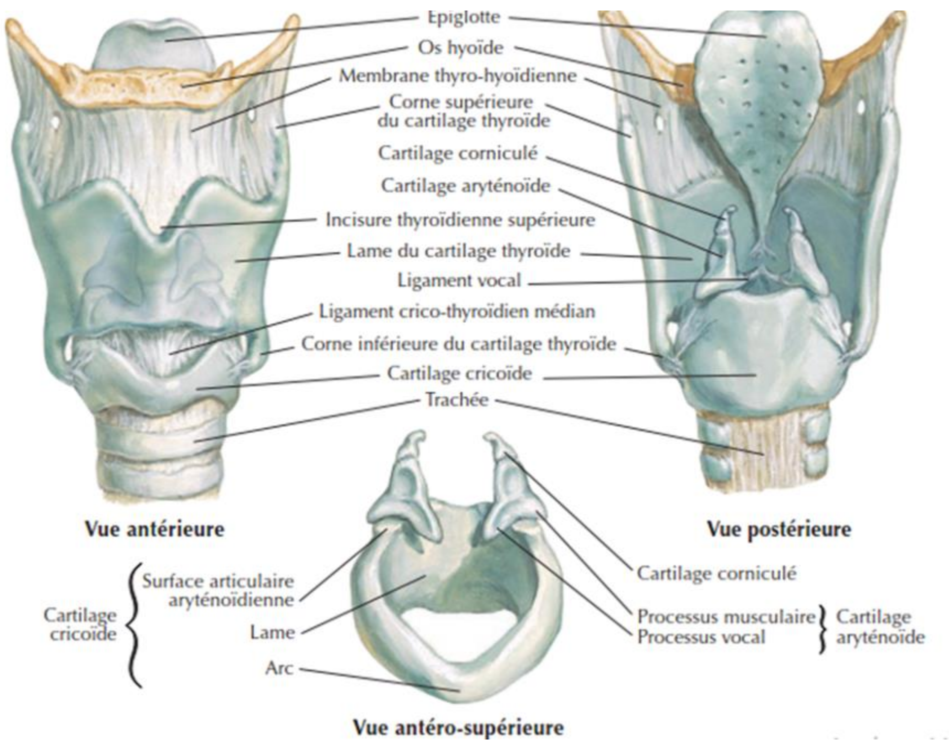
III. LARENGEAL RADIOANATOMY

Anatomical reminders [1–3]

The larynx is a fibrocartilaginous structure lined with a mucous membrane that extends from the base of the tongue to the trachea, covering the height of the fourth, fifth and sixth vertebrae. The laryngeal skeleton is made up of three unpaired cartilages: thyroid cartilage, cricoid cartilage, and epiglottis; and three smaller paired cartilages: the arytenoid, corniculate, and cuneiform. The hyoid bone, although technically not part of the larynx, provides muscle attachments from above that facilitate movement of the larynx.

The larynx is divided into three stages: supraglottic stage, glottic stage, subglottic stage. The supraglottis level is between the free edge of the epiglottis and the Morgagni ventricle. It includes the laryngeal vestibule limited at the top by the laryngeal rim, the entrance gate to the larynx which is delimited by the free edge of the epiglottis, the aryepiglottic folds, the top of the arytenoids, the upper edge of the posterior commissure.

The glottis consists of the vocal folds from the vestibular floor to the elastic cone, the base of the arytenoids, and the anterior and posterior commissures. The subglottic stage is located below the elastic cone from the underside of the vocal cords to the first tracheal ring.



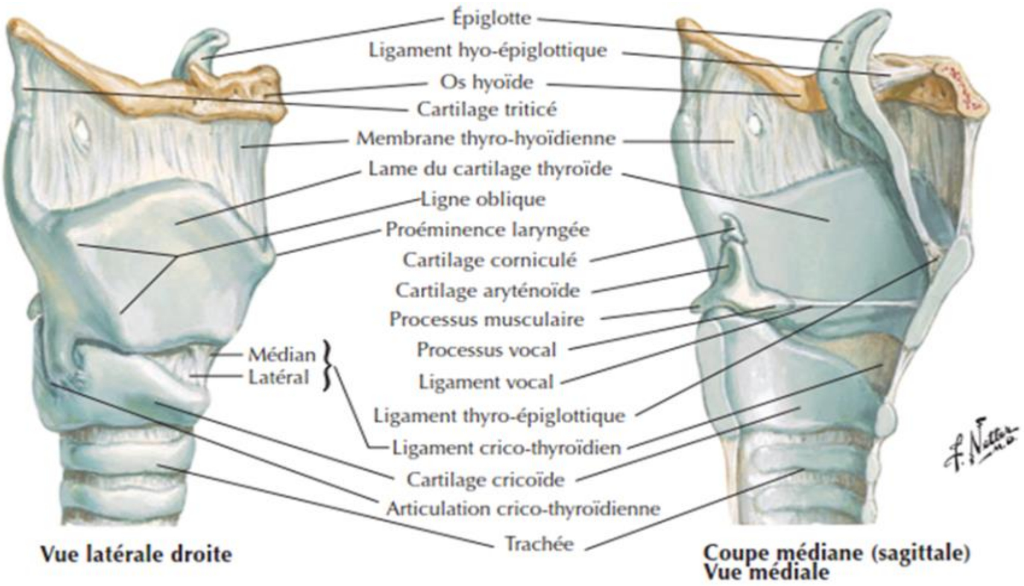


Figure 1: Laryngeal cartilages, schematic views [1]

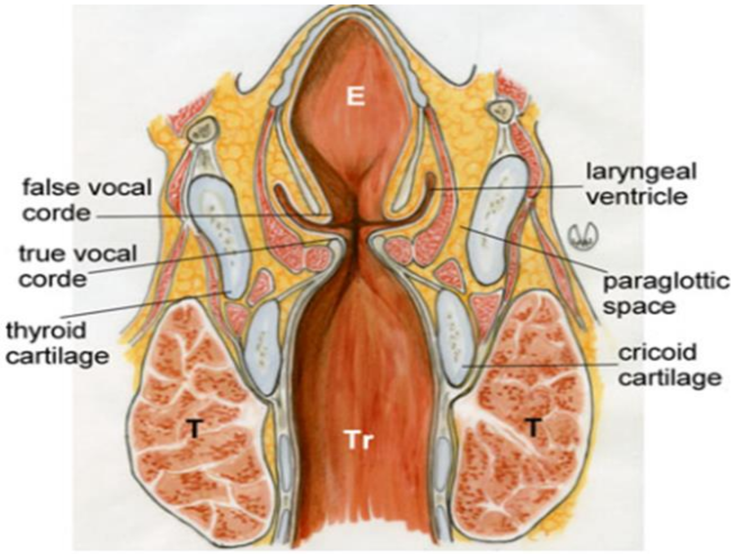


Figure 2: Anatomy of the larynx, coronal section; Epiglottis (E), thyroid (T), trachea (Tr) [2]

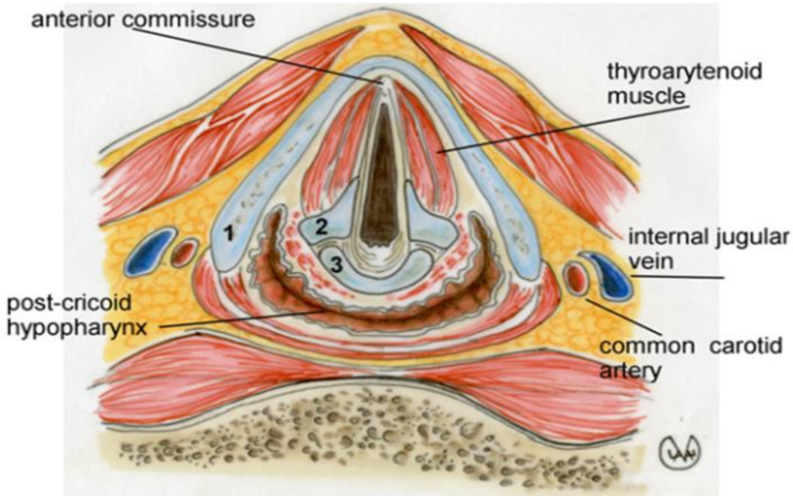


Figure 3: Anatomy of the glottis, axial section. Thyroid cartilage (1), Arytenoid cartilage (2), cricoid cartilage (3) [2]

CT Scan Radioanatomy [4–6]

Computed tomography provides a unique method of assessing the larynx. Because the larynx is such a complex anatomical structure, a full appreciation of normal CT anatomy is facilitated on high resolution CT images primarily axial but also coronal and sagittal.

The deep supraglottic spaces of the larynx are composed primarily of fat, which makes them easy to identify on a CT scan. The preepiglottic space extends from the anterior commissure inferiorly to the hyoid bone superiorly; it is generally best visualized at the level of the upper thyroid notch. No distinct border can be observed on axial CT images between the preepiglottic space anteriorly and the paralaryngeal spaces laterally. By moving caudally towards the true vocal cords, the paralaryngeal fatty spaces become less abundant. The paralaryngeal spaces are delimited laterally by the thyroid cartilage, posteriorly by the pyriform sinuses, and medially by the medial border of the aryepiglottic folds.

The subglottic space is made up of the elastic cone which is a fibrous membrane that extends from the free margin of the true vocal cord below the cricoid. Although it is not specifically visible on CT, its intimate association with the medial part of the cricoid renders abnormal any significant thickness of the soft tissue between the cricoid and the adjacent mucosa at the subglottic level.

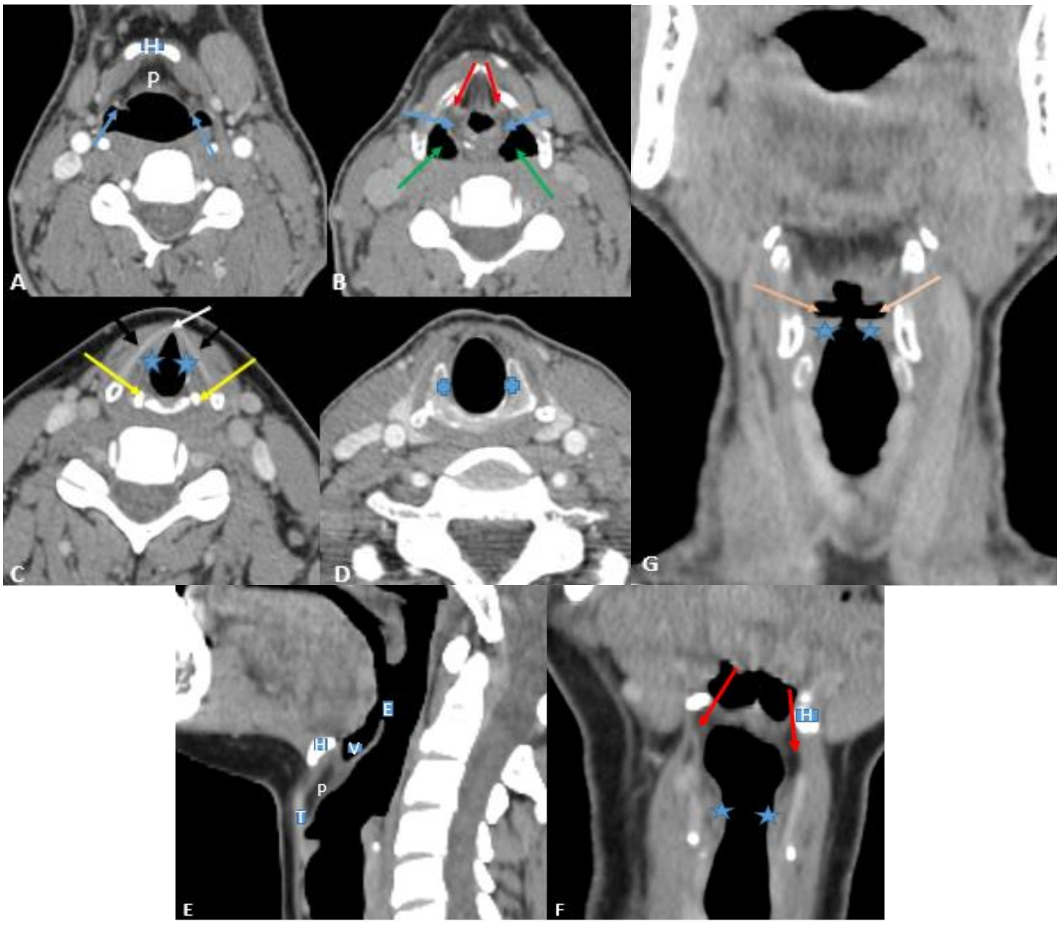


Fig 4: Normal laryngeal anatomy on CT scan. Axial computed tomography images of the soft tissue algorithm through the supraglottic stage at the level of the hyoid bone (A) and the false vocal cords (B) illustrate well the pre-epiglottic (P) and paraglottic (Red arrows) spaces of low density containing fat. The aryepiglottic folds (Blue arrows) separate the laryngeal airways from the piriform sinuses (Green arrows) that reside in the hypopharynx. The axial image at the glottis (C) shows the soft tissue density of the true vocal cords (blue asterisks) and the anterior commissure (White arrow). Fat is not visualized at the level of the true vocal cords because this space is mainly filled by the thyro-arytenoid muscle. Also note that there is little or no soft tissue between the symphysis of the thyroid cartilage and the airways at the anterior commissure (White arrow), which should be less than 2mm thick. On an axial image obtained at the level of the subglottis (D), note that there is no soft tissue visualized between the inner edge of the cricoid cartilage (blue cross) and the airways. The mid-sagittal image (E) represents the preepiglottic space containing fat (P) located between the epiglottis posteriorly and the hyoid membrane, the thyroid cartilage and the thyrohyoid membrane anteriorly. The coronal image (F) through the middle of the laryngeal airway again clearly shows the fat-containing paraglottic spaces (red arrows), deep to the supraglottis lining. G: Coronal image obtained by phonation maneuver, showing the laryngeal ventricles (pink arrows) and the true vocal cords (blue asterisks). Arytenoids (Yellow arrows); epiglottis (E); hyoid bone (H); T, thyroid cartilage (Black arrows); vallecule (V)

MRI Radioanatomy [4, 5, 7]

MRI allows a good study of the soft tissues of the larynx, superior to that of other imaging techniques.

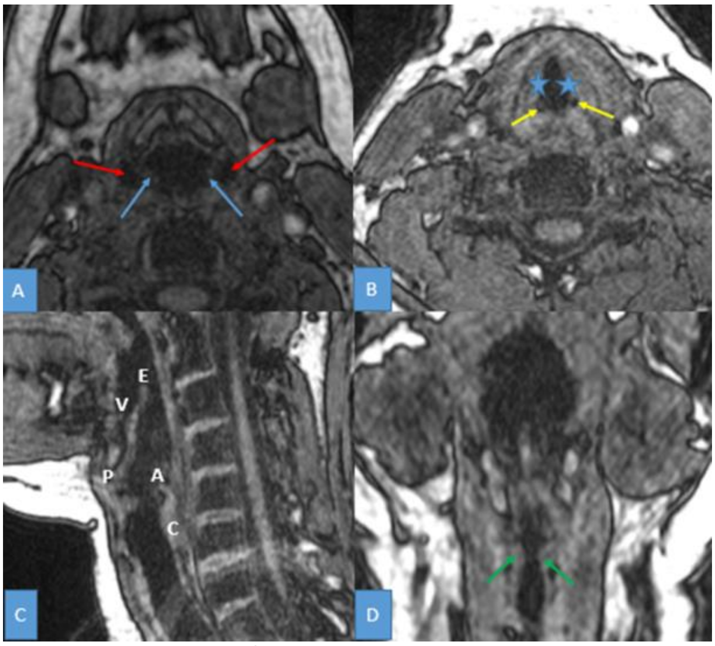


Fig 5: Normal laryngeal anatomy: Sequence 3T1 without fat saturation and without Gadolinium injection. Axial (A and B) sagittal (C) and coronal (D) images: Aryepiglottic folds (blue arrows), pyriform sinuses (red arrows), vocal cords (blue asterisks and green arrows), arytenoid cartilages (yellow arrows). A, Aryepiglottic fold; C, cricoid; E, epiglottis; V, vallecule; P, preepiglottic fat

US anatomy [8–10]

Upper airway ultrasound can be a useful addition to clinical methods of airway assessment. Most of the laryngeal components are easily identified on high-resolution ultrasound, even in a heavily calcified larynx, because the thyro-hyoid and crico-thyroid membranes are suitable for transmitting ultrasound beams. Currently, published data on airway ultrasound is limited.

Laryngeal examination should be performed with a linear high frequency frequency (7–18 MHz) and sector transducers (6.5–8 MHz) (the latter for assessment of the base of the tongue and preepiglottic space) to obtain high resolution images (static images and video). Routine ultrasound of the larynx should include transverse median, transverse paramedian, and longitudinal views (or scans) obtained in a supine patient, although a seated position may also be used in patients who have difficulty breathing.

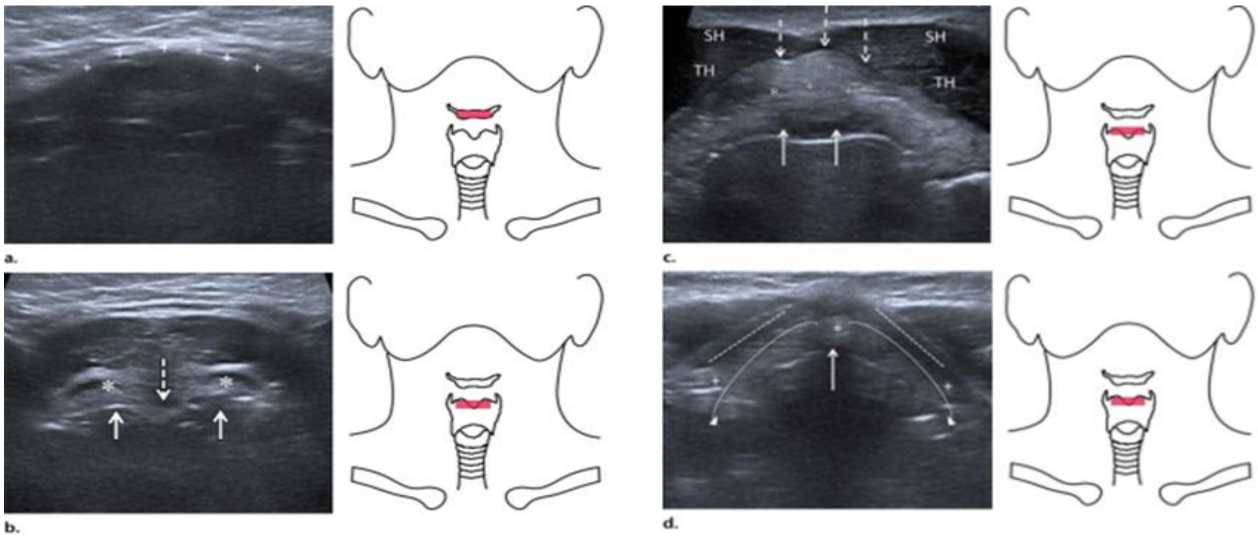


Fig 6: Midline transverse plane US images (left) of the larynx, from superior to inferior, with corresponding illustrations (right) of the anatomic orientation. (a) US image shows the hyoid bone, which appears as a bright line with a prominent acoustic shadow (+). (b) US image at the level of the floor of the vallecula (*) shows the posterior surface of the vallecula as a bright line (solid arrows). The median glossoepi-glottic folds can also be seen in this view (dashed arrow). (c) US image at the level of the thyrohyoid membrane (dashed arrows) shows the preepiglottic space (*), which is limited anteriorly by the thyrohyoid membrane (dashed arrows) and the more superficial thyrohyoid (TH) and sternohyoid (SH) muscles, and posteriorly by the hypoechoic epiglottis (solid arrows). (d) US image at the level of the thyroid notch shows the con- tinuity between the preepiglottic space (*, curved arrows) and the paraglottic space (+, curved arrows). Also visible are the thyroid cartilage (dashed lines) and the inferior aspect of the epiglottis (straight arrow) [8]

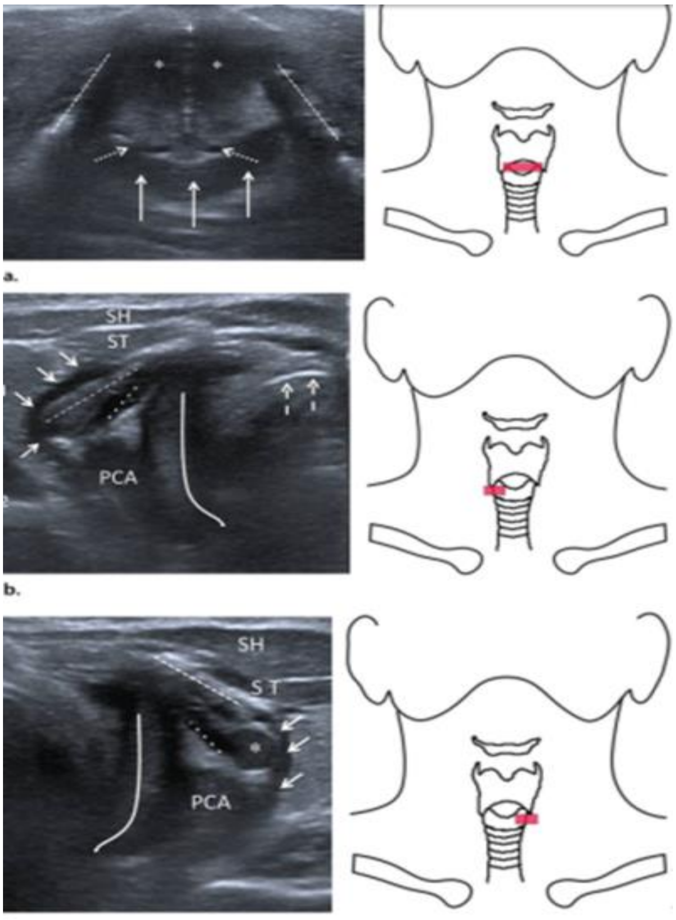


Fig 7: Midline transverse plane US images (left) of the larynx, from superior to inferior, and corresponding illustrations (right) of the anatomic orientation. (a) US image at the level of the cricothyroid and inferior thyroid laminae (dashed lines) shows the vocal cords in adduction (*). The apposed arytenoid cartilage (dotted arrows) are partly echogenic on the right, and the interarytenoid muscles (solid arrows) are seen posteriorly. Because of the superior angulation of the probe, the hypoechoic vocal cords (*) and the anterior commissure (+) are visible anteriorly, as are the hyperechoic false vocal cords posteriorly. (b,c) US images of the transverse right (b) and left (c) planes at the level of the cricoid cartilage (curved line). The cricothyroid muscle (dotted line) and the posterior cricoarytenoid muscle (PCA) can be seen. Note the sternohyoid (SH) and sternothyroid (ST) strap muscles anteriorly, and the thyropharyngeal componentof theinferior constrictor (solid arrows) and of the air and mucosal interface (dashed arrows in b) of the anterior cricothyroid region. The noncalcified inferior horn of the left thyroid cartilage (* in c) is also visible [8]

IV. CONCLUSION

The multidetector scanner is a complement to virtual laryngeal endoscopy. It reproduces the cross-sectional anatomy of the different laryngeal structures. Compliance with acquisition techniques makes it possible to respond to clinicians' concerns about the normality or otherwise of the laryngeal stages. This technique will eventually be supplemented by an MRI if necessary.

Competing Interests: The authors declare no conflict of interest.

Contributions from authors

All the authors contributed to the conduct of this work. They also state that they have read and approved the final version of the manuscript.

REFERENCES

1. Netter, F. H. (2011). Atlas of human anatomy. 5th ed. Philadelphia, PA: Saunders/Elsevier.
2. Olivetti, L, editor. (2015). Atlas of Imaging Anatomy. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-10750-9.
3. Noordzij, J. P., & Ossoff, R. H. (2006). Anatomy and physiology of the larynx. *Otolaryngologic Clinics of North America*, *39*(1), 1-10. https://doi.org/10.1016/j.otc.2005.10.004.
4. Le Corroller, T., Champsaur, P., & Moulin, G. (2008). Radioanatomie du cou. EMC - Radiol Imag Médicale - Cardiovasc - Thorac - Cervicale, 3, 1-20. https://doi.org/10.1016/S1879-8535(08)72765-X.
5. Huang, B. Y., Solle, M., & Weissler, M. C. (2012). Larynx: anatomic imaging for diagnosis and management. *Otolaryngologic Clinics of North*

America, *45*(6), 1325-1361. https://doi.org/10.1016/j.otc.2012.08.006.

6. Silverman, P. M., & Korobkin, M. (1983). High-resolution computed tomography of the normal larynx. *American Journal of Roentgenology*, *140*(5), 875-879. https://doi.org/10.2214/ajr.140.5.875.
7. Champsaur, P., Parlier-Cuau, C., Brunet, C., Moulin, G., Chagnaud, C., Lassau, J. P., & Kasbarian, M. (2000). Serial anatomy of the larynx in MRI: MRI-histologic correlations. *Surgical and Radiologic Anatomy*, *22*(1), 5-11. https://doi.org/10.1007/s00276-000-0005-7.
8. Beale, T., Twigg, V. M., Horta, M., & Morley, S. (2020). High-resolution laryngeal us: imaging technique, normal anatomy, and spectrum of disease. *Radiographics*, *40*(3), 775-790. https://doi.org/10.1148/rg.2020190160.
9. Altun, D. (2019). The role of ultrasonography in the determination of cricothyroid membrane localization in the predicted difficult airway. *Turk J Trauma Emerg Surg*. https://doi.org/10.14744/tjtes.2019.65250.
10. Singh, M., Chin, K. J., Chan, V. W., Wong, D. T., Prasad, G. A., & Yu, E. (2010). Use of sonography for airway assessment: an observational study. *Journal of Ultrasound in Medicine*, *29*(1), 79-85. https://doi.org/10.7863/jum.2010.29.1.79.