Airway Anatomy

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Abstract

The human airway consists of the upper and lower airways. The larynx, being part of the upper airway, contributes to phonation, respiration, and prevention of aspiration. Its anatomy plays a central role in the complex sensorimotor functions including swallowing and speech production. The cricoid cartilage serves as an anchoring structure connecting the laryngeal apparatus to the lower airways by means of ligaments and muscles. The tracheobronchial tree begins with the first tracheal ring and continues with incomplete cartilaginous rings, providing the skeletal framework as part of the conducting airways. The trachea and subsequent dividing branches of the bilateral lungs have remarkable reproducibility in terms of branching patterns as well as luminal calibers. The nomenclature for bronchial anatomy consists of the Jackson-Huber classification and the Boyden surgical classification. Accurate description of airway anatomy is important for both the diagnosis and the management of chest diseases.

Keywords

Soft Palate · Bronchial Artery · Thyroid Cartilage · Cricoid Cartilage · Left Main Bronchus

1 Introduction

Airway pathologies, both benign and malignant, have a myriad of clinical manifestations and radiologic findings. Knowledge of theses concepts is essential for understanding respiratory physiology, as well as critical for precise localization of thoracic pathology. Thus, understanding of airway

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S. Patel et al., *Principles and Practice of Interventional Pulmonology*, https://doi.org/10.1007/978-3-031-49583-0_8-1

anatomy is a fundamental requirement to the practice of interventional pulmonology. This chapter will explore the intricate details of these anatomical regions, highlighting key considerations and landmarks essential for successful interventions as well as common anatomic variants.

To become competent in performing bronchoscopy entails proper training and dedicated practice, as well as accurate interpretation of endoscopic findings to incorporate into differential diagnosis and management strategies. Within the context of lung cancer, for example, bronchoscopies are routinely performed to acquire specimens from lymph nodes, airway lesions, or lung parenchyma to establish a histologic diagnosis and determine cancer stage. Precise localization of lesions can determine a patient's candidacy for surgical resection versus medical therapy. Consequently, airway anatomy details are vital to communications with other specialists in various disciplines, including thoracic surgeons, anethesiologists, and radiologists [1]. For these reasons, it behooves those who perform airway procedures to be expert with respect to knowledge of airway anatomy.

The objective of this chapter is to provide both descriptive and applied anatomy of the upper and lower airways.

2 Upper Airway

2.1 Oral Cavity

The oral cavity, also known as the mouth, is an anatomical structure that plays a crucial role in various functions such as speech, mastication, and swallowing. It is bounded anteriorly by the lips, laterally by the cheeks, superiorly by the hard and soft palates, and inferiorly by the floor of the mouth. Posteriorly, it communicates with the oropharynx.

The palate forms the roof of the oral cavity and is divided into the hard palate (anterior flat bony plate) and the soft palate (posterior muscular plate). The soft palate terminates at the uvula and plays a role in speech and swallowing. During deglutition, the soft palate displaces superiorly to assist with the closure of the nasopharynx.

An overall assessment of the oral cavity should be performed prior to performing any type of procedure. Inspection ensures that the oral cavity is clear and suitable for the intended procedure, reducing the risk of complications such as trauma, aspiration, or failed intubation [2]. The clinical examination should evaluate for the safety and contraindications of a procedure as well as to guide the differential diagnosis. Poor dental hygiene may be a risk factor for high-risk patients (e.g., alcohol abuse) with aspiration causing anaerobic infections and air-fluid cavities on imaging studies [3]. A tooth that is mobile can become dislodged during manipulation and cause an airway obstruction. In a comatose or sedated patient, the tongue can frequently obstruct the upper airways and lead to oxygen desaturation and hypoventilation. During endotracheal intubation, the distal tip of the direct laryngoscope sweeps the tongue sideways in order to accommodate airway devices. Similarly, during rigid bronchoscopy intubation, the operator's nondominant hand should mobilize the tongue in order to allow passage of the rigid bronchoscope through the oropharynx. Decreased tongue mobility, such as a tongue fixation, is a predictor of failed intubation [4]. Additional clinical parameters used to assess for placement of artificial airways will be discussed later.

2.2 Nasal Anatomy

The nasal anatomy is a complex structure that serves multiple critical functions, including respiration, olfaction, and filtration of airborne particles [5]. The external nose is composed of a bony and cartilaginous framework, covered by skin, with two nostrils or nares that allow air entry. Internally, the nasal cavity is divided into two halves by the nasal septum. The lateral walls of the nasal cavity feature three bony projections called turbinates, divided into three substructures: superior, middle, and inferior turbinates. The inferior turbinate can be seen laterally, and the nasal septum is seen medially when a bronchoscope is introduced through the nose. Common pathologies may arise in the nose: septal deviation, hypertrophy of turbinates, and presence of polyps. A bronchosocopist should be able to assess and identify these pathologies readily as nasal pathology may be a manifestation of systemic diseases affecting the tracheobronchial tree.

2.3 Oropharynx and Hypopharynx

The oropharynx is located behind the oral cavity, beyond the base of the tongue, extending from the soft palate to the level of the hyoid bone to the tip to of the epiglottis (Fig. 1). It serves as a passageway for air during breathing and for food and liquid during swallowing. Key structures within the oropharynx include the tonsils, the base of the tongue, and the soft palate [6]. The hypopharynx lies below the oropharynx and extends from the hyoid bone to the entrance of the esophagus and larynx. The valleculae are two depressions or pockets located at the base of the tongue, just anterior to the epiglottis. Each vallecula is bordered medially by the median glossoepiglottic fold and laterally by the lateral glossoepiglottic folds. Valleculae are often locations for foreign-body entrapment and upper airway obstruction.

Examination of the oropharynx is a prerequisite to performing procedures of the airways [7]. The Mallampati classification is a commonly used system used to evaluate the visibility of the structures in the oropharynx and to anticipate

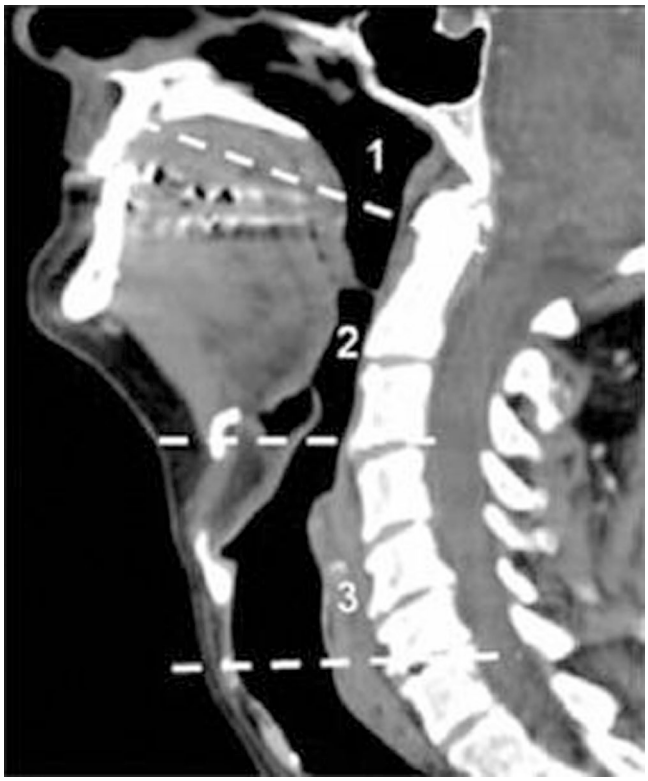

Fig. 1 Pharyngeal anatomy. Sagittal view of pharynx divided into (1) nasopharynx, (2) oropharynx, and (3) hypopharynx. (From Nemec SF, Krestan CR, Noebauer-Huhmann IM, et al. Radiologische Normalanatomie des Larynx und Pharynx sowie bildgebende Techniken. *Der Radiologe*. 2009;49(1):8–16; Reprinted with kind permission from Springer Science+Business Media)

potential difficulties with airway access. The classification is based on the visibility of the soft palate, uvula, and tonsillar pillars when the patient opens their mouth and protrudes their tongue as much as possible, *without* phonation. It is divided into four classes:

1. **Class I**: The soft palate, uvula, and tonsillar pillars are fully visible.
2. **Class II**: The soft palate and most of the uvula are visible.
3. **Class III**: Only the base of the uvula is visible, and the soft palate is partially visible.
4. **Class IV**: Only the hard palate is visible.

2.4 Hypopharynx

The hypopharynx lies inferior to the oropharynx, located just above the esophagous and larynx. It is surrounded by three constrictor muscles and three inner longitudinal muscles that are responsible for swallowing. It plays a crucial role in swallowing and directing food and liquids into the esophagus while preventing them from entering the airway. The hypopharynx is further divided into three regions:

- **Piriform Sinuses:** These are the two recesses located on either side of the laryngeal opening.
- **Postcricoid Area:** This is the region behind the cricoid cartilage.
- **Posterior Pharyngeal Wall:** This is the back wall of the hypopharynx.

The piriform recess is where the tip of the laryngoscope blade rests during intubation [8].

The hypopharynx extends from the epiglottis to the level of cricoid cartilage and then continues posteriorly to turn into the esophagus.

2.5 Larynx

The larynx, commonly known as the voice box, is a complex structure located in the anterior aspect of the neck, connecting the pharynx to the trachea. It plays a crucial role in breathing, phonation, and protecting the lower respiratory tract from aspiration.

2.5.1 Laryngeal Anatomy

The larynx is situated in the anterior part of the neck, extending from the level of the third to the sixth cervical vertebrae (C3–C6). It lies just below the pharynx and above the trachea. The laryngeal apparatus is composed of mucosal folds, cartilages, muscles, and their respective neural innervations [6].

Structure

The larynx is composed of several key structures, including cartilages, muscles, membranes, and ligaments.

Mucosal Folds

The mucosal folds of the larynx include the aryepiglottic folds, the vestibular (false vocal) folds, and the true vocal folds.

1. **Aryepiglottic Folds**: Extend between the arytenoid cartilages and the lateral margins of the epiglottis, which in turn form the lateral borders of the laryngeal inlet. They are utilized in the closure mechanisms of the larynx.
2. **Vestibular (False Vocal) Folds**: Sit superior to the true vocal folds, these folds contain three distinct muscular systems. Below the vestibular folds are small cavities called ventricles that are bound inferiorly by the true vocal folds. The vestibular folds are involved in adduction and downward pressure, contributing in part to voice production.
3. **True Vocal Folds**: The unique viscoelastic properties of these layers facilitate sound production and are critical for maintaining vocal fold pliability.

The Cartilaginous Framework of the Larynx

The structural skeleton framework of the larynx is composed of many cartilages, along with their connecting membranes and ligaments. There are three unpaired cartilages, which include the thyroid, cricoid, and the epiglottis, while there are three paired cartilages comprised of the arytenoids, corniculates, and cuneiforms [9].

1. **Thyroid Cartilage**: Provides support for soft tissue structures. It is formed by two quadrilateral laminae that fuse anteriorly and inferiorly at an angle of 90° in men and 120° in women. This forms the laryngeal prominence and due to the sharper angle is more conspicuous in men and is commonly known as the Adam's apple. It articulates with the cricoid cartilage below on the medial surface at the level just above the hyoid bone via the thyrohyoid and cricothyroid ligaments.
   This thin membrane is near the surface of the skin, relatively avascular, and serves as the landmark for an emergent cricothyroidotomy. On the external lateral surfaces, there are ridges connecting the extrinsic laryngeal muscles: the sternothyroid, thyrohyoid, and inferior pharyngeal constrictor. The posterior margin of each thyroid lamina courses both upward and downward as superior and inferior cornua. The two superior horns suspend the larynx from the hyoid bone via lateral thyroid ligaments, and two inferior horns articulate with the cricoid cartilage.
2. **Cricoid Cartilage**: Situated below the thyroid cartilage, this cartilage forms the only complete cartilaginous ring around the airway, with a narrow anterior arch and a broader posterior lamina. It articulates with the thyroid cartilage above by the median cricothyroid ligament and is attached to the first tracheal ring by the cricotracheal ligament. It supports the arytenoid cartilages.
3. **Arytenoid Cartilages**: These are paired, pyramid-shaped hyaline cartilages. They are positioned so that they sit on the superior border of the cricoid cartilage. They play a crucial role in vocal cord movement and phonation.
4. **Epiglottic Cartilage**: This leaf-shaped elastic fibrocartilage is located at the entrance of the larynx just distal to the base of the tongue. It is lined with mucous membrane and is attached to the arytenoid cartilages by the aryepiglottic folds laterally on both sides. The anterior aspect forms the inlet of the larynx. It functions to cover the glottis during swallowing, preventing food from entering the airway.
5. **Corniculate Cartilages**: These small, conical cartilages sit atop the arytenoid cartilages and are involved in the movement and tension of the vocal cords.
6. **Cuneiform Cartilages**: These are small, rod-shaped cartilages located within the aryepiglottic folds, providing structural support to the laryngeal inlet and are paired with the corniculate cartilages.

2.5.2 Radiology of the Larynx

On axial views of computed tomography of the larynx, the epiglottis is seen at the level of the hyoid cartilage and separates the vallecula from the laryngeal vestibule (Figs. 2 and 3a–e). The valleculae are separated from one another by the glossoepiglottic ligament. Aryepiglottic folds appear at the anterolateral aspect of the larynx and are triangular in shape. They form a border between the laryngeal airway anteriorly and the piriform sinuses posteriorly (Fig. 3b). The supraglottic larynx consists of epiglottis, false/ventricular folds, aryepiglottic folds, and the arytenoids. Beneath this level is the glottis that consists of the true vocal folds, including the anterior commissure (Fig. 3c). The anterior commissure is the mucosa reflected from the anterior aspect of the true vocal folds, covering the posterior aspect of the thyroid cartilage in the glottis. Superiorly, the glottis is bound by the vocal cord epithelium, which turns upward to form the lateral wall of the vestibules. The distinguishing feature between true and false vocal cords is the presence of fat in the false vocal cords (Fig. 3d). True vocal folds appear thin and elliptical in shape and are bounded by the thyroid cartilage anteriorly and thyroarytenoid muscles laterally.

Beneath the glottis is the subglottic region. It is the narrowest part of the airway and is situated between the vocal folds and the upper trachea. The subglottic space is circular in shape and is bounded posteriorly by the cricoid cartilage (Fig. 3e).

As mentioned above, the cricoid cartilage is the landmark used in emergent cricothyroidotomy to rescue a difficult airway. Subglottic stenosis can occur secondary to this procedure or from a tracheostomy tube, which is performed too high (above the first tracheal ring) as the complete ring of the cricoid perpetuates mucosal edema and the cartilages are inadequately vascularized [10]. In cases of subglottic stenosis amenable to surgical repair, an anterior cricoid split is performed: a vertical anterior resection of the cricoid cartilage from the inferior aspect of the thyroid cartilage to the

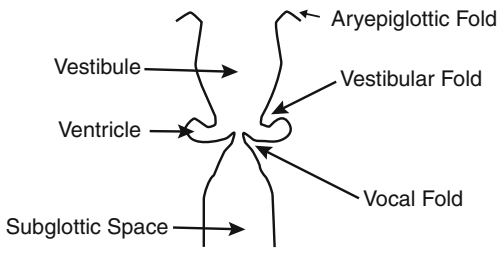

Fig. 2 Coronal view of the laryngeal apparatus

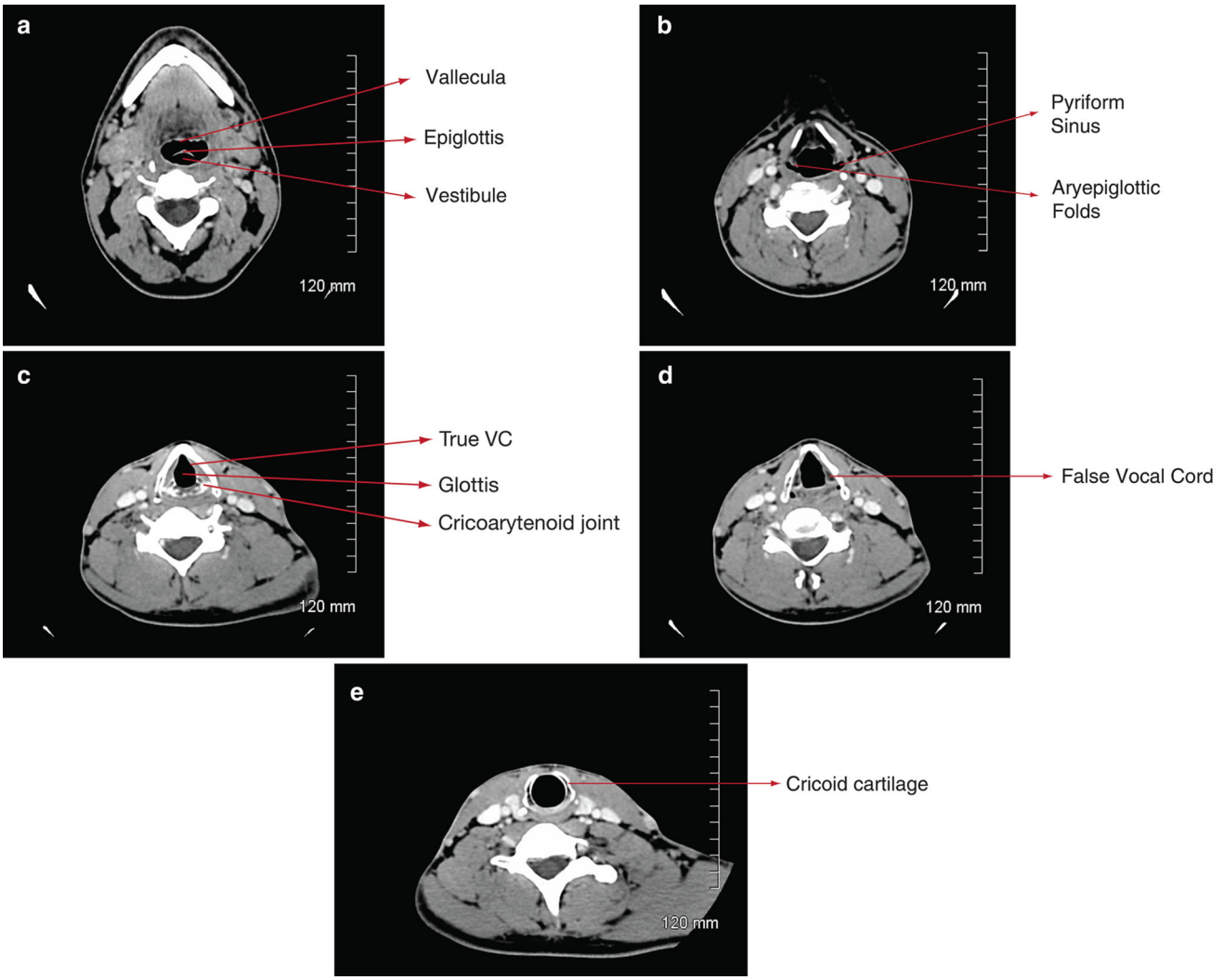

Fig. 3 Normal laryngeal anatomy CT images from superior to inferior margins. (**a**) Free edge of the epiglottis and vallecula (**b**) The aryepiglottic folds and puriform sinus (**c**) The glottis and true vocal cords. (**d**) False vocal cords (**e**) Subglottis and cricoid cartilage

distal aspect of the stenotic segment. The membranous portion of the cervical trachea is preserved and used as a flap for reconstruction of the posterior cricoid plates [11].

2.5.3 Muscles

The laryngeal muscles are categorized into extrinsic and intrinsic muscles. Working in pairs, the intrinsic muscles are primarily responsible for controlling the tension and position of the vocal cords while also controlling the degree of opening of the glottis. During expiration, speech, and deglutition, the adductor muscles reverse the process to close the glottis [12]. The tension of the vocal folds modulates airflow when they are adducted. The cricothyroid, vocalis, and thyroarytenoid muscles are responsible for tightening and relaxing the vocal folds for speech and phonation. These muscles are innervated by the recurrent laryngeal nerve, except the cricothyroid muscle, which is innervated by the external branch of the superior laryngeal nerve.

The extrinsic group consists of the suprahyoid and infrahyoid muscles and function to position the larynx within the neck and work to elevate or depress it during swallowing and phonation. They are further divided into elevators and depressors.

3 Lower Airway (3*)

3.1 Trachea

The adult trachea extends from the distal aspect of the cricoid cartilage, at the level of sixth cervical vertebrae, to the bifurcation at the main carina. The trachea is approximately 10–11 cm in length, with an internal diameter of 16–20 mm [13]. The sagittal diameter is slightly longer than the coronal aspects, with the adult trachea measuring approximately 16 and 14 mm, respectively. Sixteen to twenty U-shaped

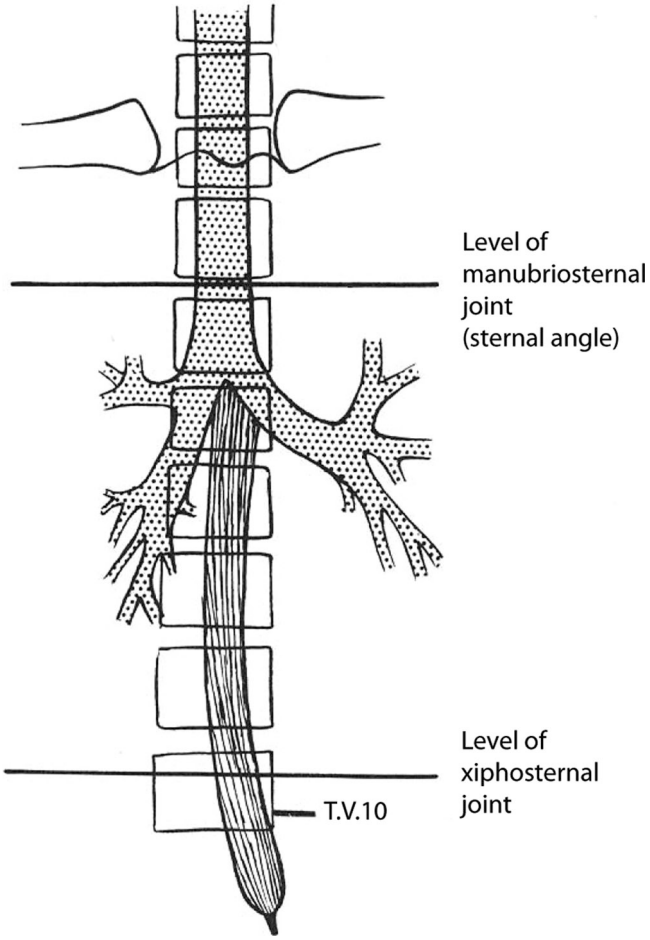

Fig. 4 The trachea and esophagus in relation to vertebral and sternal levels in a subject in the erect position. (Reprinted with permission from O'Rahilly R, Müller F, Carpenter S, Swenson R. Basic Human Anatomy: A regional study of human structure. Copyright © O'Rahilly 2008)

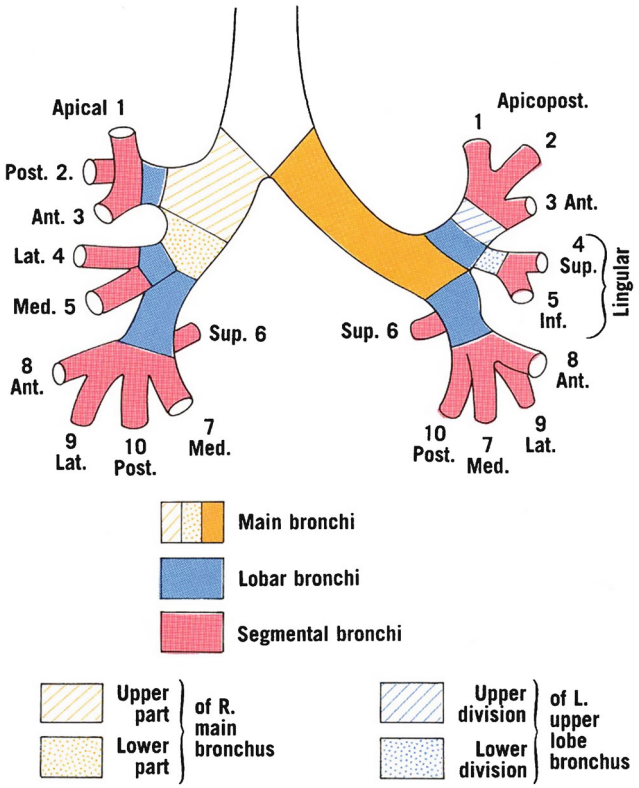

Fig. 5 Airway tree schematic. (Reprinted with permission from O'Rahilly R, Müller F, Carpenter S, Swenson R. Basic Human Anatomy: A regional study of human structure. Copyright © O'Rahilly 2008)

(or horseshoe) cartilages support the trachea (rings facing anteriorly) and allow for expansion during swallowing. The posterior part of the trachea consists of a smooth muscle (trachealis) that joins the ends of the tracheal cartilage.

The trachea bifurcates at the carina into the right and left main stem bronchus (Fig. 4). It tapers slightly as it terminates at the level of the fifth thoracic vertebrae, superior to the heart at the level of the sternal angle.

3.2 Tracheal Blood Supply

The blood supply of the trachea is derived from multiple sources, characterized by a complex network of arteries and anastomose [13]. Branches of the inferior thyroid artery provide blood supply to the upper trachea and bronchial arteries supply the lower trachea (Fig. 5). The bronchial arteries additionally supply blood to the esophagus via anastamosis with the inferior thyroid artery. The posterior membranous wall of the trachea, however, receives some contribution from the esophageal arteries and their subdivisions.

From the main carina onward, subsequent airway branches derive their blood supply from three bronchial arteries: two branches supplying the left lung and one branch supplying the right lung. The left bronchial artery originates from the descending aorta supplying the left lung. The right lung airways have various alternative supplies, including the aorta, first or third intercostal arteries, internal mammary artery, or the right subclavian artery.

The venous drainage of the airways contains a superficial and a deep system. The superficial system receives blood from the bronchial vein system of the hilum and the visceral pleura, which leads to the azygous vein of the right lung and accessory hemiazygous vein of the left lung. The deep venous system drains the deeper tributaries and then drains directly to the pulmonary vein or the left atrium.

3.3 Endoscopic View of Trachea

Starting at the upper trachea, mucosal integrity should be examined, even when there are no gross endobronchial lesions. The presence of extrinsic tracheal deviation and compression due to paratracheal masses should be noted.

Both the anterior cartilaginous and posterior membranous portion of the trachea are sometimes sites for dynamic airway compromise caused by tracheomalacia or excessive dynamic airway collapse. Occasionally, a nodular studding can be seen that localizes to the cartilaginous rings while sparing the membranous portion of the trachea. This benign condition, called tracheopathia osteochondroplastica, is usually asymptomatic and found incidentally, accounting for approximately two to seven per 1000 cases of bronchoscopies [14].

3.4 Main Carina

The main carina, derived from "keel of a boat," is observed as a sharp ridge separating the right and left mainstem bronchi. It is oriented anteroposteriorly, and its dimensions vary during inhalation and exhalation (Fig. 6a).

3.5 Classification of Bronchial and Segmental Airways

Bronchoscopists commonly refer to bronchial anatomy according to the Jackson-Huber classification of segmental airway anatomy (Table 1). This classification is named according to spatial orientation (i.e., anterior/posterior, superior/inferior, and medial/lateral) [15]. A less commonly adopted system is the Yamashita Japanese nomenclature [16], which assigns upper lobe anterior and posterior segments as listed in Table 1 and as shown in Fig. 5. Many

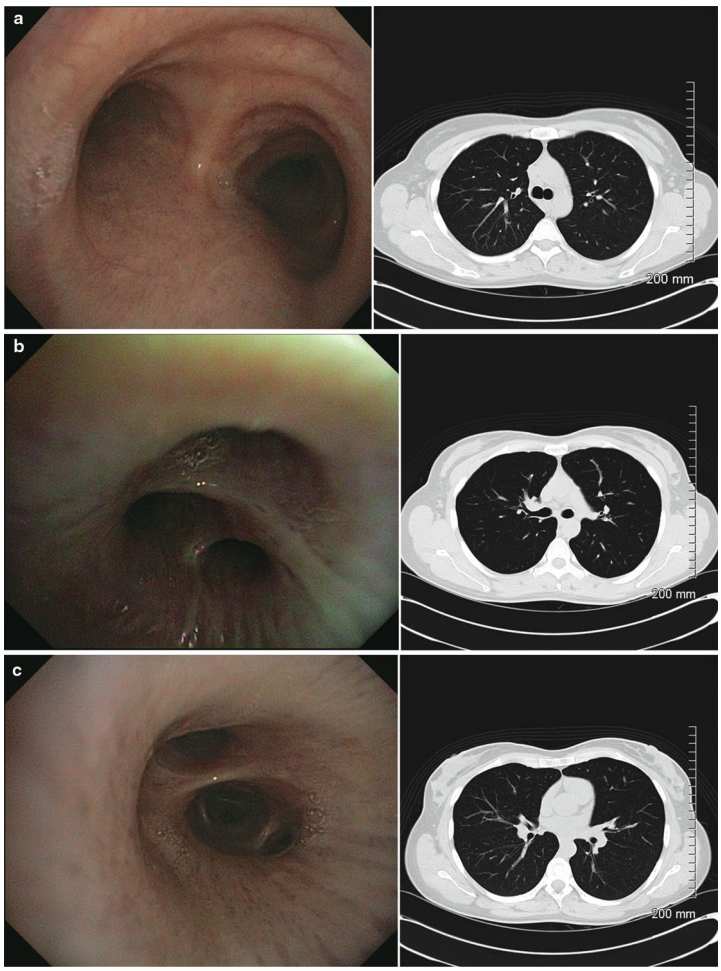

Fig. 6 (**a**) Carina with *right* and *left* main bronchi, (**b**) *right upper* lobe (B1: Apical, B2: Anterior, B3: Posterior), (**c**) *right middle* lobe and *right lower* lobe, (**d**) *left upper* lobe and *left lower* lobe division (B4: superior segment of LUL, B5: inferior segment of LUL, B6: superior segment of LLL, Apicoposterior segments not shown), (**e**) basilar segment of *left lower* lobe (B6: superior segment, B7,8: anteromedial segment, B9,10: lateral and posterior segment) (**d** and **e** Reprinted with permission from Kumaran R, Sung A, Ernst A. Airway anatomy for the bronchoscopist. In: Ernst AE, editor. *Introduction to bronchoscopy.* Cambridge, UK: Cambridge University Press; 2009)

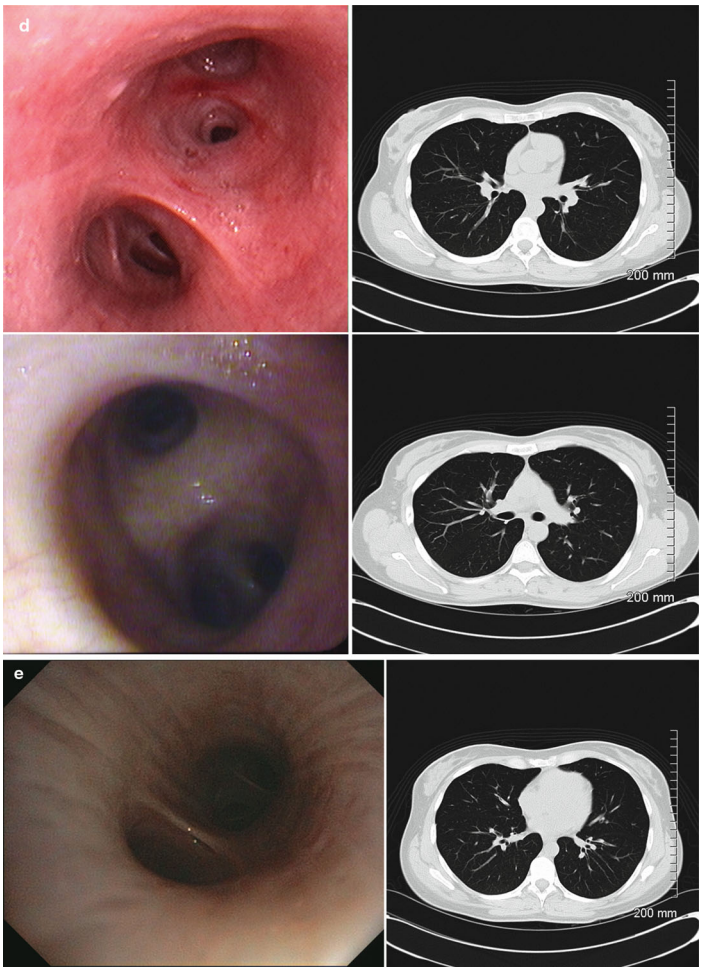

Fig. 6 (continued)

Table 1 Segmental airway nonmenclature/Jackson–Huber classification

Right bronchial tree		Left bronchial tree	
RUL		LUL	
B1	Apical	Upper division	
B2	Posterior	B1/2	Apicoposterior
B3	Anterior	B3	Anterior
RML		Lingular	
B4	Lateral	B4	Superior
B5	Medial	B5	Inferior
RLL	LLL		
B6	Superior	B6	Superior
B7	Medial basal	B7/8	Anteromedial
B8	Anterior basal	B9	Lateral basal
B9	Lateral basal	B10	Posterior basal
B10 posterior			

Source: Kumaran R, Sung A, Ernst A. Airway anatomy for the bronchoscopist. In: Ernst AE, editor. *Introduction to bronchoscopy*. Chapter 4, Table 4.1 Cambridge, UK: Cambridge University Press; 2009
Note: *RUL* right upper lobe, *LUL* left upper lobe, *RML* right middle lobe, *RLL* right lower lobe, *LLL* left lower lobe

thoracic surgeons and radiologists prefer to use the Boyden classification of bronchi, which also assigns numbers to the segmental airways [17]. The Boyden classification refers to anterior and posterior segment of the left upper lobe as B2 and B3. This nomenclature is infrequently used by bronchoscopists who instead refer to posterior as B2 and anterior as B3. The Jackson–Huber classification is the most widely used and less complex.

3.5.1 Right Bronchial Tree

The right main bronchus is defined as the airway starting from the bifurcation of the trachea to the origin of the right middle lobe bronchus and the superior segment of the right lower lobe [18]. The right main bronchus is shorter, wider, and more vertical compared to the left main bronchus. It descends at an approximate 25° angle from the trachea, making it more accessible and prone to foreign body aspiration. The total length of the right main bronchus is approximately 5 cm, which includes the upper (giving off the right upper lobe) and lower part (giving off the right middle and lower lobes).

Shortly after its origin, the right main bronchus gives rise to the right upper lobe. This branch is positioned anteriorly and somewhat superiorly. It courses laterally for a distance of 1–2 cm before branching into apical, anterior, and posterior segments. The apical segment, or RB1, courses superiorly and divides into the anterior and apical subsegments. The posterior segment, or RB2, courses superoposteriorly and divides into the anterior and lateral subsegments. The anterior segment of the right upper lobe, or RB3, divides into anterior and lateral subsegments. Variations in this branching pattern have been documented, including configurations where RB1 and RB2 share a common trunk or where RB2 and RB3 share a common trunk.

The branch point of the RUL bronchus can be identified as a faint curvilinear density marginating the lateral wall of the right main bronchus on chest CT. The horizontal course of the RUL bronchus with origins of anterior and posterior segments gives the inverted whale tail appearance (Fig. 6b). On CT imaging, at the level of distal trachea, the apical segment appears as a circular lucency in proximity to pulmonary vessels. Both anterior and posterior segments can be easily seen. Sometimes, a tracheal bronchus or an accessory bronchus is noted on CT scans arising immediately above the main carina and at the right lateral aspect. The tracheal bronchus is referred to as a bronchus suis if it supplies the entire upper lung lobe. The accessory bronchus can be a source of recurrent or nonresolving infiltrate on chest radiograph, particularly in a young adult. An additional variant is the accessory cardiac bronchus, a supernumerary bronchus that originates from the medial side of the right main bronchus or bronchus intermedius [19].

The main bronchus then continues as the bronchus (or truncus) intermedius for approximately 2.5 cm before dividing into the right middle and right lower lobes. The carina separating the right upper lobe orifice from the bronchus intermedius is right carina 1 or RC1. On chest CT, the bronchus intermedius is characteristically seen on several adjacent sections. It has an oblique shape and courses directly posterior to the right main pulmonary artery and the right interlobar pulmonary artery further inferiorly (at a lower level than the right main pulmonary artery).

The right middle lobe is the smallest lobe of the right lung. Its opening may have a “fish-mouth” appearance due to extrinsic compression by interlobar lymph nodes. The RML is bordered anteriorly by the pericardium and is separated from the RUL and RLL by the horizontal and oblique fissures, respectively. Right middle lobe syndrome is clinically seen as recurrent infectious episodes due to a postobstructive process from external compression of right middle lobe orifice.

The branches of the RML typically consist of two segmental bronchi: the lateral bronchus (RB4) and the medial bronchus (RB5). These divisions occur anterolateral-inferiorly (Fig. 6c) after 1–2 cm. The lateral segmental bronchus is visualized over a greater distance. The medial segment has a more oblique course and is less visualized. Less commonly, the medial and lateral segmental bronchi can present as a trifurcation.

Distal to the right middle lobe orifice arises the right lower lobe bronchus. The carina, which separates the right middle and right lower lobes, is right carina 2 or RC2. The right lower lobe bronchus is further divided into five segmental bronchi: superior segment, posterior, lateral, anterior, and medial subsegments. The superior segment (RB6) defines the posterior aspect of the termination of the bronchus intermedius. It arises at approximately the same level as the right middle lobe orifice and is seen on the same plane on CT scan as the bifurcating segment. The superior segment courses horizontally and toward the posterior aspect and divides into the medial, superior, and lateral subsegments (Fig. 6d). A common accessory bronchus is seen in the right lower lobe and is a subsuperior bronchus. It originates some distal to the origin of the superior segment (RB6) and ventilates the parenchyma of the bronchopulmonar segments B6 to B10.

The distal to proximal configuration of the remaining right lower lobe segments includes the medial (RB7), anterior (RB8), lateral (RB9), and the posterior (RB10) basal segments. The posterior segment courses inferiorly. The medial basal segment aims inferomedially, the lateral segment anterolaterally, and the anterior segment takes an anterolateral and inferior course.

3.5.2 Left Bronchial Tree

The left main bronchus is approximately 4–5 cm in length and extends inferolateraly, passing under the aortic arch and anterior to the esophagus and thoracic aorta [18]. The diameter of the left main bronchus is slightly narrower compared to the right main bronchus and takes on a more horizontal course, forming an angle approximately 45° relative to the plane of the trachea. It terminats at the level of the secondary carina at the level of the sixth thoracic vertebrae.

The left main bronchus then divides into the left upper lobe bronchus and the left lower lobe bronchus (Fig. 6e) The left upper lobe bronchus originates from the distal left main bronchus and further subdivides into the left upper lobe division bronchus and the lingular (or lower division) bronchus. The upper division bronchus is lateral to the lingular and divides into two segmental bronchi, which include the apicoposterior (LB1/2) and anterior (LB3) bronchi. Collectively, this forms the superior, or apical, lobe of the left lung. The anterior segment of the left upper lobe forms the upper lobe division of the left upper lobe, whereas the AP segments comprise the superior-posterior aspects (Fig. 6e). The anterior segmental bronchus is directed anteriorly and accompanied by the anterior segmental artery.

The lingula—derived from the Latin word for "little tongue" due to its tonguelike projection from the lung's surface—arises and extends 2–3 cm slightly downward in an inferolateral direction from the upper lobe division bronchus. The lingular bronchus is about 2–3 cm in length and divides into superior (LB4) and inferior segments (LB5). It is analogous to the middle lobe of the right lung. The subcarina separating the upper division of the left upper lobe and the lingula is left carina 1 or LC1. The subcarinal separating the left upper lobe from the left lower lobe is left carina 2 or LC2.

3.5.3 Left Lower Lobe

The superior segment (LB6) of the left lower lobe bronchus arises immediately on entering into the left lower lobe. A subsuperior segment may also be seen on the left, but this variant is less common than on the right. Beyond this, the left lower lobe bronchus is approximately 1 cm in length and divides into the superior segment and three basal segments: the anteromedial basal (LB7/8), lateral basal (LB9), and posterior basal (LB10).

3.5.4 Distal Airways

The bronchi are lined with smooth muscles and incomplete cartilage, with the mucosa lined with pseudostratified ciliated columnar cells with mucus-secreting glands. As the bronchi branch more distally and become devoid of cartilage, they become the bronchioles. The terminal bronchioles are located within the secondary lobules, or the Miller's unit, and are the basic functional units [20]. The respiratory bronchioles are divisions of the terminal bronchioles and are lined with alveolar ducts and sacs that are outpouchings and responsible for gas exchange.

4 Conclusion

Bronchosocopists should have a thorough fundamental knowledge of the upper airway and tracheobronchial tree. Accordingly, understanding upper and lower airway anatomy can be decisive in the application of airway pathology, navigation, and clinical decision making and ensure a shared language when communicating with other specialties involved in the care of patients with thoracic pathology.

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