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Original Research Article

Variation in Tracheobronchial Tree Branching Patterns in a Regional Population: A Cadaveric Study

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Abstract

The respiratory system is a fundamental requirement for living things to continue to exist. This system has changed over time and evolved into a branching network of bronchial trees in multicellular species like humans. The trachea, the left and right major bronchi, and their branches leading to the alveoli make form the bronchial tree. The trachea's size and the bronchial tree's branching pattern are determined through cadaveric dissection in this study. Thoracic surgeons and others can use this for a variety of surgical operations and interventions. 20 lung specimens from unclaimed bodies at Jawahar Lal Nehru Medical College & Hospital's anatomy department were used in the study. Numerous measurements are collected, including the width and length of the trachea, the subcarinal angle, and the length of the left and right major bronchus. Every dimension in the current investigation falls within the typical ranges. Four specimens out of the forty lungs displayed different branching patterns. These days, bronchoscopy techniques are frequently employed for both diagnostic and therapeutic objectives, and the results indicate that there are few variances in the dimensional study. Indirectly, the subcarinal angle aids in segment surgical excision and cardiovascular disease diagnostics.

Keywords: Trachea, Bronchial Tree, Subcarinal Angle, Branching Pattern.

Introduction

The fundamental component of all living things' life processes is the exchange of breathing gasses. This system's evolution from unicellular to mammalian airway transit has been significant. Diemerbroack discovered the bronchial tree pattern in the latter years [1,2]. The study of this bronchial tree and its dimensions is helpful in a number of ways, including identifying any abnormalities of the airways, such as bronchial obstructions, foreign bodies, or mediastinal masses; maintaining posture for patients with suppurative lung disorders; and assisting anesthetists in determining the quality of the trachea for bronchoscopy and intubation.

Thoracic surgeons need to understand bronchial architecture in order to perform a variety of surgical procedures. Procedures using bronchoscopy are frequently employed for both therapeutic and diagnostic reasons.

Studying this bronchial tree and its dimensions is beneficial in a number of ways, including, to the thoracic surgeons for their challenging maneuvers, to understand how diseases like bronchiectasis spread, to keep patients with suppurative lung diseases in proper posture, to be aware of foreign particle entrance, for anesthetists to be aware of the quality of trachea for procedures like bronchoscopy and intubation, for the surgical removal of lobes or segments in lung disorders and also indirectly, the subcarinal angle aids in the diagnosis of certain cardiovascular issues. Both invasive and non-invasive methods, such as computed tomography scans, magnetic resonance imaging scans, virtual bronchoscopies, and bronchograms, are used to analyse the bronchial tree. The current study 20 pairs of lungs are taken and then dissecting them till the terminal bronchi are reached, and calculating a number of factors.

Material and Methods

The department of anatomy at Jawahar Lal Nehru Medical College & Hospital in Bhagalpur, Bihar,

India, performed a gross anatomical dissection of embalmed cadavers. The study was conducted between April 1, 2024, and March 31, 2025. The current investigation makes use of forceps, a scalpel, rectangular trays, wooden blocks, a measuring tape, digital calipers, and a measuring scale. The Anatomy Department used embalming fluid to preserve the cadavers that were received. The cadaver is maintained in a supine posture on the dissection table following appropriate fixation.

Every cadaver's sex was recorded. Both sides of the sternum were sliced, and the bone cutter was used to cut the ribs and clavicles. They sever the sternopericardial ligaments. The pericardium is sliced and separated, and the sternum is dissected down to reveal the pulmonary arteries entering the lung. The trachea is detached from the esophagus posteriorly and severed at the lower end of the cricoid cartilage. After being extracted in bulk from the thoracic cavity, the lungs are extensively cleaned with water and left to soak in 10% HCL for a full day. Later, a knife and blunt forceps are used to scrape the parenchymatic tissue. The third generation of the bronchial tree was cleansed. Following its removal from the parenchyma, the bronchial tree was allowed to dry in the air for an hour before being placed on paper and having its outline sketched.

Later the measurements are taken as follows:

1. Tracheal length is the distance between the carina, where the trachea is bifurcated, and the lower end of the cricoid cartilage.
2. Tracheal diameter: The distance between the two outer borders is used to calculate the external diameter at the trachea's level of origin.
3. A protractor is used to measure the subcarinal angle between the major bronchi at the carina level.
4. A scale is used to measure the length of the main bronchi from the bronchus's origin to its division point.
5. Angles formed by the main bronchi are measured between the main bronchi's axis and the central axis that passes through the trachea.
6. Width of left main bronchus: The scale measures the maximal diameter at the origin.
7. The branching pattern's variants are noted.

The item is then stored in a plastic jar with 10% formalin for future research after all the measurements have been tallied.

Results

40 pairs of lungs are used for the bronchial tree study, and the following findings are noted. The average tracheal length was 7.79 cm, with a range of 5.9 to 9.5 cm. The average tracheal diameter was 2.01 cm, with a range of 1.3 to 2.6 cm. The average number of C-shaped hyaline tracheal rings is 19, with a range of 16 to 29.

The mean subcarinal angle between the two main bronchus was 75.69, with a range of 40 to 150. The length of the right main bronchus ranges from 1 to 2.6 cm, with an average of 2.31 cm. The average angle is 40.13, with a range of 30 to 60 (Table 1).

Main bronchus on the left Length ranged from 2.8 to 4.4 cm, with an average of 3.92 cm. The average angle is 44.2, with a range of 30 to 60. The average width was 0.86 cm, with a range of 0.59 to 1.5 cm. Three versions showed differences in the branching pattern. The middle lobar bronchus in the right lung started from the anteromedial surface of the main bronchus and travelled medially downward rather than laterally, while the upper lobar bronchus in two specimens took origin at the level of the carina. lung on the left The apical and anteroposterior segmental bronchus were separated from the upper lobar bronchus in one specimen.

Table 1: Dimensions of principal bronchi

Parameters	Trachea			Subcarinal angle	Right main bronchus		Left main bronchus		Left bronchus width / tracheal width
	Length (cms)	Width (cms)	Number of rings		Length (cms)	Angle	Length (cms)	Angle	
Range	5.9-9.5	1.3-2.6	16-29	40-150	1-2.6	30-60	2.8-4.4	30-60	0.59-1.5
Average	7.79	2.01	19	75.69	2.31	40.13	3.92	44.2	0.86

Discussion

According to a review of the literature, tracheal dimensions, chest X-rays, CT scans, and specimen dissection were used to assess the bronchial tree.

Establishing global anatomical standards for a range of characteristics is their goal. The current study measures and compares a number of parameters with the body of existing literature.

There aren't many variances in the length and diameter of the major bronchi, but they do occur very frequently. The goal of the current study was to determine an objective approach to measure minor airway constriction. Numerous writers have examined the lengths and diameters, which are of great endoscopic significance [3-8]. In his third edition of his textbook on diagnostic surgical pathology, Strenberg S. (1999) [9] said that the

tracheal length was 11 cm. 50 specimens were examined by Rosen FS (2003) [10], who discovered that the average length was 6.68 cm, with variations ranging from 4.2 to 9.9 cm. Leader JK (2004) [11] conducted a CT scan research on 24 males and 19 females, finding that the length of each was 7.86 cm +/- 1.68 cm.

The length in this study ranges from 5.9 to 9.5 cm, with an average of 7.79 cm. In his study of 808 patients' X-rays, Breatnach (1984) discovered that the diameters of the males and females were 2.5–2.7 cm and 2.1–2.3 cm, respectively. Strenberg S. (1999) [9] defined the tracheal diameter as 2-2.5 cm in his third edition of his textbook on diagnostic surgical pathology. According to the current study, the diameter ranged from 1.3 to 2.6 cm, with an average of 2.01 cm.

According to Michael G. (1992) [12], there are two rings for every 2 cm. According to Rosen FS's 2003 study of 50 cases, the average trachea includes 13.3 rings. There are a minimum of 19 rings, a maximum of 29, and an average of 16 rings in the current study. In 1956, Latarjet M. examined 129 CT scans and discovered that the angle was 71 and the range was 40–108.Coppole V (1998) looked at 500 patients' CT scans and discovered that the angle ranged from 37 to 105 degrees. The range of the current study is between 40 and 150, with an angle of 75.69.

According to Richard S. Snell's seventh edition of the Clinical Anatomy Textbook, the length is 2.5 cm. Current research indicates that the average length is 2.31 cm. Miller (1997) determined the angle to be 20 through gross dissection. Boyd E. (1958) determined the angle between 27 and 30 after studying 100 examples. The average angle in the current study is 44.2. According to Richard S. Snell's seventh edition of the Clinical Anatomy Textbook, the length is 4.5 cm. Current research indicates that the average length is 3.91 cm. Through thorough dissection, Miller (1997) determined the angle to be 40. Boyd E. (1958) determined the angle between 43.5 and 46 after analysing 100 examples. The average angle in the current investigation is 39.68. In a study of 31 patients' CT scans, Brodsky (2001) discovered that the ratio was 0.75 +/- 0.09 for men and 0.77 +/- 0.09 for women. The average for the current study is 0.82.

Conclusion

Cardiothoracic surgeons, ENT specialists, and anesthetists may find that having prior knowledge of potential anatomical variations lowers the chance of unintentional harm, enhancing the opportunity to educate radiologists about the significance of CT. X-rays, scans, and methodical endobronchial anatomy identification during bronchoscopy procedures. Forty pairs of lungs participated in the current investigation, which was observed. In the current investigation, the diameters and lengths are calculated linearly. In healthy individuals, the tracheal bifurcation angle varies greatly, and a precise measurement of the carina angle has limited diagnostic utility.

Article information

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