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Anatomy

A STUDY ON ANATOMICAL VARIATIONS IN HORIZONTAL FISSURES AND BRONCHOPULMONARY SEGMENTS AND IT'S CLINICAL SIGNIFICANCE.

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ABSTRACT **Introduction :** The present study aimed to investigate the anatomical variations of pulmonary fissures and the branching patterns of bronchi in lung specimens. **Materials and Methods:** Thirty formalin fixed cadavers, obtained during routine MBBS classes in Kurnool Medical College, Kurnool, A.P, were meticulously dissected to examine the pulmonary fissures and bronchial branching patterns. **Observation and Results:** Among the right-sided lungs, three out of the fifteen specimens showed incomplete horizontal fissure. Amongst the three specimens, one of them showed the principal bronchus directly dividing into segmental bronchi which was not reported in any literature. Both right and left-sided lungs had structurally normal oblique fissures. **Conclusion:** The findings from the present study has significant implications for clinical practice, particularly in the fields of thoracic surgery, radiology and pulmonology. The present study contributes to the knowledge of anatomy of lungs, also helpful in medical education which is very useful in improving patient care.

KEYWORDS : Right Lung; Variations; Incomplete Horizontal Fissure; Oblique Fissure; Bronchi.

INTRODUCTION

Lungs are a pair of respiratory organs on either side of the mediastinum, which are part of the respiratory system and essential for life. The right lung consists of three lobes: the superior, middle and inferior, separated by both an oblique and horizontal fissure. Brock said that oblique fissure begins in the fifth intercostal space, tends to follow, downward and forward, the line of sixth rib and ends close to costochondral junction of sixth rib.(Hollinshead W.H. ,1956) The longer oblique fissure segregates the inferior from the superior and middle lobe, while the shorter horizontal fissure separates the superior and middle lobe.The horizontal or secondary fissure of the right lung begins at oblique fissure in midaxillary line and run almost horizontally or upwards upto fourth rib costochondral junction which is rarely complete mostly at it's anterior end according to Deve (Hollinshead W.H. ,1956). The left lung features only two lobes the superior and inferior, which is divided solely by the oblique fissure (Standring, 2005).

All medical professionals should be aware of the variations in lung fissure morphology which may range from complete to incomplete to absent. These variations can significantly influence the spread of infections, malignancies, and radiological manifestations of pulmonary disorders.

The lung lobes function independently. They are aerated by lobar bronchi, which further branch into segmental or tertiary bronchi to aerate the bronchopulmonary segments (Standring, 2005). Understanding bronchial branching patterns is necessary as it aids in diagnosing respiratory diseases, interpreting imaging studies and planning interventions. Pulmonologists and cardiothoracic Surgeons rely on these information for safe lung procedures. The Knowledge acquired during these studies enhances medical education and further research in the present field.

The present study explores the variations in lung fissure morphology and branching pattern of the bronchi emphasizing the importance of this knowledge in clinical practice, medical education and research.

MATERIALAND METHODS

Thirty cadaveric lungs (fifteen right and fifteen left), irrespective of gender, fixed in formalin, were collected during undergraduate dissection classes in the Department of Anatomy, Kurnool Medical College, Kurnool from 2022 April to July 2023 . The present study is a descriptive study in which number, fissures, and lobes are looked upon carefully for any variations. Lungs with any pathological lesions or damage incurred during removal or preservation were excluded from the study. After careful observation and examination, any variations in fissures were documented, photographed and recorded.

According to Cunningham's Manual of Practical Anatomy the lungs were dissected from hilum to its periphery using the dissection instruments, forceps, scissors and the branching pattern of the bronchial tree was observed and recorded. Photographs were taken as required. Percentage was calculated after analyzing the data.

OBSERVATION AND RESULTS

Thirty lungs (both left and right irrespective of gender) were removed during routine dissection for undergraduate students, the pulmonary fissures and lobes were explored and required measurements were obtained. The specimens were numbered and photographed. The Oblique fissure was normal in both fifteen right and fifteen left lungs.

The anatomical classification by Craig and Walker (1997) (Table 1) was utilized to determine the completeness of fissures. This classification describes various grades of fissure development and fusion in the lung parenchyma. Out of the 15 right lungs, three Specimens (10%) showed Right lungs with incomplete horizontal fissure (Figure 3, 4, 5). It belonged to Craig and Walker classification grade3 (Table1) (Craig & Walker, 1997). In all the three right lung specimens, incomplete horizontal fissure, 6 cm long was found from the hilum of right lung (Figure.1, 2, 3). There was no absent fissures and lobes. No accessory lobes are present.

Therefore, the right lung specimens were found to possess a completely divided inferior lobe, with superior and middle lobes incompletely separated from each other. The remaining twelve right lungs had normal horizontal fissure.

Table 1. Craig And Walker Classification (Craig & Walker, 1997).

GRADING	DESCRIPTION	
GRADE I	COMPLETE	Complete fissure with entirely separated lobes
GRADE II	INCOMPLETE	Complete visceral cleft but parenchymal fusion at the base of fissure

GRADE III	INCOMPLETE	Visceral cleft evident for a part of fissure.
GRADE IV	ABSENT	Complete fusion of lobes with no evident fissural line.

Figure 1. Specimen One: Incomplete Horizontal Fissure In The Right Lung

This figure depicts the incomplete horizontal fissure observed in specimen one right lung.

Figure 2. Specimen Two: Incomplete Horizontal Fissure In The Right Lung.

This figure depicts the incomplete horizontal fissure observed in specimen two right lung.

Figure 3. Specimen Three: Incomplete Horizontal Fissure In The Right Lung

This figure depicts the incomplete horizontal fissure observed in specimen three right lung. Bronchopulmonary segments :

In the present study, in specimen one , the right principal bronchus directly divided into tertiary bronchi (Figure 4, 5). The other two right lungs with incomplete horizontal fissures had normal divisions. No abnormality were detected in the fifteen left lungs.

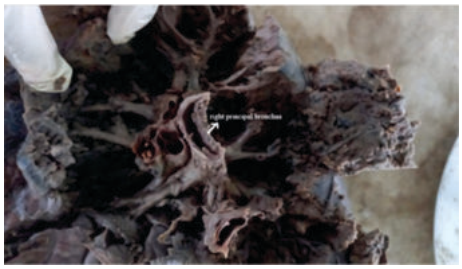

Figure 4. Specimen One Of Right Lung Showing Primary Bronchi Directly Dividing Into Segmental Bronchi.

This figure depicts a rare anatomical variation where the primary bronchi directly divide into segmental bronchi without forming any lobar bronchi.

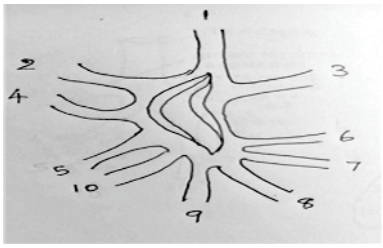

Figure 5: Primary Bronchi Directly Dividing Into Segmental Bronchi.

1 = apical; 2 = posterior; 3 = anterior; 4 = lateral—middle lobe; 5 = medial—middle lobe; 6 = apical (inferior lobe); 7 = anterior basal; 8 = lateral basal; 9 = medial basal; 10 = posterior basal.

DISCUSSION

The lungs are divided by the fissures into lobes. "The oblique fissure begins posteriorly at the level of fifth thoracic vertebra. It passes antero-inferiorly in a spiral course to meet the inferior margin of the lung, close to the sixth costochondral junction. It extends into the lung almost to the hilum. A second, horizontal fissure extends horizontally backwards from the anterior margin at the fourth right costal cartilage to meet the oblique fissure in the mid-axillary line" (Koshi, 2017).

"The embryologic development of lungs determines the pattern of its fissures. Lungs develops from numerous bronchopulmonary buds which fuses completely in the later part of its development except at the sites of formation of fissures, resulting in lobes and fissures"(Frijja et al, 1998).Deviation from the normal pathway of fusion of bronchopulmonary buds can lead to variations in lobes and fissures of the lungs (Saddler, 2004). The higher percentage of absence of horizontal fissures may be due to tendency to obliterate the fissure in the adult through adhesions (Hollinshead W.H. ,1956).

Hayashi et al (2001), had inferred that anatomy of normal variants of the major fissures is essential for recognizing their variable imaging appearances and related abnormalities. It may alter the usual patterns of collapse seen in endobronchial lesions and may also give rise to atypical type of pleural effusion (Meenakshi et al, 2004)

Table 2. Comparison Of Previous Studies With Present Study

Author (Year of publication)	Right Horizontal fissure		Right Oblique fissure		Left Oblique fissure	
	Incomplete	Absent	Incomplete	Absent	Incomplete	Absent
Medlar (1947)	17.1	45.20%	25.60%	4.80%	10.60%	7.30%
Lukose et al (1999)	21%	10.50%	0%	0%	21%	0%
Meenakshi et al (2004)	68.42%	17.39%	36.60%	0%	35%	0%
Prakash et al (2010)	50%	7.10%	39.30%	7.10%	35.70%	10.70%
Nene et al (2011)	8%	14%	6%	2%	12%	0%
Jacob and Pillay (2013)	83.40%	6.60%	5%	3.40%	38.90%	0%

Radha & Durai Pandian (2015)	40%	17%	5%	0%	7%	0%
Mamatha et al, 2016	50%	0%	15%	0%	35%	%
Halagatti et al (2020)	45%	80%	35%	0%	24.32%	0%
Present study	10%	0%	0%	0%	0%	0%

The presence of incomplete horizontal fissure in right lung was 10 % in the present study for the specimens taken (n=30), which was lower than the findings of Medlar (1947), lukose et al (1999), Meenakshi et al (2004), Prakash et al (2010), Nene et al (2011), Jacob and Pillay (2013), Radha & Durai Pandian (2015), Mamatha et al (2016) and Halagatti & Channabasanagouda, (2020).

Incidence of Absence of horizontal fissure described by Medlar(1947), Lukose et al(1999), Meenakshi et al (2004), Prakash et al (2010), Nene et al (2011), Jacob and Pillay (2013), Radha & DuraiPandian (2015) . Halagatti et al (2020) has reported the highest percentage of absent horizontal fissures of right lung in his study. No such anomaly was noted in the present study.

The present study did not show the presence of incomplete oblique fissure of right lung, though it was reported in other studies by Medlar (1947), Meenakshi et al (2004), Prakash et al (2010), Nene et al (2011), Jacob and Pillay (2013), Radha & Durai Pandian (2015), Mamatha et al (2016), Halagatti et al (2020).

Presence of incomplete oblique fissure of left lung was reported by Medlar (1947), lukose et al(1999), Meenakshi et al (2004), Prakash et al (2010), Nene et al (2011), Jacob and Pillay (2013), Radha & Durai Pandian (2015), Mamatha et al (2016), Halagatti et al (2020). Present study did not report any incomplete oblique fissure of left lung.

Incidence of Absence of oblique fissure in right lung was 4.8% by Medlar (1947), 7.1% by Prakash et al (2010), 2% by Nene et al (2011), 3.4% by Jacob & Pillay (2013). No such abnormality is noted in the present study.

The incidence of absence of oblique fissure in left lung is 7.3% by Medlar (1947), 10.7% by Prakash et al (2010). No similar abnormality is noted in the present study.

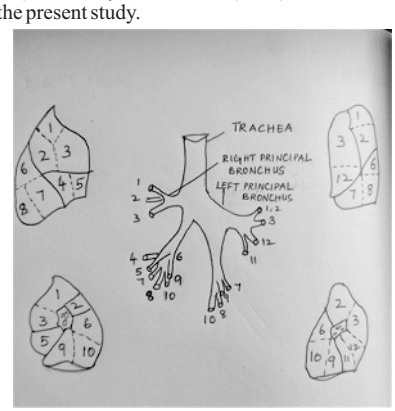

Figure 6. The Bronchi And Bronchopulmonary Segments.

1 = apical; 2 = posterior; 3 = anterior; 4 = lateral—middle lobe; 5 = medial—middle lobe; 6 = apical (inferior lobe); 7 = anterior basal; 8 = lateral basal; 9 = medial basal; 10 = posterior basal; 11 = inferior lingular; 12 = superior lingular; The anterior and medial basal bronchi arise from a common stem in the left lung. This is often called the anteromedial basal bronchus. (Koshi ,2017).

Each principal bronchus normally divides into secondary or lobar bronchi, the right principal bronchus divides into three lobar bronchi—the right superior lobar bronchus, the right middle lobar bronchus, and the right inferior lobar bronchus. The left principal bronchus gives rise to two lobar bronchi—the left superior lobar bronchus and the left inferior lobar bronchus Koshi (2017). The portion of the lung aerated by each tertiary or segmental bronchus is known as bronchopulmonary segment. (Figure.6). Each tertiary bronchus is accompanied by a corresponding branch of pulmonary artery and supplies corresponding bronchopulmonary segment. Each bronchopulmonary segment is separated from each other by intersegmental areolar septa which is occupied by intersegmental tributaries of pulmonary veins.

Standring (2005) and Moore (2018) have explained that the right principal bronchus gives rise to the superior lobar bronchus and continues as the intermediate stem bronchus. The lung consists of ten bronchopulmonary segments. Bailey and love commented on the developmental anomalies, such as the absence of a main bronchus leading to unilateral agenesis, and the failure of a lobar bronchus to develop resulting in lobar agenesis (Bailey and Love, 2004). Deve found a fissure usually incomplete in the plane between the superior and basal segments in 22% in his study (Hollinshead W.H. ,1956).

In the present study, it is observed that the right single principal bronchus is directly dividing into segmental bronchi which is not reported in any literature [fig.4]. No change in the pattern of bronchopulmonary segments and intersegmental areolar septa and pulmonary veins.

Pulmonary segments not entire lobes are localized for infection. Bronchiectasis has a segmental distribution – middle and basal-lower lobe in right lung , lingular and basal- lower lobe in left lung. Abscess, cytic disease and tuberculosis are segmental and mostly superior.

Segmental resection is needed and highly useful in all circumstances where only part of tissue of segments of lung are involved. For these purposes, the knowledge about the normal anatomy and variations of lung and bronchopulmonary segments of the lung are important.

The present study describes a higher incidence of incomplete horizontal fissure of right lungs, belonging to Craig and Walker classification of Grade 3.In specimen one of right lung, at hilum, only one primary bronchus is seen dividing directly into segmental or tertiary bronchi. This is not reported in any literature.

CONCLUSION

Morphological variations of lung fissures and branching pattern of the bronchi when understood in depth, makes interpretation of radiographs and CT scans accurate. Cardiothoracic Surgeons should be particularly vigilant about anatomical variations of lung fissures, especially during lobectomies and segmental resections, as there is a higher risk of complications in these procedures. Complete knowledge of fissures, lobes and branching pattern of bronchi and their varaiations are necessary for prior planning of the procedures .

The present study also contributes to medical education and research in the field of lung fissure variations and branching pattern of pulmonary bronchi.

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