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Case Report

Rare anatomical variations in lungs - A case report

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ABSTRACT

The lungs are a pair of respiratory organs situated in a thoracic cavity. Comprising bronchi, bronchioles, and alveoli, they maximize surface area for gas exchange. Their main function is to facilitate the gaseous exchange and to contribute in maintaining the blood's acid-base balance by regulating carbon dioxide levels. They play a pivotal role in immune defence by protecting against pathogens and foreign particles. Lungs are essential for sustaining life by supporting cellular metabolism and physiological homeostasis. Their intricate structure and function make them indispensable for respiratory and overall health. During the routine dissection at the National Institute of Ayurveda, Jaipur it was observed that the number of lobes and fissures in the lungs were different from the normal anatomy of the lungs. The subject was formalin fixed a 90-year-old male cadaver of North Indian origin. This study aims to summarise rare anatomical variations of the lungs according to lobes and fissures as in addition to having numerous other therapeutic implications, structural changes in the lungs are crucial during segmental or lobar resection of the lungs.

1. Introduction

Lungs are two paired spongy organs situated within the thorax and are essential for respiration. They are situated on either side of the heart, occupying most of the thoracic cavity, and they are divided by fissures into lobes. The right lung has three lobes: the right superior lobe (RSL), right middle lobe (RML), right inferior lobe (RIL). The RSL and RML are separated by a horizontal fissure (HF), which runs from the midaxillary line at the 5th rib to the sternum at the 4th rib. And the right inferior lobe (RIL) is separated from the right middle lobe (RML) by the oblique fissure (OF).[1] Even though it can be compared to the right lung, the left lung has distinctive characteristics all around. The left lung is smaller than the right lung. It has two lobes: the left superior lobe (LSL) which is separated from the left inferior lobe (LIL) by an oblique fissure from 4^{th} thoracic spine obliquely ending at 6^{th} costal cartilage (going from the 5th rib in the midaxillary line to the 6th rib at the midclavicular line). The OF is less vertical on the right lung than the left lung and cuts into the whole thickness of the lung, except at the hilum. The LSL features a tiny tongue-like structure termed the lingula on the anterior surface of the inferior border. During respiration, lung fissures allow for greater distension of each lung with the movement of the lobes concerning one another. A more uniform expansion of the entire lung is then achieved for more air intake. Since fissures delineate the borders between the lung lobes, understanding how they are positioned is crucial. There are many studies focusing on the variations present in number of fissures and lobes of the lungs. In addition, certain lungs might possess an additional fissure. This can be recognised by a visceral pleura-lined fissure that varies in depth, signifying the confluence of bronchopulmonary

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segments.[2]

The anatomical classification proposed by Craig and Walkers[3] based on both the degree of completeness of the fissures and the location of the pulmonary artery at the base of the oblique fissure was followed to determine the presence of completeness of fissures.

1. Grade I: Complete fissure with entirely separated lobes.
2. Grade II: Complete visceral cleft but parenchymal fusion at the base of fissure.
3. Grade III: Visceral cleft evident for a part of fissure.
4. Grade IV: Complete fusion of lobes with no evident fissure line.

Any deviation from the normal embryological process occurring around 28 days post-fertilization will result in variation in the morphology of the lobes and fissures of the lungs.[4] This is the key to appreciate the lobar anatomy and locating the bronchopulmonary segments which is significant both anatomically and clinically.

2. Case Report

The dissection was done in the department of Sharir Rachana, National Institute of Ayurveda, Jaipur. These variations were found while dissecting an approximately 96-year-old formalin fixed male cadaver of North Indian origin. The formalin fixed cadaveric lungs were observed for this study. Accessory lobes and fissures were noted in the subject during routine dissection.

3. Materials and Methods

A routine dissection was performed on the cadaver and observed that an accessory lobe (lingula lobe) was present on the left lung with the presence of minor fissure between lingual lobe (LL) and left superior lobe (LSL). In the base of left lung an accessory fissure also present. In right lung HF was absent only a notch was found on anterior surface of right superior lobe (RSL). The lungs were observed and analysed to record the anatomical morphology in terms of the presence or absence of the main fissures and lobe, variations in main fissures (incomplete or complete), and accessory fissures and lobe.

3.1. Variations present in the left lung

1. A. During dissection of this cadaver we observed a minor fissure present in inferior border of LSL that separate lingula of the left lung from LSL. The dimensions of minor fissure are 1inch in depth & 2.4 inch in length that form a separate accessory lobe or lingula lobe.[5] The LL is 4inch in length & 1.8 inch in width. It completely separate from LSL. As shown in Figures 1 and 2.
2. An accessory Grade III incomplete fissure was present in the base of left lung. The depth of fissure is 0.2 inch with 4inch in length. This fissure runs backwards, laterally in the base from pulmonary ligament to the point where inferior border meets posterior border of the left lung. As shown in (Figure 3A,B).

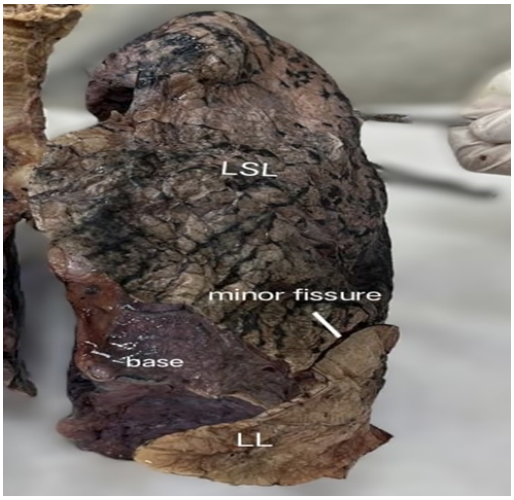

Figure 1: (Anterior view) Left lung showing left superior lobe (LSL), lingula lobe (LL), Minor fissure separating LSL and LL

Figure 2: (Medial view) Left lung with lingula lobe (LL), oblique fissure (OF) and minor fissure, Pulmonary ligament (PL), starting point of accessory fissure in the base

3.2. Variations presents in the right lung

A. During routine dissection of the subject a minor Grade III fissure[6] was observed in the RSL. The depth of minor fissure was 1inches in length & depth is 0.5inch. (Figure 4)

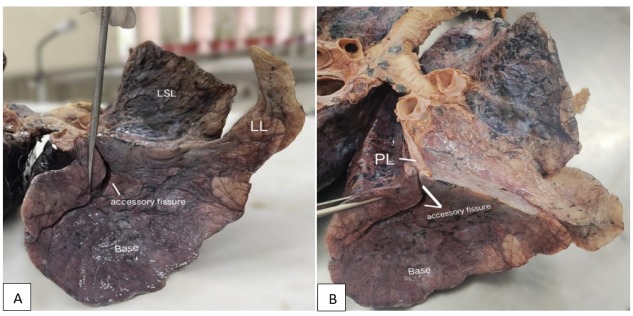

Figure 3: (A) & (B) Showing the base of left lung with accessory minor fissure begins from the end of pulmonary ligament and it ends where inferior border meets the posterior border

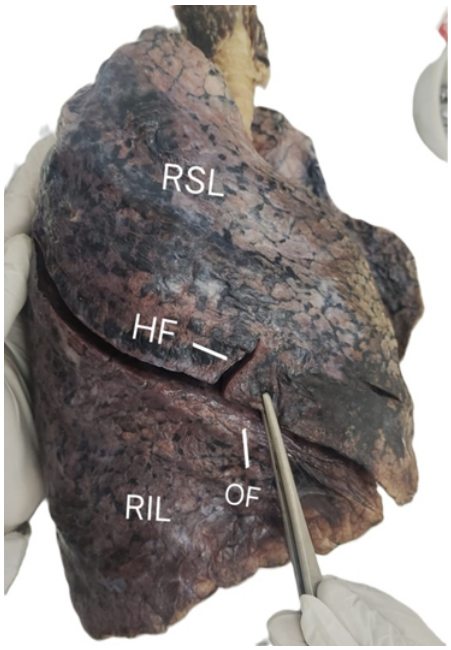

Figure 4: Right lung showing complete oblique fissure (OF), Incomplete horizontal fissure (HF)

4. Result

Table 1: This study shows that left lung have

1.	Lobes	3	Left superior lobe (LSL) Lingula lobe (LL) Left inferior lobe (LIL)
2.	Fissure	3	Main fissure – Oblique fissure (OF) Accessory fissure – Minor fissure in LSL - Minor fissure in Base

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Table 2: The right lung have

1.	Lobes	2	Right superior lobe (RSL) Right inferior lobe (RIL)
2.	Fissure	2	Main fissure – Oblique fissure (OF) Accessory fissure – Minor Horizontal fissure

4.1. Clinical significance

A comprehensive grasp of normal anatomy is a crucial cornerstone of surgical expertise. While research has delved into the fissures and lobar configuration of the lungs in select populations, the intricate hilar anatomy has often been neglected.[7] Anomalies in anatomy could result in misinterpretations of radiographs or computed tomography (CT) scans. Knowledge of these variants is important for radiologists, surgeons, and other healthcare professionals to avoid misinterpretation of imaging studies and during surgical procedures.[8] As in the case of extra lobes, certain radiological findings can mislead the diagnosis because they mistakenly appear to be lung lesions. In the presence of extra lobes, the CT scan shows a significant increase in the size of mediastinum around the trachea.[9] Patients with endobronchial lesions may experience an altered pattern of lung collapse due to the accessory fissure, which might complicate the diagnosis of the degree of the lesion. Normally pneumonia will be restricted to the lobes affected by it, but in patients with incomplete fissures, it may spread to adjacent lobes through the parenchymal continuation.[10,11] Extra lobes or fissures can alter the distribution of breath sounds during respiratory auscultation, potentially leading to diagnostic confusion or misinterpretation Extra fissures or incomplete fissures can predispose individuals to certain complications such as air leaks or pneumothorax (collapsed lung) during surgical interventions or invasive procedures. During surgical procedures involving the lungs, such as lobectomies or segmentectomies, the presence of extra lobes or fissures can pose challenges.

5. Discussion and Conclusion

The high prevalence of morphological variations in lung anatomy underscores the urgent need for a comprehensive understanding of lung fissures. A deeper understanding of lung fissures and lobe variations holds significant clinical relevance for anatomy students, cardiothoracic surgeons, and radiologists. Surgeons rely on knowledge of lung fissures to identify variations during procedures like lobectomies and segmental resections, while both radiological and surgical specialists must be vigilant about potential complications during such interventions.

Cadavers offer the most effective means to study the variant anatomy of organs, including the lungs. Researchers have extensively documented anomalous lung

anatomy in human cadavers. During lung development, bronchopulmonary buds form and subsequently fuse, except at sites where fissures develop. Incomplete fissure formation may result from partial obliteration of these fissures, while accessory fissures may arise from non-fusion of spaces between bronchopulmonary buds. Variations in the fusion process during development can lead to differences in the formation of lung lobes and fissures.[12]

Understanding the development of minor lung segments and pulmonary veins is also clinically relevant. Knowledge of lung fissures and lobes is vital for planning surgical procedures to mitigate post-operative complications like air leakage. Additionally, it aids in interpreting various radiological images depicting the lobar anatomy of the lungs and the positioning of interlobar fluid. Prior anatomical knowledge and awareness of potential variations are crucial for clinicians, surgeons, and radiologists to ensure optimal patient care.

6. Abbreviations

LIL: Left inferior lobe, AL: Accessory lobe, LL: Lingula lobe, HF: Horizontal fissure, AF: Accessory fissure, OF: Oblique fissure LSL: Lleft superior lobe, RIL: Right inferior lobe, RSL: Right superior lobe, RML: Right middle lobe, PL: Pulmonary ligament.

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8. Conflict of Interest

None.

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