

# Morphological Variations in Fissures and Lobar Pattern in Human Lungs.

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## ABSTRACT

**Background:** Our study aims to study the variations in lobar pattern and fissures of both right and left human lungs. **Methods:** 41 formalin fixed cadaveric lungs were obtained from the Department of Anatomy, SRMS IMS. The lungs were studied to observe the variations of fissures and lobes. Abnormal or accessory lobes were also noted. **Results:** 18 right lung and 23 left lung specimens were obtained and studied. Among the right lungs studied one showed an incomplete oblique fissure, six showed incomplete horizontal fissures. The horizontal fissure was absent in three right lungs. In the left lung only one lung showed the presence of an incomplete oblique fissure. **Conclusion:** The lung is a vital organ for life. Hence, considering the clinical importance of such anomalies, we as anatomists suggest that awareness and knowledge of the variations in the lobes and fissures of the lungs may be important for surgeons planning lobectomies and surgical resections involving individual segments and for radiologists to accurately interpret radiological images. This knowledge has further become more significant with the increasing incidence of lung carcinomas.

**Keywords:** Endoderm, Germ layers, Horizontal fissure, Oblique fissure.

## INTRODUCTION

Lungs are essential organs of respiration, located in the thoracic cavity, on either side of the heart. Their principal function is to transport oxygen from the atmosphere into the bloodstream and to release carbon dioxide from the bloodstream into the atmosphere. The endothelium of pulmonary capillaries, in addition to respiratory exchange, helps clearing the thrombi or emboli in circulating blood, liberates thromboplastin, helps conversion of angiotensin I to angiotensin II and modifies the hormones and Prohormones.

The lungs are located in the thoracic cavity on either side of the heart. The right and left lungs are similar but not identical. Classically the right lung is divided into three lobes, i.e. upper, middle and lower by an oblique and a horizontal fissure whereas the left lung is divided into upper and lower lobes by an oblique fissure.

In the right lung, oblique fissure separates the inferior from the middle and upper lobes, and corresponds closely to the left oblique fissure. It is less vertical than the left and crosses the inferior border of the lung approximately 7.5 cm from its anterior end. On the posterior border, it is either level with the spine of the fourth thoracic vertebra or slightly lower.

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A short horizontal fissure separates the superior and middle lobes. It passes from the oblique fissure, near the mid axillary line, horizontally forwards to the anterior border of the lung, level with the sternal end of the fourth costal cartilage and then passes backwards to the hilum onto the mediastinal surface.<sup>[1]</sup>

These fissures provide slippery surfaces between the lobes as a result of inward extension of the visceral pleura, which lines the depth of the fissures. This promotes easier and uniform expansion of the whole lung.

Apart from normal anatomy, variations in the fissures and lobes are clinically important to identify bronchopulmonary segments for lobectomies and surgical resections of involved segments, interpreting X-rays and CT scans and for academic interest to all medical personnel.<sup>[2]</sup> Hence this study was carried out to gain further knowledge of the fissures and lobes and variations in their patterns in human lungs.

## AIM

Variations in the lobar pattern and fissures of the lung have been frequently described on imaging techniques, whereas fewer studies have been done on cadaveric lungs. The present study was performed to examine lung specimens with respect to the morphology of fissures and lobes, to note the variations, to compare them with previous studies and to correlate with their clinical implications.

**MATERIALS AND METHODS**

Study material comprised of 18 right and 23 left lungs, obtained from the museum and dissection classes of undergraduate medical students in the Department of Anatomy SRMS IMS, Bareilly. These lungs were observed and photographed for the following:

- morphology of lobes and fissures
- presence of any abnormal or incomplete fissure
- presence of any accessory lobe.

The anatomical classification proposed by Craig and Walker (1997)<sup>3</sup> was followed to determine the presence and completeness of fissures.

**RESULTS**

On the right side, the classical complete oblique fissure, grade I, was seen in 16 lungs (88.88%). In 2 lungs (11.11%) an incomplete oblique fissure was detected which was classified as grade III based on Craig and Walker’s classification [Table 2]. A classical complete horizontal fissure, grade I, was observed in 9 lungs (50%). 5 lung specimens (33.33%) showed the presence of an incomplete horizontal fissure of grade III. In 4 specimens (16.66%) the horizontal fissure was completely absent and was hence classified as grade IV [Table 2].

From a total of 23 left lungs, 22 lungs (95.65%) were seen to have a complete classical oblique fissure and hence classified as grade I. In 1 specimen, an incomplete oblique fissure was observed and was classified as grade III.

**Table 1:** Relationship between oblique and horizontal fissures of right lung.

Complete oblique fissure with complete horizontal fissure	8/18 (44.44%)
Complete oblique fissure with incomplete horizontal fissure	6/18 (33.33%)
Complete oblique fissure with absent horizontal fissure	2/18 (11.11%)
Incomplete oblique fissure absent horizontal fissure	2/18 (11.11%)

**Table 2:** Incidence of fissures according to grading.

Lung	Grade I	Grade II	Grade III	Grade IV
Right (n=18)				
-Oblique fissure	16	None	2	None
-Horizontal fissure	9	None	5	4
Left (n=23)	22	None	1	None

A correlation between oblique and horizontal fissures of the right lung was observed [Table 1]. A classical, complete oblique fissure with complete horizontal fissure was seen in 8 (44.44%) lungs [Figure 1]. A complete oblique fissure with incomplete horizontal fissure was seen in 6 (33.33%) lungs [Figure 2] and in 2 (11.11%) lungs the oblique fissure was complete, but the horizontal fissure was entirely absent [Figure 3]. In 2 (11.11%) lungs the oblique fissure was incomplete and the horizontal fissure was absent [Figure 4].



**Figure 1:** Complete oblique fissure with complete horizontal fissure.



**Figure 2:** Complete oblique fissure with incomplete horizontal fissure.



**Figure 3:** Complete oblique fissure with absent horizontal fissure.



**Figure 4:** Incomplete oblique fissure with absent horizontal fissure.

## DISCUSSION

Developmentally the lungs are derived from endodermal and mesodermal germ layers. The endoderm of the lung bud gives rise to the mucosal lining of the bronchi and to the epithelial cells of the alveoli.

The vasculature of the lung, muscles and cartilage supporting the bronchi are derived from the foregut splanchnopleuric mesoderm, which covers the bronchi as they grow out of the mediastinum into the pleural space.<sup>[4]</sup>

When the developing fetus is 4 weeks old, a respiratory diverticulum (lung bud) appears as an outgrowth from the ventral wall of the foregut. During its separation from the foregut the lung bud forms the trachea and two lateral out-pocketings, the bronchial buds. At the beginning of the fifth week, each of these buds enlarges to form right and left main bronchi. The right and left bronchi further divide into three and two secondary bronchi respectively, thus foreshadowing the three lobes of the lung on the right side and two on the left.<sup>[5]</sup>

As the lung grows, the spaces and fissures that separate individual bronchopulmonary segments become obliterated except along planes, which persist as oblique and horizontal fissures.<sup>[4]</sup>

When these fissures undergo partial or complete obliteration, it results in an incomplete fissure or absence of fissure. Accessory fissure could be the result of non-obliteration of spaces which are normally obliterated.<sup>[6]</sup>

Thus, defective pulmonary development gives rise to variations in lobes and fissures.

Several authors have reported the anomalous fissures and lobes. Craig and Walker (1997), proposed a classification of these fissures based on their degree of completeness.<sup>[3]</sup>

The four grades described are as follows:

Grade I--Complete fissure with entirely separate lobes

Grade II--Complete visceral cleft but parenchymal fusion at the base of the fissure

Grade III--Visceral cleft evident for part of the fissure

Grade IV--Complete fusion of the lobes, with no evident fissural line.

According to the data obtained in our study 16 right oblique fissures, 9 right horizontal fissures and 22 left oblique fissures were classified as grade I.

Variations observed in 2 right oblique and 5 right horizontal fissures can be classified as a grade III.

The oblique fissure in 1 left lung was classified as grade III.

Complete fusion of the lobes without any evidence of a horizontal fissure was seen in 4 right lungs and considered as grade IV [Table 2].

[Table 4] shows a comparison of data obtained from studies conducted by previous authors and the present study of the variations in pulmonary fissures.

Right oblique fissure was found to be incomplete in 2 (11.11%) lungs in the present study [Table 3]. Previous workers like Medlar et al<sup>[8]</sup> studied 1200 pairs, Meenakshi et al<sup>[6]</sup> studied 30, Bhima Devi et al<sup>[7]</sup> studied 22 and Singh et al<sup>[2]</sup> studied 30 cadaveric lungs respectively. They found the incidence of incomplete right oblique fissure to range from 25.6-30%, 36.6%, 9%, and 6.67% respectively.

Absence of the right oblique fissure on the other hand was a rare finding and was reported in about 58 (4.8%) cases by Medlar et al.<sup>[8]</sup>

Right horizontal fissure was incomplete in 5 (27.7%) cases in the present study [Table 3]. In the studies by above mentioned workers 205 (17.1%), 19 (63.3%), 4 (18%) and 8 (26.67%) cases presented with an absent right horizontal fissure. Absence of the right horizontal fissure was seen in 4 (22.22%) right lungs in the present study (Table 3). This finding can be compared with the findings of previous workers who have reported an absent right horizontal fissure in 542 (45.2%), 5 (16.6%) and 2 (9%) cases respectively.

Left oblique fissure was incomplete in 1 (4.34%) specimen in the present study [Table 3] and in 127 (10.6%), 14 (46.6%), 8 (36.3%) and 9 (30%) specimens in studies done by previous workers. Absence of the left oblique fissure is a rare finding as it was only reported by Medlar et al<sup>[8]</sup> and Bhima Devi et al<sup>[7]</sup> in 88 (7.3%) and 2 (9%) cases respectively.

Knowledge of anatomical variations alerts the surgeons during surgical intervention. An incomplete fissure is also a cause of postoperative air leakage.<sup>[3]</sup> Radiologists must be aware of the depth and occurrence of these variations in order to prevent and avoid misinterpretation of radiological images. On skiagrams an atypical fissure may be

**Table 3:** Findings of present study.

		Right lung (n=18)	Left lung (n=23)
Oblique fissure	Normal	16 (88.88%)	22(95.65%)
	Incomplete	2 (11.11%)	1(4.34%)
	Absent	-	-
Horizontal fissure	Normal	9 (56.25%)	
	Incomplete	5 (27.7%)	
	Absent	4(22.22%)	

**Table 4:** Comparison with other studies.

		Present study- 2014 (n=24)	Singh et al (2013) (n=30)	N Bhimai Devi et al. (2011) (n=22)	Meenakshi et al (2004) (n=30)	Medlar et al (1947) (n=1200)
Right oblique fissure	Incomplete	2 (11.11%)	6.67%	9%	36.6%	25.6-30%
	Absent	0%	0%	0%	0%	4.8%
Right horizontal fissure	Incomplete	5 (27.7%)	26.67%	18%	63.3%	17.1%
	Absent	4 (22.22%)	0%	9%	16.6%	45.2%
Left oblique fissure	Incomplete	1 (4.34%)	30%	36.3%	46.6%	10.6%
	Absent	0%	0%	9%	0%	7.3%

mistaken for pleural effusion. Knowledge of such variations and their incidences will also help avoid misinterpretations of bronchograms.

### CONCLUSION

Clinicians must be aware of the frequency of variations in the pattern of the lobes and fissures of the lungs in order to avoid and reduce the mortality and morbidity associated with invasive procedures. Radiological diagnosis of diseases like lobar pneumonia and tumours should be based on the knowledge of variations of fissures of lung.

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