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Original Research Article

# A STUDY OF MORPHOLOGICAL VARIATIONS OF FISSURES AND LOBES IN HUMAN CADAVERIC LUNGS CORRELATING WITH SURGICAL IMPLICATIONS IN THE TELANGANA ZONE

**Gayathri. P [*1], S.Saritha [2], T.V.Ramani [3], D. Nagajyothi [1], N.Himabindu [3], Asra Anjum[3].**

[*1] Assistant professor, Kamineni Academy of Medical Sciences and Research Centre (KAMSRC), Hyderabad, Telangana, India.

[2] Professor& HOD, Kamineni Academy of Medical Sciences and Research Centre (KAMSRC), Hyderabad, Telangana, India.

[3] Lecturers, Department of Anatomy, Kamineni Academy of Medical Sciences and Research Centre (KAMSRC), Hyderabad, Telangana, India.

## ABSTRACT

**Introduction:** The lungs are paired essential organs of respiration in humans and are situated in the thoracic cavity. The lungs are separated by fissures into 3 lobes on the right side and two lobes on left side, which facilitate the movements in relation to one another. An accurate interpretation of anatomical variations of fissures and lobes are utmost importance for cardiothoracic surgeons, radiologists and physicians.

**Materials and Methods:** 50 formalin fixed lungs removed from the cadaver from the department of anatomy, KAMSRC and other medical colleges in Telangana zone, were utilised for the study of pattern of lobation and fissures. Formal permission from concerned authority and institutional ethical committee was taken.

**Results:** In total 25 right lungs, 8 specimens showed variations in the fissures and lobes. 17 specimens showed the normal pattern of the lobes. In total 25 left lungs, 3 specimens showed variation in fissure and lobes and remaining 22 had a normal pattern.

**Conclusion**: A proper knowledge of variations of lobes and fissures in particular are helpful for cardiothoracic surgeons in diagnosis and resection of segments and radiologists for accurate radiological interpretation.

**KEY WORDS**: Lung, Oblique fissure, Horizontal fissure, Accessory fissure and Lobes.

**Address for Correspondence:** Dr. Gayathri. P, Kamineni Academy of Medical Sciences and Research Centre (KAMSRC), Nalgonda Road, Near Andhra Bank, Suryodaya Colony, LB Nagar, Hyderabad, Telangana 500068, India. **E-Mail:** dr.gayatri.p@gmail.com.

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## INTRODUCTION

A pair of lungs present in the thoracic cavity. The right lung is broader and heavier and the left lung is longer and lighter. The right lung is divided into three lobes superior, middle and inferior by oblique and horizontal fissures. The oblique fissure separates the inferior from the middle lobe and short horizontal fissure separates the superior and middle lobes of the right lung respectively. The oblique fissure begins on the medial surface postero-superior to the hilum runs upwards reaches the costal surface,

then runs obliquely and crosses the inferior border of the lung about 7.5cm behind its anterior end. The horizontal fissure begins at the costal surface from the oblique fissure and cuts the anterior border at the 4th costal cartilage. The left lung is divided into superior and inferior lobes by oblique fissure. It begins on the medial surface postero-superior to the hilum runs obliquely upwards cuts the posterior border then runs across the costal surface and reaches the inferior border [1,2].

These fissures are double fold of pleurae that sections the lung and help in expansion of the lung in relation to one another especially in the distension and movement of lower lobes during respiration [3,4].

The left oblique fissure is more or less vertical approximately indicated by the vertebral border of scapula in fully abducted arm [5].

The positions of fissures can be used as reliable land marks in specifying the lesions within the lung in general [6].

These inter-lobar fissures may be complete, incomplete or absent. In case of complete fissures the lung lobes are held together at the hilum by the bronchi and the pulmonary vessels. But in cases of incomplete inter-lobar fissures or absent fissures the lobe parenchyma are either partially or completely fused with each other along the floor [7].

The accessory fissure in lung specimens is not uncommon but appreciating them on radiographs and CT scan is difficult and completely misinterpreted. The accessory fissures could be the result of non- obliteration of spaces which normally are obliterated [8].

Such anatomical variations of fissures and lobes are not uncommon for surgeons when they encounter while performing pulmonary lobectomies and for radiologists to interpret the X-rays and CT scans [9].

Hence an attempt was carried out to gain further insight into the morphology of human lung fissures and lobes obtained from the cadavers of the Departments of Anatomy, KAMSRC and other medical colleges in Telangana zone.

## MATERIALS AND METHODS

The present study was carried out in the departments of Anatomy, KAMSRC and KIMS, Narketpally. With prior permission from concerned ethical committee and HOD of the department over a period of one year. 50 Formalin fixed adult lungs. The right 25 and left 25 were collected from the departmental museum as well as under graduate dissection classes. The lungs were studied meticulously irrespective of gender and age. Each lung was studied carefully for

1. The number of fissures whether complete or incomplete or absent.
2. Whether there were any accessory fissures or lobes. Photographs were taken and documented.

## OBSERVATIONS

**Right Lungs:** Variations in fissures and lobes of right lungs were observed in 8 out of 25 specimens (32%). 17 right lungs were normal with complete oblique and horizontal fissure (68%).

a. The right lung showed incomplete oblique fissure in three lungs. (Figure 4, 5 & 9) (12%) and the lobation was imperfect.

b. Irregular oblique fissure with lingular process in one lung. (figure 8) (4%)

c. Complete absence of horizontal fissure in four lungs (figure 5, 6, 9, 10) (16%) and middle lobe was not appreciated.

d. Complete absence of oblique and horizontal fissure in one lung (figure 10) (4%).

e. Right lung divided into three distinct lobes by two fissures and two hilar structures on the medial surface in one lung (figure 3) (4%)

Note: a. No accessory fissures were observed in the right lungs.

**Left lungs:** Variations of fissures and lobes were observed in 3 out of 25 specimens (12%).22 left lungs were normal with complete oblique fissure (88%).

a. A Left lung with 2 lobes, with incomplete oblique fissure a lingular process on the inferior border. (fig 13)(4%)

b. A Left lung with 3 lobes, with oblique fissure extending up to inferior border & presence of superior accessory fissure (Fig 12) (4%)

c. A Left lung with complete absence of oblique fissure (fig 11) (4%).

Note: Lingular process present along inferior border of lung (fig 13)

**Fig. 1a:** Variations in Inter-lobar fissure in Right lungs obtained from the cadavers.

**Fig. 1b:** Variations in Inter-lobar fissure in Left lungs obtained from the cadavers.

**Fig. 2a:** Coastal Surface of Right and left lung with absence of fissures.

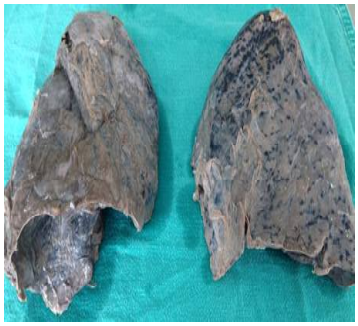


**Fig. 2b:** Medial surface of Right and Left lung with absence of fissures.

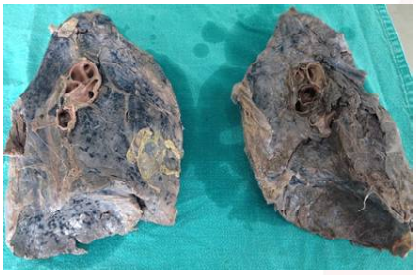


**Fig. 3:** Complete and irregular divisions of Right lung into 3 lobes by the fissures Medial surface showing two hilar structures.

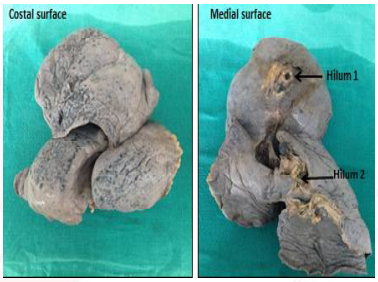



**Fig. 4:** Right lung: incomplete oblique fissure and extension of horizontal fissure.

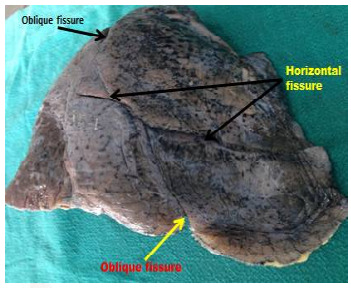
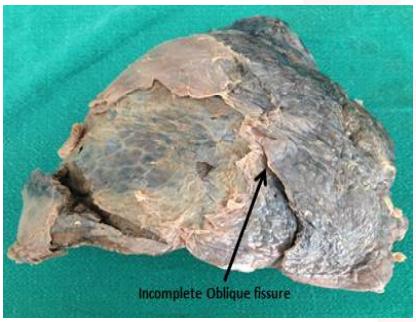



**Fig. 5:** Right lung with 2 lobes, incomplete oblique fissure & Complete absence of horzontal fissure.

**Fig. 6:** Right lung with 2 lobes and complete absence of horizontal fissure, oblique fissure extending obliquely.

**Fig. 7:** Right lung with 2 lobes and complete absence of horizontal fissure, oblique fissure extending horizontally.



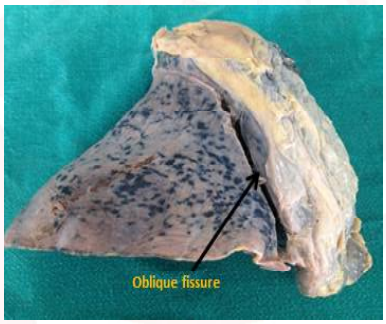
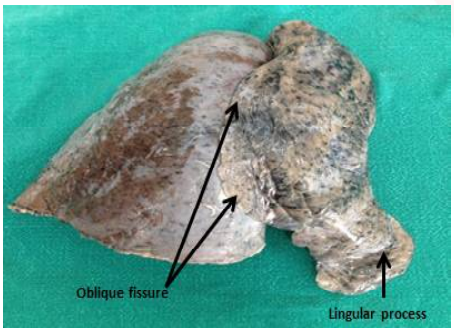



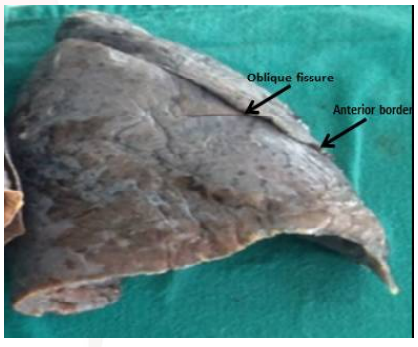


**Fig. 8:** Right lung with 2 lobes, Irregular oblique fissure with lingular process extending b/w anterior and inferior border and complete absence of horizontal fissure.

**Fig. 9:** Right lung with 2 lobes and oblique fissure extending upto anterior border and complete absence of horizontal fissure.

**Fig. 11:** Costal surface of left lung with absence of fissure.



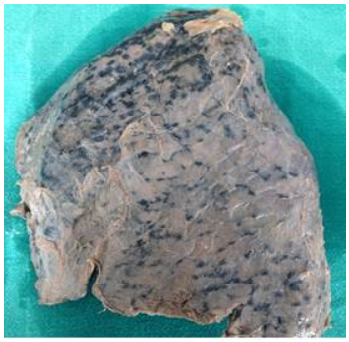
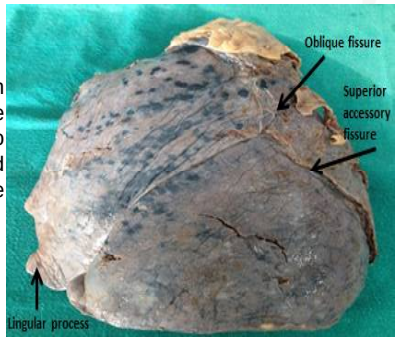



**Fig. 12:** Left lung with 3 lobes, with oblique fissure extending upto inferior border and presence of complete accessory fissure.



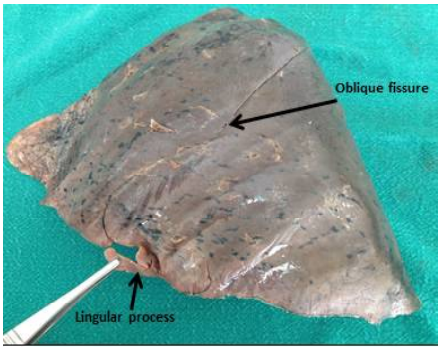




**Fig. 13:** Left Lung with 2 Lobes, with incomplete oblique fissure extending upto inferior border and lingular process on inferior border.

## RESULTS

**Table 1:** Total number of lungs studied -50.

| Lungs | Total | Normal & percentage | Variations & percentage |
|---|---|---|---|
| Right Lungs | 25 | 17 & 68% | 8 & 32% |
| Left Lungs | 25 | 22 & 88% | 3 & 12% |

**Table 2:** Incidence of variations in major and minor fissures of right lungs (25) and left lungs (25).

| Lung | Fissures | Complete | Incomplete | Absent | Accessory |
|---|---|---|---|---|---|
| Right lung | Horizontal Fissure | 68% | Nil | 16% | Nil |
| | Oblique Fissure | 68% | 12% | 4% | |
| Left lung | Oblique Fissure | 88% | 4% | 4% | 4% |

**Table 3:** Incidence of major (oblique) and minor (horizontal) fissures of lungs in our study according to Craig and Walker criteria.

| Lung (present study) | Fissures | Grade I | Grade II | Grade III | Grade IV |
|---|---|---|---|---|---|
| Right Lung - 25 | Horizontal Fissure | 68% | Nil | Nil | 16% |
| | Oblique Fissure | 68% | 12% | Nil | 4% |
| Left lung - 25 | Oblique Fissures | 88% | Nil | 4% | 4% |

**Table 4:** Showing the incidence of lung Fissures Observed by Various authors in Cadaveric Study.

| Variations of fissures | | Lukose et al. [22] | IEHAV Bergman et al [21] | Meenakshi et al. [9] | Present study |
|---|---|---|---|---|---|
| RIGHT LUNG | | | | | |
| Horizontal fissure | Absent | 10.50% | 21.00% | 16.60% | 16.00% |
| | Incomplete | 21.00% | 67.00% | 63.30% | - |
| Oblique fissure | Absent | - | - | - | 4.00% |
| | Incomplete | 5.30% | 30.00% | 36.30% | 12.00% |
| Both fissure | Absent | - | - | 3.00% | 4.00% |
| Accessory fissure | | - | - | - | - |
| LEFT LUNG | | | | | |
| Oblique fissure | Absent | - | - | - | 4.00% |
| | Incomplete | 21.00% | 30.00% | 46.40% | 4.00% |
| Accessory fissure | | - | - | - | 4.00% |

**Table 5:** Literature.

| Accessory Fissures | | Nene AJ et al | Godwin & Tarver | Present study |
|---|---|---|---|---|
| SAF | Right lung | 4% | 30% | - |
| | Left lung | - | 5-14% | 4% |
| IAF | Right lung | 14% | 40% | - |
| | Left lung | 24% | 50% | - |
| LMF | | 26% | - | - |

## DISCUSSION

The lung develops as an endodermal diverticulum at 4th week of intrauterine life. An embryological insult around 4 weeks of post fertilization might have resulted in developmental anomalies of lung. Ontogenetically the lung is a composite of endodermal and mesodermal tissue. The endodermal lung bud bifurcates into two primary bronchi left and right, which ultimately develops into left and right lungs [10].

Each lung bud is surrounded by splanchnopleuric mesoderm which gives rise to bronchial smooth muscle, connective tissue and blood vessels [11].

During development fissures separate individual bronchopulmonary segments and the spaces remain along the interlobar planes give rise to major or oblique and minor or horizontal fissures in fully developed lungs. Defective pulmonary development gives rise to variations in lobes and fissures of the lungs. Many of these fissures get obliterated except along two planes which leave the main fissures in their complete form throughout adult life. Based on this right lung having two complete fissures with corresponding 3 lobes, while left lung having one complete fissure with corresponding two lobes [12].

Absence or incomplete oblique or horizontal fissures could be due to obliteration of these fissures either completely or partially [8,13]. Parenchymal fusion is seen along the floor in case of incomplete fissure. Implications of incomplete fissure is important for planning lobar resection because it may lead to air leak in lobar fusion and are responsible for spread of any lung disease [7,8].

The accessory fissures in lung specimens are not uncommon but appreciating them on radiographs and CT scans is difficult and is completely misinterpreted. Accessory fissures usually indicate junction between bronchopulmonary segments. Regarding accessory fissures occasional monopodial branching of the stem bronchi accounts for accessory bronchi and lobes often seen in adult lungs [14]. From radiological point of view an accessory fissure is important and can be mistaken for lung lesion [15]. As per Godwin there are superior accessory fissures (SAF), inferior accessory fissure (IAF) or left minor fissure (LMF). The SAF separates the apical segment of the lower lobes from the basal segment, IAF separates medial basal segment from the remainder of the lower lobe and LMF seen in the left lung [1].

Godwin et al. reported incidence of SAF in 30% &14% in right and left lungs respectively, IAF in 40% & 50% of right and left specimen's respectively [2].

Knowledge of accessory fissures is helpful for clinicians and cardiothoracic surgeons to differentiate the accessory fissures from normal anatomical and pathological structures. The accessory fissures fail to be detected on CT scans because of their thick sections, incompleteness and in relation to a particular plane [16].

The medial part of upper lobe is partially separated by a fissure of variable depth containing the terminal part of Azygos vein so forming lobe of Azygos vein [5].

Craig and Walker (1997) have proposed a fissural classification based on both the degree of completeness of the fissures and the location of the pulmonary artery at the base of the oblique fissure.

Four stages have been described.

Grade I- Complete fissure with entirely separate lobes;

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

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

Grade IV- Complete fusion of lobes with no evident fissural line[17].

Gradation of fissures is important surgically. The surgeon approaches to ligate the vessels and bronchi through the depth of the fissures.

Meenakshi et al [9] studied 30 pairs of lungs, 5 right lungs showed absence of horizontal fissure and 19 right lungs showed incomplete horizontal fissure. 11 right lung and 14 left lung showed incomplete oblique fissure. Accessory fissure was seen in three left lung and one right lung.

Medlar [19] found incomplete oblique fissure in 10.6% and 25.6% in right and left lung respectively. An incomplete horizontal fissure in 17.1% of right lung. Oblique fissure were absent in 7.3% of left lung and 4.8% in right lung. Horizontal fissure was absent in 45.2% of right lung.

N. Bhimai devi et al [20] studied 22 cadavers. Observed 2 left lungs with absence of fissures, 8 left lung with incomplete oblique fissure, in 4 right lung horizontal fissure was incomplete, in 2 right lungs incomplete oblique fissures, accessory lobes were present one on the right side and one on the left side.

In 1999 Bergman et al in his study reported horizontal fissures was absent in 21% and incomplete in 67% of right lung. He reported that 30% of right lung had incomplete oblique fissure and 30% incomplete oblique fissure on the left sided lung [21].

Lukose et al conducted a study on morphology of lungs where he observed 21% of left lungs showed incomplete oblique fissure. He also observed horizontal fissure was absent and incomplete in 10.5% and 21% respectively, and incomplete oblique fissure in 5.3% of right lung [22].

Nene AJ et al [23] studied accessory fissures of lungs in detail. He reported SAF in 4% and 0% of lungs of right and left side respectively. He also reported Inferior accessory fissure in 14% and 24% on right and left sides respectively and LMF in 26%.

To conclude, in our present study of right lung we observed absence of horizontal fissure in 16%, absence and incomplete oblique fissure in 4% and 12% respectively. Both the fissures were absent in right lung in 4% of specimens. We specially noticed a rare right lung with irregular oblique fissure with lingular process extending between the anterior border and inferior border[8]. In our study we also observed a rare right lung divided into 3 distinct lobes by two fissures and two hila present on the medial surface [3]. The above two rare right lungs were not reported in the previous literature.

In the current study we also report the left lung with absence of oblique fissure in 4%, incomplete oblique fissure in 4% and SAF seen in 4% of specimens. We observed a rare Left lung with lingular process on the inferior border [13].

In the available literature many authors have described about the fissure and variations of the lobes of lungs. The present study includes 25 right lungs and 25 left lungs. The comparative study of different authors with the present study shown in the table 4&5 respectively. Any variations in the morphological pattern of fissures indicates the variation in normal pattern of lung development.

## CONCLUSION

The knowledge of morphological variations in minor, major and accessory fissures including lobes of lung might explain bizarre presentation related to clinical cases pertaining to lung pathology. Considering the importance of anatomical knowledge of these variations is important for pulmonologists, radiologists, surgeons and clinicians.

**Conflicts of Interests: None**

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