International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Morphological Study of Lung Fissures and Lobes in the Tamil Nadu Population – A Cadaveric Study

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OPEN ACCESS

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Received: 02-12-2025
Accepted: 20-12-2025
Available online: 27-12-2025

ABSTRACT

Background: Pulmonary fissures define lobar anatomy and serve as key landmarks in thoracic imaging and lung surgery. Variations such as incomplete or absent fissures and accessory fissures may alter lobar boundaries, influence disease spread, and complicate surgical approaches.
Objectives: To document the gross morphological variations of pulmonary fissures in cadaveric lung specimens and to determine the frequency of incomplete, absent, and accessory fissures.
Materials and Methods: A descriptive cross-sectional study was performed on 88 adult formalin-fixed human lungs(44 right and 44 left). Each specimen was examined on costal and medial surfaces for the morphology of the right horizontal fissure, oblique fissure on both sides, and the presence of any accessory fissures. Fissures were classified as complete, incomplete, or absent. Data were expressed as numbers and percentages; a chi-square test was used for side comparison of oblique fissure incompleteness.
Results: In the right lung (n=44), the horizontal fissure was incomplete in 28 (63.6%) and absent in 20 (45.5%) specimens. The right oblique fissure was incomplete in 10 (22.7%) and was not absent in any specimen. A cross-shaped accessory fissure was observed in 2 (4.5%) right lung. In the left lung (n = 44), the oblique fissure was incomplete in 16 (36.4%), while 28 (63.6%) showed a complete fissure. Side comparison of oblique fissure incompleteness did not show statistical significance (p = 0.509).
Conclusion: Pulmonary fissural variations are common in cadaveric specimens, with the right horizontal fissure showing the highest variability. Recognition of incomplete, absent, and accessory fissures is important for accurate radiological interpretation and for safe surgical planning during lobectomy and segmental resections.

Keywords*: Pulmonary fissures; Oblique fissure; Horizontal fissure; Accessory fissure; Lung lobes; Cadaveric study; Gross anatomy; Anatomical variation.*

INTRODUCTION

The lungs are essential respiratory organs whose internal architecture is organized by fissures that divide the parenchyma into anatomically and functionally distinct lobes[1,2]. These fissures—namely the oblique fissure in both lungs and the horizontal fissure in the right lung—play a crucial role in facilitating uniform expansion of lung tissue during respiration and permitting relative movement between lobes. In addition, fissures serve as important anatomical landmarks for localizing bronchopulmonary segments and thoracic lesions [3,4].

Classically, the right lung is described as having three lobes separated by oblique and horizontal fissures, whereas the left lung is divided into two lobes by a single oblique fissure. However, numerous anatomical studies have demonstrated that this standard pattern is subject to considerable variation. Fissures may be complete, incomplete, or entirely absent, and additional accessory fissures may be present. Such variations alter normal lobar anatomy and may influence both physiological function and clinical interpretation [5,6].

Embryologically, the lungs develop from multiple bronchopulmonary buds arising from the foregut [7,8]. During normal development, the spaces between these buds are progressively obliterated except along planes that persist as major fissures. Variations in the extent of obliteration result in incomplete or absent fissures, while persistence of normally obliterated spaces leads to the formation of accessory fissures. Thus, fissural morphology reflects developmental events and may vary among individuals and populations.[9]

Knowledge of pulmonary fissural anatomy has important clinical implications. Incomplete or absent fissures can complicate thoracic surgical procedures such as lobectomy and segmental resection by obscuring interlobar planes and increasing the risk of postoperative air leakage. From a radiological perspective, fissural variations may alter classical patterns of lobar collapse, pleural effusion distribution, and disease spread, and accessory fissures may mimic pathological linear opacities if not correctly identified. Furthermore, incomplete fissures may permit extension of infectious or neoplastic processes across lobes, resulting in atypical radiographic presentations [10,11].

Despite their clinical relevance, fissural variations are often underemphasized in routine anatomical teaching. Cadaveric studies remain the most reliable method for direct visualization and documentation of these variations. Moreover, reported incidences of fissural anomalies differ widely across populations, highlighting the need for region-specific anatomical data.[12,13]

The present study was therefore undertaken to document the morphological variations of pulmonary fissures through gross examination of cadaveric lung specimens. By analyzing the frequency and patterns of incomplete, absent, and accessory fissures, this study aims to contribute to anatomical knowledge with direct relevance to surgical anatomy, radiological interpretation, and clinical practice.

MATERIALS AND METHODS

Study design:

The present study was conducted as a descriptive cross-sectional cadaveric study aimed at documenting morphological variations of pulmonary fissures through direct gross examination.

Study material:

A total of 88 adult human lung specimens were included in the study, consisting of 44 right lungs and 44 left lungs. The specimens were obtained from routinely embalmed cadavers used for undergraduate teaching in the Department of Anatomy, Govt. Vellore Medical College, Vellore. All lungs were preserved in 10% formalin and were free from gross pathological changes, traumatic damage, or post-surgical alterations that could interfere with assessment of fissural morphology.

Inclusion and exclusion criteria:

Only lungs with intact pleural surfaces and well-preserved anatomical features were included. Specimens showing evidence of advanced pulmonary pathology, adhesions, gross distortion, or damage during dissection were excluded from the study.

Method of examination:

Each lung specimen was carefully cleaned of surrounding connective tissue and examined on both costal and medial surfaces under adequate illumination. [14,15] The presence and morphology of the major fissures were assessed, including the oblique fissure in both lungs and the horizontal fissure in the right lung. Fissures were classified as:

- Complete, when the fissure extended from the surface of the lung to the hilum, separating the lobes entirely except at the root
- Incomplete, when the fissure was present but did not reach the hilum, resulting in partial fusion of adjacent lobes
- Absent, when no identifiable fissural line or cleft was present

The lungs were also examined for the presence of accessory fissures, and any unusual fissural patterns, including atypical or intersecting fissures, were documented.

Documentation:

All observed variations were systematically recorded in a structured proforma. Representative specimens demonstrating normal anatomy and variations were photographed using a digital camera for documentation and correlation with gross findings.

Statistical analysis:

The collected data were entered into a spreadsheet and analyzed using standard statistical software. Results were expressed as absolute numbers and percentages. Comparative analysis between right and left lungs was performed where applicable. A chi-square test was used to assess side-related differences in fissural incompleteness, with a p-value of less than 0.05 considered statistically significant.

Ethical considerations:
The study was conducted in accordance with institutional ethical guidelines for research involving cadaveric material. As the study involved preserved anatomical specimens used for teaching purposes, individual consent was not applicable.

RESULTS
Study sample
A total of 88 cadaveric lung specimens were examined (44 right lungs and 44 left lungs). Variations were documented for major fissures (right: horizontal and oblique; left: oblique) and for accessory fissures, including a rare cross-shaped accessory fissure.

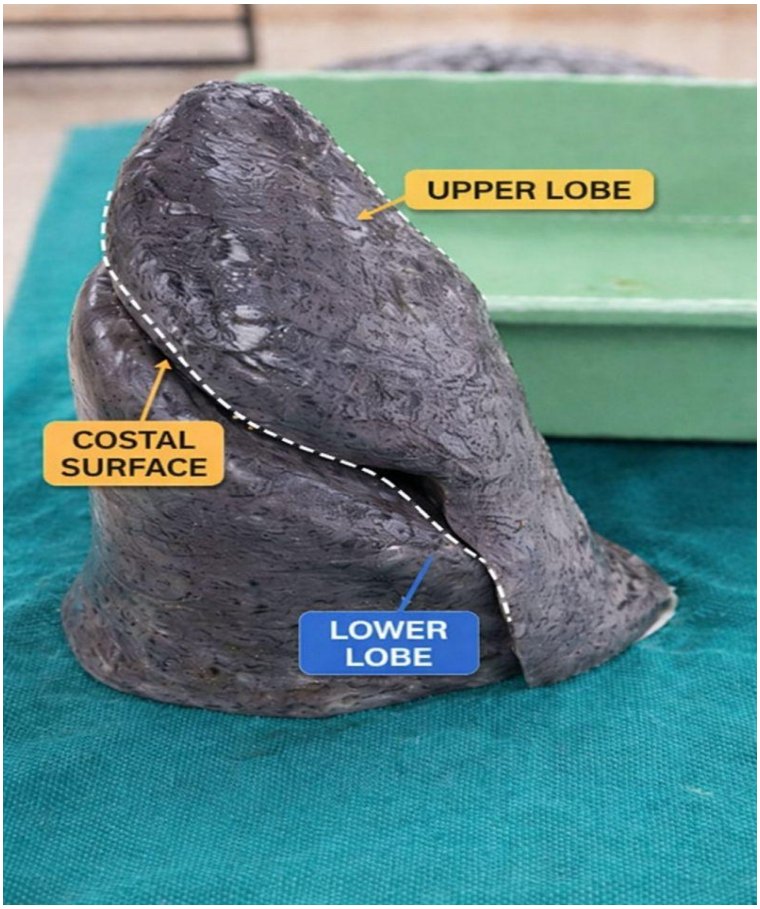

Figure 1. Right lung – absent horizontal fissure (two-lobed right lung) Specimen:

Finding: Complete absence of the horizontal fissure, resulting in failure of separation between upper and middle lobes (functional two-lobed pattern). This gross appearance corresponds to patterns described in prior cadaveric series where the horizontal fissure may be absent.

Table 1. Right lung fissural and accessory fissure variations (n = 44)

Parameter	Category	n	% (of right lungs)	95% CI (Wilson)
Horizontal fissure	Incomplete	28	63.6	43.0 – 80.3
	Absent	20	45.5	26.9 – 65.3
Oblique fissure	Incomplete	10	22.7	10.1 – 43.4
	Absent	0	0.0	—
Accessory fissure	Cross-shaped fissure	2	4.5	0.8 – 21.8

Note: Percentages and counts reflect the present study dataset.

Figure 2. Left lung – incomplete oblique fissure Specimen:

Finding: A distinct Left lung – incomplete oblique fissure, fissure on the left lung surface, representing an uncommon accessory fissural pattern in gross anatomy series.

Table 2. Left lung fissural variation (n = 44)

Parameter	Category	n	% (of left lungs)	95% CI (Wilson)
Oblique fissure	Incomplete	16	36.4	19.7 – 57.0
	Absent	0	0.0	—
	Complete (normal pattern)	28	63.6	43.0 – 80.3

Side comparison (Right vs Left) for oblique fissure incompleteness:
Right: 10/44 (22.7%) vs Left: 16/44 (36.4%); χ^2 p = 0.509 (not statistically significant).

Table 3. Comparison of fissural variations with prior cadaveric studies

Variation	Present study	Meenakshi et al. (30 pairs)	Ajay et al. (50 pairs)
Right lung: Incomplete horizontal fissure	63.6% (28/44)	63.3%	8%
Right lung: Absent horizontal fissure	45.5% (20/44)	16.6%	14%
Right lung: Incomplete oblique fissure	22.7% (10/44)	36.6%	6%
Left lung: Incomplete oblique fissure	36.4% (16/44)	46.6%	12%

These findings reinforce that incomplete or absent fissures and accessory fissures occur with variable frequency across different cadaveric populations, consistent with previous gross anatomical reports.

DISCUSSION

The present cadaveric study highlights that morphological variations of pulmonary fissures are frequent findings rather than rare anomalies. In the examined specimens, the right lung demonstrated a higher degree of fissural variability compared with the left lung, particularly involving the horizontal fissure. Incomplete and absent fissures were commonly observed, confirming that the classical textbook description of lung lobation does not consistently represent the anatomical reality [16,17].

The right horizontal fissure exhibited the greatest variation in this study. A considerable number of specimens showed incomplete formation of this fissure, while complete absence was also encountered. Absence of the horizontal fissure

resulted in a functional two-lobed right lung, with fusion of the upper and middle lobes[18,19]. This variation is clinically relevant, as it alters normal lobar anatomy and may complicate both radiological interpretation and surgical dissection. In contrast, the right oblique fissure demonstrated comparatively fewer variations, and complete absence was not observed in the present series.

On the left side, variations were limited to the oblique fissure, as expected anatomically. Incomplete oblique fissures were observed in a notable proportion of specimens, leading to partial fusion between the upper and lower lobes. Such fusion may obscure interlobar planes and influence patterns of disease spread across lobes [20,21].

The embryological basis of these variations lies in the development of the lungs from multiple bronchopulmonary buds. During normal development, the spaces between these buds are largely obliterated except along planes that persist as the major fissures. Incomplete fissures represent partial obliteration of these embryonic spaces, while complete absence of a fissure indicates near total fusion of adjacent lobes. Conversely, accessory fissures arise due to persistence of spaces that normally disappear. The identification of a rare cross-shaped accessory fissure in the present study supports this developmental explanation and illustrates the wide spectrum of possible fissural patterns [22].

When compared with previous cadaveric studies, the incidence of incomplete and absent fissures in the present series shows variability but remains within the broad range reported in anatomical literature [23]. Differences in incidence across studies may be attributed to population-specific developmental factors, genetic influences, environmental conditions, differences in sample size, and variations in criteria used to define fissural completeness. These factors emphasize the importance of region-specific anatomical data.

From a surgical perspective, the presence of incomplete or absent fissures is of considerable importance. In thoracic procedures such as lobectomy and segmental resection, incomplete fissures may necessitate extensive parenchymal dissection, increasing the risk of postoperative air leakage. Knowledge of such variations allows surgeons to modify operative strategies, particularly in minimally invasive and thoracoscopic procedures where fissure-based approaches are commonly employed [24].

Radiologically, fissural variations may lead to diagnostic challenges. Incomplete fissures can alter classical patterns of lobar collapse and pleural effusion tracking, while accessory fissures may appear as abnormal linear shadows on radiographs or CT scans. Without awareness of these variations, accessory fissures may be misinterpreted as pathological findings such as atelectasis, fibrosis, or pleural scarring. Therefore, correlation between anatomical knowledge and imaging interpretation is essential.

Fissural morphology also influences the spread of pulmonary diseases. In lungs with complete fissures, infections such as pneumonia tend to remain confined to individual lobes. In contrast, incomplete fissures permit parenchymal continuity, allowing disease processes to extend across lobes and produce atypical radiological patterns. This may explain unusual lobar involvement seen in certain cases of infection or malignancy [25].

Despite its contributions, the present study has limitations. Being a gross anatomical study, it does not provide radiological correlation, which would enhance clinical applicability. Additionally, the assessment of fissural completeness is inherently subjective and may vary depending on observer interpretation. Future studies integrating high-resolution imaging with cadaveric findings and applying standardized fissural grading systems would strengthen anatomical-clinical correlations.

CONCLUSION

Pulmonary fissural variations are common and display significant diversity. Awareness of these variations is essential for anatomists, radiologists, and thoracic surgeons alike. Incorporating knowledge of fissural morphology into clinical practice can improve diagnostic accuracy, surgical planning, and patient outcomes.

Funding: Nil.
Conflicts of interest: There are no conflicts of interest**.**
Acknowledgments:
I thank all the faculty, teaching and non-teaching staff and the administration Department of Anatomy, Govt. Vellore Medical College, Vellore, Tamil nadu , India for granting permission to carry out the research work.
Data Availability:
All datasets generated or analysed during this study are included in the manuscript.

REFERENCE

1. Aldur MM, Denk CC, Celik HH, Tasçioglu AB. An accessory fissure in the lower lobe of the right lung. Morphologie. 1997;81:5-7.
2. Craig SR, Walker WS. A proposed anatomical classification of the pulmonary fissures. J R Coll Surg Edinb. 1997;42:233-234.

3. Rosse C, Gaddum-Rosse P. Hollinshead's Textbook of Anatomy. 5th ed. Philadelphia: Lippincott-Raven; 1997.
4. Meenakshi S, Manjunath KY, Balasubramanyam V. Morphological variations of the lung fissures and lobes. Indian J Chest Dis Allied Sci. 2004;46:179-182.
5. Standring S, Borley NR, Gray H. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 40th ed. Spain: Churchill Livingstone; 2008. p. 92.
6. Damor BK, Solanki S, Kumar SV, Pensi CA. Morphological variations of the fissures and lobes in cadaveric human lungs in Gujarat State. Int J Sci Res. 2012;3(2):27-29.
7. Abhilasha W, Charulata S. A cadaveric study of morphological variations of lungs in Vidarbha region. Int J Sci Res. 2013;4:2163-2166.
8. Brahmbhatt RJ, Chauhan KB, Bansal M, Brahmbhatt JN. Cadaveric study of azygos lobe of lung. Int J Basic Appl Med Sci. 2013;3:30-33.
9. Dutta S, Mandal L, Mandal SK, Biswas J, Ray A, Bandopadhyay M. Natural fissures of lung: anatomical basis of surgical techniques and imaging. J Med Res. 2013;3:117-121.
10. Esomonu UG, Taura MG, Modibbo MH, Egwu AO. Variation in the lobar pattern of the right and left lungs: a case report. Australas Med J. 2013;6:511-514.
11. Jacob SM, Pillay M. Variations in the inter-lobar fissures of lungs obtained from cadavers of South Indian. Int J Morphol. 2013;31(2):497-499.
12. Mayuri J, Pradeep P, Vasudha N, Aparna T, Smita M. Anomalous lobar pattern of right lung: a case report. J Res Med Den Sci. 2013;1:80-81.
13. George BM, Nayak SB, Marpalli S. Morphological variations of the lungs: a study conducted on Indian cadavers. Anat Cell Biol. 2014;47(4):253.
14. Nishan K, Vishram S, Rucira S, Vinod K. Anomalous fissures and lobes of human lungs of North Indian population of western U.P. J Anat Soc India. 2014;63:26-30.
15. Varalakshmi KL, Nayak NJ, Sangeetha M. Morphological variations of fissures of lung: an anatomical study. Indian J Appl Res. 2014;4(8):467-469.
16. Zareena SK. A study of morphology and variations of lungs in adults and foetus. Int J Adv Res Technol. 2014;3:150-157.
17. Divya C, Venkateshu KV, Swaroop RBV. Anatomical study of pulmonary fissures and lobes. Int J Sci Res. 2015;6:4554-4557.
18. Gebregziabher A, Berhe T, Ekanem P. Variations of fissures and lobes of the lungs in human cadavers in selected universities of Ethiopia. Int J Pharm Sci Res. 2015;6(6):981-990.
19. Radha K, Durai PK. Fissures and lobes of lungs: a morphological and anatomical study. Int J Anat Res. 2015;3(2):995-998.
20. Mamatha Y, Murthy CK, Prakash BS. Study of morphological variations of fissures and lobes of lung. Int J Anat Res. 2016;4(1):1874-1877.
21. Thapa P, Desai SP. Morphological variation of human lung fissures and lobes: an anatomical cadaveric study in North Karnataka, India. Indian J Health Sci Biomed Res. 2016;9:284-287.
22. Gopalakrishna K, Deepalaxmi S, Somashekara SC, Rathna BS. A cadaveric study on morphological variations of fissures and lobes in the human lungs and its clinical significance. J Exp Clin Anat. 2017;16(1):7.
23. Shivaleela C, Lakshmiprabha S, Afroze MKH. A study of anatomical variations in patterns of fissures and lobes in human lungs: a cadaveric study with clinical significance. Int J Anat Res. 2018;6(1.1):4819-4823.
24. Sudikshya KC, Shrestha P, Shah AK, Jha AK. Variations in human pulmonary fissures and lobes: a study conducted in Nepalese cadavers. Anat Cell Biol. 2018;51(2):85-92.
25. Ekanayaka EADA, Chrishan AN, Dassanayake DMTD, Dissanayake JK. A cadaveric study of the variations in pulmonary fissures. Sri Lanka Anatomy Journal. 2019;3(2):111.