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

Incomplete and Accessory Pulmonary Fissures: Gross Anatomical Variations and Their Clinical Implications

Dr. K. Vidulatha[1], Dr G Sundar[2]

[1]Associate professor, Department of Anatomy, Coimbatore medical college, Coimbatore, Tamilnadu
[2]Associate Professor, Department of Anatomy, Government Vellore Medical College, Vellore , Tamilnadu

OPEN ACCESS

Corresponding Author:

Dr. K. Vidulatha
Associate professor, Department of Anatomy, Coimbatore medical college, Coimbatore, Tamilnadu

Received: 01-12-2025
Accepted: 20-12-2025
Available online: 27-12-2025

ABSTRACT

Background: Pulmonary fissures demarcate lung lobes and serve as key landmarks in thoracic imaging and operative planning. Variations such as incomplete, absent, and accessory fissures may obscure interlobar planes, alter the radiological distribution of disease, and increase technical difficulty during lobectomy and segmental resections.
Objectives: To determine the frequency and pattern of incomplete, absent, and accessory pulmonary fissures in cadaveric lung specimens and to highlight their clinical implications.
Materials and Methods: A descriptive cross-sectional cadaveric study was conducted on 88 formalin-fixed adult human lungs comprising 44 right and 44 left lungs. Each specimen was examined on costal and medial surfaces for the morphology of the right horizontal fissure, oblique fissures bilaterally, and for the presence of accessory fissures. Fissures were classified as complete, incomplete, or absent by gross inspection. Data were expressed as frequency and percentage.
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. An accessory cross-shaped fissure was identified 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%) specimens showed a complete fissure.
Conclusion: Incomplete and absent fissures are common in cadaveric lungs, with the right horizontal fissure demonstrating the highest variability. Rare accessory fissures may produce complex fissural patterns. Awareness of these variations is essential for accurate radiological interpretation and for optimizing surgical strategies during thoracic procedures.

Keywords*: Pulmonary fissures; Lung lobes; Incomplete fissure; Absent fissure; Accessory fissure; Cadaveric study; Thoracic anatomy; Lobectomy; Radiological anatomy; Surgical anatomy.*

INTRODUCTION

Pulmonary fissures are pleural invaginations that partition the lung parenchyma into lobes and establish the external framework for lobar and segmental anatomy. The oblique fissure is normally present in both lungs, while the horizontal fissure is a characteristic feature of the right lung. These fissures facilitate relative movement of lobes during respiration, contribute to uniform expansion of lung tissue, and serve as reliable anatomical landmarks for locating bronchopulmonary segments and intrathoracic lesions.[1-5]

Although standard anatomical descriptions portray the right lung as trilobed and the left lung as bilobed, fissural morphology is frequently variable.[6,7] Major fissures may be complete, incomplete, or absent, and additional accessory fissures may occur. Such variations alter expected lobar boundaries and may produce atypical lobar configurations. Incomplete fissures are characterized by parenchymal fusion between adjacent lobes, whereas absent fissures indicate complete fusion along the expected fissural plane. Accessory fissures represent additional clefts that may partially subdivide lobes and are often related to segmental boundaries.[8,9]

The developmental basis for these variations is attributed to the embryological formation of the lungs from branching bronchopulmonary buds. During growth, the clefts between adjacent bronchopulmonary units are largely obliterated except along planes that persist as the major fissures. Variations in the degree of obliteration result in incomplete or absent fissures, while persistence of additional clefts gives rise to accessory fissures. Consequently, fissural anatomy reflects developmental events and may differ across individuals and populations.[10,11]

The clinical relevance of fissural variations is substantial. In thoracic surgery, incomplete fissures may obscure interlobar planes, complicate identification of hilar structures, and increase the risk of postoperative air leakage during lobectomy or segmentectomy. Accessory fissures may further alter operative orientation and modify dissection strategy.[12,13] From a radiological standpoint, incomplete fissures may change classical patterns of lobar collapse, pleural fluid tracking, and consolidation, while accessory fissures can mimic linear pulmonary pathology and lead to diagnostic uncertainty if unrecognized. In addition, fissural incompleteness may allow pathological processes such as infection or malignancy to extend across lobes, producing non-classical patterns of spread.[14,15]

Despite these implications, fissural variants are often underrecognized in routine anatomical teaching and may be overlooked during imaging interpretation or preoperative planning. Cadaveric studies provide the most direct method for documenting fissural patterns and generating population-specific anatomical data relevant to clinicians.[16]

The present study was therefore undertaken to document the gross anatomical variations of pulmonary fissures in cadaveric lung specimens, with particular emphasis on incomplete and accessory fissures, and to highlight their potential clinical implications in radiology and thoracic surgery.

MATERIALS AND METHODS

Study design:

The present investigation was conducted as a descriptive cross-sectional cadaveric study aimed at documenting the gross anatomical variations of pulmonary fissures, with particular emphasis on incomplete and accessory fissures and their potential clinical relevance.

Study material:

The study was carried out on 44 adult human lung specimens, comprising 44 right lungs and 44 left lungs. The specimens were obtained from routinely embalmed cadavers used for undergraduate teaching in the Department of Anatomy. All lungs were preserved in 10% formalin and had been removed carefully during standard thoracic dissection.

Inclusion criteria:

- Adult lung specimens with intact pleural surfaces
- Well-preserved lungs with clearly identifiable external morphology
- Specimens without gross pathological lesions that could distort fissural anatomy

Exclusion criteria:

- Lungs showing evidence of severe pulmonary pathology such as extensive fibrosis, consolidation, or tumors
- Specimens damaged during dissection or removal
- Lungs with dense pleural adhesions obscuring fissural planes

Method of examination:

Each lung specimen was washed and examined systematically under adequate illumination. The examination was performed on both the costal and medial surfaces, and the following parameters were assessed:

1. Major fissures
    - Right lung: horizontal fissure and oblique fissure
    - Left lung: oblique fissure
2. Accessory fissures
    - Presence, number, orientation, and surface location of any accessory fissures
    - Special attention was paid to atypical fissural patterns, including intersecting or complex fissures

Fissures were classified based on gross morphology as follows:

- Complete fissure: a deep cleft extending from the lung surface to the hilum, resulting in complete separation of adjacent lobes except at the root
- Incomplete fissure: a visible fissural line or shallow cleft that did not extend to the hilum, indicating partial fusion of lobes
- Absent fissure: complete absence of a fissural cleft along the expected anatomical plane

Documentation and photography:

All observed variations were recorded in a structured proforma. Representative specimens demonstrating incomplete fissures, absent fissures, and accessory fissures were photographed using a digital camera. The photographs were later annotated to identify lobes, fissures, and surfaces for documentation and publication purposes.[17,18]

Data recording and analysis:
The collected data were tabulated and analyzed descriptively. Findings were expressed as absolute numbers and percentages. Comparative evaluation between right and left lungs was performed where applicable to assess side-related differences in fissural patterns.

Ethical considerations:
The study was conducted in accordance with institutional ethical guidelines governing the use of cadaveric material for research and teaching. As the study involved preserved cadaveric specimens obtained through a body donation program, individual consent was not applicable.

RESULTS
A total of 88 adult cadaveric lung specimens (44 right lungs and 44 left lungs) were examined with specific emphasis on incomplete, absent, and accessory pulmonary fissures.

Absent Major Pulmonary Fissures
Figure 1. Gross specimen of the right lung showing complete absence of the horizontal fissure, resulting in a two-lobed right lung with only upper and lower lobes separated by a well-defined oblique fissure.

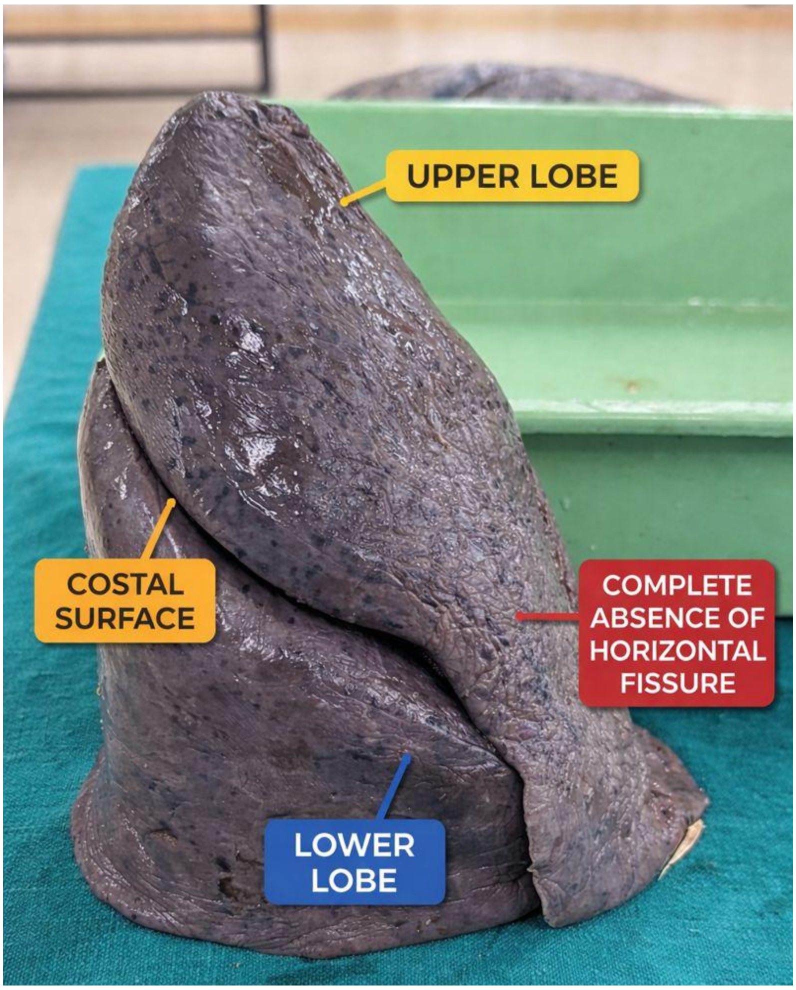

Figure 1. Right lung showing complete absent of horizontal fissure

Caption: Gross anatomical photograph of a preserved right lung specimen demonstrating complete absence of the horizontal fissure. The upper and lower lobes are identified on the costal surface, with no demarcation corresponding to the horizontal fissure, indicating a congenital fissural variation.

Table 1. Distribution of incomplete and absent major fissures

Lung side	Fissure	Incomplete n (%)	Absent n (%)
Right lung (n = 44)	Horizontal fissure	28 (63.6%)	20 (45.5%)
	Oblique fissure	10 (22.7%)	0 (0%)
Left lung (n = 44)	Oblique fissure	16 (36.4%)	0 (0%)

Accessory Fissures and Atypical Fissural Patterns

Accessory fissures were observed less frequently than incomplete major fissures. A rare cross-shaped accessory fissurewas identified in one right lung specimen. This accessory fissure intersected the major fissural plane, producing an unusual pattern of lobar subdivision.

Figure 2 illustrates Right Lung incomplete oblique fissural configuration.

Figure 2. Gross specimen of the right lung showing an incomplete oblique fissure, resulting in partial separation between the upper and lower lobes. The fissure is shallow and does not extend completely across the lung parenchyma, leading to areas of lobar fusion along the costal surface. This represents a common developmental variation of fissural anatomy with potential clinical and surgical relevance.

Figure 3: illustrates incomplete horizontal fissure

Figure 3. Gross anatomical photograph of a preserved right lung specimen showing an incomplete horizontal fissure. The fissure is shallow and does not extend fully across the lung parenchyma, resulting in incomplete separation of the upper and middle lobes. This represents a common anatomical variation of the right lung fissural pattern.

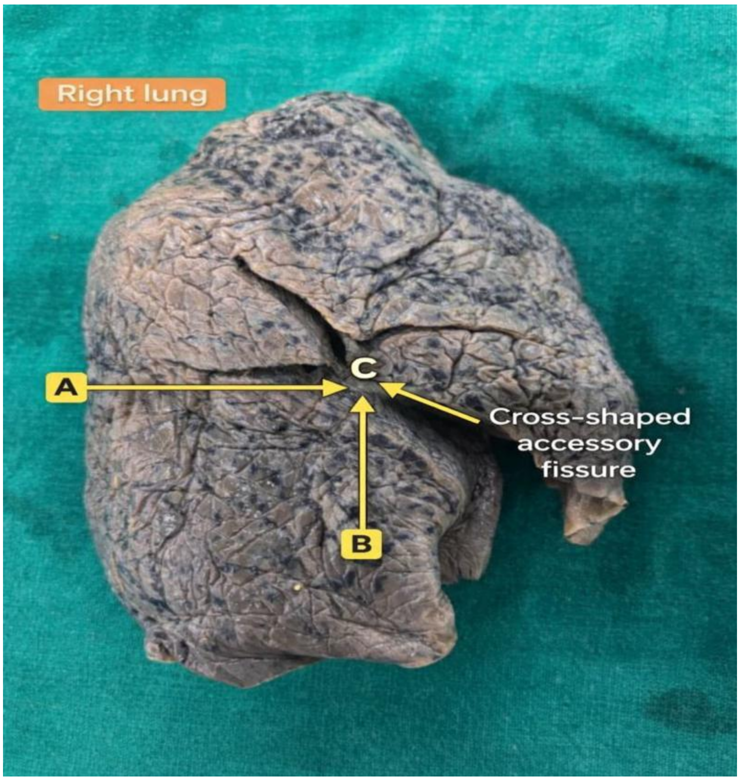

Figure 4:Right lung cross shaped fissure

Figure 4. Figure 4. Right lung showing cross-shaped fissure Labels to be placed on the image (using solid arrows):
Solid Arrow A: Point to the horizontal component of the accessory fissure, running transversely across the lung surface.
Solid Arrow B: Point to the vertical component of the accessory fissure, extending inferiorly and intersecting the horizontal fissure.

Solid Arrow C: Point to the intersection of the horizontal and vertical fissures, highlighting the characteristic cross-shaped fissural pattern.

Figure 4. Gross anatomical photograph of a preserved right lung demonstrating a cross-shaped accessory fissure. Solid arrows indicate the horizontal and vertical fissural components, whose intersection produces a distinct cross-like configuration on the lung surface. This uncommon fissural variation represents an atypical subdivision of the pulmonary parenchyma and is of anatomical, radiological, and surgical importance, as it may influence lobar identification, interpretation of imaging studies, and surgical planning.

Table 2. Incidence and type of accessory fissures

Lung side	Type of accessory fissure	Number (n)	Percentage (%)
Right lung	Cross-shaped accessory fissure	2	4.5
Left lung	Accessory fissure	0	0
Total (n = 88)	—	2	2.3

Table 3. Combined fissural variation patterns

Pattern of variation	Number of specimens	Percentage (%)
Single incomplete fissure	38	43.2
Multiple incomplete fissures	26	29.5
Absent fissure alone	20	22.7
Incomplete fissure with accessory fissure	4	4.6

Incomplete fissures were more common than absent or accessory fissures. The right horizontal fissure demonstrated the highest variability, followed by the oblique fissure on both sides. Accessory fissures were rare but produced marked alterations in lobar configuration when present.

DISCUSSION

Pulmonary fissures define lobar anatomy and provide important surface landmarks for radiological localization and surgical dissection. Nevertheless, fissural patterns show substantial interindividual variability.[19] The present cadaveric series demonstrates that incomplete major fissures are frequent and that accessory fissures, although uncommon, may form complex configurations capable of altering expected lobar topography. These findings reinforce that the conventional textbook description of lung lobation represents an idealized pattern rather than a constant anatomical rule.[20,21]

Developmental interpretation

Fissural morphology is best understood in the context of lung development. During embryogenesis, the bronchial tree branches into bronchopulmonary units separated by clefts. With further growth, these clefts largely regress, persisting only along planes that form the major fissures.[23] Incomplete fissures likely represent partial fusion of adjacent lobes due to incomplete persistence of the cleft, whereas absence of a fissure reflects complete fusion across the expected fissural plane. Conversely, accessory fissures can be explained by persistence of additional clefts that usually disappear. The coexistence of incomplete and accessory fissures within the same specimen supports the concept that fissural anatomy reflects variable degrees of obliteration or persistence of embryonic planes.[24,25]

Predominance of right-sided fissural variability

A consistent theme in anatomical literature is greater variability of the right lung, particularly the horizontal fissure. The horizontal fissure is developmentally more susceptible to partial formation or obliteration and therefore commonly appears as an incomplete cleft or may be absent entirely. When the horizontal fissure is absent, separation between the upper and middle lobes is lost, producing a functionally two-lobed right lung. [26,27]Such morphology is not merely a descriptive anomaly; it changes the expected relationship between lobes and may obscure the identification of the middle lobe as a distinct surgical unit.[28,29]

Surgical implications

Fissural integrity directly affects the conduct of thoracic procedures. Incomplete fissures create parenchymal bridgesbetween lobes, limiting access to the interlobar pulmonary artery and complicating the development of safe dissection planes. Where fissures are incomplete, surgeons may be forced to divide lung parenchyma to reach hilar structures, increasing the likelihood of postoperative air leakage, especially after lobectomy or segmentectomy. These considerations are amplified in minimally invasive surgery, where visualization is constrained and fissure-based approaches may be less forgiving. Therefore, awareness of fissural variants—and preoperative appraisal when imaging is available—can inform selection of fissure-sparing strategies and reduce avoidable complications.[30,31]

Radiological implications and interpretative pitfalls

Fissures are routinely used on radiographs and CT to define lobar boundaries, locate lesions, and interpret patterns of collapse and consolidation. Variations in fissural anatomy can alter these expected patterns. Incomplete fissures may permit extension of disease across lobar boundaries, producing atypical distributions of infection or malignancy that do not conform to classic lobar anatomy. Accessory fissures may appear as sharp linear interfaces and can be mistaken for atelectasis, pleural scarring, or fibrosis if not recognized. Accurate radiological interpretation therefore requires familiarity with fissural variants and careful assessment of whether a linear opacity corresponds to a pleural invagination consistent with a fissure.[32,33]

Functional considerations

Beyond their role as anatomical landmarks, fissures influence interlobar separation and potentially affect the spread of air, fluid, or pathology within the lung. Incomplete fissures provide parenchymal continuity that may facilitate interlobar collateral pathways and allow inflammatory exudate to cross lobar planes. Clinically, this may manifest as non-classical involvement patterns in pneumonia or atypical collapse configurations. While this study is anatomical, such functional implications underscore why fissural morphology remains clinically relevant.[34]

Significance of complex accessory fissures

The occurrence of a cross-shaped accessory fissure underscores the range of possible accessory configurations. Unlike a single accessory cleft corresponding to a typical segmental boundary, an intersecting fissural pattern suggests persistence of multiple developmental planes. Such configurations can complicate surface-based orientation by introducing misleading "pseudo-lobar" partitions. In operative settings, this may lead to incorrect assumptions about lobar boundaries unless correlated with hilar bronchovascular anatomy. On imaging, intersecting fissures may generate unexpected linear shadows and should be considered in the differential when atypical fissural lines are observed.[35]

Variability across studies and populations

Reported incidences of incomplete, absent, and accessory fissures vary widely across cadaveric and imaging-based investigations. Differences likely reflect population heterogeneity, variation in specimen selection, definitional thresholds for "incomplete," preservation-related surface changes, and observer interpretation. These factors support the value of region-specific cadaveric data for anatomical education and for shaping local clinical expectations.

Limitations
This study is limited by its cadaveric design and the absence of radiological correlation. Gross evaluation, while definitive for morphology, does not capture the full range of appearances on imaging where fissure visualization depends on technique, slice thickness, and lung inflation. Additionally, accessory fissures were recorded by surface inspection; correlation with segmental bronchovascular anatomy would provide more precise classification. Future work integrating thin-section CT correlation and standardized fissure grading systems would strengthen translation to surgical and radiological practice.

CONCLUSION
Incomplete pulmonary fissures are common cadaveric findings, with the right horizontal fissure showing the greatest variability. Accessory fissures, although less frequent, may produce complex fissural patterns that alter normal lobar anatomy. Awareness of these variants is important for accurate radiological interpretation and for safe surgical planning during lobectomy and segmental resections.

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, Tamilnadu, India for granting permission to carry out the research work.

Data Availability:
All datasets generated or analyzed during this study are included in the manuscript.

REFERENCE
1. Foster-Carter AF, Hoyle C. The segments of the lungs: a commentary on their investigation and morbid radiology. *Dis Chest*. 1945;11(6):511-564.
2. Medlar EM. Variations in interlobar fissures. *Am J Roentgenol Radium Ther*. 1947;57(6):723-725.
3. Yamashita H. *Roentgenologic anatomy of the lung*. Tokyo: Igaku Shoin; 1978.
4. Godwin JD, Tarver RD. Accessory fissures of the lung. *AJR Am J Roentgenol*. 1985;144(1):39-47.
5. Craig SR, Walker WS. A proposed anatomical classification of the pulmonary fissures. *J R Coll Surg Edinb*. 1997;42:233-234.
6. Ariyürek OM, Gülsün M, Demirkazik FB. Accessory fissures of the lung: evaluation by high-resolution computed tomography. *Eur Radiol*. 2001;11(12):2449-2453.
7. Aziz A, Ashizawa K, Nagaoki K, Hayashi K. High resolution CT anatomy of the pulmonary fissures. *J Thorac Imaging*. 2004;19(3):186-191.
8. Yıldız A, Gölpınar F, Çalıkoğlu M, Duce MN, Özer C, Apaydın FD. HRCT evaluation of the accessory fissures of the lung. *Eur J Radiol*. 2004;49(3):245-249.
9. Meenakshi S, Manjunath KY, Balasubramanyam V. Morphological variations of the lung fissures and lobes. *Indian J Chest Dis Allied Sci*. 2004;46:179-182.
10. Gesase AP. The morphological features of major and accessory fissures observed in different lung specimens. *Morphologie*. 2006;90(288):26-32.
11. Gülsün M, Ariyürek OM, Cömert RB, Karabulut N. Variability of the pulmonary oblique fissures presented by high-resolution computed tomography. *Surg Radiol Anat*. 2006;28(3):293-299.
12. Prakash, Bhardwaj AK, Shashirekha M, Suma HY, Krishna GG, Singh G. Lung morphology: a cadaver study in Indian population. *Ital J Anat Embryol*. 2010;115(3):235-240.
13. Cronin P, Gross BH, Kelly AM, Patel S, Kazerooni EA, Carlos RC. Normal and accessory fissures of the lung: evaluation with contiguous volumetric thin-section multidetector CT. *Eur J Radiol*. 2010;75(2):e1-e8.
14. Nene AR, Gajendra KS, Sarma MV. Lung lobes and fissures: a morphological study. *Anatomy*. 2011;5(1):30-38.
15. Özdemir O, Gülsün Akpınar M, İnanıcı F, Hasçelik HZ. Pulmonary abnormalities on high-resolution computed tomography in ankylosing spondylitis: relationship to disease duration and pulmonary function testing. *Rheumatol Int*. 2012;32(7):2031-2036.
16. Suja JM, Minnie P. Variations in the interlobar fissure of lungs. *Int J Morphol*. 2013;31:497-499.
17. Jacob SM, Pillay M. Variations in the inter-lobar fissures of lungs obtained from cadavers of South Indian origin. *Int J Morphol*. 2013;31:497-499.
18. Enakshi G, Ritupurna B, Anjana D, Amindya R, Hironmoy R, Amitava B. Variation of fissures and lobes in human lungs. *Int J Anat Radiol Surg*. 2013;2:5-8.
19. Dutta S, Mandal L, Mandal SK, Biswas J, Ray A, Bandopadhyay M. Natural fissures of lung: anatomical basis of surgical techniques and imaging. *Natl J Med Res*. 2013;3(2):117-121.
20. Heřmanová Z, Ctvrtlík F, Heřman M. Incomplete and accessory fissures of the lung evaluated by high-resolution computed tomography. *Eur J Radiol*. 2014;83(3):595-599.
21. Lattupalli H. Lungs lobes and fissures: a morphological study. *Int J Recent Trends Sci Technol*. 2014;11(1):122-126.

22. Varalakshmi KL, Jyothi NN, Sangeetha M. Morphological variations of fissures of lung. *Indian J Appl Res*. 2014;4:457-469.
23. Kaul N, Singh V, Sethi R, Kaul V. Anomalous fissures and lobes of human lungs of North Indian population of western UP. *J Anat Soc India*. 2014;63:S26-S30.
24. George BM, Nayak SB, Marpalli S. Morphological variations of the lungs: a study conducted on Indian cadavers. *Anat Cell Biol*. 2014;47(4):253-258.
25. Quadros LS, Palanichamy R, D'souza AS. Variations in the lobes and fissures of lungs—a study in South Indian lung specimens. *Eur J Anat*. 2014;18(1):16-20.
26. Chandrashekar DC. Anatomical study of pulmonary fissures and lobes. *Int J Recent Sci Res*. 2015;6(6):4554-4557.
27. 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.
28. 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.
29. Anbusudar K, Dhivya S, Anbusudar K. Anatomical study on variations of fissures of lung. *Indian J Clin Anat Physiol*. 2016;3(4):449-451.
30. KC S, 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.
31. Standring S. Development of the lungs, thorax and respiratory diaphragm. In: *Gray's Anatomy: The Anatomical Basis of Clinical Practice*. London: Elsevier; 2021. p. 314-322.
32. Manjunath M, Sharma MV, Janso K, John PK, Anupama N, Harsha DS. Study on anatomical variations in fissures of lung by CT scan. *Indian J Radiol Imaging*. 2022;31:797-804.
33. Ranaweera L, Sulani WN, Nanayakkara WL. Morphological variations of human pulmonary fissures: an anatomical cadaveric study in Sri Lanka. *Ital Anat Embriol*. 2022;126:161-169.
34. Joshi A, Mittal P, Rai AM, Verma R, Bhandari B, Razdan S. Variations in pulmonary fissure: a source of collateral ventilation and its clinical significance. *Cureus*. 2022;14(3):e23121.
35. Moiz N, Khakwani S, Asad Ullah M, et al. Anatomical variations in pulmonary fissures on computed tomography (CT). *Cureus*. 2022;14(11):e32062.