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Variations in the lobes and fissures of lungs – a study in South Indian lung specimens

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SUMMARY

Detailed knowledge of variations in the lobes and fissures of the lungs is important for radiologists to be able to correctly interpret radiological images and also for clinicians in planning segmental resection or pulmonary lobectomy. The right lung normally has three lobes divided by two fissures, and the left lung has two lobes divided by one fissure. Many studies have presented variations in the fissural and lobar patterns of the lungs through radiological examination, CT scan, and also through embalmed cadavers and specimens. We have conducted a study on 76 formalin-fixed lung specimens (36 right and 40 left) from male cadavers ranging from 45-65 years of age to characterize the variations in the formalin-fixed lung specimens from a population of South Indian origin. It was found that four out of seventy -six lungs (5%) exhibited accessory lobes, and fourteen out of seventy-six lungs (18%) presented accessory fissures. These findings are of clinical importance and also of academic interest to all in the medical field.

Key words: Respiration – Lung – Embryology – Invasive procedure – Anatomical variation – Lobe – Fissure

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INTRODUCTION

The lungs occupy major space in the thoracic cavity. The right lung is usually divided by the oblique and horizontal fissures into the upper, middle and lower lobes. The left lung is divided by the oblique fissure into upper and lower lobes (Standring, 2005). The oblique fissure begins from the upper part of the hilum on the mediastinal surface. This fissure cuts the vertebral border at the level of the 4th or the 5th sthoracic spine, courses along the costal surface, cuts the inferior border and will re-appear on the mediastinal surface and ends at the lower end of the hilum. The horizontal fissure begins at the oblique fissure, courses along the costal surface, cuts the anterior border and appears on the mediastinal surface to end at the hilum (Standring, 2005).

The fissures may be complete or incomplete, thus dividing the lungs into complete and incomplete lobes. When the fissures are complete, the lobes are held together only at the hilum. These fissures allow the distension of the lungs, especially the lower lobes, during respiration.

The knowledge of variations in the fissural and lobar pattern is of clinical importance for the surgeons while performing the segmental resection of the infected bronchopulmonary segments. This knowledge is extremely important for the radiologists in interpreting the radiological images and is also of academic interest.

MATERIALS AND METHODS

The lungs of 50 embalmed male cadavers of

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South Indian origin were used for the study. Those lungs which were affected by diseases were excluded from the study. Hence, 76 formalin -fixed lung specimens (36 right and 40 left) were obtained. The age of the cadavers ranged in between 45 and 65 years. Parameters such as fissures, lobes, accessory fissures and accessory lobes were noted and photographed. The classification proposed by Craig and Walker (1997) was followed.

RESULTS

The azygos lobe was not found in any of the lungs. Bilateral variations in the lungs were seen in 5 pairs of lungs belonging to 5 cadavers. Table 1 shows the incidence of anatomical variations of fissures in right and left lungs.

Incomplete oblique fissure was seen in 2 right lungs (5.55%) and 1 left lung (2.5%) (Fig. 1A). Incomplete horizontal fissure was seen in 9 right lungs (25%) (Fig. 2A.). There was complete absence of horizontal fissure in 4 right lungs (11.11%) (Fig. 2B). Accessory fissures were observed in 5 right lungs (13.88%), out of which the superior accessory fissure (SAF) (Fig. 2D) was observed in 8.33% (Table 2.) and Inferior accessory fissure (IAF) (Fig. 2E) was observed in 5.55% of right lung. Accessory fissures were observed in 9 left lungs (22.5%) out of which IAF was observed in 5% and Left minor fissure (LMF) (Fig. 1B) was seen in 17.5% (Table 2).

Table 1. Incidence of anatomical variations of fissures in right and left lungs. * corresponds to one right lung with incomplete oblique and horizontal fissures and two accessory fissures

		Right lung (n=36)	Left lung (n=40)
Oblique fissure	Normal	34 (94.44%)	39 (97.5%)
	Incomplete	2* (5.55%)	1 (2.5%)
	Absent	0 (0%)	0 (0%)
Total		36 (100%)	40 (100%)
Horizontal fissure	Normal	23 (63.88%)	-
	Incomplete	9* (25%)	0 (0%)
	Absent	4 (11.11%)	0 (0%)
Total		36 (100%)	0 (0%)
Accessory fissure		5* (13.88%)	9 (22.5%)

One right lung showed incomplete oblique and horizontal fissures and two accessory fissures, thus dividing the entire lung into five incomplete lobes (Fig. 2. C) (Table 1*). This is an unusually interesting finding. Accessory (supernumerary) lobes were seen in 5 right lungs and 9 left lungs.

DISCUSSION

The fissures help the lobes to move on each other during respiration. The pulmonary pleura extend into these fissures. The fissures may be obliterated by pleurisy and an infection may become localized in the fissure to form an abscess between the lobes of the lungs (Romanes, 1986). The presence of fissures in the normal lungs enhances uniform expansion, and their position could be used as reliable landmarks in specifying lesions within the thorax, in general and within the lungs in particular (Kent and Blades, 1942).

Developmental background

As the lung grows, the spaces and fissures that separate individual bronchopulmonary segments become obliterated except along two planes, which persist in the adults as oblique or horizontal fissures. 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 normally are obliterated (Larsen, 1993).

Several authors have reported the anomalous fissures and lobes. 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 fissure; Grade III – visceral cleft evident for a part of the fissure; and Grade IV – complete fusion of lobes with no evident fissural line (Craig and Walker, 1997). According to the data obtained in our study, the oblique fissure in 34 right lungs and 39 left lungs and horizontal fissure in 23 right lungs can be classified as Grade I. Variations involving oblique fissure in 2 right lungs and 1 left lung and variations involving horizontal fissure in 9 right

Table 2. Incidence of lung accessory fissures. Abbreviations: SAF, superior accessory fissure; IAF, inferior accessory fissure; LMF, left minor fissure.

	SAF (%)	IAF (%)	LMF (%)
Right lung	8.33 (3/36)	5.55 (2/36)	0
Left lung	0	5.0 (2/40)	17.5 (7/40)

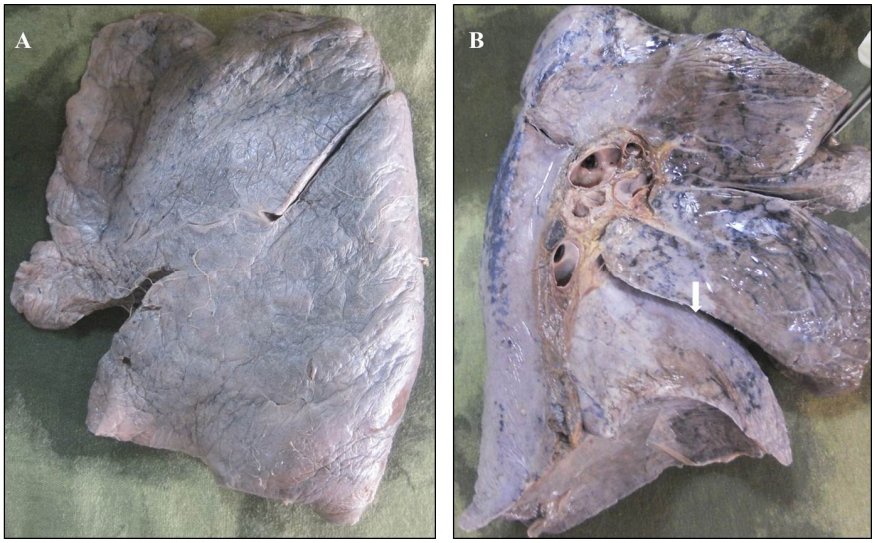

Fig. 1. Anatomical variations of the left lung. **(A)** Costal surface showing incomplete oblique fissure. **(B)** Mediastinal surface showing left minor fissure (arrow).

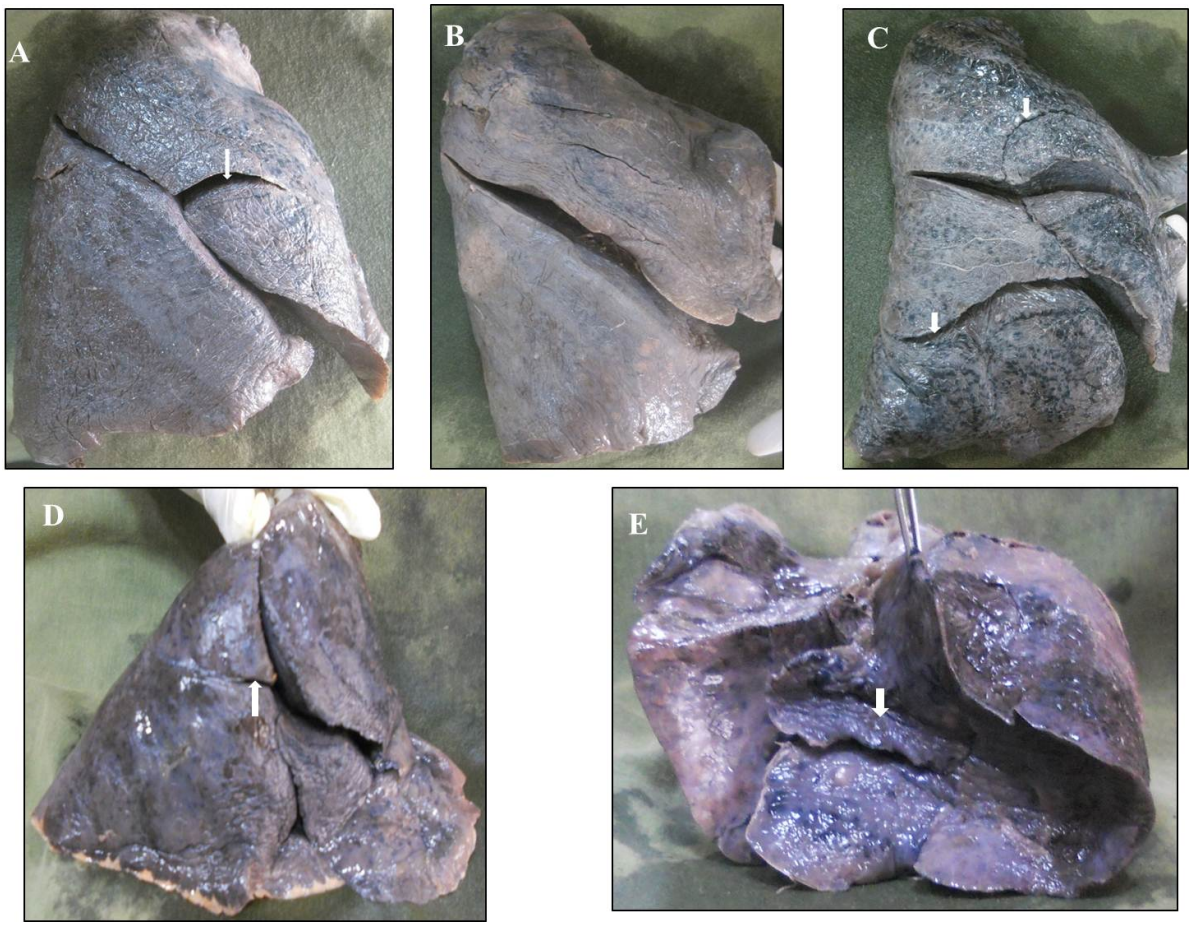

Fig. 2. Anatomical variations of the right lung: **(A)** Costal surface showing incomplete horizontal fissure (arrow). **(B)** Costal surface showing the absence of a horizontal fissure. **(C)** Costal surface showing an incomplete oblique fissure, an incomplete horizontal fissure and two accessory fissures (arrows), thus dividing the lung into five lobes. **(D)** Costal surface showing a superior accessory fissure (arrow). **(E)** Diaphragmatic surface showing an inferior accessory fissure (arrow).

lungs can be classified as Grade II. Absence of horizontal fissure was noted in 4 right lungs which are considered as Grade IV (Fig. 2B). Remaining 5 right lungs and 9 left lungs showed accessory fissures in addition to oblique fissure and horizontal fissures.

An atypical fissure may confuse a radiologist interpreting skiagrams. Often, an anomalous fissure may be mistaken as pleural effusion (Meenakshi et al., 2004). The accessory fissures fail to be detected on CT scans, because of their incompleteness, thick sections and orientation in relation to a particular plane (Ariyurek et al., 2001). Sometimes, especially in infants, accessory fissures of varying depth can be seen in unusual locations of the lung, delimiting abnormal lobes which correspond to the normal bronchopulmonary segments (Rosse and Gaddum-Rosse, 1997). Often this accessory fissure acts as a barrier to infection spread, creating a sharply marginated pneumonia which can wrongly be interpreted as atelectasis or consolidation (Godwin and Tarver, 1984). Many diseases require accurate segmental localization of the lesion, and the knowledge of accessory fissure is of much clinical importance to the clinician. Preoperative planning and strategy for segmental resection or pulmonary lobectomy may also change during the presence of such accessory fissure (Nene et al., 2011). Knowledge of anatomical variations alerts the surgeons to potential problems that might be encountered during surgical intervention (Cimen et al., 2005). An incomplete fissure is also a cause of postoperative air leakage (Craig and Walker, 1997). Accurate recognition of incomplete major and minor interlobar fissure in different populations may lead to improve the understanding of lesions like pneumonia, pleural effusion, and collateral air drift along with disease spreading through the lung, as seen by imaging techniques (Prakash et al., 2010). The lung fissures variations have been well documented in the literature. However, a good knowledge of the fissures of the lungs and their supernumerary lobes is important for the diagnostic image techniques, thoracic surgery, and for clinicians in general. The comparison of our study with the previous studies on cadavers and specimens has been shown in Table 3. We found lower incidence of absent or incomplete oblique and horizontal fissures in the right lungs, and absent or incomplete oblique fissure in the left lungs, when compared to the previous studies. But we report a greater incidence of accessory lobes when compared to the study by Devi et al. (2011).

Accessory fissures can be mistakenly confused with areas of linear atelectasis, pleural scars or walls of bullae (Godwin and Tarver, 1984). Therefore, we also looked for the occurrence of superior accessory fissure, inferior accessory fissure and left minor fissure in right and left lungs shown in Table 3. The superior accessory fissure is seen in the lower lobe. The superior accessory fissure separates the superior segments from the lower basal segments. When it is present, the superior segment has been called the posterior or dorsal lobe (Godwin and Tarver, 1984) (Fig. 2D). The inferior accessory fissure is seen in the medial basal segment of the lower lobe (Fig. 2E). The

Table 3. Comparative prevalence of anatomical variations of lung fissures.

Author(s)	Right lung				Left lung	
	Oblique fissure		Horizontal fissure		Oblique fissure	
	Absent (%)	Incomplete (%)	Absent (%)	Incomplete (%)	Absent (%)	Incomplete (%)
Medlar, 1947	4.8 (58/1200)	25.6-30.0 (307-360/1200)	45.2 (506/1200)	17.1 (205/1200)	7.3 (88/1200)	10.6 (127/1200)
Lukose et al., 1999	-	-	10.5 (2/19)	21.0 (4/19)	-	21.0 (4/19)
Meenakshi et al., 2004	-	36.6 (11/30)	16.6 (5/30)	63.3 (19/30)	-	46.6 (14/30)
Bergmann et al., 2008	-	30.0 (83/277)	21.0 (58/277)	67.0 (186/277)	-	30.0 (83/277)
Prakash et al., 2010	7.1 (2/28)	39.3 (11/28)	7.1 (2/28)	50.0 (14/28)	10.7 (3/28)	35.7 (10/28)
Bhima Devi et al., 2011	-	9.0 (2/22)	9.0 (2/22)	18.0 (4/22)	9.0 (2/22)	36.3 (8/22)
Nene et al., 2011	2.0 (1/50)	6.0 (3/50)	14.0 (7/50)	8.0 (4/50)	0	12.0 (6/50)
Present study	0	5.55 (2/36)	11.11 (4/36)	25.0 (9/36)	0	2.5 (1/40)

left minor fissure separates the lingual from the rest of the left upper lobe (Fig. 1B). According to Nene et al. (2011), SAF was seen in 4% of right lung. In the present study, SAF was observed in 8.33% of right lung. IAF was observed in 14% right lung and 24% left lung. In the present study, IAF was observed in 5.55% right lung and 5% left lung which was lower than the previous study. LMF was observed in 26% of left lung. In the present study, LMF was observed in 17.5% of left lung which was also lower (Table 2).

Clinicians must be aware of the frequency of variations in the pattern of lobes and fissures of the lungs in order to avoid and reduce the mortality and morbidity associated with invasive procedures. A radiologist must be warranted towards the depth and occurrence of these variations in order to prevent and avoid the misinterpretation of the radiological images.

REFERENCES

ARIYUREK OM, GULSUN M, DEMIRKAZIK FB (2001) Accessory fissures of the lung: evaluation by high-resolution computed tomography. *Eur Radiol*, 11: 2449-2453.

BERGMAN RA, AFIFI AK, MIYAUCHI R (2008) Variations of the lobes and fissures of lungs. In: Illustrated Encyclopedia of Human Anatomic Variations: Opus IV: Organ Systems: Respiratory System. http://www.anatomyatlases.org/AnatomicVariants/OrganSystem/Text/LungsTrachea.shtml. Accessed on 7th April 2012.

CIMEN M, ERDIL H, KARATEPE T (2005) A cadaver with azygos lobe and its clinical significance. *Anat Sci Int*, 80: 235-237.

CRAIG SR, WALKER WS (1997) A proposed anatomical classification of the pulmonary fissures. *J R Coll Surg Edin*, 42: 233-234.

DEVI NB, RAO BN, SUNITHA V (2011) Morphological variations of lung - A cadaveric study in north coastal Andhra Pradesh. *Int J Biol Med Res*, 2: 1149-1152.

GODWIN JD, TARVER RD (1984) Accessory Fissures of the Lung. *Am J Roentgenol,* 144: 39-47.

KENT EM, BLADES B (1942) The surgical anatomy of the pulmonary lobes. *J Thorac Surg*, 12: 18-30.

LARSEN WJ (1993) *Human Embryology*. Churchill Livingstone, New York, pp 111-130.

LUKOSE R, PAUL S, SUNITHA, DANIEL M, ABRAHAM SM, ALEX ME, THOMAS R, NAIR V (1999) Morphology of the lungs: Variations in the lobes and fissures. *Biomedicine*, 19: 227-232.

MEDLAR EM (1947) Variations in interlobar fissures. *Am J Roentgenol Radium Ther*, 57: 723-725.

MEENAKSHI S, MANJUNATH. KY, BALASUBRAMANYAM V (2004) Morphological variations of lung fissures and lobes. *Indian J chest Dis Allied Sci*, 46: 179-182.

NENE AR, GAJENDRA KS, SARMA MVR (2011) Lung lobes and fissures: a morphological study. *Anatomy*, 5: 30-38.

PRAKASH, BHARADWAJ AM, SHASHIREKHA M, SUMA HY, KRISHNA GG, SINGH G (2010) Lung morphology: a cadaver study in Indian population. *IJAE*, 115: 235-240.

ROMANES GJ (1986) *Cunningham's manual of practical anatomy. The cavity of the thorax,* 2(15): 33.

ROSSE C, GADDUM-ROSSE P (1997) *Hollinshed's Textbook of Anatomy*. Lippincot-Raven, Philadelphia, pp 441-461.

STANDRING S (2005) *Gray's Anatomy.* 39th edn. Churchill Livingstone, New York, pp 945-949.