

ORIGINAL RESEARCH

NATURAL FISSURES OF LUNG- ANATOMICAL BASIS OF SURGICAL TECHNIQUES AND IMAGING

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ABSTRACT

Background: The fissures in lung enhance uniform expansion. These fissures may be complete, incomplete or absent. A detailed knowledge of variations of classical and accessory fissures is necessary for proper radiological interpretation. It is a guide to cardiothoracic surgeons performing segmental lung resections, lobectomies to have an uncomplicated perioperative outcome. So, the cadaveric study was done to note the morphological variation of the fissures of lung in eastern Indian population and compare it with previous studies.

Methods: 102 lungs obtained during dissection of formalin fixed cadavers in Calcutta National Medical College, Kolkata and preserved in 10% formalin were thoroughly studied to note every morphological details of fissures present in the lungs.

Results: 44% of left lungs had classically complete oblique fissure compared to 26.92% on the right. No oblique fissure could be detected in 8% lungs of left and 11.54% of right side. Horizontal fissure was completely absent in 34.6%. Various degree of parenchymal fusion was more common on the right side. None of the oblique fissures had uniform depth.

Conclusion: Comparison with other studies shows wide regional variations in morphological patterns of lung fissures, implying environmental and genetic factors in its development. Present study unfolds that parenchymal fusion of various extent is a very common entity of oblique fissure of lung. So, more lung parenchyma has to be dissected to reach the bronchi and pulmonary arteries during partial lung resection which naturally might lead to peroperative hemorrhage and more postoperative complications. This knowledge of anatomy of fissures of lung may also help clarifying confusing radiographic findings.

Key Words: Lung fissures, Cadaver, Lung Resection.

INTRODUCTION

The lungs are the essential organs of respiration. Fissures are an integral part of human lung. The oblique fissure divides the left lung into superior and inferior lobes which extends from the costal to the medial surfaces starting above and in front of the hilum, ending below and behind it. Right lung has both oblique and horizontal (transverse) fissures dividing it into superior, middle and inferior lobes. The transverse fissure passes from the oblique fissure, near the mid-axillary line, horizontally forwards towards the anterior border and then passes backwards to the hilum on the mediastinal surface. ¹ The fissures facilitate the movement of the lobes in relation to one another, which accommodates greater distention and movement of the lobes during respiration. The fissures may be complete, incomplete or absent. In case of complete fissure the lung lobes are held together only at the hilum by the bronchi and the pulmonary vessels. Parenchymal fusion of varied extent along the floor is found in case of incomplete fissure. ²

In addition to those fissures lung might also have accessory fissures, usually indicating junction between bronchopulmonary segments. As per Godwin ³, they are superior accessory fissure, inferior accessory fissure or left minor fissure. Hayashi et al ⁴ affirmed that an incomplete major fissure may lead to disease spread, collateral air drift, or the "incomplete fissure sign," a sign that may, however, also be present in cases of complete fissure. Knowledge of the anatomy and variations of the major fissures are essential for recognizing their variable imaging appearances as well as related abnormalities. The cardiothoracic surgeons performing segmental lung resections and the radiologists must have a detailed knowledge of variations of classical and accessory fissures regarding their length, depth, positions etc to have uncomplicated peroperative and postoperative events and proper radiological interpretations respectively. We have studied the morphological variation of the fissures of lung in eastern Indian population and compared it with previous studies done in other parts of the world.

MATERIALS AND METHODS

102 specimens of adult lungs were obtained from formalin fixed cadavers which were removed during routine dissection for undergraduate teaching at Calcutta National Medical College, West Bengal, India. All the specimens were preserved in 10% formalin. The specimens having pathological lesions, marks of previous surgery, damaged during removal were not included in the study. Of the 102 lungs thus obtained, 50 were of the left side and the rest 52 belonged to the right. The specimens were serially numbered and photographs were taken. Every morphological detail of the natural fissures present in the lungs was recorded in a proforma. The anatomical classification proposed by Craig and Walker⁵ was followed to determine for the presence and completeness of fissures. The depth of oblique fissure was noted by introducing a rigid metallic probe perpendicular to the surface of the lung and then measuring it to the nearest millimeter. The depth was measured at three sites. First at the upper end, then at the lower end as well as along with the floor of the fissure throughout its length. Then the maximum depth thus obtained was recorded. In the specimens where the oblique fissure was found to be incomplete, the obliterated distances were measured from the nearest point of the hilum. Vernier calipers and parametric ribbon method were used for measurement and data analyzed by Microsoft excel software.

RESULTS

Left Lung

Of the 50 left sided lung specimens only 44 % (22) had classically complete oblique fissure (Table-1). 28 % (14) belonged to Grade I variety. Rest showed various degree of parenchymal fusion along the course. In 8% (4 specimens) no oblique fissure could be detected (Fig 1), rest were incomplete either at its beginning or at its end or both. Table-2 shows that in 66.66% (16) of

specimens on the left were incomplete at both ends. The fissures were of 27.32±7.29 cm length when all the lungs with oblique fissure were considered (Table-3). Interestingly in one specimen the oblique fissure terminated on the diaphragmatic surface without reaching the mediastinal surface. Depth of oblique fissure was found to be widely variable. Maximum depth was 4.75± 1.44 cm. Accessory fissures were noted in 5 of the specimens studied and all of them were in the upper lobe. Three of those were connected to oblique fissure. In one specimen the accessory fissure was horizontally placed almost resembling transverse fissure. It divided the left upper lobe into an additional incomplete middle lobe or cleft upper lobe. Lingula has arisen from this lobe. (Fig 2).

Right Lung

Of the 52 right sided lung specimens 26.92%(14) had classically complete oblique fissure (Table-1). Only 23.07%(12) belonged to Grade I variety. In 11.54%(6) no oblique fissure could be detected, rest were incomplete either at its beginning or at its end or both (Table-2). The fissures were of 30.15±6.26 cm length when all the lungs with oblique fissure were considered (Table-3). Maximum depth of the oblique fissure was 5.73± 1.41 cm. In one right lung oblique fissure ended on the costal surface 7 cm away from the hilum at its lower end. Horizontal fissure was completely absent in 34.62% (18).

Table 1- Comparison of Oblique Fissures of lungs

| Lung | Complete (%) | Incomplete (%) | Absent (%) |
|--------------|--------------|----------------|------------|
| Left (n=50) | 22 (44) | 24 (48) | 4 (8) |
| Right (n=52) | 14(26.92) | 32 (61.54) | 6 (11.54) |

P=0.050

Table 2 –Comparison of Incompleteness of Oblique Fissures

| Incomplete at upper end | | | | Incomplete at lower end | | | | Incomplete at both ends | |
|-------------------------|-------------|-------------------|-------------|-------------------------|-------------|-------------------|-------------|-------------------------|-------------------|
| Left Lung (n=24) | | Right lung (n=32) | | Left lung (n=24) | | Right Lung (n=32) | | Left lung (n=24) | Right Lung (n=32) |
| No (%) | D (cm) | No (%) | D (cm) | No (%) | D (cm) | No (%) | D (cm) | (%) | (%) |
| 18 (75) | 5.76 ± 3.77 | 26 (81.25) | 3.22 ± 1.48 | 22 (91.66) | 5.06 ± 3.99 | 18 (56.25) | 3.23 ± 2.10 | 16 (66.66) | 12 (37.5) |

D=distance from nearest point of hilum, shown in mean±sd

Amongst those specimens, 4 did not show any oblique fissure as well. In those specimens where horizontal fissure was present 38.89% was incomplete. Accessory fissure was found in 3 lungs, one of which was in the lower lobe. All of them were connected to the oblique fissure. Fig 3 shows that horizontal fissure started 6cm away from the oblique fissure. An accessory fissure is present in the costal surface of upper lobe extending from the oblique fissure and terminated 6.5cm away from anterior border.

In both lungs, oblique fissure was found to be deepest near the middle on the costal surface in majority of

cases; in a few it was deepest either at the beginning or at the end. In none of the fissure the depth was uniform.

Table 3- Length of Oblique Fissure (cm)

| Lung | Mean ± SD | Range |
|--------------|--------------|---------|
| Left (n=46) | 27.32 ± 7.29 | 40.5-11 |
| Right (n=46) | 30.15 ± 6.26 | 43-20.5 |

P=0.048



Fig 1

Fig 1- shows absence of fissures in left lung.

variations from normal pattern of development of lung⁷ Hence, detection of any accessory fissure is indicative of persistence of those prenatal fissures.

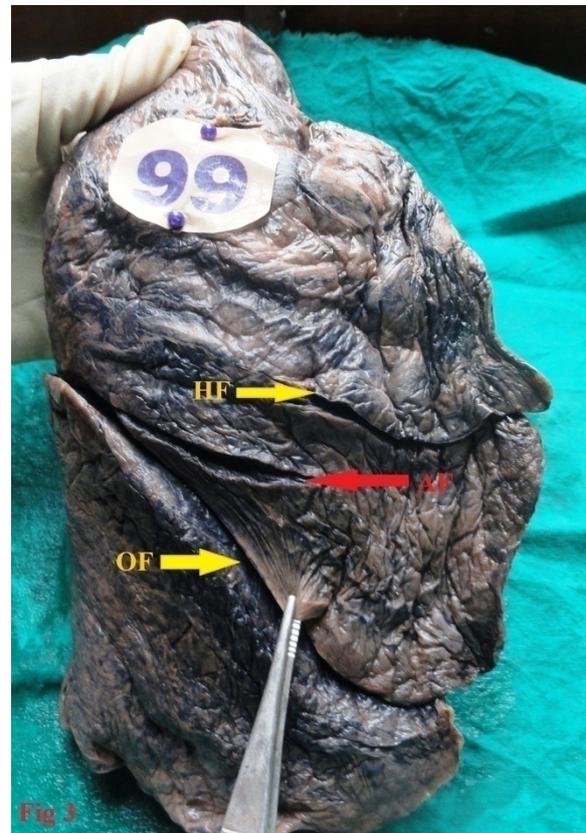


Fig 3

Fig 3- Yellow arrow indicates oblique fissure (OF) and horizontal fissure (HF),red arrow shows accessory fissure (AF) in the upper lobe below HF.

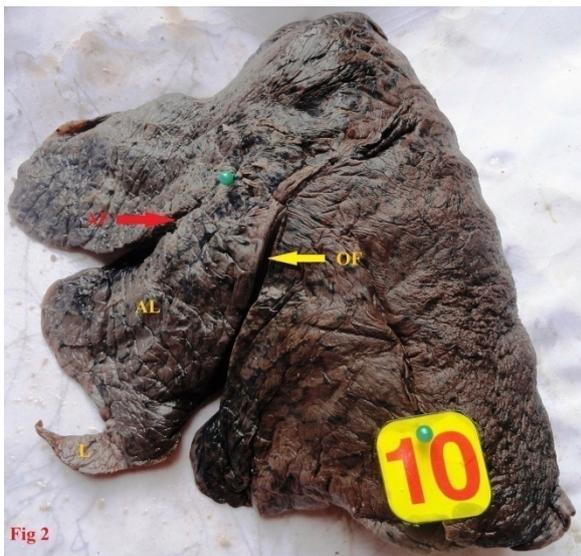


Fig 2

Fig 2- Yellow arrow indicates oblique fissure(OF),red arrow indicates accessory fissure (AF) and green ball marks its extent, AL denotes cleft upper or middle lobe,L indicates lingula.

Our study revealed that, in majority of cases the fissures were incomplete, more on the right side than on the left ($p=0.050$)(Table 1).These findings are being compared with those of other researchers in Table 4.More incidence of incomplete oblique fissures on the right side might indicate early commencement of fusion of the prenatal fissures which may proceed further before birth leading to fusion along floor of the oblique fissure. Our finding matches with Glazer et al ⁹, though the table shows wide variability which may be due to regional variation. An incomplete fissure is also a cause for postoperative air leakage during lobectomies⁵

DISCUSSION

Lung develops as an endodermal diverticulum at about 28 days after fertilization. The lung bud bifurcates into 2 main bronchi left and right which ultimately develops into secondary bronchi and the lung lobes.⁶ In prenatal life fissures separate individual bronchopulmonary segments. All fissures gradually get obliterated leaving behind oblique and horizontal fissures. Any variation in the morphological pattern of the fissures indicate

Lymphatics of lung drain centripetally from pleura towards the hilum. Altered course of oblique fissure would mean altered course of visceral pleura, thereby changing the arrangement of lymphatic drainage.¹⁴ In the present study oblique fissure was absent in 8% of left lungs and 11.4% of right lung. But Prakash et al ¹² reported absent oblique fissure in 10.7% and 7.1% and Medlar ⁸ in 7.3% and 4.8% specimens of left and right lungs respectively. These results do not match with our data as oblique fissure was absent more on the right side.

Table 4- Comparison of our data with other researchers

| Author(s) & Yr | Method of Study | Incomplete or absent Horizontal fissure Right Lung (%) | Incomplete Oblique fissure Right lung (%) | Incomplete Oblique fissure Left lung (%) |
|--|----------------------------------|--|---|--|
| Medlar, 1947 ⁸ | Morphological study from cadaver | 62.3 | 25.6-30 | 10.6-18 |
| Glazer et al, 1991 ⁹ | Thin Section CT | - | 64 | 52 |
| Lukose et al, 1999 ¹⁰ | Morphological study from cadaver | 31.5 | - | 21 |
| Aziz et al, 2004 ¹¹ | Radiological Study -CT Scan | 63 | 48 | 43 |
| Prakash et al, 2010 ¹² | Morphological study from cadaver | 57.1 | 39.3 | 35.7 |
| N.Bhimaidevi et al, 2011 ¹³ | Morphological study from cadaver | 18 | 9 | 36 |
| Present Study, 2012 | Morphological study from cadaver | 75.8 | 61.54 | 48 |

N Bhimai Devi et al¹³, studied the length of oblique fissure in the lung specimens obtained from the cadavers of people of north coastal Andhra Pradesh where they found the length as 28-13 cm on right side and 28-7 cm on left side. Table 3 shows that, our study also revealed a wider range but the mean is very close to the above study. The difference in the length of oblique fissure of right and left lungs is significant ($p=0.048$) in our study.

Table 5-Comparison of Grades of Fissure

| Lung | Grade I (%) | Grade II (%) | Grade III (%) | Grade IV (%) |
|--------------|-------------|--------------|---------------|--------------|
| Left (n=50) | 14 (28) | 8 (16) | 24 (48) | 4 (8) |
| Right (n=52) | 12 (23.07) | 2 (3.85) | 32 (61.54) | 4 (7.69) |

P=0.153

The maximum depth of oblique fissure was found to be more on the right side (5.73 ± 1.41 cm) than left (4.75 ± 1.44 cm). The fissures were deepest at the middle and shallow at its ends barring a few lungs. This pattern indicates that the fusion of the prenatal fissures of the lung starts from its two ends and then meets in the middle. But, in few of the specimens maximum depth was noted either at the beginning or termination of the oblique fissure. Even after intense search of the literature we could not find any morphological study regarding the depth of the fissure. As per Craig and Walker⁵ the completeness of natural fissures of lung can be classified into 4 grades. 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. From the data in this study morphological variations of grades of oblique fissures are depicted in Table- 5 and these variations between the left and right lung is not significant ($p=0.153$). Only in 28 % of left lung and 23.07 % of right lung entirely separate lobes were noted. Parenchymal fusion of various extent is more commonly seen on the right side in comparison to the left side. Surgically the gradation of fissure is important. The surgeon approaches to ligate the vessels and bronchi through the depth of the fissure. Grade I oblique fissure facilitates the approach while doing lobectomy and video assisted thoracoscopic surgery.¹⁵ But otherwise the lung parenchyma has to be

dissected to reach those structures leading to peroperative hemorrhage and more postoperative complications.¹⁶ On the other hand while performing right upper lobectomy, middle lobe has the chance of undergoing torsion if the oblique fissure is of grade 1 variety. So, preventive fixation of the middle lobe is essential to avoid this complication.¹⁷

Present study unfolds that in only 38.46% (20) cases horizontal fissure is classically complete. Comparison with the findings of other researchers (Table 4) shows that though the values do not match exactly but always there is a high percentage of lungs with absent or incomplete horizontal fissure. The average length of the horizontal fissure in our study was 8.49 ± 4.03 cm, maximum being 18.5 cm minimum being 3 cm. N Bhimaidevi et al¹³ found the length of horizontal fissure ranged from 17-10 cm widely varying from ours.

The presence of fissures in normal lung 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.¹⁸ Accessory fissures of the lung are commonly observed in lung specimens, but are often unappreciated or misinterpreted on radiographs and CT scans. Accessory fissures can be mistakenly confused with areas of linear atelectasis, pleural scars, or walls of bullae.³ On CT scans accessory fissures are seen as high attenuation curvilinear band.¹⁹ Berkmen et al²⁰ in their imaging study of 17 patients by CT scan and X-ray found 18 accessory fissures. This knowledge of anatomy may help clarification of confusing radiographic findings like extension of fluid into an incomplete major fissure or spread of various diseases through different pathways.²¹

In the present study accessory fissures were more commonly observed on the left side (5 Specimens) than on the right side (3 Specimens). In patients with endobronchial lesion, an accessory fissure might alter the usual pattern of lung collapse and pose difficulty in diagnosing

a lesion and its extent. Pneumonia in a particular lobe is contained within the confines of the lobe by complete fissures. In patients with incomplete fissures, pneumonia may spread to adjacent lobes through the parenchymal continuation. Odd lobar involvement with carcinoma of the lung may be explained on a similar basis.²²

Current study indicates that incompleteness of the fissures predominates in the right lung. In few cases horizontal fissure is classically complete. The results of present study and their comparison with the previous works show that there is a wide range of difference in occurrence of classical and accessory fissures between and among different populations. This implies that a variety of genetic and environmental factors might affect development of these fissures. The study also unfolds that parenchymal fusion of various extent is a very common entity of oblique fissure of lung. So more lung parenchyma has to be dissected to reach the bronchi and pulmonary arteries during lung resections and thoracoscopic surgeries leading to perioperative hemorrhage and more postoperative complications. Documentation and familiarization of these anomalies remains important for making correct radiological diagnosis and for proper surgical management of lung pathology. Recognition of lung anomalies improves understanding of pneumonia, pleural effusion, collateral air drift along with disease spreading through lung.

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