Original article

ANATOMICAL STUDY OF FISSURES AND LOBES OF LUNG WITH THEIR SURGICAL AND IMAGING IMPORTANCE

Natwar Lal Agrawal*, Nidhi Agrawal, Mayura Setiya
Associate Professor, Professor, Assistant Professor
Department of Anatomy, N. S. C. B. Medical College, Jabalpur (MP)

Abstract

Background: Lungs are the primary organs of respiration located on either side of the heart in the thoracic cavity and are suspended from the mediastinum by the lung root which is a collection of structures entering and leaving the lungs. For the purpose or intention of uniform expansion, the whole lung is divided into lobes by means of fissures which form an elemental part of the lung. Sound knowledge of the disposition of fissures of the lungs directs the cardiothoracic surgeons performing segmental lung resections and lobectomies to avoid any untoward situation during surgery and also minimize the postoperative complications. Aims of the study: This cadaveric study was done to show the anatomical variations in fissures and lobes of lung to help surgeons and radiologist in clinical interpretations. Materials and methods: The present observational study wherein 103 adult formalin fixed cadaveric lungs were procured during routine cadaveric dissection was conducted in the department of anatomy of our institute NSCB, Medical College Jabalpur, M.P. All the specimens were preserved in 10% formalin and were thoroughly studied to note every morphological detail of fissures present in the lungs. Results: The observations of the present study showed that there was presence of incomplete oblique fissure (Grade II & III) in 4 lungs (09.09%) on the right and in 10 lungs (16.95%) on the left side. Horizontal fissure was incomplete in 20 lungs (45.45%) of right side. Conclusion: Present study reveals that parenchymal fusion of various extents 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 perioperative hemorrhage and more postoperative complications. This knowledge of anatomy of fissures of lung may also help resolve perplexed radiographic findings.

Introduction

Lungs are pair of spongy air filled organs accountable for carrying out an indispensable role i.e. respiration. For the purpose or intention of uniform expansion, the whole lung is anatomically divided into lobes by means of fissures which form an elemental part of the lungs. Lung fissures are a double fold of visceral pleura that either completely or incompletely invaginates the lung parenchyma to form the lung lobes. The right and left lungs do not have an identical lobular structure. The left lung has a superior and inferior lobes separated by an oblique fissure, whereas the right lung has an oblique and horizontal fissure dividing it into superior, middle and inferior lobes.[1] These fissures can be said as complete when the lobes remain held together only at the hilum by bronchi and pulmonary vessels, or they may be incomplete when there are areas of parenchymal fusion between the lobes or they may be absent altogether.[2] The oblique fissure begins from the mediastinal surface above and behind the hilum, passes upwards and backward and cuts the posterior border of the lung about 2.5 cm lateral to the junction of the T3-T4 spine. It then follows downward and forward along the costal surface coinciding with the 5th intercostal space in the mid-axillary line, and cuts the inferior border of the lung at the 6th costochondral junction about 7.5 cm lateral to the middle line and finally reaching the hilum. Oblique fissure of the left lobe is more vertical. [3,4] The oblique fissure act as a plane of cleavage so that during inspiration upper part of the lung expands forwards and laterally by the elevation of ribs, whereas lower part of the lung moves downwards and backwards by the piston movement of the diaphragm.[1] When the oblique fissure is incomplete the adjacent lobes are connected by a substantial portion of pulmonary tissue as the fissure fails to reach the hilum. An incomplete fissure may lead to spreading of disease to adjacent lobes and collateral air drift through contiguous parenchymal unit.[5] Altered course of oblique fissure leads to change in the pattern of arrangement of lymphatic drainage as the lymphatics of the lung drain centripetally from pleura towards the hilum. [6] Horizontal fissure is present only in

Keywords:
Lung fissure, Lobes, Oblique fissure, Horizontal fissure, Accessory fissure

* Corresponding Author: KRANTI KUMAR GOUR
Department of Anatomy, N. S. C. B. Medical College, Jabalpur (MP)
the right lung and extends horizontally from the oblique fissure at mid–axillary line up to the anterior border and separates a wedge shaped middle lobe from the upper lobe. [3,7] These fissures ease the movement of the lobes helping in greater distension and facilitate a uniform expansion of whole lung for more air intake during respiration. These fissures form the partition for the lobes of the lungs, and clear understanding of their position is necessary to acknowledge lobar anatomy thereby helps in locating the bronchopulmonary segments which are noteworthy both anatomically and radiologically. [8] Accessory fissures of the lung are commonly observed in lung specimens, but are often unclassified or misconceived on radiographs and computerized tomographic (CT) scans. Anatomically, an accessory fissure is a cleft of varying depth lined by visceral pleura. These accessory fissures usually occur at the boundaries of the bronchopulmonary segments and namely these are superior accessory fissure, inferior accessory fissure or left minor fissure. As per Godwin, the most common accessory fissures are the inferior accessory fissure but in our study there was a predominance of superior accessory fissure. The accessory fissures might alter the diagnosis. [9] Radiologically an accessory fissure appearing as a thin white line may be misinterpreted as areas of linear atelectasis, pleural scars or walls of bullae or may resemble the major or minor fissure, except for its location. [9,10] A fissure appearing complete on X-ray might be seen as an incomplete one on CT scan. [10] In order to provide framework for descriptive operating techniques and to allow significant comparison between different surgical sequence parameters. First, the degree of completeness of the fissure and second the location of the pulmonary artery at the base of the oblique fissure. [11] But in our study we are including the anatomical classification based on the degree of completeness of fissure as proposed by Craig and Walker rather than considering the location of pulmonary artery at the base of oblique fissure.

<table>
<thead>
<tr>
<th>Grades</th>
<th>Craig and Walker criteria of completeness of a fissure</th>
<th>No. of lungs which showed in Table 2.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>Complete fissure with entirely separate lobes</td>
<td>(20): Right (9, 0.45%) Left (11, 0.55%)</td>
</tr>
<tr>
<td>Grade 2</td>
<td>Complete visceral cleft but parenchymal fusion at the base of the fissure</td>
<td>(0): Right (0, 0%) Left (0, 0%)</td>
</tr>
<tr>
<td>Grade 3</td>
<td>Visceral: cleft evident for part of the fissure</td>
<td>(0): Right (0, 0%) Left (0, 0%)</td>
</tr>
<tr>
<td>Grade 4</td>
<td>Complete fusion of the lobes with no evident fissural line</td>
<td>(0): Right (0, 0%) Left (0, 0%)</td>
</tr>
</tbody>
</table>

When the embryo is approximately 4 weeks old, the respiratory diverticulum i.e. lung bud appears as an outgrowth from the ventral wall of the foregut. On 22nd day it bifurcates into two primary bronchial buds. Early in 5th week the right bronchial bud branches into three secondary bronchial buds while the left one branches into two. By the 6th week secondary bronchial buds branch into tertiary bronchial buds (10 on right and 10 on left side) to form the bronchopulmonary segments. In prenatal life individual bronchopulmonary segments are set apart by means of fissures. Gradually as the lung grows all the spaces between individual bronchopulmonary segments get obliterated except along the line of division of principal bronchi where deep complete fissures remain dividing the right lung into three lobes and left lung into two lobes, which persist in adult as oblique and horizontal fissures. [8, 12] Absence or incompleteness of a fissure could be due to obliteration of these prenatal fissures either completely or partially. [13] Incomplete fissures indicate partial fusion between lobes. [12, 14] The monopodial branching of stem bronchi accounts for accessory bronchi and lobes often found in adult lung. [8] Any divergence in the morphological pattern of the fissures indicates deviation from normal pattern of development of lung. The character of the fissure is of eminent significance in scheming operative strategy for thoracoscopic pulmonary resection where an incomplete fissure may contribute to post operative air leakage. [12] The perception of anatomical variations in fissures and lobes is of eminent threat for location of bronchopulmonary segments which might help surgeons to exactly diagnose, scheme and perform lobectomies and in segmental resection. It could also be of significance in elucidating radiological images. 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. The following study is aimed to find out the anomalous fissures and lobes along with their patterns, in human lungs; collected from formalized donated cadavers and we believe that the statistically significant data from the present study certainly adds an important reference in the medical literature.

**MATERIALS AND METHODS**

The present study was conducted in the department of anatomy of our institute NSCB, Medical College Jabalpur, M.P. The thoracic cavities of properly embalmed cadavers containing lungs were dissected as a part of routine dissection for MBBS students and 103 adult formalin fixed cadaveric lungs were procured. Lungs which exhibited pathological changes and mutilations were excluded from the study. These lungs were meticulously observed for the patterns of lobes and fissures, variations were noted and documented in the form of photograph. The classification proposed by Craig and Walker (1997) was followed. [11]

**RESULTS**

The observations of the present study showed that there was presence of incomplete oblique fissure (Grade II & III) in 4 lungs (09.09%) on the right side and in 10 (16.95%) on the left side. In the present study oblique fissure was absent (Grade IV) in single (2.27%) right lung and in 2 (3.39%) left sided lungs. Horizontal fissure was incomplete (Grade II & Grade III) in 20 (45.45%) of right lung and incomplete horizontal fissure was present in 1 left lung (1.69%) as showed in table 1. Presence of accessory fissure was noticed in 6 (13.64%) right sided lungs out of which all were superior accessory fissure and in 3 (5.08%) left sided lungs out of which 2 left sided lungs showed the presence of superior accessory fissure and one showed the presence of inferior accessory fissure as showed in table 2.

**OBSERVATIONS: Table 1 : Number and percentage of Fissures of Lungs.**

<table>
<thead>
<tr>
<th>Side of Lungs</th>
<th>Number of Lungs studied</th>
<th>Complete Oblique Fissure (Grade I)</th>
<th>Complete Horizontal Fissure (Grade II &amp; III)</th>
<th>Incomplete Oblique Fissure (Grade II &amp; III)</th>
<th>Incomplete Horizontal Fissure (Grade II &amp; III)</th>
<th>Absent Oblique Fissure (Grade IV)</th>
<th>Absent Horizontal Fissure I Fissure (Grade IV)</th>
<th>Absent Horizontal II Fissure (Grade IV)</th>
<th>Absent Horizontal III Fissure (Grade IV)</th>
<th>Accessory Fissure (Grade IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>64</td>
<td>19 (80.46%)</td>
<td>14 (31.82%)</td>
<td>18 (40.54%)</td>
<td>10 (23.23%)</td>
<td>91</td>
<td>91 (90.99%)</td>
<td>10 (22.73%)</td>
<td>91 (90.99%)</td>
<td>91 (90.99%)</td>
</tr>
<tr>
<td>Left</td>
<td>59</td>
<td>47 (79.66%)</td>
<td>14 (24.14%)</td>
<td>16 (26.36%)</td>
<td>10 (16.95%)</td>
<td>103</td>
<td>103 (103.103%)</td>
<td>103 (103.103%)</td>
<td>103 (103.103%)</td>
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</tbody>
</table>
# Table 2: Number and percentage of Oblique & Horizontal fissures of lungs (Grade wise).

<table>
<thead>
<tr>
<th>Side of Lungs</th>
<th>Number of Lungs</th>
<th>Oblique Fissure</th>
<th>Horizontal Fissure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grade</td>
<td>Grade</td>
<td>Grade</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>Right</td>
<td>44</td>
<td>39 (88.64%)</td>
<td>02 (04.55%)</td>
</tr>
<tr>
<td>Left</td>
<td>59</td>
<td>45 (76.27%)</td>
<td>06 (10.17%)</td>
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</table>

# Table 3: Number of Accessory fissures (All Grade II)

<table>
<thead>
<tr>
<th>Side of Lungs</th>
<th>Superior Accessory Fissure</th>
<th>Inferior Accessory Fissure</th>
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<tbody>
<tr>
<td>Right</td>
<td>06</td>
<td>00</td>
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<tr>
<td>Left</td>
<td>02</td>
<td>01</td>
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# Table 4: Comparison of occurrence of various fissures.

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</tr>
</thead>
<tbody>
<tr>
<td>Right oblique fissure</td>
<td>Incomplete</td>
<td>04 (09.09%)</td>
<td>6.67%</td>
<td>61.54%</td>
<td>6%</td>
<td>9%</td>
<td>36.60%</td>
<td>3(15%)</td>
<td></td>
</tr>
<tr>
<td>Right horizontal fissure</td>
<td>Incomplete</td>
<td>20 (45.45%)</td>
<td>26.67%</td>
<td>75.80%</td>
<td>14%</td>
<td>16.60%</td>
<td>21%</td>
<td>10(50%)</td>
<td></td>
</tr>
<tr>
<td>Accessory fissure on right lung</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>Incomplete</td>
<td>10</td>
<td>30%</td>
<td>48%</td>
<td>12%</td>
<td>36%</td>
<td>46.60%</td>
<td>21%</td>
<td>7(35%)</td>
</tr>
<tr>
<td>oblique fissure</td>
<td></td>
<td></td>
<td>(16.95 %)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Absent</td>
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<td></td>
<td></td>
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<tr>
<td>Left oblique fissure</td>
<td></td>
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**Fig. 1** Absent Horizontal Fissure in Right Lung

**Fig. 2** Incomplete Horizontal Fissure in Right Lung
Fig. 3 Accessory Fissure in Left Lung

Fig. 4 Incomplete Fissure in Left Lung

DISCUSSION

Fissures are an integral part of lungs as they provide uniform expansion of lungs thereby promoting more intake of oxygen during respiration. They also provide core for illustrative operating techniques and allow notable comparison between different surgical procedures. These fissures form the partition for the lobes of the lungs, and clear impression of their disposition is necessary to acknowledge the lobar anatomy thereby helping in locating the bronchopulmonary segments which are noteworthy both anatomically and radiologically. Lungs develop by division and re-division of lung buds arising from endodermal foregut. Defective development from the lung buds will give rise to variations such as incomplete or absence of fissures of right or left lung. [20] In prenatal life individual bronchopulmonary segments are set apart by means of fissures. Gradually as the lung grows all the fissures get sequentially obliterated, except along those two planes which persist in adult as oblique and horizontal fissures. [12] Obliteration of these prenatal fissures either completely or partially represents as absence or incompleteness of a fissure. [13] Partial fusion between lobes, is indicated by incomplete fissures. Accessory fissures could be the result of non-obliteration or persistence of the prenatal fissures. Any divergence in the morphological pattern of the fissures indicates deviation from normal pattern of development of lung. [14] Findings of our study were compared with those of other studies as shown in Table 3. The present study showed that in majority of cases incomplete oblique fissures were documented more on left side than on the right side. In the present study incomplete oblique fissure was documented in 10 (16.95%) of left sided lungs as compared to 4 (9.09%) in case of right lung. Incomplete oblique fissure which was found in 4 (9.09%) right sided lungs almost matched with the finding of study by Bhimadevi et al where they also found incomplete oblique fissure in 9% of right lung. [17] Occurrence of incomplete oblique fissure in left lung which was about 16.95%, was in concordance with the findings of Nene et al in which they noticed incomplete oblique fissure in 12% of left sided lungs. [16] The habitual pattern of collapse perceived in patient with endobronchial lesion may be altered by incomplete fissure and may give a false picture of pleural effusion. [21] Predominance of incomplete oblique fissure on the left side indicates premature onset of fusion of the prenatal fissure which may proceed further before birth leading to fusion along the floor of the oblique fissure. Table 3 shows a wide variability in fissure and lobes of lung which may be due to zonal variation. Alterations in the pattern of fissures in lung are quite frequent. A compromise in knowledge of such deviations will result in inadvertent intraoperative complication. In the present study oblique fissure was absent in single (2.27%) right lung and 2 (3.39%) left sided lungs. One of the findings of our study which is in concordance with the result of the study done by Mamtha et al is that in our study incomplete horizontal fissure was seen in 20 (45.45%) lungs of right side which is comparable with the study done by Mamtha which showed incomplete horizontal fissure in 50% of right lung. [19] We reported a greater incidence of superior accessory fissure as compared to inferior accessory fissure which is not in concordance with the statement as given by Godwin. Presence of accessory fissure was noticed in 6 (13.64%) right sided lungs out of which all were superior accessory fissure and in 3 (5.08%) left sided lungs out of which 2 left sided lungs showed the presence of superior accessory fissure and one showed the presence of inferior accessory fissure.

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. [9, 22] 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. [23, 24] The knowledge of anatomy of fissures of lung may help in clarifying initially confusing radiographic findings like extension of fluid into an incomplete major fissure or spread of various diseases through different pathways. [25]

CONCLUSION

Comparative analysis of our work with previous data in the literature suggest that different studies performed on radiological images reported greater prevalence of incomplete or absent pulmonary fissures as compared to various cadaver studies.
Our aforementioned findings regarding the variations seen in fissures and lobes of both lungs were different from previous studies. Variations of lung anatomy are important for both the diagnosis and treatment of various diseases involving all the domains of medicine.

References
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