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Morphological Lung Variations: A Cadaveric Study in South Indians

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Abstract

Introduction: In the light of increase in incidence of pulmonary diseases, there is a concomitant increase in study of lungs and bronchial tree morphologically and clinically. The knowledge of this study is of immense value in endoscopic procedures for diagnostic and therapeutic purposes. The lungs are the essential organs of respiration which are divided into lobes by fissures. The fissures facilitate the movement of the lobes and help in a more uniform expansion of the whole lung. These fissures may be complete, incomplete or absent. In addition to these fissures, lung might also have accessory fissures, usually indicating the junction between bronchopulmonary segments. Knowledge of fissures is necessary for the appreciation of lobar anatomy and thus for locating the bronchopulmonary segments which are significant both anatomically and clinically. *Aims and objectives*: To study morphological variations in relation to fissures and lobes of lung and calculating percentage and comparing it with the previous studies to conclude incidence of occurance of variations bilaterally among coastal south Indians. *Materials & Methods*: we have studied 77 lungs obtained from embalmed cadavers by dissection method according to standard method described in Cunningham's Practical manual. *Results*: Out of total 37 right lungs, 9 showed absences of horizontal fissure, 9 showed incomplete horizontal fissure and 19 lungs showed complete both horizontal and oblique fissures. Out of total 40 left lungs, 30 lungs showed complete oblique fissure and 10 showed incomplete oblique fissures. No Accessory fissure was seen bilaterally. *Conclusions:* Awareness of the variations in the lobes and fissures of the lungs is important for radiologists for proper radiological interpretation and to clinicians for performing segmental lung resections, lobectomies and endoscopic procedures.

Keywords: Lobes; Fissures; Oblique; Lung; Variant; Accessory; Craig and Walker; Morphology.

Introduction

Anatomical knowledge of variation in fissure and lobes are important not only for students of anatomy but also to clinicians of cardiothoracic as well as for the faculties of radiology and imaging. The knowledge of anatomical variations alerts the surgeons to potential problems that might be encountered during surgical intervention. The fissures may be complete whereas lobes remain intact at the hilum by bronchii and pulmonary vessels. Sometimes they may be incomplete when there is a parenchymal fusion between the lobes or the fissure may be completely absent. The fissures are also helpful in the movement of lobes in relation to one another in order to accommodate greater distension of lower lobe during respiration. The fissures also help in the uniform expansion of lung. Appreciation of lobar anatomy thus becomes more significant with the finding of fissure that forms the boundaries of lobes and this will facilitate location of bronchopulmonary segment for performing lobectomies and segmental dissection of lobes [1].

The lungs are a pair of essential organs of respiration located within the thoracic cavity. Each lung is divided into lobes by fissures. Anatomically, left lung is divided into upper and lower lobes by oblique fissure whereas right lung is divided into upper, middle and lower lobes by oblique and

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horizontal fissures. In each lung, the oblique fissure begins from the mediastinal surface above and behind the hilum and cuts the posterior border of the lung about 2.5cms lateral to the junction of the T4 and T5 spine. Then it runs along the costal surface, cuts the inferior border of the lung and reappears on the mediastinal surface and ends at the lower end of hilum. The horizontal fissure begins at the oblique fissure near midaxillary line, passes horizontally forward to anterior border of the lung, level with the sternal end of fourth costal cartilage and then passes backwards to the hilum on the mediastinal surface [14].

Knowledge of the fissures and lobes of the lungs are important to plan various surgical procedures to avoid post-operative complications like air leakage. It can also help to explain various radiological appearances of lobar anatomy of the lungs and the position of the interlobar fluid. Prior anatomical knowledge and suspicion for probable variations may be crucial for clinicians, surgeons and radiologists. [2]

Materials and Methodology

The lungs of 77 adult cadavers were studied after proper embalming with 10% formalin. Thoracic wall of embalmed cadavers were dissected; the lungs were removed to study morphological features like the number of lobes and extent of fissures. Three damaged lungs were discarded. The anatomical classification proposed by Craig and Walker was followed to determine the presence and completeness of fissures and percentage of incidence of occurance was calculated and compared with the previous studies.

Results

Out of 77, 37 were right sided lungs, 40 were left sided lungs.

Right lungs (oblique fissure): out of 37, 31(83.78%) shown normal pattern of oblique fissure. 5(13.5%) had incomplete oblique fissure and 1(2.7%) had absence of oblique fissure.

Right lungs (horizontal fissure): out of 37, 19(51.35%) shown normal pattern of fissure, 9(24.32%) had incomplete horizontal fissure and 9(24.32%) had complete absence of horizontal fissure.

Left lungs (oblique fissure): out of 40, 30(75%) shown normal pattern of oblique fissure, 10(25%) had incomplete oblique fissure.

Table 1: Showing percentage of occurance of variation in horizontal and oblique fissure

Right side lungs(37)					Left side lungs (40) Oblique fissure		
Horizontal fissure			Oblique fissure				
Complete	Incomplete	Absence	Complete	Incomplete	Complete	Incomplete	Absence
19(51.35%)	9(24.32%)	9(24.32%)	31(83.7%)	5(13.5%)	30(75%)	10(25%)	0(%)

Table 2: Showing the incidence of percentage of occurance of variations classified according to Craig and Walker

Grades	Right Lungs(37)				Left Lungs(40)	
	Horizontal Fissure		Oblique Fissure		Oblique Fissure	
	No. of lungs	%	No of lungs	%	No. of lungs	%
Grade I	19	51.35	24	64.86	23	57.5
Grade II	4	10.8	07	18.91	07	17.5
Grade III	7	18.9	05	13.50	10	20.0
Grade IV	7	18.9	01	02.70	NIL	00

Table 3: Comparative incidence of variations of oblique and horizontal fissures

Authors	Year	Right Lung – Oblique Fissure (%)		Right Lung Horizontal Fissure (%)		Left Lung – Oblique Fissure (%)	
		Incomplete	Absent	Incomplete	Absent	Incomplete	Absent
Medlar EM[8]	1947	25.6	4.8	62.3	-	10.6	7.3
Lukose et.al[7]	1999	-	-	21	10.5	21	-
Meenakshi S et al[9]	2004	36.6	-	63.3	16.6	46.6	0
Prakash et.al[12]	2010	39.3	7.1	50	7.1	35.7	10.7
Nene AR et.al[11]	2011	6	2	8	14	12	0
Present study	2015-16	13.5	2.7	24.32	24.32	25	0

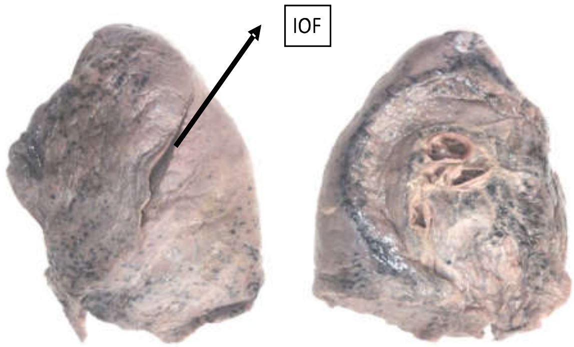

Fig. 1: Incomplete oblique fissure (IOF) –left lung

Fig. 3: Absence of fissure-right side

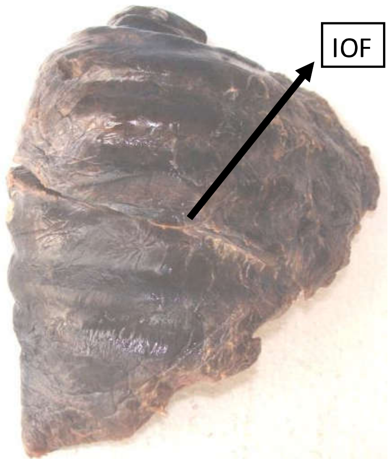

Fig. 2: Incomplete Oblique fissure (IOF) –right lung

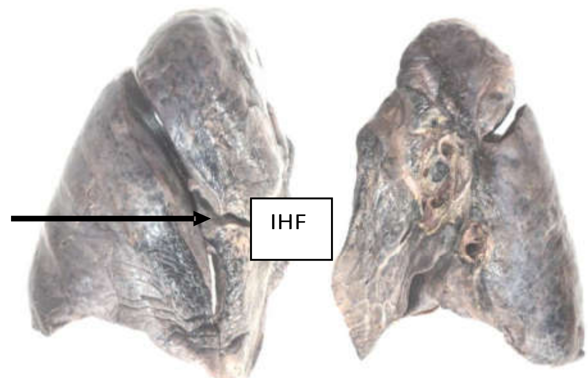

Fig. 4: Incomplete horizontal fissure(IHF)-right side

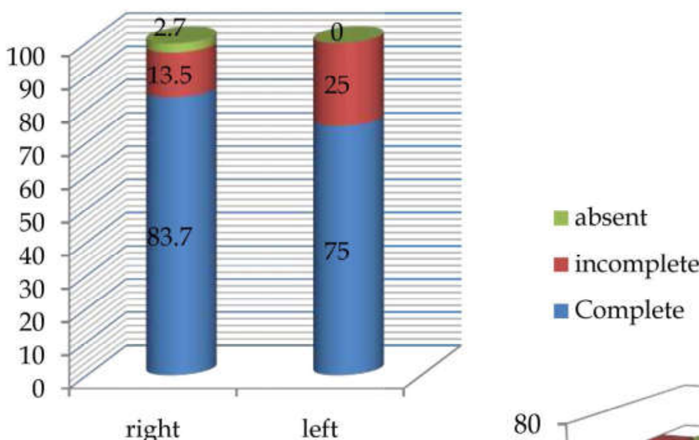

Fig. 5: Graph showing the variation of oblique fissure in right and left lungs.values in the graph depict the Percentage

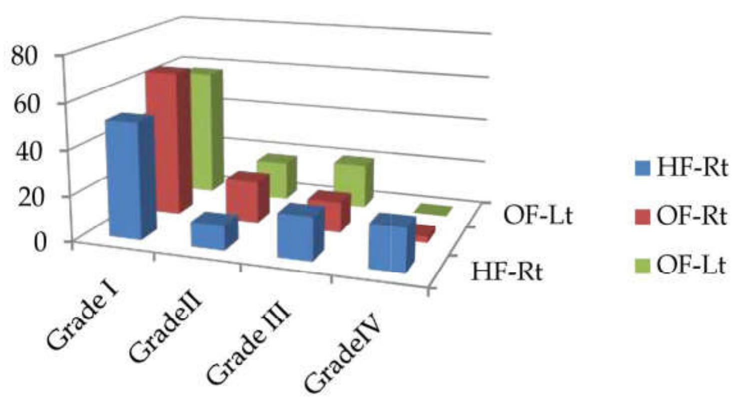

Fig. 6: Graph depicting the comparison of percentage of variation of oblique fissure(OF) on right(Rt) and left(lt) side lungs and horizontal fissure(HF) on right lung

Further according to Craig and Walker grade I type of horizontal fissure in right lung were observed among 19(51.35%) and oblique fissure among 24(64.86%) on left side among 23(57.5%), grade II type of horizontal fissure in right lung among 4(10.8%) and oblique fissure in 7(18.91%) and on left side among 7(17.5%), grade III type of horizontal fissure in right lung in 7(18.9%) and oblique fissure among 5(13.5%) and on left side among 10(20%) and grade IV type horizontal fissure in right lung among 7(18.9%) and oblique fissure among 1(2.7%).

Discussion

Ontogenetically the lung is a composite of endodermal and mesodermal tissues. The endoderm of the lung bud gives rise to the mucosal lining of the bronchi and to the epithelial cells of the alveoli. The vasculature of the lung & the muscles & cartilage supporting the bronchi are derived from the foregut splanchnopleuric mesoderm, which covers the bronchi as they grow out from the mediastinum into the pleural space.

When the embryo is approximately 4 weeks old, the respi-ratory diverticulum (lung bud) appears as an outgrowth from the ventral wall of the foregut. On day 22 it bifurcates into two primary bronchial buds between day 26 and day 28. Early in the 5th week the right bronchial bud branches into three secondary bronchial buds while the left one branches into two. By 6th week secondary bronchial buds branch into tertiary bronchial buds (ten on the right and eight on the left) to form the bronchopulmonary segments. All the spaces between individual bronchopulmonary seg-ments get obliterated except along the line of division of prin-cipal bronchi where deep complete fissures remain dividing the right lung into 3 lobes and left lung into 2 lobes. These fis-sures are oblique and horizontal in position in right lung where as only in oblique position in left lung [6].

Morphological variations in the lobes and fissures of lung are mainly due to the defective pulmonary development. During the development, as the lung grows, the spaces or fissures that separate individual bronchopulmonary buds/segments become obliterated except along two planes, evident in the fully developed lungs as oblique or horizontal fissures. Obliteration of these fissures either completely or partially may lead to absence or incomplete fissures. Accessory fissure could be due to non-obliteration of spaces which normally are obliterated [16].

Craig and Walker have proposed a manner of classification of fissure for describing operative technique and also for comparing different surgical series. The criteria used to classify the lung fissures were degree of completeness of fissure and the location of the pulmonary artery at the base of the oblique fissure. Four grades 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 fissure line [3].

The present study showed that, in majority of cases the fissures were incomplete more on right side (Table 1). These findings were compared with those of other studies as shown in table 3. Increased 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. Table 3 shows wide variability which may be due to the regional variations. In the present study oblique fissure was incomplete in 13.5% and 25% on right and left side respectively but in our study variation observed was more on left sided lung as compared to others.

Finding accessory fissures in lung specimens is not uncommon, but appreciating them on radiographs and CT scans is difficult and hence they are either not appreciated as distinct entities or are completely misinterpretated. They usually occur at the boundaries between bronchopulmonary segments. The commonly found accessory fissures are superior accessory fissure, inferior accessory fissure and left minor fissure. The superior accessory fissure (SAF) separates superior segment from the rest of the segments of lower lobe of lung, the inferior accessory fissure (IAF) separates a small 'infracardiac lobe' from other segments of lower lobe of lung on the diaphragmatic surface and the left minor fissure (LMF) separates the lingula from the other segments of upper lobe of left lung [13].

Surgically the gradation of fissure is important. The surgeon approaches to ligate the vessels and bronchi through the depth of the fissure. Grade 1 oblique fissure facilitates the approach while doing lobectomy and video assisted thoracoscopic surgery. But otherwise the lung parenchyma has to be dissected to reach those structures leading to intra-operative hemorrhage and more postoperative complications [4].

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 [10].

LUKOSE et al, (1999) worked on the morphology of the lungs and variations in lobes and fissures along with a comparative study with the earlier authors stated that incomplete and absence of horizontal fissures was reported as 21% and 10.5%. MEDLAR, (1947) reported that incomplete oblique fissure in right and left lungs as (25.6% & 10.6%), incomplete horizontal fissure in right lung (17%) and absent oblique fissure (4.8% & 7.3%) absent horizontal fissure (45.2%) which is supported by the present study. The presence of fissures in the normal lungs enhances uniform expansion, and their position could be used as reliable landmark in specifying lesions within the lungs in particular [5].

Even though variations in the fissures are mainly due to defective development,they are of great clinical importance. An incomplete fissure frequently leads to postoperative air leakage. They alter the spread of infection within the lung from one lobe to other. It may causes odd appearances of fluid tacking within the lung. The lymphatics of lung drain from pleura towards the hilum. Altered course of oblique fissure would lead to altered course of visceral pleura,thereby changing the arrangement of lymphatic drainage [15].

And incomplete fissures are also responsible for altering the spread of diseases. Gradation of fissures is important surgically. The surgeon approaches to ligate the vessels and bronchi through the depth of the fissure. Grade I oblique fissure makes the approach easy while doing lobectomy and video assisted thoracoscopic surgery [4].

Knowing the frequency of occurrence of a variant fissure in a particular population might help the radiologist and clinician to make correct diagnosis. Similarly, it might help the surgeon to plan, execute and modify a surgical procedure depending on the merit of the case. This will help to reduce the morbidity and mortality associated with lung surgeries. 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, and collateral air drift along with disease spreading through lung.

Conclusion

Considering the clinical and surgical importance of such variations, from anatomical point of view, one can opine that prior anatomical knowledge and high index of suspicion for probable variations in the fissures, lobes and bronchopulmonary segments in the lung may be important for clinicians, surgeons and radiologists. Variations in the number and pattern of hilar structures in both human lungs have been studied in detail by earlier researchers, thus this study add a database for the same. Knowing the frequency of occurrence of a variant fissure in a particular population can help the radiologist and clinician to make correct diagnosis, plan, execute and modify a surgical procedure depending on the merit of the case. This will help to reduce the morbidity and mortality associated with lung surgeries.

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