

A Novel Grading System for Oblique Fissure of Right Lung Based on : Cadaveric Study of North Indian Population



Anatomy

KEYWORDS : Fissure, Oblique fissure, Horizontal fissure, Accessory fissure, Lung.

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ABSTRACT

AIM: An attempt has been made to provide a grading system for oblique fissure of right lung from Grade zero to IV depending upon the absence and depth of fissure from costal surface to the hilum.

MATERIAL & METHOD: Material for the present study comprised of right lungs obtained from 50 well embalmed adult human cadavers of both the sexes dissected in the Department Of Anatomy, Govt. Medical College, Amritsar

RESULTS: Oblique fissure was found to be complete in 48%, incomplete in 42% and absent in 10% of the right lungs.

CONCLUSION: Due to vast incidence of variations in absence or incompleteness of fissures & to the lack of an agreeable classification of fissures, an attempt has been made to provide one such classification. Accordingly the fissures are graded from Grade zero to IV depending upon their absence and depth from costal surface to the hilum. The nature of the fissure is of great importance in planning operative strategy for thoracoscopic pulmonary resection where an incomplete fissure may contribute to post-operative air leakage.

INTRODUCTION

The lungs are a pair of essential respiratory organs in many air breathing animals, including most tetra pods, a few fish and a few snails. In human beings lungs are separated into lobes by fissures. On the right side, there are two fissures viz , oblique & horizontal which divide it into three lobes i.e. superior; middle & inferior.¹ The fissures facilitate the uniform expansion of lobes in relation to each other. It is particularly so for oblique fissure which acts as a plane of cleavage so that during inspiration, upper part of the lung expands forwards and laterally by the elevation of the ribs while lower part of the lung moves downwards and backwards by the piston movement of the diaphragm.² These also act as important landmarks for evaluation of pulmonary diseases.³ Knowledge of the position of these fissures is necessary for the appreciation of lobar anatomy and thus for locating the bronchopulmonary segments which is significant both anatomically and clinically.⁴ The fissures may vary in the degree of completeness and tend to divide the lobe into smaller subdivisions. Complete fissures show continuity of lobes at the bottom only by parts of bronchial tree and blood vessels. In the region of incomplete fissures the adjacent lobes are connected by sizeable chunk of pulmonary tissue as the cleft fails to reach the hilum. The fissures may be absent altogether.⁵

Raasch et al⁶ emphasized that an accurate knowledge of anatomy is required for appropriate interpretation of medical imaging like Computed Tomography and Magnetic Resonance Imaging. Various radiological appearances of interlobar fissures may be explained on the basis of fissural anatomy. Ghosh et al⁷ stressed that while the anatomy of fissures is used as a reliable landmark in planning the pulmonary resection, an incomplete fissure may contribute to post-operative air leakage. These may alter the usual pattern of collapse of the lungs seen in endobronchial lesion & also give rise to atypical appearance of pulmonary effusion thus complicating the identification of various pathological conditions. While Tarver⁸ pointed out that pneumonia in a particular lobe is often limited to that lobe alone by a complete fissure but may spread to adjacent lobes through the incomplete fissures, Dandy⁹ stated that a knowledge of anatomy of fissures of lung may help to clarify confusing

radiographic findings like extension of fluid into an incomplete major fissure or spread of various diseases through different pathways. Thus these may be important for pulmonologists, radiologists, surgeons & clinicians. An accurate recognition of incomplete major and minor interlobar fissures in different populations may help 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.¹⁰ Also it might help the radiologist and surgeon to make a correct diagnosis, plan, execute and modify a surgical procedure depending upon the merit of the case.¹¹

Thus a detailed knowledge of morphology & morphometry of fissures of lungs is necessary because of their clinical, radiological and surgical significance. So the present study is designed to attain this information on oblique fissure of right lung in detail.

MATERIAL AND METHOD

Material for the present study comprised of right lungs obtained from 50 well embalmed adult human cadavers of both the sexes dissected in the Department Of Anatomy, Govt. Medical College, Amritsar.

The lungs were removed from the cadavers as per the guidelines in Cunningham's Manual of Practical Anatomy¹² taking special precautions so as to preserve all the vessels, bronchi and ligaments at the hilum. Different morphological features of lung & oblique fissure were noted and measurements were taken as follows:

LENGTH OF POSTERIOR BORDER:

It was measured with wet silk thread spread from apex to base along the posterior border. Then the thread was lifted off the lung and measured along a graduated metric scale.

LENGTH OF SHARP PART OF INFERIOR BORDER:

For measuring this length a wet silk thread was kept along inferior border. It was kept along inferior border starting from anterior border, going along the inferior border between lateral & inferior surface to posterior border & then to the point of demarcation between vertebral & mediasti-

nal parts of medial surface (this part of inferior border is usually sharp). It was then marked at the designated points and lifted off the lung and measured along graduated metric scale.

OBSERVATIONS OF OBLIQUE FISSURE:

1. It was noted whether the oblique fissure was complete or incomplete.
2. Distance between apex and point of its intersection on posterior border was measured with a wet silk thread from apex to the intersecting point on the posterior border and then the silk thread was lifted off the field and measured along a graduated metric scale.
3. Percentage of above measured distance (Sr No.ii) with regard to total length at posterior border (vide supra) was calculated.
4. Distance between lower end of posterior border & the point of its (oblique fissure's) intersection on posterior border was measured with a wet silk thread as in Sr.No. ii above.
5. Percentage of above measured distance (Sr No.iv) with regard to total length at posterior border (vide supra) was calculated.
6. Distance between point of (oblique fissure's) intersection on inferior border and later's anterior end was measured with a wet silk thread.
7. Percentage of above measured distance (Sr No.vi) with regard to length of sharp part of the inferior border (vide supra) was calculated.
8. Distance between its (oblique fissure's) point of intersection on inferior border and later's posterior end was measured with a wet silk thread.
9. Percentage of above measured distance (Sr No.viii) with regard to length of sharp part of inferior border (vide supra) was calculated.

RESULTS

1. Length of Posterior Border:
2. Mean length of posterior border was 19.9 ± 3.21 cm (15- 28cm).
3. Length of Sharp part of Inferior Border:
4. Mean length of sharp part of inferior border was 26.21 ± 3.99 cm (20-36 cm).
5. Observations of Oblique Fissure:

Completeness:

It was found to be complete in 24(48%) lungs, incomplete in 21(42%) lungs & altogether absent in 5(10%) lungs.

In the present study the upper end of the oblique fissure intersected the posterior border at a mean distance of 7.76 ± 1.94 cm (Range 4.5 to 12cm) from the apex which was $38.8 \pm 6.9\%$ (Range 21.43% to 55%) of the total length of posterior border. It was in consonance with **Modgil**¹³ who found this distance to be 7.0cm.

Similarly the Oblique fissure intersected the posterior border at a mean distance of 12.19 ± 2.43 cm (Range 8-17cm) from later's inferior end & it was $61.21 \pm 6.98\%$ (Range 45-78.57%) of the total length of posterior border.

In the present study the inferior end of oblique fissure intersected the sharp part of inferior border at a mean distance of 5.53 ± 2.62 cm (Range 2-13cm) from later's anterior end which was $20.55 \pm 8.9\%$ of the length of sharp part of inferior border. Earlier contrasting results have been reported by **Modgil**¹³ & **Standing**¹ i.e 2cm & 7.5cm respectively. Our value of 5.53cm falls almost in between these two values.

In the present study, the distance between point of intersection of inferior end of oblique fissure on sharp part of inferior border & later's posterior end was 21.367 ± 3.58 cm (Range 11-29cm) which was $79.45\% \pm 8.9\%$ (Range 45.83%-92.59%) of the length of sharp part of inferior border. No data could be traced in earlier accessible literature to compare the same.

DISCUSSION

COMPLETENESS OF OBLIQUE FISSURE

Table I compares the incidence of completeness of oblique fissure as observed in the earlier studies with the present study.

TABLE I : COMPARISON OF INCIDENCE OF ABSENCE & INCOMPLETENESS OF OBLIQUE FISSURE

S.no	Author (year)	Incidence of absence of oblique fissure	Incidence of incompleteness of oblique fissure
1	Kent & Blades ¹⁴	-	30%
2	Medlar ¹⁵	4.8%	25.6%
3	Raasch et al ⁶	47%-70%	
4	Frija et al ¹⁶	87%	
5	Glazer et al ¹⁷	-	64%
6	Otsuji et al ¹⁸	83.1%	
7	Aziz et al ³	-	48%
8	Meenakshi et al ¹⁹	-	36.6%
9	Bergman et al ²⁰	-	30%
10	Parkash et al ¹⁰	7.1%	39.3%
11	Nene et al ¹¹	2%	6%
12	Devi et al ²¹	-	9%
13	Arora et al ²²	2%	20.0%
14	Dutta et al ²³	11.54%	61.54%
15	Ghosh et al ⁷	2.17%	19.56%
16	Jacob & Pillay ²⁴	3.4%	50%
17	Present study	10%	42%

Thus as evident from Table I, there is a wide variation in the incidence of completeness of fissures with incidence of incompleteness ranging from 6% to 87%. Such wide range of variations may be attributed to the fact that there is no agreeable classification of completeness of fissures available in the literature.

However the criteria of degree of completeness of fissure and location of pulmonary artery at the base of oblique fissure, **Craig and Walker**²⁵ classified fissures into following 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.

Grade IV complete fusion of lobes with no evident fissure line.

But in this classification a complete fissure is classified as grade I while no fissure is classified as grade IV which makes it all the more confusing.

So an attempt has been made to deduce a new classification in this study (vide infra) & then provide the incidence of

completeness of fissures according to that. This classification is named as **Kaur et al classification** accordingly these fissures are graded from grade zero to grade IV as under:

GRADE 0	Fissure completely absent. No external marking is identifiable
GRADE I	External marking of fissure is present but this cannot be separated even with effort.
GRADE II	Fissure can be opened up to ½ the depth. So lobes can't be completely separated
GRADE III	Fissure can be opened for > ½ the depth but not up to hilum.
GRADE IV	Fissure can be opened up to the hilum so that lobes are attached to each other only at hilum

All the grades are further divided into 3 sub grades depending upon length of fissures:

Complete	In >2/3 of length of fissure
Partial	In b/n 1/3- 2/3 length of fissure
Incomplete	In <1/3 of length of fissure

According to this grading system, the fissures of lungs of the present study are classified in Table II

Grading of oblique fissure: It is depicted in Table II

**TABLE II
GRADING OF OBLIQUE FISSURE**

Sr. No.	Grades	Sub Grade	Number of lungs showing that grade[n(%age)]	Specimen No.
1	0	Complete	4 (8%)	7,34,42,47
		Partial	4* (8%)	32*,33*,40*,41*
		Incomplete***		
2	I	Complete	1 (2%)	11
		Partial	1** (2%)	26**
		Incomplete***		
3	II	Complete	1 (2%)	6
		Partial	1** (2%)	32**
		Incomplete***		
4	III	Complete	9 (18%)	5,8,10,12,22,36,37,38,44
		Partial	1*,1** (4%)	26*,40**
		Incomplete***		
5	IV	Complete	30 (60%)	1,2,3,4,9,13,14,15,16,17,18,19,20,21,23,24,25,27,28,29,30,31,35,39,43,45,46,48,49,50
		Partial	2** (4%)	33**,41**
		Incomplete***		
*In Upper half		**In Lower half		
=*** None of the fissure is shown to be incomplete as in all the lungs the other 2/3 rd length of the fissure was of some other subgrade. So it was classified there.				

As evident from Table II, according to the new system of classification, the Oblique fissure was of Grade IV & complete in majority [30(60%)] of the lungs, being Grade IV partial in another 2 (4%) lungs (specimen no: 33&41). In both of these specimens the fissure was Grade IV in lower half & Grade 0 in upper half. In another 9 lungs (18%) the Oblique fissure was Grade III complete being Grade III partial in 2(4%) more specimens (specimen no: 26 & 40). In specimen no:26 it was Grade III in upper half & Grade I in lower half but in specimen no: 40 it was Grade III in lower half & Grade 0 in upper half. Thus on combining, it was seen that 78% of lungs depicted Grade IV (60%) & Grade III (18%) complete oblique fissure with additional 8% showing Grade IV (4%) & Grade III (4%) partial. While Grade I complete & Grade II complete were seen in one lung each. In one specimen (Sp.No.32) oblique fissure was grade II partial in lower half i.e. almost upto site of origin of horizontal fissure but above that it was altogether absent (Gr 0 Partial). Grade 0 complete was seen in 4(8%) lungs. Here it is pertinent to note that while grading & subgrading of fissures was done, these were observed only on costal surface & not on vertebral & mediastinal surfaces. However, it was seen that apart from the lungs in which oblique fissure was grade 0 complete, the oblique fissure was absent (grade 0) on both vertebral & mediastinal surfaces in 6 lungs (Sp.No. 6,10,25,26,37&38), on vertebral surface alone in 13(26%) lungs (Sp.No.5, 8, 12, 21, 22, 27, 28, 29, 31, 32, 33,39 & 41) & on mediastinal surface alone in 3 lungs (Sp.No. 11, 30 & 36) In the first category where oblique fissure was absent on both vertebral & mediastinal surfaces, on the costal surface it was grade II or grade III in 5 specimens & grade IV in one specimen. In 2nd category

where oblique fissure was absent on vertebral surface alone, on the costal surface, it was grade III or IV C in 12 lungs & grade II in one lung. In 3rd category where oblique fissure was absent on mediastinal surface alone, on the costal surface, it was grade I C, grade IV C & III C in specimen no's 11, 30 & 36 respectively. Thus, it leads to an important deduction that if the oblique fissure is absent on vertebral or mediastinal surface it doesn't always mean that it would be absent on costal surface also, rather it is usually grade III or grade IV on costal surface. On the contrary, if oblique fissure is absent on costal surface (grade 0) it is also absent on vertebral & mediastinal surface. But if it is grade III or IV on costal surface, it doesn't always mean that it would be grade III or IV on vertebral & mediastinal surface. There it may be even absent (grade zero).



Figure 1
Grade 0 (Complete) Specimen 7: Showing Single Lobed lung due to absence of Oblique Fissure & Horizontal Fissure

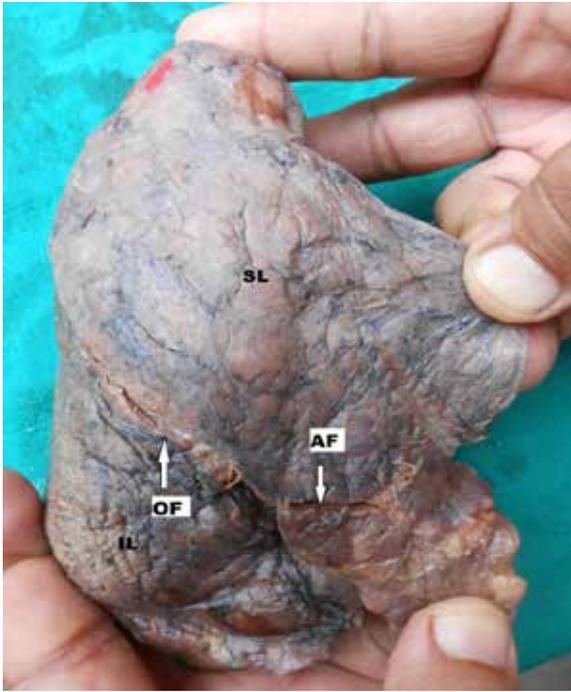


Figure 2

Grade 1 (Complete) Specimen 11: Showing oblique fissure (OF) in form of indentation but cannot be separated even with effort. (SL- Superior Lobe; IL- Inferior Lobe ;Accessory Fissure (AF)



Figure 3

Grade II(Complete) Specimen 6 : Fissure can be opened upto half the depth but lobes can't be completely separated.

CLINICAL IMPLICATIONS

Rosse⁵ emphasized that complete fissures show continuity of lobes at their bottom only by the parts of bronchial tree and blood vessels. In the region of incomplete fissures the

adjacent lobes are connected by a sizeable chunk of pulmonary tissue as the cleft fails to reach the hilum. The fissure may be absent altogether. The fissures are conducive to uniform expansion of lobes. They provide routes for movements of lobes in relation to each other. This is more relevant to distension and movement of the lower lobes during breathing.

A knowledge of fissural anatomy & thereby an 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.¹⁰

An incomplete major fissure causes the odd appearance of fluid tracking within the fissure. Incomplete fissures may also alter the spread of disease within the lung. Pneumonia in a particular lobe is contained within the confines of the lobe by complete and normal fissure. 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.⁸ Hayashi et al²⁶ 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.

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 perioperative and postoperative events and proper radiological interpretations respectively. Surgically the gradation of fissure is important. The surgeon approaches to ligate the vessels and bronchi through the depth of the fissure. A deep oblique fissure facilitates the approach while doing lobectomy and video assisted thoracoscopic surgery.²⁷ But otherwise the lung parenchyma has to be dissected to reach those structures leading to perioperative hemorrhage and more postoperative complications.²⁸ 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(deep) variety (Grade IV in our classification). So, preventive fixation of the middle lobe is essential to avoid this complication.²⁹

SUMMARY AND CONCLUSION

Oblique fissure was found to be complete in 48%, incomplete in 42% and absent in 10% of the lungs. Its upper end intersected posterior border at a mean distance 7.76cm from the apex & 12.19cm from inferior end. Similarly its lower end intersected the sharp part of the inferior border at a mean distance of 5.53 ± 2.62 cm from later's anterior end & 21.367cm from later's posterior end.

Vast incidence of variations in absence or incompleteness of fissures & to the lack of an agreeable classification of fissures, an attempt has been made to provide one such classification. Accordingly the fissures are graded from Grade zero to IV depending upon their absence and depth from costal surface to the hilum. Each grade is further divided into 3 subgrades depending upon the completeness or incompleteness of these fissures with respect to their length. According to this classification the oblique fissure was Grade IV complete in 60% and Grade III complete in 18%. Grade 0 complete & Grade 0 partial were seen in 8% specimens each, the rest of the lungs falling in between. An important observation about oblique fissure as made in the present study was that if oblique fissure is absent

on vertebral or mediastinal surface, it doesn't mean that it would be absent on costal surface also, rather it is usually Grade III or Grade IV on costal surface. On the contrary, if oblique fissure is absent on costal surface, it is also absent on vertebral and mediastinal surfaces

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