



**A NOVEL GRADING SYSTEM FOR HORIZONTAL FISSURE OF RIGHT LUNG BASED ON
CADAVERIC STUDY OF NORTH INDIAN POPULATION**

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ABSTRACT

Introduction: The right lung has two fissures, an oblique and a horizontal, dividing it into three lobes namely the upper, middle, and lower. 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

Aim: To assess the gross morphological features of right lung with special emphasis on the completeness of horizontal fissure.

Material & Method: Material for the present study comprised of right lungs obtained from 50 well embalmed adult human cadavers of both the sexes dissected as a part of 1st year MBBS curriculum in the Department of Anatomy, Govt. Medical College, Amritsar.

Results: *Horizontal fissure* was found to be complete in only 10% of the lungs while in rest 90% it was either incomplete or absent.

Conclusion: Inferable from the huge variation in nonappearance or partial appearance of horizontal fissure in the right lung and to the absence of an acceptable classification of fissures, an endeavor has been made to give one such classification. In like manner, the horizontal fissure is evaluated from Grade zero to IV contingent on its absence and profundity from costal surface to the hilum. Each evaluation is additionally divided into 3 subgrades relying on the culmination or incompleteness of these fissures with respect to their length.

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INTRODUCTION

The right lung is divided into superior, middle, and inferior lobes by an oblique and a horizontal fissure. The upper, oblique fissure separates the inferior from the middle and upper lobes, and corresponds closely to the left oblique fissure, although it is less vertical, and crosses the inferior border of the lung approximately 7.5 cm behind its anterior end. The short horizontal fissure also called secondary fissure separates the superior and middle lobes.¹ It passes from the oblique fissure, near the midaxillary line, horizontally forwards to the anterior border of the lung, either straight or with an upward inclination. The fissures vary in depth in different individuals, but never completely downward inclination.^{1,2} It then passes backwards to the hilum on the mediastinal surface.² It may be much less deep and may end prematurely or even be absent so that middle lobe is a very irregular structure.^{1,3} The horizontal fissure is usually visible on a lateral radiograph and on a high-resolution CT scan as a curvilinear band from the lateral aspect to the hilum.²

The fissures vary in depth in different individuals, but never completely separate the lobes at the hilum where there may be some fusion, particularly vessels may pass from one lobe into another.³

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. In some cases, the fissures may be absent altogether.⁴

As the fissures structure the limits for lobes of the lungs, information on their position is fundamental for appreciation of lobar anatomy and consequently for finding the bronchopulmonary segments which is significant both anatomically and clinically. Subsequently, the familiarity with their variations is fundamental in performing lobectomies and in segmental resection. It could likewise be of significance in deciphering radiological pictures. Along these lines, the current study is intended to achieve this data on horizontal fissure of right lung in detail.

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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 as a part of 1st year MBBS curriculum 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 Anatomy⁷ taking special precautions so as to preserve all the vessels, bronchi and ligaments at the hilum. Distinctive morphological features were noted and measurements were taken as follows:

Length of Anterior Border

Length was measured with wet silk thread spread from apex to base along the anterior border. It was marked with Indian ink then lifted off the lung and measured along the graduated metric scale.

Observations of Horizontal Fissure

Horizontal Fissure

1. It was noted whether the horizontal fissure was complete or incomplete.
2. Distance between apex and point of its intersection on anterior border was measured with a wet silk thread and then the silk thread lifted off the field and measured along a graduated metric scale.
3. Percentage of above measured distance with regard to total length of anterior border was calculated.
4. Distance between the base & point of its intersection on anterior border was measured from the intersecting point on anterior border to inferior border with a wet silk thread.
5. Percentage of above measured distance with regard to total length of anterior border was calculated.

RESULTS

1. Length of Anterior Border
Mean length of anterior border was 17.8 ± 2.74 cm (12cm to 24cm)
2. The anterior end of horizontal fissure intersected the anterior border at a mean distance of 13.27 ± 2.36 cm (Range 10-19cm) from apex which was $73.22 \pm 7.13\%$ (Range 57.9% to 88.24%) of the total length of anterior border.
3. The mean distance between point of intersection of anterior end of horizontal fissure at anterior border & latter’s inferior end was 4.8 ± 1.41 cm (Range 2-8cm) & it was $26.75 \pm 7.13\%$ of total length of anterior border.
4. Observations of Horizontal Fissure:
 - o Completeness: It was found to be complete in 5(10%), incomplete in 30(60%) & absent in 15(30%) lungs.
 - o In the present study the anterior end of horizontal fissure intersected the anterior border at a mean distance of 13.27 ± 2.36 cm (Range 10-19cm) from apex which was $73.22 \pm 7.13\%$ (Range 57.9% to 88.24%) of the total length of anterior border. It was in consonance with **Modgil**⁸ who found this distance to be 13cm.

Similarly, the mean distance between point of intersection of anterior end of horizontal fissure at anterior border & latter’s

inferior end was 4.8 ± 1.41 cm (Range 2-8cm) & it was $26.75 \pm 7.13\%$ of total length of anterior border.

DISCUSSION

Completeness of Horizontal Fissure

Table 1 compares the incidence of absence & incompleteness of horizontal fissure as observed in the present study with earlier studies.

It is evident from table 1 that there is wide variation in incidence of incompleteness of this fissure ranging from 8% to 83.4%. This is again because of the lack of any standard classification of fissures. It gave us an impetus to derive a classification or grading of fissures which may be of help in future.

Table 1 Comparison of incidence of absence & incompleteness of Horizontal Fissure

S.no	Author (year)	Incidence of Absence of horizontal fissure	Incidence of incompleteness Of horizontal fissure
1.	Medlar ¹⁰	45.2%	17%
2.	Raasch <i>et al</i> ¹¹		94%
3.	Frija <i>et al</i> ¹²		96.7%
4.	Berkman ¹³	20%	72%
5.	Otsuji <i>et al</i> ¹⁴		96%
6.	Lukose <i>et al</i> ¹⁵	10.5%	21%
7.	Aziz <i>et al</i> ¹⁶	-	63%
8.	Meenakshi <i>et al</i> ⁶	16.6%	63.3%
9.	Bergman <i>et al</i> ¹⁷	21%	67%
10.	Parkash <i>et al</i> ¹⁸	7.1%	50%
11.	Nene <i>et al</i> ¹⁹	14%	8%
12.	Devi <i>et al</i> ²⁰	9%	18%
13.	Arora <i>et al</i> ²¹	9.0%	27.2%
14.	Dutta <i>et al</i> ²²	34.6%	41.2
15.	Ghosh <i>et al</i> ²³	48%	26%
16.	Kommuru <i>et al</i> ²⁴	10%	30%
17.	Jacob & Pillay ²⁵	6.6%	83.4%
18.	Present study	30%	60%

However, using the criteria of degree of completeness of fissure and location of pulmonary artery at the base of oblique fissure, Craig and Walker⁹ 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.

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. The classification is named as Kaur *et al* classification; accordingly, these fissures are graded 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 2*

As evident from *Table 2* the horizontal fissure was absolutely absent (Gr 0) in the whole length in maximum number of lungs [14(28%)]. In another 5(10%) it was grade zero in \geq anterior 2/3rd length which according to our new classification is also considered to be complete (\geq 2/3rd). Thus, in toto 19(38%) lungs depicted a grade zero horizontal fissure. This figure is extremely high as 38% of lungs depicted no middle lobe or in other words these were bilobed. It is contrary to the general and most widely accepted view that right lung has 3 lobes. If we add 4 more specimens showing grade I in anterior 2/3rd (Sp No.18) & in whole length (SpNo.13, 21&40) in this category (because in grade I only marking of the fissure is seen on the surface with no evidence of separation into lobes at all), this number increases further to 23(46%) in which the right lung is 2 lobed.

On the other hand, grade IV complete fissure was seen in the whole length of only 4(8%) specimens (Sp No: 3, 8, 28, 49) & in posterior 2/3rd in one (specimen no 23). Thus only 5(10%) lungs depicted the well-formed horizontal fissure.

Another observation in Horizontal fissure was grade Zero (Partial) which was found in 10 (20%) specimens. In all these specimens' grade zero was seen in anterior half of horizontal fissure, the posterior half showing grade II (partial) in 7 specimens & grade III (partial) in 3specimens. From this, it can be deduced that 2nd common presentation of horizontal fissure [1st being grade 0 (vide supra)], is grade zero partial in anterior half seen in 10(20%) specimens. Here it is pertinent to mention that whenever horizontal fissure shows grade zero partial, it is in anterior half. Also, in these cases, the posterior half depicts grade II partial in 7(70%) specimens & grade III partial in 3(30%) specimens. As far as grade zero incomplete is concerned it was observed in anterior 1/3rd in 5(10%) lungs (Specimen no: 10,22,23,45 &46). Out of these in 3 specimens' posterior 2/3rd depicts grade II (complete) & in one specimen each posterior 2/3rd depicted grade III & grade IV complete.

Table 2 Grading of Horizontal Fissure

Sr.No.	Grades	Sub Grade	Specimen No.							
			Anterior 1/3	Anterior 1/2	Anterior 2/3	Complete	Posterior 1/3	Posterior 1/2	Posterior 2/3	
1.	0	Complete			5,17,24,43,50	6,7,11,25,26,27,29,31,33,34,38,42,47,48				
		Partial		2,4,12,14,20,30,35,36,39,41						
		Incomplete	10,22,23,45,46							
2.	I	Complete			18	13,21,40				
		Partial		1,15						
		Incomplete					5			
		Complete			19	37,44			10,22,45	
3.	II	Partial		9				2,12,14,15,20,36,39,41		
		Incomplete					17,43,50			
4.	III	Complete				32			16,46	
		Partial						1,4,9,30,35		
5.	IV	Incomplete	16					18,19,24		
		Complete				3,8,28,49,			23	
		Partial								

Table 3 Showing Grading of Horizontal Fissure on Costal Surface in the Lungs with grade 0 on Mediastinal Surface

S.No	Grade of horizontal fissure on costal surface	Number of lungs n (%)	Specimen numbers
1.	Gr 0 C (full length)	14	6,7,11,23,26,27,29,31,33,34,38,42,47,48
2.	Gr 0 C (Anterior 2/3)	5	5,17,24,43,50
3.	Gr 0 P (anterior 1/2)	10	2,4,12,14,20,30,35,36,37,41
4.	Gr 0 I (anterior 1/3)	5	10,22,23,45,46
5.	Gr I C (full length)	3	13,21,40
6.	Gr I P (anterior 1/2)	2	1,15
7.	Gr II C (full length)	1	37
8.	Gr II C (anterior 2/3)	1	19
9.	Gr II P (anterior 1/2)	1	9
10.	Total	42(84%)	



Fig 1 GRADE 0: Showing absence of Horizontal Fissure. Lung has 2 lobes (SL- Superior Lobe; IL- Inferior Lobe)

Another interesting observation about the horizontal fissure was that grade 0 was never seen in posterior 1/3, 1/2 or 2/3 with some other grade (I-IV) in anterior part which means that in none of the lungs the horizontal fissure of any depth could be seen in anterior part only (i.e. with grade zero in posterior part).



Fig 2 GRADE I: Showing Horizontal fissure (HF) in the form of slight indentation (SL-Superior Lobe; IL- Inferior Lobe)

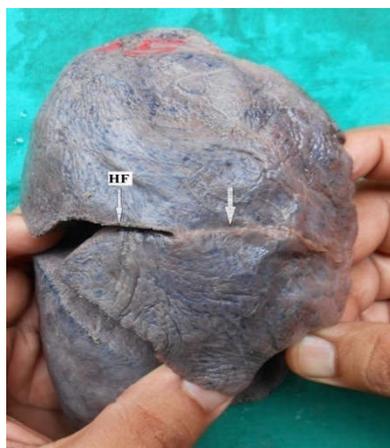


Fig 3 GRADE I: Showing Horizontal fissure (HF) in the form of slight indentation (SL-Superior Lobe; IL- Inferior Lobe Showing absence of Horizontal Fissure in anterior part (only marking seen)



Fig 4 GRADE II: Showing a slight marking of Horizontal Fissure (HF) on mediastinal surface. Fissure can be opened upto 1/2 the depth



Fig 5 GRADE III: Showing absence of Horizontal on vertebral surface thus can be opened for > 1/2 the depth but not up to hilum

In other words, if horizontal fissure has to be absent (grade zero) it has to be absent in anterior part or in whole length & not in posterior part only.



Fig 6 GRADE IV Presence of complete Horizontal Fissure which can be opened upto hilum

As discussed above, grade IV was seen in full length in 4 specimens & in posterior 2/3 in one specimen. Similarly grade III was also seen only in posterior part of horizontal fissure. On the contrary in anterior part (alone) grade IV was never seen. It was seen only when the fissure was complete in full length (Sp. No: 3, 8, 28 & 49). Similarly grade III was seen only once (Sp. No. 16) in anterior 1/3rd (only) but complete (in whole length) in another one specimen (Sp. No. 32). It leads to the deduction that grade III & IV are almost never seen in anterior part alone. If these are present in anterior part, the posterior part also shows a similar or higher grade of fissure.

Thus, in anterior part of horizontal fissure grade III & IV are never seen alone & in posterior part grade '0' is never seen alone. In specimen.no32 horizontal fissure was much longer than normal. It started from posterior border at a distance of 6cm from apex & continued on costal & mediastinal surfaces. Thus, in posterior part it was occupying place of upper part of oblique fissure. However, it was not extending on vertebral surface.

On the mediastinal surface, the horizontal fissure was absent in 42(84%) lungs which is a very high figure. It was grade 0 C or grade I C in all these lungs. In another 4(8%) lungs, there was slight indentation i.e. grade II

The grading of horizontal fissure on costal surface of the 42 lungs which had grade 0 horizontal fissure on mediastinal surface is depicted in *Table 3*.

It is evident from *Table 3* that in majority of the lungs (39) where horizontal fissure was absent (Grade 0/I) on mediastinal surface. It was Grade '0' Complete/Partial/Incomplete in *anterior* part. Only in 3 lungs, it was Grade II but never Grade III or IV on costal surface.

In another 4 specimens, the horizontal fissure on mediastinal surface was of Grade II (Sp. No 16, 18, 23, 44). In these, on the costal surface the horizontal fissure was Grade III / IV. Similarly, in rest of the 4 specimens (Sp. No. 3, 8, 28, 49) the horizontal fissure was Grade IV C on both mediastinal & costal surfaces.

CONCLUSION

Horizontal fissure was found to be complete in only 10% of the lungs while in rest 90% it was either incomplete or absent. This figure is extremely high but strangely none of the textbooks of anatomy have included it.

Owing to the 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.

As far as horizontal fissure is concerned, according to the new classification, the horizontal fissure was Grade '0' (completely absent) or Grade I (only markings present) in 46% of lungs which thus had only 2 lobes. Only 10% specimens depicted a well-formed Grade IV complete horizontal fissure. These observations were based on the grading of horizontal fissure on costal surface. If mediastinal surface was also included then following conclusions were made:

- Horizontal fissure is absent (Grade 0/I) on the mediastinal surface in 84% of lungs.
- In all the lungs, where horizontal fissure is absent on mediastinal surface, its grade on costal surface is either Grade '0' (68%) or Grade 'I' (10%) or Grade 'II' (6%) & never Grade III or IV.
- If horizontal fissure is absent on mediastinal surface, then on the costal surface also, it is absent (in anterior part at least).
- If horizontal fissure on mediastinal surface is Grade II or more, then on costal surface it is either Grade IV or Grade III.

To conclude, it can be said that the findings of the present study confronts by the results of previous authors. However, a new classification (grading system) has been provided for the horizontal fissures & thereby the lobes. The results of the present study are discussed in the light of this classification. These definitely merit a place in standard textbooks of anatomy. This knowledge of fissures & lobes is of academic interest to all medical professionals. Not only that, considering the fact that malignant lung neoplasms are on the rise all over the world and also in India, this study would also be particularly useful to cardiothoracic surgeons during surgical resection of individual lung segments.

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