ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 02 | February - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

PULMONARY FISSURE COMPLETENESS: A TOOL FOR STRATIFICATION OF SURGICAL RISK OF LUNG CANCER

Anatomy

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ABSTRACT

Background: Lung cancer is the most common cause of cancer-related deaths in both developing and developed countries. The non-small-cell lung cancer accounts for 85% of all lung cancer cases. The degree of pulmonary fissure completeness (PFC) is an important parameter for surgeons while performing lobectomy surgeries, a standard procedure for non-small-cell lung cancer. Fissural anatomy in cadaveric specimens might be more representative of the findings which surgeons might expect during thoracic surgery. Therefore, the objectives of the current study were to estimate degree of Pulmonary Fissure Completeness (PFC) in cadaveric lung specimens & to estimate their Fissure Development Score (FDS) & Fissure Sum Average (FSA). **Methodology:** A cross-sectional study was conducted over a period of 2 months on 48 lung specimens obtained during routine dissection. Parameters like circumference & thickness of lungs, depth of fissures were recorded to estimate PFC, FDS & FSA. **Results:** Statistical analysis was performed using the SPSS Version 20. Mean & standard deviation was calculated for the relevant parameters. Regression analysis was done for certain parameters. P – values of <0.01 were regarded as statistically significant. **Conclusion:** Inclusion of degree of pulmonary fissure completeness (PFC) as an assessment model for determining the risk of lung cancer patients might lead to better postoperative results. A decreased FSA score also decreases the postoperative morbidity of patients.

KEYWORDS

Pulmonary fissure completeness; fissure development score; fissure sum average

INTRODUCTION

Lung cancer is the most common cause of cancer-related deaths in both developing and developed countries. The non-small-cell lung cancer accounts for 85% of all lung cancer cases. The degree of pulmonary fissure completeness (PFC) is an important parameter for surgeons while performing lobectomy surgeries, a standard procedure for non-small-cell lung cancer (Li, Wang, et al., 2018). The PFC can be quantified to obtain Fissure Development score (FDS) which can be further used to calculate Fissure Sum Average (FSA) (Lee et al., 2016). These FSA scores are utilised for further grouping of patients at high surgical risk (Li, Wang, et al., 2018). Fissural anatomy in cadaveric specimens might be more representative of the findings which surgeons might expect during thoracic surgery (West et al., 2021). Understanding the location of these fissures is essential for identifying the bronchopulmonary segments, which are important both anatomically and clinically (Mpolokeng et al., 2022). Incomplete interlobar fissures may make surgery more challenging and raise the risk of a persistent air leak (PAL) (Li, Wang, et al., 2018). Hence, the objectives of the current study were to estimate degree of Pulmonary Fissure Completeness (PFC) in cadaveric lung specimens & to estimate their Fissure Development Score (FDS) & Fissure Sum Average (FSA).

MATERIALS & METHODS

A cross-sectional study was conducted over a period of 2 months (July & August 2024) on 48 formalin fixed lung specimens (24 right & 24 left) obtained during routine dissection. An intact visceral pleura covering the lungs everywhere except hilum were included in the study; lungs damaged during removal from cadavers, those having pathologic lesions like necrosis, trauma or adhesions were excluded. Completeness of fissure was observed & graded according to anatomical classification proposed by Craig & Walker (1997): Grade I – complete fissure with entirely separated lobes, Grade II – complete visceral cleft but parenchymal fusion at base of fissure, Grade III – visceral cleft evident for a part of fissure, Grade IV – complete fusion of lobes with no evident fissural line (Fig. 1). Different parameters like circumference & thickness of lungs, & depth of fissures were recorded to estimate PFC, FDS & FSA. Circumference of lung was determined using a measuring tape starting & ending at anterior border of hilum encircling around mid-point of oblique fissure on costal surface. Thickness of lung was determined by using a spreading calliper across the centre of hilum (mediastinal surface) & mid-point of oblique fissure (costal surface) (Fig. 2a). Depth of fissure was directly measured by inserting the digital vernier calliper into the midpoint of the fissure (Fig. 2b). Quantified degree of pulmonary fissure completeness (PFC) was determined by dividing thickness of lung from depth of fissure, expressed as percentage (Singh et al., 2022) & graded as Grade 0, 1, 2, 3 (Grade 0: complete fissure separating the lobes completely), Grade 1: 0 < Incomplete ≤ 30%, Grade 2: 30% < Incomplete ≤ 70%, Grade 3: 70% < Incomplete [(Singh et al., 2022), (Lee et al., 2016)]. For calculating Fissure Development Score (FDS), fissures were divided into various areas: upper major fissure (A), lower major fissure (B), minor fissure (C) & area over pulmonary artery (E) (Fig.3). Subsequently, quantified degrees ofPFC were determined for each of these regions & graded in a similar manner to find out the FDS scores. Fissure Sum Average (FSA) was calculated by considering the average of FDS at these regions, range 0 – 3 (Lee et al., 2016) (Table 1).

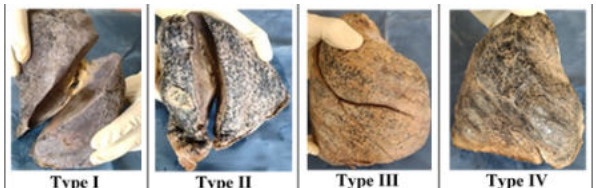

Fig. 1: Completeness of fissure according to Craig & Walker classification

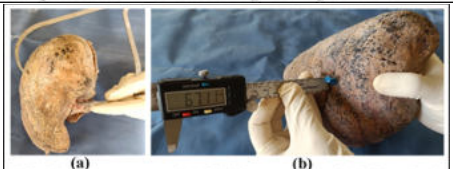

Fig. 2: Measurement of (a) Thickness of lung & (b) Depth of fissure

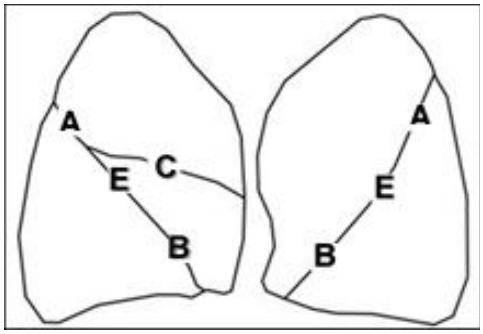

Fig. 3: Areas for calculation of FDS

Table 1: Method For Calculation Of FSA

Location	FSA
Right Upper Lobe	A + E + C / 3
Right Middle lobe	C + E + B / 3
Right Lower Lobe	A + E + B / 3
Left Upper / Lower Lobe	A + E + B / 3

RESULTS

Table 2: Mean Values Of Parameters With Standard Deviations

Parameter	Mean values with SD	
	Right lung	Left lung
Thickness	6.25 ± 0.86 cm	5.41 ± 1.24 cm
Circumference	34.4 ± 5.5 cm	33.4 ± 5.2 cm
Depth of oblique fissure	4.41 ± 1.21 cm	3.39 ± 1.55 cm
Depth of horizontal fissure	3.06 ± 1.84 cm	–

The most common type of fissure according to Craig & Walker classification found in our study was Grade III (both ROF & LOF 70.8% each, RHF 79.1%), least common type was Grade IV (RHF 8.3%, both ROF & LOF 0%). The mean values of different parameters measured is given in Table 2. The quantified degree of PFC for oblique fissures of right & left lungs was found to be Grade 1 (50% & 33% respectively), whereas in horizontal fissure of right lung, Grade 2 accounted for the majority (38%). The maximum & minimum mean values of FDS for right lung were 1.7 & 1.2 for areas C & B, whereas for left lung, these values were 1.1 for area B & 1 for areas A & E. The mean FSA for right upper lobe & right lower lobe came out to be 1.5 ± 0.6; 1.5 ± 0.5 for right lower lobe & 1.0 ± 0.8 for both left upper & lower lobes. On applying regression analysis, a strong correlation found out between thickness & circumference of right lung. (p value <0.01).

DISCUSSION

Various authors have studied the lung fissures over the years. Their findings compared with the current study is given in Table 3. Thoracic surgeons consider the degree of pulmonary fissure completeness (PFC) to be a crucial factor while undergoing VATS lobectomy for lung cancer.

Table 3: Comparison of pulmonary fissure completeness (Craig & Walker's classification)

	Type I (%)			Type II (%)			Type III (%)			Type IV (%)		
	ROF	HF	LOF	ROF	HF	LOF	ROF	HF	LOF	ROF	HF	LOF
(Nene, 2011)	70	68	58	22	12	30	6	6	12	2	14	0
(Kc et al., 2018)	47.8	39.1	33.3	13	21.7	14.8	34.8	30.4	51.9	0	13	0
(Singh et al., 2022)	40	27.5	31.6	7.5	17.5	7.9	42.5	40	52.6	0	25	7.9
Present study	**4.1**	**4.1**	**25**	**25**	**8.3**	**4.1**	**70.8**	**79.1**	**70.8**	**0**	**8.3**	**0**

ROF: Right Oblique Fissure, HF: Horizontal Fissure, LOF: Left Oblique Fissure

(Li, Zhou, et al., 2018). When performing thoracic surgery to operate on the pulmonary artery at the depth of an oblique fissure, the depth of the fissure is more therapeutically relevant than its length (Singh et al., 2022). FSA scores are helpful in further grouping of patients [Group A: $0 \leq FSA \leq 1$ (0-30% incomplete fissures); Group B: $1 \leq FSA \leq 3$ (>30% incomplete fissures)] (Lee et al., 2016), which is useful for stratification of patients at high risk of post-operative complications & decide the best therapeutic strategy. Incomplete fissures have an adverse effect on 5-year survival (Li, Wang, et al., 2018). In their study, they found that with rising FSA scores, there is a consistent trend for the overall morbidity and mortality rate to rise.

CONCLUSION

Surgeons need prior anatomical knowledge of fissures for efficient surgical planning (Singh et al., 2022). Inclusion of quantified degree of pulmonary fissure completeness (PFC) as an assessment model for determining the risk of lung cancer patients might lead to better postoperative results as the morbidities can be accurately predicted by the degree of PFC. A decreased FSA score also decreases the overall postoperative morbidity of patients. (Li, Wang, et al., 2018).

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