# Prevalence of incomplete interlobar fissures of the lung

# Zuzana Sedlackova, Filip Ctvrtlik, Miroslav Herman

**Background.** Some patients benefit from accurate integrity assessment of pulmonary fissures. There are a number of methods for the assessment of incomplete interlobar fissures: imaging techniques, endobronchial methods measuring collateral air flow, a perioperative view, and autopsies used in research into pulmonary anatomy.

**Methods and Results.** We performed a computerized advanced search for primary evidence in the PubMed (Public/ Publisher MEDLINE) and Google Scholar electronic databases using the following terms: incomplete and fissure. The search was not restricted to the English literature, nor limited by publication time. The bibliographic search was then extended to the "Related Articles" links and to the list of literature references of each article.

**Conclusion.** Publications have consistently shown that interlobar fissures exhibit high variability and that preoperative or at least detailed perioperative assessment can influence the effect of treatment.

**Key words:** pleura, interlobar fissure, incomplete, computed tomography

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Department of Radiology, Faculty of Medicine and Dentistry, Palacky University Olomouc and University Hospital Olomouc, Czech Republic Corresponding author: Filip Ctvrtlik, e-mail: filip.ctvrtlik@fnol.cz

#### INTRODUCTION

Pulmonary interlobar fissures are formed by the visceral pleura and they separate the lung lobes from each other. They enable uniform expansion during breathing. Most of the population has an oblique fissure on both sides and a horizontal fissure on the right-hand side. The position of the fissures exhibits high variability; for example, supernumerary accessory fissures can be encountered and sometimes a fissure is missing completely (usually the horizontal one). Very frequently, only a part of a fissure is missing – mostly in the hilar region (Fig. 1).

Interlobar fissures are used in anatomical resections of the lung lobes and can affect the spread of fluid or infection<sup>1,2</sup>. Thus a radiologist can explain some atypical images on chest x-rays or CT scans<sup>3,4</sup>. When lobectomy is performed in a patient with an incomplete interlobar fissure, there is a higher risk of air leakage<sup>2,4-7</sup>. Incomplete interlobar fissures can also lead to an inadequate result of one of the possible therapeutic approaches in emphysema – the implantation of one-way valves in these patients does not lead to complete lobar atelectasis as a result of collateral ventilation and the effect of the therapy is not optimal<sup>8-10</sup>. On the other hand, the very same condition prevents atelectasis after obstruction of the bronchus by mucus impaction, a tumour or foreign bodies<sup>8</sup>.

There are several possibilities for assessing fissures: imaging techniques, currently preferred is CT (HRCT or MDCT); endobronchial systems assessing collateral flow; perioperative methods and autopsies. On thin slices of CT, the fissure can be seen as a thin line separating the lobes; in the case of incompleteness, the line is disconnected by vessels or the lung parenchyma. Endobronchial methods use a catheter with a balloon component that blocks an airway after inflation. Several techniques can be employed to measure collateral ventilation. The inert gas technique was an older method in which helium was

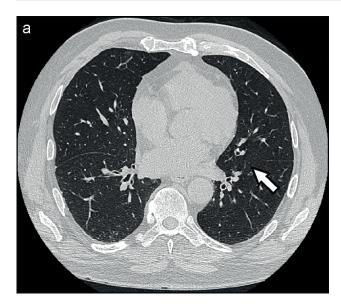
inhaled and its content in a blocked area measured with a mass spectrometer. Afterwards, forced constant airflow going through a double-lumen catheter was used. However, particularly in patients with severe emphysema, this method can lead to barotrauma; therefore, systems operating with spontaneous airflow are currently used<sup>11</sup>. Perioperative mapping is limited by the surgeon's area of interest and is only performed in patients with serious pulmonary disease. In autopsy, well-separated lobes can be detached from one another, while "bridges" between lobes prevent this. An obvious drawback of this method is that it can only be performed on eviscerated lungs.

### LITERATURE SEARCH METHODS

We performed a computerized advanced search for primary evidence in the PubMed (Public/Publisher MEDLINE) and Google Scholar electronic databases using the following terms: incomplete and fissure. The search was not restricted to the English literature, nor limited by publication time. The bibliographic search was then extended to the 'Related Articles' links and to the list of literature references of each article. Using this approach, 31 original articles describing the assessment of incomplete fissures were found (of which 13 used CT only, 2 compared perioperative and CT findings, 3 compared CT with endobronchial measurement of collateral ventilation, and 13 were based on autopsies).

# PREVALENCE OF INCOMPLETE FISSURES

The frequencies of incompleteness obtained by different techniques are summarized in Tables 1-3. For assessment on CT, the authors usually state criteria for incomplete fissures, with several using four types accord-



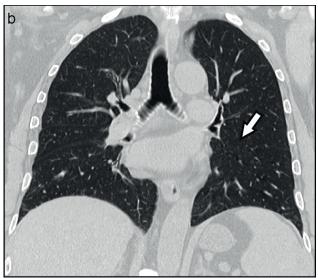




Fig. 1. a) Axial, b) coronal and c) sagittal HRCT reconstructions showing the incomplete left oblique fissure with parahilar disconnection (arrows).

ing to the varying presence of vessels, including the situation when a fissure is simply missing. Data from various CT methods were mostly obtained from hundreds of patients <sup>1,12-23</sup>. Only Frija et al. <sup>12</sup> used healthy volunteers. Hereafter, scans of patients indicated for this examination with no pathological finding on the chest CT (selected retrospectively) were used, as during CT examination irradiation cannot be avoided and it would not be ethical to perform such a study on healthy population. Pu et al. <sup>22</sup> also included COPD patients. The prevalence of incomplete fissures ranged from 19.2% to 77% (mean 48.7), 17.4% to 87% (mean 55.4), and 48.3% to 89% (mean 69.8) for left oblique, right oblique, and horizontal fissures, respectively.

In two papers, the authors compared CT and perioperative findings of incomplete fissures. Kent et al.<sup>24</sup> found a positive predictive value of CT compared with the perioperative findings of 100%, 75%, and only 33% for right oblique fissures, left oblique fissures, and horizontal fissures, respectively, and their study consisted of 46 patients. Schieman et al.<sup>25</sup> assessed the types of incomplete fissures on CT and during operations. They found that there was agreement between the type of incompleteness in CT and perioperative findings in 48% of cases; in the case of a totally complete fissure, the level of agreement was 94% in a total count of 61 patients.

Since the numbers of radiodiagnostic examinations are constantly growing and the search for incomplete fissures is time-consuming, automated computerized assessment<sup>26-28</sup> offers a solution. A publication comparing the results of radiologists and an automatic system found no statistically significant difference in assessment<sup>19</sup>; in addition, the authors comparing CT and endobronchial measurement of collateral air flow<sup>29-31</sup> concluded that the results correlated.

Detailed autopsies were mostly performed on small numbers of lungs and the prevalence ranged from 7.1% to 46.7% (mean 21.5%), 5.6% to 39.3% (mean 24.6%), and 7.8% to 74% (mean 40.4%) for left oblique, right oblique, and horizontal fissures, respectively<sup>2,3,7,32-41</sup>. In this summary, we intentionally ignored a paper by Dogan et al.<sup>40</sup> (included in Table 1) because they assessed the incompleteness of fissures in routine forensic autopsies, leaving large parts of the lung uninvestigated.

# **CONCLUSION**

For better assurance before the implantation of an endobronchial valve in patients with COPD, the combination of CT and endobronchial methods is beneficial. In the case of lobectomy, a preoperative CT scan with a description of incomplete or even missing fissures can prevent perioperative as well as postoperative complications; however, the surgeon cannot totally depend on the information gained from CT. If a patient is indicated for surgical or endobronchial coil treatment, assessment of fissures is mandatory. The use of CT-based automated computerized assessment has proved to be very effective.

Table 1. Frequencies of incomplete fissures on CT.

CT technique (slice thickness/space between slices)	Number of patients	LOF	ROF	HF	Ref.
1.5 mm/10 mm	30	77%	87%	-	12
10 mm/10 mm	50	52%	64%		13
1 mm/10 mm	-	50%	-	83.1%	1
1 mm/10 mm	622	43%	48%	63%	14
1.5 mm/6-10 mm	144	59.7%	62.5%	-	15
1 mm/1 mm	1000	19.2%	17.4%	-	16
1.25 mm/0.625 mm	150	25.3%	34%	48.3%	17
1 mm/1 mm	387	48.3%	69.7%	86.9%	18
0.6-0.8 mm/1 mm	96	33%	51%		19
1 or 1.25 mm/1 mm	247	50%	81%	89%	20
0.625 mm/0.625 mm or 1.25 mm/0.625 mm	250	24.4%	35.2%	74.4%	21
0.625 mm/0.625 mm	573	75%	74%	86%	22
1.25 mm/1.25 mm	208	46%	41%	62%	23

LOF - left oblique fissure, ROF - right oblique fissure, HF - horizontal fissure

**Table 2.** Frequencies of incomplete fissures obtained from autopsies.

Pairs of lungs	LOF	ROF	HF	Ref.
50	40%	70%	47%	3
	21%		31.5%	33
30	46.7%	36.7%	63.3%	35
51	-	-	7.84%	36
29	35.7% (+10.7% CM)	39.3% (+7.1% CM)	50% (+7.1% CM)	37
50	8%	12%	22%	32
30	7.1% (+3.6% CM)	-	46.9%	38
40 left, 36 right	2.5%	5.55%	25%	34
36 left, 46 right	13.88%	19.56%	74%	39
65 left, 73 right	15.06%		35.38%	2
40	31.8%	22.7%	63.6%	7
210	1%	1.4%	8.6%	40
40	35%	15%	50%	41

LOF - left oblique fissure, ROF - right oblique fissure, HF - horizontal fissure; CM - completely missing; \* routine forensic autopsies

Table 3. Frequencies of incomplete fissures, comparison of CT and endobronchial measurement.

Patients		CT		Endobronchial	CT	CT	CT	Ref.
	LOF	ROF	HF	measurement	sensitivity	specificity	accuracy	
25	65.2%	84%	92%	57%	95%	44%	73%	30
146		63.6%		54.5%	88.9%	66.7%	78.8%	31
21		85.7%		52.4%	93%	33%	76%	29

LOF - left oblique fissure, ROF - right oblique fissure, HF - horizontal fissure

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