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Brief Research Report

Iatrogenic pneumothorax after CT-guided lung biopsy

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ABSTRACT

INTRODUCTION. CT-guided lung biopsy is an essential diagnostic tool for evaluating pulmonary infiltrates, but iatrogenic pneumothorax (PTX) is a frequent complication. Evidence regarding risk factors and management strategies for post-biopsy PTX is limited, and no specific guidelines exist.

METHODS. We conducted a retrospective observational study including 267 patients who underwent CT-guided lung biopsy at Bispebjerg Hospital, Denmark, from 1 January to 30 June 2024. Data were collected on age, sex, smoking status, lung function, lesion location, distance to pleura and final diagnosis. The primary outcome was PTX within 72 hours after biopsy. The secondary outcome was the need for chest tube drainage among those with PTX.

RESULTS. PTX occurred in 80 patients (30%). Those with PTX were more often male (52.5% versus 36.4%, p = 0.02), and male sex remained an independent predictor in multivariable analysis (OR = 1.93, 95% CI: 1.13-3.30). No associations were found for age, smoking status, lesion location, forced expiratory volume in the first second or distance to pleura. Seventeen patients (21%) with PTX required chest tube drainage. Lesion distance to pleura was significantly greater in the drainage group (44 mm versus 28 mm, p = 0.012) but did not differ between patients with and without PTX (31 mm versus 29 mm, p = 0.329).

CONCLUSIONS. Iatrogenic PTX is a common complication of CT-guided lung biopsy. Male sex predicts PTX, whereas lesion depth predicts need for drainage. These findings support risk stratification and careful procedural planning to reduce the risk of iatrogenic PTX.

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At the Department of Respiratory Medicine and Infectious Disease, Bispebjerg Hospital, Denmark, approximately 1,100 patients undergo work-up for lung cancer and other pulmonary infiltrates annually. CT-guided lung biopsy is a key diagnostic tool [1-3], enabling tissue sampling, which is essential for accurate diagnosis and treatment planning. Pneumothorax is the most frequent complication of CT-guided lung biopsy, occurring in 15-30% of procedures [1, 4]. It may range from clinically silent to requiring chest tube drainage. Whereas previous guidelines from the British Thoracic Society [5] recommended drainage for pneumothorax ≥ 2 cm, recent updates emphasise clinical symptoms rather than size alone, especially for spontaneous cases [6]. No formal guideline exists for iatrogenic pneumothorax, resulting in heterogeneity in clinical practice. This study aimed to determine the incidence of pneumothorax within 72 hours after CT-guided lung biopsy, identify independent risk factors and evaluate the need for chest tube drainage. Understanding these factors may help

optimise procedures, reduce complications and improve patient outcomes.

Methods

We performed a retrospective observational study including 267 patients who underwent CT-guided lung biopsy for pulmonary infiltrates between 1 January and 30 June 2024. Data were extracted from electronic medical records, including age, sex, smoking status, lung function, lesion location, distance to pleura and final diagnosis. The primary outcome was the incidence of pneumothorax within 72 hours after CT-guided biopsy. To verify a pneumothorax, we evaluated three modalities – physician notes, chest X-ray performed one hour after the procedure and the CT-guided biopsy itself. The secondary outcome was a requirement for chest tube drainage among patients with pneumothorax. As the study design was quality-based, no trial registration was required. However, we had applied for and received permission to look up data in the medical records from the hospital's legal department (WZ 24045936).

Statistical analysis

Categorical variables (sex, smoking status, diagnosis and lesion location) were compared using χ^2 tests. Continuous variables (age, forced expiratory volume in the first second (FEV1), forced expiratory volume percentage predicted (FEV1%), pack-years and distance to pleura) were analysed using Student's t-test. Univariable and multivariable logistic regression were performed to identify independent risk factors. $p < 0.05$ was considered statistically significant.

Trial registration: not relevant.

Results

Baseline characteristics are summarised in **Table 1**.

TABLE 1 Baseline characteristics of 267 patients undergoing CT-guided lung biopsy.

Sex, n (%)	
Men	110 (41.2)
Women	157 (58.8)
Age, mean, yrs	70
Smoking status	
Never-smokers, n (%)	38 (14.2)
Former smokers, n (%)	132 (49.4)
Pack-years, mean ± SD	40 ± 24
Current smokers, n (%)	97 (36.3)
Pack-years, mean ± SD	44 ± 18
FEV1, l (% predicted)	
Total	1.92 (73.4)
Never-smokers	2.28 (91.0)
Former smokers	1.85 (71.3)
Current smokers	1.87 (69.4)

FEV1 = forced expiratory volume in the 1st sec.

Primary outcome

Pneumothorax occurred in 80 patients (30%) within 72 hours after CT-guided biopsy (**Table 2**). In multivariable analysis, sex was established as an independent predictor, whereas age was not significant (Supplementary table 1). Regarding the continuous variables, no significant notable differences were observed in FEV1, FEV1%, distance to pleura, pack-years among former smokers or current smokers.

TABLE 2 Baseline characteristics stratified by pneumothorax status.

	Pneumothorax (N_{pneu+} = 80)	No pneumothorax (N_{pneu-} = 187)
Sex, n (%)		
Men	42 (52.5)	68 (36.4)
Women	38 (47.5)	119 (63.6)
Age, mean, yrs	71.66	69.28
Smoking status		
Never-smokers, n (%)	7 (8.8)	31 (16.6)
Former smokers, n (%)	38 (47.5)	94 (50.3)
Pack-years, mean ± SD	42 ± 20	39 ± 28
Current smokers, n (%)	35 (43.8)	62 (33.2)
Pack-years, mean ± SD	49 ± 21	42 ± 14
FEV1, l (% predicted)	1.88 (71.7)	1.94 (74.1)
Distance to pleura, mm	31	29
Lesion location, %		
Upper/middle lobe	65	51.9
Lower lobe	35	48.1
Diagnosis, %		
NSCLC	61.3	59.1
SCLC	1.3	3.8
Non-malignant	28.8	27.4
Other	8.8	9.1

FEV1 = forced expiratory volume in the 1st sec.; NSCLC = non-small cell lung cancer; SCLC = small-cell lung cancer.

Secondary outcome

Seventeen (21%) of these patients required chest tube drainage. Indications included dyspnoea (41%), pain (12%) and pneumothorax > 3 cm on imaging (12%). Most chest tubes were placed within 48 hours of biopsy (82%). The only statistically significant risk factor for chest tube placement was the distance of the lesion from the pleura. Interestingly, we found no notable difference in lesion-to-pleura distance between patients with and without pneumothorax. All patients who were treated with pleural drainage were hospitalised for at least 24 hours, depending on their symptoms. Before discharged, all patients had a supplementary X-ray performed to verify that their pneumothorax was regressing.

Discussion

This study confirmed that iatrogenic pneumothorax is a common complication of CT-guided lung biopsy. Male sex was independently associated with pneumothorax, whereas lesion depth predicted the need for chest tube drainage but not pneumothorax itself. Our findings align with previous studies by Yeow et al. [1], Yamagami et al. [4] and Shera et al. [7], which report similar associations between male sex, lesion depth and complication risk.

A major strength of this study is the inclusion of a clinically relevant and representative population. In addition, we had access to a comprehensive dataset including detailed patient information such as recent lung function measurements and smoking history. All measurements of lesion-to-pleura distance were performed by the same author, eliminating interobserver variability. We also had access to the original CTs, ensuring a consistent and high-quality assessment of the lesions. Finally, decisions regarding chest tube placement were made by a small group of physicians with a shared clinical framework, reducing variation in treatment decisions and strengthening the internal consistency. However, as this was a retrospective observational study, we cannot exclude the possibility that the observed associations between risk factors and pneumothorax were influenced by unmeasured or uncontrolled variables. Moreover, diffusion capacity for carbon monoxide (DLCO) was not included in the dataset, as this test is not routinely performed in patients without curative treatment potential. Although there is no strong evidence that DLCO directly affects the risk of developing pneumothorax, a low DLCO may increase the symptom burden in the event of pneumothorax and thus influence the clinical course [8]. We had access to data on lesion-to-pleura distance, which is a well-known risk factor [1, 3], we lacked information on lesion mobility during respiration and internal characteristics such as density and consistency, which may also influence complication risk [7]. While randomised trials are scarce, some large retrospective series indicate that technical variables, such as smaller-gauge needles or the use of a coaxial guide system (which limits the number of pleural punctures), may reduce pneumothorax and chest drain rates. Kuban et al. found reduced risk with a 19-gauge coaxial system [9], and Zhang et al. showed that the coaxial technique lowered complication rates in deep lesions [10]. These findings highlight the potential of procedural refinement in minimising post-biopsy complications.

Most chest tubes were inserted early (within 48 hours); and in most cases, the indication was clinical symptoms such as dyspnoea and/or pain. Only three patients underwent drainage solely based on radiological findings - two with pneumothorax > 3 cm and one with tension pneumothorax. This finding is clinically important as it supports a symptom-guided approach, in which patients with asymptomatic pneumothorax can be safely observed without drainage.

Conclusions

In this retrospective study, pneumothorax occurred in 30% of patients following CT-guided lung biopsy. Male sex was an independent risk factor, and greater lesion depth predicted the need for chest tube drainage. Overall, the study provides updated knowledge on the risk of iatrogenic pneumothorax after CT-guided lung biopsy in a diagnostic context. The findings are relevant for clinical practice in both pulmonary and radiology departments and may serve as a basis for further quality improvement of the procedure.

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Supplementary material a09250767-supplementary.pdf

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