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Safety of Endobronchial Ultrasound - guided Transbronchial Needle Aspiration (EBUS-TBNA) in Thai elderly: a retrospective study

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Abstract

Background

Endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) is known as a less invasive procedure for pathological diagnosis of mediastinal and hilar lymph nodes under sedation with minimal complications. However, data regarding the EBUS-TBNA in elderly population is limited. Therefore, this study's objective is to examine the safety of EBUS-TBNA in elderly and the secondary objective is to identify covariate factors that may affect the complications of EBUS-TBNA.

Methods

A retrospective cohort study of patients undergoing EBUS-TBNA was conducted between March 2017 and April 2020, at King Chulalongkorn Memorial Hospital. Procedures, demographic data, and outcome data including 30-days follow-up were collected. Patients were divided into 2 groups, those less than 75-year-olds or 75 and older. Complications were categorized into major or minor groups.

Results

443 patients were recruited. Mean age of the participants was 63 ± 13.7 years (range, 22–94 years), 93 (21%) of them were ≥ 75-year-old. The older group (≥ 75-year-old) had worse performance status ($p = 0.004$) and required significantly lower levels of sedation ($p < 0.001$). The overall complication rate in older group was significantly higher (17.2% versus 7.4%; $p = 0.004$). The multivariate regression analysis showed that the factors that increase the likelihood to have complication were baseline ECOG score (OR 2.21, 95%CI 1.29–3.78), underlying ischemic heart disease (OR 4.69, 95%CI 1.42–15.48), and oxygen desaturation before procedure (OR 0.87, 95%CI 0.79–0.94).

Conclusion

EBUS-TBNA is a safe and well-tolerated procedure but should be performed cautiously in elderly patients with poor performance status, underlying ischemic heart disease and desaturation.

Introduction

Endobronchial Ultrasound - guided Transbronchial Needle Aspiration (EBUS-TBNA) is the procedure that provides pathological diagnosis of mediastinal and hilar lymph nodes and tumor adjacent to the central airways under sedation. EBUS-TBNA was initially used for lung cancer staging, then it was applied for other indications, such as sarcoidosis, lymphoma, or tuberculosis [1, 2]. This procedure is known to be less invasive, shorter performing time, and shorter recovery time comparing to mediastinoscopy [3]. Many guidelines suggested that EBUS-TBNA should be the first diagnostic procedure for lung cancer when radiological evidence is suggestive of mediastinal lymphadenopathy [4].

Until recent years, EBUS-TBNA had been the procedure of choice for elderly with comorbid diseases. There were a few cohort studies reporting on the complication rates of this procedure. There was no statistically significant difference in the complication rates, both major and minor complications, among elderly group compared to control group [5, 6]. One retrospective cohort study of bronchoscopy found that the complication rate in the elderly patients (above 75 years old) was not different from the control group [7]. A 2023 study reported that, compared with younger patients, elderly patients had similar complication rates, recovery times, and procedure durations, but required lower doses of propofol [8].

However, the data on EBUS-TBNA complications and factors that may increase risk for complications in elderly are still limited especially in Southeast Asian population. The objective of this study was to examine the complications of EBUS-TBNA and identify covariate factors that may increase risks for complications in elderly patients.

Method

We conducted a retrospective cohort study at the bronchoscopy unit of King Chulalongkorn Memorial Hospital, including consecutive patients who underwent EBUS-guided transbronchial needle aspiration (EBUS-TBNA) between March 2017 and April 2020. EBUS-TBNA was performed for a range of clinical indications, including mediastinal/hilar nodal staging in suspected or established lung cancer; evaluation of lymphadenopathy accompanied by pulmonary abnormalities (mass, nodule, consolidation, infiltration, or atelectasis); isolated mediastinal lesions; lymphadenopathy in the setting of extrapulmonary malignancy; suspected or known lymphoma; and suspected infection. Procedures were carried out under moderate (conscious) sedation without general anesthesia, using fentanyl and midazolam. Bronchoscopies were performed by an interventional pulmonology team (attending interventional pulmonologists with fellows and bronchoscopy unit staff), with all trainees working under direct attending supervision. EBUS-TBNA was conducted using Olympus convex-probe bronchoscopes (BF-UC180F or BF-UC190F; Hachioji-shi, Tokyo, Japan) with 21-gauge or 22-gauge needles. Target selection and sampling strategy were determined in advance based on the pre-procedure plan.

We extracted data through structured chart review, capturing patient demographics/clinical characteristics, procedure details, and outcomes. Adverse events were documented by the performing bronchoscopist from the immediate post-procedure period through 30 days after EBUS-TBNA and were categorized a priori as major or minor.

Major complications included clinically significant bleeding requiring resuscitation, blood transfusion, or intensive/critical care admission; arrhythmia requiring treatment; seizure; myocardial infarction or pulmonary edema; pneumothorax requiring needle aspiration or intercostal chest drainage; oversedation requiring ventilatory support or pharmacologic reversal; unplanned hospital admission; infection; or death. Minor complications comprised mild-to-moderate bleeding requiring ongoing suctioning and/or topical vasoconstrictors; arrhythmia not requiring treatment; hypotension requiring intervention; and poor procedural tolerance leading to premature termination.All specimens were interpreted by a thoracic

pathologist and reported according to standard diagnostic criteria based on histomorphology and immunohistochemistry.

Statistical analysis

Statistical analyses were performed using SPSS (version 28.0.0.0) and JASP (version 0.19.3). For the primary analysis, participants were stratified by age into < 75 years and ≥ 75 years. The primary outcome was the occurrence of post-procedural complications, and secondary analyses examined variables associated with complication risk. Categorical variables are reported as counts and percentages and were compared using the χ^2 test. Continuous variables are summarized as median (interquartile range) and were compared using the Kruskal–Wallis test.

Assuming an overall complication rate of 10%, based on two prospective studies of standard flexible bronchoscopy, a minimum sample size of 398 was estimated to provide 80% power to detect a 10% absolute difference in complication rates between age groups, using a two-sided α of 0.05 [9, 10].

Results

Patient cohort’s characteristics

A total of 468 patients who underwent EBUS-TBNA were recruited. However, 25 patients had missing data and were excluded from the analysis, leaving 443 patients in the final cohort. More than half of the patients were men (242/443, 54.6%), and the majority were Thai (98.8%). In exploratory analyses evaluating multiple age thresholds, the risk of procedure-related complications increased progressively with advancing age and reached statistical significance at the ≥ 75-year cut point (odds ratio 2.59, 95% CI 1.32–5.06; p = 0.008). In contrast, lower age thresholds (≥ 60, ≥ 65, and ≥ 70 years) were not significantly associated with complications, and the association was attenuated at ≥ 80 years, likely due to limited sample size. Based on this observed inflection point, age ≥ 75 years was selected as the operational definition of the elderly group for subsequent analyses (Supplementary Table 1). The median age (interquartile range) was 62.0 (53.0–68.0) years in patients aged < 75 years and 79.0 (76.0–81.0) years in those aged ≥ 75 years. A total of 350 patients (79%) were younger than 75 years. Baseline demographic and clinical characteristics of the study cohort stratified by age < 75 years and ≥ 75 years are summarized in Table 1.

Table 1
Demographic data of the patient cohort

Measure		Age group		P value
		< 75 years old (n = 350)	≥ 75years old (n = 93)	
Sex: Male, *N (%)*		185 (52.9)	57 (61.3)	0.147
ECOG, *N (%)*	0	134 (38.2)	13 (14.0)	< 0.001
	1	191 (54.6)	66 (71.0)	
	2	8 (2.3)	2 (2.2)	
	3	2 (0.6)	5 (5.4)	
Age (years)		62.0 (53.0–68.0)	79.0 (76.0–81.0)	< 0.001
Height (cm)		160.0 (156.0-168.0)	160.0 (153.0-165.0)	0.037
Weight (kg)		60.0 (52.0-68.5)	55.0 (50.0-63.8)	0.002
BMI (kg/m2)		23.1(20.6–25.6)	21.6 (19.2–25.3)	0.033
Medication, *N (%)*	Aspirin	27 (7.7)	20 (21.5)	< 0.001
	Clopidogrel	4 (1.1)	6 (6.5)	0.007
	Warfarin	5 (1.4)	4 (4.3)	0.097
	LMWH	9 (2.6)	0	0.215
	NOACs	3 (0.9)	0	1.000
Indication, *N (%)*	Nodal staging in known lung cancer	20 (5.7)	6 (6.5)	0.514
	Lung lesion (mass, nodule, consolidation, infiltration, atelectasis) with LN	148 (42.3)	45 (48.4)	
	Isolated mediastinal LN or mass without lung mass	60 (17.1)	18 (19.4)	
	Evaluate metastasis in	96 (27.4)	21 (22.6)	

ECOG; Eastern Cooperative Oncology Group performance status. 0 = fully active, 1 = strenuous physical activity restricted, 2 = capable of all self-care but unable to carry out any work activities, 3 = capable of only limited self-care, 4 = totally confined to bed or chair. BMI; Body Mass Index. LWMH; low molecular weight heparin. DOACs; Direct oral anticoagulants. LN; lymph node. HFNC; High flow nasal cannula.

Measure		Age group		P value
		< 75 years old (n = 350)	≥ 75years old (n = 93)	
	extrapulmonary cancer			
	Lymphoma	8 (2.3)	0	
	Infection	18 (5.1)	3 (3.2)	
Type of Oxygen support, *N (%)*	Cannula	93 (26.6)	24 (25.8)	0.917
	Mask	15 (4.3)	4 (4.3)	
	HFNC	23 (6.6)	4 (4.3)	
	Mechanical ventilation	1 (0.3)	0	
Sedation dose	Fentanyl (ug)	100.0(75.0-125.0)	100.0(75.0-100.0)	0.008
	Midazolam (mg)	5.0 (3.0–5.0)	4.0 (3.0–5.0)	0.002
Duration (min)		50.0 (40.0–60.0)	60.0 (40.0–70.0)	0.092
Mortality, *N*		4	0	

ECOG; Eastern Cooperative Oncology Group performance status. 0 = fully active, 1 = strenuous physical activity restricted, 2 = capable of all self-care but unable to carry out any work activities, 3 = capable of only limited self-care, 4 = totally confined to bed or chair. BMI; Body Mass Index. LWMH; low molecular weight heparin. DOACs; Direct oral anticoagulants. LN; lymph node. HFNC; High flow nasal cannula.

Patients aged ≥ 75 years demonstrated poorer functional status, with a higher proportion having ECOG performance status ≥ 2 ($p < 0.001$). The ≥ 75-year group also had lower body weight and body mass index, as well as a modest but statistically significant difference in height (all $p < 0.05$). Regarding medication use, aspirin and clopidogrel were more frequently prescribed in patients aged ≥ 75 years (both $p < 0.01$), while the use of warfarin, low-molecular-weight heparin, and non–vitamin K oral anticoagulants did not differ significantly between age groups. Procedural characteristics showed that patients aged ≥ 75 years received lower doses of sedative agents, including fentanyl and midazolam (both $p < 0.01$). Procedure duration tended to be longer in the ≥ 75-year group, although this difference did not reach statistical significance ($p = 0.092$).

In contrast, sex distribution, indication for EBUS, type of oxygen support during the procedure, and mortality were comparable between the two age groups, with no statistically significant differences observed (all $p > 0.05$). (Table 1).

Primary outcome

Overall, 42 complications were recorded (42 of 443, 9.48% of all procedures). The older group had 16 complications in which 6 of them were major complications. The younger group had 26 complications in which 13 of them were major complications (Table 1). Among 19 patients with major complications there were 6 pneumonia, 3 pneumothorax, 3 major bleeding, 2 hypoxic respiratory failure, 1 bradycardia, and 4 deaths. Among 23 patients with minor complications were 11 transient hypoxemia or apnea, 4 hypotension with volume responsive, 3 transient premature ventricular contractions, 2 mild bleeding, 2 poor tolerance of the procedure, and 1 mild allergic reaction. The overall complication rate in the older group was statistically significantly higher than the younger group ($p = 0.004$). However, there was no statistically significant difference in severity of complications between major and minor complications ($p = 0.530$).

Four mortalities were found within 30 days post procedures, all of them were in the younger group. First patient was a 62-year-old male, end stage renal disease, stroke, atrial fibrillation, hypertension, and type 2 DM. he was capable of only limited self-care. EBUS-TBNA was performed to evaluate hilar lymphadenopathy, and the results was negative. The patient died naturally at home at 26th day after procedure. Second patient was a 68-year- old female with dyslipidemia and hypothyroidism. She was admitted with pneumonia, then developed septicemia, acute respiratory distress syndrome, and mediastinal lymphadenopathy before EBUS-TBNA was performed. She died at 14th day after procedure because of uncontrolled infection and deteriorating respiratory system. Third patient was a 58-year-old male with suspected interstitial lung disease and epilepsy. EBUS-TBNA was done, and the diagnosis was aspergilloma. He died at 17th day after procedure because of multi-organ failure. Last patient was a 55-year-old female with recurrent breast cancer stage 4. Her diagnosis that admission was lymphangitis carcinomatosis. EBUS-TBNA showed evidence of mediastinal node metastasis. She died at 5th day after procedure from disease progression.

Secondary outcome

To further assess factors that might increase the likelihood to develop complication, the data was recategorized into two groups, those with complications and those who did not suffers from post procedure complication. Univariate analysis was used to compare the difference factors between two groups (Table 2). Greater age was still significantly related with complication (67.7 ± 12.4 years and 62.7 ± 13.8 years, $p = 0.012$). Besides age, there was statistically significant difference among the following factors: hypertension ($p = 0.030$), diabetes mellitus ($p = 0.023$), arrhythmia ($p = 0.010$), ischemic heart disease ($p = 0.016$), clopidogrel usage($p = 0.059$), warfarin usage($p = 0.044$), alcohol drinking ($p = 0.025$), midazolam dosage ($p = 0.029$), and preprocedural oxygen desaturation ($p = 0.018$) between two groups.

Table 2

Comparison of factors stratified by complication ECOG; Eastern Cooperative Oncology Group performance status. 0 = fully active, 1 = strenuous physical activity restricted, 2 = capable of all self-care but unable to carry out any work activities, 3 = capable of only limited self-care, 4 = totally confined to bed or chair. BMI; Body Mass Index. LWMH; low molecular weight heparin. DOACs; Direct oral anticoagulants.

Measure		Complication		P value
		Complication (n = 42)	No complication (n = 401)	
Age (years)		67.7 ± 12.4	62.7 ± 13.8	0.012
Sex: Male, *N (%)*		19 (45.2)	223 (55.6)	0.199
ECOG, *N (%)*	0	6 (14.3)	141 (35.2)	0.002
	1	28 (66.7)	229 (57.1)	
	2	1 (2.4)	9 (2.2)	
	3	3 (7.1)	4 (1.0)	
Height (cm)		159.1 ± 9.5	161.1 ± 8.4	0.072
Weight (kg)		58.0 ± 12.6	59.9 ± 11.6	0.159
BMI (kg/m2)		22.9 ± 4.2	22.4 ± 5.8	0.290
Underlying conditions, *N (%)*	Hypertension	22 (52.4)	142 (35.4)	0.030
	Diabetes mellitus	12 (28.6)	60 (15.0)	0.023
	Arrhythmia (mostly Atrial fibrillation)	4 (9.5)	6 (1.5)	0.010
	Ischemic heart disease	5 (11.9)	12 (3.0)	0.016
	Cerebrovascular disease	2 (4.8)	14 (3.5)	0.656
	Interstitial lung disease	1 (2.4)	5 (1.2)	0.452
	Airway disease (Asthma or COPD)	4 (9.5)	36 (9.0)	0.783
	Renal disease	4 (9.5)	14 (3.5)	0.080
	Lymphoma	0	14 (3.5)	0.381
	Lung cancer	7 (16.7)	48 (12.0)	0.380
	Extrapulmonary cancer	11 (26.2)	96 (24.0)	0.746
Smoking, *N (%)*		16 (38.1)	168 (41.9)	0.639

Measure		Complication		P value
		Complication (n = 42)	No complication (n = 401)	
Alcohol, *N (%)*		13 (30.9)	69 (17.2)	0.025
Medication, *N (%)*	Aspirin	6 (14.3)	41 (10.2)	0.428
	Clopidogrel	3 (7.1)	7 (1.7)	0.059
	Warfarin	3 (7.1)	6 (1.5)	0.044
	LMWH	0	9 (2.2)	1.000
	NOACs	1 (2.4)	2 (0.5)	0.259
Sedation	Fentanyl (ug)	101.0 ± 42.1	109.1 ± 40.8	0.110
	Midazolam (mg)	4.0 ± 2.1	4.5 ± 1.8	0.029
Duration (min)		57.4 ± 20.8	55.1 ± 18.5	0.237
Vital signs pre-procedure	Systolic BP (mmHg)	137.8 ± 21.6	137.7 ± 20.9	0.488
	Diastolic BP (mmHg)	77.9 ± 13.3	77.1 ± 11.9	0.350
	Pulse rate (bpm)	84.3 ± 15.5	79.9 ± 16.3	0.055
	Respiratory rate (/min)	19.7 ± 4.7	19.3 ± 4.3	0.277
	O2 saturation (%)	96.1 ± 4.8	97.7 ± 2.7	0.018

Logistic regression analysis using forward LR technique was performed using the factors mentioned earlier. The result showed that the factors that increase likelihood to develop complication were baseline ECOG score (OR 2.21, 95%CI 1.29–3.78), ischemic heart disease (OR 4.69, 95%CI 1.42–15.48), and preprocedural oxygen desaturation (OR 0.87, 95%CI 0.79–0.94) (Table 3).

Table 3
The results of logistic regression analysis for developing complication (Forward LR technique)

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Performance status	0.852	0.263	10.526	1	0.001	2.344	1.401	3.922
	Constant	-3.016	0.309	95.490	1	< 0.001	.049		
Step 2[b]	Performance status	0.893	0.265	11.362	1	< 0.001	2.441	1.453	4.103
	O2 saturation	-0.133	0.045	8.947	1	0.003	0.875	0.802	0.955
	Constant	9.901	4.296	5.312	1	0.021	19957.497		
Step 3[c]	Performance status	0.794	0.274	8.404	1	0.004	2.213	1.293	3.786
	Ischemic heart disease	1.545	0.609	6.430	1	0.011	4.689	1.420	15.481
	O2 saturation	-0.143	0.046	9.786	1	0.002	0.867	0.793	0.948
	Constant	10.806	4.401	6.030	1	0.014	49317.801		
a. Variable(s) entered on step 1: Performance status.									
b. Variable(s) entered on step 2: O2 saturation.									
c. Variable(s) entered on step 3: ischemic heart disease.									

Discussion

This study showed that the overall complication rate of EBUS-TBNA was about 10% which is comparable to previous studies. [11–13] It reflects that the safety of EBUS-TBNA procedure and complication detection in our center was properly measured. However, when compared between the elderly group and the younger group the complication rate was 7.4 and 17.2% respectively. According to a study of EBUS-TBNA which investigated the safety profile and efficacy of the procedure, they found no statistically significant difference in rate of complications between the elderly and the younger group. However, they discovered that the rate of complication was higher in patients with poor performance status.[5] In our study, the elder group also had significantly lower performance status compared to the younger group ($p < 0.001$). Therefore, the poor performance status may be the confounding factor that led to a higher complication rate in elderly group in our study. This finding had led us to the secondary outcome, to identify other risk factors that may led us to a higher complication rate.

Our major complications were higher than the previous studies.[11–13] Pneumonia was the main major complication in our study, diagnosed in 6 patients out of 19 patients. According to the previous study of EBUS-TBNA,[5] their participants were mostly cancer patients and their main indication for EBUS-TBNA was lymph node biopsy to identify cancer. However, the main indication for EBUS-TBNA in our study was any lung lesion with mediastinal lymphadenopathy (148 of 350, 42.3% in younger group, and 45 of 93, 48.4% in older group) which includes participants who were already diagnosed with respiratory infections and lymphadenopathy.

Four mortalities were found within 30 days post procedures, all of them were in the younger group. According to the detailed history of each patient, all mortalities did not occur immediately after procedure and the cause of death were related to his/her previously severe condition before EBUS-TBNA was performed rather than the direct consequence of the procedure.

As for bleeding complications, every patient with antiplatelet and anticoagulant usage were informed to stop using those medications before procedure as general suggestion, 7 days for aspirin, 5 days for warfarin, 12–24 hours for LMWHs and 1 day for NOACs. Our study found that 4 out of 5 patients with bleeding complications did not use any antiplatelet or anticoagulant prior to procedure. Therefore, we suggest that history of antiplatelet and anticoagulant usage does not increase risks of bleeding complication. However, platelet level and coagulopathy lab investigation were not obtained before procedure. A more detailed study involving analysis of bleeding tendency and postprocedural bleeding should be done.

Surprisingly, among patients with underlying diseases prior to procedure. We discovered that patients with underlying ischemic heart disease were the only one with statistically significant difference in rate of complications (OR = 4.689). Four out of 5 patients with ischemic heart disease suffered from minor complications. There was only one patient who had major complication which was pneumothorax. Further study primarily focused on patients with underlying ischemic heart disease should be done to enlighten us more on this matter.

Prior studies that investigate EBUS-TBNA procedure complications were focused about the incidence, however, our study is the first study to do a risk factor analysis of EBUS-TBNA. Although our recruited patients were smaller in number comparing to the previous studies, but we recruited every patient in the specified time, both outpatients and inpatients, with various underlying disease and in indication of the procedure to reduce selection bias. Moreover, we try to find other factors that might increase the likelihood to develop complications. We found that worse performance status, ischemic heart disease, and lower oxygen saturation before procedure were the potential factors, which are all the patient's conditions before procedure, not directly by the procedure itself.

Limitation

Our hospital is a tertiary care center which patients with higher comorbidities are referred to. As a result, a referral bias may occur and postprocedural complications especially major complications were more

likely to happen.

Since we recruited every patient who underwent EBUS-TBNA in specific period, the number of patients between two groups were unequal and the data might not be in the normal distribution. But the patient characteristics between two groups were not much different and this therefore should not bias the analysis.

This study was a single center, retrospective study. The data and the results might not reflect the temporal relationship between the complications and the associated factors we found. The larger prospective study is needed to confirm this causal relationship.

Conclusion

In conclusion, EBUS-TBNA is a safe and well-tolerated procedure. However, it should be performed cautiously in elderly patients with poor performance status, ischemic heart disease and preprocedural desaturation.

Abbreviations

- **21G / 22G** - 21-gauge / 22-gauge
- **ARDS** - Acute respiratory distress syndrome
- **CI** - Confidence interval
- **DM** - Diabetes mellitus
- **EBUS** - Endobronchial ultrasound
- **EBUS-TBNA** - Endobronchial ultrasound-guided transbronchial needle aspiration
- **ECOG** - Eastern Cooperative Oncology Group (performance status)
- **IQR** - Interquartile range
- **LMWH** - Low-molecular-weight heparin
- **NOAC** - Non–vitamin K oral anticoagulant
- **OR** - Odds ratio

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand (IRB 838/63). The requirement for informed consent to participate was waived by the Institutional Review Board because this was a minimal-risk retrospective study using de-identified data, in accordance with institutional standard operating procedures.

Consent for publication

Not applicable. The requirement for consent for publication was waived by the Institutional Review Board due to the retrospective design and use of de-identified data.

Availability of data and materials

The data underlying this article will be shared on reasonable request to the corresponding author.

Competing interests

The authors declare that they have no competing interests.

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None

Authors' contributions

KL conceived, designed the study, collected the data and was a major contributor to drafting the manuscript. TS co-led the study with KL, contributed to study conception and design, oversaw clinical/procedural aspects and data interpretation, and was a major contributor to manuscript revision. CS performed the statistical analyses, created the tables, and contributed to manuscript writing and revision. VT, NL, VW, KK, CSit, AW, and MP contributed to data collection and verification. All authors read and approved of the final manuscript.

Declaration of generative AI and AI-assisted technologies in the writing process

AI tools (ChatGPT4o) were used to assist with language editing and formatting. After using this tool/service, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the publication.

References

1. Yasufuku K, et al. Endobronchial ultrasound guided transbronchial needle aspiration for staging of lung cancer. Lung Cancer. 2005;50(3):347–54.
2. T B. Endobronchial ultrasound: A new innovation in bronchoscopy. Lung India. 2009;26(1):17–21.
3. Sampsonas F et al. EBUS: Faster, cheaper and most effective in lung cancer staging. Int J Clin Pract, 2018. 72(2).
4. Yasufuku K, et al. A prospective controlled trial of endobronchial ultrasound-guided transbronchial needle aspiration compared with mediastinoscopy for mediastinal lymph node staging of lung cancer. J Thorac Cardiovasc Surg. 2011;142(6):1393–e4001.

5. Evison M, et al. EBUS-TBNA in elderly patients with lung cancer: safety and performance outcomes. J Thorac Oncol. 2014;9(3):370–6.
6. Yilmaz Demirci N, Ozturk C. Diagnostic utility of endobronchial ultrasound-guided transbronchial needle aspiration in elderly patients. Tuberk Toraks. 2018;66(2):115–21.
7. Yildizeli SO, et al. Risk factors for bronchoscopic complications in patients over 75 years of age. Eur Geriatr Med. 2018;9(1):89–94.
8. Tunç M, et al. Safety of geriatric patients undergoing endobronchial ultrasound-guided transbronchial needle aspiration with deep sedation: a retrospective study. BMC Anesthesiol. 2023;23(1):276.
9. Hehn BT, et al. The relationship between age and process of care and patient tolerance of bronchoscopy. J Am Geriatr Soc. 2003;51(7):917–22.
10. Bechara R, et al. Practice and Complications of Flexible Bronchoscopy With Biopsy Procedures. J Bronchol Interventional Pulmonol. 2005;12(3):139–42.
11. Varela-Lema L, Fernandez-Villar A, Ruano-Ravina A. Effectiveness and safety of endobronchial ultrasound-transbronchial needle aspiration: a systematic review. Eur Respir J. 2009;33(5):1156–64.
12. Gu P, et al. Endobronchial ultrasound-guided transbronchial needle aspiration for staging of lung cancer: a systematic review and meta-analysis. Eur J Cancer. 2009;45(8):1389–96.
13. Eapen GA, et al. Complications, consequences, and practice patterns of endobronchial ultrasound-guided transbronchial needle aspiration: Results of the AQuIRE registry. Chest. 2013;143(4):1044–53.

Supplementary Files

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- SupplementaryTable1.docx