Review Article

Transesophageal endoscopic ultrasound with bronchoscope-guided fine-needle aspiration for diagnostic and staging purposes: a narrative review

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Background and Objective: Transesophageal endoscopic ultrasound with bronchoscope-guided fine-needle aspiration (EUS-B-FNA) is a feasible and well-tolerated modality that is increasingly used to diagnose intrathoracic lesions. This narrative review summarizes the current application of EUS-B-FNA for diagnosing lung cancer, thoracic sarcoidosis, and metastases from extrathoracic malignancies.

Methods: A comprehensive and systematic online literature search via Medline/PubMed for the period January 2005 to December 2022 was conducted for articles published using the keywords "EUS-B-FNA", "endobronchial ultrasound transbronchial needle aspiration (EBUS-TBNA)", "endoscopic ultrasound fine-needle aspiration (EUS-FNA)", "lung cancer", "staging", and "sarcoidosis".

Key Content and Findings: Recent data prove the efficacy and safety of EUS-B-FNA for providing complete lung cancer staging, when combined with EBUS-TBNA, and in the evaluation of para-esophageal lesions. EUS-B-FNA allows access to inferior mediastinal lymph nodes and para-esophageal masses that are not accessible by EBUS-TBNA. Additional advantages of using EUS-B-FNA include significantly lower doses of anesthetics and sedatives, a shorter procedural time, fewer incidents of oxygen desaturation due to a poor respiratory reserve, significantly less cough, and higher operator satisfaction. Moreover, this procedure can be performed sequentially in the same setting with EBUS-TBNA by one operator. Other benefits include a lower cost, a single setting, and scope use.

Conclusions: As EUS-B-FNA and EBUS-TBNA have complementary access to the mediastinum, the diagnostic yield of EUS-B-FNA combined with EBUS-TBNA is higher than that of endosonographic techniques alone in the diagnostic workup of intrathoracic lesions.

Keywords: Endobronchial ultrasound combined with transbronchial needle aspiration (EBUS-TBNA); endoscopic ultrasound fine-needle aspiration (EUS-FNA); endoscopic ultrasound with bronchoscope fine-needle aspiration (EUS-B-FNA); lung cancer; sarcoidosis

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Introduction

The combination of endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) and endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) has an important role and provides greater sensitivity than either procedure alone. These two procedures are recommended as being safe and effective for the diagnosis and staging of lung cancer and other diagnostic indications including lymphoma, granulomatous diseases (thoracic sarcoidosis, tuberculosis), and mediastinal metastases of esophageal and extrathoracic malignancies (1,2).

As linear endosonography modalities, EBUS-TBNA and EUS-FNA have a complementary effect with respect to the mediastinum (1-4). Although EBUS-TBNA provides an easy approach to pretracheal and right paratracheal lesions, EUS-FNA is useful for approaching the inferior mediastinum, the left paratracheal area, and the aortopulmonary window. EBUS-TBNA is conventionally performed using a dedicated echobronchoscope by a pulmonologist, whereas EUS-FNA is mainly performed using an echoendoscope by gastroenterologists. Patients requiring both procedures currently incur a higher cost for the two treatments, as well as potentially longer and more difficult diagnostic sessions.

A new technique using a convex probe–endobronchial ultrasound (CP-EBUS) scope through the esophagus, endoscopic ultrasound with bronchoscope (EUS-B), involves endoscopic ultrasound with bronchoscope-guided fine-needle aspiration (EUS-B-FNA) (5). This procedure may be preferable to EUS-FNA for some pulmonologists, as it eliminates the need for an EUS or an experienced endoscopist. This transesophageal approach using the CP-EBUS scope was first announced in 2007 (6). In 2010, two milestone studies reported that dual use of EBUS through the tracheobronchial tree and the esophagus is feasible and can be performed sequentially in the same session by a single bronchoscopist (7,8). Additionally, these studies demonstrated high diagnostic yield for lung cancer staging.

EUS-B-FNA is important for evaluating lesions that cannot be accessed by EBUS, and is particularly useful for assessing lower mediastinal lesions, including paraesophageal, vertebral, and paravertebral lesions. The additional value of performing EUS-B-FNA after EBUS-TBNA for diagnostic purposes has not been well studied. Dhooria *et al.* reported that the diagnostic gain of EUS-B-FNA is close to 7.6% (9). In Hwangbo *et al.* (10), of 84 patients who underwent EUS-B-FNA in which bronchoscopy and/or EBUS-TBNA was performed prior to EUS-B-FNA, that EUS-B-FNA provided additional diagnostic gain to EBUS-TBNA in 16 patients (19%). In 2022, Torii *et al.* reported the largest study on the usefulness of EUS-B-FNA for diagnostic purposes of intrathoracic lesions (11). In that study, 276 patients who underwent EUS-B-FNA for diagnostic purposes were examined; the results showed that adding EUS-B-FNA to EBUS-TBNA increased the diagnostic yield by 3.3% (from 72.6% to 75.9%) (11).

EUS-B-FNA offers an alternative or adjunct to EBUS-TBNA and provides increased accessibility to paraoesophageal lesions, as well better cost-effectiveness in terms of avoiding the need for an additional EUS scope (12,13).

In this review article, we describe the usefulness of EUS-B-FNA for diagnostic purposes and provide a road map to facilitate integration of EUS-B-FNA into clinical practice. We present this article in accordance with the Narrative Review reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-681/rc).

Methods

A comprehensive and systematical online literature search via Medline/PubMed database for the period January 2005 to December 2022 was performed for articles published using the keywords “EUS-B-FNA”, “EBUS-TBNA”, “EUS-FNA”, “lung cancer”, “staging”, or “sarcoidosis”. The search strategy is summarized in *Table 1*.

Techniques

There are no specific recommendations for required skills with respect to EUS-B-FNA as they are extrapolated from EBUS and conventional bronchoscopy guidelines. EUS-B-FNA can be performed in an outpatient setting under local anesthesia, with mild to moderate sedation through the mouth. The anesthetic agents and techniques used are similar to those of EBUS-TBNA. Lidocaine is commonly used for topical anesthesia; intravenous midazolam and fentanyl are used for conscious sedation. EUS-B-FNA involves the use of the same dedicated EBUS-TBNA needles. The CP-EBUS scope is inserted into the esophagus carefully rotating and advancing the scope under visual control to the gastric fundus (14,15). During the transesophageal approach, low-flow oxygen (1–2 L/min) is sometimes injected through the working channel through a connected tube when the scope is introduced into the

Table 1 Search strategy summary

Items	Specification
Date of search	22 February 2023
Databases and other sources searched	Medline, PubMed
Search terms used	EUS-B-FNA, EBUS-TBNA, EUS-FNA, lung cancer, staging, sarcoidosis
Timeframe	From January 2005 to December 2022
Inclusion and exclusion criteria	Inclusion criteria: original article, research article, full paper, English language
	Exclusion criteria: editorial, comments, letters, proceedings, books, abstracts, non-English papers
Selection process	First author conducted the selection process, initial literature review, assessed all of the identified studies based on the eligibility criteria. All authors reviewed the final list of studies included in the review

EUS-B-FNA, endoscopic ultrasound with bronchoscope-guided fine-needle aspiration; EBUS-TBNA, endobronchial ultrasound-transbronchial needle aspiration; EUS-FNA, endoscopic ultrasound fine-needle aspiration.

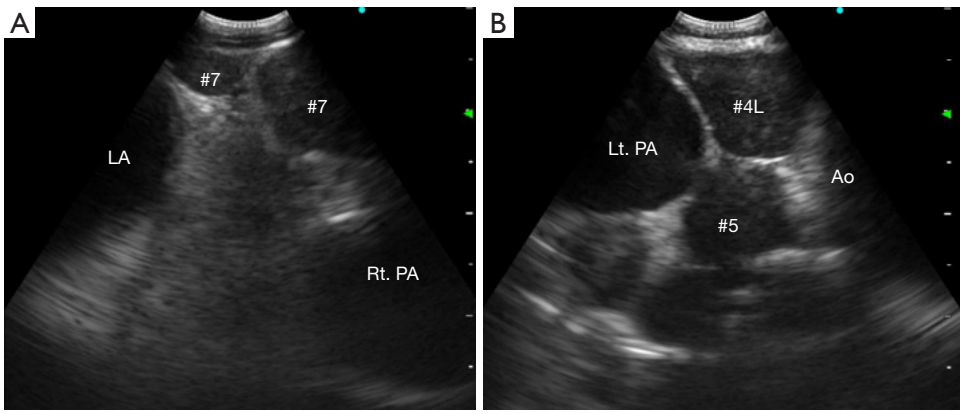

Figure 1 EUS-B image of subcarinal, left lower paratracheal, and subaortic lymph nodes. EUS-B, endoscopic ultrasound with bronchoscope; LA, left atrium; Rt. PA, right pulmonary artery; #7, subcarinal lymph node; Lt. PA, left pulmonary artery; Ao, aortic arch; #4L, left lower paratracheal lymph node; #5, subaortic lymph node.

esophagus to facilitate visualization (14,16). The endoscopic image is not useful, and endosonography scanning guides the procedure.

The method of EUS-B-FNA is similar to EBUS-TBNA, but is often easier to implement due to the softness of the esophageal wall, as the TBNA portion of the esophagus is easier to maneuver through due to the absence of cartilage rings. On the other hand, in some ways, EUS-B-FNA is more difficult, because the esophagus is a soft, hollow organ. The endoscopic image becomes more difficult to acquire, especially as the EBUS tool is a thin scope without a dedicated channel for air injection, unlike the endoscope. Moreover, there are no anatomical landmarks on the esophageal wall. Therefore, the CP-EBUS scope distance from the mouth is important and, in the EUS examination, knowledge of the anatomy of the blood vessels is essential.

The approach range of EUS-B is similar to EUS. Notably, it is possible to puncture the left adrenal gland; the left lobe of the liver; lymph node stations 2L, 4L, 7, 8, and 9; and in specific situations, the lower part of station 5, the posterior part of station 4R, station 1, station 3P, and celiac node (*Figure 1*). Operators should work on the tracheal side before inserting the scope into the esophagus. It is not recommended to reintroduce EBUS after EUS-B-FNA.

In general, mediastinal staging is performed with a systematic N3-N2-N1 order, followed by sampling of the mass itself when attempting to avoid cross-contamination. There may be a situation in which there is a suspected

case of left adrenal metastasis, such that EBUS-TBNA and EUS-B-FNA are considered in the same session. In this case, after the EBUS procedure is completed and the left adrenal gland is visualized via a transgastric approach, a separate needle should be used to eliminate the risk of contamination.

EUS-B-FNA in the diagnosis and staging of lung cancer

For accurate diagnosis and staging of lung cancer patients, tissue confirmation is mandatory. Intrathoracic lymphadenopathies are always suspicious for malignancy and require further evaluation. However, obtaining a histological diagnosis is a challenge for patients with no endobronchial abnormalities and lung tumors located centrally rather than near the main airway. In this case, EBUS-TBNA and EUS-B-FNA are useful and safe procedures for obtaining a tissue diagnosis (7-10).

In a randomized controlled study that enrolled 241 patients in which immediate surgical staging was compared to endoscopic staging followed by surgical procedures in cases of negative endosonography (17). The sensitivities for lymph node metastasis of surgical staging and endosonographic staging were 79% and 85%, respectively. A previous study reported a 95.5% (448/464 samples) diagnostic yield for EBUS-TBNA in non-small cell lung cancer (NSCLC) patients regarding adequacy for the site, and 92.6% (430/464) adequacy for diagnosis (18). As such, current international guidelines recommend the minimally invasive endoscopic needle technique as being superior to surgical staging as the first test for mediastinal staging of lung cancer patients (19,20).

For mediastinal staging of lung cancer, combination of EBUS-TBNA with EUS-B-FNA or EUS-FNA can provide higher diagnostic yield than EBUS-TBNA alone (14,21-29). Notably, Crombag *et al.* demonstrated that the systematic use of EBUS followed by EUS-B increased sensitivity for the detection of N2/N3 disease by 9% compared to positron emission tomography/computed tomography-targeted EBUS alone (26). Steinfort *et al.* reported in a small, select cohort study that in 26 out of 27 patients EUS-B was diagnostic (30). In that study, EUS-B-FNA sampling of pulmonary parenchymal lesions was performed in 27 patients. Ten target lesions (36%) were inaccessible to bronchoscopic sampling through the airways, and 9 lesions were inaccessible to EBUS-TBNA. EUS-B-FNA was diagnostic in 26 of the 27 patients (96%), and the sensitivity of EUS-B-FNA was 100%. Similarly, Mondoni *et al.* demonstrated a diagnostic accuracy of 95.2% using EUS-B-FNA for identifying pulmonary malignant lesions (31).

As mentioned earlier, in two milestone studies performed in 2010, the overall diagnostic yield of EUS-B-FNA combined with EBUS-TBNA in patients with suspected lung cancer was estimated (7,8); in these studies, the sensitivities for EBUS-TBNA were 92% and 84.4%, respectively. The sensitivities of the combination of EBUS-TBNA and EUS-B-FNA increased to 96% and 91.1%, respectively.

In a prospective study by Bugalho *et al.* (32), 123 patients with undiagnosed but suspected malignant lung lesions who had undergone at least one diagnostic flexible bronchoscopy or computed tomography-transthoracic needle aspiration attempt were evaluated by both EBUS-TBNA and EUS-B-FNA. A definitive diagnosis was achieved in 87.6% and the diagnostic accuracy was 90.1%. The authors also provided evidence that the use of a bronchoscope in combination with EBUS-TBNA and EUS-B-FNA significantly reduces the overall cost.

As previously mentioned, in a meta-analysis on the utility and safety of EUS-B-FNA combined with EBUS-TBNA in mediastinal lymph node sampling that involved 1,080 subjects in 10 studies, the sensitivities of the combined procedure and EBUS-TBNA alone were 91% and 80%, respectively (9). According to a study on the diagnostic yield of EUS-B-FNA in paraesophageally located lung tumors and its added value to bronchoscopy and EBUS (33), the yield and sensitivity of EUS-B-FNA for detecting lung cancer was 90%; adding EUS-B to conventional bronchoscopy and EBUS increased the diagnostic yield from 51% to 91%. Results on the diagnostic value of using EUS-B-FNA for lung cancer are summarized in *Table 2*.

Two head-to-head comparison studies of EBUS-TBNA and EUS-B-FNA were conducted to evaluate their performance for evaluating undiagnosed mediastinal lymphadenopathy with respect to diagnostic yield and patient comfort (13,35). In one, a specific diagnosis was made in 50 of 55 patients (91%) in the EBUS-TBNA group and in 48 of 55 patients (87%) in the EUS-FNA group (13). Compared to EBUS-TBNA, EUS-FNA was associated with a shorter procedure duration, lower doses of midazolam and intra-airway lidocaine, less frequent oxygen desaturation, and higher operator satisfaction. In the other study, the proportions of adequate (EBUS-TBNA 92% and EUS-B-FNA 96%) and diagnostic aspirates (EBUS-TBNA 76% and EUS-B-FNA 74%) were similar in the

Table 2 Diagnostic yield for intrapulmonary malignant lesions of the combined EBUS-TBNA/EUS-B-FNA among the distinct studies

Study	Type of study	Patient numbers	Method	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Herth FJ *et al.* (7)	Prospective	139	EBUS-TBNA + EUS-B-FNA	96	100	100	95
Hwangbo B *et al.* (8)	Prospective	143	EBUS-TBNA + EUS-B-FNA	91	100	100	96
Lee KJ *et al.* (14)	Retrospective	37	EBUS-TBNA + EUS-B-FNA	100	100	100	100
Oki M *et al.* (24)	Prospective	146	EBUS-TBNA + EUS-B-FNA	73	100	100	93
Szlubowski A *et al.* (25)	Prospective	106	EBUS-TBNA + EUS-B-FNA	68	96	95	73
Crombag LMM *et al.* (26)	Prospective	220	EBUS-TBNA + EUS-B-FNA	82	87	82	87
Chrysikos S *et al.* (27)	Prospective	39	EBUS-TBNA + EUS-B-FNA	100	100	–	–
Chrysikos S *et al.* (28)	Prospective	130	EBUS-TBNA + EUS-B-FNA	93.8	100	100	93.4
Kang HJ *et al.* (29)	Prospective	74	EBUS-TBNA + EUS-B-FNA (EBUS-centered)	85.3	100	100	88.9
		74	EUS-B-FNA + EBUS-TBNA (EUS-centered)	92	100	100	96.1
Mondoni M *et al.* (31)	Prospective	99	EBUS-TBNA + EUS-B-FNA	95.2	100	–	–
Araya T *et al.* (34)	Prospective	14	EUS-B-FNA independent	100	100	–	–
		5	EBUS-TBNA + EUS-B-FNA	100	100		

EUS-B-FNA, endoscopic ultrasound with bronchoscope-guided fine-needle aspiration; EBUS-TBNA, endobronchial ultrasound-transbronchial needle aspiration; PPV, positive predictive value; NPV, negative predictive value.

two groups (35). In both studies, the authors concluded that operator-rated patient comfort was significantly higher, and the procedure duration was much shorter using the EUS-B-FNA approach.

EUS-B-FNA has a role in the diagnosis of locoregional recurrence of surgically treated lung cancer. Sanz-Santos *et al.* confirmed locoregional tumor recurrence by EUS-B-FNA in cases where EBUS-TBNA was not possible (36). Among 73 patients who underwent EBUS-TBNA, 7 had EUS-B-FNA, 4 of whom experienced confirmed recurrence. Moreover, in a prospective study, tissue samples obtained with EUS-B-FNA were applied in a multimodal analysis of epidermal growth factor receptor (*EGFR*) mutations and echinoderm microtubule-associated protein-like 4–anaplastic lymphoma kinase (*EML4-ALK*) fusion genes in NSCLC (34). The authors demonstrated that *EGFR* mutations and the *EML4-ALK* fusion gene could be evaluated in all patients with NSCLC (n=20) using EUS-B-FNA samples. One case with *EGFR* mutation and one case with *ALK* fusion gene were diagnosed.

EUS-B-FNA provides the ability to obtain cytological and histological samples of lung lesions immediately adjacent to the esophagus. However, it is unclear what "immediately adjacent" exactly means. Christiansen *et al.* concluded that all tumors within 19 mm of the esophagus could be sampled; however, the maximal allowable esophagus–tumor distance depends on the tumor size (37).

Recently, rapid on-site evaluation (ROSE) has been used during EBUS-TBNA and EUS-B-FNA procedures. There is still controversy regarding the role of ROSE during these diagnostic treatments. Mondoni *et al.* pointed out that ROSE, performed by pathologists or trained pulmonologists, is a strong predictor for complete molecular profiling in selected patients with advanced lung cancer (31). However, according to the guidelines requiring the presence of a cytopathologist for ROSE, there does not seem to be an effect on the diagnostic yield, but the number of punctures and the procedure time are reduced, which can be helpful when evaluating the quality of the material and quantity of adequate cells (38).

EUS-B-FNA in the diagnosis of thoracic sarcoidosis

Sarcoidosis is a chronic inflammatory multisystemic disease of unknown cause that is characterized by the formation of granulomas, mainly in the lymph nodes and the lungs. Clinical manifestations of sarcoidosis are often nonspecific;

Table 3 Diagnostic yield for thoracic sarcoidosis of the EUS-B-FNA or combined ultrasound-guided needle aspiration among the distinct studies

Study	Type of study	Patient numbers	Method	Accuracy (%)	Sensitivity (%)	PPV (%)	NPV (%)
Oki M *et al.* (42)	Prospective	33	EUS-B-FNA	88	86	–	50
Filarecka A *et al.* (43)	Prospective	50	EBUS-TBNA + EUS-B-FNA	92.16	91.67	–	42.86
Crombag LMM *et al.* (44)	Prospective	173	EUS-B-FNA	68	82	–	–

EUS-B-FNA, endoscopic ultrasound with bronchoscope-guided fine-needle aspiration; EBUS-TBNA, endobronchial ultrasound-transbronchial needle aspiration; PPV, positive predictive value; NPV, negative predictive value.

thus, pathologic confirmation showing the presence of non-caseating granulomas is often required to establish the diagnosis (39).

Bilateral hilar and mediastinal lymphadenopathy are common in sarcoidosis and include stations 7 (98.6% of patients), 11R (97.3%), 11L (86.5%), and 4R (79.7%) (40). Hence, affected lymph nodes can be sampled from both the airways and the esophagus. Since the development of endosonography during the last decade, the standard procedure for the diagnostic workup of stage I and II pulmonary sarcoidosis has become EBUS-TBNA and EUS-FNA (41). However, there are few studies on the application of EUS-B-FNA in the diagnosis of sarcoidosis.

Oki *et al.* assessed the diagnostic utility of EUS-B-FNA in 33 patients for stage I and II sarcoidosis and achieved a diagnostic yield of 86% without complications (42). Filarecka *et al.* evaluated the relative diagnostic yields of EBUS-TBNA, EUS-B-FNA, and combined ultrasound-guided (EBUS + EUS-B) needle aspiration in 50 patients suspected of stage I and II sarcoidosis (43); the overall sensitivities of EBUS-TBNA, EUS-B-FNA, and the combined procedure were 76.6%, 70.2%, and 91.7%, respectively. There were no differences between EBUS-TBNA and EUS-B-FNA, but the combined procedure had a higher diagnostic yield. No procedure-related complications were noted (43).

In 2022, a large-scale study was published (44) that included 358 patients who were randomly assigned to EBUS-TBNA (n=185 patients) and EUS-B-FNA (n=173) diagnostic groups. In 306 patients (86%), sarcoidosis was finally diagnosed. The granuloma detection rate was 70% for EBUS-TBNA and 68% for EUS-B-FNA. Sensitivity for diagnosing sarcoidosis was 78% for EBUS-TBNA and 82% for EUS-B-FNA. There were no significant differences between the two needle types with respect to the granuloma detection rate or sensitivity. The authors demonstrated a high granuloma detection rate of mediastinal/hilar nodes by endosonography in patients with suspected sarcoidosis stage I/II, and the results were similar for EBUS and EUS-B. One patient developed mediastinitis 10 weeks after the EBUS procedure with a standard 22-gauge needle, requiring antibiotics. After treatment, the patient recovered completely. No serious adverse events were reported in the EUS-B-FNA group. Results on the diagnostic value of using EUS-B-FNA for thoracic sarcoidosis are summarized in *Table 3*.

EUS-B-FNA for diagnosis of extrathoracic lesions

According to traditional guidelines (5,21), in patients with a left adrenal gland suspected for distant metastasis, EUS-FNA is recommended. However, in this case, EUS-B-FNA requires careful consideration. EUS-B-FNA is an important procedure, because in selected cases in which a mediastinal lesion and upper abdominal lesion (such as left adrenal lesion) are observed together, the entire mediastinal and upper-abdominal sampling can be done by a single endosonographist in the same session. This approach shortens the procedure time and avoids the risk for repeated interventions under sedation, improving patient safety and satisfaction.

The safety and feasibility of EUS-B-FNA for sampling pulmonary parenchymal lesions and adrenal lesions have been reported. Recently, there were several case reports on successful sampling of EUS-B in the diagnosis of left adrenal lesions (45-49). Crombag *et al.* reported on the value of EUS-B compared to EUS-FNA for diagnosing left adrenal lesions (50,51). The success rates were almost the same using EUS-B-FNA and EUS-FNA (89% *vs.* 93%, respectively), and the sensitivities for metastases were 87% and 83%. Orzechowski *et al.* demonstrated the utility of EUS-B-FNA as a minimally invasive endoscopic method for left adrenal gland analysis (52). In 90 patients for EUS-B-FNA, specificity and positive prediction values were

Table 4 Diagnostic yield for extrathoracic lesions of the EUS-B-FNA among the distinct studies

Study	Type of study	Target lesions	Patient numbers	Method	Accuracy (%)	Sensitivity (%)	NPV (%)
Christiansen IS *et al.* (48)	Retrospective	LAG	135	EUS-B-FNA	87	98	100
Crombag LMMJ *et al.* (51)	Prospective	LAG	44	EUS-B-FNA	89	87	–
Orzechowski S *et al.* (52)	Retrospective	LAG	142	EUS-B-FNA	93.3	88	87
Christiansen IS *et al.* (55)	Retrospective	Liver lesions	23	EUS-B-FNA	91.3	86	–
		Retroperitoneal node	19		100	83	–

EUS-B-FNA, endoscopic ultrasound with bronchoscope-guided fine-needle aspiration; LAG, left adrenal gland; NPV, negative predictive value.

100%, and the sensitivity, accuracy, and negative prediction values were 88%, 93.3%, and 87%, respectively.

The current literature also suggests a role for EUS-B-FNA in the diagnosis of thyroid gland lesions (53). Moreover, there is a rare case report of successful sampling of coeliac lymph nodes to extend the utility of EUS-B-FNA further in assessing patients with lung cancer (54). Christiansen *et al.* demonstrated the usefulness of EUS-B for evaluating liver lesions and retroperitoneal lymph nodes in a lung cancer staging (55). In all, 23 left liver lobe lesions and 19 retroperitoneal lymph nodes were sampled by EUS-B-FNA. The sensitivity and diagnostic yield of the sampled liver lesions were 86% and 83%, respectively, and those of retroperitoneal lymph node samples were 83% and 63%. Results on the diagnostic value of using EUS-B-FNA for extrathoracic lesions are summarized in *Table 4*.

EUS-B-FNA seems to be an appropriate method of choice for assessing extrathoracic lesions and should be considered a minimally invasive technique to provide tissue sampling.

Safety of EUS-B-FNA

EUS-B-FNA, as a minimally invasive procedure to sample intrathoracic lesions, is a safe procedure. No serious complications have been reported; however, there was one report of a lymph node abscess after simultaneous EBUS-TBNA in one subject (56). In a systematic review of the combination of EUS-B-FNA and EBUS-TBNA for staging of mediastinal lymph nodes in lung cancer patients, complications were reported in two cases: one with a lymph node abscess and the other with pneumothorax (57). In another study, pneumothorax occurred in one patient (30).

In the setting of a normal esophagus, damage to the organ would be unlikely, especially because an EBUS scope is thin compared to an EUS scope. However, the CP-EBUS scope is sharper as well as thinner at the tip, which is not easily visible due to the side-view optic. Therefore, if the esophagus is narrowed by stricture or an ulcerative lesion is present, there is a possibility of severe bleeding or even perforation of the esophageal wall.

The transesophageal approach guarantees a significantly lower dose of anesthetics and sedatives, a shorter procedural time, a lower chance of oxygen desaturation, significantly less cough, and higher operator satisfaction (13,35). Hence, patients with respiratory failure with hypoxemia or hypercalcemia, who are not suitable for sedation, are candidates for EUS-B-FNA.

Limitations of EUS-B-FNA

The usefulness and safety of EUS-B-FNA has been confirmed in various clinical fields. However, EUS-B-FNA is not technically simple and requires an experienced endosonographist. When a bronchoscopist performs EBUS-TBNA, the bronchoscopist will locate the correct nodal station endobronchially while looking at the endoscopic image, and optimize the position while looking at the sonographic image. By contrast, EUS-B-FNA is more challenging than EBUS-TBNA, as there are no endoluminal localization points in the esophagus; therefore, target localization is based on interpretation of the sonographic image alone. As these seem to be the key factors limiting EUS-B-FNA application, probably the most important approach is attaining knowledge and training with this diagnostic technique (15).

Currently, there are no training guidelines for pulmonologists performing EUS-B-FNA (58). It is reasonable to train individual bronchoscopists in EBUS and EUS-B-FNA simultaneously to allow for optimal

endosonographic evaluation in one session. Leong *et al.* showed that experienced pulmonologists can safely and accurately perform EUS-B-FNA, with a high diagnostic sensitivity for intrathoracic lesions (59); moreover, pulmonologists experienced in EBUS-TBNA can transition to EUS-B-FNA relatively easily. Other studies also indicated that EUS-B-FNA can be performed accurately and safely and can be readily learned by lung cancer specialists familiar with the EBUS-TBNA technique (58,59).

Another important consideration is maintaining competency after the initial EBUS and EUS-B training. Diagnostic yield can be improved by continuous practice, and the number of complications tends to decrease.

Conclusions

The combination of EUS-B-FNA with EBUS-TBNA enhances the diagnostic yield for intrathoracic lesions. Furthermore, EUS-B-FNA provides access to the left adrenal gland, which is not accessible via EBUS-TBNA. These two procedures have complementary access to the mediastinum and can be performed by one operator using a single EBUS scope. Therefore, this approach provides obvious financial and practical advantages. Moreover, EUS-B-FNA is an effective and safe approach that can obtain tissue specimens from patients whose respiratory condition is poor.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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