The Feasibility of EBUS-Guided TBNA Through the Pulmonary Artery in Highly Selected Patients

Erik Folch, MD, MSc, Jose F. Santacruz, MD,† Sebastian Fernandez-Bussy, MD,‡ Sidhu Gangadharan, MD,* Michael S. Kent, MD,* Michael Jantz, MD,§ David R. Stather, MD,‖ Michael S. Machuzak, MD,¶ Thomas R. Gildea, MD,¶ and Adnan Majid, MD**

Background: **The use of endobronchial ultrasound–guided transbronchial needle aspiration (EBUS-TBNA) for diagnosis and staging of benign and malignant thoracic disease has rapidly evolved into the standard of care. The lymph node stations that can be reached by EBUS and EUS are substantially more than those that can be accessed by mediastinoscopy. In rare cases, the clinician is faced with extraordinary circumstances in which a minimally invasive approach to the lymph nodes in station 5 is required. We present our findings in 10 cases, at 7 different institutions, where EBUS was instrumental in reaching a diagnosis.**

Methods: **We retrospectively collected 10 cases where EBUS-TBNA was performed through the pulmonary artery in an attempt to reach the territory of lymph node station 5. All cases were performed by experienced interventional pulmonologists at 7 tertiary care centers in the United States and Canada. We describe the patients' demographics, comorbidities, complications, and cytopathology.**

Results: **A definitive diagnosis was reached in 9 of the 10 patients. One case showed atypical cells and required a confirmatory Chamberlain procedure. No complications occurred as a result of careful transpulmonary artery needle aspiration.**

Conclusions: **This multicenter case series suggests that transpulmonary artery needle aspiration guided by EBUS is possible and safe in the hands of experienced interventional pulmonologists. It is important to recognize that this is not an alternative to left VATS or Chamberlain procedure, but a last resort procedure.**

Key Words: endobronchial ultrasound, transvascular puncture, transpulmonary artery, subaortic lymph nodes, lung cancer, staging, EBUS, complications

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The use of endobronchial ultrasound–guided transbronchial needle aspiration (EBUS-TBNA) for diagnosis and staging of benign and malignant thoracic disease has rapidly evolved into the standard of care in most academic centers and many community hospitals.[1,2] The complications associated with this procedure are rare and frequently minor. In comparison with traditional TBNA, this procedure is considered safer and rare complications reported include pneumomediastinum, bleeding, pneumothorax, infections, and mediastinitis. Three deaths have been reported in the medical literature.[3–5]

The lymph node stations that can be reached by EBUS and EUS are substantially more than those that can be accessed by mediastinoscopy (Fig. 1).[6] However, in rare cases, the clinician is faced with extraordinary circumstances in which a minimally invasive approach to the lymph nodes in station 5 is required (Fig. 2). We present our findings in 10 cases, at 7 different institutions, where EBUS was instrumental in reaching a diagnosis.

METHODS

We retrospectively collected information on EBUS cases at 7 institutions, including 10 EBUS-guided TBNA of lymph nodes or masses in the location of lymph node 5 performed in patients with relative or absolute contraindications for surgery.

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From the *Division of Thoracic Surgery and Interventional Pulmonology, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA; †Pulmonary, Critical Care and Sleep Medicine, Houston Methodist Hospital, Texas Medical Center, Houston, TX; ‡Division of Interventional Pulmonology, Clinica Alemana, Universidad del Desarrollo, Santiago, Chile; §Division of Pulmonary, Critical Care, and Sleep Medicine, University of Florida, Gainesville, FL; ‖Department of Medicine, Division of Respiratory Medicine, University of Calgary, Calgary, AB, Canada; and ¶Department of Pulmonary Medicine, Respiratory Institute, Cleveland Clinic, Cleveland, OH.

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Reprints: Erik Folch, MD, MSc, Beth Israel Deaconess Medical Center, 185 Pilgrim Rd, Deaconess, 201, Boston, MA 02215 (e-mail: efolch@bidmc.harvard.edu).

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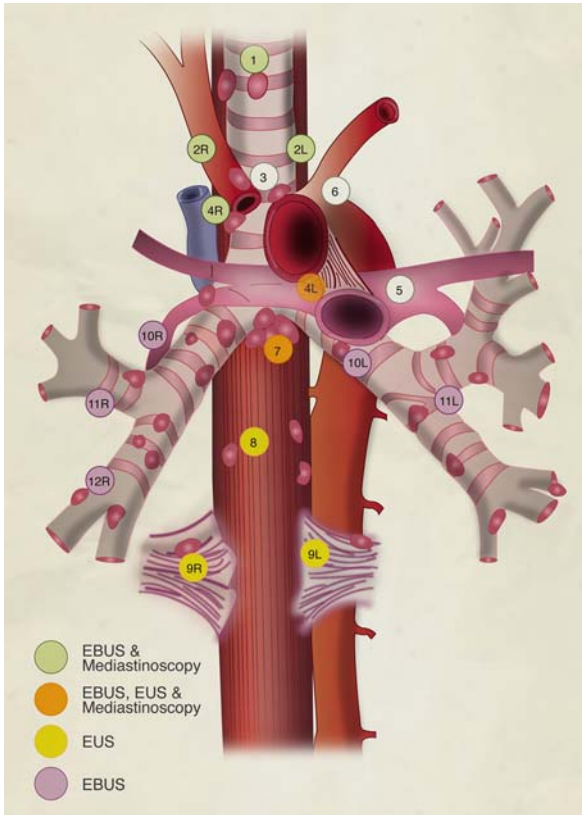

FIGURE 1. Lymph node map adapted from the 2009 IASLC classification. The colors demonstrate the lymph nodes that can traditionally be reached by EBUS, mediastinoscopy, and EUS. The area of lymph node 5 and 6 are traditionally considered to be out of the reach of all of these methods. EBUS indicates endobronchial ultrasound.

We defined the territory of lymph node station 5 according to the IASLC map (7th TNM Classification 2009)[7]: subaortic lymph nodes lateral to the ligamentum arteriosum with the upper border being the lower border of the aortic arch and the lower border being the upper rim of the left main pulmonary artery.

Nine patients had a significant history of smoking and 1 had history of renal cell carcinoma. The procedures were carried out at 7 different institutions by experienced interventional pulmonologists. Six cases were performed under moderate sedation and endobronchial lidocaine to minimize cough and discomfort. Four cases were performed under general anesthesia and use of laryngeal mask. Every patient was consented for the procedure with particular emphasis on the high risk of complications and the unusual nature of the procedure. All cases were performed in isolation from each other. There were no clinical or echocardiographic signs of pulmonary hypertension. A computed tomography was available before the procedure in all cases. Given the complexity of these cases, a multidisciplinary team was involved at the individual institutions before the decision to proceed with transvascular needle aspiration.

RESULTS

A total of 10 patients between 45 and 83 years of age underwent convex-probe EBUS using a 21 or 22 G needle; diagnostic tissue was obtained from lymph node station 5 by traversing the pulmonary artery.

In 3 cases, the concomitant use of fluoroscopy allowed the clinician to document the location of the lesion during the needle biopsy (Fig. 3A). In comparison, the fluoroscopic image of EBUS-TBNA of

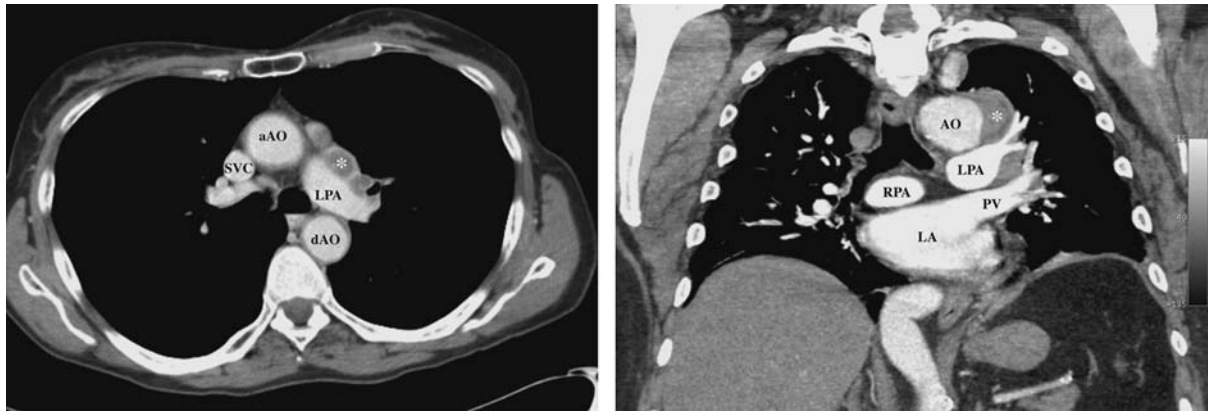

FIGURE 2. Axial and coronal CT chest showing lymph node in station 5 (*) in a patient who refused CT-guided needle biopsy or surgery and with negative cytology on other lymph node stations. Trans-PA EBUS confirmed adenocarcinoma (N2). aAO indicates ascending aorta; CT, computed tomography; dAO, descending aorta; EBUS, endobronchial ultrasound; LA, left atrium; LPA, left pulmonary artery; PA, pulmonary artery; PV, pulmonary vein; RPA, right pulmonary artery; SVC, superior vena cava.

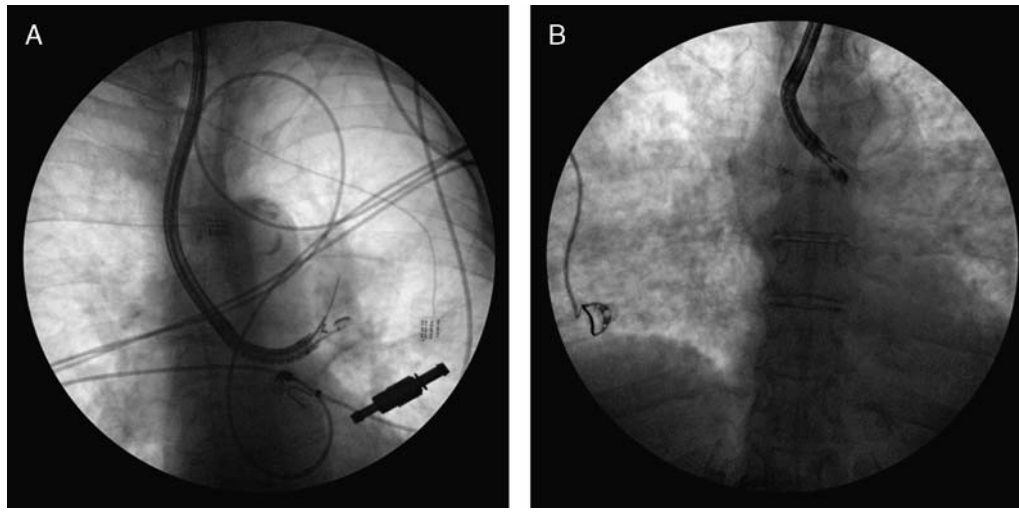

FIGURE 3. A, Fluoroscopic image of EBUS-TBNA of a lung lesion in the territory of lymph node station 5. The dedicated needle was used to obtain adequate cytology samples for diagnosis of non-small cell lung cancer. In contrast, (B) shows the fluoroscopic image of EBUS-TBNA of lymph node 4 L adjacent to the aorta and pulmonary artery, but in close proximity to the lower paratracheal space. EBUS indicates endobronchial ultrasound; TBNA, transbronchial needle aspiration.

lymph node station 4L can be seen in Figure 3B. However, the use of fluoroscopy is not usually necessary as the ultrasonographic findings are sufficient to guide the procedure.

Using the dedicated EBUS bronchoscope, the needle was advanced through the vessel wall and traversing to the other side of the pulmonary artery only once. While the needle was inside the lymph node/mass, the needle was moved in usual manner back and forth approximately 15 times while being careful not to repeatedly puncture the vessel wall. In 3 patients, this was repeated once (Figs. 4, 5 and Video 1, Supplemental Digital Content 1, http://links.lww.com/LBR/A125). Suction was applied during the procedure in all cases.

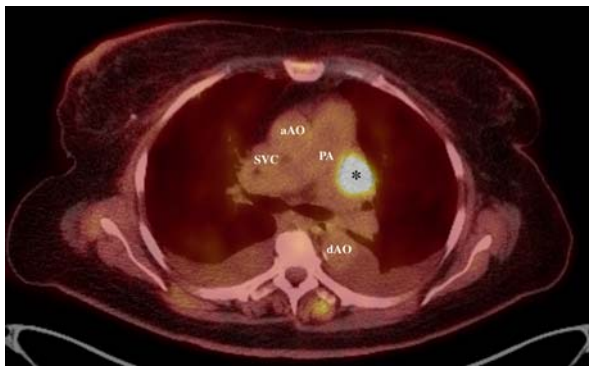

FIGURE 4. Fused PET-CT demonstrating a single lesion in the territory of lymph node station 5(*). aAO indicates ascending aorta; dAO, descending aorta; PA, pulmonary artery; SVC, superior vena cava.

All samples were abnormal. In 9 cases, the information obtained was definitive and 1 required a confirmatory Chamberlain procedure. There were no complications associated with the procedures as verified by ultrasound and chest x-ray in all cases, and contrasted-CT chest in 1 case (Table 1). We did not perform any transaortic needle aspirations. No blood was seen in the aspiration syringe during the procedures.

In all cases, the information obtained led to a change in management. All patients were followed for at least 12 months without any signs of complications from the procedure.

DISCUSSION

The emergence of EBUS in the last 10 years is the result of a growing lung cancer epidemic coupled with the need for a safe and effective way to acquire diagnostic tissue from mediastinal and hilar lymph nodes. Recently, the lung cancer guidelines have evolved into recommending EBUS as a primary procedure to accomplish adequate mediastinal staging.[1] EBUS-TBNA has also yielded enough tissue for genetic mutation analysis,[4,8–10] while minimizing the time to treatment.[11]

The use of traditional TBNA has significantly decreased as the use of convex-probe EBUS increased.[12,13] To those trained in traditional TBNA, the accidental puncture of a blood vessel is not rare,[14,15] most often leading to a repeat attempt in a different location. To interventional

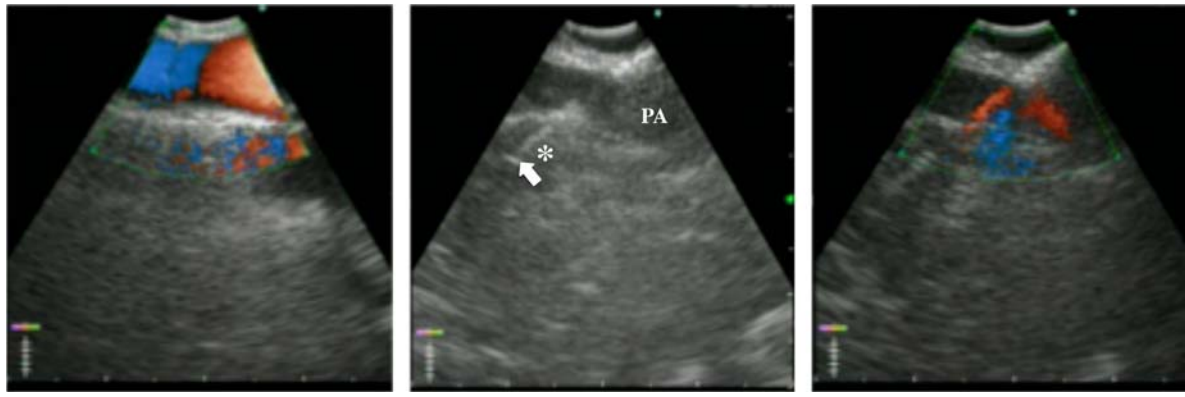

FIGURE 5. Endobronchial ultrasound view with Doppler enhancement before and during trans-PA needle aspiration in patient 6 (*lymph node station 5). The arrow indicates the tip of the needle. PA indicates pulmonary artery.

radiologists, the voluntary or accidental puncture of a blood vessel is common practice.[16,17] Furthermore, during complicated mediastinoscopies, thoracic surgeons encountering a structure that is suspected to be the pulmonary artery, frequently use a fine needle to gently penetrate and identify if it is a vessel.[18] This procedure has not been associated with severe bleeding or meaningful complications.

In contrast, the pulmonary artery is a thin vessel with low pressures, but high flow and a significant laceration is likely to cause a life-threatening complication.

Previous case reports by Vincent et al[19] and Boujaoude et al,[20] presented initial evidence that intentionally traversing the pulmonary artery was possible in diagnosing one case of neuroendocrine tumor and two cases of adenocarcinoma respectively. Furthermore, we presented our experience in 4 cases at the ACCP Conference in 2011.[21]

As for the reasons that may explain a lack of significant bleeding in our series and those previously reported in the literature, we should consider that the pulmonary artery is a high-flow, low-pressure system, and traversing its wall with a fine needle of 21 or 22 G is likely to be immediately sealed upon removal of the needle, as long as there is no laceration of the vessel. This is also the case during mediastinoscopy where intentional needle puncture is perfomed.[18]

Furthermore, some authors have speculated that bleeding from low-pressure systems such as the SVC or PA would cease without packing and will not result in large hematoma or pseudoaneurysm because of the closed nature of the mediastinal compartment with separation from the pleural cavity or open air space, thus they recommend that packing is not necessary unless the bleeding is profuse.[22]

As this technology becomes widely available, the limitations of EBUS in reaching lymph node stations 5, 6, 8, and 9 have become apparent. As more and more patients are referred to undergo this procedure, specialists and high-volume centers are asked to evaluate sicker patients and more complex cases.

However, we all recognize that traversing the pulmonary artery should not be considered a safe alternative to left VATS or Chamberlain procedure, but a last resort procedure. It should be carried out after discussing the significant inherent risks with the patient and under the umbrella of a multidisciplinary team where all options have been considered. Most importantly, it should only be performed if the results will be changing management and only by experienced operators who have access to the necessary surgical expertise. In this instance, it should be remembered that the potential candidates for this procedure are already high-risk patients for surgery and a complication that requires emergent surgery is likely to be fraught with difficulties.

It should be noted that the cytologic findings of these trans-PA biopsies resulted in changes in management. In some instances, they confirmed the high suspicion of malignant disease, but in other cases, further discussion with multidisciplinary teams about the risk-benefit ratio, led to a surgical intervention with good results. In other cases, they resulted in cautionary measures to avoid radiation injury to the nearby vessels.[23–25]

Although algorithms for differentiating risk levels for patients who are candidates for surgical resection have been published,[26] the estimation

TABLE 1. Description of Patient Demographics, Comorbidities, Risk Factors for Lung Cancer, and Details of the Procedure With Final Diagnosis in 10 Patients Who Underwent EBUS-TBNA Through the Pulmonary Artery

	Age/Sex	Comorbidities	Risk Factor for Lung Cancer	Needle (G)	No. Passes	Complications	EBUS-TBNA Pathology Results	Final Diagnosis	Treatment
Patient 1	64 M	Ischemic CM, complicated postoperative course. Oxygen-dependent COPD	Current smoker 30 py hx	21	1	None	Poorly differentiated small cell lung cancer	Small cell lung cancer	Chemotherapy
Patient 2	59 F	COPD, hypertension, atherosclerosis, hx CVA, dyslipidemia, carotid endarderectomy	Former smoker 47 py hx	21	1	None	Adenocarcinoma-primary lung	Adenocarcinoma-lung	Chemotherapy and radiation
Patient 3	56	Hx renal cell carcinoma 7 y prior	Hx RCCA	22	2	None	Renal cell carcinoma	Renal cell carcinoma	Chemotherapy
Patient 4	45 M	Severe emphysema. Oxygen dependent	Current smoker 50 py hx	21	2	None	Atypical cells suspicious for NSCLC	NSCLC confirmed during Chamberlain procedure	Chemotherapy
Patient 5	71 F	HCV, TIA, hx bladder cancer, emphysema, admitted with numerous metastatic lesions to brain	Current smoker 45 py hx	22	1	None	Adenocarcinoma-lung primary	Adenocarcinoma-lung primary	Brain radiation and palliative care
Patient 6	68 F	CHF, pulmonary embolism 1 mo prior, breast cancer 8 y prior	Current smoker 80 py	21	1	None	Adenocarcinoma-lung primary	Poorly differentiated adenocarcinoma-lung primary	Left pneumonectomy
Patient 7	83 F	Rheumatoid arthritis, HTN, GERD	Former smoker 120 py	21	1	None	Squamous cell carcinoma	Squamous cell carcinoma of the lung	LU lobectomy with vascular sleeve resection
Patient 8	71 M	COPD, hypertension, GERD	Former smoker 30 py	22	1	None	Adenocarcinoma-lung primary	Adenocarcinoma of the lung	Chemotherapy
Patient 9	65 M	COPD, coronary disease	Former smoker 50 py	22	2	None	Adenocarcinoma-lung primary	Adenocarcinoma-lung primary	Chemotherapy
Patient 10	50 M	HTN, ETOH abuse, GERD, CAD	Current smoker 45 py hx	21	1	None	Adenocarcinoma-lung primary with EGFR 19-exon mutation	Adenocarcinoma-lung primary with EGFR 19-exon mutation	Chemotherapy

CAD indicates coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; EBUS, endobronchial ultrasound; EGFR, epidermal growth factor receptor; ETOH, ethanol; F, female; GERD, gastroesophageal reflux disease; HCV, Hepatitis C virus infection; HTN, hypertension; M, male; NSCLC, non-small cell lung cancer; RCCA, renal cell carcinoma; TBNA, transbronchial needle aspiration; TIA, transient ischemic attack.

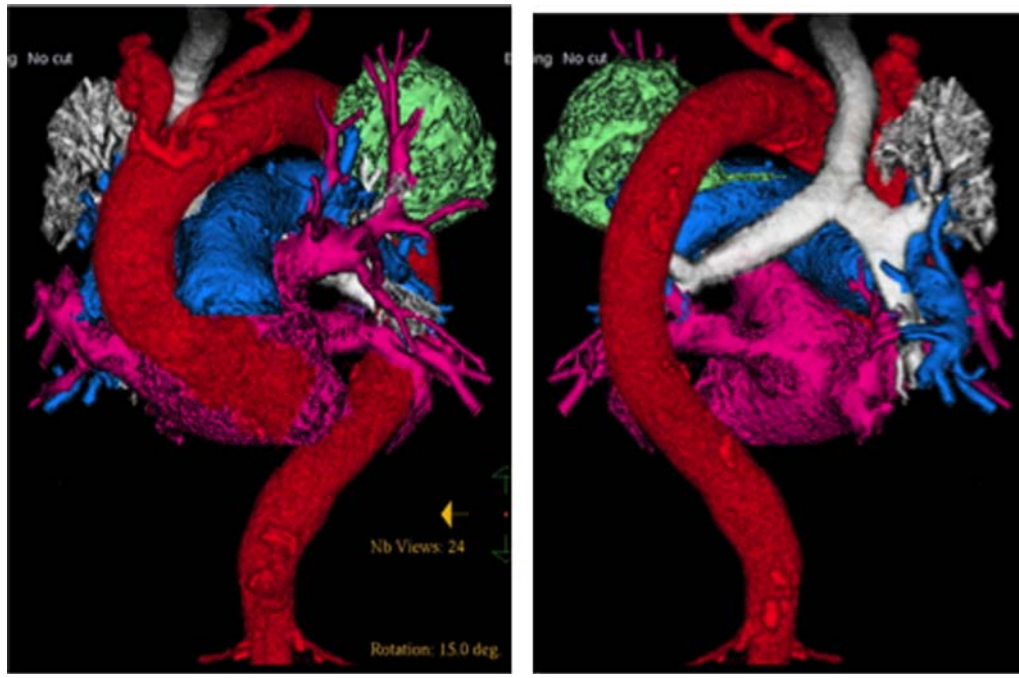

FIGURE 6. Reconstruction of the relationship of the LUL mass with vital vascular and bronchial structures displayed in greater detail to assist surgical planning. Anteroposterior (A) and posteroanterior (B) view where the aorta is depicted in red, the pulmonary artery in blue, the pulmonary vein in magenta, and the LUL tumor in green.

of the risk is highly dependent on the surgical expertise available at each site, and perceptions of the patient and the multidisciplinary team. Criteria that define marginally resectable as contrasted with unresectable are not standardized, and clinical evaluation by an experienced surgeon is necessary and likely to determine the treatment options offered to the patient (Fig. 6).[27]

The most significant contribution of our manuscript is the external generalizability—the fact that trans-PA needle aspiration guided by EBUS is possible and did not have any complications in the 10 cases included in this study, while being performed by experienced interventional pulmonologists at 7 different sites. How generalizable are these results in other settings remains to be determined.

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