

Feasibility of Endobronchial Ultrasound in Mechanically Ventilated Patients

Dear Editor,

The safety profile and diagnostic utility of endobronchial ultrasound (EBUS) for the diagnosis and staging of lung cancer,¹ centrally located tumours, unknown hilar and/or mediastinal lymphadenopathy have been well established in elective diagnostic bronchoscopy; however, their safety and utility in intensive care units (ICU) has not been described before. We have found a new utility for both linear and radial EBUS in mechanically intubated patients in the ICU with undiagnosed mediastinal lymphadenopathy and unresolved pneumonia.

Materials and Methods

Between January 2009 and December 2012, we performed 480 EBUS-transbronchial needle aspiration (TBNA) and 121 EBUS-transbronchial lung biopsies. Amongst these cases, EBUS was performed in 6 ICU patients with diagnostic dilemma. Computed tomography scanning revealed either mediastinal/ hilar lymphadenopathy or central masses adjacent to the major airways, which were subsequently targeted for needle biopsy.

All patients were intubated with an endotracheal tube of at least 7.5 mm (preferably 8 or 8.5 mm) and ventilated with assist control ventilation that was pressure targeted; positive end-expiratory pressure (PEEP) being 5 cm water. Patients were deeply sedated to a sedation agitation scale score of 3 with intravenous propofol. Morphine was used as an analgesic. Supplemental oxygen was increased to 100% prior to bronchoscopy as per our standard practice; and 5 ml of lidocaine 2% solution was also instilled via the endotracheal tube before the procedure.

EBUS-TBNA was performed for all 6 patients using a bronchoscope with an integrated linear ultrasound transducer (BF-UC260F-OL8; Olympus, Tokyo, Japan) and EU-C2000; Olympus processor. This bronchoscope has an external diameter of 6.9 mm and an oblique endoscopic view. EBUS balloon tip was utilised for all cases. A22-gauge needle was used to obtain at least 2 core specimens from each lymph node station. Core specimens were fixed in formaldehyde; needle aspirates were smeared on slides and sent in an alcohol fixative to the cytopathology laboratory. Rapid on-site cytopathology was utilised for all patients except Patient no. 3.

Additionally, transbronchial lung biopsy was performed in 2 patients (Patients 1 and 2). Radial EBUS probe (MAJ-935; with 20 MHz radial probe UM-S20-20R; Olympus, Tokyo, Japan) was passed through the working channel of a standard flexible bronchoscope to identify lesions. A guide sheath was used so that once the lesion was identified, the radial probe could be replaced with forceps to biopsy the visualised region. A chest radiograph was performed after the procedure to exclude any iatrogenic pneumothorax.

Results

Patient Characteristics

The median age of the 6 patients was 71.0 years. Three patients (Patients 1 to 3) presented with hypoxic respiratory failure and radiological suggestion of severe community acquired pneumonia (CAP). There was no response to standard antibiotic therapy, and all microbiological cultures including bronchoalveolar lavage were unyielding. They were subsequently diagnosed to have advanced lung cancer (2 adenocarcinoma and 1 poorly differentiated carcinoma). Two patients (Patients 4 and 5) presented with hypercapnic respiratory failure with obstructions in tracheal and right upper lobe and diagnoses of small cell lung cancer and anaplastic large cell lymphoma were made. Patient no. 6 presented with large right upper lobe mass compressing the superior vena cava and right main pulmonary artery. Aggressive lung malignancy was suspected. She underwent 2 previous procedures which were unyielding (1st EBUS-TBNA from subcarinal lymph node revealed mainly blood and transthoracic needle aspiration of the right upper lobe mass revealed mainly inflammatory cells). Computed tomography one month later revealed increasing size of mass with new cavitation, occlusion of superior vena cava and severe narrowing of the right main pulmonary artery, right upper lobe pulmonary artery and right upper lobe bronchus. She was electively intubated for EBUS-TBNA in the ICU. EBUS-TBNA of the right upper lobe mass extending to the right paratracheal region was performed (7 passes) revealing high grade dysplasia, but no carcinoma. Right upper lobe endobronchial biopsies revealed the same finding. Microbiological samples were sent for bacteria (including modified acid fast for nocardia), mycobacteria,

Table 1. Clinical Presentation, Findings, Diagnostic Results and Outcome of Patients who Had EBUS Guided Biopsy in the ICU

Age/Gender/ Smoking history (pack-years)	Clinical Presentation	EBUS Findings (size)	EBUS Results	Clinical Outcome
1. 75/female/ Non-smoker	Severe community acquired pneumonia	EBUS-TBNA of subcarinal lymph node Radial EBUS – Right lower lobe consolidation	Adenocarcinoma histological T3N2M0 stage 3A Adenocarcinoma	Palliative care and withdrawal of ventilator support after refusal of chemotherapy
2. 70/male/ Smoker (40)	Adult respiratory distress syndrome and shock	EBUS-TBNA–of left hilar lymph node (15 mm) Radial EBUS–Right lower lobe consolidation	Adenocarcinoma histological T1N3M1 stage 4 Adenocarcinoma	Palliative care and withdrawal of ventilator support
3. 64/male/ Smoker (40)	Severe community acquired pneumonia	EBUS-TBNA of lower right paratracheal lymph node (30 mm)	Poorly differentiated carcinoma T3N2M1 stage 4	Palliative care and withdrawal of ventilator support
4. 75/male/ Smoker (40)	Stridor	EBUS-TBNA–Anterior mediastinal mass with obstruction of superior vena cava (>40 mm)	Small cell lung cancer (limited disease)	Etoposide and cisplatin chemotherapy. Extubated 2 days after EBUS
5. 43/male/ Smoker (20)	Right upper lobe collapse	Extrinsic compression of right upper lobe bronchus by lymph nodes at right lower paratracheal lymph node and subcarinal lymph node (>40 mm)	Anaplastic large cell lymphoma (ALK positive)	Chemotherapy with cyclophosphamide, vincristine, doxorubicin and prednisolone and extubated 4 days after EBUS
6. 72/female/ Non-smoker	Right upper lobe mass	EBUS-TBNA of subcarinal Lymph node EBUS-TBNA of right upper lobe/ paratracheal mass	Mainly blood Atypical squamous cells	Palliative radiotherapy and demise without definitive diagnosis

EBUS: endobronchial ultrasound; ICU: intensive care unit; EBUS-TBNA: EBUS-transbronchial needle aspiration

and fungal investigations. However, all the results were negative. Patient was extubated the next day and she received palliative radiotherapy for suspected carcinoma but passed away 3 weeks later without histological confirmation of cancer.

Outcomes

The mean duration of EBUS in the ICU was 52 min (range, 20 to 110 min). Mean number of passes was 4 (range, 2 to 7). No major complications were encountered. No increase in ventilator or sedation requirements was observed after the procedures. None of the patients developed pneumothorax. Patient 1 had bleeding after EBUS-transbronchial lung biopsy but it stopped after local instillation of ice cold saline. Diagnostic yield was 87% and a specific histological diagnosis was made in 5 cases leading to definitive treatment management decisions (Table 1).

Discussion

EBUS appears to be safe and useful in mechanically ventilated patients in the ICU. EBUS appears to add

minimally to standard bronchoscopic complications like hypoxia, bronchospasm and pneumothorax even if the patients are on positive pressure mechanical ventilation.² The advantages of EBUS are that it is a portable bedside procedure and does not involve ionising radiation. Alternatives like surgical biopsy and mediastinoscopy have risks of general anaesthesia in patients who are often physiologically compromised, especially in the ICU.³ CT-guided biopsy has a high risk of pneumothorax even in non-intubated patients, which can be catastrophic on positive pressure mechanical ventilation.⁴ Transesophageal endoscopic ultrasound (EUS)—fine needle aspiration is an alternative for patients with subcarinal lymph node involvement such as Patients 1, 5 and 6. Unfortunately, EUS cannot replace the role of EBUS if the lymph node involvements are hilar, mediastinally to the right or the tumour mass abuts the trachea anteriorly or towards the right, such as Patients 2, 3 and 4.

Some technical issues to be aware of when performing EBUS in the ICU include: (i) ensuring endotracheal tube is at least 7.5 mm, but preferably 8 to 8.5 mm for ease of introducing the linear EBUS scope (outer diameter of 6.9

mm), (ii) lowering the PEEP during the transbronchial lung biopsy to reduce risk of causing pneumothorax, and (iii) ensuring adequate oxygenation throughout the procedure. It is of great importance to also ensure that the procedure is done within the shortest time possible as these patients have marginal physiological reserves. Therefore, this requires preparation (with respect to equipments, accessories, resuscitation trolley) in advance and coordination amongst bronchoscopists, intensivists, respiratory therapists and nurses throughout the procedure. Also, the bronchoscopist needs to be experienced in performing EBUS in an elective setting before doing one on an ICU patient who is mechanically ventilated.

Conclusion

In conclusion, EBUS can play an important diagnostic role in mechanically ventilated patients in the presence of lymphadenopathy or tumour adjacent to the airway, and when standard investigations or treatment are unyielding. Although the numbers are small with inherent “selection bias”, it appears to have reasonable yield and its risks are not higher than usual bronchoscopic procedures performed in the ICU. We recommend that intensivists and pulmonologists to consider EBUS in the armamentarium of diagnostic procedures in the ICU.

Acknowledgements

The authors appreciate the support of the SingHealth/ Duke-NUS Academic Medicine Research Institute and medical editing assistance of Taara Madhavan (Associate in Clinical Sciences, Duke-NUS Graduate Medical School, Singapore).

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