A Guide to Endobronchial and Endoscopic Ultrasound (EBUS and EUS) for Thoracic Radiologists.

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Overview

• Introduction to EBUS and EUS
• The IASLC lymph node map and lymph nodes stations that can be reached using EBUS/EUS
• EBUS/EUS and lung cancer staging
• Cases
  • Malignancies other than lung cancer
  • Non-neoplastic pathologies
• Summary
• References
Endobronchial Ultrasound (EBUS) and Endoscopic Ultrasound (EUS)

EBUS and EUS are minimally invasive techniques that use ultrasound along with a bronchoscope (EBUS) or endoscope (EUS) to visualize the airway wall or oesophagus and structures adjacent to it.

**EBUS scope.** This is a linear scope. Radial scopes can also be used but are outside the remit of this presentation. The EBUS scope is sometimes used in the oesophagus (EUS B).

**EUS scope.** Linear scope. Larger bore than the EBUS probe.
Technique

• Ideally patient should be able to lie prone.

• EBUS and EUS are usually performed under moderate sedation. Our centre uses an opioid and benzodiazepine to achieve this (Fentanyl and Midazolam). Deep sedation with continuous infusions of anaesthetic agents (Propofol) may also be used.

• Trans bronchial and oesophageal needle biopsies are obtained using 19 -22G needles. Trans-bronchial needle aspirate (TBNA) with EBUS and fine needle aspirate (FNA) with EUS.

• At each biopsy site several needle passes are usually performed.

• Samples are sent for histopathological analysis. Some centres have a pathology service in the procedure room/suite (ROSE – Rapid On-Site Evaluation).
Quality of images

- Images ideally saved to PACS, or printed out from the scope stack
- Videos saved to PACS demonstrate
  - Ultrasound characteristics of lesion
  - Anatomical associations to the region being sampled
  - Evidence of vascular involvement
- Useful to assist MDT discussion
Optimising sampling

• EBUS and EUS have excellent diagnostic sensitivity for most pathologies.
  • Optimal number of samples per biopsy site appears to be 3\(^{(1,2)}\)

• Although samples are fine needle aspirates they produce multiple micro-cores and can be handled by the pathologists as histology samples

• Newer needles up to 19G can produce larger samples, although there are no good quality studies that prove this increases diagnostic yield.

• There is work demonstrating that EBUS-TBNA is safe and effective for diagnosis of lymphoma\(^{(3)}\)

• In the era of molecular testing EBUS practitioners may also consider extra samples in patients with advanced disease for personalised medicine e.g. EGFR, PD-L1, ALK testing
Reaching the Nodal Stations – the IASLC map

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2R: Thoracic inlet to Inferior margin of the brachiocephalic vein
2L: Thoracic inlet to superior border of the aortic arch. It is important to remember that 2R extends to the left lateral border of the trachea, not the midline.

These stations can usually be reached using both EBUS and EUS.
IASLC Nodal Stations: Station 4, 5, 6

4L - Extends inferiorly to the upper border of the left main pulmonary artery
4R - Inferior extent is the lower border azygos vein

Station 4 nodes are a common drainage pathway for lung pathology. They can usually be sampled using both EBUS and EUS. Station 5 can often be sampled, but station 6 nodes are usually not amenable to TBNA as they are on the other side of the aorta. Often the vessel acts as an acoustic window so nodal morphology can be observed. There are case reports of trans-aortic sampling of these nodal stations\(^5\), but this is not a common procedure!
7- subcarinal nodes.
Station 7 is very commonly sampled using either EBUS or EUS. Station 10 is hilar to the take off of the upper lobe bronchus, 11 is distal to the LUL bronchus. The hilar stations are usually only amenable to EBUS TBNA. Station 8 is paraoesophageal below the carina and is assessed with EUS.
IASLC Nodal Stations: Stations 9 and 12

9 - inferior pulmonary vein to the diaphragm. This station is assessed and sampled using EUS. 

Station 12 is subsegmental and is usually too far distal to sample with EBUS.
Patient limitations for EBUS/EUS

Although most patients are suitable, there are some limitations for EBUS/EUS:

• Patients with previous oesophageal surgery or pharyngeal pouch are higher risk for perforation with EUS.

• Poor lung function.
  • On CT, it is important to comment on the degree of emphysema or fibrosis. Even with relatively poor lung function the patient may be amenable to EUS using the EBUS scope in the oesophagus, since this scope is narrower caliber than the EUS scope it is often better tolerated.
  • However, in patients with very poor lung function it should be considered what further assessment is hoping to achieve.

• Other comorbidities which make sedation difficult e.g. alcohol excess, drug use.
EBUS/EUS complications

• Mostly similar to those associated with standard bronchoscopy or endoscopy – cough, hypoxaemia, post-procedure pyrexia

• Case reports of pneumothorax, airway injury, lung abscess, mediastinitis, haemopneumomediastinum, occasional mortality

• Generally complications are rare and large retrospective reviews show low complication rates of 0.15-1.44% \(^{(6, 7)}\)
Staging literature

• In 2010 the ASTER randomised trial proved that EBUS was as effective as mediastinoscopy\(^8\) and is reflected in the ACCP, NICE and ESTS guidelines, which recommend minimally invasive needle techniques are the tests of first choice to stage the mediastinum\(^9,10,1\).

• Since then, prospective controlled trials are scarce, but in 2011 Yasufuku et al also demonstrated that EBUS-TBNA and mediastinoscopy achieve similar results for the mediastinal staging of lung cancer and suggested that EBUS-TBNA can replace mediastinoscopy in patients with potentially resectable non-small cell lung cancer \(^12\).

• Another prospective study from Korea in 2015 showed the diagnostic sensitivity, specificity, accuracy, positive predictive value, and negative predictive value (NPV) of EBUS-TBNA on a per-person analysis were 88.0%, 100%, 92.9%, 100%, and 85.2%, respectively\(^13\). In this study EBUS-TBNA was superior to mediastinoscopy in these terms.

• The ESTS guidelines for preoperative mediastinal lymph node staging for non-small-cell lung cancer recommend that it is possible to visualize and sample lymph nodes with a short axis of >5 mm and the optimal number of aspirations per station is 3\(^1\).

• Evidence of efficacy of EBUS/EUS is demonstrated in meta-analyses from 2009 and 2013 \(^6,11\) involving 1299 and 1066 patients respectively. Both studies demonstrated a pooled sensitivity of \(\geq 0.90\).
Lung Cancer

Common pathway:
Routine staging CT performed
+/- PET CT (especially in early stage lung cancer)
+/- EBUS/EUS

• Staging the T
• Staging the N
• Staging the M (liver, adrenal, coeliac axis)
Staging the T

Medial primary lesions can be directly sampled

EUS provided diagnostic material and staging information
Staging the N

- Guidelines state full staging necessary\(^{(1,6)}\)
- Nodal morphology better assessed than on CT

**Case:** A 32 yo woman presented with iliac DVT. Small nodes on CT showed increased uptake on PET, they were assessed with EBUS and EUS and proved to be metastatic lung cancer.
Staging the M

- The left adrenal is a common site for lung cancer metastasis. The adrenal can usually be assessed with EUS or EUS-b (EBUS scope in the oesophagus) and sampled with FNA.
- Coeliac axis nodes and the liver can also be assessed for metastases with EUS.
- Sometimes the right adrenal can also be assessed, but this is more difficult due to its anatomical relation to the stomach.

Left adrenal mass on staging CT. EUS-FNA confirmed this was a metastasis from a primary lung tumour.
Malignancies other than lung cancer

Case: **Pulmonary artery sarcoma** – confirmed with EUS biopsy
Metastases

Case 1: Paraesophageal and subcarinal nodal masses. EUS FNA demonstrated metastatic malignant melanoma.

Case 2: Single enlarged 4R node with central low attenuation. EBUS-TBNA proved metastatic breast cancer.
Lymphoma

Case: Large mediastinal/hilar mass. EUS demonstrated **follicular lymphoma**.
Bulky mediastinal disease

Case: EUS needle aspirate demonstrated **epithelioid mesothelioma**
Non-neoplastic Pathologies

• EBUS and EUS are often used to assist diagnosis in cases where there is uncertainty. The following slides demonstrate some cases where the differential was neoplastic, but the true diagnosis was not.

• These techniques are also useful to fully assess mediastinal abnormalities and examine their anatomical locations or associations more closely than is possible with CT.
Infection

**Case:** A 47 yo female with weight loss and cough. EBUS-TBNA proved her widespread mediastinal lymphadenopathy was due to **TB**.
Sarcoid

With or without parenchymal disease, the differential for sarcoid can be difficult. EBUS and EUS provides a reliable way to biopsy these nodes as they allow multiple TBNA/FNA from each node and can give a good volume of representative tissue.
Sarcoid-like reaction

**Case:** Rectal tumour. Staging CT demonstrated widespread lymphadenopathy.

EUS FNA confirmed sarcoid-like reaction.
Assessment of mediastinal mass

Case: A 50 old female investigated for cough. Mediastinal mass on CT. MRI was equivocal as the abnormality contained a high concentration of proteinaceous fluid. EUS confirmed bronchogenic cyst alleviating need for concern. No biopsy was performed as there is a risk of infection and no potential for malignant transformation.
Ectopic parathyroid

Case: A 46 yo male with hypercalcaemia. CT was performed to search for ectopic parathyroid.

EUS FNA confirmed the abnormality was ectopic parathyroid rather than a node.
Summary of Radiological evaluation

• If considering referral for EBUS/EUS:
  • **Size** – no minimum, but should be commented upon. Targets of 4 mm can be sampled by an experienced operator.
  • **Location** – IASLC nodal stations
  • **Attenuation** – low attenuation can indicate necrotic nodes
  • **Anatomical location and relation to other structures** – access to the CT imaging during the EBUS/EUS procedure essential for guidance. Helpful to review CT imaging at MDT to decide which targets to assess.
References and Suggested Reading


10. The Diagnosis and Treatment of Lung Cancer (Update). National Collaborating Centre for Cancer (UK). Cardiff (UK): National Collaborating Centre for Cancer (UK); 2011 Apr.


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