Hybrid DynaCT-guided electromagnetic navigational bronchoscopic biopsy†

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Abstract
Electromagnetic navigational bronchoscopic-guided biopsy of small pulmonary nodules can be challenging. Navigational error of the system and movement of the biopsy tool during its deployment adversely affect biopsy success. Furthermore, conventional methods to confirm navigational success such as fluoroscopy and radial endobronchial ultrasound become less useful for the biopsy of small lesions. A hybrid operating theatre can provide unparalleled real-time imaging through DynaCT scan to guide and confirm successful navigation and biopsy of difficult-to-reach or small lesions. We describe our technique for DynaCT image-guided electromagnetic navigational bronchoscopic biopsy of a small pulmonary nodule in the hybrid operating theatre. The advantages, disadvantages and special considerations in adopting this approach are discussed.

Keywords: DynaCT • Electromagnetic navigational bronchoscopic • Hybrid operating theatre • Lung biopsy

INTRODUCTION
The clinical use of electromagnetic navigational bronchoscopy (ENB)-guided biopsy for obtaining tissue in the diagnosis of peripheral lung lesions dates back almost a decade [1, 2]. However, even with technological improvements and software modifications over the years, a navigational error of 4–6 mm is not uncommon, meaning that for small pulmonary lesions of <1 cm, the diagnostic yield falls sharply. Classically, radial endobronchial ultrasound (EBUS) and/or standard fluoroscopy are used to provide imaging to support successful navigation. However, for very small pulmonary lesions and those with high ground glass opacity (GGO) content, these techniques may not identify the lesion and hence cannot confirm navigational accuracy. With increasing number of patients presenting with small pulmonary nodules and GGO lesions, this ENB limitation may be increasingly encountered. We describe our method and special considerations when utilizing the hybrid theatre DynaCT to guide ENB navigation for the diagnostic biopsy of small pulmonary lesions.

SURGICAL TECHNIQUE
A 54-year old lady with a history of carcinoma of uterus presented with multiple pulmonary nodules on computed tomography (CT) scan. The largest nodule was 8 mm in the right middle lobe. Electromagnetic navigational bronchoscopy was carried out with a standard preoperative CT scan followed by pathway planning and transfer of navigational data to the ENB console (SuperDimension Version 7, Covidien, USA) in the hybrid operating theatre. The patient received general anaesthesia and was intubated with a single lumen endotracheal tube. A flexible bronchoscope with 2.8-mm working channel allowed navigation by Edge 90° catheter system (SuperDimension Version 7, Covidien, USA) to the right middle lobe lesion (Fig. 1), with the ENB navigation indicating the catheter tip was at a distance of 4 mm and pointing directly into the centre of the 8-mm lesion. Fluoroscopy was unable to confirm the position of the catheter in relation to the lung nodule because of its small size. A 21-gauge biopsy needle (Olympus, Tokyo, Japan) was deployed at the target lesion, and an immediate DynaCT scan was performed (Artis Zeego, Siemens, Germany). The DynaCT-reconstructed image showed the biopsy tool had missed the target lesion by a few millimetres posteriorly (Fig. 2A). The biopsy needle was retrieved, a CT-guided adjustment of the Edge navigational catheter to a more anterior direction was made and the biopsy needle redeployed. A DynaCT-reconstructed image showed the biopsy needle within the target lesion and tissue sampling was performed (Fig. 2B). Patient was discharged the following day without complications and final pathology showed metastatic carcinoma.

COMMENT
The use of ENB for the diagnosis of peripheral pulmonary lesions is gaining popularity. Its advantages over percutaneous CT-guided...
biopsy are access to lesions shielded by ribs or scapula or even lesions close to the mediastinal structures; multiple lesions may be biopsied in the same session, and repeated multi-instrument biopsies can be performed. Furthermore, ENB is associated with lower risk of pneumothorax, even though it is often clinically insignificant. However, the diagnostic yield of ENB falls with sub-centimetre pulmonary lesions because of electromagnetic navigational error, catheter movement during biopsy tool deployment and the inability of conventional fluoroscopy to guide the biopsy process. The application of hybrid theatre dynaCT in thoracic procedures is rapidly increasing and gaining acceptance [3, 4]. The DynaCT scan during ENB allows the operator to clearly identify a ‘mishit’ even for very small lesions, and additionally provide valuable information on the direction and amount of catheter correction required to achieve success in the subsequent biopsy attempt. Furthermore, another advantage of performing intraoperative DynaCT scan is to provide undisputable evidence that the ENB biopsy tool did indeed reach and biopsied the target lesion which may be important in the era of litigious medicine.

There are several considerations when performing the ENB procedure in the hybrid theatre. Firstly, prior to using the ENB system in the hybrid theatre, a team of technicians is required to measure and calibrate for electromagnetic interference to ensure compatibility of the hybrid operating theatre with the ENB. Usually, a designated position to place the ENB machine in relation to the DynaCT is recommended during the procedure to minimize interference. Secondly, during the DynaCT scan, it is essential that a special non-metallic table-mounted supporting device is used to hold the bronchoscope in the desired fix position and angle to avoid dislodgement of the biopsy tool during the period of scanning. Thirdly, it is preferable to disconnect the ENB electromagnetic board prior to performing the DynaCT scan to avoid any interference that may reduce the CT image quality. On the other hand, the cost implications of using the hybrid theatre will depend on the country and institution-specific operational and manpower costs. Another potential disadvantage is radiation exposure to the patient by DynaCT scan. So far, we have not had to perform more than two DynaCT scans per ENB procedure, which has similar radiation exposure to percutaneous CT-guided FNA. Usually, the first scan identifies any minor mishit, and the second would confirm successful biopsy following adjustment. The electromagnets attached to the patient to guide the navigation catheter do not emit harmful radiation and is pacemaker safe.

The combined navigational ability of ENB and imaging capabilities of the hybrid operating theatre allow more effective and accurate diagnostic biopsy of small pulmonary nodules. Looking into the future, the other advantage of having intraoperative dynaCT imaging is to allow precise placement of ENB therapeutic tools for procedures such as radiofrequency ablation [5]. Further studies are required to provide data on the potential benefits of this approach and better define the role of hybrid theatre in ENB procedures.

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**REFERENCES**


