

## TECHNOLOGICAL NOTE

# Vectorial localization of peripheral pulmonary lesion guided by electromagnetic navigation: A novel method for diagnostic surgical resection without dye marking

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## Abstract

We describe a novel method using electromagnetic navigation bronchoscopy (ENB) without dye marking to perform vectorial localization for an impalpable peripheral lesion in the right lower lobe during diagnostic surgical resection in a 52-year-old woman. After the ENB registration process, the anesthetist changed the single-lumen endotracheal tube to a double-lumen endobronchial tube. Guided by the ENB system, the operator delivered the probe of the locatable guide to the planned site through the right lumen of the endobronchial tube. The ENB system allows calculation of the direction and distance between the probe and the lesion, confirming the relative location of the lesion. The locatable guide was retained during surgery as an intraoperative indicator, rather than applying dye marking. During video-assisted thoracoscopic surgery, the protuberant visceral pleura poked by the probe accurately indicated the relative location of the lesion. Accordingly, we performed precise wedge resection for diagnosis, followed by lobectomy, resulting in a diagnosis of invasive adenocarcinoma. Vectorial localization is an alternative method of ENB-guided localization to peripheral pulmonary lesions, which can provide the accurate location of such lesions for diagnostic surgical resection.

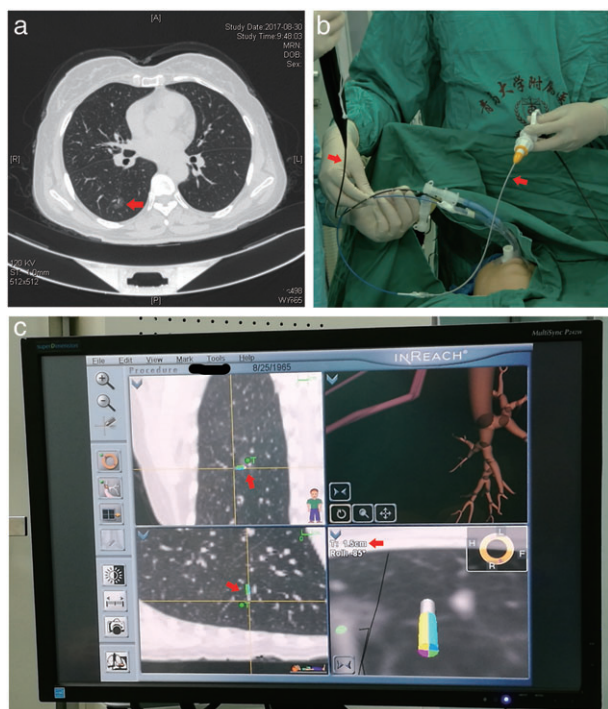
## Introduction

Peripheral pulmonary lesions have become one of the major incidental findings during lung screening by computed tomography (CT).<sup>1</sup> A survey of American Thoracic Society Clinicians of pulmonary nodule management showed that the number of clinicians that recommended surgical resection as appropriate increased with cancer risk.<sup>2</sup> There are several methods to localize the nodules before diagnostic surgery, especially for impalpable or ground glass opacities. The CT-guided hook-wire is widely accepted in current clinical practice, but is an invasive technique and sometimes the hook-wire may be detached from the lung.<sup>3</sup> Recently, dye marking guided by electromagnetic navigation bronchoscopy (ENB) has been suggested as a minimally invasive technique for localizing small nodules. However, dye marking with ENB only

provides the general area rather than the precise location of a lesion.<sup>4,5</sup> To accelerate the accuracy of ENB-guided localization, we utilized the probe of the locatable guide (LG) itself as the intraoperative indicator without using a dye injection, and retained the LG during diagnostic surgery for vectorial localization of the peripheral pulmonary lesion.

## Methods

A 52-year-old woman was referred to our hospital with a 14 mm pulmonary lesion in the dorsal segment of the right lower lobe. CT revealed that the lesion was 25 mm deep to the visceral pleura with only one visible bronchus approximately 2 cm nearby (Fig 1a). A pulmonary function test and other preoperative exams, including metastatic



**Figure 1** (a) Computed tomography image of the peripheral pulmonary lesion (red arrow). (b) The locatable guide and portable bronchoscope were inserted through the endobronchial tube (red arrow). (c) The direction and distance between the locatable guide probe and lesion on the electromagnetic navigation bronchoscopy screen, which was inferolateral and 1.5 cm (red arrow), respectively.

examination, were normal. The patient refused CT-guided percutaneous lung puncture, preferring minimally invasive treatment. After obtaining informed consent, we performed ENB-guided vectorial localization before diagnostic surgical resection.

Before commencing the ENB procedure, the CT images were imported into SuperDimension software

(SuperDimension Inc., Minneapolis, MN, USA). The patient was placed in a supine position under general anesthesia. She was intubated with an 8 mm internal diameter single-lumen endotracheal tube. After completing the ENB registration process, the bronchoscope and locatable guide were removed from the endotracheal tube. The anesthetist then changed the single-lumen endotracheal tube to a 37 Fr left double-lumen endobronchial tube. The assistant handled a 2.8 mm internal diameter portable bronchoscope (A20-2.8, Zhuhai MDH Medical Technical Inc., Zhuhai, China) and inserted it into the right lumen of the endobronchial tube. Under bronchoscopic monitoring, the operator delivered the LG into the right dorsal segmental bronchus, which was through the same lumen and parallel to the bronchoscope (Fig 1b). Monitoring the real time location of the LG probe on the ENB screen, the operator pushed the LG along the planned pathway. Once the LG probe reached the planned site, the direction and distance between the lesion and the probe were recorded (Fig 1c). After confirming the relative location of the lesion, the LG was fixed on the portal of the right endobronchial tube and the bronchoscope was removed (Fig 2a).

With the LG retained, the patient was gently placed in the left decubitus position with single lung ventilation. We performed two-port approach thoracoscopic surgery. During surgery, the LG probe propped up the visceral pleura from the surface of the right dorsal segment, which looked like a tent (Fig 2b). According to the direction and distance between the lesion and the probe, the operator used an electric knife to mark the probe and the projected location of the nodule on the visceral pleura. After the LG was removed, the operator performed precise wedge resection. Because of the collapsing feature of the lung and rigid support from the LG, the lesion was closer to the LG probe mark in the resected lung tissue (Fig 2c).



**Figure 2** (a) The locatable guide fixed on the right portal of the double-lumen endobronchial tube. (b) The protuberant tent-like visceral pleura propped by the locatable guide probe. (c) The distance between the lesion (sutured) and probe mark (cauterized) on the dissected specimen was approximately 1.3 cm.

## Results

The patient underwent lobectomy and mediastinal lymph node dissection, which resulted in a diagnosis of invasive adenocarcinoma by frozen sections. The ENB and surgical procedures lasted approximately 10 minutes and 150 minutes, respectively. Blood loss during the ENB procedure was negligible. The chest drain was removed on the first postoperative day. The patient was discharged on the third postoperative day. No postoperative complications occurred.

## Discussion

Vectorial localization is a kind of measurable method in which lesion location can be confirmed by three-dimensional coordinates, taking the LG probe as the origin. Using the ENB system, the distance between the LG probe and the lesion was calculated and the direction indicated by the three axes of CT images on the ENB screen. Instead of dye marking, the LG was retained during surgery to provide the relative location of the lesion. In current clinical practice, dye marking is one of the main methods for the localization of pulmonary nodules.<sup>4,5</sup> However, the complex structure of pulmonary parenchyma and the interval time between the ENB and surgical procedures might influence the dyeing area.<sup>6,7</sup> Furthermore, the injection process often requires fluoroscopic guidance, which increases the radiation exposure to both the patient and operator.<sup>4,8</sup>

In our experience, this novel technique is suitable for small and impalpable nodules in the outer third of the pulmonary parenchyma, a less invasive technique that delivers better accuracy. In practice, we consider that there are two key factors to reach a better result in vectorial localization: first, the planned site for the LG probe should be set as close to the visceral pleura as possible; second, the patient should be gently repositioned to the lateral position to prevent dislodging the probe. Fluoroscopy or portable CT are alternative methods to confirm the location after repositioning; however, these procedures subject the patient and operator to extra radiation exposure. Because of the intrinsic characteristics of the ENB system, there are still some limitations to overcome, but ENB-guided localization, using vectorial or dye-marking methods, has great potential advantages.

In conclusion, vectorial localization is an alternative method of ENB-guided localization to peripheral pulmonary

lesions, which can provide accurate lesion location for diagnostic surgical resection.

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## Disclosure

No authors report any conflict of interest.

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