The Utility of Electromagnetic Navigational Bronchoscopy as a Localization Tool for Robotic Resection of Small Pulmonary Nodules

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Background. **Resection of small pulmonary nodules with minimally invasive techniques can be challenging when the lesions are not palpable. Localizing theses nodules by electromagnetic navigational bronchoscopy (ENB) techniques has not been well studied.**

Methods. **A review of our thoracic surgery database was performed for patients undergoing ENB localization of pulmonary nodules for robotic resection between August 2012 and April 2013.**

Results. **19 patients were identified who underwent a combined localization with ENB and then da Vinci robotic lung resection. A transbronchial needle biopsy was performed in 14 patients followed by methylene blue dye marking on the pleural surface to localize the lesion. Five patients did not have a needle biopsy and underwent dye marking only. After dye marking, patients underwent robotic resection. Three patients who underwent transbronchial needle biopsy were found to have a diagnosis of malignancy and no diagnostic resection was needed. We proceeded directly to anatomic resection. Four patients had lesions too deep for a wedge resection, and a diagnostic segmentectomy was needed. The remaining 11 patients required a diagnostic wedge resection. The median time for the ENB portion of the procedure was 28 minutes. No adverse events were related to the placement of the dye marker, and no patients underwent conversion to an open procedure to localize the lesion.**

Conclusions. **We found ENB to be a safe and effective technique for localization of small pulmonary nodules with the diagnostic needle biopsy, possibly altogether negating the need for a wedge resection without adding significant time to the procedure.**

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Lung cancer is the leading cause of cancer death in the United States, with over 150,000 deaths expected for 2013 [1]. With recent data showing that lung cancer screening can decrease the risk of death resulting from lung cancer, the number of people undergoing screening is certain to increase [2]. With this increase in the number of patients undergoing a screening computed tomography (CT) scan, a many small pulmonary nodules will need evaluation. Resection of small pulmonary nodules or ground glass lesions can be challenging with minimally invasive thoracic surgical techniques, which have decreased ability to palpate the lung in comparison with open thoracotomy. To overcome this hurdle, various methods of mass or nodule localization have been developed. Recent case report studies by Feins and Minnich have looked at the use of electromagnetic navigational bronchoscopy (ENB) to guide the localization of small pulmonary nodules for either video-assisted thoracic surgery (VATS) or robotic-assisted thoracic surgery (da Vinci) (unpublished data). However, to our knowledge, no case series of patients undergoing localization with ENB has been performed. The purpose of our study was to evaluate the safety and effectiveness of ENB as a localization strategy for pulmonary nodules that are either small or too deep to feel or for patients with ground glass opacities.

Material and Methods

A retrospective review of the thoracic surgery database at the Greenville Health System University Medical Center for all patients undergoing ENB localization for da Vinci robotic lung resection was performed from August 2012 to April 2013. All patients who had undergone ENB localization were included in the analysis; no patients were excluded from the study. The ENB procedures were carried out by two surgeons using the Edge catheter system (superDimension, Minneapolis, MN). The patients underwent a combined procedure at the same

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operative setting with ENB localization of the lesion followed by da Vinci robotic resection. The lesions were localized with one or more dye localizations being placed on the pleural surface with methylene blue. Most patients also underwent a transbronchial needle biopsy of the lung lesion immediately before placement of the dye marker. A rapid on-site cytopathologic evaluation (ROSE) was done in all cases in which a needle biopsy was performed. This was accomplished by having an on-site cytology technician in the operating room to prepare the slides, and then all samples were reviewed intraoperatively by an in-house pathologist. Collected data included demographic information, preprocedure diagnosis, size of lesion, location of lesion (peripheral or deep), type of lesion (solid vs ground glass), number of lesions localized, transbronchial biopsy diagnosis, final pathologic diagnosis, type or resection needed for diagnosis, perioperative data, and adverse events. We evaluated the success rate of the transbronchial needle biopsy instant analysis in negating the need for a wedge resection or segmentectomy to determine the diagnosis. The patients were then evaluated to determine whether the localization was successful. Successful localization was defined by the lesion being found in the wedge resection for superficial lesions and in either the wedge resection or the segmentectomy for deeper lesions. We then examined the data for adverse events related to the localization technique, including need for conversion to open resection.

Technique

Each procedure began with placement of a single-lumen endotracheal tube. The planning software was then loaded into the computer system (Fig 1). The navigational bronchoscope was then used to guide to the lesion. If biopsy specimens were taken, then one or two transbronchial needle biopsy specimens were taken under fluoroscopic guidance. We then placed 0.5 to 1.0 mL methylene blue at the site of the lesion. The catheter was then guided to the pleural surface, and in two separate locations the pleural surface was marked with 0.5 to 1.0 mL of methylene blue at each location (Fig 2). The bronchoscope was then removed, and the patient was intubated with a double-lumen tube. The patient was then placed in the lateral decubitus position, and the robotic instruments were inserted. If examination of the transbronchial needle biopsy specimen came back with a positive result for malignancy (n = 3), a lobectomy with mediastinal lymph node dissection was performed. If the result was not positive, the blue dye localization areas were then used to guide the resection (Fig 3). We resected all lung tissue between the two blue dye localization points and sent the lesion for a frozen section. The appropriate operation was then done depending on the results of the pathologic examination.

Results

Upon review of the thoracic surgery database, we identified 238 patients who had undergone an ENB procedure. When we searched for ENB localization procedures, our first patient was identified in August 2012. Between August 2012 and April 2013, 19 patients underwent ENB localization and biopsy with subsequent da Vinci robotic resection. The majority of the patients were female (n = 14, 74%), the mean age was 59 years, and the majority of the patients had a history of smoking (n = 16, 84%). The preprocedure diagnosis was an undiagnosed lung mass in all patients. The most common tumor location was the upper lobe. The tumor locations are given in Table 1. The mean size of the lesion localized in this study was 18 mm (range, 8 to 40 mm). There were 4 patients with lesions larger than 20 mm in this series (Table 2), all 4 of whom had ground glass lesions with no solid component and therefore were not palpable and needed localization. The indications for localization in this study are detailed in Table 3; the most common indication was small size of the lesion (<16 mm) in 11 patients (58%). Two patients underwent localization of two separate nodules. One patient had two metastatic lesions, and the other had a single cancer and one granuloma. The type of operation and histology types are listed in Table 1.

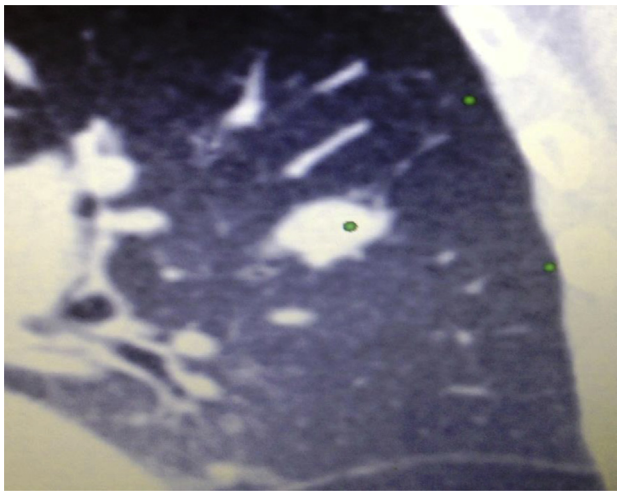

Fig 1. Navigational planning showing areas to be marked for the localization.

Fig 2. Pleural surface dye marker with discoloration showing area marked by deep injection at the site of the lesion as well.