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Case Report
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Combining the Use of Robotic Bronchoscopy with Augmented Fluoroscopy to Diagnose Peripheral Pulmonary Lesions

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Abstract

Bronchoscopy is commonly used for the sampling of peripheral pulmonary lesions. Several advances in technology along with a multimodality approach using guided bronchoscopy have helped improve the diagnostic yield. Herein, we present a novel approach using robotic bronchoscopy combined with augmented fluoroscopy to diagnose peripheral pulmonary lesions.

Introduction

Bronchoscopy is commonly utilized for the evaluation for peripheral pulmonary lesions. Peripheral pulmonary lesions are defined as focal radiographic opacities that are not visible by conventional flexible bronchoscopy and are located beyond the segmental bronchi [1,2]. Specifically, the multimodality approach including the use of radial probe ultrasound, thinner bronchoscopes that reach farther into the periphery of the lung, and fluoroscopy have improved the operator's ability to successfully reach and biopsy these lesions. Additional advances in technology including the use of electromagnetic navigation along with the use of radial probe ultrasound have further improved diagnostic yield [3,4]. Electromagnetic navigation utilizes Computed Tomography (CT) data to reconstruct the tracheobronchial tree and uses an electromagnetic field to track a sensor that is advanced through the airways. Regardless of technology, studies show that CT to body divergence has always limited its accuracy, especially for smaller and lower lobe lesions. Robotic Bronchoscopy with the Monarch system (Auris, Redwood City, CA) provides greater stability in the periphery and real-time optics, but exact lesion location can be off-target by a few millimeters, also due to CT-body divergence, a phenomenon noted with all platforms involving electromagnetic navigation. More recently, the use of augmented fluoroscopy has also demonstrated the ability to improve the diagnostic yield of peripheral pulmonary lesions [5-7]. Augmented fluoroscopy allows enhanced real-time fluoroscopic visualization of airways with predetermined pathways and target lesions utilizing tomosynthesis which reduces CT-body divergence [6,8]. The LungVision® system (BodyVision, New York, NY) allows for updated confirmation of a peripheral pulmonary lesion in real-time based on tomosynthesis registration of the lesion and its relationship to the previously performed CT scan. The ability to see a lesion in real-time with fluoroscopic imaging in three dimensions in order to relate positioning to biopsy instruments has historically only been possible with cone beam CT. However, cone beam CT is only rarely available to bronchoscopists and it's unclear whether it contributes to an increase in the diagnostic yield. Here we present a unique approach where the combined use of robotic bronchoscopy using the Monarch® bronchoscopy platform along with augmented fluoroscopy utilizing the LungVision® platform improved navigation confidence resulting in successful biopsy of peripheral pulmonary lesions.

Case Presentation

A patient was referred for evaluation of right upper lobe (9 mm) and left lower lobe (7 mm) cavitary lung nodules suspicious for metastatic disease. Neither lesion had a bronchus sign. He underwent a robotic guided bronchoscopy utilizing the Monarch® robotic bronchoscope platform in addition to augmented fluoroscopy for guidance and image confirmation utilizing the LungVision® platform. General anesthesia was utilized with endotracheal intubation. Notably, successful navigation and biopsy of both the right upper lobe and left lower lobe cavitary nodules during the same procedure was achieved using the robotic navigation and augmented fluoroscopic technologies with positive diagnostic material based on rapid onsite evaluation by the cytology team. Initial navigation to the left lower lobe lung nodule using the robotic bronchoscope provided a position

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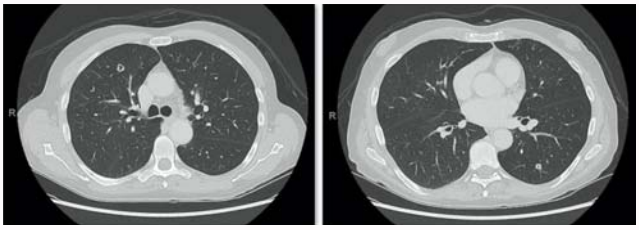

Figure 1: Left - CT image of the right upper lobe cavitary nodule. Right - CT image of the left lower lobe.

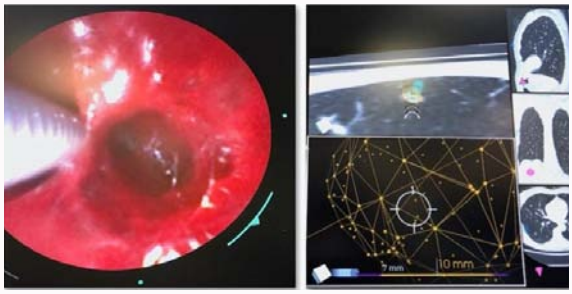

Figure 2: Monarch® Robotic Bronchoscopy representative image view of navigation to left lower lobe lung nodule. Left – white light image with radial probe extended into pulmonary parenchyma. Note the dissection of the airway performed using a needle to get into the lung parenchyma. Right - navigation guidance to a nodule.

Figure 3: Left - initial radial probe ultrasound image with eccentric view of left lower lobe lung nodule. Right - fluoroscopic view of radial probe ultrasound to lesion.

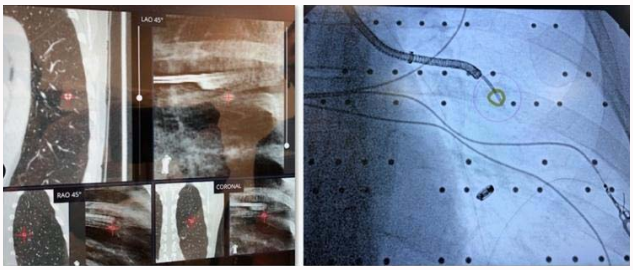

Figure 4: Left - LungVision® platform image demonstrating augmented fluoroscopic image of left lower lobe lung nodule with tomosynthesis imaging done to confirm real time updating to the live fluoroscopy image which allows better targeting in 3D. Right - LungVision® fluoroscopic view of robotic bronchoscope advancing needle into target.

that was off-target by 8 mm from the lesion confirmed by fluoroscopic tomosynthesis. Using LungVision®, fine adjustments were made to the robot bronchoscope's relationship to the airway to allow needle penetration into the airway wall and into the lesion. The addition of the augmented fluoroscopic navigation allowed fine adjustments to the robotic bronchoscopic approach with additional real-time

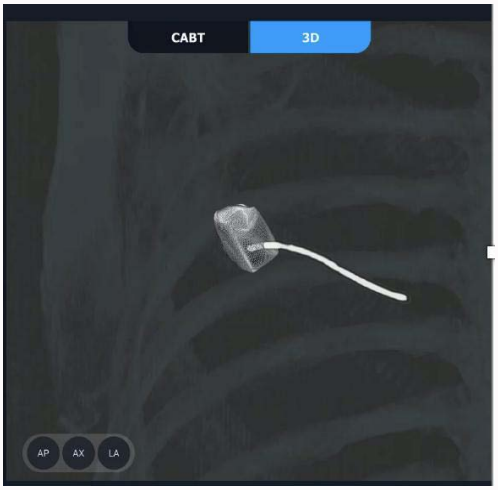

Figure 5: A separate case example of a 3-Dimensional view of the needle and bronchoscope relationship to a right upper lobe lesion using LungVision®. Tomosynthesis view using a standard c-arm fluoroscopy unit.

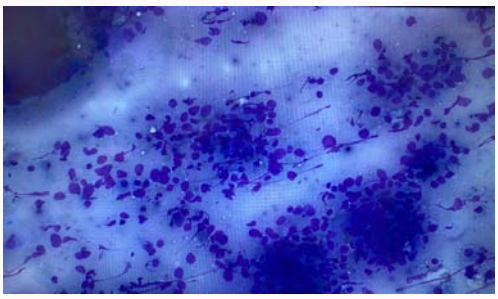

Figure 6: Needle aspirate of the left lower lobe lung nodule at the time of rapid onsite assessment. Figure demonstrating cells consistent with carcinoma.

guidance and confirmation. This allowed successful transbronchial needle aspirations and transbronchial biopsies with forceps of both lesions. Notably, new instruments were used for the separate lesions to prevent contamination. Figures 1 to 6 are representative and relevant images from this case.

Discussion

To date, the authors have successfully utilized the Monarch® robotic bronchoscope platform along with augmented fluoroscopy utilizing the LungVision® platform in ten cases to navigate to peripheral pulmonary lesions with successful tissue diagnosis in all ten cases. The addition of the augmented fluoroscopic navigation approach to robotic navigation can be helpful for improved localization and in obtaining a diagnostic specimen. The robotic bronchoscope provides electromagnetic and optical navigation, stability, and reach into the periphery while the volumetric data obtained from augmented fluoroscopy with LungVision® provides an improved real-time view of the bronchoscope and tools in relation to the peripheral lesion. These combined technologies allow for fine tuning adjustments to the bronchoscope position during the procedure. The use of multimodality approaches during bronchoscopic evaluation of peripheral pulmonary lesions has become common practice and has improved our approach and confidence for biopsy of small peripheral pulmonary lesions. Future studies should clarify whether the multimodal approach described herein improves the diagnostic yield when compared with either technology alone.

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