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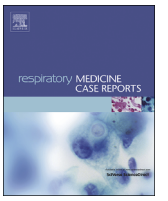

Case Report

Proof of concept: Shape-sensing robotic-assisted bronchoscopy performed under moderate sedation

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ABSTRACT

We describe a first reported case of shape-sensing robotic-assisted bronchoscopy using ION-intuitive platform done successfully under moderate sedation. A 76-year-old woman was found to have a right upper lobe mass measuring 3 × 2.9 cm. Diagnostic robotic navigational bronchoscopy was successfully performed under moderate sedation. Pathologic examination later revealed adenocarcinoma consistent with primary pulmonary malignancy. Conscious sedation allows the use of robotic bronchoscopy with minimal CT-to-body divergence and systems error. Robotic bronchoscopy under moderate sedation is feasible and seems to be safe and can be done without immediate complications.

1. Introduction

Robotic-assisted bronchoscopy using the ION shape-sensing robotic-assisted bronchoscopy endoluminal system (Intuitive Surgical, Inc.) has been gaining popularity for the diagnosis of peripheral pulmonary nodules. This technology allows physicians to move the flexible bronchoscopy with precision using a controller. While the operator physician is controlling the robotic system, a 3-D map of the lung and bronchial tree is shown on a computer screen. shape-sensing robotic-assisted bronchoscopy is conventionally done under generalized anesthesia, which can pose a scheduling issue where resources are limited.

2. Case vignette

A 76-year-old woman with a history of pretibial skin invasive squamous cell carcinoma was referred for evaluation of an abnormal chest imaging. Chest computed tomography (CT) and F-18 fluorodeoxyglucose positron emission tomography (18F-FDG-PET) revealed a 3 cm by 2.9 cm FDG-avid right upper lobe mass (standardized uptake value of 6.3) without evidence of mediastinal or hilar adenopathy. Robotic-assisted bronchoscopy was planned using the ION shape-sensing robotic-assisted bronchoscopy endoluminal system by Intuitive Surgical, Inc. Procedure was conducted in a standard bronchoscopy room. The tracheobronchial tree was successfully topically anesthetized with a total of 30 mL of 1% lidocaine (~4 mg/kg) using a conventional 4.2 mm outer diameter bronchoscope (BF–P190 Olympus). A total of 3 mg of midazolam and 25 mcg of fentanyl were given for moderate sedation. The white light bronchoscope was left at the level of the trachea to facilitate guidance of the robotic catheter. The ION robotic bronchoscope was then initiated and docked to the ION magnetic swivel adapter as depicted in Fig. 1. Robotic catheter, with outer diameter 3.5 mm, was advanced through the oropharynx and past the vocal cords to the level of trachea. Robotic registration was then achieved without complications. The robotic bronchoscope was then navigated to the right upper lobe. Target was localized in less than a minute. Radial endobronchial ultrasound scanning confirmed concentric position. Under direct fluoroscopic visualization, multiple fine needle aspiration (23 gauge needle), brush biopsies, and transbronchial biopsies were collected for pathology analysis. Episodic cough did not significantly affect the overall procedure. As seen in Fig. 2, a few system error messages were triggered but were rapidly cleared without

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Fig. 1. ION robotic bronchoscopy setup: silver magnetic swivel adapter connected to robotic arm and robotic catheter going through the mouth.

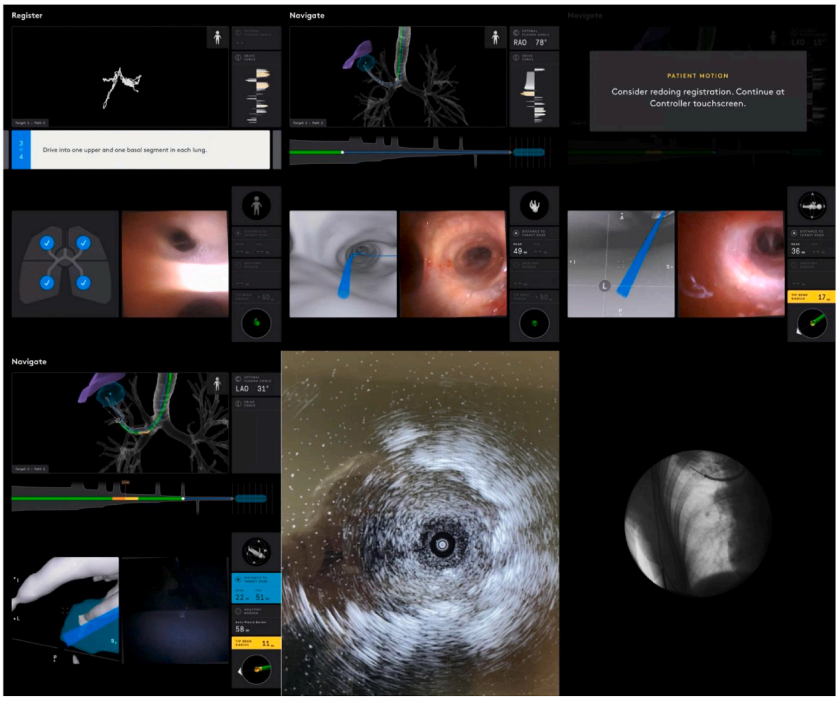

Fig. 2. Screenshots of robotic bronchoscopy registration, navigation, error message, catheter at target, radial EBUS confirmation, fluoroscopic guidance.

lasting effect on navigation or the procedure. Hemostasis was confirmed and the robotic bronchoscope was then removed. Pathologic examination later revealed adenocarcinoma with positive TTF-1 and Napsin A markers consistent with primary pulmonary malignancy. Our patient tolerated the procedure well. She was discharged home after 45 min of observation and reported no significant post-procedural discomfort.

3. Discussion

A growing body of evidence supports the clinical usefulness of robotic bronchoscopy in the diagnosis of pulmonary nodules [1,2]. American College of Chest Physicians consensus statement on analgesia and sedation during flexible bronchoscopy was published in 2011 [3]. Current practice recommendations during robotic navigational bronchoscopy include general anesthesia, endotracheal intubation, muscle relaxants, PEEP and low FiO2. These recommendations are intended to reduce CT-to-body divergence [4]. Intravenous sedoanalgesia and general anesthesia showed comparable diagnostic yield, complications, and patient tolerance during bronchoscopy with endobronchial ultrasound (EBUS) [5–7]. Conventional flexible bronchoscopy in combination with radial EBUS under moderate sedation is routinely performed in multiples centers around the world. Although the robotic system is designed to be used with a secure airway under generalized anesthesia, our case report demonstrates the feasibility of performing robotic bronchoscopy under moderate sedation. Similar to a conventional bronchoscopy under moderate sedation, the robotic system is able to navigate the bronchial tree with some orientation and suctioning limitations. Against our preconceptions, airway registration was accurate and rapidly accomplished. Navigation was no different than our experience during the general anesthesia cases. Catheter stability and precision was well maintained even during coughing spells, demonstrating the benefits of the shape sensing technology. Radial EBUS confirmation and tissue sampling using multiple instruments were much easier than when performed with conventional bronchoscopy. This case was complete with a certain degree of urgency mainly due to the fear of significant motion and system errors. Spontaneous ventilation under moderate sedation could lead to less atelectasis as compared to general anesthesia that utilizes muscle relaxants. Further studies are needed to determine reproducibility and diagnostic yield.

4. Conclusion

- Robotic-assisted bronchoscopy using the ION shape-sensing robotic-assisted bronchoscopy endoluminal system (Intuitive Surgical, Inc.) is feasible under moderate sedation without definitive airway.
- Cough does occur but does not hinder overall navigation and procedure.
- Given the ease of navigation, robotic-assisted bronchoscopy could be done under moderate sedation to facilitate the diagnosis of large peripheral lesions.
- It can utilized to decrease procedure time and in areas where anesthesia time is not readily available to facilitate earlier malignancy diagnosis.
- Future directions include formal clinical trials to evaluate the safety and efficacy of robotic bronchoscopy under moderate sedation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rmcr.2022.101787.

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