Editorial Commentary

Current trends in minimally invasive anatomical pulmonary segmentectomy using a robotic platform

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Comment on: Zhou N, Corsini EM, Antonoff MB, *et al.* Robotic Surgery and Anatomic Segmentectomy: An Analysis of Trends, Patient Selection, and Outcomes. Ann Thorac Surg 2022;113:975-83.

Received: 23 June 2022; Accepted: 10 July 2022; Published: 30 September 2022.

doi: 10.21037/vats-22-13

View this article at: https://dx.doi.org/10.21037/vats-22-13

The current issue of *The Annals of Thoracic Surgery* has published remarkable work by Zhou and associates (1), which investigated a single-center experience of patients undergoing anatomical pulmonary segmentectomy, comparing perioperative outcomes between different surgical approaches, including robotic, open, and video-assisted thoracic surgery (VATS). From 2015 to 2019, 222 segmentectomies were performed and 77 (35%) were performed using a robotic approach, while 40 and 105 were performed by VATS and open, respectively (1). When compared with open and VATS techniques, robotic operations were performed without an increase in postoperative complications or perioperative mortality rate; this approach was also associated with less estimated blood loss, lower rates of prolonged air leaks, and shorter hospitalization, although longer operative times were required. The authors concluded that the rate of robotic segmentectomies, a safe and feasible technique, has increased over time, and the advantages offered by the robotic approach seem to be applicable to anatomical pulmonary segmentectomies.

Since 1995, when the Lung Cancer Study Group demonstrated that a higher locoregional recurrence rate with relatively poorer postoperative outcomes was associated with sublobar resection compared with lobectomy [based on a prospective, randomized, comparative trial of sublobar resection *vs.* lobectomy for small non-small cell lung cancer (NSCLC) in 1995 (2)], lobectomy has been performed as a standard surgical procedure for NSCLC, regardless of the tumor size. However, many previous studies have suggested favorable oncologic outcomes in patients with small NSCLC who underwent sublobar resection, especially segmentectomy (3-6). The latest large randomized controlled study of segmentectomy *vs.* lobectomy for clinical stage IA NSCLC ≤2 cm and consolidation-to-tumor ratio >0.5 (7) demonstrated superiority and non-inferiority for segmentectomy in overall survival compared to lobectomy, and improved overall survival was consistently observed across all predefined subgroups in the segmentectomy group. Thus, as Zhou *et al.* indicated in their article (1), segmentectomies will be expected to be increasingly performed not only in patients intolerable to lobectomy due to older age, decreased lung function, or comorbid diseases, but also in patients with a tumor ≤2 cm in expectation of non-inferior postoperative outcomes compared to those with lobectomy.

Zhou *et al.* mentioned in their article (1) that superior dexterity and enhanced visualization of the robotic platform seem suitable for minimally invasive anatomical segmental resection. Since segmentectomy requires dissection deep into the lung parenchyma and precise division of segmental bronchi and vessels. In fact, in their series, 55% of the robotic segmentectomies were complex segmentectomies, which create several or intricate intersegmental planes and involve more complex procedures (8). In terms of technical aspects, thoracic surgeons need detailed knowledge of the three-dimensional anatomy of the pulmonary lobes to perform anatomical segmentectomies (9). High-definition, three-dimensional images with better maneuverability, accuracy, and stability over VATS may be an advantage of robotic platform mediated anatomical pulmonary segmentectomy (10). Another possible advantage with

robotic segmentectomy is that the DaVinci™ surgical robot Xi platform (Intuitive Surgical, Santa Clara, CA, USA) includes the Firefly™ system (Intuitive Surgical) as standard equipment, which is the near-infrared imaging system for visualizing indocyanine green (ICG) (11). During pulmonary segmentectomy, an inflation-deflation line has been used to identify the intersegmental plane, by selectively inflating a specific bronchus with/without identifying pulmonary veins along the intersegmental plane. A recent study reported the efficacy of delineation of the predicted intersegmental plane by identifying the line separating the nonfluorescent and fluorescent lung parenchyma after systemic injection of ICG (12). In fact, Zhou *et al.* used the Firefly™ system with systemic injection of ICG in their series of robotic segmentectomies (1). The Firefly™ system enables switching to near-infrared imaging mode without replacing thoracoscopy; thus, it seems to be suitable for minimally invasive pulmonary segmentectomy.

For general thoracic surgeons, opportunities will increase that they encounter patients with small malignant lung tumors and consider performing pulmonary segmentectomy as a curative surgical treatment. Thus, general thoracic surgeons may need to be prepared to perform minimally invasive anatomical pulmonary segmentectomies using a robotic platform.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Video-Assisted Thoracic Surgery*. The article did not undergo external peer review.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://vats.amegroups.com/article/view/10.21037/vats-22-13/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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doi: 10.21037/vats-22-13
Cite this article as: Koike T, Miyajima M, Nakamura M, Shimizu Y, Goto T, Tsuchida M. Current trends in minimally invasive anatomical pulmonary segmentectomy using a robotic platform. Video-assist Thorac Surg 2022;7:16.