Editorial Commentary

Robotic surgery: a game-changer for anatomic segmentectomies

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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: 08 July 2022; Accepted: 21 July 2022; Published online: 05 August 2022.
doi: 10.21037/vats-22-18
View this article at: https://dx.doi.org/10.21037/vats-22-18

The role of anatomic segmental resection for early-stage non-small cell lung cancer (NSCLC) has evolved over the last decade: recent literature has shown comparable oncological outcomes with similar disease free and overall survival when comparing segmentectomy *vs.* lobectomy for the management of early-stage NSCLC (1-8). Segmentectomies are more technically challenging operations than lobectomies due to the need to identify and divide smaller, more distal hilar structures and the absence of clear fissures demarcating the lines of parenchymal transection. In this study, Zhou *et al.* compare the robotic approach to segmentectomy compared to video-assisted thoracoscopic surgery (VATS) and open approaches by reviewing the perioperative outcomes of 222 patients that underwent anatomical segmentectomy from 2015 to 2019 for primary NSCLC or metastatic lesions by either robotic, VATS or open technique. Of note, a thorough selection process was conducted by the authors to ensure inclusion of only true anatomic segmentectomies defined by separate ligation of the segmental pulmonary artery and bronchus as documented in the operative notes. Of the total 222 segmentectomies, 77 (35%) were robotic, 40 (18%) were VATS and 105 (47%) were performed using an open approach. The percentage of patients undergoing segmentectomy at their institution increased from 9.6% of all anatomic lung resections in 2004–2005 to 21.9% in 2018–2019. The percentage of segmentectomies performed robotically has also greatly increased, with almost no cases in the years 2004–2005 to over 40% of all segmentectomies performed by their group in 2018–2019. These results correlate with the current national trends of increased robotic lung resections overall, once again highlighting the rapid adoption of the robotic platform in this field.

Patient characteristics, comorbidities and pulmonary function tests were similar in the three groups (robotic/VATS/open), with the exception of age (median of 59 in the open group, compared to 65 in the robotic group and 67 in the VATS group, P=0.028). A significant difference in tumor origin was also seen, with a higher proportion of primary lung cancer in the robotic and VATS groups *vs.* a higher number of metastasectomies in the open group (primary lung cancer in 57.5% of robotic *vs.* 77.5% of VATS *vs.* 43.8% of open patients, P<0.001). Another important point to highlight in this study is the higher proportion of complex segmentectomies performed robotically. Of all the robotic segmentectomies performed, 45% were categorized as complex segments, compared to only 15% and 22% in the VATS and open groups respectively. This demonstrates the capability of the robotic platform for a successful resection in more challenging cases.

When looking at the operative outcomes between all groups, the robotic approach had an overall excellent performance compared to VATS and open. Intraoperative blood loss, hospital length of stay and chest tube duration was comparable between the robotic and VATS groups, but better than the open group. Notably, no need for conversion to open approach was seen during robotic operations, which was significantly different when compared to VATS (0% *vs.* 7.5%, P=0.038). A higher number of lymph node stations dissected was seen in robotic group compared to the VATS and open groups. On the negative side, operative times were significantly longer for robotic resections

(205 *vs.* 147 minutes VATS and 147 minutes open, P<0.001). When counting patients discharged home with a chest tube as having a prolonged air leak (a very fair decision), there were significantly fewer postoperative complications in the robotic group (9% *vs.* 23% VATS *vs.* 23% open, P=0.042), 30-day mortality, and 90-day mortality were similar between all three groups. From an oncologic standpoint, the likelihood of R0 resection and recurrence over a median 25 months of follow-up were similar between all three groups; robotic segmentectomies, however, were more likely to demonstrate a resection margin ≥1 tumor diameter (63% *vs.* 48% VATS *vs.* 23% open, P=0.003).

As the investigators readily acknowledge, however, the principal limitation of this study is that >90% robotic cases were done by a single surgeon. Therefore, the advantages of robotics in terms of the complexity of cases done and results presented may rest potentially with the particular expertise of this surgeon rather than an inherent benefit of the robotic technique itself. In addition, no information with regards to the number of and details for planned segmentectomies that were converted to lobectomies or wedge resections is provided. Nonetheless, the study makes a compelling case for the technical applicability of robotic approach for segmentectomy in the treatment of lung cancer and metastatic lung lesions. While the indications for segmentectomy *vs.* lobectomy in early-stage lung cancer are still controversial and constantly evolving, this study reiterates the safety and feasibility of robotic anatomic segmentectomies as previously described (9).

Overall, this study is a well-conducted but limited retrospective review of a cohort or patients undergoing anatomic segmentectomies by either robotic, VATS or open techniques. The results presented are promising and hint at some of the advantages of the robotic platform for challenging operations such as complex segmentectomies. Larger-scale studies comparing robotic to VATS and open segmentectomy at multiple institutions, nationwide, and/or even worldwide, will be welcome news.

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: Both authors have completed the ICMJE uniform disclosure form (available at https://vats.amegroups.com/article/view/10.21037/vats-22-18/coif). BW reports one-time presentation was performed for Intuitive Surgical and no ongoing relationship; and serves as an unpaid editorial board member of *Video-Assisted Thoracic Surgery* from January 2023 to December 2024. The other author has 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-22-18
Cite this article as: Muñoz-Largacha JA, Wei B. Robotic surgery: a game-changer for anatomic segmentectomies. Video-assist Thorac Surg 2023;8:11.