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EDITORIAL – THORACIC ONCOLOGY

Advances in Robot-Assisted Thoracoscopic Surgery: Demand for Precision

William D. Tucker, MD, and Caitlin T. Demarest, MD, PhD

Department of Thoracic Surgery, Vanderbilt University Medical Center, Nashville, TN

Since the first report of robotic lung resection in 2002, robotic surgery has become commonplace in thoracic oncology.[1] While arguably all surgeons agree that minimally invasive lung resection is superior to open surgery, debate still exists as to whether robotic-assisted thoracoscopic surgery (RATS) is superior to video-assisted thoracoscopic surgery (VATS), with staunch proponents on both sides of the fence. At any national or international thoracic conference, the debate persists: VATS versus RATS, with many opinions and no objective conclusions. A consensus cannot be found in the literature either; many publications claim no significant difference in morbidity, mortality, and length of stay, while others demonstrate a lower complication rate and length of stay with robotic assistance. To many, RATS offers several distinct advantages compared with VATS, namely improved visualization with a three-dimensional field of view, active instrument stabilization, and improved maneuverability with wristed instruments allowing for increased precision. Additionally, robotic technology is in a constant state of innovation and improvement. Potential disadvantages may include operating room availability, costs associated with disposable equipment and upfront costs associated with the robotic console, and surgeon familiarity with the robotic platform.

The RVlob Trial comparing robotic-assisted lobectomy with video-assisted lobectomy for early-stage non-small cell lung cancer (NSCLC) did not show any difference in early mortality or complications between the two groups. However, bleeding was significantly less in the robotic-assisted arm and the number of lymph nodes sampled was significantly higher.[2] The Pulmonary Open, Robotic, and Thoracoscopic Lobectomy (PORTaL) Study was published in 2023 and retrospectively evaluated data from lobectomies for clinical stage IA–IIIA lung cancer performed between 2013 and 2019. Compared with open surgery, RATS and VATS had less overall postoperative complications, shorter hospital stay, and lower transfusion rates (all $p < 0.02$), while compared with VATS, RATS had shorter operative time ($p < 0.0001$), lower conversion rate ($p < 0.0001$), shorter hospital stay ($p < 0.0001$), and a lower postoperative transfusion rate ($p = 0.01$). RATS and VATS cohorts had comparable postoperative complication rates. In-hospital mortality was comparable between all groups.[3] The authors did not discuss lymph node sampling in this review. This study is important because it includes the most recent patient cohorts, and surgeon comfort with robotics has steadily increased over time.

So now, we have a new question to answer: does the robot provide a physiologic and oncologic benefit that cannot be achieved with VATS? One area that may usher in a paradigm shift and tip the balance in favor of RATS is the growing body of evidence supporting sublobar resections, particularly segmentectomies, which require precision that many argue only the robot allows. Improvements in our understanding of small pulmonary nodules and their malignant potential coupled with an improved utilization of lung screening with low-dose, non-contrasted computed tomography in high-risk populations has led to higher numbers of thoracic surgery consultations and interventions at earlier stages.[4,5] While lobectomy has been the standard of care for early-stage lung cancers, including NSCLC, there are recent studies challenging the necessity of a larger parenchymal resection and its potential morbidity compared with sublobar resections, particularly anatomic segmentectomy and possibly even non-anatomic wedge resection. A recent randomized controlled trial comparing segmentectomy

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C. T. Demarest, MD, PhD
e-mail: caitlin.demarest@vumc.org

with lobectomy in over 1100 patients with clinical stage IA NSCLC determined that a survival advantage exists in the segmentectomy group and has proposed that anatomic segmentectomy become the standard of care in the treatment of these small pulmonary nodules.[6] Patients in each arm of the trial (JCOG0802) had >90% survival at 5 years of follow-up. In a separate retrospective study, data obtained from the National Cancer Database demonstrated that even in patients undergoing resection of a small pulmonary nodule consistent with clinical T1N0M0 NSCLC found to have N1 or N2 nodal disease, survival was not significantly different between those who had lobectomy compared with those who had segmentectomy, further supporting the idea that less may be more when it comes to parenchymal resection for small pulmonary nodules.[7] Similarly, Zhou et al. provide a compelling case for RATS compared with VATS in anatomic segmentectomy for clinical stage IA NSCLC in a total of 130 patients.[8] Most recently, Altorki et al. demonstrated findings very similar to those of JCOG0802. This study confirmed non-inferiority of sublobar resection (either wedge resection or anatomic segmentectomy) compared with lobectomy for clinical stage IA NSCLC for disease-free survival and overall survival.[9] Agreement between these two studies investigating treatment for a disease process once thought to necessitate lobectomy is likely to predict a steep rise in the use of sublobar resection in this patient population.

Yang et al. conducted a head-to-head comparison between RATS and VATS segmentectomy for small pulmonary nodules in terms of short-term outcomes. They reported their results in an article titled, 'Comparison of Short-Term Outcomes Between Robot-Assisted and Video-Assisted Segmentectomy for Small Pulmonary Nodules: A Propensity Score-Matching Study'.[10] In that study, a total of 299 segmentectomies (132 RATS and 167 VATS) for small pulmonary nodules between June 2018 and November 2021 were included. Propensity score matching analysis was conducted to minimize bias. Patients who had a robotic segmentectomy had less blood loss, a shorter length of postoperative stay, and less use of strong opioids, but more cost (all $p < 0.001$). The operation time also trended shorter in the RATS group ($p = 0.053$). While most of these advantages were either statistically significant or trending in that direction, some may argue that 30 min less operating time and 30 cc of blood loss is not clinically significant.

Although it cannot be definitively stated that a robotic-assisted thoracic operation is superior to a similar operation in the hands of a skilled VATS surgeon, there seems to be a trend arising that would indicate the future will demand more skilled robotic thoracic surgeons. Thoracic surgery trainees are likely to find programs offering adequate training in RATS more appealing, so that upon completion of training their patients receive the best care possible with an option for either VATS or RATS. For the practicing thoracic surgeon, this information may shine a light on current comfort with, or access to, RATS generally and to robotic-assisted segmentectomy specifically. For those uncomfortable with RATS, data exist highlighting not only short-term outcomes from pioneers in the technique but also guidance for technical intricacies with port placement, surgical approach, and data-driven expectations for competency with robotic-assisted segmentectomy.[10–12] The rapidly growing body of evidence appears to indicate that improved implementation of cancer screening for high-risk patients found to have small pulmonary nodules should be met with precision resection of these nodules best afforded by robotic-assisted segmentectomy. Overall, continued growth of robotic-assisted segmentectomy appears likely as trainees facile with RATS enter clinical practice and new robotic platforms enter the market.

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