Sleeve resection after neoadjuvant treatment via minimally invasive approaches for lung cancer

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To the Editor: Sleeve resection, which is a procedure to resect and reconstruct bronchial and/or pulmonary arteries, is considered a valid therapeutic approach for centrally located lung cancer. With the establishment and development of the comprehensive treatment concept, applying neoadjuvant treatment such as neoadjuvant immunotherapy against centrally located lung cancer with locally advanced staging is effective. Neoadjuvant treatment might reduce the tumor size to increase the chances of complete resection and achieve parenchyma-sparing procedures of sleeve resection. Generally, sleeve resection improves postoperative respiratory function and quality of life, and achieves lower postoperative morbidity and mortality with similar oncological outcomes to pneumonectomy after neoadjuvant treatment.

Sleeve resection is traditionally performed by thoracotomy. In the recent two decades, minimally invasive surgery has gradually become an alternative to thoracotomy owing to the development of instruments and surgical techniques. However, minimally invasive sleeve resection via video-assisted thoracoscopic surgery (VATS) or robot-assisted thoracoscopic surgery (RATS) is still technically challenging, with major concerns regarding the safety and feasibility in terms of perioperative and oncological outcomes. Additionally, the safety and efficacy of minimally invasive sleeve resection after neoadjuvant treatment are still controversial.

Sleeve resection is most commonly indicated for centrally located lung cancer or metastatic N1 lymph node infiltrating the origin of the lobar bronchus and/or pulmonary arterial lobar branches. In addition, sleeve resection can also be used to achieve radical resection when frozen sections confirm microscopic residual disease on the bronchial or arterial margin after standard lobectomy.

In the application of the minimally invasive approach in sleeve resection, the continuous improvement and optimization of technical strategies have gradually made it feasible. In 2002, Santambrogio et al[1] reported the first case of left lower sleeve lobectomy via VATS. Thereafter, the hybrid VATS (mini-thoracotomy with VATS) and complete VATS approaches were successively used for sleeve lobectomy. Because of an association of less chest pain with fewer ports, multiple portal VATS sleeve lobectomy with four or three ports gradually evolved into biportal or uniportal VATS. In the RATS procedure, the first case of sleeve lobectomy using a combined robotic and thoracoscopic approach was reported by Schmid et al[2] in 2011 who suggested the application potential of RATS in sleeve resection. In 2019, a landmark study published by Jiao et al[3] established the technological maturity of RATS for sleeve resections. This large series with 67 patients showed excellent clinical outcomes, indicating the safety and feasibility of RATS in complex and extended lung resections represented by bronchial sleeve lobectomies. In 2020, Qiu et al[4] reported the evolution of surgical approaches from thoracotomy to VATS and then to RATS for sleeve resections including single and double sleeve lobectomies. Additionally, RATS with fewer ports (biportal and uniportal RATS) and suture adjustment (v-loc sutures) strategies is useful application in sleeve resections. These applications should be further explored.

With increased surgical experience and cases, clinically acceptable perioperative outcomes from a series of studies indicated the safety of minimally invasive sleeve resection. We reviewed the relevant studies published to date [Supplementary Table 1, http://links.lww.com/CM9/B870] and found the following. In minimally invasive sleeve resection, the conversion rate to thoracotomy ranged from 0 to 21.1%, R0 resection rate ranged from 84.5% to 100%, postoperative morbidity rate ranged from 0 to

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44.4%, 30-day mortality rate ranged from 0 to 6.8%, and 90-day mortality rate ranged from 0 to 6.8%. In the balanced population, the perioperative outcomes were not compromised or even better with minimally invasive sleeve resection than with thoracotomy [Supplementary Table 2, http://links.lww.com/CM9/B870]. A meta-analysis showed that VATS sleeve lobectomy led to less blood loss, a longer operation time, similar lymph node dissection, and similar postoperative complications compared with thoracotomy sleeve lobectomy. Moreover, no significant difference in the R0 rate, drainage duration, postoperative hospital stay, or 30-day mortality rate was found between VATS and thoracotomy sleeve lobectomy. Even the details of postoperative complications, such as pneumonia, bronchopleural fistula or empyema, chylothorax, pulmonary embolism, arrhythmia, and prolonged air leakage, were not different between these techniques. Furthermore, surgeons prefer to adopt some preventive measures in the hope of reducing the occurrence of complications, such as interposing a viable tissue flap (mediastinal fat pad, pericardial flap, or pleural flap) around the anastomosis to prevent a possible anastomotic fistula and irrigating the artery with heparin to avoid thrombosis. Notably, recent studies have shown that a minimally invasive approach is an independent favorable factor for postoperative complications, even in patients with neoadjuvant treatment. Regarding RATS sleeve resection, Jiao et al[3] reported excellent perioperative outcomes from the largest series (n = 67) of patients who underwent RATS bronchial sleeve lobectomy. All of the patients achieved R0 resections with few complications and no intraoperative blood transfusion, conversion to open thoracotomy, or 90-day mortality. Moreover, similar results were reported in other relevant studies. Qiu et al[4] retrospectively compared the feasibility of RATS sleeve lobectomy with VATS and thoracotomy procedures in the balanced population. They found that RATS sleeve lobectomy had a shorter operative time, less blood loss, shorter tube drainage time, shorter hospital stay, and similar postoperative morbidity and mortality compared with VATS and thoracotomy procedures. Therefore, the outcomes reported from a limited number of studies suggest that RATS sleeve resection is technically feasible with acceptable clinical outcomes for an experienced veteran surgeon in a high-volume institution.

In addition, sleeve lobectomy, and even double sleeve lobectomy, following neoadjuvant treatment can still be safely performed with similar postoperative mortality and morbidity to direct surgery, without significantly increasing anastomosis-related complications.[5] However, neoadjuvant treatment may cause therapy-related changes, such as fibrosis or adhesion, which make hilar dissection and reconstruction of the lobar bronchus or artery more challenging. Additionally, there is concern about the feasibility and efficacy of minimally invasive sleeve resection after neoadjuvant treatment. In recent years, minimally invasive sleeve resection following neoadjuvant therapy has been continuously attempted, and the proportion of neoadjuvant therapy in a minimally invasive sleeve resection cohort ranged from 2% to 45.5%. After neoadjuvant treatment, when considering minimally invasive approaches as the first choice for major lung resections, especially a complex sleeve resection, the main concern is a potential intraoperative crisis, such as the inevitable conversion to open thoracotomy. Although the conversion to thoracotomy represents a failed attempt to perform a minimally invasive procedure, patients who undergo conversions do not show a worse perioperative mortality, readmission rate, or long-term survival than those who undergo the thoracotomy procedure. According to recent data, 11.3% to 20.0% of patients who initially underwent minimally invasive sleeve resection after neoadjuvant therapy required conversion surgery. Additionally, preliminary findings suggest that minimally invasive sleeve resection following neoadjuvant treatment appears safe and feasible with similar perioperative outcomes to those with thoracotomy.[5] However, the research on minimally invasive sleeve resection after neoadjuvant therapy remains limited, and more high-quality studies or prospective, randomized, controlled, clinical trials are still required to further validate its safety and efficacy. Importantly, surgeons should comprehensively and carefully evaluate patients after neoadjuvant treatment before planning minimally invasive sleeve resection and fully consider their clinical experience and technical level. The prediction of an intraoperative crisis is crucial, and conversion should be readily carried out whenever necessary and appropriate to safely complete the surgery.

Although many factors, such as the pathological staging, affect patients' prognosis, oncological outcomes are still important parameters for evaluating the efficacy of surgical procedures. The satisfactory survival of minimally invasive sleeve resection indicates the reliability of its oncological efficacy. Our previous review summarized 5-year survival data of thoracotomy sleeve resection. We found that the 5-year disease-free survival (DFS) rate ranged from 44.7% to 62.9%, and 5-year overall survival (OS) rate ranged from 37.5% to 69.0%. Regarding minimally invasive sleeve resection [Supplementary Table 3, http://links.lww.com/CM9/B870], the 3-year DFS rate ranged from 60.8% to 76.3%, and the 3-year OS rate ranged from 64.9% to 89.7%. Additionally, the 5-year DFS rate ranged from 50.7% to 67.9%, and the 5-year OS rate ranged from 56.1% to 85.0%. After eliminating the effect of confounding factors, no significant difference was observed in oncological outcomes between minimally invasive and thoracotomy sleeve resection [Supplementary Table 2, http://links.lww.com/CM9/B870]. Furthermore, meta-analyses have shown that VATS sleeve resection has similar OS and DFS to thoracotomy. However, there have been less research and survival data on RATS sleeve resection than VATS sleeve resection. For RATS sleeve resection, the 2-year DFS and OS rates were 81.3% and 82.4%–88.2%, the 3-year DFS and OS rates were 76.3% and 89.7%, and the 5-year DFS and OS rates were 67.9% and 73.0%, respectively. There was no significant difference in DFS among the RATS, VATS, and open groups in the matched cohort.[4] The OS of patients in the RATS sleeve resection group was better than that in the open surgery group, but similar to that in the VATS group.[4] Although current data suggest the potential survival advantages of RATS sleeve resection, further studies with larger sample sizes and longer follow-up time are still required.

Neoadjuvant chemoimmunotherapy can increase the major pathological response and improve survival compared with mono-neoadjuvant chemotherapy or chemoradiotherapy. Similarly, sleeve resection following neoadjuvant chemoimmunotherapy can achieve a pathological complete response more easily than neoadjuvant chemotherapy, which may indicate better survival.[5] Interestingly, the minimally invasive approach has not been identified as an independently favorable prognostic factor for survival. Most minimally invasive sleeve resections were usually completed in recent years. Therefore, a limitation of many studies is the short follow-up time. With the increasing experience of minimally invasive sleeve resection, more evidence of 5- or 10-year survival analysis is required, especially for neoadjuvant chemoimmunotherapy cases.

In summary, minimally invasive sleeve resection is safe and feasible with similar perioperative outcomes, a better postoperative recovery, and similar survival compared with thoracotomy surgery. However, more definitive evidence is required for the efficacy of minimally invasive sleeve resection after neoadjuvant treatment. The VATS and RATS approaches are well established and can be considered complementary procedures in high-volume institutions. The choice of the optimal procedure should be based on the clinical experience and technical level of the surgeons and the team.

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Conflicts of interest

None.

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