JCS Journal of Chest Surgery
https://doi.org/10.5090/jcs.25.032
pISSN: 2765-1606 eISSN: 2765-1614
J Chest Surg. 2025;58(4):164-165

Commentary

Commentary: Advancing toward Minimally Invasive Lung Transplantation

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ARTICLE INFO
Received April 8, 2025
Accepted April 8, 2025

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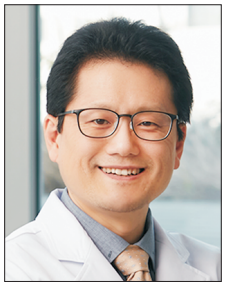
See Article page 160.



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Since the inception of lung transplantation, the clamshell incision has remained the standard approach for thoracic access [1]. However, as minimally invasive techniques—such as video-assisted thoracoscopic surgery (VATS) and robotic-assisted procedures—have become standard in various surgical fields, there has been a global effort to adapt these methods for lung transplantation [2,3]. Although such techniques are routinely used for lung cancer, esophageal cancer, and mediastinal tumors, they have not been widely adopted for lung transplantation and are performed in only a few centers. Hybrid procedures, such as the combination of sternum-sparing bilateral anterior thoracotomies with VATS as described by Park [4], serve as a bridge toward fully minimally invasive lung transplantation.

Despite the advancements in minimally invasive techniques in general thoracic surgery, several challenges hinder their widespread adoption in lung transplantation. First, patients undergoing lung transplantation often experience rapid hemodynamic changes and are at risk for massive intraoperative bleeding. Park [4] also notes that, in cases of unstable vital signs, conversion to a clamshell incision is necessary. Second, current surgical instruments for cardiac retraction, vascular clamping, and bronchial and vascular anastomoses are not yet optimized for completely minimally invasive procedures. Whereas general thoracic surgeries frequently rely on stapler-based resections, lung transplantation requires a pneumonectomy combined with complex anastomoses that depend on needle holders designed for open thoracotomy or VATS. The vertical anatomical configuration of the thoracic cavity and the spatial arrangement of the bronchus, pulmonary artery, and pulmonary veins complicate anastomoses through limited trocar ports or small window incisions, potentially prolonging operative time and increasing the burden on surgeons—especially during nighttime procedures. Third, in East Asian populations, particularly in Korea, patients often present with smaller thoracic cavities. The majority of lung transplant candidates in Korea suffer from idiopathic pulmonary fibrosis or connective tissue disease-associated pulmonary fibrosis. Elderly female patients with advanced lung disease typically exhibit smaller thoracic dimensions than those with chronic obstructive pulmonary disease (COPD) or bronchiolitis obliterans, which complicates instrument manipulation. Additionally, inserting instruments for clamping the pulmonary vessels—together with cannulas for extracorporeal membrane oxygenation (ECMO) or cardiopulmonary bypass (CPB) to maintain hemodynamic stability—further reduces the available space for pneumonectomy and subsequent anastomoses. If

the donor lung is not fully collapsed due to edema or consolidation, accommodating it within this confined space becomes challenging.

Regardless of these challenges, the future direction of lung transplantation should focus on minimally invasive approaches that leverage advancements in medical technology to overcome current limitations. The use of sternum-sparing bilateral anterior thoracotomies combined with VATS, as employed by Park [4], represents a promising transitional method toward fully minimally invasive lung transplantation.

To facilitate this transition, several conditions must be met. First, maintaining hemodynamic stability is crucial. Many lung transplant centers have adopted ECMO rather than traditional CPB to achieve stable hemodynamics. This shift lowers the required heparin dose, thereby minimizing intraoperative bleeding and facilitating minimally invasive procedures. The institution by Park [4] also employs peripheral ECMO to realize these benefits. Second, advancements in surgical instruments are necessary. Robotic-assisted surgeries, such as those utilizing the da Vinci system, offer improved instrument articulation, which is particularly beneficial for performing precise anastomoses. It is anticipated that the use of robotic systems in lung transplantation will increase in the future. Third, selecting appropriate candidates is essential. Prioritizing minimally invasive techniques for patients with larger thoracic cavities—such as those with COPD, bronchiolitis obliterans following bone marrow transplantation, or younger patients—can enhance surgical outcomes and facilitate the expansion of indications in the future.

In conclusion, combining VATS with sternum-sparing incisions in lung transplantation reflects the growing body of experience in Korea. This approach serves as a valuable bridge toward fully minimally invasive lung transplantation and holds promise for the future integration of robotic-assisted techniques.

Article information

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Author contributions

All the work was done by Jin Gu Lee.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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