Editorial

High-frequency jet ventilation jets the way to minimally invasive carinal resection?

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Carinal resection with reconstruction is a challenging and technically demanding procedure for both thoracic surgeons and anesthesiologists. This procedure requires careful patient evaluation, technical finesse, and experienced postoperative care for optimal surgical outcomes. Standardization of anastomotic techniques and development of advanced ventilation modalities have contributed to improved outcomes after this operation (1).

Airway management is a crucial part of the procedure, particularly during reconstruction and is especially important when considering a minimally invasive approach to tracheobronchial surgery. Different methods of intraoperative airway management have been described including single lumen small diameter endobronchial tube, cross-field ventilation, high frequency jet ventilation (HFJV), intermittent apneic ventilation, spontaneous breathing anesthesia, and circulatory support. The essential requirements of the ideal ventilation strategy during carinal reconstruction include adequate oxygenation and maintenance of sufficient gas exchange in the presence of surgically interrupted airways, unobstructed surgical field, and prevention of aspiration of blood and debris. Conventional methods of lung isolation, such as double lumen tube or bronchial blocker are of limited use during carinal surgery (2). The usage of small lumen single-lumen tube has been described in the resection of tumors of the main stem bronchus with partial carinal reconstruction (3). The main disadvantages of these methods are restriction of surgical field with limited access to the posterior aspect of the anastomosis, occasionally necessitating intermittent withdrawal of the tube with variable periods of apnea during creation of the anastomosis.

Cross-field ventilation remains a universally accepted strategy during tracheal and carinal reconstruction. In minimally invasive procedures an endobronchial tube is usually introduced through an additional port. HFJV has been recommended as an alternative technique of ventilating the patient during these procedures and has been applied successfully for video-assisted thoracoscopic surgery (VATS) carinal reconstruction (4). Eriksson in 1975 first described HFJV in settings of tracheal stenosis using two insufflation catheters. EI-Baz in 1982 reported a high-frequency positive-pressure ventilation of one lung. In 1987, Watanabe applied HFJV for major airway reconstructive surgery in 21 patients (5). HFJV has been applied in two cases to both lungs simultaneously using double catheter technique. The double catheter technique allows an unobstructed surgical view during anastomosis creation without undue hypoxia or hypercarbia (6). In the authors' practice we use a small caliber tube for delivery of oxygen

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such as an IV line or an endotracheal suction catheter, which allows successful continuous distal ventilation. This tube can be advanced endobronchially through the partially withdrawn endotracheal tube or can be set up as a cross-field circuit. In this case we usually secure the tube to the edge of the distal airway with 3-0 Vicryl suture. Due to its low-profile, this tube allows virtually unobstructed suture application during the anastomosis even if delivered via the cross-field route. This advantage is particularly important during VATS procedures. Zhao *et al.* described an endobronchial blocker for one-lung ventilation during procedure with HFJV during the anastomosis (7). Authors performed an end-to-end primary anastomosis of the trachea and left main bronchus with running suture. Subsequently they implanted right main bronchus end-to-side into the left main stem bronchus.

Severe complications and mortality in tracheobronchial surgery include non-cardiogenic pulmonary edema with subsequent respiratory failure and acute respiratory distress syndrome (ARDS). Postoperative respiratory complications usually develop in the first 72 hours and the causes are poorly defined. HFJV has been implicated by some in the development of postoperative ARDS. Porhanov *et al.* attributed ARDS development to HFJV (72% of cases developed ARDS) and advised against its routine use in tracheobronchial surgery (8). However, other studies challenge this conclusion with significantly lower rate of ARDS after HFJV of around 2% (9). HFJV makes minimally invasive surgery such as VATS or RATS an effective and feasible approach for carinal resection and reconstruction (10). Li *et al.* and He *et al.* summarized their experience of VATS resection and reconstruction of the carina or trachea, using cross-field ventilation, HFJV, and spontaneous breathing anesthesia with excellent results (11,12). Intubation of the opposite bronchus in the beginning of the procedure and a jet ventilation catheter inserted through it during the reconstruction is another strategy predominantly used in VATS.

Other reported complications of the HFJV include CO_2 retention either from hypoventilation or the reentry of expired CO_2 from the thoracic cavity, barotrauma, hypothermia due to high rate of gas flow, and aerosolization of blood and secretions in the operating field as a health hazard for the operating team (5).

In the recent paper by Qiu *et al.* the authors presented a retrospective analysis of the efficacy of HFJV on intraoperative oxygen saturation in the settings of open and minimally invasive carinal reconstruction compared with cross-field ventilation (13). Authors utilized HFJV in 10 patients, undergoing carinal resection and reconstruction and conventional cross-filed ventilation in 22 patients. For the purposes of oxygen delivery in the HFJV group authors utilized a modified hollow exchange tube with an outer diameter of only 6 mm. This did not interfere with the surgical exposure and allowed surgeons to maintain oxygenation during suture application. On the contrary, the larger endotracheal tube used in cross-field ventilation group required intermittent withdrawal of the tube for the performance of anastomosis.

The study demonstrated that HFJV did not increase the severity of duration of intraoperative hypoxemia. Hypercarbia in the HFJV group did not exceed 80 mmHg. One patient in the cross-field ventilation group with persistent hypoxia was salvaged with HFJV. Superior visualization and exposure due to low profile of the HFJV tube facilitated a minimally invasive approach to the procedure. Most patients (60%) in the HFJV underwent successful thoracoscopic carinal resection and reconstruction, while only 4.5% of cross-field patients had minimally invasive intervention. The paper concludes that thanks to satisfactory intraoperative oxygenation while limiting surgical steps interruption, HFJV may be a better approach for airway management, especially in minimally invasive tracheal surgery. The authors should be congratulated on completing this comparative study of the two methods of the airway management in tracheal surgery.

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References

1. Petrov RV, Bakhos CT, Abbas AE. Carinal resection. Shanghai Chest 2018;2:84.
2. Kosarek L, Busch E, Abbas A, et al. Effective use of bronchial blockers in lung isolation surgery: an analysis of 130 cases. Ochsner J 2013;13:389-93.
3. Iriarte F, Abbas AE, Petrov R, et al. Right transthoracic approach for robotic left main stem bronchus sleeve resection. JTCVS Tech 2021;10:572-4.
4. Bakhos CT, Magarinos J, Bent D, et al. Tracheobronchoplasty for tracheobronchomalacia. J Vis Surg 2022;8:15.
5. Perera ER, Vidic DM, Zivot J. Carinal resection with two high-frequency jet ventilation delivery systems. Can J Anaesth 1993;40:59-63.
6. McKinney M, Coppel DL, Gibbons JR, et al. A new technique for sleeve resection and major bronchial resection using twin catheters and high frequency jet ventilation. Anaesthesia 1988;43:25-6.
7. Zhao G, Dong C, Yang M, et al. Totally thoracoscopic tracheoplasty for a squamous cell carcinoma of the mediastinal trachea. Ann Thorac Surg 2014;98:1109-11.
8. Porhanov VA, Poliakov IS, Selvaschuk AP, et al. Indications and results of sleeve carinal resection. Eur J Cardiothorac Surg 2002;22:685-94.
9. Rea F, Marulli G, Schiavon M, et al. Tracheal sleeve pneumonectomy for non small cell lung cancer (NSCLC): short and long-term results in a single institution. Lung Cancer 2008;61:202-8.
10. Gritsiuta AI, Bakhos CT, Petrov RV. The current state of carinal resection and role of minimally invasive techniques. Transl Lung Cancer Res 2021;10:4029-34.
11. He J, Wang W, Li J, et al. Video-assisted thoracoscopic surgery tracheal resection and carinal reconstruction for tracheal adenoid cystic carcinoma. J Thorac Dis 2016;8:198-203.
12. Li J, Wang W, Jiang L, et al. Video-Assisted Thoracic Surgery Resection and Reconstruction of Carina and Trachea for Malignant or Benign Disease in 12 Patients: Three Centers' Experience in China. Ann Thorac Surg 2016;102:295-303.
13. Qiu Y, Yu F, Yao F, et al. The efficacy of high-frequency jet ventilation on intraoperative oxygen saturation compared to cross-field ventilation in patients undergoing carinal resection and reconstruction. J Thorac Dis 2022;14:3197-204.

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