



Surgical perception of lower tracheal or carinal resection

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Circumferential or non-circumferential airway resection with end-to-end anastomosis is the most common strategy for treating thoracic malignancies invading the trachea or carina. Carinal resection and lower tracheal or bronchial sleeve resection are fairly challenging procedures for thoracic surgeons. The perioperative management for these procedures can be complex due to the following reasons: (I) most cases are considered inoperable, and operable cases are very few, if not rare; (II) anatomic tension increases significantly as the length of resection goes beyond 4 cm, leading to an increased rate of postoperative complications and anatomic failure (1); (III) for a relatively large tracheal defect, an endotracheal tube for airway management potentially complicates the surgical field during end-to-end anastomosis repair; and (IV) the procedure involves a serious risk of postoperative mortality and morbidity.

Chen *et al.* reported a case wherein central reconstruction was performed with a bronchial flap and omental flap reinforcement using minimally invasive approaches (2). Following the partial response to neoadjuvant chemotherapy, the right main bronchus was opened distal to the 3.5 cm × 3.8 cm mass of the carina, under bronchoscopic guidance. Notably, the omental flap was harvested in a supine position via a 4-port laparoscopic approach with CO₂ insufflation at 12 mmHg, and carinal reconstruction was performed using a bronchial flap and omental flap via 3-ports thoracoscopic approach with a maximum 4–5 cm incision in the left lateral decubitus position. Fortunately, the cuff of the bronchus, including the right upper lobe orifice, bronchus intermedius, and distal left main bronchus, could be preserved. The cuff of the right lobe and bronchus intermedius were sutured

to the trachea and the left main bronchus margin. The patient's postoperative course was uneventful and with no evidence of complications or recurrence at the 1-year follow-up. Finally, they concluded that minimally invasive carinal reconstruction with bronchial flap and omental reinforcement after neoadjuvant treatment could be safely performed.

Long-segment circumferential tracheal or carinal resection usually leaves a large central airway defect, and repair through an end-to-end anastomosis is considered unfeasible and risky. In addition, anastomosis of the trachea and bronchus with different calibre is a complicated procedure and might cause ischemia at the junction of the trachea or the bronchus (3). Therefore, performing end-to-end anastomosis to reconstruct long-segment bronchial defects is challenging even for experienced surgeons. Several studies have shown that thoracic surgeons required experience handling more than 4 to 9 cases of bronchial anastomosis until they can complete the procedure in less than 60 minutes (4,5). Nakada *et al.* suggested that a 3-dimensional thoracic model simulating the bronchus can help thoracic surgeons practice suturing through the actual port site, and confirmation of the optimal angle of the needle and handling of the thread could help avoid string tangling and aid in the quick understanding of surgical pitfalls (6).

To the best of our knowledge, a large retrospective study (n=73) examining the reconstruction of long non-circumferential tracheal or carinal resections with bronchial flaps proposed that airway defects that do not exceed 50% of the airway circumference are a prerequisite to bronchial flap reconstruction during preoperative evaluation (7). However,

even under favourable circumstances, the maximum length of tracheal-carinal resections with end-to-end anastomosis is limited and should not exceed approximately 4 cm (8). For tracheal defects greater than 4 cm, end-to-end anastomosis is believed to be less feasible because of excessive tension (9). Peng *et al.* reported the effectiveness of reducing the anatomical and longitudinal tension by creating an additional V-shaped trim on the junction of the trachea and bronchial flap technique (7).

Postoperative bronchopleural fistula (BPF) is a serious complication that can affect approximately 5% of cases (7,10). The following are major risk factors for BPF: (I) perioperative susceptibility for a lung infection; (II) devascularization of anastomosis due to thorough systemic lymph node dissection or complete disruption of bronchial arterial flow; and (III) technical error while suturing. Routine flap coverage of the stump is reportedly crucial and can help prevent dehiscence of the stump because of the enhanced blood supply and can plug leakage into the thoracic space if dehiscence occurs (3). Chen *et al.* justified using an omental flap harbouring the promotion of healing and neovascularisation to reduce the risk of airway anastomosis complications after neoadjuvant chemotherapy (2). If possible, bronchial arterial preservation is desirable for retaining the arterial flow surrounding the anastomosis. Ishihara *et al.* reported that bronchial arterial circulation consisted primarily of systemic arterial blood after sleeve lobectomy in dogs with preserved bronchial artery. The bronchial articulation significantly improved in those with preserved bronchial artery than those with pedicled pleural wrap (11).

The simultaneous handling of anastomosis and coverage materials in patients with severe complications can be challenging for thoracic surgeons, even via thoracotomy. Emerging evidence and clinical experience suggest that tracheal or carinal resection via the thoracoscopic approach is a safe and feasible procedure in selected patients (2,12). Hu *et al.* reported that the visual and mechanical precision provided by robotic tools could facilitate accurate suturing even in confined spaces (13). Jiang *et al.* introduced no intubation technique for spontaneous ventilation thoracoscopic surgery for tracheal or carinal resection. It provides surgeons with an unobstructed view of the surgical field because the trachea is more flexible, with a wider range of motion during resection and anastomosis, even though urgent intubation is required (14). Finally, the knowledge of 'the recent development of minimally invasive techniques' highlights the future steps in tracheal or carinal resection.

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