Case Report

Successful carinal reconstruction with right main bronchial flap rotational embedded augmentation: a case report

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Background: Tracheo-carinal resection and reconstruction in cases of extensive malignant tumors present a significant surgical challenge, often complicated by high anastomotic tension and potential for incomplete anastomosis.

Case Description: We report on a 45-year-old male with a primary adenoid cystic carcinoma. The tumor was about 3 cm in size and invaded about 1 cm of the lower trachea, 2 cm of the left main bronchus (LMB), and 1 cm of the right main bronchus (RMB), blocking about 70% of the tracheal lumen, 90% of the LMB, and 50% of the RMB. Resection of the lower trachea and part of the LMB and RMB was performed via the right chest. We used the right main bronchial flap as a bridge, suturing it separately to the lower tracheal segment and the LMB, thereby completing the carinal reconstruction. This technique was crucial for bridging the defect between the trachea and LMB, which was impossible to anastomose directly due to the tumor's extensive involvement. The elliptical-shaped lingual flap from the RMB provided a stable and tension-free foundation for the reconstruction, overcoming the limitations of conventional methods.

Conclusions: The novel carinal reconstruction technique demonstrated a reliable alternative for complex tracheo-carinal defects, ensuring tension-free anastomosis and complete tumor resection with clear margins.

Keywords: Case report; carinal reconstruction; bronchial flap; tracheal tumors; adenoid cystic carcinoma

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Introduction

Long-segment complicated tracheo-carinal reconstruction remains a great challenge for thoracic surgeons (1,2). For malignant tumors invading the lower bronchus and carina, circumferential airway resection and end-to-end or end-to-side anastomosis are the most common surgical approaches. However, for irregular airway defects after long-segment carinal tumor resection, especially in cases where the tumor invades both the lower trachea and the left main bronchus (LMB), conventional end-to-end or end-to-side tracheal and bronchial anastomoses have the disadvantage of high anastomotic tension and even the possibility of incomplete anastomosis intraoperatively (3,4). Herein, we present a case of primary malignant carinal tumor invading the lower trachea as well as the bilateral main bronchus (invading LMB about 2.5 cm) using an innovative tracheo-carinal reconstruction technique. We present this article in accordance with the CARE reporting checklist (available at https://tlcr.amegroups.com/article/view/10.21037/tlcr-24-146/rc).

Case presentation

A 45-year-old male patient was admitted with persistent cough and hemoptysis for over 8 months. Physical examination revealed no significant abnormalities. Computed tomography (CT) and fiberoptic bronchoscopy detected a tumor located at the tracheal carina (*Figure 1A,1B*). The tumor invaded the lower trachea and the medial wall of the LMB and right main bronchi (RMB), 2.5 cartilaginous rings from the opening of the right upper lung bronchus (4 cartilaginous rings in total) and 3.5 cartilaginous rings from the opening of the left upper lung bronchus (7 cartilaginous rings in total). The tumor was about 3 cm in size and invaded about 1 cm of the lower trachea, 2 cm of the LMB, and 1 cm of the RMB, blocking about 70% of the tracheal lumen, 90% of the LMB, and 50% of the RMB (*Figure 1C*). A bronchoscopic pathological biopsy further confirmed the presence of adenoid cystic carcinoma. The patient had no known family history of similar conditions and had not received any treatment for the tumor prior to this admission. The patient's past physical examinations revealed no history of underlying diseases or surgeries.

Highlight box

Key findings

- This case report demonstrates the successful use of a right main bronchial flap in rotational carina reconstruction, which significantly reduced anastomotic tension and enabled effective tumor removal when traditional methods posed high risks of lung loss and postoperative complications.

What is known and what is new?

- It is well-established that extensive resection involving the trachea and main bronchi often leads to high risks of anastomotic dehiscence or stenosis when exceeding 4 cm in length.
- The novel approach described in this study utilizes a right main bronchial flap as a rotational bridge for carinal reconstruction, a technique not previously documented, thus preserving lung function and offering a new method for challenging tracheo-bronchial surgeries.

What is the implication, and what should change now?

- This innovative technique suggests a shift in surgical practice for treating extensive tracheo-carinal tumors, particularly those involving the left main bronchus. Surgeons should consider this flap technique to reduce the need for total lung resection and minimize the risk of severe postoperative complications. This approach could become a standard consideration in complex tracheal and bronchial surgeries to preserve lung integrity and patient quality of life.

After transoral tracheal intubation and general anesthesia the patient first underwent left pneumonolysis and pericardiolysis in the right lateral position under thoracoscopy. The fourth intercostal space in the left anterior axillary line was selected as an access incision, and the seventh intercostal space in the left midaxillary line was selected as the port site. The inferior pulmonary ligament was separated, and the pericardium surrounding the hilum was incised medially to the phrenic nerve.

Subsequently, the carinal tumor resection and tracheo-carinal reconstruction were performed through the right fifth intercostal posterior lateral incision. We first performed pneumonolysis and pericardiolysis similar to those done on the left chest. Subsequently, we completely freed the lower trachea, the carina, and the main bronchi on both the left and right sides (*Figure 2A*). The anesthesiologist was instructed to retract the transoral tracheal tube to the middle trachea and the surgeon immediately incised the RMB at 0.5 cm from the inferior margin of the right main bronchial tumor. The RMB was intubated and ventilation was maintained by an assistant, and then the trachea was cut at 0.5 cm from the upper edge of the tumor, naturally forming an inverted V-shaped notch at the lower end of the trachea. The RMB was cut obliquely at its severed end since the tumor involved only the medial wall of the main bronchus bilaterally, and the healthy lateral wall of the RMB was preserved to form a lingual bronchial flap with an oval cross-section (the lingual flap had about 4 cartilage rings). The LMB was also cut obliquely at the lower edge of the left main bronchial tumor 0.5 cm, and about 2 cartilaginous rings of the lingual flap were preserved.

After removing the protruding tumor specimen, the lower tracheal section (left annulus) was sutured to the upper end of the left main bronchial lingual flap with three stitches using 4-0 Vicryl suture. The rest of the site could not be further sutured due to excessive tension, thus creating a "v" shaped tracheal and bronchial notch with a circumference of approximately 20 mm (*Figure 2B,2C*). Thereafter, the anesthesiologist was instructed to insert a transoral tracheal tube into the LMB for ventilation with the help of the operator. However, because the LMB was too short (only 2.5 cartilage rings remained), the transoral tracheal tube could only be ventilated in the left lower lung bronchus, and it was difficult to maintain the patient's pulse oxygen. Therefore, the transoral tracheal tube was returned to the middle trachea, and the on-table tracheal tube was inserted into the right middle bronchus and ventilated intermittently, using the oxygen reserve to complete the

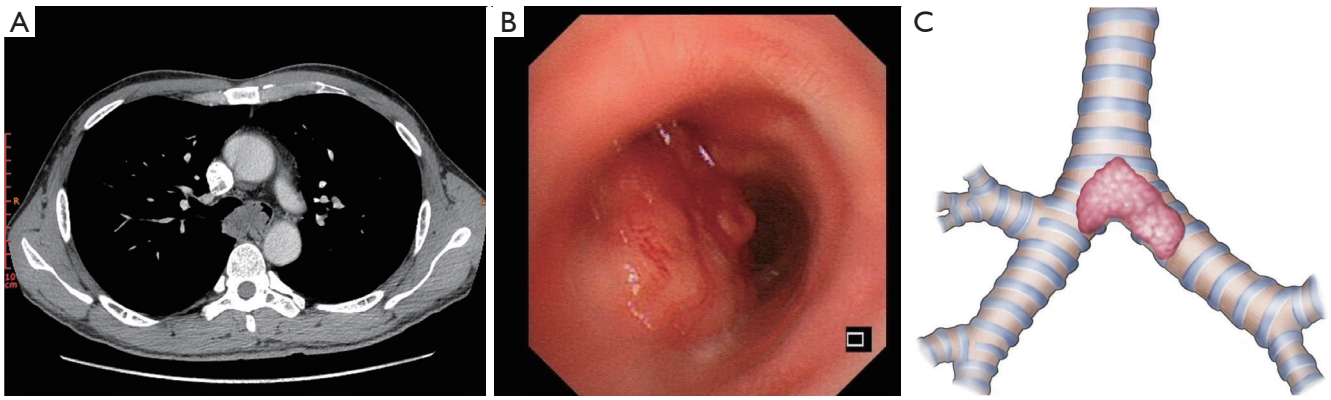

Figure 1 Preoperative examination and assessment. Preoperative computed tomography (A) and fiberoptic bronchoscopy (B) detected a tumor located at the tracheal carina. (C) Schematic diagram of tumor size and location.

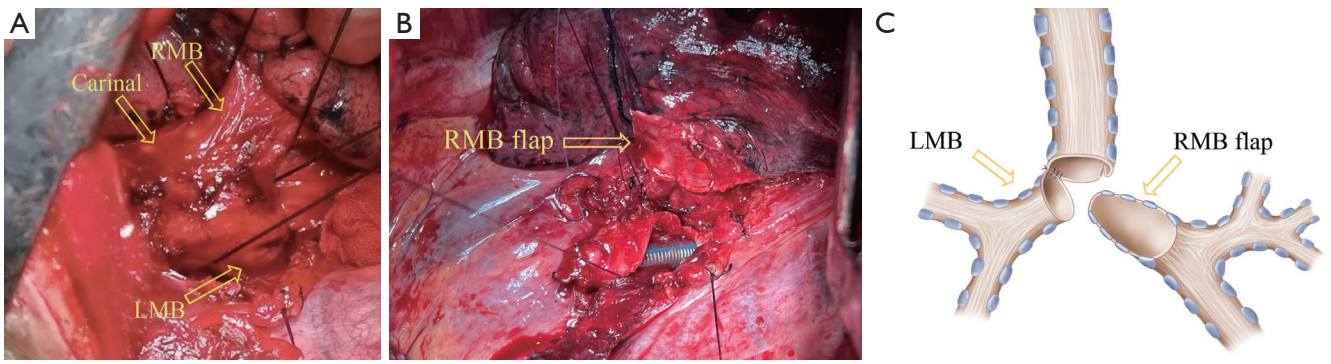

Figure 2 Illustration of key intraoperative steps and anastomosis methods. (A) Lower trachea, carina, left and right bronchi are fully released. (B) Lower tracheal section (left annulus) was sutured to the upper end of the left main bronchial lingual flap with three stitches and formation of RMB lingual flap. (C) Posterior view of the unstitched separated carina. RMB, right main bronchus; LMB, left main bronchus.

tracheal suture between ventilations.

The upper end of the lingual flap of the RMB was inserted into the "v" shaped trachea and the notch of the left bronchus, and one side of the lingual flap was sutured intermittently to the tracheal notch, while the other side of the lingual flap was sutured intermittently to the LMB notch. During the suturing process, the RMB was gradually rotated about 90 degrees to the spinal side until the lower tracheal segment was closed with the initial three sutures of the lingual flap of the LMB. Finally, the inverted V-shaped notch at the lower end of the trachea was sutured, completing the carina reconstruction (*Figure 3A,3B*). After completion of the suture, bronchoscopy was performed again to check the integrity of each anastomosis of the new carina. After clearing the lumen of the trachea and the right and LMB, systematic mediastinal and hilar lymph node dissection was performed. Finally, the airway was checked for airtightness, and the displaced intercostal muscle was freed to embed the anastomosis.

The patient experienced phlegmatic weakness for the first three days after surgery, so he was aspirated using a fiberoptic bronchoscope daily, and the anastomosis was observed at the same time. The patient gradually recovered from phlegmatic weakness starting on the 4th postoperative day, with no air leakage observed. The upper and lower chest tubes were removed on the 5th postoperative day. The patient was discharged on the 16th postoperative day in good condition. The final tumor pathology was adenoid cystic carcinoma, and the bronchial margin was negative. No lymph node metastasis was found. At 69 days after surgery, the mucosa of the anastomosis was well-healed, with no tumor recurrence observed. The lower trachea and the

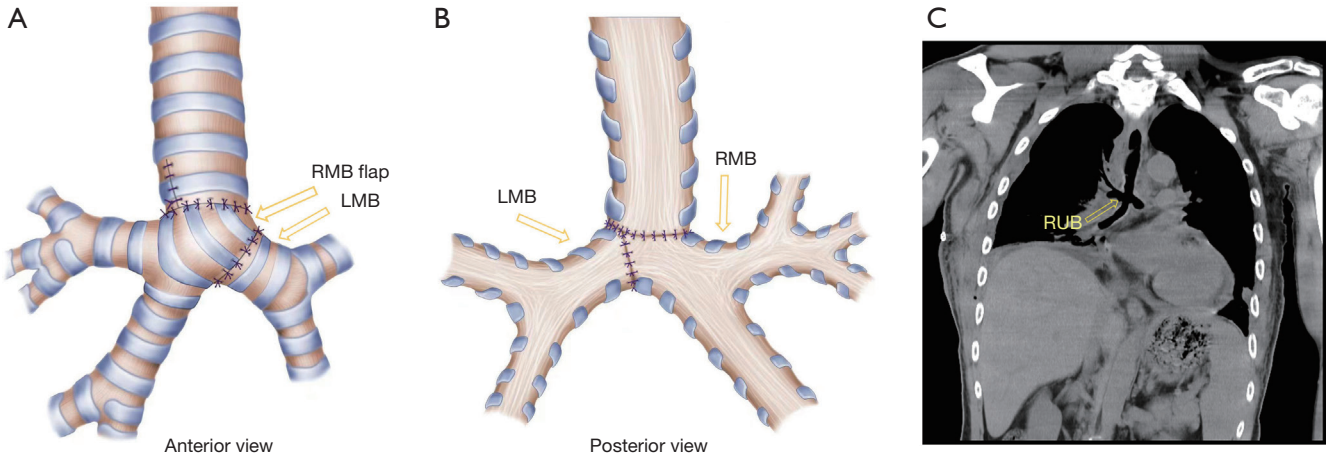

Figure 3 Illustration of the reconstructed carinal and postoperative Computed tomography assessment. (A,B) Schematic diagram of the reconstructed carina: (A) anterior view; (B) posterior view. (C) Computed tomography shows the reconstructed airway is unobstructed at 69 days after surgery. RMB, right main bronchus; LMB, left main bronchus; RUB, right upper bronchus.

lumen of the left and RMB were unobstructed (*Figure 3C*). The patient reports that the previous symptoms have now completely resolved, and no other symptoms are present. The patient has not experienced complications, metastasis, or recurrence after surgery, and it has been 13 months to date. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient. A copy of the written consent is available for review by the editorial office of this journal.

Discussion

To our knowledge, this is the first case in which the right main bronchial lingual flap was bridged between the trachea and the LMB, and reconstructed by suturing to both separately. We named it carinal reconstruction with right main bronchial flap rotational embedded augmentation.

The internationally accepted length of distal trachea, aneurysm and LMB resection should not exceed 4 cm, and excessive anastomotic tension in excess of 4 cm will lead to anastomotic dehiscence or stenosis (5). For cases where the carinal tumor significantly involves the LMB, the usual surgical approaches include sleeve pneumonectomy of the entire left lung through the left chest, or tracheal and RMB anastomosis via the right chest, leaving the left lung collapsed (the collapsed left lung can be surgically removed, either via an additional thoracotomy or with thoracoscopic assistance from the left side) (6). However, the mentioned procedure results in the loss of the patient's healthy left lung. For surgeons who are particularly experienced in carinal surgery, anastomosis of the RMB through the right thoracic trachea and end-lateral anastomosis of the left main bronchial stump with the right middle trunk bronchus can be attempted, but it is extremely difficult to complete end-lateral anastomosis with the right middle trunk bronchus because of the short left main bronchial stump, and the chance of postoperative anastomotic fistula and anastomotic stenosis due to excessive anastomotic tension is very high (7-9).

In the case reported herein, the right main bronchial flap embedded in rotational carina reconstruction played a crucial role in tumor removal and reducing anastomotic tension. The right main bronchial flap served as a bridge between the trachea and the LMB, addressing the problem that about 80% of the circumference of the LMB could not be directly anastomosed with the lower tracheal segment. The elliptical-shaped right main bronchial lingual flap provided a stable foundation for the procedure's success. This innovative technique offers a safer and more reliable option for extensive tracheo-carinal resection and reconstruction.

Patient perspective

For the first three days after surgery, the patient

experienced considerable discomfort due to daily fiberoptic bronchoscopy suctioning. Aside from that, due to the patient's youth and the preservation of lung function during the operation, symptoms of chest tightness were immediately alleviated after the surgery. Overall, the process was relatively smooth and stable.

Conclusions

The novel carinal reconstruction technique demonstrated a reliable alternative for complex tracheo-carinal defects, ensuring tension-free anastomosis and complete tumor resection with clear margins.

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Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at https://tlcr.amegroups.com/article/view/10.21037/tlcr-24-146/rc

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tlcr.amegroups.com/article/view/10.21037/tlcr-24-146/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient. A copy of the written consent is available for review by the editorial office of this journal.

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