

# Successful lung-sparing carinal reconstruction after induction chemoradiotherapy for carinal cancer via median sternotomy: Reefing bronchial membrane technique



Naoki Date, MD, Yojiro Yutaka, MD, PhD, and Hiroshi Date, MD, PhD, Kyoto, Japan

From the Department of Thoracic Surgery, Kyoto University Hospital, Kyoto, Japan.

Disclosures: The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

Read at the 102nd Annual Meeting of The American Association for Thoracic Surgery, Boston, Massachusetts, May 14-17, 2022.

Received for publication Aug 24, 2022; revisions received Oct 9, 2022; accepted for publication Oct 18, 2022; available ahead of print Oct 25, 2022.

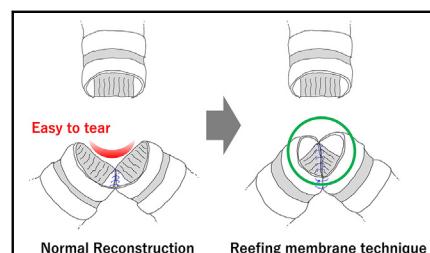
Address for reprints: Hiroshi Date, MD, PhD, Department of Thoracic Surgery, Kyoto University Hospital, 54 Kawahara-cho, Shogoin, Sakyo-ku, Kyoto 606-8507, Japan (E-mail: [hdate@kuhp.kyoto-u.ac.jp](mailto:hdate@kuhp.kyoto-u.ac.jp)).

JTCVS Techniques 2023;17:170-3

2666-2507

Copyright © 2022 The Author(s). Published by Elsevier Inc. on behalf of The American Association for Thoracic Surgery. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

<https://doi.org/10.1016/j.jtc.2022.10.008>



Carinal reconstruction by a novel reefing membrane technique.

## CENTRAL MESSAGE

The reefing membrane technique can ensure reliable anastomosis in bronchial cartilage.

▶ Video clip is available online.

Carinal resection is a challenging procedure, having high morbidity and mortality rates. Reducing anastomotic tension and preserving tracheobronchial blood supply are important for successful reconstruction. Herein, we report a case of lung-sparing carinal plasty using the bronchial membrane reefing technique via median sternotomy to avoid excessive anastomotic tension.

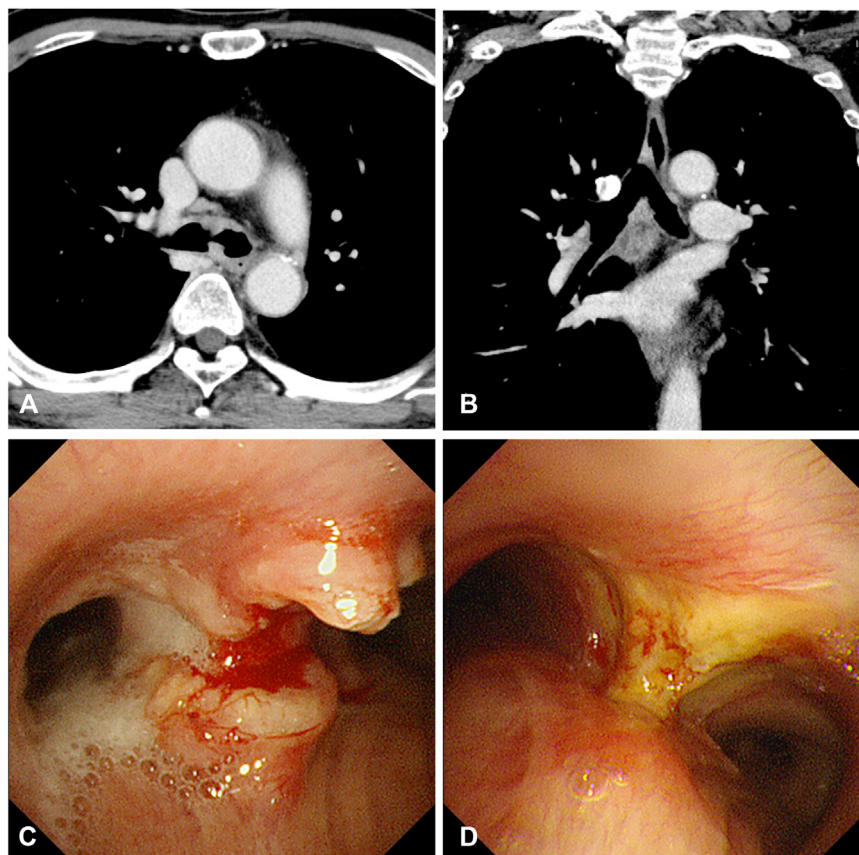
## CASE PRESENTATION

A 68-year-old man with hemoptysis was diagnosed with squamous cell carcinoma of the carina that had directly invaded the subcarinal lymph nodes (cT4N2M0, 35 mm). He was scheduled for carinal resection after 2 cycles of weekly carboplatin (area under the concentration-time curve of 2) combined with weekly paclitaxel (40 mg/m<sup>2</sup>) plus irradiation (50 Gy), which yielded partial response (ycT4N0M0, 15 mm) (Figure 1). The ethics committee of Kyoto University

Hospital approved the study protocol (R-2504-1, June 22, 2020), and the patient provided informed written consent.

## Surgical Technique

A transsternal approach was selected for lung-sparing carinal resection and reconstruction, followed by omentopexy. After median sternotomy, the pericardium was opened vertically, and the trachea was exposed between the superior vena cava and ascending aorta. Right pulmonary arterial mobilization enabled excellent exposure of the carina and proximal main-stem bronchi. A 23-gauge needle was inserted through the trachea at the level of the planned division line, and simultaneous bronchoscopy was conducted for internal examination for a safe proximal margin. Resection began with transverse division of the trachea at 2 rings above the carina. Cross-field ventilation was established via direct intubation of the left main bronchus. The following procedure was performed for intermittent apnea: carinal tumor along with the subcarinal lymph nodes was resected en bloc having free surgical margins, as confirmed by frozen sections. After minimum airway mobilization to avoid devascularization, reconstruction began by creating a neocarina by suturing the medial cartilaginous portion of both the main bronchi together, using a running 4-0 polydioxanone suture (PDS).



**FIGURE 1.** A, Computed tomography of the chest reveals a carinal tumor diagnosed with squamous cell carcinoma. B, The tumor directly invaded subcarinal lymph nodes. C, Initial bronchoscopic image showing the tumor invading the carina. D, Bronchoscopy after induction therapy shows marked response to the chemoradiotherapy.

During end-to-end anastomosis of the neocarina to the trachea, excessive tension was observed on the anastomosis, which could result in tearing of the vulnerable membranous portions (Figure 2, A). Therefore, we resutured and fully approximated the vulnerable posterior membranous portions of both mainstem bronchi with 4-0 PDS running sutures, thereby eliminating the vulnerable membranous portion in the distal airway edge. This technique resulted in 90° rotation of both main bronchi and shorter airway distance for posterior wall anastomosis (Figure 2, B). Reefing the vulnerable membranous portion enabled successful end-to-end anastomosis with a running suture on the posterior wall and interrupted sutures on the anterior wall using 4-0 PDS (Figure 2, C and D). Finally, the airway anastomosis was wrapped around by a pedicled omentum (Video 1).

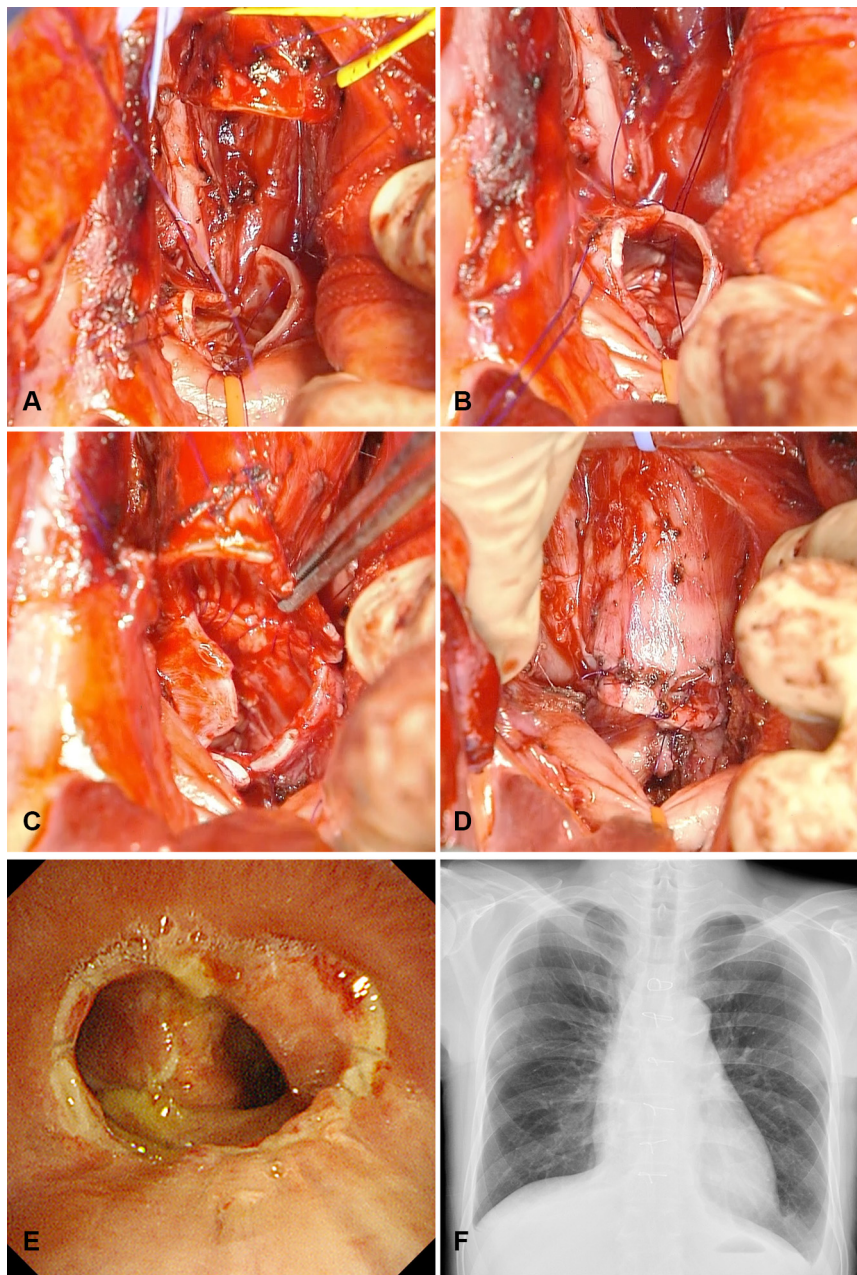
### Outcome

There was no sign of sputum retention, and the postoperative course was uneventful, with satisfactory airway healing (Figure 2, E), and the patient was discharged on postoperative day 16. Pathologic findings revealed a good response to preoperative chemoradiotherapy, with only a 2-mm viable

residual tumor (E<sub>f</sub>2). Six months' postsurgery, there was no sign of recurrence and no respiratory symptoms (Figure 2, F).

### DISCUSSION

Since the initial report by Abbott in 1950,<sup>1</sup> carinal resection and reconstruction for the treatment of bronchogenic carcinoma invading the carina remains a challenge for thoracic surgeons because of the technical difficulties and perioperative complications. The postoperative mortality rate is reported to be approximately 6.8% to 9.4%<sup>2,3</sup> and increases in patients receiving induction therapy. For successful carinal reconstruction, avoiding excessive tension during anastomosis by airway mobilization is important. It is also important to maintain sufficient blood supply to the airway by minimum devascularization, especially after induction chemoradiation therapy. In the present case, we observed excessive tension in anastomosing vulnerable membranous portions between the proximal trachea and distal main bronchi after suturing the medial wall of both main bronchi. Therefore, we used the novel reefing bronchial membrane technique, which eliminated the vulnerable membranous portion in the distal airway edge and

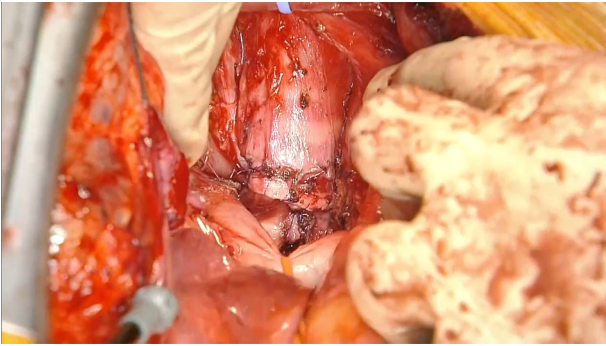


**FIGURE 2.** A, Intraoperative image after resection of carina shows neocarina formation in a normal fashion. A large gap between the trachea and neocarina can be observed. B, The reefing bronchial membrane technique. The edge of the neocarina entirely consists of the solid cartilaginous portion. C, Running suture of posterior wall. D, Complete reconstruction of carina. E, Bronchoscopy 2 weeks after the surgery shows excellent healing of the anastomosis. F, Chest radiography 6 months after surgery shows full expansion of both lungs and no signs of recurrence.

shortened the distance for posterior wall anastomosis by 90° rotation of both main bronchi. Although the orifice of the distal airway was slightly smaller, it did not cause any clinical symptoms. We recognize that there are other techniques to relieve anastomotic tension. Dissection of the pretracheal plane and hilar release<sup>4,5</sup> can be combined with our technique. Placement of heavy-traction sutures in

the cartilaginous wall of the trachea or mainstem bronchi that are tied before tying any anastomotic sutures may be useful.<sup>5</sup>

Although right posterolateral thoracotomy is an alternative approach for carinal resection, median sternotomy can provide excellent visualization of the carina and both main bronchi from the front, especially in cases with isolated



**VIDEO 1.** Operative video of carinal reconstruction via media sternotomy. The reefing membrane technique is effective for safe anastomosis, even after induction chemoradiotherapy. Video available at: [https://www.jtcvs.org/article/S2666-2507\(22\)00534-X/fulltext](https://www.jtcvs.org/article/S2666-2507(22)00534-X/fulltext).

carinal resection.<sup>2,3</sup> The anastomosis should be covered with vital tissue to prevent bronchopleural fistula, and an omental flap is preferable in patients who have received preoperative

radiotherapy.<sup>2</sup> It is easy to access the omentum from the same wound as the median sternotomy by caudally extending the incision.

### CONCLUSIONS

The reefing membrane technique for carinal plasty may be effective in reducing anastomotic tension and risk of tearing, especially when minimum airway mobilization is needed to avoid devascularization after radiotherapy.

### References

1. Abbott OA. Experiences with the surgical resection of the human carina, tracheal wall, and contralateral bronchial wall in cases of right total pneumonectomy. *J Thorac Surg.* 1950;19:906-22.
2. Costantino CL, Geller AD, Wright CD, Ott HC, Muniappan A, Mathisen DJ, et al. Carinal surgery: a single-institution experience spanning 2 decades. *J Thorac Cardiovasc Surg.* 2019;157:2073-83.
3. Dartevelle PG, Mitilian D, Fadel E. Extended surgery for T4 lung cancer: a 30 years' experience. *Gen Thorac Cardiovasc Surg.* 2017;65:321-8.
4. Tapias L, Lanuti M. Carinal resections. *Ann Cardiothorac Surg.* 2018;7:309-13.
5. Petrov RV, Bakhos CT, Abbas AE. Carinal resection. *Shanghai Chest.* 2018;2:84.