

# Subtotal Cricoid Cartilage Resection and Crico-tracheal Reconstruction for Papillary Thyroid Carcinoma Involving Cricoid

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## Abstract

Currently, there is some controversy surrounding surgery for papillary thyroid carcinoma (PTC) that involves more than half of the cricoid cartilage, as some studies suggest that partial cricoidectomy may cause tracheal stenosis and total laryngectomy may be necessary. The aim of this study was to describe a new technique for subtotal cricoid resection and crico-trachea reconstruction that preserves laryngeal function. A 51-year-old man with recurrent PTC underwent subtotal cricoid cartilage resection, tracheal resection and crico-tracheal reconstruction. The PTC had spread to the frontal and right lateral parts of the cricoid cartilage and the 1st to 3rd tracheal rings. The surgery involved removing three quarters of the cricoid cartilage and the 1st to 4th tracheal rings, and modifying, rotating, and anastomosing the remaining trachea to the remaining part of the cricoid cartilage. The procedure was successful in completely removing the tumor, preserving speech function, and avoiding tracheal stenosis. The patient did not experience dyspnea after tracheal cannula removal. This novel crico-trachea reconstruction surgery shows promise in preserving speaking function while avoiding complications associated with partial cricoidectomy.

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**Key words:** Papillary thyroid carcinoma, Cricoid cartilage, Surgery, Crico-tracheal reconstruction

### 1. Introduction

Thyroid carcinoma is the most common cancer of the head and neck, and its incidence is increasing worldwide<sup>1</sup>. Differentiated thyroid carcinoma (DTC) accounts for approximately 90% of thyroid carcinoma<sup>2</sup>.

While DTC generally develops slowly, it can sometimes invade surrounding organs, such as the trachea (4%-46%), esophagus (9%-31%), and larynx (12%-24%)<sup>3,4</sup>.

Shin proposed a staging method for tracheal invasion, with Shin IV patients having the most severe form of tracheal invasion<sup>5</sup>. For these patients, the classic surgery for thyroid carcinoma involving less than half of the cricoid cartilage is partly cricoid cartilage and tracheal resection and primary anastomosis, while total laryngectomy is recommended if the tumor involves one-half to three-fourths of the cricoid cartilage<sup>6</sup>.

However, there is still controversy over the surgical method for DTC that invades most of the cricoid cartilage. Can laryngeal be preserved in patients whose tumors involve more than half of the cricoid cartilage? To address this question, we propose a novel cricoid subtotal resection and crico-tracheal reconstruction surgery that aims to preserve the patient's speech function while maintaining airway patency.

## 2. Patient Information:

A 51-year-old man presented with a history of PTC. He had previously undergone total thyroidectomy and cervical lymph node dissection in 2008, with postoperative pathology confirming PTC. From 2016 and 2018, he underwent twice cervical lymph node dissection for recurrent tumors. Following the 2016 surgery, he developed chronic hoarseness due to right vocal cord paralysis. He received two rounds of radioactive iodine treatment but residual tumor remained in the right tracheoesophageal sulcus.

In November 2021, the patient presented with difficulty breathing, and physical examination revealed a palpable mass on the right side of the thyroid bed. An emergency tracheotomy and biopsy were performed in another hospital due to dyspnea, and pathology confirmed the recurrence of PTC. Laryngoscopy revealed right vocal cord paralysis and a mass in the tracheal cavity (Figure 1A). A follow-up CT scan and MRI showed invasive PTC at the cricoid cartilage, trachea, and in the right tracheoesophageal sulcus, with an ill-defined boundary and a size of 4\*3cm. The carcinoma locally invaded the right recurrent laryngeal nerve, frontal and right lateral parts of the cricoid cartilage and the 1st to 3rd tracheal rings, resulting in partial tracheal stenosis, as well as bilateral enlarged lymph nodes (Figure 1). Gastroscopy showed no tumor invasion of the mucosal and submucosal layers of the esophagus.

The treatment plan involved extensive radical thyroidectomy, subtotal cricoid cartilage resection, tracheal resection, cricoid cartilage and tracheal anastomosis, and neck dissection. The patient provided consent for the procedure

## 3. Surgical technique

### 3.1 Body position and exposure

The patient was administered general anesthesia. A 'U'-shaped incision was made at the original neck scar and subplatysmal flaps were raised both superiorly and inferiorly and then secured in place. Then the sternohyoid, thyrohyoid, and omohyoid muscles were separated bilaterally at the midline. The subhyoid muscle groups were cut at the lower margin of the hyoid bone to expose the hyoid bone, thyroid cartilage, cricoid cartilage, and cricothyroid membrane.

### 3.2 Tumor resection and subtotal cricoid cartilage resection

Firstly, bilateral cervical lymph node dissection was performed. Then the tumor located in the right tracheoesophageal sulcu, three quarters of the cricoid cartilage and the 1st to 4th tracheal rings were removed. The left 1/4 of the cricoid cartilage was preserved to provide partial support to the airway. The length of the resulting tracheal defect was approximately 3cm, and the esophagus remained intact (Figure 2B). Intraoperative frozen section pathology confirmed that the surgical margin was free of tumor and that a minimum safety range of 3mm had been achieved.

### 3.3 Trachea reconstruction

The fractured trachea was reshaped to match the residual cricoid cartilage. The tracheal stump was separated from the surrounding tissue and rotated 15° clockwise to align the tracheal cartilage with the cricoid cartilage

defect and the membranous trachea with the remaining cricoid cartilage (Figure 2C). This maneuver provided bony support to the cricoid cartilage, which helped prevent airway narrowing. The trachea was then lifted up without tension and directly sutured to the cricoid stump using 2-0 absorbable suture. The knots were placed outside the trachea (Figure 2D). To ensure airtight tracheal closure, each suture was tied tightly while an assistant held tension between adjacent stitches (Figure 3). The strap muscles were then removed to cover and sutured onto the surface of the laryngotracheal complex, and a drainage tube was inserted. Finally, the incision was closed in multiple layers.

#### 4. Results

No postoperative complications were observed. The patient maintained a low head position for two weeks after the surgery. Nasogastric feeding was initiated within 24 hours and continued for a duration of two weeks. After 15 days, oral feeding was introduced, and the gastric tube was removed. A CT scan performed after 15 days indicated no signs of air leakage in the patient's trachea, as shown in Figure 4. The tracheal cannula was subsequently removed, and the tracheostomy was closed 21 days after the surgery. A fiberoptic bronchoscopy was conducted 25 days after the surgery, which revealed an unobstructed trachea and well-healed wound, as depicted in Figure 4. The final pathology report confirmed the presence of papillary thyroid carcinoma infiltrating the annular tissue and airway wall, but it revealed clear margins.

During the one and a half years follow-up, the patient's vocal quality was satisfactory, with only slight hoarseness noted, and there were no occurrences of dyspnea. Simultaneously, no tumor recurrence was detected in the laryngotracheal region.

#### 5. Discussion

Approximately 13-15% of papillary thyroid carcinoma involve the adjacent structures outside the thyroid gland, such as the trachea, esophagus, and recurrent laryngeal nerve<sup>7</sup>. However, due to its slow growth, patients generally have a favorable prognosis<sup>8</sup>. When PTC affects the trachea and throat, it can result in breathing difficulties, necessitating radical surgery. Nevertheless, the optimal surgical approach remains a subject of debate, particularly for patients with thyroid carcinoma that extends beyond half of the cricoid cartilage. Therefore, we propose a novel surgical technique in such cases.

##### Technique

Our technique is characterized by the replacement of the removed cricoid cartilage with tracheal cartilage, which serves as a support and helps prevent tracheal stenosis. In previous crico-trachea reconstructions, tracheal cartilage was directly anastomosed to the cricoid cartilage. However, this approach lacked cartilage support in the tracheal membrane, leading to the occurrence of tracheal stenosis when there was a defect in the posterior cricoid cartilage. In such cases, total laryngectomy was recommended if the tumor involved more than half of the cricoid cartilage<sup>6</sup>. To address this issue, we resolved it by rotating the trachea, allowing the tracheal membrane to fit snugly with the remaining cricoid cartilage, while the tracheal cartilage replaced the excised portion of the cricoid cartilage.

The second notable feature of our technique is the adequate dissociation of the trachea. Previous studies have demonstrated that crico-trachea reconstruction can often result in postoperative tracheal fractures, particularly when multiple tracheal rings are removed<sup>9</sup>. When rotating the trachea to align with the cricoid cartilage, it is crucial to ensure sufficient dissociation of the trachea from the surrounding soft tissue. This dissociation helps to alleviate tension within the trachea, both horizontally and vertically, and prevents tracheal anastomotic fractures. By effectively separating the trachea from the surrounding soft tissue, we enhance the mobility and flexibility of the trachea, thereby reducing the risk of anastomotic rupture caused by excessive tension.

##### Indications

This technique is suitable for patients with papillary thyroid carcinoma (PTC) involving the cricoid cartilage within the range of one-half to three-fourths. However, it is not appropriate in cases where the tumor involves

bilateral arytenoid joints. When both arytenoid joints are affected, the removal of these joints results in the inability of both vocal cords to move. In such instances, we excise the cricoid cartilage at the arytenoid joint on one side, preserving the contralateral vocal cords' normal mobility post-surgery, even in the presence of recurrent laryngeal nerve palsy.

It is important to note that this method has certain limitations. In order to preserve the cricoid cartilage, the safety margin is limited to only 3mm, which may not be sufficient for tumors with a high degree of malignancy. Therefore, careful consideration is required when applying this technique to cases with highly malignant tumors.

## 6. Conclusion

The novel cricoid subtotal resection and crico-tracheal reconstruction is a straightforward and practical technique that proves to be highly effective in preserving speech for patients with cricoid cartilage invasion.

**Conflict interest:** The authors declare no competing interest.

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**Ethical approval:** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee (the Human Research Ethics Committee of the Sixth Affiliated Hospital of Sun Yat-sen University) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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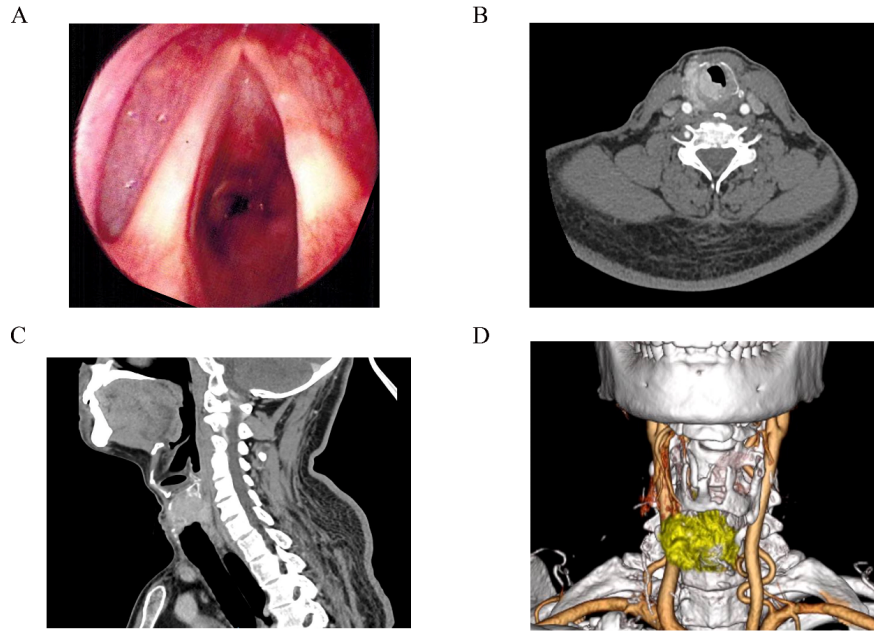


Figure 1. Preoperative laryngoscopy and CT scan findings. (A: A tumor located on the inner aspect of the trachea. B, C: Expansile lesion involving the right side of the cricoid cartilage and the first to third tracheal rings. D: 3D reconstruction of the tumor and cricoid cartilage, with the tumor depicted in yellow.)

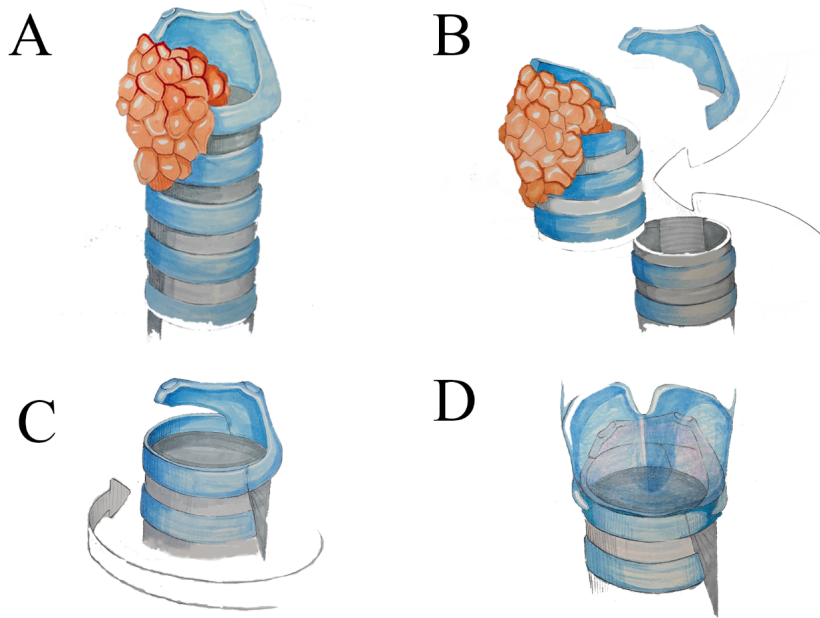


Figure 2. Tumor resection and simultaneous tracheal and cricoid cartilage reconstruction for thyroid cancer involving the trachea and cricoid cartilage. (A: Tumor location. B: Partial removal of the cricoid cartilage and trachea. C: Rotation of the trachea and anastomosis of the trachea and residual cricoid cartilage. D: Fixation in the thyroid cartilage.)

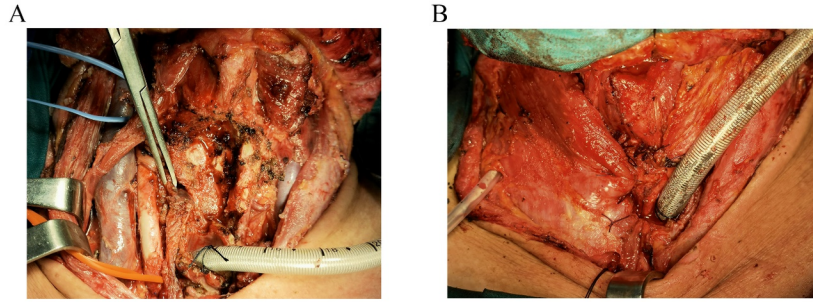


Figure 3. Surgical Procedure. (A: Tumor resection. B: Closure of the incision.)

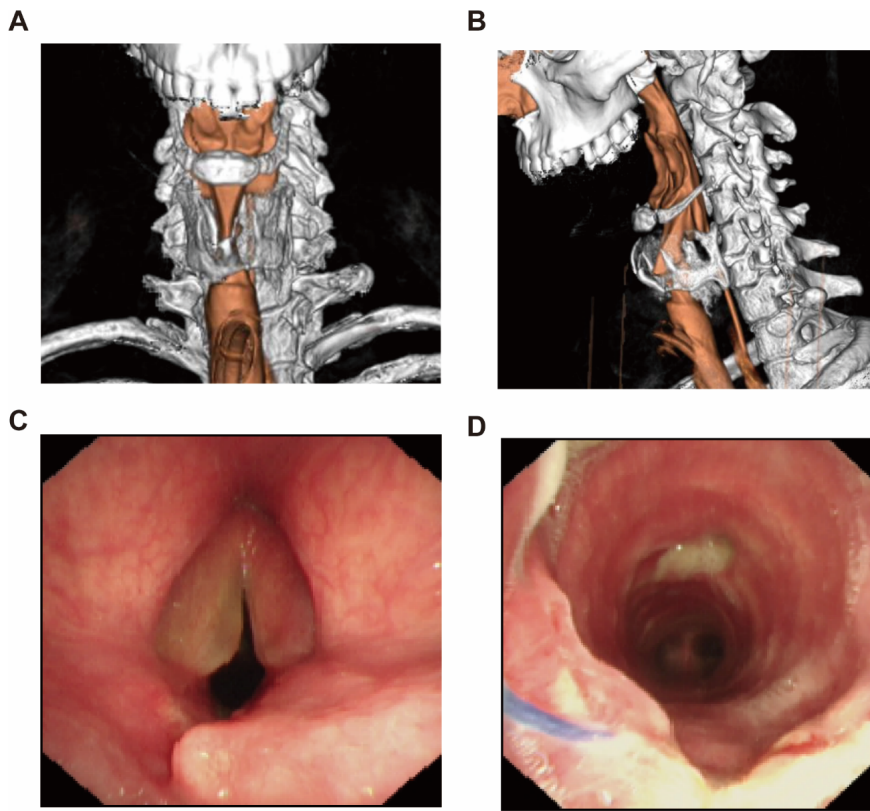


Figure 4. Postoperative Trachea. (A, B: 3D reconstruction of the postoperative trachea. C, D: Visualization of the postoperative tracheal cavity through fiberoptic bronchoscopy.)