# Microsurgical reconstruction of combined tracheal and total esophageal defects

Shadi Ghali, MD,[a] Edward I. Chang, MD,[a] David C. Rice, MD,[b] Garrett L. Walsh, MD,[b] and Peirong Yu, MD[a]

**Objective:** Lesions involving both the trachea and the esophagus are often considered inoperable because of the lack of reliable reconstruction. The purpose of this study was to review our experience of combined supercharged jejunal and other flaps for tracheal and esophageal reconstruction.

**Methods:** A retrospective review of 5 consecutive cases with combined tracheal and total esophageal defects was performed. The esophageal defect was reconstructed with a supercharged jejunal flap, and the trachea was reconstructed with a free anterolateral thigh flap or a pedicled muscle flap.

**Results:** Primary diagnosis included tracheostoma recurrence after a total laryngectomy for laryngeal cancer in 2 patients and tracheoesophageal fistula due to esophageal stenting for complications from prior treatment for non-Hodgkin's lymphoma, parathyroid cancer, and esophageal cancer in 3 patients, respectively. Tracheal and esophageal reconstructions were staged in 4 patients, and 1 patient received simultaneous reconstruction. Tracheal necrosis developed in 1 patient with a mediastinal tracheostoma, and the patient eventually died of infection 2 months later. The other 4 patients recovered well and resumed an oral diet.

**Conclusions:** Complex and often life-threatening lesions involving both the trachea and the esophagus are not necessarily inoperable. With careful planning, these combined defects can be safely reconstructed with multiple flaps with good functional outcomes and reasonable survival. (J Thorac Cardiovasc Surg 2015;150:1261-6)

See related commentary on pages 1266-7.

Esophageal reconstruction after an esophagectomy is commonly accomplished with a gastric pull-up procedure.[1] When the stomach is unavailable, previously radiated, or unable to reach the pharynx or when a concomitant total laryngopharyngectomy is performed, a colon interposition or a supercharged jejunal flap is a common alternative.[2-4] Although the supercharged jejunal flap is a complex and lengthy procedure requiring microsurgical skills, it provides a well-vascularized conduit because of the additional set of vascular anastomosis in the neck. When the trachea is involved in the disease in addition to a total esophageal defect due to cancer or tracheoesophageal fistula, reconstruction of both organs can be extremely challenging, if not impossible. With significant loss of the cervical trachea, formation of an anterior mediastinal tracheostomy may provide an immediate airway but carries high morbidity and mortality rates.[5] Defects in the lower trachea near the carina due to a tracheoesophageal fistula can be life-threatening and difficult to repair. The goals of reconstruction for these combined tracheal and esophageal defects are to provide a secure airway, reliable coverage of major blood vessels, and restoration of the continuity of the alimentary tract. When possible, these goals can be achieved in a single stage, but the enormity and complexity of these procedures frequently require staged reconstructions, especially in reestablishing alimentary tract continuity. In this series, we present a single reconstructive surgeon's experience in the reconstruction of combined tracheal, esophageal, and neck defects using a combination of a supercharged jejunum and other pedicled or free flaps.

## PATIENTS AND METHODS

From November 2005 to July 2010, 5 male patients ranging in age from 38 to 76 years presented with lesions involving both the airway and the esophagus requiring resection of the trachea and a total esophagectomy. This retrospective review was approved by the institutional review board of the University of Texas, MD Anderson Cancer Center.

Primary diagnosis included tracheostoma recurrence after a total laryngectomy for laryngeal cancer in 2 patients and tracheoesophageal fistula due to esophageal stenting for complications from prior treatment for non-Hodgkin's lymphoma, parathyroid cancer, and esophageal cancer in 3 patients, respectively. Reconstruction of the esophagus was achieved using a supercharged jejunal flap in all patients. Reconstruction of the tracheal/bronchial defects was accomplished with a free anterolateral thigh (ALT) flap in 2 patients, a pedicled pectoralis major muscle flap in 1 patient, a pedicled latissimus dorsi muscle flap in 1 patient, and an intercostal muscle flap in 1 patient (Table 1).

From the Departments of [a]Plastic Surgery and [b]Thoracic and Cardiovascular Surgery, the University of Texas MD Anderson Cancer Center, Houston, Tex.

Received for publication June 22, 2011; revisions received Sept 8, 2011; accepted for publication Oct 9, 2011; available ahead of print May 18, 2015.

Address for reprints: Peirong Yu, MD, Department of Plastic Surgery, Unit 1488, 1515 Holcombe Blvd, Houston, TX 77030 (E-mail: peirongyu@mdanderson.org).

0022-5223/$36.00



http://dx.doi.org/10.1016/j.jtcvs.2011.10.100

**Abbreviation and Acronym**
ALT = anterolateral thigh

## Surgical Techniques

**Supercharged jejunal flap.** The supercharged jejunal flap was prepared as previously described.[6,7] Briefly, the mesentery of the proximal and mid-jejunum was closely examined using a fiberoptic light to transilluminate the tissues and elucidate the vascular anatomy. The first mesenteric branch beyond the ligament of Treitz was identified and preserved. The second mesenteric branch was dissected down to the level of the superior mesenteric artery and vein, and ultimately divided to serve as the vascular pedicle for supercharging the proximal flap. The third mesenteric branch was ligated and divided. The mesentery between the second and third branches was divided up to the serosal border, allowing the jejunal segment to unfurl (Figure 1). Secondary arcade vessels between the third and fourth mesenteric branches were preserved so that the segment of bowel normally supplied by the third branch could be now supplied by the pedicled fourth branch through intact arcade vessels. The jejunum between the first and second mesentery vessels was divided with a linear cutting stapler.

There are 2 potential routes for transferring the jejunal flap to the neck. For immediate reconstruction, the retrocardiac (orthotopic) route was usually chosen. For delayed reconstruction, the substernal route was chosen and a portion of the manubrium, clavicular head, and first rib was removed to enlarge the thoracic inlet and avoid constriction on the jejunal conduit. The proximal jejunum was then revascularized using microsurgical techniques. Any excess length of jejunal conduit was removed to minimize redundancy in the neck. The proximal 3 to 5 cm of jejunum based on 1 or 2 terminal arcade vessels was exteriorized as a postoperative monitoring segment, which was usually removed at bedside 7 to 10 days after surgery. The esophagojejunal anastomosis was then performed in the neck. Intestinal continuity was reestablished in the abdomen through a gastrojejunal anastomosis using the posterior wall of the stomach or through a Roux-en-Y jejunojejunal anastomosis if a gastrectomy was performed. A feeding jejunostomy tube was routinely placed.

**Anterolateral thigh free flap.** Flap design was outlined on the basis of the ABC perforator system previously described by Yu[8] and Yu and colleagues.[9] Briefly, a straight line (AP line) was drawn connecting the anterior superior iliac spine and the superolateral corner of the patella, and its midpoint was marked. Perforator B was marked at the midpoint and 1.5 cm lateral to the AP line. Perforators A and C were marked 5 cm proximal and distal to perforator B, respectively. A flap width of 8 cm is usually required for circumferential tracheal reconstruction to obtain a luminal diameter of 2.5 cm. The flap design was centered on perforator B. The medial incision was made first, and the dissection was carried out in a subfascial plane until the cutaneous perforators were identified. The intermuscular space between the vastus lateralis and the rectus femoris was then entered, and the descending branch of the lateral circumflex femoris artery was isolated. Various amounts of the vastus lateralis muscle also can be included with the flap. The flap was then harvested by dividing the vascular pedicle. For circumferential tracheal reconstruction, the flap was tubed and 1 end of the tube was anastomosed to the tracheal end. The other end was brought out to the neck or chest and sutured to the surrounding skin to mature the stoma. Vascular anastomosis of the flap pedicle to recipient vessels, usually the transverse cervical vessels or internal thoracic vessels, was then performed under an operating microscope. An endotracheal tube was placed in the tubed flap just beyond the anastomosis with the native trachea under bronchoscopic guide.

*Case 1.* A 76-year-old man with a history of laryngeal squamous cell carcinoma was treated 8 years previously with chemoradiation and neck dissections. Tracheal stenosis developed 4 years later, and a permanent tracheostomy was performed. He then presented to the University of Texas MD Anderson Cancer Center with a moderately differentiated squamous cell carcinoma of the esophagus involving the cervical tracheostomy. Total laryngectomy, tracheal resection, and a total esophagectomy were performed. A mediastinal tracheostoma was created by resecting the manubrium, the medial parts of bilateral first and second ribs, and both clavicular heads and advancing the chest skin to the remaining 5 cm of trachea. An initial attempt for gastric conduit reconstruction was abandoned because of inadequate length. Therefore, the supercharged jejunal flap was used instead via the retrocardiac route with the left internal thoracic vessels as recipient vessels. An omental flap was placed between the trachea and the innominate artery. A right pectoralis major muscle flap was also used to further protect the trachea and major blood vessels (Figure 2). Skin grafts were placed over the muscle flap to address skin shortage in the neck and upper chest. Necrosis of the remaining trachea with exposure of the aorta then developed in the patient. This was debrided down to within 1 cm of the carina. Circumferential tracheal reconstruction was accomplished with a free ALT flap with vascular anastomoses to the right internal thoracic vessels (Figure 3). A Y-type stent was placed through the reconstructed trachea down to the left and right main stem bronchi. Flexible bronchoscopy 2 weeks later confirmed full healing of the flap to the carina, and he was breathing spontaneously. The patient contracted a multidrug-resistant pseudomonas infection resulting in multiorgan failure, and he died 3 weeks later, despite viability of the flap for tracheal reconstruction.

*Case 2.* A 74-year-old man was initially treated 15 years earlier for laryngeal squamous cell carcinoma with radiotherapy alone. One year later, a recurrence developed and he underwent a salvage total laryngectomy. He was disease-free for 14 years and then presented with dysphagia and was found to have a stomal recurrence invading the esophagus. An esophagectomy, pharyngectomy, and tracheal resection were performed. The tracheal defect involved the posterior two thirds of the trachea to within 5 cm of the carina. To avoid a risky mediastinal tracheostomy, reconstruction of both the trachea and the esophagus was planned. A free ALT flap with a portion of the vastus lateralis muscle was used to reconstruct the trachea, and the esophagus was reconstructed with a supercharged jejunal flap (Figure 4). The jejunum was brought to the base of tongue via the native esophageal (retrocardiac) route and revascularized to the left transverse cervical vessels. The anterior neck skin defect was resurfaced with part of the ALT flap (Figure 5), and the vastus lateralis muscle was used to protect the major blood vessels in the neck. A Bivona tube (Smiths Medical, Dublin, Ohio) was initially placed in the reconstructed trachea, which was changed to a soft Larry tube (Platon Medical Ltd, Eastbourne, England) 1 week later. He recovered well and was discharged 2 weeks postoperatively. He then completed adjuvant radiotherapy and continued to do well at 5 months follow-up tolerating a soft diet with supplemental tube feeds.

*Case 3.* A 38-year-old man was initially treated with multiple surgeries and radiotherapy since 1995 at an outside institution for a parathyroid cancer. The tumor eventually invaded the esophagus, which was treated with photodynamic therapy. An esophageal stricture then developed, which was managed with a stent. The stent eventually eroded through to the trachea causing a 4-cm wide tracheoesophageal fistula extending from the thoracic inlet to 2 cm above the carina with life-threatening pulmonary complications, including cardiopulmonary arrest. At the time of presentation to our hospital, his vocal cords were nonfunctional. A 2-stage surgery was planned. During the first stage, a total laryngectomy was performed, the cervical and upper thoracic esophagus was debrided, and a spit fistula was created in the neck. A pectoralis major muscle flap was raised from the left chest and split into 3 segments. The medial segment was used to protect the innominate artery. The middle segment was used to repair the posterior tracheal wall over a Bivona tube and obliterate the distal esophageal lumen, which was demucosalized with an Argon beam. The lateral segment was used to obliterate the dead space in the neck above the tracheostoma. The patient recovered well from surgery with complete healing of the tracheal defect. At the second-stage surgery 6 months later, total esophageal reconstruction was performed with a supercharged jejunal flap via a substernal route with revascularization to the transverse cervical vessels. After an unremarkable