Anterior Mediastinal Tracheostomy
Past, Present, and Future

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KEYWORDS

• Anterior mediastinal tracheostomy • Cervical exenteration • Laryngotracheal resection
• Stomal recurrence • Tracheal surgery

KEY POINTS

- Historically, anterior mediastinal tracheostomy (AMT) has been performed first for resection of stomal recurrence after previous laryngectomy for carcinoma and has been associated with high mortality as a result of innominate artery rupture.
- Relocation of the tracheal stump inferior to the innominate artery and construction of the mediastinal stoma using a pectoralis major myocutaneous island flap dramatically reduced the vascular-related mortality.
- When the relocated tracheal stump is less than 5 cm in length, division of the left innominate vein is required. Consequently, the pectoral flap harvesting should be routinely performed on the right side to avoid venous congestion and consecutive flap necrosis.
- Survival analysis from the literature demonstrates the usefulness of AMT for cure of subglottic carcinomas, stomal recurrences, and well-differentiated thyroid carcinomas invading the trachea.

INTRODUCTION

The surgical treatment of malignant lesions involving both the larynx and upper trachea requires a laryngotracheal resection or a division of the retrosternal trachea in the case of stomal recurrence after previous laryngectomy for carcinoma. Additionally, when the tumor involves the upper esophagus, cervicomediastinal exenteration (ie, laryngopharyngo-esophagectomy) completed by reconstruction of the upper digestive tract is required. In all cases, the adequate 15-mm-long tracheal margin[1] requires the division of the retrosternal trachea followed by the establishment of an anterior mediastinal tracheostomy (AMT). Occasionally, AMT should be considered for the treatment of benign conditions, such as stricture of a cervical tracheostoma or repair of large tracheodigestive fistula developed after previous laryngectomy or after laryngopharyngo-esophagectomy for cervical esophageal cancer.[2]

As written by Hermes C. Grillo and Mathisen[3] in 1990, "these operations constitute formidable challenges for the patient and physician."[3]

ANTERIOR MEDIASTINAL TRACHEOSTOMY: HISTORY

The history of AMT started in 1952, when single cases of AMT for stomal recurrence were reported by William P. Kleitsch[4] and George Minor,[5] respectively. In 1959, William R. Waddell and Bradford Cannon[6] reported 4 cases of establishment of a "sternal tracheostomy" after subtotal excision of the trachea, which was accomplished by construction of a skin tube passed through the mediastinum to be anastomosed to the remaining

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trachea.[6] Among these patients, 2 died of massive hemorrhage due to innominate artery erosion. Similar catastrophic outcomes were reported by George A. Sisson and coworkers[7]: of their 5 patients who were operated on, 2 sustained fatal arterial hemorrhage in the postoperative period. This devastating complication resulted from pressure necrosis of the innominate artery due to the trachea,[6] tracheostoma separation caused by tension suture leading to exposure of great vessels (particularly in patients with a prior history of radiation therapy),[7] and persistence of a dead space in the upper mediastinum, a cause of mediastinitis or mediastinal abscess.[6,7] To avoid close contact of the tracheal stump with the innominate artery, Waddell and Cannon[6] proposed the relocation of the trachea inferior to the innominate artery. To solve the issue of mediastinal dead space, Grillo[8] proposed performing a breastplate resection including the manubrium, medial clavicles, and costal cartilages of the first and second ribs on either side. To reduce tension on the tracheocutaneous anastomosis, he constructed the stoma by using a large bipedicled flap of the thoracic skin (thoracic apron flap) elevated from the pectoral fascia and dropped into the mediastinal defect. In 1966, Grillo[8] reported on 2 patients having undergone this procedure with no postoperative severe adverse events. However, in the multicenter series of 21 patients who were operated on with this technique and reported by Jose J. Terz and coworkers[9] in 1980, the mortality rate from vascular rupture was 38%. Having observed subsequent innominate artery erosions, Grillo (in the discussion section of the Orringer article[1]) proposed prevention of this complication by performing elective division of the vessel associated with interposition of a pedicled omental flap to avoid close contact between the tracheal stump and vascular suture. Thanks to these additional measures, no subsequent arterial ruptures were observed in 14 patients who were operated on. Unfortunately, one of these sustained an ischemic stroke as a consequence of the innominate artery division.[3]

Another important contributor to the field was Mark B. Orringer[10] who reported on 44 patients undergoing AMT, 10 as an isolated procedure and 34 following cervical exenteration, mainly for esophageal carcinoma. He emphasized the value of relocation of the remaining tracheal stump inferior to the innominate artery, thus, avoiding prophylactic division. To reconstruct the upper digestive track, he routinely performed a gastric pull-up. However, anastomotic leaks complicated 9 of 31 pharyngogastric anastomoses and patients had severe gastro-pharyngeal reflux both early after the operation and in the midterm/long-term.[10] Finally, Orringer[11] suggested that a colonic interposition was the preferred method to restore digestive continuity in the case of laryngopharyngo-esophagectomy associated with AMT.

Another approach to construct the mediastinal stoma was the use of a pectoralis major myocutaneous island flap, first described by Beak and coworkers[12] and Ariyan,[13] respectively, for head and neck reconstruction. This flap was used by Hugh F. Biller and coworkers[14] in 1980 after resection of peristomial recurrences after previous laryngectomy, with minimal morbidity and no operative mortality. This reliable flap provides bulky muscle to fill the dead space after resection, avoiding the need for epiploplasty; it also creates an interposition between the trachea and the innominate artery. Furthermore, it provides viable skin coverage, avoiding stomal separation or skin necrosis.

Finally, from the 1980s onward, this technique has been widely used in the setting of AMT reconstruction and has emerged as the gold standard in the construction of the mediastinal stoma.[15–27]

TECHNIQUE

According to the magnitude of the operation, candidates for AMT should have good general

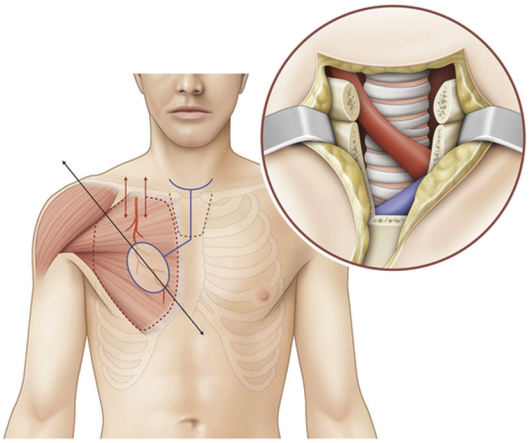

Fig. 1. The cervical and median incision, while the oval skin paddle (*blue oval*) of the flap is outlined along its vascular axis that follows a line drawn from the shoulder tip to the xyphoid process (*black line*). An additional oblique incision toward the skin paddle is performed to achieve the harvesting of the pectoralis major muscle (the different skin incisions are depicted in *blue*). *Dotted line in brown* delineates the detachment of the pectoralis major, sparing the acromiothoracic pedicle of the muscle (located between the *double red arrows*).