Operative Techniques in Thoracic and Cardiovascular Surgery

Technique for Managing Tracheo-Innominate Artery Fistula

Gorav Ailawadi, MD

Tracheo-innominate artery fistula (TIF) is an uncommon complication (0.1-1%) following both open and percutaneous tracheostomy.[1-5] TIF is caused by pressure from the tracheostomy tube, cuff, or balloon, causing erosion of the trachea and innominate artery (Fig. 1). Current tracheostomy tube designs employing a gentle curve (compared with rigid tubes with 90° bend) and compliant, low-pressure endotracheal cuffs (compared with high-pressure cuffs) have decreased the incidence of TIF.[1,2] Other factors that have been implicated include a low tracheostomy tube placement, malpositioned cannula tip, excessive neck movement, prior radiation, steroid use, and prolonged intubation. Typically, the injury occurs at the 7th to 9th tracheal ring[1-3]; however, given the variability of the anatomy of the innominate artery relative to the trachea, TIF can occur at higher levels of the trachea. Bleeding within the first 48 hours following insertion is most often due to venous injury to the anterior jugular or inferior thyroid veins. TIF occurs most frequently (72% of cases) within the first 3 weeks postoperatively[1,2,4] but has been reported to occur many months after tracheostomy.[5]

Initial Maneuvers

Roughly 50% of cases have evidence of a herald bleed before massive hemorrhage.[6] Minor bleeding from within or around the tracheostomy tube warrants investigation with flexible and/or rigid bronchoscopy and should be performed in the operating room (OR) if the index of suspicion is high. If massive hemorrhage from the trachea is evident as in 50% of cases, initial goals in the ICU are to (1) control the airway, and (2) tamponade the bleeding while the patient is resuscitated and an OR is prepared. The first maneuver is to compress the TIF by overinflating the tracheal cuff and is successful in 85% of cases (Fig. 2).[4] If unsuccessful and hemorrhage is ongoing, the tracheostomy incision is extended inferiorly and widely and blunt finger dissection of the pretracheal space should be performed below the level of the innominate artery. Manual compression of the innominate artery against the posterior sternum can control the bleeding (Fig. 3). For maintenance of the airway, endotracheal intubation is preferred. Wall suction should be available to remove blood from the oropharynx and trachea to ensure proper tube position. Blood should be sent for cross-match and control of bleeding should be maintained during transport to the OR.

Department of Surgery, University of Virginia, Charlottesville, Virginia.
Address reprint requests to Gorav Ailawadi, MD, PO Box 800679, Charlottesville, VA 22908. E-mail: gorav@virginia.edu

Operating Room Management

Sentinel Bleed

Flexible bronchoscopy can be performed in cases of sentinel bleed to confirm the TIF. If the diagnosis is still in question, a rigid bronchoscopy with ventilation should be performed to maintain the airway and confirm the TIF. The airway is established with an endotracheal tube.

Massive Hemorrhage

In cases where the diagnosis is clear on presentation, expeditious transport to the OR is needed. If the tracheostomy cuff is tamponading the TIF, a 0° rigid bronchoscope is inserted through the glottis. The tracheostomy tube is carefully removed while visualization is maintained through the bronchoscope. If this incites ongoing hemorrhage, the bronchoscope is advanced beyond the TIF and manual compression of the scope against the anterior trachea is used to control the bleeding. Inhalational anesthetic can be used through the bronchoscope. If hemorrhage is not present, an endotracheal tube is inserted below the fistula and the balloon is inflated to prevent bleeding into the distal airway.

A left radial arterial line is used for blood pressure monitoring as the innominate artery will be divided. Large-bore venous access is established and can be most expeditiously performed in the femoral vein or right subclavian vein. Internal jugular venous access will obscure the operative field, while left subclavian access may be rendered ineffective if the innominate vein is ligated.

The approach of median sternotomy versus upper hemisternotomy has been debated. Median sternotomy in the setting of TIF can result in postoperative mediastinitis (up to 40% in one series)[1]; however, it provides the most optimal exposure and is expedient. We prefer full sternotomy because it is unknown if hemisternotomy has a lower incidence of infection. The thymus is divided and innominate vein mobilized and divided if necessary with vascular stapler. Dissection of all the structures may be time-consuming in the setting of a large hematoma in the anterior mediastinum. Once identified, the innominate artery is identified and oc-

1522-2942/09/$-see front matter
doi:10.1053/j.optechstcvs.2009.02.003

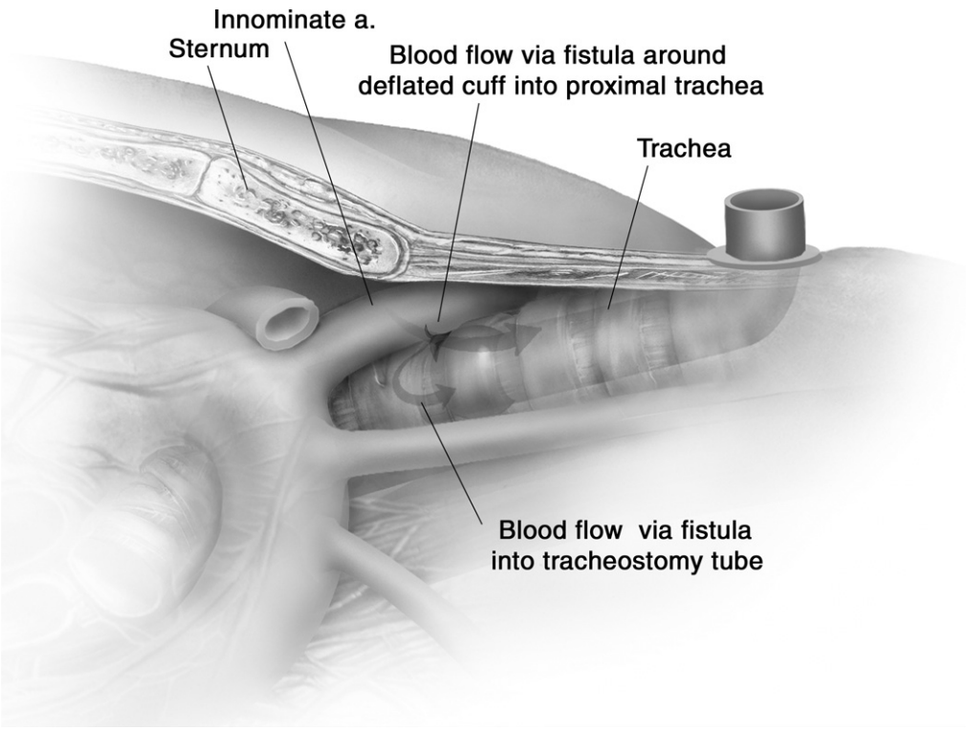

Figure 1 Erosion of the tracheostomy tube or cuff through the trachea into the innominate artery, causing a tracheo-innominate fistula and bleeding into or around the tracheostomy tube. a. = artery.

cluded proximally and distally (Fig. 4). The involved region is resected and the healthy intact innominate artery is oversewn in two layers with running 4-0 Prolene suture (first layer horizontal mattress and second layer over and over) at the proximal and distal ends (Fig. 5). At the proximal extent, it is often necessary to ligate the innominate artery at its origin. The distal ligation should be proximal to the bifurcation of the right subclavian and right common carotid arteries. Vascular staplers can be used to divide the artery expeditiously; however, long-term data on rebleeding at the staple line are unknown. The tracheal injury is debrided to healthy tissue and repaired with interrupted 4-0

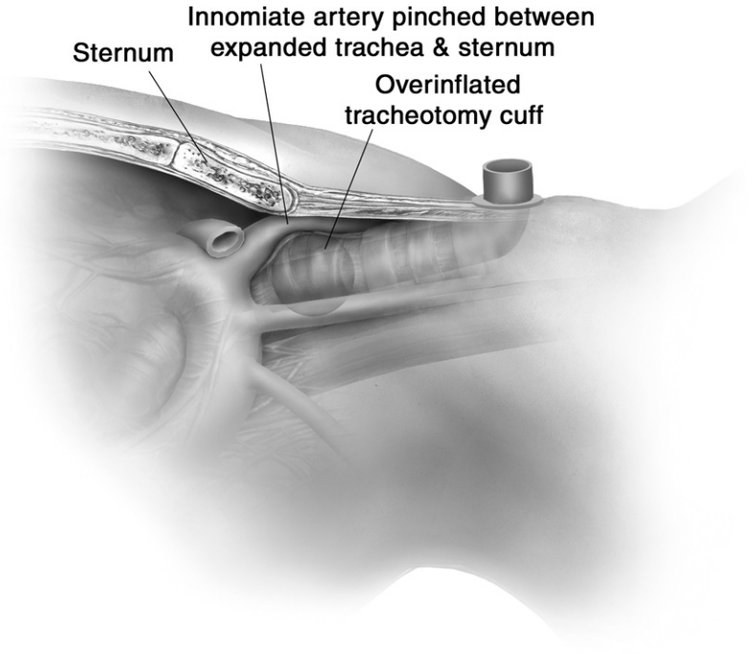

Figure 2 Initial control of the innominate artery should be attempted with overinflation of the tracheal cuff to compress the innominate artery. This is successful in 85% of cases to tamponade the hemorrhage. Care should be taken not to overdistend the cuff further to avoid breaking the cuff.

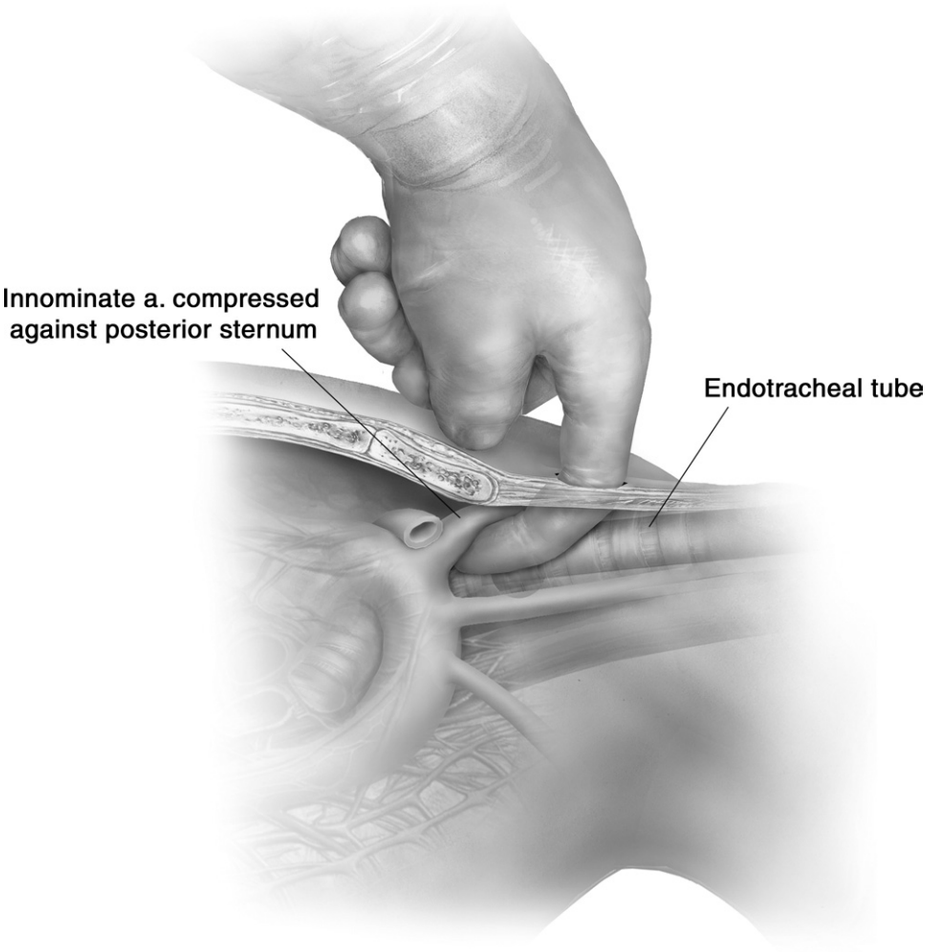

Figure 3 After extending the tracheostomy site widely, blunt finger dissection can create the pretracheal space. Then, palpation of the pulsatile innominate artery will allow identification of its location. Manual compression of the innominate artery against the posterior sternal table can be performed. Rapid endotracheal intubation is necessary to maintain the airway. a. = artery.

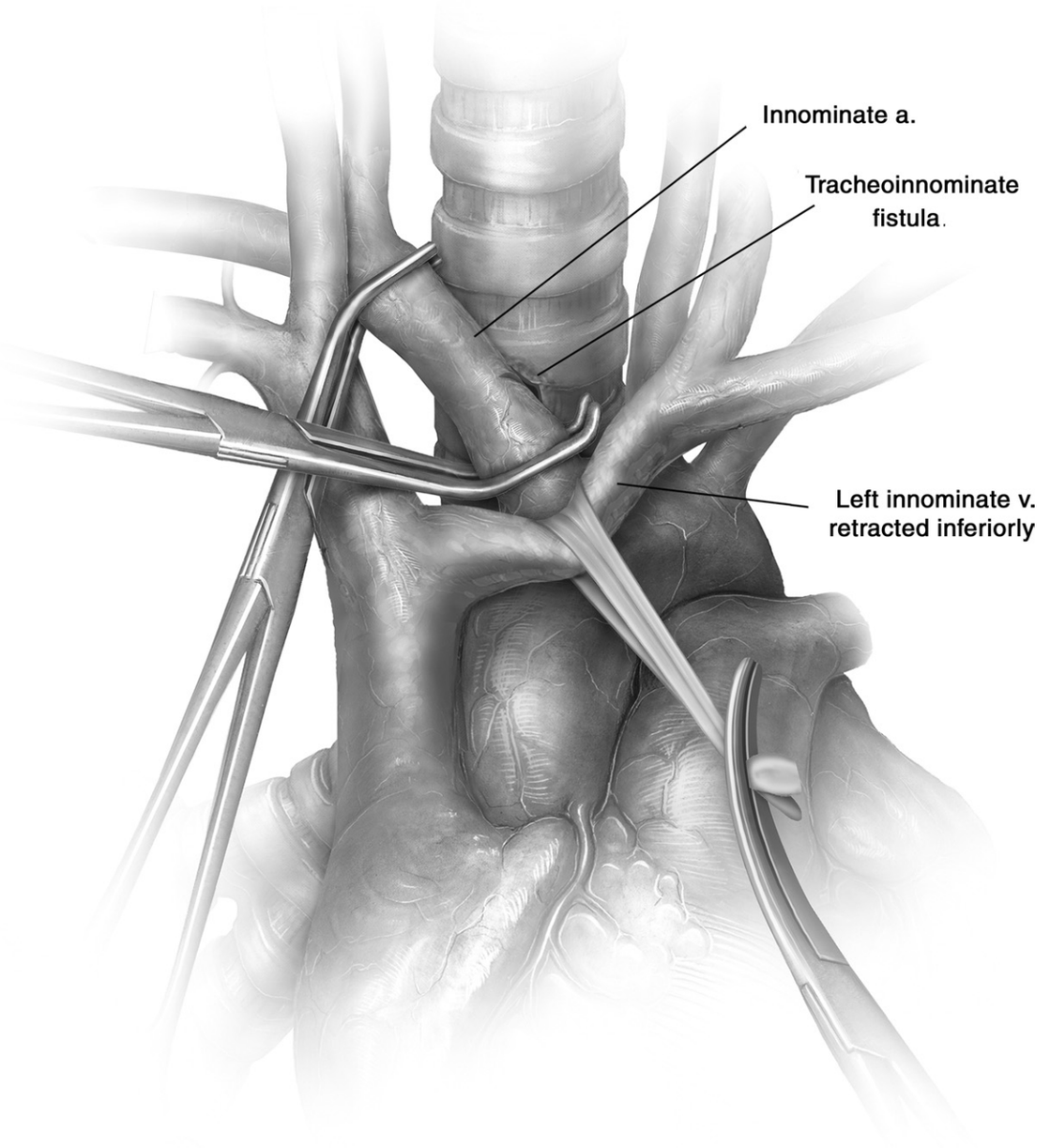

Figure 4 Through a median sternotomy, the thymus is divided and upper part of the pericardium is opened to expose the distal ascending aorta. The innominate vein is encircled and retracted inferiorly; however, it can be divided if necessary. The innominate artery is isolated and controlled proximally and distally. The tracheo-innominate fistula is visualized. a. = artery; v. = vein.

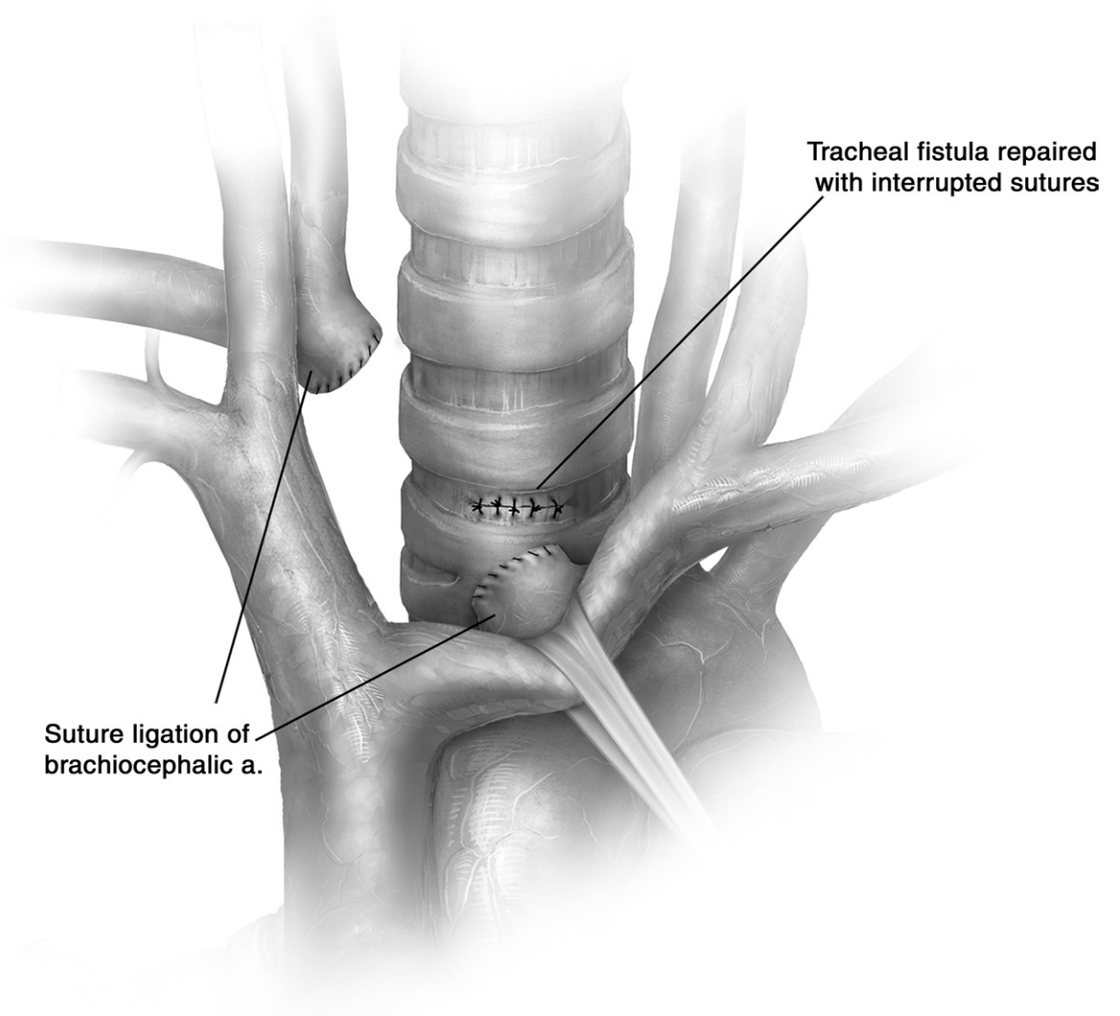

Figure 5 The innominate artery is ligated proximally and distally with two-layer running 4-0 Prolene suture. The tracheal injury is debrided to healthy tissue and repaired primarily with interrupted 4-0 polydioxanone suture. Larger defects require coverage with bovine pericardium. a. = artery.

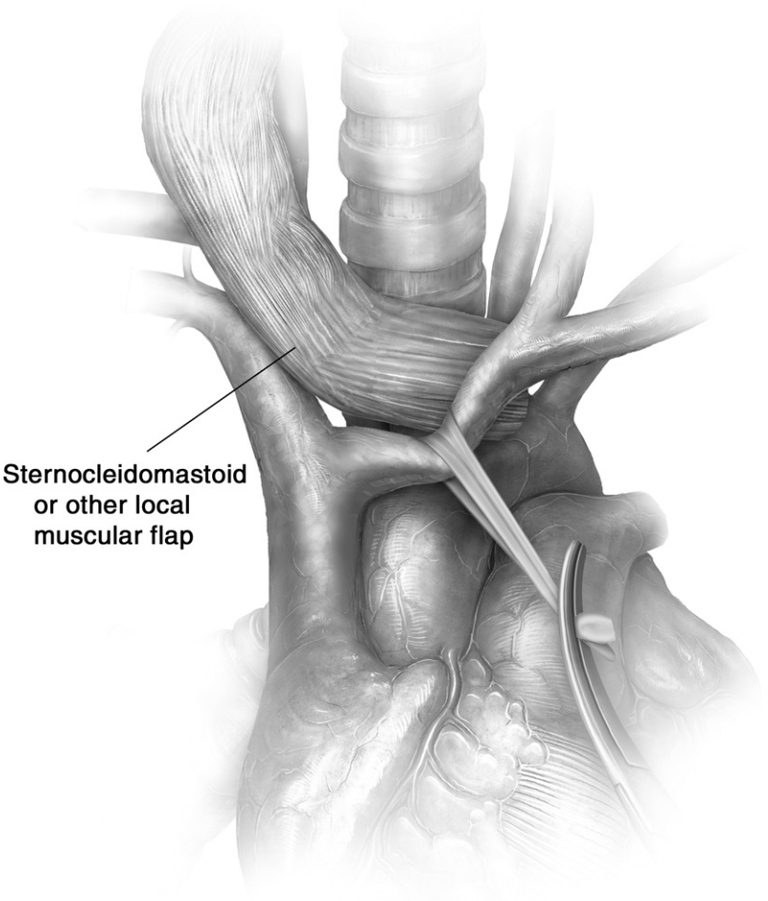

Figure 6 A sternocleidomastoid muscle (or strap muscle) flap is used to buttress tracheal repair and blunt ends of arterial ligation and is placed between the trachea and innominate artery.

Figure 7 Interposition graft (jugular or saphenous vein) is placed with 5-0 Prolene to maintain flow to the right carotid and subclavian arteries but increases the risk of recurrent bleeding/infection. A muscle flap is placed between the trachea and innominate artery reconstruction.

polydioxanone suture and buttressed with a muscle flap using the sternocleidomastoid or strap muscles (Fig. 6). An alternative is to use thymus to buttress and separate the trachea and artery. The incidence of stroke is low after innominate artery ligation.[1,6] Following sternal closure, bronchoscopy should be performed to remove all blood from the distal airways.

The alternate approach of reconstructing the innominate artery is controversial due to a high risk of recurrent bleeding (60-86%).[5,6] However, this approach should be considered in the setting of severe left carotid artery stenosis/occlusion or patent right internal mammary artery bypass graft. Primary repair is not recommended as often tension is placed on the repair, increasing the risk of recurrent bleed. After resection of the innominate artery, an interposition vein graft (saphenous or jugular vein) is created by using running 5-0 Prolene suture (Fig. 7). Repair of the tracheal injury is performed as described above. A muscle flap is placed between the innominate artery and trachea.

Recent reports have described successful percutaneous stent graft insertion to control the acute hemorrhage.[7] At a later time, debridement and reconstruction of the innominate artery can be performed depending on the status of the patient.

Recovery and Results

The airway should be maintained with an 8-mm endotracheal tube to allow for repeat bronchoscopy if needed and the balloon should be seated below the site of tracheal repair. The strap muscles should be closed if possible but the skin at the tracheostomy site should be left open for dressing changes. The blood pressure should be controlled, keeping the systolic blood pressure $<$120 to 140 with beta-blockade to decrease the risk of stump blowout and recurrent hemorrhage. Due to these patients' comorbidities, often survival rates are 25 to 50% with this injury.[1,6] Even with successful surgery, long-term survival is poor with fewer than 25% still alive at 1 year.[1,3,6]

References

1. Allan JS, Wright CD: Tracheoinnominate fistula: Diagnosis and management. Chest Surg Clin North Am 13:331-341, 2003
2. Cooper JD, Grillo HC: The evolution of tracheal injury due to ventilatory assistance through cuffed tubes: A pathologic study. Ann Surg 169:334-338, 1969
3. Grant CA, Dempsey G, Harrison J, et al: Tracheo-innominate artery fistula after percutaneous tracheostomy: Three case reports and a clinical review. Br J Anaesth 2006;96:127-131 [Epub 2005]
4. Jones JW, Reynolds M, Hewitt RL, et al: Tracheo-innominate artery erosion: Successful surgical management of a devastating complication. Ann Surg 184:194-204, 1976
5. Gellman JJ, Aro M, Weiss SM: Tracheo-innominate artery fistula. J Am Coll Surg 179:626-634, 1994
6. Grillo CG: Tacheal fistula to barchiocephalic artery, in Grillo CG (ed): Surgery of the Trachea and Bronchi. Hamilton, Ontario, BC Decker, Ch. 13, 2003, pp 1-9
7. Sorial E, Valentino J, Given CA, et al: The emergency use of endografts in the carotid circulation to control hemorrhage in potentially contaminated fields. J Vasc Surg 46:792-798, 2007