Tracheal Injuries and Fistulas

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Thomas Schneider

Introduction

Tracheal and tracheobronchial injuries due to trauma or iatrogenic etiology are rare but potentially lethal events. Traumatic injuries result from penetrating trauma (in 75–80 % of cervical tracheal injuries), but most are associated with blunt thoracic trauma: high-energy impact or rapid hyperextension. About 80 % of blunt tracheal ruptures occur within 2.5 cm of the carina, resulting in a circular disruption. The most common reasons for iatrogenic tracheal lacerations are single-lumen intubations under emergency conditions and dilational tracheostomies. The risk of tracheal lacerations seems to increase with difficult or emergency intubations, multiple vigorous attempts by an inexperienced anesthesiologist, or the inappropriate use of a stylet. Overweight patients are susceptible to an overestimation of the size of their endobronchial anatomy and hence the selection of oversized endotracheal tubes. Iatrogenic lacerations typically result in a longitudinal tear in the membranous part of the trachea that may reach down into the main bronchus. Typical symptoms are dyspnea, hemoptysis, (massive) soft tissue or mediastinal emphysema, and pneumothorax. However, the diagnosis may be delayed because superficial tracheobronchial injuries are not always readily apparent. Tracheobronchoscopy will reveal the location and extent of the laceration. Radiographic findings may include pneumothorax, pneumomediastinum, and fractures of the bony thorax (Schneider et al. 2007).

Free rupture of a proximal bronchus into the pleural space is an absolute indication for surgery and should be repaired as soon as the patient is hemodynamically stable and more life-threatening injuries have been excluded. The repair of mainstem bronchial transections or circular tracheal disruptions typically is achieved by end-to-end anastomosis. In addition, pericardium or a pericardial fat pad should be wrapped around the repair to minimize pleural contamination and prevent bronchovascular fistula or mediastinitis (Massard et al. 1996).

The classic surgical approach to repair lacerations of the thoracic trachea is right-sided posterolateral thoracotomy. In longitudinal lacerations of the posterior wall, however, the cervical transtracheal approach must be considered because of minor surgical trauma. Tracheal lacerations reaching down to the tracheal bifurcation may be sewed with running sutures by this approach; lacerations extending to the mainstem bronchus may require an additional thoracotomy (Angelillo-Mackinlay et al. 1995).

Tracheoesophageal fistulas (TEFs) may be acquired or congenital. Acquired TEFs are classified as either benign or malignant. A malignant TEF usually represents end-stage disease; median survival after diagnosis is only a few weeks. Palliation may be obtained best by stenting of the aerodigestive tract. Endotracheal cuff overinflation in long-term intubation is the most common cause of benign TEF; associated factors include excessive motion of the tube, hypotension, infections, steroids, and diabetes. Inflammatory diseases, posttraumatic fistula, and fistulation due to chemical burn injury of the esophagus are rare causes of benign TEF (Grillo et al. 1976).

Once the diagnosis of TEF is made, prompt intervention is indicated to prevent further soilage of the airway. Surgical intervention for benign TEF includes resection of the fistulous tract and closure of the membranous tracheal defect, as well as repair of the esophagus. In patients whose trachea is stenotic at the site of the fistula, a tracheal resection and anastomosis with primary esophageal closure should be performed. Healthy tissue, such as a muscle flap or omentum, between the trachea and esophagus may be interposed to reduce the risk of recurrence (Macchiarini et al. 2000).

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A cervical fistula that requires no tracheal resection may be approached from the side along the sternocleidomastoid muscle. If a tracheal resection is necessary, an anterior approach using a U-shaped cervical incision, eventually including the tracheostomy stoma, is useful. Low intrathoracic lesions near the carina or in either mainstem bronchus may be approached through a right-sided posterolateral thoracotomy. The interposition of omentum or a diaphragmatic muscle flap is appropriate in simple resection of the fistula, as well as in bronchoplastic resection (Macchiarini et al. 2000).

Figure 6.1

(**a**) For the cervical approach, the patient commonly is intubated with a single-lumen tube under general anesthesia and is placed in a supine position with the neck hyperextended. A 4- to 5-cm wide transverse incision is made above the sternal notch; the access may be enlarged by a T-shaped extension into the sternal notch. The skin, subcutaneous fat, and platysma are elevated as one layer, and the flap is raised to the level of the suprahyoid region. The infrahyoid muscles are divided along the midline down to the sternum, and the pretracheal fascia is opened longitudinally. The trachea is dissected digitally down to the carinal level. If the innominate artery is within the surgical access, it has to be dissected and moved away from the anterior tracheal wall. (**b**) The anterior wall of the trachea is incised at a length of 3–4 cm longitudinally in the midline at the level of the laceration. The exact level can be determined intraoperatively under endoscopic control after withdrawal of the tracheal tube. If ventilation cannot be interrupted during the incision of the anterior tracheal wall, the tracheal tube must be placed with the cuff distal to the laceration to avoid carving into the tracheal cuff

Figure 6.1

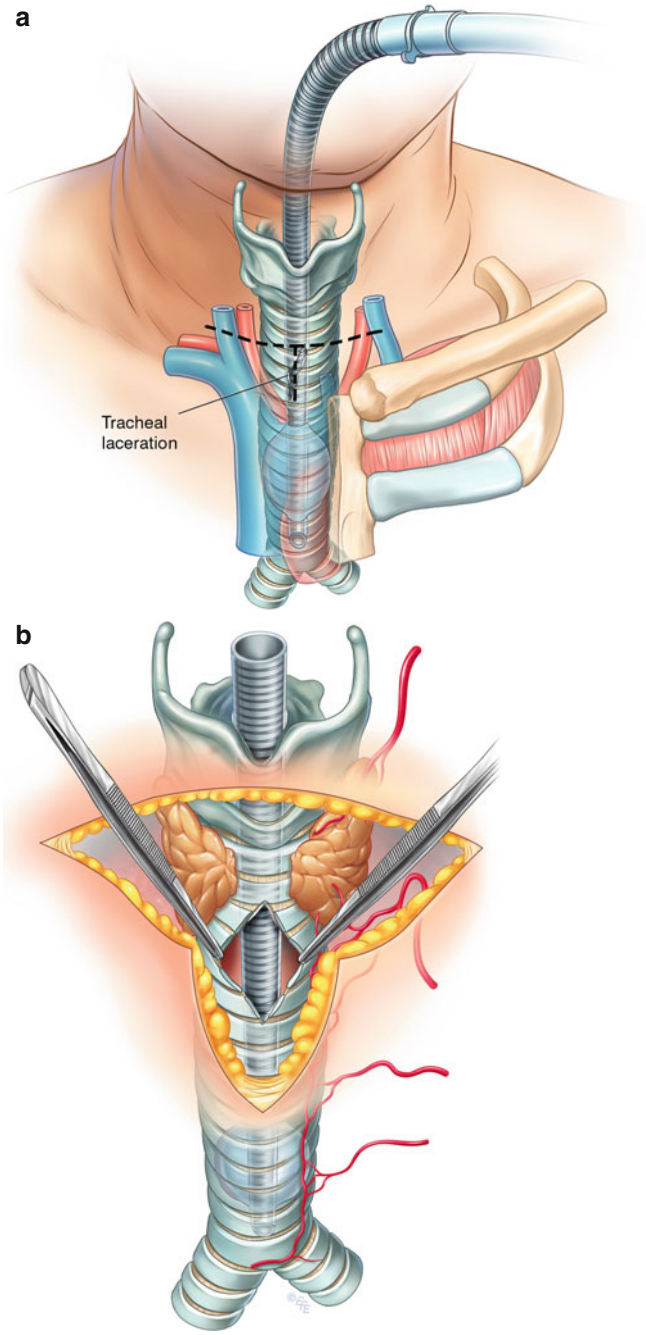


Figure 6.2

After incision of the anterior tracheal wall, the tracheal tube is withdrawn to enable access to the posterior tracheal wall; a Jet tube for high-frequency jet ventilation is introduced via the single-lumen tube, crossing the injured part of the trachea, and is placed into the distal part of the trachea. If the laceration reaches down to the tracheal bifurcation, the Jet tube is placed into a mainstem bronchus, or two Jet tubes may be placed in each mainstem bronchus. The Jet tube should be retained with forceps during the whole procedure. Subsequently, the tracheal laceration, particularly its depth, is examined to exclude accompanying injuries, such as those to the esophagus

Figure 6.2

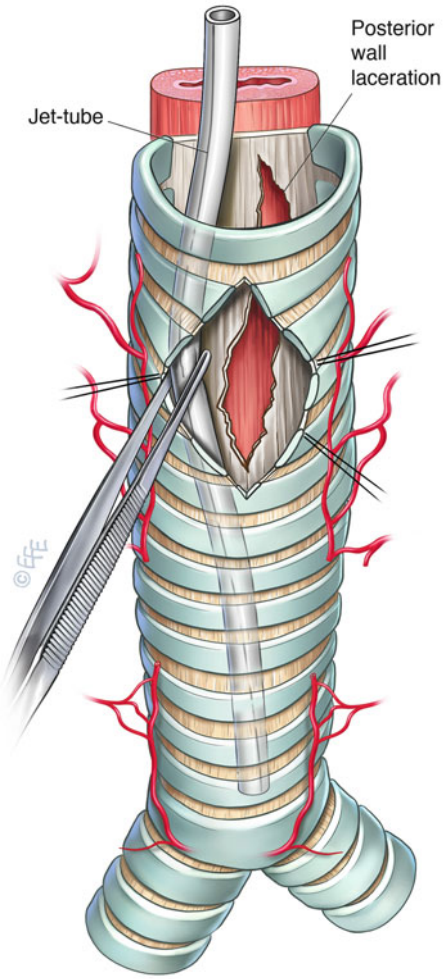


Figure 6.3

The tracheal laceration may be sewed with a running (4-0 resorbable monofilament) suture beginning at the distal bottom and running upward to the upper ending. If the laceration reaches down to the tracheal bifurcation, video-assisted thoracic surgical instruments and an additional light source may be helpful. The suture should include all layers of the posterior tracheal wall and render the margins of the laceration airproof. If there is an additional perforation of the anterior esophageal wall, it must be repaired separately with a running suture. A pedicular muscle flap should be interposed between the tracheal and esophageal sutures. During sewing of the trachea, the Jet tube is retained in the correct position in the distal trachea or mainstem bronchus to ensure sufficient intraoperative oxygenation of the patient

Figure 6.3

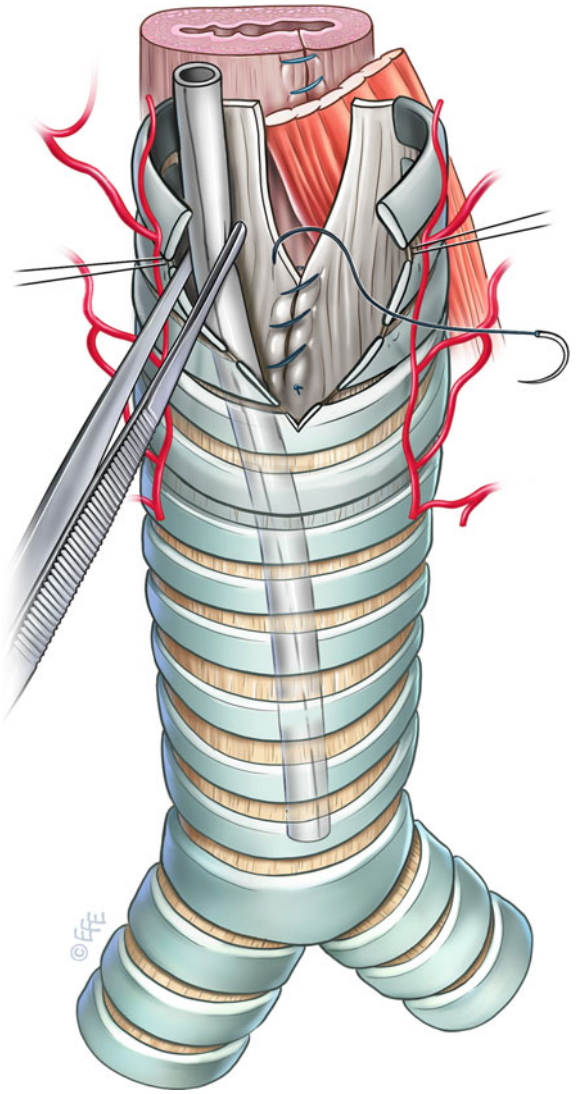


Figure 6.4

After suturing of the posterior tracheal wall is complete, the single-lumen tube is placed again with the cuff positioned distal to the laceration. The incision of the anterior tracheal wall is closed with interrupted sutures. The stitches are passed through both the intercartilaginous membranes and the cartilaginous rings—the edges of the suture should be joined together and should not overlap. The wound is closed in layers; a Redon drainage tube may be placed subcutaneously

Figure 6.4

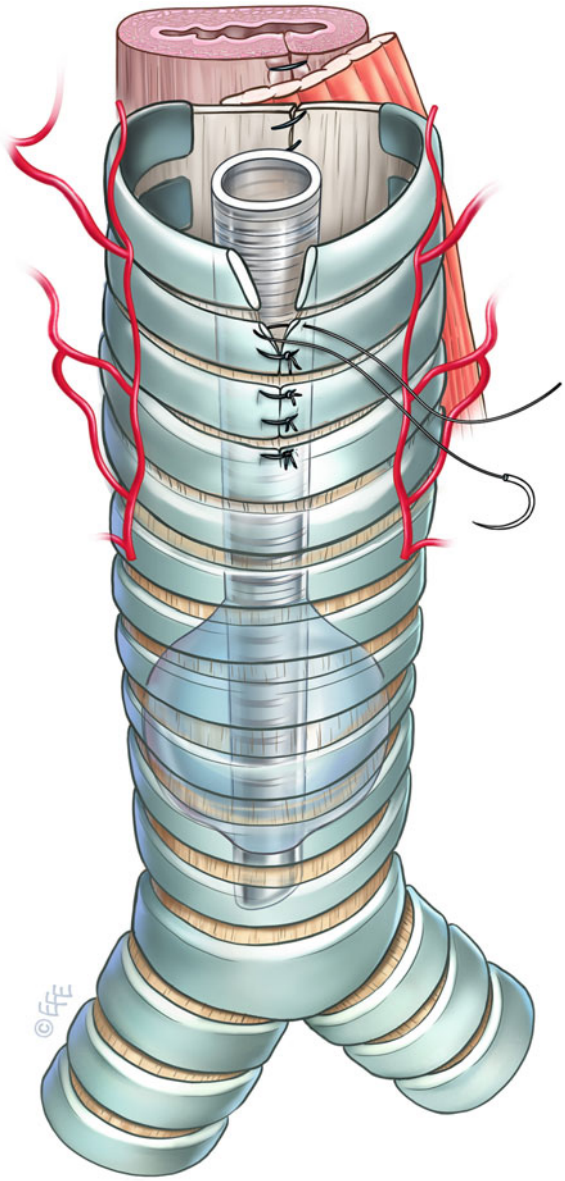


Figure 6.5

The surgical approach to a cervical fistula requiring tracheal resection is an anterior U-shaped cervical incision including an eventual tracheostomy stoma; for upper thoracic fistulae, the access can be enlarged by a T-shaped extension to the sternal notch. The skin, subcutaneous fat, and platysma are elevated as one layer, and the flap is raised to the level of the suprahyoid region. The sternohyoid muscles are divided in the midline, and the thyroid isthmus is divided and ligated to expose the anterior surface of the trachea. The trachea is freed circumferentially only above and below the site of the fistula, and care must be taken to maintain the dissection as close to the outer tracheal surface as possible to avoid injury to both recurrent laryngeal nerves and to preserve the lateral blood supply to the uninvolved parts of the trachea. The trachea then is divided in a healthy plane above and below the stenosis. Once the distal airway is divided, ventilation is obtained by a catheter for high-frequency jet ventilation into the distal tracheal airway; the catheter is introduced via the single-lumen tube, which has been withdrawn by the anesthetist

Figure 6.5

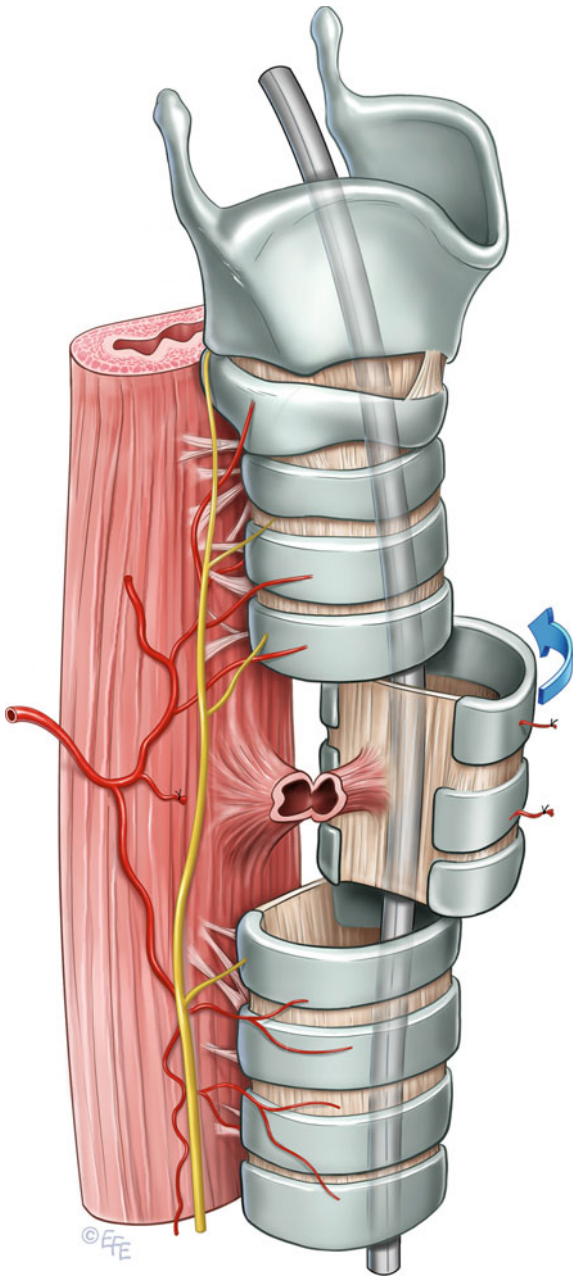
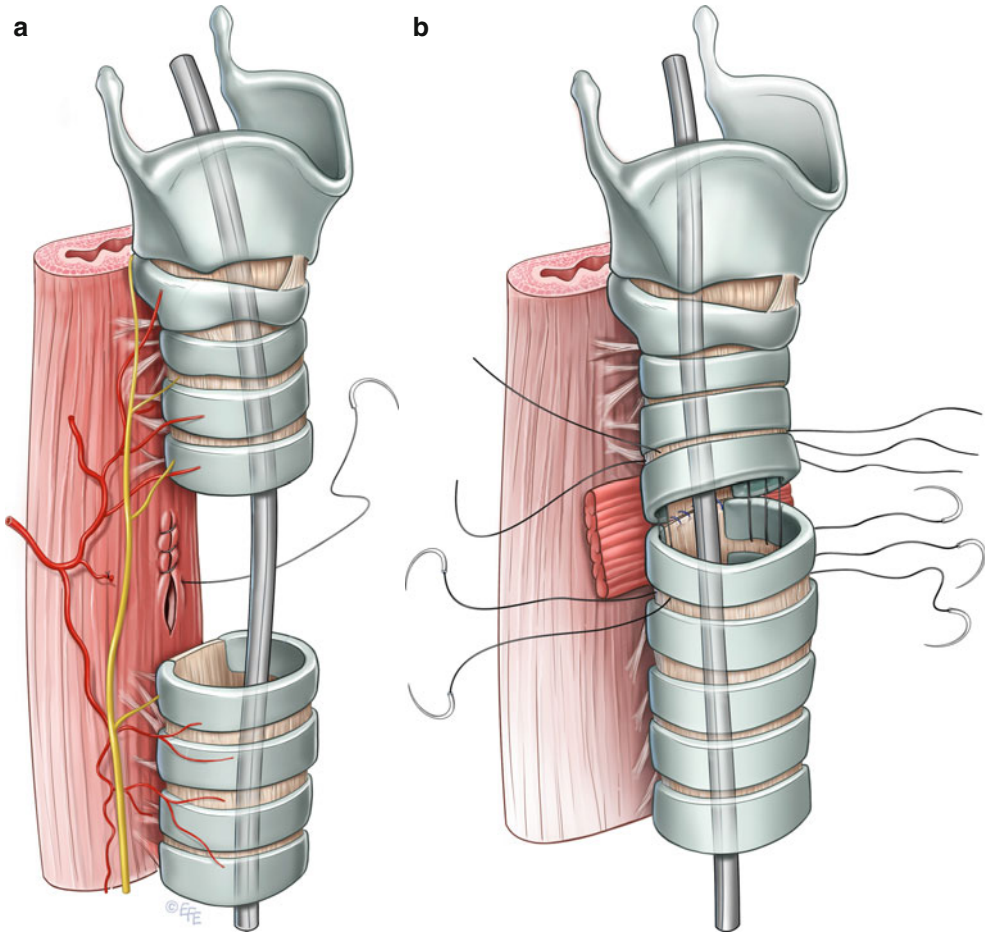


Figure 6.6

(**a**, **b**) Opening of the airway completely exposes the esophageal defect. The edges of the esophageal defect are débrided, and a two-layer closure is made. Subsequently, the trachea is reconstructed, the posterior wall via a continuous 4-0 polydioxanone (PDS) suture and the cartilaginous part by interrupted 3-0 PDS sutures. The wound is then filled with sterile saline to test the anastomosis for air leakage. A muscle flap may be interposed between the trachea and esophagus to prevent recurrent fistulation if the sutures are in close contact. The anterior part of the tracheal anastomosis may be covered with the thyroid isthmus and by approaching the linea alba cervicalis. If the anastomosis is located behind the innominate artery, another muscle flap may be interposed between the suture line and the artery

Figure 6.6



Conclusion

In stable patients with uncomplicated tracheal lacerations, nonsurgical therapy should be considered if all the following criteria for nonoperative management are met:

1. Uncomplicated mechanical ventilation without any loss of tidal volume *and*
2. A laceration sufficiently covered by the esophagus *and*
3. Only mild soft tissue emphysema with no progress during ventilation

The criteria for surgical treatment are:

1. Insufficient mechanical ventilation *or*
2. An open perforation into the pleural cavity *or*
3. Progressive subcutaneous or mediastinal emphysema

Pneumothorax per se is not an indication for surgery if the patient can be ventilated sufficiently (Schneider et al. 2007). In stable patients with a delayed (24 h) diagnosis of the tracheobronchial injury, conservative treatment is particularly appropriate; the delay of the diagnosis itself qualifies patients for conservative management because of a confirmed stable clinical course (Gomez-Caro et al. 2005). However, low tidal volumes and positive end-expiratory pressures are mandatory with conservative management because positive airway pressures may exacerbate the condition. If surgical treatment is necessary, the cervical approach is compelling because of the low additional trauma. The tracheal laceration and the treatment modalities have only little impact on the clinical course of underlying disease or additional injuries; the trachea mostly shows good local healing. Endoscopy is performed to confirm local healing and to detect tracheobronchial stenosis on further follow-up. Endoscopic stenting in iatrogenic or non-iatrogenic tracheal lacerations is not recommended. For extended distal ruptures involving the tracheal bifurcation, a stent may not be able to cover the laceration completely; conversely, the expansion of a stent might result in dilation of the rupture, impairing the local situation (Massard et al. 1996 and Schneider et al. 2007).

In benign tracheoesophageal fistulas, surgical closure should be attempted in each instance because spontaneous closure is very rare. Most TEFs are diagnosed while patients are still under assisted ventilation; however, repair should be delayed until the patient is fully stabilized and weaned from assisted ventilation. Nasogastric tubes should be removed because, along with tracheostomy tubes, they contribute to the continuous pressure necrosis of the closely opposed tracheoesophageal walls. Gastric decompression to avoid gastroesophageal reflux may be achieved by a draining gastrostomy; nutrition can be maintained by jejunostomy. Pulmonary complications can be avoided and the nutritional status will be improved under these precautions. Once the patient is weaned, surgical repair may be performed. The anterior approach has several advantages. It does not require extensive tracheal or esophageal devascularization, and the recurrent laryngeal nerves are less likely to be injured. The operative field has a large surface, and complete exposure of the entire tracheoesophageal damage, including intrathoracic tracheal and esophageal defects otherwise unreachable from the lateral approach, is achievable. The surgical approach to a cervical fistula requiring no tracheal resection may be from the side along the sternocleidomastoid muscle; however, we prefer the anterior approach for better anatomic exposure.

In tracheal resection, the esophageal and tracheal anastomotic lines mostly are not in contact with each other because of the reduced tracheal but unchanged esophageal length. Therefore, muscle interpositions, with their risk of late membranous tracheal wall compression or stenosis, are not mandatory (Grillo et al. 1976 and Macchiarini et al. 2000).

References

Angelillo-Mackinlay T (1995) Transcervical repair of distal membranous tracheal laceration. Ann Thorac Surg 59:531–532

Gomez-Caro Andres A, Moradiellos Diez FJ, Ausin Herrero P, Diaz-Hellin Gude V, Larru Cabrero E, de Miguel PE, Martin De Nicolas JL (2005) Successful conservative management in iatrogenic tracheobronchial injury. Ann Thorac Surg 79:1872–1878

Grillo HC, Moncure AC, McEnany MT (1976) Repair of inflammatory tracheoesophageal fistula. Ann Thorac Surg 22:112–119

Macchiarini P, Verhoye JP, Chapelier A, Fadel E, Dartevelle P (2000) Evaluation and outcome of different surgical techniques for postintubation tracheoesophageal fistulas. J Thorac Cardiovasc Surg 119:268–276

Massard G, Rouge C, Dabbagh A, Kessler R, Hentz JG, Roeslin N, Wihlm JM, Morand G (1996) Tracheobronchial lacerations after intubation and tracheostomy. Ann Thorac Surg 61:1483–1487

Schneider T, Storz K, Dienemann H, Hoffmann H (2007) Management of iatrogenic tracheobronchial injuries: a retrospective analysis of 29 cases. Ann Thorac Surg 83:1960–1964