

Tracheal injury during oesophagectomy – incidence, treatment and outcome

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ABSTRACT

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Background and aim: Iatrogenic tracheal injuries are uncommon, potentially lethal and associated with significant morbidity. In this report we analyze the incidence of iatrogenic tracheobronchial injuries sustained during oesophagectomies and the results and outcome of repair using a pedicled intercostal muscle flap.

Methods: A retrospective analysis was done on all patients who underwent an oesophagectomy between June 2000 and May 2011. Data was collected from an electronic database and the medical records of patients, maintained at our hospital.

Results: One hundred and fourteen patient records were analyzed. There were 85 male and 29 female patients. Their mean age was 47 years (range 16 to 86 years). Forty two (36%) underwent a transhiatal oesophagectomy, 34(31%) Mckeown's oesophagectomy, 35(31%) Ivor Lewis oesophagectomy and 3(2%) thoracoscopy assisted oesophagectomy. Of the 114 oesophagectomies, 86 (75%) were performed for malignant and 28 (25%) for benign pathologies (benign tumors and corrosive strictures of the esophagus). In our study, four patients sustained injury to the tracheobronchial tree during oesophagectomy. In patients who sustained injury during a transhiatal dissection a right anterolateral thoracotomy was made. All injuries in the thoracic tracheobronchial tree were repaired primarily and reinforced with an intercostal muscle flap. In the patient with injury to the cervical part of the trachea, repair was done primarily and reinforced with cyanoacrylate glue. All patients who sustained injury had malignancy and three patients had received neoadjuvant chemoradiotherapy. Two patients sustained injury during transhiatal oesophagectomy and two during a Mckeown's oesophagectomy. There was one mortality which was due to ventilator associated pneumonia and related complications. The remaining three were alive with no evidence of repair breakdown.

Conclusions: Iatrogenic tracheal injuries are uncommon complications but associated with significant morbidity. Preoperative chemoradiotherapy and malignancy are risk factors for iatrogenic tracheal injuries. Reinforcement of the suture line with a muscle flap is an effective technique of repair. Prompt ontable identification and adequate surgical treatment is necessary for a good outcome.

KEYWORDS: Oesophagus, surgery, trachea, injuries, oesophagectomy, adverse effects, iatrogenic disease

Introduction

Tracheo bronchial injuries (TBI) are most commonly seen following penetrating or blunt chest trauma. Winslow made

the first published report of a bronchial injury in 1871.¹ The first medical report of a tracheobronchial injury was by Seuvre

in 1873. Nissen was the first to describe in 1931 the successful removal of a lung in a patient with bronchial stenosis due to an injury.² In 1945, Sanger successfully repaired a ruptured bronchus.³ The first report of an iatrogenic tracheal injury was by Goldstein in 1949.⁴

Iatrogenic tracheal injuries are uncommon, but potentially lethal and associated with significant morbidity.⁵ Iatrogenic tracheal injuries are known to occur following endotracheal intubations, mediastinoscopy, percutaneous tracheostomy and mediastinal surgical interventions.⁶⁻⁹ Unlike TBI that results from blunt trauma, most iatrogenic injuries to the airway involve longitudinal tears to the back of the trachea or tears on the side that pull the membranous part of the trachea away from the cartilage.¹⁰ Early diagnosis is important to prevent complications, which include narrowing of the airway, respiratory infections and damage to the lung tissue.

During oesophagectomy the close proximity of the trachea to oesophagus makes it vulnerable to injury. The outcome depends on prompt recognition of the injury intraoperatively and adequate repair. Various methods for repairing tracheal injuries have been described. In this report we analyze the incidence of iatrogenic tracheobronchial injuries (TBI) sustained during oesophagectomies (transthoracic and transhiatal). The associated morbidity and mortality is reported along with the results and outcome of repair using a pedicled intercostal muscle flap.

Methods

A retrospective analysis was done on all patients who underwent an oesophagectomy between June 2000 and May 2011, at the Christian Medical College Hospital, Vellore. Data was collected from an electronic database, and medical records of the patients, maintained at our hospital. Patient demographics, risk factors, preoperative staging, histological diagnosis, operations performed and postoperative complications were documented. Ethical clearance was obtained for this work from the institutional review board.

All patients underwent detailed clinical examination and endoscopy for diagnosis. This was followed by a CT scan for staging patients with cancer and a barium study for patients with corrosive strictures. Tracheal involvement was excluded with a flexible bronchoscopy and bronchio alveolar lavage for all patients with upper or middle third malignancy. A detailed cardiac and pulmonary evaluation was done to assess the physiological status of the patients. For patients with T1 lesions

with no evidence of lymph node or distant metastasis, surgery was done upfront. Patients with lesions T2 or greater, or patients with nodal disease and no evidence of metastasis, neoadjuvant chemoradiation was administered. After completion of the neoadjuvant chemoradiation, patients were restaged prior to subsequent surgery. In our series, the surgical approach was planned based on the location of the tumor, the type of tumor (adenocarcinoma or squamous), the physiological status and nodal status of the patient. We used a transthoracic approach when dealing with a tumor at or above the carina and the transhiatal approach for tumors well below the carina.

In our study, four patients sustained injury to the tracheobronchial tree during oesophagectomy. All injuries recognized during the operation were repaired immediately. In patients who sustained injury during a transhiatal dissection, conversion to a right anterolateral thoracotomy was made, after insertion of a double lumen endotracheal tube. After the injury was identified, primary suture repair was performed with interrupted 4.0 polypropylene sutures (**Figure 1**). An intercostal muscle flap was raised without compromising the neurovascular bundle and not including the periosteum, from a convenient intercostal space. The flap was then used to buttress the repair (**Figure 2**). Care was taken not to take suture bites through the endotracheal tube. At the end of the repair, the endotracheal tube was withdrawn a little to ensure that there was no inadvertent suturing of the airway tube. Filling the hemithorax

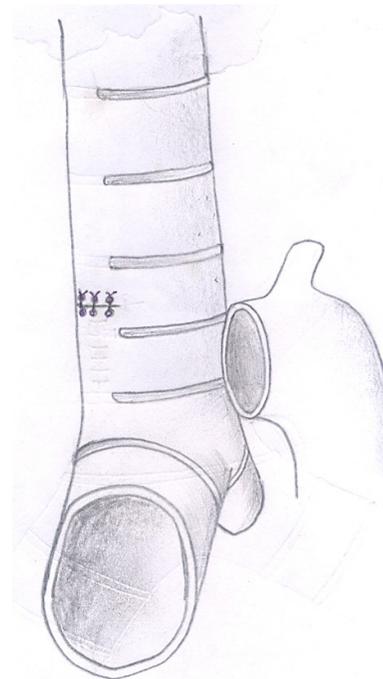


Figure 1: Diagrammatic representation of the primary repair of tracheal injury

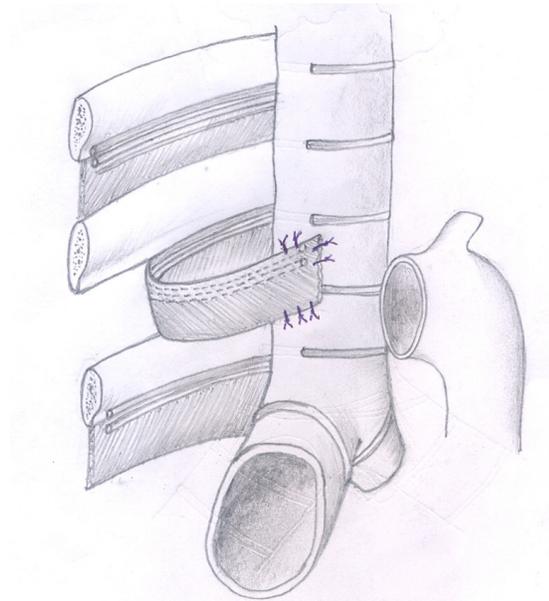


Figure 2: Diagrammatic representation of the intercostal muscle flap used to reinforce the primary repair

with saline and insufflating with air assessed the integrity of the repair. The thoracotomy was closed with two chest drains and the patients were ventilated during the immediate postoperative period. In the patient with injury to the cervical part of the trachea, repair was done primarily and reinforced with cyanoacrylate glue.

Results

One hundred and fourteen records were analyzed. There were 85 male and 29 female patients. Their mean age was 47 years (range 16 to 86 years). Forty two (36%) underwent a transhiatal oesophagectomy, 34 (31%) Mckeown's oesophagectomy, 35(31%) Ivor Lewis oesophagectomy and 3 (2%) thoracoscopy assisted oesophagectomy. Of the 114 oesophagectomies, 86 (75%) were performed for malignant and 28 (25%) for benign pathologies (benign tumors and corrosive strictures of the esophagus).

Four patients sustained an iatrogenic tracheobronchial injury. In 2 patients, the airway injury was identified during operation due to loss in airway pressures during ventilation and in one patient the injury was detected because of an audible air leak during the operation. In the patient with the cervical tracheal injury, the injury was obviously visible. The three injuries in the thoracic part of the trachea were repaired primarily and reinforced with an intercostal muscle flap as described. The one patient, who sustained injury to the cervical part of the trachea, had primary repair and cyanoacrylate glue reinforcement. The clinical details and outcome of the patients are shown in **Table 1**. All patients who sustained injury had malignancy and three patients had received neoadjuvant chemoradiotherapy.

Table 1: Clinical details of the patients who sustained iatrogenic tracheal injuries during oesophagectomy

	Patient 1	Patient 2	Patient 3	Patient 4
Age	43	50	52	63
Sex	M	F	M	M
Co morbid illness	nil	nil	nil	nil
Smoking	Yes	Yes	No	Yes
Benign/malignant	Malignant	Malignant	Malignant	Malignant
Histopathology	Squamous cell carcinoma	Squamous cell carcinoma	Squamous cell carcinoma	Poorly differentiated carcinoma
Preoperative staging	Stage II B	Stage II A	Stage III	Stage III
Neoadjuvant treatment	Chemoradiotherapy	No	Chemoradiotherapy	Chemoradiotherapy
Surgical approach	Mckeown's	Transhiatal	Transhiatal	Mckeown's
Time of detection	On table	On table	On table	On table
Site of tumor	Distal third	Middle third	Distal third	Cervical trachea
Duration of ventilation	7 days	27 days	28 days	2 days
Post operative-tracheostomy done	Yes	Yes	Yes	No
Iontropic support	Yes	Yes	Yes	
VAP	No	Yes	Yes	No
RLN injury	Yes	No	No	Yes
Oesophageal anastamotic leak	No	No	No	No
Duration of hospital stay (days)	32	50	28	16
Mortality	No	No	Yes	No

Abbreviations: VAP: Ventilator associated pneumonia; RLN: Recurrent laryngeal nerve

Discussion

Tracheal injuries during oesophagectomies though known are rare, dreaded and potentially lethal. Though difficult to quantify, the reported incidence of tracheal injury during oesophagectomy ranges between 1 – 10%.¹¹⁻¹³ This corresponds to our experience, with an incidence of 3.5%. Iatrogenic tracheal injuries during oesophagectomy almost exclusively involve the membranous trachea as seen in our case series.

Direct surgical injury, fistulisation due to local peritracheal infection, ischaemic injury secondary to extensive dissection or endotracheal cuff are the described modes of injury to the trachea after mediastinal dissection.¹¹ Direct surgical injury usually arises due to blind blunt dissection of the mediastinum. But otherwise also the trachea may split when it is unsupported after mobilization of the oesophagus.¹⁴ Although logically blunt mediastinal dissection is more likely to cause tracheal injury, two large trials did not show any difference when the incidence, was compared between transhiatal oesophagectomy and transthoracic oesophagectomy.^{5,15} This is similar to our experience where two patients sustained injury during blunt esophageal (transhiatal) dissection and for two it occurred during sharp (transthoracic) dissection. In one patient although the tumor was in the lower third of the oesophagus the injury occurred during a transhiatal dissection due to incomplete blunt dissection of few strands attached to the trachea, prior to extracting the specimen.

Preoperative chemoradiotherapy, extensive lymph node dissection, peritumoral infection and abscess formation, and advanced tumors located above or at the level of the carina are associated with a significantly increased risk for iatrogenic tracheal injuries.¹¹ In our series neoadjuvant chemoradiation was also a significant risk factor where 3 of the 4 patients with iatrogenic tracheobronchial injury had had neoadjuvant chemoradiation. With more extensive dissection the risk of injury is higher. Maruyama et al¹⁶ had shown that 3 field lymphadenectomy or lymph node dissection of more than 60 nodes were independent risk factors for development of tracheobronchial injuries. Tracheobronchial injuries occur when oesophagectomies are done for both malignant and benign pathologies.¹³ In our series, all the injuries occurred associated with malignant lesions. Most of the injuries described in literature were in the range of 1-5 cm which was similar in our patients.^{10,15,17}

Surgical repair of tracheobronchial injuries should be performed as soon as they are recognized. The described surgical approaches are transcervical, transthoracic or median sternotomy.¹⁸ The potential benefits of surgery are: 1) closure of the defect to facilitate effective ventilation, 2) prevent mediastinitis due to contamination from non sterile airways and 3) prevent strictures and their complications of the tracheobronchial tree.¹⁰

Usually these injuries are diagnosed on table during operation when there is a large amount of air escaping the operation field or by the anesthetist due to reduction in ventilatory pressures. When recognized, immediate control of the airway has to be achieved. In case of transhiatal dissection, a thoracotomy is performed after insertion of a double lumen endotracheal tube. Airway pressures have to be maintained as low as possible. When postoperative ventilation is necessary, a regular endotracheal tube may be changed under bronchoscopic guidance, to avoid disruption of the repair.

But if missed intraoperatively, patients may present as persistent air leak in the chest drains or as subcutaneous emphysema of the neck and face. This may require early repair, after returning to theatre.

Reinforcement of the primary repair with some flap cover is the most preferred mode of repair. Most common autologous flaps used are pericardium, pleura, extrathoracic muscle flaps and intercostal muscle flaps.⁵ Oesophageal replacements (gastric tube) have also been used to reinforce the primary repair.^{5,19,20} The patches using pleura or pericardium are relatively poorly vascularised and may not be always available because of tumor ingrowth. There is also the risk of graft failure due to postoperative radiotherapy. The extra thoracic flaps require more extensive surgery and technical expertise.

Compared to the aforementioned flaps intercostal muscle flaps are relatively easier to create, morbidity of flaps are less and risk of graft failure secondary to postoperative radiotherapy is negligible. Striated skeletal muscles have been shown to prevent dehiscence especially in contaminated wounds.²¹ Using an intercostal muscle flap was found to help in increasing the diameter, as well as relieve the tension on the suture line, especially when the bronchus with its smaller lumen is involved.²² In our experience also, we found intercostal muscle flaps to provide a tension free repair with no evidence of dehiscence in any of the three patients that were operated upon.

Polytetrafluoroethylene (Marlex) grafts have also been

used, but being a foreign body their use in a potentially infected space is questionable.²³ Biological glues have also been used primarily or as reinforcement.²⁴ The reports of success with biological glues are conflicting. We had one patient where we used biological glue with success. In this patient the injury was in the neck, the defect was small and a striated muscle flap would have come in the way of the anastomosis. So only a primary repair of the tracheal laceration reinforced with biological glue was undertaken. This is only anecdotal and needs to be further evaluated.

We had one mortality in this series. The mortality in this patient was due to ventilator associated pneumonia. Even in this patient there was no evidence of breakdown of the repair.

In summary, iatrogenic tracheal injuries are uncommon complications following esophageal resection. In our series we found neoadjuvant chemoradiation and malignancy to be risk factors for tracheobronchial injuries during oesophagectomy. Reinforcement of the suture line with an intercostal muscle flap is an effective technique for repairing tracheal injuries. Prompt identification of the injury on table and appropriate surgical intervention results in a better outcome.

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