

Management of Laryngotracheal and Tracheobronchial Injuries

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Abstract

Laryngotracheal and tracheobronchial injuries are uncommon, and their successful diagnosis and management often require a high level of expertise. This paper aimed at retrospective analysis of a thoracic surgeon's experience in the diagnosis and management of traumatic injuries to the larynx, trachea and major bronchi. Forty one patients with major airway trauma were managed from March 1994 to November 2008. Their demographic characteristics including age, gender, mechanisms and locations of injuries, associated other organ injuries as well as surgical airway managements and the outcomes were recorded. Seven patients had re-implantation of the main bronchus, and one patient had a repair of the right upper lobe bronchus with concomitant bilobectomy. In cases of tracheal injury, 16 patients had a primary repair of trachea. However, seven patients with tracheal injury first conservative approaches, but 4 of them were later subjected to sleeve resection of trachea. In patients with laryngotracheal injuries, and in a patient with thermal injury, Montgomery T-Tube was used with or without repair and/or reconstruction. Four patients died, but no significant morbidity was seen in others. The analysis of the cases suggests that laryngotracheal and tracheobronchial injuries require early correct diagnosis, skillful management, and prompt individualized surgical airway repair.

Iran J Med Sci 2010; 35(3): 242-247.

Keywords • Trauma • Larynx • Trachea • Bronchi • Intubation

Introduction

Trauma to the airway is infrequent, but is potentially life-threatening. The immediate sequel can include death from asphyxiation. Moreover, the lack of recognition or incorrect management may result in life-threatening or disabling airway stricture.¹⁻³

The larynx, trachea and major bronchi are vulnerable to penetrating or blunt trauma, or sometimes thermal injury.¹⁻³ Iatrogenic injuries of membranous trachea have also become increasingly common, and can complicate procedures such as endotracheal intubation, nasogastric intubation, mediastinoscopy, percutaneous tracheostomy, and excision of neoplasms with mediastinal involvement.⁴ The maintenance of airway patency is the most fundamental intervention for patients with laryngotracheal or tracheobronchial injuries. Either routine intubation or a tracheostomy can secure the airway patency.⁵

Considering the grave consequences of laryngotracheal or tracheobronchial injuries, these injuries require prompt

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Received: 10 September 2009
Revised: 27 July 2009
Accepted: 30 May 2009

recognition, airway protection, and skillful management to lessen the morbidity and mortality.

This article reviews a thoracic surgeon's experience with some unique cases hoping to help improved management of the upper airway trauma in developing countries.

Subjects and Methods

From March, 1991 to November, 2008, 41 (34 males and 7 female) patients (age range one to 65 years) with laryngotracheal or tracheobronchial injuries were managed in two hospitals and followed for 1.5 to 14 years. Demographic characteristics including age, gender distribution, mechanisms and locations of injuries, associated other organ injuries, surgical airway managements, and the outcomes were recorded for all patients.

Some cases were primarily managed by a general surgeon or other specialities prior to transfer and management in centres, where the cases constituting the present study were managed. For all stable patients conventional radiography and CT scan were performed. However, for more recent cases virtual bronchoscopy was also performed. Diagnostic bronchoscopy was done liberally in all suspi-

cious cases.

Results

Diagnosis was delayed from 1 day to 2.5 years in 9 patients with blunt trauma. The mechanisms of injuries are presented in table 1. Some features of cases in the present study were reported previously.⁶ There are, however, some interesting cases, which are mentioned here. A patient had fallen down from a mountain and had endured a laryngotracheal disruption with subcutaneous emphysema and respiratory distress. He had been intubated blindly in an emergency situation in another hospital, and had been referred the next day. Diagnosis was made by performing CT scan and bronchoscopy (figure 1). He had an uneventful surgery. Another case was a young driver who had been hit severely to the dashboard of his car. He had developed a complex laryngotracheo-pharyngo-esophageal injury with only one-third of posterior hypopharyngeal wall left intact. He was diagnosed after bronchoscopy and was operated successfully through collar incision to repair his complex airway injury. He was managed doing laryngeal cartilage debridement, laryngeal mucosal repair, left vocal

Table 1: The mechanisms of laryngotracheal and tracheobronchial injuries

Mechanisms of injury		Number	
Trauma (27, 65.9%)	Blunt	17	
	Penetrating	Stab/sharp injury	6
		Impalement/ slash injury	2
		Gun shot	2
	Iatrogenic (13, 32.7%)	Reintubation or forceful intubation	2
General anesthesia/mechanical ventilator		7	
Therapeutic bronchoscopy		1	
*Insertion tracheostomy		1	
**Surgery		2	
Burn (1, 2.4%)		1	
Total (100%)		41	

*Careless insertion of tracheostomy tube in open tracheostomy, **Rupture of trachea in transhiatal esophagectomy

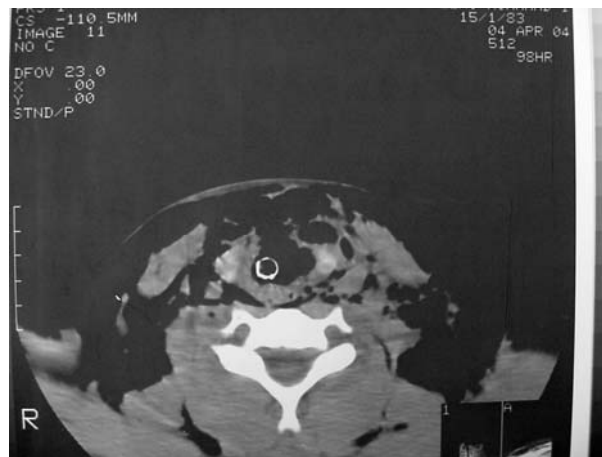


Figure 1: A CT scan showing laryngotracheal disruption in a patient who fell down from a mountain.

cord reattachment moulded on Montgomery T-tube, and pharyngoesophageal repair with gastrostomy and jejunostomy tube. He completely recovered from an aerodigestive tract injury. Another old lady had conventional open tracheostomy in an elective resection of carcinoma of tongue. The insertion of tracheostomy tube had caused laceration of posterior tracheal membrane from thoracic inlet to 2.5 cm proximal to carina. She was diagnosed the day after the operation using bronchoscopy for unexplained mediastinal and subcutaneous emphysema. Her airway injury was repaired using thoracic esophagus. Two other cases with iatrogenic injuries had disruptions of membranous portion of distal trachea during operations under general anaesthesia (figure 2a, 2b). One patient had iatrogenic confined mediastinal tracheal rupture induced by forceful orotracheal intubation in an emergency situation. This patient had an undiagnosed midtracheal stenosis due to a previous head injury and tracheostomy. Fiberoptic guided distal tracheal intubation was done through reopening tracheostomy stoma. Virtual bronchoscopy showed the exact diagnosis and the length of tracheal disruption. It was retrospectively revealed why it had been difficult to find the distal part of trachea by flexible bronchoscopy. He

was managed by successful sleeve tracheal resection following 6 weeks of airway protection by a long tracheostomy tube.

Locations of injuries are presented as laryngeal, laryngotracheal, tracheobronchial and bronchial injuries (table 2). Eight patients had right main bronchus injuries; one patient had left main bronchus injury and one had tracheobronchial injury. Six patients had ten associated injuries including: cervical esophageal injuries (3), concomitant thoracic duct and left intercostal artery injuries (1), concurrent spleen, left kidney and diffuse compact head injuries (1), internal jugular vein tearing (1), and spinal cord injury associated with quadriplegia (1).

Surgical Interventions

The operations performed in all patients are shown in Table 3. Various incisions including: 18 collar and oblique neck incisions, 11 classic posterolateral thoracotomies, one median sternotomy extended to right anterolateral, thoracotomy and one left trapdoor were used. Seven patients had re-implantation of bronchus, which were buttressed by intercostals muscle flap. A thymic flap was used in the case of tracheobronchial injury. Primary repair of tracheal injuries were performed in 16 pa-



Figure 2a: CXR showing mediastinal emphysema due to confined posterior tracheal membrane rupture after general anesthesia



Figure 2b: CT scan showing posterior tracheal membrane rupture following general anesthesia.

Table 2: Classification of location of airway injuries

Location	Number
laryngeal injuries	5
Laryngotracheal injury	2
Laryngo-tracheo-pharyngo-esophageal injury	1
Tracheal injury (23)	
Cervical	12
Thoracic (mediastinal)	11
Tracheobronchial injury	1
Bronchial injury (9)	
Right main bronchus	8
Left main bronchus	1
Total	41

Table 3: Types of airway injuries and managements.

Types of injury		Management	Number
Isolated laryngeal injury		Tracheostomy+T-tube	5
Complex laryngeal or laryngotracheal injuries+/- pharyngo-esophageal injury		Repair +/- reconstruction + T-tube +/- gastrostomy + jejunostomy	3
Tracheal injury	Cervical	Repair	4
		Repair + distal tracheostomy	2
		Sleeve resection	3
	Thoracic	Conservative	3
		Repair	9
		Sleeve sesetion	1
Tracheobronchial injury		Conservative	11
Main bronchus	Right main bronchus injury	Repair	1
		Re-implantation	6
	Left main bronchus injury	Bilobectomy + right upper lobe bronchus repair	1
		Reject to operation *	1
Total		Re-implantation	1
			41

*Patient with quadriplegia and one month delay in diagnosis with unstable hemodynamic parameter with change position

tients. Seven patients with blunt tracheal injuries were managed primarily with transient tracheostomy or orotracheal intubation. However, laryngotracheal or tracheal resection and reconstruction were later performed in 4 of them. In all complex laryngeal or laryngotracheal injuries, Montgomery T-tube was utilized

Morbidity and Mortality

Morbidities included delayed diagnosis (9 patients), failure of early conservative treatment (4 patients), granulation tissue formation (one patient), persistent open tracheostomy stoma (one patient), persistent hoarseness (two patients) with difficulty in swallowing liquid (one patient). Four patients died. One of them was subjected to bilobectomy and repair of right upper lobe bronchus. He died from respiratory failure one week after the operation. The second one died from cardiac arrest at the end of the re-implantation of the right main bronchus. He had also a diffuse compact head injury, and underwent splenectomy and repair of kidney laceration. The third patient was a one year old boy, who had iatrogenic multiple tracheobronchial perforations with pneumothorax, which had been induced during several attempts by a young surgeon to remove a foreign body. He was managed with orotracheal intubation, mechanical ventilation, and tube thoracostomy. He passed away after sudden respiratory arrest, which was most likely due to a mucus plug in the airway. The fourth death was a 65 year old woman with iatrogenic long laceration of membranous portion of trachea. She was mechanically ventilated. She developed cardiac arrest 4 days after the operation. She died within 10 days of the operation as a result of hypoxic brain damage, but no evidence of air leakage.

Discussion

There are some important issues such as incidence, primary airway protection, associated injuries, surgical airway management, complications and mortality, which need to be addressed.

Incidence

Laryngotracheal trauma and tracheobronchial rupture are rare, but immediately life-threatening injuries. These injuries do occur more frequently in developing countries with increasing number of motor vehicles, sub-standard roads, and careless driving. The cases of the present paper were managed in two referral hospitals, which had an annual admission of more than five thousands trauma patients. Therefore, the incidence of such injuries is roughly estimated to be about 1%. In Iran, car accidents are high. However, an accurate incidence of such injuries has not yet been reported. According to the literature, tracheobronchial injuries appear to occur in 1% to 2% of patients sustaining blunt injury and in 2% to 9% of those sustaining penetrating injury to the thorax.¹ Considering the increased road accidents, the low incidence of such injuries in the present report (table 1) might be justified by the death of some patients in pre-hospital phases or missed airway injuries in emergency departments. Iatrogenic injuries also seem to be more frequent, due to unfamiliarity of medical as well as paramedic staffs with orotracheal intubation, and/or careless protection of the airways.

Associated Injuries

Early reports showed a paucity of other organ injuries associated with tracheobronchial

injuries, probably due to early death of the patients. In 1976, Kirsh and Orringer reported that at least 50% of the patients had associated injuries.⁷ Other reports showed that 75% to 100% of the patients suffering from blunt tracheobronchial trauma had associated injuries.⁸⁻¹⁰ Feliciano and co-workers reported 23 cases of combined tracheal and oesophageal injuries from penetrating causes.¹¹ Of equal importance was the observation of concomitant spinal column injuries in 6 of them.¹¹ In the present study only six patients had associated injuries, which may reflect suboptimal transfer and early death of some of the victims.

Airway Protection

The first and most important step in the management of acute laryngotracheal or tracheobronchial injuries is to secure a satisfactory airway patency. While an important issue, only a few patients studied in the present study had critical airway problems on arrival. This is reminiscent of the nature of the situation that some patients with initial emergency airway problems were missed or died. However, there is a controversy regarding the best method of gaining a secure airway. There are two recommendations. Some authors believe in early tracheostomy, but the majority recommend orotracheal intubation with or without flexible bronchoscopy, and leave tracheostomy for certain cases.¹²⁻¹⁵

Edwards and colleagues,¹² and Rossbach and coworkers,¹³ reported that approximately 60% of the patients studied required prompt control of their airways. In Rossbach and Johnson's case series, 74% of the patients requiring emergency intubation were successfully managed by orotracheal intubation only, whereas 10% required intubation with fiberoptic guidance, 10% were intubated through an open neck wound, and 5% required emergency surgical airway through tracheostomy or cricothyroidotomy.¹³ Because of the risk of complete airway obstruction, blind intubation should not be used in patients with potential laryngotracheal trauma. It should be emphasized that a close cooperation between anesthesiologists and surgeons is critical for the successful management of a laryngotracheal or tracheobronchial injury.³

Surgical Management

Minor airway injuries may not be initially apparent or recognized, because of the lack of clinical suspicion or concealment by prompt distal intubation, which is required for stabilization of patients with multiple injuries. Minor

injuries involving less than one third of the airway circumferences may heal without surgical treatment.³ Mucosal defects not associated with ongoing air leak may also heal without requiring immediate interventions. The types of repair for small anterior tracheal wounds, posterior injuries, extensive tracheal destructions, laryngeal and bronchial injuries are well established.^{3,8} It has been emphasized to repair all posterior injuries. However, recently Yopp and colleagues successfully managed posterior membranous rupture with the deployment of covered tracheal stent in a 75-year old woman, who was a poor candidate for surgery.¹⁶ The concept of repair for posterior membrane rupture in iatrogenic injuries is also evolving. Schneider and coworkers recommend surgery when: 1) mechanical ventilation is not possible, 2) subcutaneous or mediastinal emphysema is progressive, 3) an open perforation into the pleural cavity is present, and 4) an endobronchial tube cannot be placed beyond the laceration.¹⁷ Conti and his colleagues recommend that surgical repair should be reserved for patients in whom bridging the lesion is technically not feasible, as well as for injuries diagnosed during thoracic surgery.¹⁸

Five of the patients in the present case study had isolated non-functioning vocal cord due to blunt trauma or prolonged intubation. They were managed with tracheostomy and Montgomery T-tube, which was associated with excellent outcomes.

All cases of bronchial injuries, except one, had intact peribronchial tissues and no massive air leakage on arrival to the emergency department. As mentioned earlier, the lower incidence of such injuries might be due to the prehospital death of some victims with massive air leakage.

Complications

The complications of laryngotracheal or tracheobronchial injuries are similar to those of the airway resection and reconstruction³. It is more justified to postpone the repair in an unstable patient than the repair or reconstruction be done by a surgeon who do not have the expertise in managing such injuries. It is highly recommended to secure the patency of airway, and refer such cases to a specialized center.

Mortality

The mortality in the present case series was 10%. Two patients with iatrogenic injuries died during care in ICU. Two others died with blunt injuries. Previous case series of combined penetrating and non penetrating

injuries have shown that even after surgical corrections, the mortality was 14% to 25% depending on the mechanisms of tracheobronchial and associated other organ injuries^{9-11,19,20}

Death is generally due to the associated injuries, and not to the tracheobronchial ones.¹

Conflict of Interest: None declared

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