Unsuspected tracheal rupture in blunt thoracic trauma

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The purpose of this report is to describe the discovery and management of an unanticipated injury during fibreoptic tracheal intubation. A 23-yr-old man sustained blunt cervical, thoracic and abdominal trauma in a motor vehicle accident. He was brought to the operating room for urgent management of his abdominal and cervical spine injuries. Examination of his airway during awake fibreoptic tracheal intubation revealed an unexpected tracheal injury. Surgical repair of the trachea was uneventful. The diagnosis and airway management of tracheal rupture are discussed. This case illustrates the importance of a full diagnostic examination during invasive anaesthetic procedures such as tracheal intubation.

Cette observation décrit la découverte fortuite et la prise en charge d'une lésion trachéale pendant une intubation fibroscopique. Le sujet est un traumatisé cervical, thoracique et abdominal de 23 ans. Il est amené en salle d'opération pour le traitement urgent de lésions abdominales et cervicales. L'examen fibroscopique des voies aériennes à l'état vigile révèle une lésion trachéale insoupçonnée. La réparation chirurgicale de la trachée se déroule sans incident. Le diagnostic et la prise en charge de la rupture trachéale sont discutés. Cette observation illustre l'importance d'un examen diagnostique complet au moment d'une procédure aussi effractive que l'intubation trachéale.

Key words
COMPLICATIONS: intubation, tracheal rupture;
INTUBATION, TRACHEAL: technique;
SURGERY: trauma.

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Tracheobronchial injuries are rare, and diagnosis can prove to be challenging. The signs and symptoms of this injury are subtle and their importance may be obscured by other injuries. This report describes a case of unsuspected tracheal rupture and its anaesthetic management in a patient who presented to the operating room for urgent surgical management of other injuries.

Case report

A 23-yr-old man was a belted passenger in the front seat of a car which collided with a dump truck. He was found walking on the highway, complaining of neck, chest, and abdominal pain. On arrival at a peripheral hospital, the patient was conscious with a Glasgow coma score of 15. He had stable vital signs. Radiographic investigation demonstrated a fracture of the second cervical vertebra. The patient had no neurological signs suggestive of spinal cord injury and arrangements were made for his transfer to Sunnybrook Health Science Centre, a level one trauma centre.

On arrival, the patient was conscious and alert. He remained neurologically intact and haemodynamically stable with no evidence of respiratory distress. Physical examination revealed a tender neck to palpation in the area of the cervical spine. His airway was patent with bilateral and symmetrical air entry on chest auscultation. Subcutaneous emphysema was noted on the upper chest wall. No crepitus was felt over his larynx. His abdomen was painful and rigid to palpation. No bowel sounds were heard. Radiographic investigations revealed multiple left-sided rib fractures, subcutaneous emphysema and mediastinal emphysema. A cervical spine radiograph revealed a fracture through the pedicles of the second cervical vertebra with anterior subluxation of the body of the second on the third cervical vertebra.

On the basis of the patient's peritoneal signs, he was taken to the operating room for an urgent laparotomy. A chest tube was to be inserted after induction of anaesthesia and cervical stabilization with halo-pelvic fixation was to be applied after laparotomy.

In view of the patient's cervical fracture, awake fibreoptic-guided tracheal intubation was planned. The patient was sedated with midazolam and topical anaes-

thesia was applied to the airway with lidocaine 10% spray. A further 5 ml lidocaine 2% was injected through the bronchoscope when the vocal cords were seen. During the course of fibreoptic bronchoscopy normal upper airway anatomy was noted. Distal to the vocal cords, on the posterior aspect of the trachea, a longitudinal submucosal haematoma was seen 2–3 cm from the carina. A diagnosis of a probable tracheal tear was made and the fibreoptic bronchoscope was removed.

Thoracic Surgery was consulted and confirmed the diagnosis of a tracheal rupture. The patient's trachea was then intubated with the aid of a fibreoptic bronchoscope under direct vision using a 7.0 mm armoured tube, passing the cuff distal to the tear. Anaesthesia was then induced with thiopentone and fentanyl and maintained with isoflurane in an air and oxygen mixture with the patient breathing spontaneously. Halo-cervical stabilization was applied, a left tube thoracostomy was performed, and the patient was placed in the left lateral position. A right thoracotomy for primary repair of the tracheal tear was carried out and positive-pressure ventilation was commenced when the pleural space was entered. Neuromuscular blockade was achieved with pancuronium

Operative findings included a longitudinal tear in the membranous trachea starting 2 cm above the carina and extending approximately 4 cm proximally, with the endotracheal tube cuff positioned at the level of the tear. Turning the patient for thoracotomy caused a shift in the position of the endotracheal tube proximally and the exact placement of the cuff beyond the tracheal tear required close cooperation between the anaesthetist and the surgeon. A severe mediastinal contusion was also noted along with a 7 cm longitudinal tear of both muscle layers of the oesophagus.

The tip of the endotracheal tube was manoeuvred into the left main stem bronchus with the help of the surgeon so that the cuff was positioned below the level of the tear. This eliminated leakage of the anaesthetic gases through the tracheal rupture, and also allowed a partial collapse of the right lung to facilitate the surgical procedure. The tracheal rupture was repaired with interrupted absorbable mono-filament poly-glycolic acid (Maxon-Davis and Geck) sutures. The oesophageal tear was also repaired using interrupted absorbable mono-filament poly-glycolic acid sutures. The fifth rib was then excised. The intercostal muscle mass between the fifth and sixth ribs was mobilized based on the fifth intercostal neurovascular bundle posteriorly. The intercostal muscle pedicle graft was then used to buttress the tracheal repair. The endotracheal tube was pulled proximally and positioned with the cuff above the tracheal suture line. The right lung was re-expanded and after placement of two chest tubes the chest was closed. The patient was carefully turned into the supine position. Laparotomy was performed and revealed a perforation of the mid-jejunum which was repaired.

Postoperatively, the patient was taken to the intensive care unit and the trachea was extubated without complications after recovery from anaesthesia. The patient was ultimately discharged home.

TABLE Mechanisms of blunt tracheal injury[5]

1	Sudden increase in intra-tracheal pressure in the presence of a closed glottis leading to a linear rupture of the membranous trachea.
2	Crush injury resulting in a sudden decrease in the A-P diameter of the chest, compressing the lungs laterally away from the carina, causing a laceration or transection of the trachea or the mainstem bronchi.
3	Acceleration/deceleration injuries resulting in movement of the trachea around its fixed points at the cricoid and the carina, causing a shearing force.
4	Direct blows to the hyper-extended neck or a clothes-line injury may result in a crush injury to the airway as it is compressed against the vertebral bodies.

Discussion

Our patient had an unsuspected tracheal rupture which was discovered by the anaesthetist during tracheal intubation. The only presenting signs were mediastinal emphysema on chest radiography and subcutaneous emphysema. The new diagnosis resulted in a change in the intraoperative management.

Tracheobronchial tears due to blunt trauma are rare. Many patients with this injury do not survive to reach hospital. The incidence in patients arriving at the emergency department is $<1\%$ of all patients with blunt trauma.[1] Tracheal rupture has a reported mortality of 20–50%[1-3] and a morbidity of 10–25%.[3] The morbidity resulting from this injury is mainly due to failure to recognize the injury, resulting in progressive airway obstruction, distal atelectasis and bronchiectasis due to stenosis at the site of the injury.[4]

The trachea is a well-protected structure, thus accounting for the low incidence of the injury. Its position relative to the mandible, the sternum, the vertebral column and the first four ribs as well as its mobility, elasticity, and cartilaginous support all make the trachea a difficult structure to injure. Proposed mechanisms of blunt injury to the trachea are presented in the Table.[5] As a result, 80% of tracheobronchial tears can be found within 2.5 cm of the carina.[6]

Associated injuries include tears to the oesophagus, vascular injuries (e.g., innominate artery, carotid artery, subclavian artery, internal and external jugular veins),

spinal cord injuries, chest trauma, closed head injuries, and facial fractures. Of these, the most commonly associated organ to be injured is the oesophagus.[3]

Diagnosis of tracheobronchial tears can be difficult. Clinical presentation can vary from death before arrival at hospital due to airway obstruction to no visible signs of injury. Unless the injury is obvious (e.g., bronchopleural fistula or visible transection of the trachea), the diagnosis of a tracheal tear can be missed. Factors which would lead one to suspect the presence of this type of injury include: the mechanism of injury (e.g., clothesline injury), haemoptysis, subcutaneous and especially mediastinal emphysema. Subcutaneous emphysema may be minimal in patients breathing spontaneously but may become severe when assisted ventilation is required. Retrospective studies have suggested that subcutaneous emphysema is a common finding in this injury.[3,7] In one study, 64% of the patients with tracheobronchial tear had subcutaneous emphysema.[3] Bronchoscopy is mandatory to rule out tracheo-bronchial disruption in patients presenting with dyspnoea, haemoptysis and mediastinal emphysema following trauma.

Radiological findings in tracheobronchial injuries are relatively unhelpful with 10% of patients showing no evidence of tracheobronchial injury, 41% with non-specific findings such as rib fractures or mediastinal emphysema and 67% with pneumothorax. Of those patients with rib fractures, 90% of the fractures occurred within the first three ribs.[8] Highly suggestive radiological findings of a tracheobronchial injury include a persistent or a recurring pneumothorax, increasing pneumomediastinum, or progressive deep cervical emphysema.[8] Mediastinal emphysema, especially in the absence of a pneumothorax, is due to a tracheal or oesophageal injury unless proved otherwise.[9]

Bronchoscopy is the diagnostic technique of choice for patients with tracheobronchial injuries.[10] Fibreoptic bronchoscopy is an important method of determining tracheal tube placement. Direct visualization ensures that the tracheal cuff is placed appropriately distal to the site of injury.[9,10] At the end of the procedure, the endotracheal tube should be pulled back so that the tip is proximal to the repair.[11]

The tracheal tube may shift position when the patient is turned from the supine to the lateral position. At thoracotomy, the surgeon, by direct vision, can confirm the position of the tube and help to manoeuvre it into the most desirable position. In our patient, by manoeuvring the endotracheal tube into the left main stem bronchus, the cuff was placed below the tracheal rupture site and at the same time allowed the collapse of the right lung thus facilitating repair of the trachea injury. Close cooperation between the anaesthetist and surgeon regarding airway issues is mandatory.[9-12]

Tracheobronchial injury is a rare occurrence and the diagnosis can be difficult. The injury should be suspected in the presence of subcutaneous emphysema at the neck or mediastinal emphysema. Early diagnosis and prompt operative management can minimize the morbidity and mortality of tracheobronchial injuries.[10] In this situation observations made by the anaesthetist during fibreoptic intubation are important for early diagnosis.

References

1 *Shorr RM, Crittenden M, Indeck M, Hartunian SL, Rodriguez A.* Blunt thoracic trauma: analysis of 515 patients. Ann Surg 1987; 206: 200–5.

2 *Edwards WH Jr, Morris JA Jr, deLosier JB III, Adkins RB Jr.* Airway injuries: the first priority in trauma. Am Surg 1987; 53: 192–7.

3 *Minard G, Kudsk KA, Croce MA, Butts JA, Cicala RS, Fabian TC.* Laryngotracheal trauma. Am Surg 1992; 58: 181–7.

4 *Kelly JP, Webb WR, Moulder PV, Everson C, Burch BH, Lindsey ES.* Management of airway trauma I: tracheobronchial injuries. Ann Thorac Surg 1985; 40: 551–5.

5 *Mulder DS.* Blunt neck injury. *In*: Hurst JM (Ed.). Common Problems in Trauma. Chicago: Year Book Medical Publishers, 1987; 135–7.

6 *Cilley JH Jr, Mure AJ.* Chest wall and pulmonary injuries. Topics in Emergency Medicine 1990; 12: 45–52.

7 *Mathisen DJ, Grillo H.* Laryngotracheal trauma. Ann Thorac Surg 1987; 43: 254–62.

8 *Goodman LR, Putnam CE.* Intensive Care Radiology: Imaging of the Critically Ill, 2nd ed. Philadelphia: W.B. Saunders Company, 1983; 149–51.

9 *Grover FL, Ellestad C, Arom KV, Root HD, Cruz AB, Trinkle JK.* Diagnosis and management of major tracheobronchial injuries. Ann Thorac Surg 1979; 28: 384–91.

10 *Baumgartner F, Sheppard B, de Virgilio C, et al.* Tracheal and main bronchial disruptions after blunt chest trauma: presentation and management. Ann Thorac Surg 1990; 50: 569–74.

11 *Symbas PN.* Cardiothoracic trauma. Curr Probl Surg 1991; 28: 741–97.

12 *Symbas PN, Justicz AG, Ricketts RR.* Rupture of the airways from blunt trauma: treatment of complex injuries. Ann Thorac Surg 1992; 54: 177–83.