CASE REPORT

Emergent repair of bronchial transection: both right and left main bronchial lung ventilation at surgery makes it easy for all

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SUMMARY

Maintaining adequate gas exchange is crucial during surgical repair of tracheobronchial injuries in children and reflects the skills of the anaesthetist and the surgeon. We present a 7-year-old girl who underwent urgent repair of the bronchial transection and novel use of ventilation of the transected lung helped accomplish the repair successfully.

BACKGROUND

Tracheobronchial injuries (TBIs) are potentially life-threatening and nearly all injuries are caused by blunt trauma.¹ These injuries may be missed initially as these are rare and associated with other grievous injuries which command more attention. Therefore, a high index of suspicion is required for diagnosing bronchial injuries.² Early diagnosis and immediate repair of the injury can spare the lung parenchyma and improve the outcome.

CASE PRESENTATION

A 7-year-old girl was brought to the trauma centre with a history of having sustained injury to the chest and abdomen after falling off a tractor and being run over by its rear wheels. There was no history of loss of consciousness, vomiting or external bleed. On general physical examination, the child was haemodynamically stable but restless and agitated. There were no external injury marks or clinical evidence of a rib fracture. The respiratory rate was 45/min with gross subcutaneous emphysema involving both the front and back of the chest and abdomen; however, the patient was maintaining O₂ saturation. On abdominal examination, there was tenderness in the right hypochondrium but the rest of the abdomen was unremarkable.

INVESTIGATIONS

A chest radiograph revealed a gross right pneumothorax with mediastinal shift; the lung was completely collapsed and had dropped down (figure 1). In view of the pneumothorax, a right intercostal chest drain was placed immediately which showed a significant air leak but without lung expansion, hence leading to a suspicion of bronchial injury. After initial stabilisation and resuscitation, a contrast-enhanced CT scan of the chest and abdomen was performed which revealed complete transection of the right main bronchus and grade IV injury of the liver (figure 2).

Figure 1 Plain X-ray of the chest showing gross pneumothorax and the collapsed right lung.

TREATMENT

The child was taken up for urgent repair of bronchial transection and the usual endotracheal intubation was performed as selective left endobronchial intubation could not be done due to the non-availability of a double lumen tube and fibre optic bronchoscope.

At thoracotomy, the right main bronchus was seen to be completely transected at about 1.5 cm from the carina; however, the injury was partially sealed by the surrounding peribronchial tissue. The right lung was completely collapsed and lying at

Figure 2 Contrast-enhanced CT scan of the chest showing the 'fallen-lung sign'.

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Figure 3 Line diagram showing the ventilation of the transected lung.

the bottom of the chest cavity. During dissection of the torn edges of the bronchus, there was a continuous air leak from the proximal end associated with repeated episodes of desaturation, impeding the progress of surgical procedure. Various manoeuvres to block the proximal end of the bronchus, including Fogarty balloon tamponade, were not entirely successful in stopping the air leak due to the proximity to the carina. A 5 Fr endotracheal tube was placed in the distal end of the transected bronchus and connected to a separate ventilation circuit (figure 3). Thus, the transected lung could also be ventilated, leading to improvement and stabilisation of saturation. Eight interrupted sutures of 4/0 prolene could now be placed between the proximal and distal ends of the bronchus with intermittent finger occlusion of the proximal stump. End-to-end anastomosis was completed after tying the sutures, leading to prompt expansion of the lung. The chest was closed with an intercostal tube drain after checking for the air leak. The child was electively ventilated for 3 days.

OUTCOME AND FOLLOW-UP

Postoperative X-rays showed complete expansion of the right lung without any pneumothorax (figure 4). The chest tube, however, continued to drain serous fluid, which gradually

Figure 4 Postoperative X-ray showing the completely expanded lung.

decreased over a period of 2 weeks, and the patient was discharged on the 17th postoperative day. In the follow-up, the patient is doing well and the lung is maintained in the expanded state.

DISCUSSION

TBIs are rare and mandate a high degree of clinical suspicion.² The true incidence of TBI is still unknown as 30–80% of the victims succumb at the scene of accident.^{3 4} TBI are usually the result of high-velocity road traffic accidents, and they can also be caused by a crushing or twisting injury or by a fall from a height. The site of injury is usually within 2 cm of the carina in 76% of the patients and the right main bronchus is involved in 43% of the cases.^{4–6} These patients present with non-specific symptoms; hence, it frequently goes unnoticed during initial trauma assessment as was seen in our index case. About 10% of the patients of TBI are asymptomatic.⁷ The elasticity of the thoracic wall in children, transmitting forces of trauma directly to intrathoracic structures, accounts for TBIs found in the absence of rib fractures or external injuries as was observed in our case. Injuries to the bronchi occur due to the rapid deceleration and shearing of the mobile lung and the bronchi while the proximal airways are relatively fixed. Also, compression between the sternum and vertebral column may also cause bursting of the air-filled structures.⁸

The immediate management in the trauma centre is to control the airway and breathing which may be in the form of endotracheal intubation and intercostal drainage; this, however, might lead to further compromise of the ventilation.² Therefore if the patient has a good airway and is well oxygenated, it is prudent not to attempt intubation before taking the patient to the operating room.

Continuous air leak and failure of complete lung expansion after chest tube insertion should raise the suspicion of airway disruption.⁸ In some cases of bronchial rupture, loose peribronchial tissue might maintain continuity of the airway and limit air leakage, thus tiding over the dire emergency. Consequently, the clinical presentation is subtle and they are diagnosed late when atelectasis develops due to gradual narrowing and stenosis. Granulation tissue invades the injured area over 1–3 weeks.^{7 9}

Contrast-enhanced CT of the chest is the imaging modality of choice in these injuries. The sign of 'the fallen-lung' is specific for complete bronchial transection.¹⁰ The transection of the main stem bronchus itself may result in classical signs of atelectasis, absent hilum or collapse of the lung away from the hilum towards the diaphragm.^{11 12} Once the diagnosis of bronchial transection is suspected on clinical and radiological examination, bronchoscopy is the most reliable means of establishing the diagnosis and determining the site, nature and extent of tracheobronchial disruption.² It may not be advisable to subject a potentially unstable patient to bronchoscopy, if non-invasive means such as a CT scan have established the diagnosis with reasonable certainty. If it has to be done, bronchoscopy should be performed in the operating room, under general anaesthesia, using a rigid, ventilating bronchoscope allowing spontaneous breathing, if possible. Staff and equipment should be at hand for thoracotomy. Bronchoscopic signs of injury include a visible defect, mucosal disruption or exposed cartilage. Flexible bronchoscopy may facilitate endotracheal intubation beyond the site of the injury or selective intubation of the uninjured bronchus.¹³

The surgical approach is chosen depending on the localisation of the TBI. A collar neck incision for cervical trachea and a posterolateral thoracotomy for exposure of the thoracic trachea,

carinal region and the bronchi will be required. The primary reconstruction with the trimming of the border of the injury and a direct interrupted suture repair is always preferred; a flap fashioned from the nearby tissue may be used to reinforce the suture line.^{2 13} In the case of impossibility of a primary reconstruction, a sleeve anastomosis or a pulmonary resection needs to be chosen. Small lacerations of the membranous trachea and some partial bronchial tears involving up to one-third of the circumference may be treated non-operatively.^{14–16} The best results are obtained by the earliest possible restoration of the continuity of the airway.

In the presence of a massive air leak, carrying out the anastomotic repair may become difficult. It may be necessary to clamp the hilum before attempting to repair the airway. Selective intubation of the uninjured bronchus may be attempted in order to prevent the air leak and maintain adequate gas exchange during the procedure. However, the requirement of hurried execution of the procedure may not give enough time for airway manipulation. In extreme situations, urgent thoracotomy and placement of intrabronchial catheters through both the bronchi have been shown to achieve satisfactory ventilation.¹⁷ Advancing the endotracheal tube through the distal end of the severed bronchus and connecting it to a separate ventilation circuit is also helpful to achieve adequate oxygenation as the gas exchange capacity of the transected lung is generally intact.

The overall mortality of the operative intervention is estimated to be 9%. Early complications include anastomotic

leakage or pneumothorax and tracheal-vascular or oesophageal fistula formation. Late complication is usually stenosis, which can be handled with bronchoscopy and dilation.¹⁸ The late functional results of pulmonary resection or bronchial repair are usually excellent.

Contributors VD, EY and JSR were responsible for writing the article, searching literature and patient care. JKM diagnosed and operated the patient, and was responsible for critical review of the article and patient care.

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Learning points

- Early diagnosis of airway injury in children is challenging as all signs and symptoms are non-specific. A high index of suspicion is key to prompt diagnosis.
- A contrast-enhanced CT scan plays a vital role in clinching the diagnosis.
- Bronchoscopy, thought to be a cornerstone in making the diagnosis, may not always be feasible.
- Emergent surgery in these injuries produces the best results.
- Control of airways is challenging and innovative use of the transected lung for ventilation may give enough scope for the surgeon and anaesthetist to execute the repair successfully.

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