Emergency thoracotomy and major lung resection for penetrating chest trauma: Lessons learnt from a review of three cases

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SUMMARY

Emergency lung resection for chest trauma is a rare event with a reported incidence of 0.08-1.3% but is associated with a high morbidity and mortality especially if a pneumonectomy is required, if due to blunt chest trauma or when concomitant injuries are present. We report three cases of young adult males with penetrating chest injuries that required emergency thoracotomy (ET) and anatomical lung resection to achieve definitive control of life threatening pulmonary haemorrhage. All patients survived to hospital discharge and remained well on follow-up. Indications for an ET and what constitutes the optimal operative management of such patients is discussed.

KEY WORDS:
Emergency thoracotomy, Lung resection, Chest trauma

INTRODUCTION

Thoracic trauma is one of the leading causes of death in young adults and accounts for 25-50% of all trauma related injuries [1]. Most patients who sustain a thoracic injury can be managed conservatively often with an intercostal chest drain (ICD) to evacuate an associated haemopneumothorax, assisted ventilation, analgesia and chest physiotherapy. A small but significant proportion however will require an emergency thoracotomy (ET) as part of the initial resuscitation and to facilitate definitive management of their chest injuries. An ET can be defined as one performed immediately at the site of injury, or in the emergency department (ED) or the operation theatre (OT) as an integral part of the resuscitation process. Thoracic trauma may be due to a blunt or penetrating injury and may be an isolated event or concomitant with injuries elsewhere. The decision of who to 'open' and when or where to do so, is difficult but vitally important. Emergency lung resection for chest trauma is a rare event with a reported incidence of 0.08-1.3% but is associated with a high morbidity and mortality [2-4]. We describe our experience of three cases of penetrating chest trauma necessitating ET and major anatomic lung resection to control massive pulmonary haemorrhage.

CASE 1

A 24-year-old Malay male motorcyclist presented to a rural district hospital with an open chest wound after collision with a buffalo. The patient sustained a 9 x 5 cm left anterior chest laceration from being stabbed by a buffalo horn, with exposure of the underlying lung. A chest radiograph (CXR) showed a left hemithorax 'whiteout' and an ICD was inserted draining 1.4 liters of blood. His other injuries were a closed comminuted fracture of the distal left femur and a closed fracture of the distal left tibia and fibula. Following initial resuscitation, the patient was transferred to our unit for further management.

On arrival he was haemodynamically stable (HR 110, BP 114/67) however due to persistent mediastinal bleeding, an exploratory ET was performed in the OT. The bleeding originated from a large and deep laceration in the apical segment of the left upper lobe which could not be controlled with sutures and an upper lobectomy was required to achieve haemostasis. His post-operative recovery was uneventful and he was transferred back to his local hospital (at his request) a week later for definitive management of his lower limb fractures with an interlocking femoral nail and plating of the tibia. He made a full recovery and remains well on follow-up a year later.

CASE 2

A 22-year-old Indonesian male was admitted to our hospital's ED with multiple stab wounds to the thorax, upper abdomen and right upper arm following an alleged assault by seven unknown assailants. On admission he was alert but actively bleeding from a small (3 x 2 cm) right-sided anterior chest wound. The patient was haemodynamically labile (admission BP 80/40 and HR 111). A FAST scan revealed free fluid in the right hemithorax and pelvic region. CXR (Figure 1) showed a 'whiteout' of the right chest however there was minimal drainage following insertion of an ICD by the ED physician. Following adequate resuscitation, an urgent computed tomography (CT) scan (Figure 2) revealed a massive right tension haemothorax with mediastinal shift and compressive atelectasis of the right lung despite the ICD, and a grade III splenic injury. The ICD was promptly readjusted and 1 liter of blood drained from the right chest cavity. In view of the CT findings, the patient proceeded to theatre for an exploratory ET and subsequently laparotomy.

There were multiple bleeding sites in the thorax. A bleeding laceration in the middle lobe was easily controlled with a running 4-0 Prolene (polypropelene) suture reinforced with

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polytetrafluoroethylene (PTFE) felt strips however bleeding from a much deeper laceration in the lower lobe involving the segmental pulmonary artery could not be controlled with sutures and a lower lobectomy was required. Two small intercostal vessel tears and a large diaphragmatic laceration were also identified and controlled with suture ligation. Following thoracotomy closure, the general surgeons performed an exploratory laparotomy, splenectomy and repair of a gastric laceration. Finally, debridement and suture of an extensive laceration with near total transection of the triceps muscle tendon was carried out. The patient received a transfusion of twenty units of blood peri-operatively due to the ongoing massive blood loss. He was extubated on the second post-operative day but remained slightly jaundiced due to the massive blood transfusion. He was discharged home with routine post-splenectomy antibiotic prophylaxis a fortnight later and remains well on follow-up three months later.

CASE 3

A 30-year-old Burmese male presented to ED five hours after being stabbed in the anterior chest by an unknown gentleman with a 10 cm knife. On arrival he was intoxicated, drowsy, haemodynamically unstable (BP 90/50, HR140) and hypoxic with saturations of 65-70% on high flow oxygen. He was resuscitated with intravenous colloids and blood. Examination revealed an infraclavicular 2 x 1 cm stab wound over the anterior left chest just 4cm above the left nipple. CXR revealed a left haemopneumothorax and an ICD was inserted draining 1.25 liters of blood. The patient proceeded to OT and an exploratory ET was performed by extending the anterior left chest wound to obtain appropriate exposure. Intra-operatively, there was an actively bleeding anterior entry stab wound in the left upper lobe and an exit wound posteriorly that was also actively bleeding. Despite initial control of the entry and exit wounds with suture pneumorrhaphy, there was copious airway bleeding from the endotracheal tube (ETT) and the patient remained haemodynamically unstable. An upper lobectomy was emergently performed but the absence of a fissure between the lobes made it technically difficult. Following resection of the upper lobe however there was still persistent bleeding from the ETT and a completion pneumonectomy (preceeded by hilar clamping) was required to arrest the haemorrhage and stabilize the patient's haemodynamics.

In total the patient had received 11 pints of blood. He was extubated several hours later and discharged home on the 5th postoperative day. He remains well on follow-up six months later.

DISCUSSION

The survival rate following an ET for thoracic trauma remains disappointingly low, around 9-12% for penetrating trauma and less so (1-2%) for blunt trauma [4,5]. Hence the decision to perform an ET requires careful but expeditious judgement. ET is usually a futile maneuver if performed in ED for resuscitation of the patient with unresponsive severe haemodynamic compromise due to blunt chest trauma or poly trauma. In contrast, ET for an isolated penetrating chest injury in a victim who remains haemodynamically labile despite resuscitation may be indicated and rewarded with a favourable outcome. The ED physician or general surgeon must be familiar with the anatomy and technique of an anterolateral thoracotomy or less commonly sternotomy, in the absence of a resident cardiothoracic surgeon. An ET is exploratory in nature and the anterolateral thoracotomy in the supine position is often the favoured utility incision. The incision is made just below the nipple in an adult male or below the breast in a female victim, which corresponds approximately to the fourth intercostal space (ICS) level. This supine position was our approach in one patient (case 3) but the routine lateral position was utilized with the other two patients (case 1 and case 2) as this affords excellent exposure to the hilum and familiar orientation of the thorax, and was possible as both patients were relatively stable. In case 3, the surgeon extended the existing traumatic wound into an anterior thoracotomy emergently in a hemodynamically unstable patient in an attempt to get direct access and immediate vascular control of a suspected innominate/subclavian vessel injury. In retrospect however this incision was too superior (2nd ICS level) and made the eventual pneumonectomy challenging, emphasizing the importance of appropriate surgical access. Ideally use of a double lumen ETT will isolate and protect the contralateral lung however this may not be feasible in an acute trauma setting or if a cardiothoracic anaesthetist is unavailable.

When to 'open' the patient in ED is a difficult but important decision that should be made after thoughtful albeit quick deliberation with senior input. Generally speaking, an ET in the ED should be done only for penetrating chest trauma in a patient who remains haemodynamically unstable and in whom transfer to the OT is not safe or feasible. The lack of sterility, proper instruments and lighting often portends a poor outcome and ideally before embarking on this course, a cardiothoracic opinion should be sought if possible. Two of our three patients were haemodynamically unstable but we were still able to transfer them to the OT for the ET after initial resuscitation. A salvage ET for blunt trauma in a patient with severe haemodynamic compromise refractory to full resuscitative attempts is futile and probably unethical. The advantages of operating in the controlled environment of the OT are numerous and self-evident and was undoubtly partly responsible for the good outcomes reported here.

Emergency lung resection for chest trauma is quite rare and mortality increases with a larger resection [2-7]. Minor lung resection includes a pulmonary tractotomy or wedge resection whilst an anatomic resection (lobectomy or pneumonectomy) is categorized as a major lung resection. A limited pulmonary tractotomy has been advocated as a rapid technique of dealing with deep lobar injuries whilst preserving lung parenchyma but may be associated with an increased incidence of infective chest complications [8]. Tractotomy can be performed with either stapler control or clamping and oversewing of the underlying lung bridge. Most series report an increased mortality (approximately 50-70%) with a pneumonectomy hence every attempt should be made to avoid complete removal of the lung [2-5]. In all three cases reported we initially attempted local suture control of the parenchymal laceration (pneumorrhaphy) and only resorted to an anatomical resection when this failed to

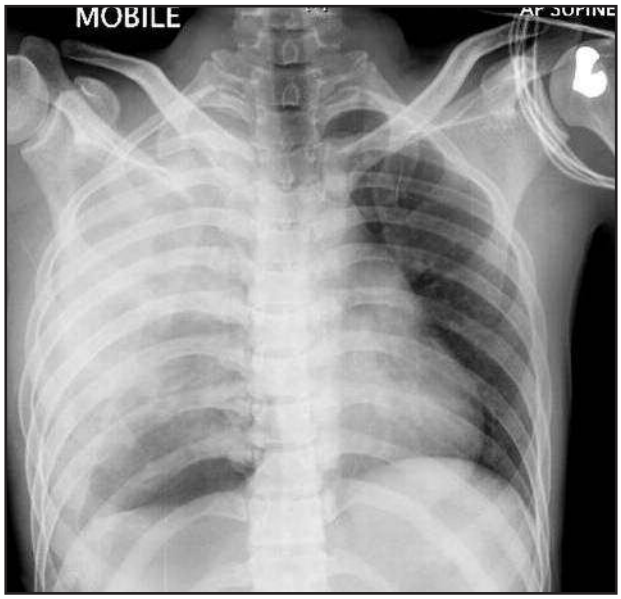

Fig. 1: CXR demonstrating a 'whiteout' of the right hemithorax due to a massive haemothorax prior to ICD insertion.

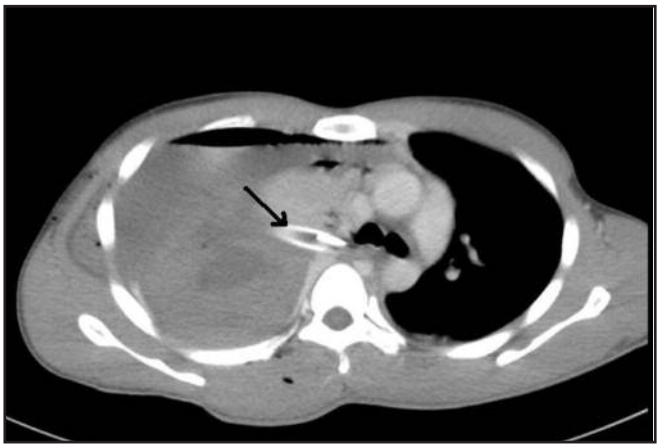

Fig. 2: CT scan demonstrating a massive tension haemothorax with mediastinal shift and compressive atelectasis of the entire right lung despite the presence of an in situ intercostal drain (ICD) (arrow).

control the life-threatening persistent haemorrhage. We were fortunate not to encounter any major pulmonary vessel or cardiac injury. A peripheral injury can be dealt with effectively by simple oversewing, reinforced with buttressed strips for pneumostasis or with an excisional non-anatomic wedge resection. However oversewing more central or deeper lobar lacerations may not arrest the bleeding and can compromise segmental or lobar pulmonary arterial perfusion with resulting parenchymal infarction. An anatomical resection (lobectomy) is beneficial in such circumstances and was favoured in the three cases reported. In case 3, we had no alternative but to ultimately proceed with a pneumonectomy as the bleeding persisted despite removal of the damaged left upper lobe. The pneumonectomy was preceeded by hilar clamping to achieve temporary haemostasis. The technique of twisting the entire lung on its hilar axis by 180 degrees has been reported to quickly control exsanguinating blood loss and prevent air embolism by occluding the hilar vessels and main bronchus (9). We have no personal experience with this lung twist salvage maneuver.

Lessons learnt

Every attempt should be made to resuscitate and stabilize the patient sufficiently to facilitate transfer to the OT. Survival to hospital discharge following an ET in the ED is extremely rare[10]. Case 1 illustrates that despite the presence of an ICD it was possible for a tension haemothorax to develop and highlights the importance of reassessment and possible re-adjustment of an ICD following initial insertion. In this case the ICD had been initially advanced too far and thus was occluded by the collapsed lung. For the stable patient, a CT scan is invaluable diagnostic tool although admittedly this may not be feasible in a less stable patient.

The indications for an ET on the basis of blood loss are variable and also dependant on the haemodynamic status of the victim but most surgeons would agree 1-1.5 liters in the initial ICD output mandates chest opening. Having said that, if the CXR or CT demonstrates a chest full of blood but minimal ICD drainage like with case 2, then an ET is also required. Other indications include persistent bleeding of 200ml/hr or more for three consecutive hours, ventilatory failure due to massive airway bleeding and massive air leak without lung re-expansion despite mechanical ventilation and ICD placement [11, 12].

In two cases, the peri-operative blood loss was life threateningly massive and substantial blood transfusions were required. Resection was indicated to achieve control of the bleeding and one should not shy away from this to achieve definitive control. The surgeon's familiarity and experience with anatomic lobectomies however must be taken into consideration. An emergency lobectomy or pneumonectomy in the face of bleeding and haemodynamic instability is a daunting task even for a thoracic surgeon and especially so for the non-thoracic surgeon who may only perform the occasional lung resection. Judicious post-operative fluid management is of paramount importance to reduce any secondary insult from a possible transfusion-related acute lung injury (TRALI) [13].

Case 2 illustrates the importance of meticulous intra-operative assessment as concomitant and occult thoracic injuries may exist. The diaphragmatic laceration only became evident following the right lower lobectomy. A higher Injury Severity Score (ISS) usually reflects polytrauma or concomitant injuries and is associated with an increased mortality. Most series report higher ISS scores for non-survivors [3]. The ISS is a valuable parameter in predicting the need for an ET [14,15]. Any associated cardiac injury will also increase the risk. It is intuitive but important that the most life threatening injuries are dealt with first. In this instance the exsanguinating pulmonary haemorrhage was identified and treated before an exploratory laparotomy and splenectomy was performed for associated abdominal trauma.

The intra-operative decision making time in critically evaluating the injury and formulating the surgical plan must be kept to a minimum. We feel this was another factor in the successful outcomes reported here. In all three cases, the operating surgeon was a consultant cardiothoracic surgeon assisted by a consultant colleague.

CONCLUSION

ET and lung resection for thoracic trauma is a rare event associated with considerable mortality and morbidity. However as most victims are young, they are well compensated despite considerable blood loss. Surgery is best performed for penetrating trauma and in the OT environment where possible. Avoidance of a pneumonectomy is preferred however ultimately arresting the life-threatening haemorrhage may necessitate one. The non-cardiothoracic surgeon must be familiar with indications for and techniques of rapid access into the thorax for such injuries. The decision of when to perform an ET in the ED should be made with senior input and where possible following consultation with a cardiothoracic surgeon.

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