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Case Report

# Blunt bronchial injury management with veno-venous extracorporeal membrane oxygenation providing a peri-operative 'survival bridge'☆

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## Introduction

Bronchial injury is a rare and morbid complication of blunt trauma. It should be suspected in patients with refractory hypoxia despite adequate chest decompression, with flexible bronchoscopy the investigation of choice. This paper reports on the use of Veno-venous Extracorporeal Membrane Oxygenation (VV ECMO) to maintain oxygenation of a patient with blunt bronchial injury in the perioperative period. VV ECMO provides a bridge to survival, providing time to perform investigations, to identify and stabilise other injuries, and to more accurately prognosticate.

## Case report

A 19-year-old male was transported to the Trauma Centre after a high-speed motorbike crash. On arrival of paramedics he had a Glasgow Coma Scale (GCS) of 3, although the remaining vital signs were normal. Following endotracheal intubation and commencement of positive pressure ventilation, the patient became progressively hypoxic, despite bilateral finger thoracostomy.

On arrival at the Trauma Centre the patient was tachycardic, hypotensive with a systolic blood pressure of 45 mmHg and hypothermic with a temperature of 31 degrees Celsius. Oxygen saturations were 75% on a fraction of inspired oxygen (FiO2) of 1. A chest x-ray demonstrated a left sided haemopneumothorax with right-sided mediastinal shift (Fig. 1). Pneumomediastinum was noted. Extended focussed assessment with sonography for trauma scanning demonstrated absent lung sliding on the right. There was no free fluid in the abdomen or pericardium. Bilateral chest decompression with intercostal catheters (ICCs) were performed, with minimal blood output.

There was no improvement in oxygen saturation or blood pressure following bilateral chest decompression. Repeat chest x-ray

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demonstrated worsening right-sided mediastinal shift and the left sided ICC was re-inserted. Persistent mediastinal shift prompted bronchoscopy, which demonstrated that the left main bronchus was disrupted 5 cm beyond the carina, at the origin of the left upper lobe bronchus (Fig. 2, Supplementary Video 1). There was visibly shredded cartilage and soft tissue, with haematoma present.

A bronchial blocker was placed down the endotracheal tube to exclude ventilation of the left lung. Urgent theatre was arranged. As oxygen saturations had stabilised, a Computed Tomography (CT) scan was undertaken which demonstrated abrupt cut-off of the left upper lobe bronchus (Fig. 3). Other identified injuries included atlanto-occipital dissociation and atlanto-axial subluxation, left 2nd-4th rib fractures and multiple closed left upper limb fractures. There was a left lateral maxillary wall fracture and an open right femur fracture.

The patient subsequently became difficult to ventilate, with oxygen saturations of 90% on an FiO2 of 1. Arterial blood gas analysis revealed a pO2 of 65 mmHg. There were concerns regarding potential hypoxic brain injury and the decision was made to undergo a Magnetic Resonance Imaging (MRI) brain to establish whether there was an unsurvivable brain injury. This demonstrated small bilateral volume subarachnoid and intraventricular haemorrhages, small volume bilateral parieto-occipital subdural haematomas, and grade 1 diffuse axonal injury. As there was ongoing difficulty achieving adequate oxygenation, despite optimised mechanical ventilation (with selective right lung ventilation using a bronchial blocker), and competing management priorities with an unstable high cervical spine fracture and significant closed head trauma, the decision was made to commence VV ECMO, as a bridge to definitive surgical repair, and to allow temporisation of other injuries.

VV ECMO was commenced by ultrasound guided placement of a 21Fr 55 cm left femoral vein multistage access cannula, and a 19Fr 15 cm right internal jugular vein return cannula. The ECMO strategy aimed for safe ventilation with a tidal volume of <6 ml/kg, with peak inspiratory pressures <30 cm/H2O and an FiO2 of <0.6, whilst maintaining oxygen saturations between 88 and 94%. Given his

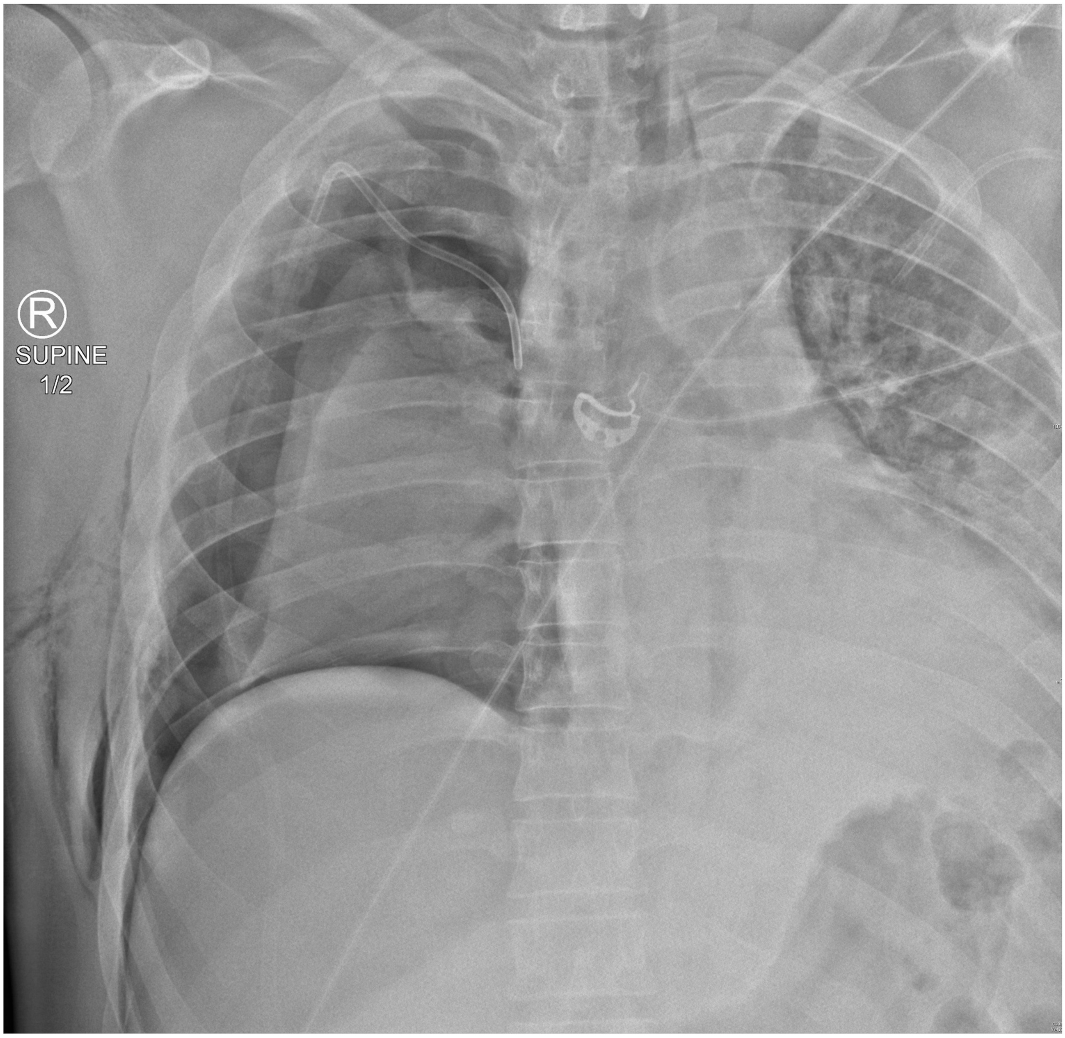


**Fig. 1.** Admission chest x-ray of a patient with blunt bronchial injury
A 19-year-old gentleman presented to the Emergency Department following a high-speed motor bike accident. A chest x-ray was performed which demonstrated a left sided haemopneumothorax with right sided mediastinal shift.

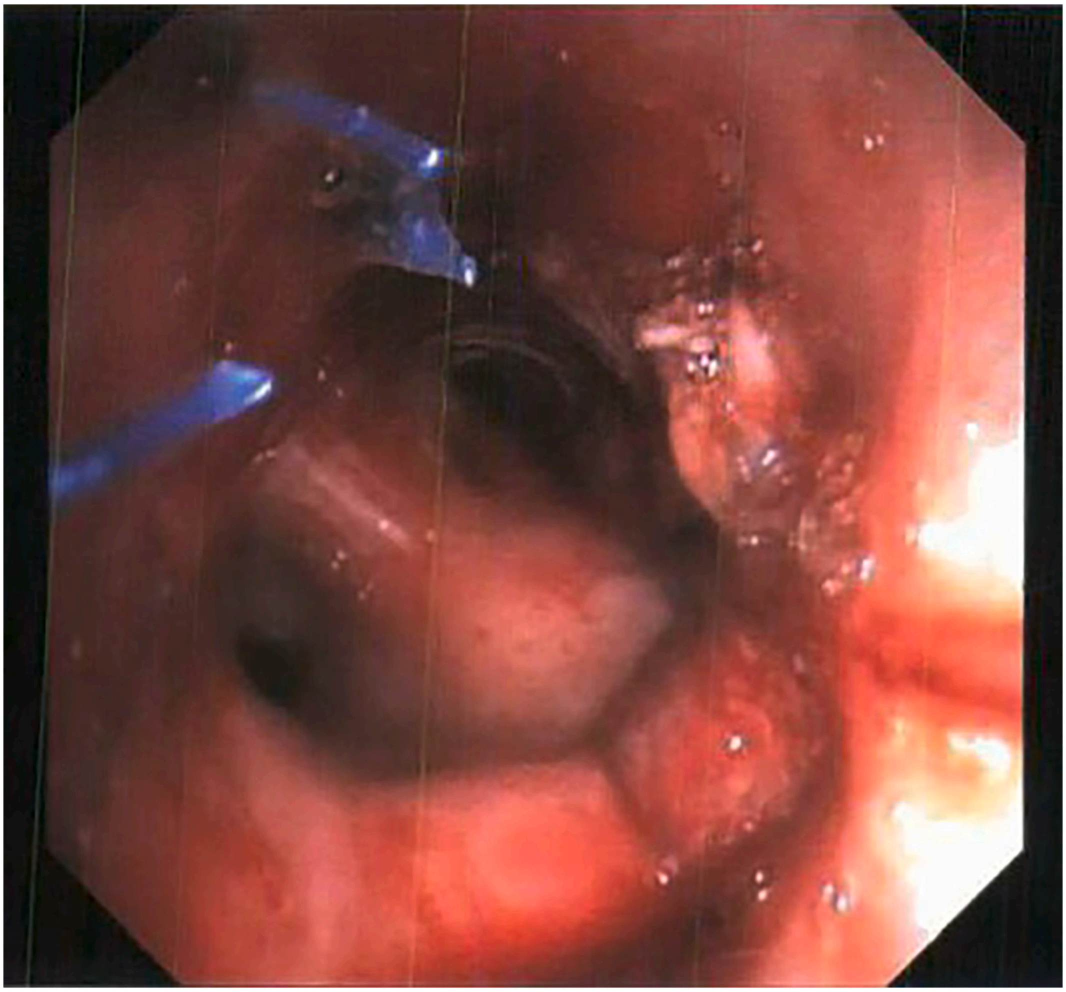

**Fig. 2.** Bronchoscopy of blunt bronchial injury
Hypoxia refractory to chest decompression prompted bronchoscopy to be undertaken, which demonstrated disruption of the left main bronchus, 5 cm beyond the carina. Visibly shredded cartilage and soft tissue was visible, with haematoma present.

closed head trauma, the patient was not anticoagulated. Coagulopathy was monitored for and aggressively managed as necessary. The patient was placed in a HALO thoracic brace for stabilisation of his cervical spine injury and planned for return to the operating theatre the next day for definitive repair of the bronchial injury.

The following day an anterior thoracotomy through the 3rd intercostal space was performed. The margins of the left main bronchus were mobilised and cartilage and devitalised tissue were excised. An end-to-end anastomosis was performed using 4′0 Prolene with interrupted sutures to the trachealis muscle and interrupted sutures to the anterior cartilage. The anastomosis was tested after completion and deemed aerostatic. The chest was washed out, and flexible bronchoscopy undertaken to confirm adequate closure. This was followed by insertion of an intracranial pressure monitor (ICPm) and an external ventricular drain (EVD).

Systemic heparin was commenced on day 5 of the admission, 6 h post-removal of his ICPm and EVD, with a target activated partial thromboplastin time (APTT) of 50–70, monitored every 6 h. This was abruptly ceased on day 6 as the patient developed acute lower limb paralysis, requiring emergent cranio-cervical fusion (C0-C4). Despite this, he recovered well from his blunt chest trauma and was successfully decannulated from VV ECMO on postoperative day 8. An IVC filter was placed at this time for a left leg femoral vein thrombus. The patient was successfully discharged to rehabilitation on post-operative day 34, with a GCS of 15.

## Discussion

Early bronchoscopy is a key investigation in determining the cause of persistent hypoxia in the trauma patient post pleural decompression [1]. Bronchoscopy may demonstrate tearing of the bronchial wall, blood in the airway and inability to view the distal branches of the bronchial tree [1].

In blunt bronchial injury, patients often have concomitant concerns regarding cervical spine injury, contraindicating rigid

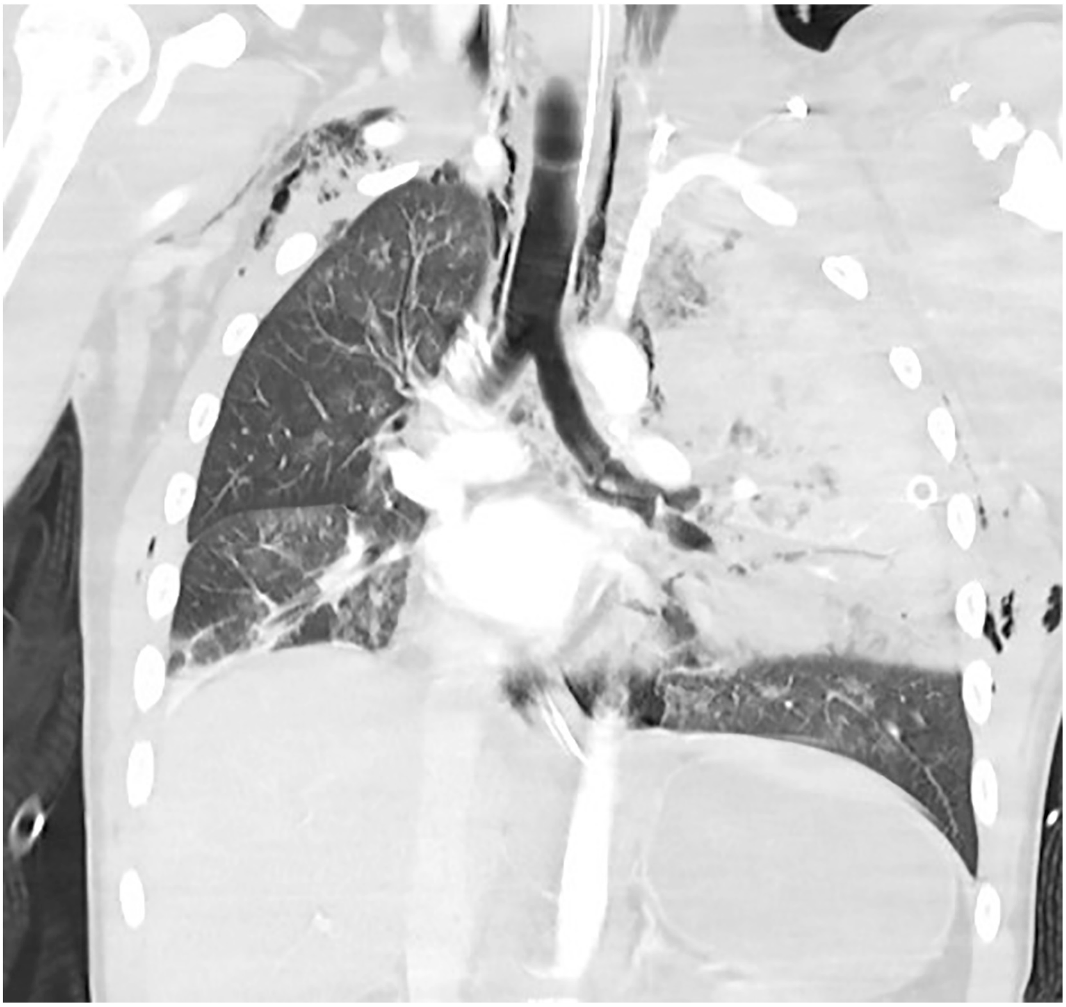

**Fig. 3.** Computerised Tomography (CT) scan of blunt bronchial injury
A CT pan-scan was performed, which demonstrated abrupt cut-off of the left upper lobe bronchus, at the site of injury.

bronchoscopy and making flexible bronchoscopy the investigation of choice [1,2].

Common chest x-ray findings include subcutaneous emphysema, pneumomediastinum and pneumothorax [1]. Despite this, it is worth noting that 10–20% of patients with traumatic bronchial injury may have no signs on chest x-ray [1,2].

In the above case, VV ECMO was used as a survival bridge in a patient with significant ventilatory defects, to enable time for stabilisation of other injuries and prognostication prior to definitive surgical repair. VV ECMO has been used successfully to maintain oxygenation in patients with iatrogenic tracheobronchial bronchial injuries [3], whilst veno-arterial (VA) ECMO has been used in patients requiring complex tracheobronchial reconstruction for malignancy [4]. The potential perioperative applications of ECMO in the trauma population are less clearly defined. VV ECMO has been used for oxygenation support in trauma patients with acute respiratory distress syndrome (ARDS) and other sequelae of blunt chest trauma [5]. Our institution has successfully used VV ECMO in the acute post-operative care of a patient with thoracic compartment syndrome, permitting ventilation with reduced pressures [6]. In this case, VV ECMO was opted for as the patient remained hemodynamically stable despite their respiratory failure, although VA ECMO has also been described as a perioperative bridge in the critically unwell trauma patient with thoracic trauma [7]. Whilst the ECMO circuitry was heparin and albumin coated, systemic heparinisation was avoided in this case due to neurosurgical trauma. Use of VV ECMO without anticoagulation for trauma patients with haemorrhagic shock has been reported in the literature, albeit in small numbers [8]. We offer this case as an example of successful use of VV ECMO without systemic heparinisation in the setting of a multi-trauma patient with intracranial haemorrhage.

## Conclusion

Blunt bronchial injury is rare but should be considered in any trauma patient with hypoxia refractory to adequate chest decompression. VV ECMO may provide life-saving oxygenation in the perioperative period. VV ECMO without anticoagulation permits such support in a trauma population with high bleeding risk.

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