



Perioperative extracorporeal membrane oxygenation in traumatic bronchial avulsion



Erin E. Bennett*, Salim Aljabari, Scott Short, Eric Scaife, W. Brad Poss

University of Utah, Salt Lake City, UT, USA

ARTICLE INFO

Keywords:

Pediatric trauma
Respiratory failure
Extracorporeal membrane oxygenation
ECMO
Bronchial avulsion

ABSTRACT

Traumatic bronchial avulsion is standardly treated with emergent lobectomy versus primary repair. We reviewed our experience with peri-operative use of extracorporeal membrane oxygenation (ECMO) to manage respiratory failure in two cases of pediatric chest trauma. ECMO can be an effective intervention to overcome respiratory failure, facilitate surgical repair, and promote healing in bronchial injuries as a result of blunt chest trauma in children.

1. Introduction

Tracheobronchial injuries are rare but associated with high mortality and morbidity. Current reports suggest a mortality rate of 9–30% [1,2] if the patient survives the initial traumatic injury. Crush injuries, blunt, or penetrating trauma are the etiologies for most tracheobronchial injuries [3,4]. Conventional treatment for tracheobronchial injuries includes conservative management with observation and supportive therapy to more invasive approaches, including surgical repair. Surgical options include lobectomy or primary repair of the avulsed bronchus [1]. In severe respiratory decompensation after traumatic injury, the use of venovenous extracorporeal membrane oxygenation (V-V ECMO) is described a viable adjunctive option as a bridge to surgical repair [1]. V-V ECMO allows for a controlled approach to surgery and allows the surgeon time to allow resolution of the acute inflammatory phase after injury. V-V ECMO in pediatric patients with traumatic airway injuries has not been well described, so we aim to highlight situations in which V-V ECMO is beneficial.

2. Aim

We describe two pediatric cases of traumatic bronchial avulsion with respiratory compromise refractory to conventional management and different forms of mechanical ventilation that were supported on V-V ECMO as a bridge to surgical repair of tracheobronchial injury.

3. Case 1

A previously healthy 2-year-old male sustained a crush injury to the

right hemithorax when he was pinned between the bucket of a tractor and the tractor itself. The patient had severe respiratory distress with pneumomediastinum and hemopneumothorax requiring multiple chest tubes (Figs. 1 and 2). Once the patient was appropriately stabilized, a flexible bronchoscopy and esophagoscopy revealed a 2 cm traumatic avulsion of the right mainstem bronchus with intact peri-bronchial tissues and no esophageal defect. Additional injuries included a right first rib fracture, bilateral non-displaced scapular fractures, mandibular de-gloving injury, right chest wall and right neck hematomas, right axillary laceration and soft tissue defect, right latissimus avulsion, and gingival laceration.

Our initial plan was to manage the patient conservatively in the pediatric intensive care unit (PICU) on rest ventilator settings. Based on prior experience at our institution, hemodynamically stable patients have successfully recovered from major tracheobronchial injury using the conservative approach. In this case, however, conservative management utilizing rest ventilation failed. Over the first 72 h of hospitalization, the patient received high frequency oscillatory ventilation (HFOV) to minimize volutrauma and maintain a stable mean airway pressure. He had progressive difficulty oxygenating and ventilating and had an acute decompensation event uncorrectable with ventilator support. His pulse oximeter saturation was 50s-60s and an arterial blood gas showed an acidotic pH of 7.23 with the following arterial partial pressures: carbon dioxide of 93 mmHg, oxygen 51, bicarbonate 39 and a base excess of 12 mmol/L. This progression was due to blossoming pulmonary contusions and pulmonary edema and rather than proceed with emergent surgical repair of the bronchus, we elected to cannulate for V-V ECMO in an attempt to facilitate pulmonary recovery while his right mainstem bronchus was allowed to heal (Fig. 3).

* Corresponding author. 295 Chipeta Way, PO Box 581289, Salt Lake City, UT, 84115, USA.
E-mail address: Erin.Bennett@hsc.utah.edu (E.E. Bennett).

<https://doi.org/10.1016/j.epsc.2018.05.012>

Received 16 May 2018; Accepted 18 May 2018

Available online 19 May 2018

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Fig. 1. Case 1: Portable anteroposterior chest x-ray demonstrating large right pneumothorax, massive subcutaneous emphysema, and pulmonary contusions.



Fig. 2. Case 1: Portable anteroposterior chest x-ray demonstrating successful evacuation of pneumothorax, bilaterally appropriately placed chest tubes.

The patient remained stable on V-V ECMO except for bleeding into his right axillary wound that required surgical incision and drainage without further complication. Serial bronchoscopies failed to demonstrate any notable healing of his right mainstem bronchus despite single lung ventilation with endotracheal tube placement in the left lung (Fig. 4). On hospital day 11 after 8 days on ECMO, he underwent primary repair of his right mainstem bronchus. V-V ECMO allowed for resolution of pulmonary contusions and improvement of his lung mechanics prior to surgical repair of the bronchial injury. Sternotomy on ECMO was attempted for repair of the avulsed bronchus, but we were unable to expose the bronchus without kinking or obstructing our V-V cannula and proceeded with centrally cannulation onto cardiopulmonary bypass for the operation. The aorta was retracted to the left, the SVC to the right, and the right pulmonary artery inferiorly to obtain good exposure to the carina/distal trachea and proximal bronchi. The

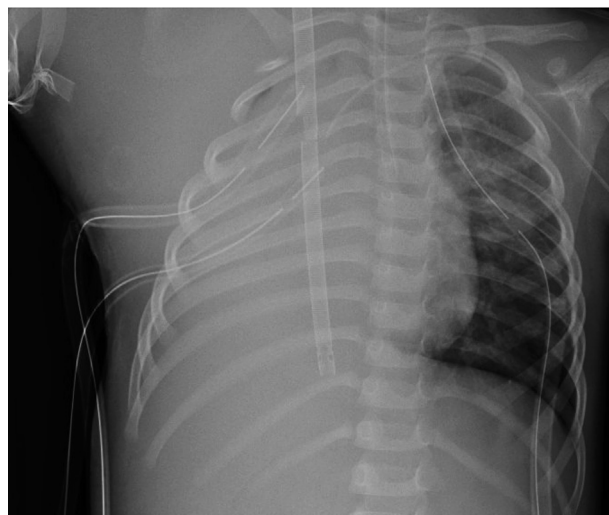


Fig. 3. Case 1: Portable anteroposterior chest x-ray demonstrating the endotracheal tube in the left mainstem bronchus, a venous ECMO cannula, 3 pleural chest tubes, a left upper extremity peripherally inserted central catheter, and a right axillary surgical drain.

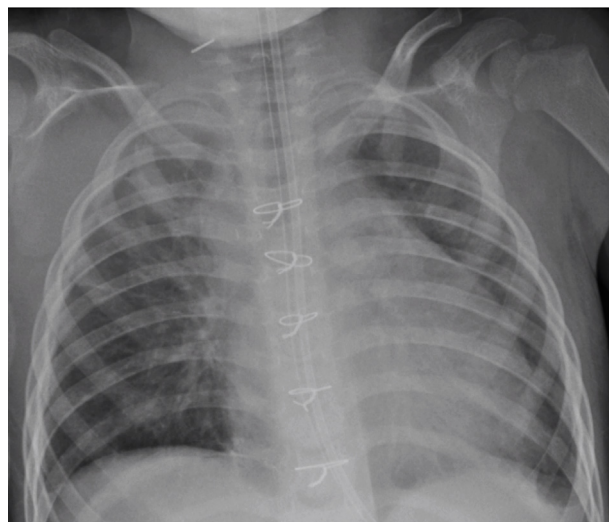


Fig. 4. Case 1: Portable anteroposterior chest x-ray demonstrating improved right lung aeration with mild patchy volume loss in the right upper lobe.

peribronchial tissue was excised, exposing a circumferential and full thickness bronchial avulsion, and the devitalized tissue was removed. The bronchial ends were then re-approximated using a 5-0 PDS running suture buttressed with pericardium on the posterior aspect and simple interrupted sutures buttressed with pericardium on the anterior side. Following repair, we assessed his ability to oxygenate without extracorporeal support and we were able to successfully decannulate at the end of the operation. The patient returned to the PICU on conventional mechanical ventilation, was extubated on hospital day 19, and was discharged on hospital day 43 (Fig. 4). At 6-month follow-up, he was neurologically appropriate for age and able to complete normal activities of daily living although has required treatment for swallowing dysfunction and surgical scar contractures.

4. Case 2

A 13-month-old previously healthy male was admitted to the pediatric intensive care unit after he suffered a crush injury to the right hemithorax from being run over by car driving at low speeds. He

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