Benefits of extracorporeal membrane oxygenation for major blunt tracheobronchial trauma in the paediatric age group

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Received 13 August 2012; received in revised form 3 October 2012; accepted 22 October 2012

Abstract

Tracheobronchial rupture due to blunt chest trauma is a rare but life-threatening injury among children. The severity of this condition ranges from death before hospital admission to clinical stability resulting in delayed management. Diagnosis is difficult because there is sometimes no evidence of external trauma, in spite of severe chest crush injury and consecutive rupture of airways. Here, we report the case of a 32-month-old girl whose torso was crushed by a van, resulting in bilateral bronchi disconnection. She was admitted to our hospital with cardiac and respiratory arrest. After prompt resuscitation, flexible bronchoscopy permitted the accurate visualization of the rupture and its extent. The life-saving procedure consisted of surgical repair using extracorporeal membrane oxygenation (ECMO) as ventilatory support. This provided rapid relief from the injury, which was previously expected to result in death. These data suggest that ECMO could be beneficial as supportive therapy for selected paediatric patients with major tracheobronchial traumas.

Keywords: Tracheobronchial trauma • Children • ECMO

INTRODUCTION

Major tracheobronchial trauma (MTT) is extremely rare among children [1]. Anatomical differences between the child and adult thorax could explain the patterns of injury observed in children. A rapid increase in tracheobronchial pressure can lead to blowout perforation of the trachea without rib fracture. Prompt diagnosis and efficient treatment are major prognostic factors for these rare injuries, which have high mortality rates [1]. This report presents the case of a child with bilateral bronchi disconnection due to severe crush injury, who received extracorporeal membrane oxygenation (ECMO) as supportive therapy.

CASE REPORT

A 32-month-old girl weighing 12 kg was involved as a pedestrian in a motor vehicle accident, and was crushed by a van. Within 30 min, she was admitted to our hospital with cardiac and respiratory arrest, which was reversed after 12 min of resuscitation, including intubation. The mean arterial pressure was then maintained at around 70 mmHg and the heart rate >150/min by an epinephrine infusion. A massive subcutaneous emphysema of the chest, neck and face appeared and right pleural drainage was placed. The initial chest X-ray showed bilateral pneumothoraces: a full one with drainage on the right side and a smaller one on the left side, as well as a distinct pneumomediastinum. At this time, the biological tests revealed severe acidosis (pH = 7.1), with PaO2 and PCO2 at 30 and 72 mmHg, respectively. The lactic acid level was 13 mmol and the haemoglobin (Hb) level was 9.5 g/dl. A computed tomography (CT) was performed, but did not enable us to accurately visualize the tracheobronchial lesions (Fig. 1). The endotracheal tube was noted to be outside the trachea. There were no signs of intrathoracic haemorrhage or associated injuries. After drainage of the left pleural space, the child was taken to the operating room within 2 h of the trauma. Fiberoptic endoscopy revealed a laceration of the carina. The tracheal bifurcation could not be visualized. Because of a decrease in FiO2 and increasing intrathoracic pressure, we switched from mechanical to manual ventilation. This was associated with a haemodynamic instability despite an epinephrine infusion. Venoarterial ECMO with heparin was then instituted through the right femoral vein and the right carotid artery. PaO2 rapidly improved from 18 to 54 mmHg and the Hb level was stable. After a few minutes, oxygenation and haemodynamic parameters were satisfactory at 2/3 of theoretical flow, allowing a right posterolateral thoracotomy. Ventilation was stopped during surgery. The two main bronchi were disconnected and the trachea was torn up to 2 cm above the tracheal bifurcation. Surgical repair required removal of the endotracheal tube. A discontinuous suture was performed. The girl was re-intubated under ECMO, and protective ventilation was started (i.e. low tidal volume (5 ml/kg) 15 times per minute, and positive-end expiratory pressure under 6 mmHg). On the second postoperative day, ECMO was switched to the venovenous mode using the right subclavian vein in order to maintain protective ventilation, as cardiac function was completely restored (the patient had been weaned off epinephrine since Day 1). ECMO was stopped on the fourth postoperative day, when ventilation with low FiO2 became possible, after reducing ECMO participation.
(flow and FiO2) in haematosis. The girl was extubated on the 19th postoperative day without any problem. She was discharged in good health and did not present any further complication after a follow-up of 2 years. A normal bronchoscopy did not reveal any tracheal stenosis.

**DISCUSSION**

This is the first reported case of MTT repair involving ECMO, although the use of ECMO for elective tracheal surgery in children has previously been described [2]. Persistent large-volume air leaks despite adequate chest drainage are highly suggestive of a large tracheobronchial tear. The critical stage in MTT diagnosis is the bronchoscopy. In cases of clinical instability, surgical intervention is necessary as a lifesaving procedure even if the diagnosis has not previously been confirmed [1].

The choice of the surgical approach depends on the location and length of the tear. A right posterolateral thoracotomy provides good exposure of the distal trachea and mainstem bronchi, but median sternotomy is preferred in cases where there is a risk of bleeding lesions. The treatment of total bronchial or tracheal rupture consists of surgical exploration and primary repair. Severe trauma injuries are regarded as a contraindication for ECMO because of the risk of unstoppable bleeding. However, ECMO was proposed as a support system for paediatric patients with post-traumatic respiratory failure or acute respiratory distress syndrome [3]. ECMO is also considered to be a supportive therapy for the postoperative period in patients with severe pulmonary contusion or for the prevention of barotrauma after bronchial repair. Recent reports regarding the use of venovenous ECMO for the management of adult patients with endobronchial haemorrhage and surgical bronchial repair after traumatic rupture have been published [4, 5].

If optimal chest drainage and ventilation fail to restore a stable condition for paediatric MTT, ECMO can be indicated urgently before surgery. It can also be instituted to facilitate surgical repair and postoperative management (particularly ventilation). In our centre, ECMO is available at any time within 30 min, and the ECMO team (a cardiac surgeon and a perfusionist) is called as soon as the medical rescue team is sent to the scene of the emergency.

In cases of haemodynamic instability, we recommend the use of venoarterial ECMO. This reduces venous bleeding by lowering central blood pressure, but risks major air embolism in cases involving large venous tears. With venovenous ECMO, the blood flow is easily maintained. This technique offers theoretical benefits by allowing native pulmonary flow (increasing the pulmonary alveolar oxygen content) and easier weaning.

We recommend using coated tubing, cautious provision of heparin and close monitoring of the activity clotting time (around 200 s). Unfortunately, ECMO remains inappropriate in cases of major bleeding or intracranial haemorrhage.

**CONCLUSION**

This case suggests that ECMO is beneficial as a supportive therapy for paediatric MTT. When initiated before surgery, it provides better conditions for surgical repair by enabling the interruption of mechanical ventilation. Moreover, in the selected cases, it provides postoperative respiratory support by maintaining systemic oxygenation without ventilator-induced barotrauma of the lungs and airways.

**Conflict of interest:** none declared.

**REFERENCES**


