J Ped Surg Case Reports 1 (2013) 273–276

Contents lists available at ScienceDirect

Journal of Pediatric Surgery CASE REPORTS

journal homepage: www.jpscasereports.com

# Sand aspiration in a child: Extracorporeal membrane oxygenation (ECMO) as a new management tool

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ARTICLE INFO

*Article history:*
Received 28 March 2013
Received in revised form
28 June 2013
Accepted 7 July 2013

*Key words:*
Child
Sand
Aspiration
ECMO
Bronchoscopy
Accident

ABSTRACT

Sand aspiration is rare in children. It is a potentially lethal injury, with outcomes ranging from full recovery to global cerebral asphyxia and death. The medical literature was searched for cases of sand aspiration in children, including mechanisms of injury and treatment methods. We found only ten reports of pediatric sand aspiration. The majority were treated with bronchoscopy and lavage. We present a unique case of sand aspiration in a ten-year-old boy caused by an accidental burial, which was successfully treated with bronchoscopy and extra-corporeal membrane oxygenation (ECMO) as a rescue therapy. This is the first ever case of the use of ECMO in the management of sand aspiration. We argue that ECMO is an effective and potentially life-saving measure in severe cases of sand aspiration requiring high ventilatory pressures allowing repeated bronchoscopies while resting the lungs.



Sand aspiration is an uncommon but potentially lethal injury. The clinical presentation can vary from moderate respiratory distress requiring supplemental oxygen, to complete airway obstruction resulting in severe hypoxemia leading to cerebral asphyxia [1,2]. Due to the rarity of occurrence in infants and children, clear diagnostic and treatment recommendations have not been established.

There have been only ten reports of pediatric sand aspiration in the medical literature since its first description in 1962 [3–10]. Mechanisms have included accidental burial, nonfatal drowning, and deliberate sand ingestion. Diagnostic and treatment modalities varied, but clinical outcomes were even more diverse from full recovery with no sequelae, to death.

We henceforth present a case of severe sand aspiration in a child caused by an accidental burial. This is the first case in the medical literature of the use of extracorporeal membrane oxygenation (ECMO) in the management of sand aspiration. The epidemiology and literature surrounding diagnostic and treatment modalities for this type of injury are also reviewed.

## 1. Case report

A previously healthy eleven-year-old boy (40 kg), was admitted with severe respiratory distress. He was digging a hole at the bottom of a sand dune with his younger brother when the dune collapsed, burying him completely except for the tip of his left hand. The child was immersed for approximately 5 min before his father was able to retrieve him. When he was extracted, he was unconscious and apneic, but did have a pulse. His father initiated rescue breaths for several minutes, after which the boy recovered consciousness and gasped for air, then vomited several times.

Emergency personnel arrived on the scene within 15 min, and immediately intubated the child with a 6.5 mm cuffed endotracheal

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2213-5766 
http://dx.doi.org/10.1016/j.epsc.2013.07.016

tube. He was manually ventilated for 6 h during air transport to the nearest tertiary care center.

On arrival in hospital, the child was hemodynamically stable and manually ventilated via endotracheal tube. Examination of the chest revealed almost no air entry to the right lung, and bilateral wheezes with bronchial breath sounds and crackles to both lung bases. An arterial blood gas measurement taken demonstrated pH 6.9, $pCO_2$ 120 torr [16.0 kPa], $pO_2$ 63 torr [8.4 kPa], $HCO_3$ 17 mmol/L, base excess −11, $SaO_2$ 90%, and Hemoglobin 136 g/L.

The child was managed with nebulized albuterol and epinephrine, but displayed little improvement. He was also started on piperacillin/tazobactam for prophylactic antimicrobial coverage. He was commenced on mechanical ventilation, with initial settings as follows: peak inspiratory pressure (PIP) 20 cm $H_2O$, positive end-expiratory pressure (PEEP) 10 cm $H_2O$ at $F_IO_2$ 0.40. The *P*/*F* ratio ($PaO_2/F_IO_2$) was 158, and the oxygenation index (OI = [mean airway pressure × $F_IO_2/PaO_2$] × 100) was 57. The otolaryngology team was consulted and recommended that the child to undergo a bronchoscopy. However, the patient quickly deteriorated and had refractory hypercarbia and hypoxemia despite maximal support on mechanical ventilation. It was felt that the most appropriate course would be to place the child on ECMO to allow for adequate ventilation and oxygenation before proceeding with bronchoscopy. ECMO was chosen instead of cardiopulmonary bypass due to the fear of secondary lung injury from bronchoalveolar lavage (BAL), resulting in temporarily worsened oxygenation, in addition to the rapid clinical deterioration and level of distress hence the likelihood of requiring longer support.

A 23 French Avalon® Bi-Caval Dual Lumen Catheter (Avalon Laboratories, LLC., Rancho Dominguez, CA, USA 90220) was inserted from the right internal jugular vein, and venovenous (VV) ECMO was initiated at a flow of 50 mL/kg/min which maintained the patient's oxygen saturation above 85%. Higher flow was not achievable due to significant negative access pressure. A chest X-ray taken soon after ECMO cannulation revealed adequate cannula placement, with bilateral fluffy peri-hilar infiltrates, and near-complete opacification of the right lung. The X-ray also demonstrated a classic sand bronchogram (Fig. 1).

The child was then airlifted from the referring hospital to our facility by our Extra Corporeal Life Support (ECLS) transport team for definitive care with ECLS, since we are the regional center for this support modality. Given the limited flow obtained with the original catheter, a second drain (15Fr Bio-Medicus® cannula [Medtronic, Inc., Minneapolis, MA, USA 55432]) was inserted in the femoral vein to optimize flow and consequently minimize the required ventilator pressures.

Following successful initiation of ECMO, the patient underwent suspension laryngoscopy, and dexamethasone and epinephrine were topically applied to the airway. Rigid bronchoscopy was performed, revealing significant edema of the vocal cords and the trachea down to the level of both main-stem bronchi with significant mucosal inflammation and friability. Sand granules were seen almost completely obstructing both main stem bronchi. Repeated saline lavage was used to remove the remaining foreign material until both bronchi were cleared.

After the procedure, the oxygen saturation was easier to maintain with ECMO flow at 60 mL/kg/min. Initial echocardiogram showed decreased left ventricular function and mild mitral valve regurgitation, while the chest X-ray revealed white-out lungs bilaterally (Fig. 2). Therefore, low dose inotropes including epinephrine were used for three days, since the patient was kept on VV ECMO.

On day 2 the child required another bronchoscopy with BAL to clear the remaining sand debris in the airway. The patient was successfully weaned off ECMO by day 3 (Fig. 3). He continued to recover and was successfully extubated 6 days after the aspiration event. He was discharged from the pediatric intensive care unit the following day, and was discharged from hospital on day 12. He left the hospital without oxygen requirements and back to his baseline according to the parents' assessment.

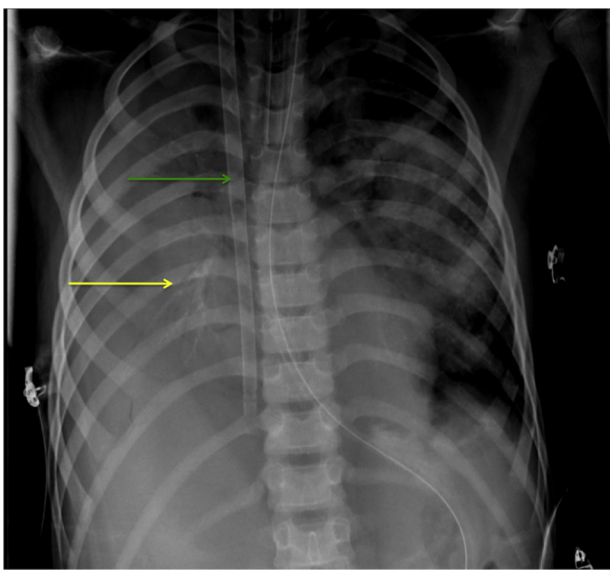

**Fig. 1.** Chest radiograph immediately following ECMO cannulation for sand aspiration, showing near complete opacification of the right lung indicative of early acute respiratory distress syndrome, and a right-sided sand bronchogram (yellow arrow). An ECMO cannula is seen entering at the right internal jugular vein (green arrow). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

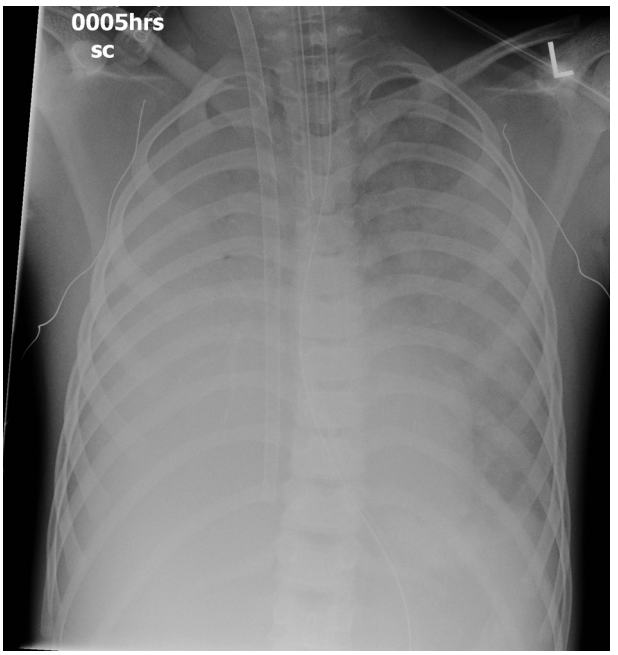


**Fig. 2.** Chest radiograph 1 h following bronchoscopy with bronchoalveolar lavage for sand aspiration showing complete white-out of both lung fields, consistent with severe acute respiratory distress syndrome. ECMO cannula is seen entering at the right internal jugular vein.