Journal of Pediatric Surgery Case Reports 72 (2021) 101951

Contents lists available at ScienceDirect

Journal of Pediatric Surgery Case Reports

journal homepage: http://www.elsevier.com/locate/epsc

# Perforated duodenum with hemorrhage while on V-V ECMO: Diagnostic challenge

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ARTICLE INFO

*Keywords:*
ECMO
Perforation
Cannula
Duodenum

ABSTRACT

ECMO and cannula-related complications remain a concern in critical care, and may conceal serious unrelated underlying medical or surgical problems. A 22 month-old male patient was put on veno-venous ECMO for H1N1 infection using jugular and femoral cannulas. Iliac vein perforation by the cannula was suspected following abdominal distention and fresh blood in the abdomen. Emergent laparotomy unexpectedly revealed a perforated duodenum, which was primarily repaired. This is the first reported case of a duodenal perforation in a child on ECMO. With increasing use of ECMO, more attention should be given to rare complications related to the underlying diseases.

## 1. Introduction

Extracorporeal membrane oxygenation (ECMO) is a method of supporting the heart and or the lungs while organ function recovers. However, despite extraordinary progress, ECMO-related complications remain a real concern in 40% of the cases [1-3]. In addition, critically ill children may present complications not often seen in the current era: A perforated duodenal ulcer is a rare occurrence in modern medicine [4]. This potentially fatal complication may present insidiously, especially when fingers point at another direction in a patient on ECMO. To the best of our knowledge, this is the first reported case of a duodenal perforation in a child on ECMO.

## 2. Case presentation

IRB approval and parent consent were obtained for this report. A 22 month-old boy was transferred to our unit after 17 days in ICU in another hospital, including 7 days of aggressive ventilation for acute respiratory distress syndrome secondary to viral infection with influenza H1N1 virus. Shortly following his arrival, veno-venous ECMO was initiated using a 19 French dual lumen cannula inserted through the right jugular vein, into the superior vena cava, the right atrium, and then down the proximal inferior vena cava. The venous drainage revealed to be suboptimal, and it was necessary to insert a second drainage cannula into the inferior vena cava, through the femoral vein. The only available pediatric venous cannula was a 14 French short one, which couldn't reach the vena cave; it was thus positioned in the iliac vein. Despite appropriate respiratory support with ECMO, the patient remained critical; he had borderline vital signs and urine output, with no signs of infection, and no clear explanation, despite broad spectrum antibiotic therapy, antiviral treatment with oseltamivir, total parenteral nutrition, and gastric protection. Gastric protection with isomeprazole was initiated in the referring institution and continued while under our care. Lab work including chemistries, coagulation parameters, and urinalysis were within normal limits. All attempts at enteral nutrition with various types of formula were not tolerated, with large amounts of formula residues remaining in the stomach.

On ECMO day 5, the patient started developing abdominal distension. An ultrasound revealed free fluid in the abdomen, thought to be secondary to right ventricular failure. Abdominal distension increased progressively and significantly over the following 8 hours. A concomitant drop in hemoglobin from 9.8 to 8.0 was attributed to the existing mild circuit hemolysis. When the abdominal ultrasound revealed the existence of a large ascites, a peritoneal tap returned 900 ml of blood. It continued draining 20–30 ml of fresh venous blood every 10 minutes, without evidence of free air in the peritoneal cavity. Injury to the iliac vein by the venous ECMO cannula was immediately suspected. Although the patient was hemodynamically stable, it was deemed dangerous to waste precious time performing a CT scan, and the patient was taken directly to the operating room for laparotomy with a cardiovascular surgeon on standby, and a presumed diagnosis of a perforated iliac vein.

Large amounts of blood clots were evacuated from the peritoneal cavity. The femoral cannula was quickly removed but no perforation

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https://doi.org/10.1016/j.epsc.2021.101951
Received 20 May 2021; Received in revised form 6 June 2021; Accepted 12 June 2021
Available online 29 June 2021

was identified. Tracking the source of bleeding lead the surgeon to the right upper abdominal quadrant, and suddenly a relatively common complication of VV ECMO was suspected: Hepatic vein injury due to the tip of the dual lumen cannula. But no perforation was found near the liver.

Further dissection revealed blood coming from an area of significant inflammatory reaction involving the transverse colon and the duodenum. Looking closer revealed some bile efflux from that area. Dissecting further into a thick inflammatory and fibrous abscess exposed a 1.5cm perforation involving the anterior-medial aspect of the first portion of the duodenum, near the gastroduodenal vessel, with a few bleeding vessels (Fig. 1). The perforation was closed in two layers and re-enforced with an omental patch. ECMO support was continued using the double lumen cannula placed initially. The post-operative course was uneventful; the patient was kept on total parenteral nutrition for a 1 week before enteral feeding was started and well tolerated.

The lungs recovered progressively and the patient was successfully weaned from ECMO after 34.

## 3. Discussion

During the last 2 decades, the role of veno-venous (VV) ECMO for refractory respiratory failure in the pediatric population has been established as a lifesaving technique [1]. Even though survival rates are improving with the continued advances in technology and intensive care, the journey while on ECMO is fraught with complications. The most common complications in pediatric patients on placed on VV ECMO for respiratory failure include bleeding related to cannulation (16.4%), other cannula associated problems (15%), culture-proven infections (10.3%), bleeding in the central nervous system (7%), and gastrointestinal hemorrhage (4.9%).[1,2] Less common complications may also occur, such as the sudden dislodgment of a cannula, or the perforation of a cannulated vessel; these are usually rare catastrophic events, requiring immediate intervention [2,3]. Few studies discussed cannula related perforations, with a reported percentage reaching up to 2% [3,5]. Vessel perforation by the large ECMO cannula is a dreaded complication. In addition to being an emergency, its management is a nightmare for both the surgeon and the intensivist: Limited alternative cannulation sites to continue ECMO support; hemodynamic instability caused by hemorrhage; cessation of anticoagulation and the risk of circuit thrombosis; massive transfusions needs, adding to the existing lung injury; the debatable transfer of a critically ill, bleeding patient on ECMO, to radiology for a CT scan; and finally, the need for an urgent surgery to repair the injured vessel. We tried to avoid going into this complex series of challenges, and decided to go to the operating room before the patient becomes unstable, with the presumed diagnosis of vessel perforation by the inappropriate short venous femoral cannula. Our diagnosis proved to be incorrect, but all intensivists and surgeons with ECMO expertise didn't regret this decision. Senior intensivists and non-cardiac pediatric surgeons admitted considering a gastrointestinal cause of bleeding, but were overwhelmed by the prevailing diagnosis of vessel perforation and its potential consequences.

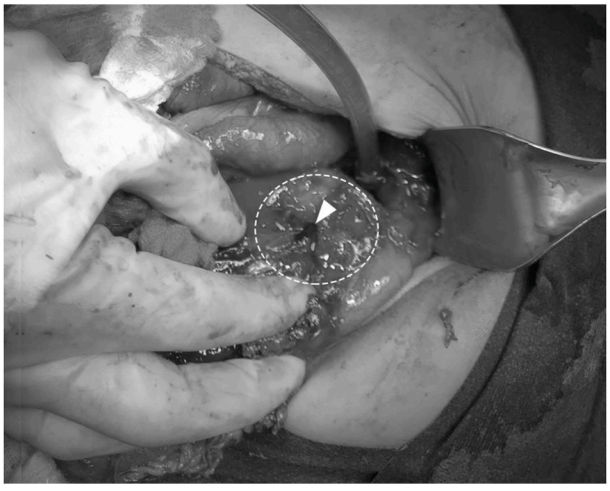

**Fig. 1.** Photograph taken during surgery showing the duodenal perforation (white arrowhead), surrounded by inflammatory thickened tissue (dotted circle).

Perforated peptic ulcer in children is today a rare cause of acute abdomen, due to the decreased prevalence of Helicobacter Pylori, and the improved efficacy of proton pump inhibitors [4]. While the literature about this disease is outdated in western countries, it is still reported in developing nations, most cases being secondary to an underlying etiology including steroid therapy, severe illness (meningitis, malaria, lymphoma, and gastro-enteritis), or increased intracranial pressure [6]. Duodenal perforation has also been reported following the use of a jejunal feeding tube in children [7]. In our case, duodenal perforation occurred while he was battling a severe respiratory infection with H1N1; he was on adequate gastric protection, and never had a *trans*-pyloric feeding tube inserted.

Several rare gastrointestinal complications as a result of ECMO have been reported in the pediatric age group, and these include hemorrhage, emphysematous gastritis and gastric perforation [8]. In the adult population, 1 case of fatal perforated peptic ulcer was reported following ECMO removal, and not during the ECMO run [9]. To the best of our knowledge, this is the first reported case of a duodenal perforation diagnosed and treated in a child on ECMO.

In conclusion, the application of ECMO in the realm of critical care is on the rise, with a varsity of indications. Patients on ECMO suffer the myriad of critical care-related complications, including the full range of intracranial, thoracic, vascular, and embolic catastrophes. However, it remains very important to spread awareness about less common complications in this medical era, sometimes related to ECMO, but very often related to the underlying diseases or the critical condition of the patient.

### Patient consent

Consent to publish the case report was obtained from the parents.

### Funding

No funding or grant support.

### Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

### Conflict of interest and source of funding statement

This report had no source of funding, and all authors confirm having no conflict of interest.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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