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## Adult ECMO and gastrointestinal bleeding from small bowel arteriovenous malformations: A novel treatment using spiral enteroscopy.

Konrad Sarosiek  
*Thomas Jefferson University*

Hitoshi Hirose  
*Thomas Jefferson University*

Harrison T Pitcher  
*Thomas Jefferson University*

Nicholas C. Cavarocchi  
*Thomas Jefferson University*

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Konrad Sarosiek, MD , Hitoshi Hirose, MD, Harrison Pitcher, MD, Nicholas C. Cavarocchi, MD.

From: Department of Surgery, Thomas Jefferson University, and Philadelphia, PA

Corresponding Author: Hitoshi Hirose, MD.  
Department of Surgery, Thomas Jefferson University  
1025 Walnut Street Room 605, Philadelphia, PA 19107, USA.

Tel: 215-955-5654

Fax: 215-955-6010

E-mail: [genex@nifty.com](mailto:genex@nifty.com)

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**Introduction:** Hemorrhagic complications on extracorporeal membrane oxygenation (ECMO) are common because of the need for anticoagulation to maintain the oxygenator and circuitry. Gastrointestinal bleeding (GIB) is reported to occur in 3-6% of ECMO patients,<sup>1</sup> requiring frequent transfusions as well as multiple diagnostic and therapeutic interventions. Multiple transfusions can result in volume overload, coagulopathies and infections leading to significant morbidity and mortality. We present the first published case of GIB from an arteriovenous malformation (AVM) treated with a novel therapy termed spiral enteroscopy while the patient remained on venoarterial (VA) ECMO.

**Case report:** A 48 year-old-male without previous coronary risk factors and GIB was found at home to be unresponsive due to a drug overdose. He was intubated for aspiration pneumonia and transferred to our hospital. On echocardiography, he was found to have severe left ventricular dysfunction and despite mechanical ventilation coupled with multiple inotropes, his condition continued to deteriorate. The patient developed acute kidney failure, lactic acidosis, liver dysfunction and subsequently VA ECMO was initiated via bi-femoral percutaneous cannulation. ECMO flow was maintained with 4.5-5.0 l/min and mean arterial pressure at 65-75 mm Hg. Anticoagulation with heparin was started on postoperative day (POD) #1 with a goal PTT of 40-50. On POD #10, there was an acute drop in the patient's hemoglobin with hemocult positive stool. Upper endoscopy, colonoscopy, and mesenteric angiography were all negative. At that point, anticoagulation was held for 36 hours yet the tarry stools persisted while the patient remained on ECMO. A capsule endoscopy was performed which showed multiple sites of bleeding from the small bowel distal to the ligament of treitz and thus this bleeding was out-of-reach for a conventional upper endoscope.[Figure 1] Spiral enteroscopy using the Discovery Small Bowel (DSB) Overtube (Olympus, Tokyo, Japan) was performed in the operating room and confirmed more than 20 bleeding AVMs in the small bowel which were treated at the same time with electrocautery. After the procedure, the patient did not require further transfusions and the melena resolved. Subsequently, the patient was weaned from ECMO and it was discontinued. The patient was then discharged from the hospital without further complications and has had no further episodes of bleeding.

**Discussion:** Veno-arterial ECMO provides non-pulsatile arterial flow to the body. Studies of left ventricular assist devices (LVAD) demonstrated that GIB is more frequently seen in patients with continuous flow than in pulsating devices,<sup>2</sup> and such GIB was more frequently due to AVM from the small bowel.<sup>3</sup> The mechanism of development of intestinal AVM associated with non-pulsatile circulatory devices is unknown. Malperfusion of the intestinal mucosa and tissue hypoxia could lead to restructuring of the mucosal vascular network which will then be more vulnerable to bleeding. Formation of the intestinal AVM and bleeding can occur even in the patient with short-term non-pulsatile continuous flow mechanical support, such as VA-ECMO and other axial flow LVAD devices.

Spiral enteroscopy has been developed to diagnose the small bowel lesions. The technique utilizes an existing endoscope passed through an Endo-Ease DSB Over-tube, which has a raised ridge wrapped from proximal to distal along its length.<sup>4</sup> First, the over-tube is placed in the small bowel beyond the ligament of Teritz under the guidance of the inner endoscope. Then, clockwise spiral rotation of the over-tube is applied so that the small bowel can be pleated over the over-tube.[Figure 2] The endoscope passing through the over-tube visualizes the circumferential distal small bowel, and since it's performed under endoscope guidance, the risk of the bowel perforation is minimal.<sup>4</sup> Coagulation forceps, argon beam instrument, and biopsy forceps can be inserted through the side port of the endoscope which can be used as additional treatment

modalities. Spiral enteroscopy allows for more visualization of the small bowel distal to the ligament of treitz; in fact average distances attained by Khashab and colleagues' averaged 300cm versus single balloon push enteroscopy of 222cm.<sup>5</sup> Not only can we see further with spiral enteroscopy but complication rates are much lower (1.9% versus 3.8%) when compared with the balloon system.<sup>5</sup>

Traditionally, small bowel bleeding was treated with laparotomy; however, the development of spiral enteroscopy is a new technology that can diagnose and treat bleeding from the small bowel distal to the ligament of treitz that traditionally has been off limits to endoscopes.

**Legends of Figure**

Figure 1: Images from capsule endoscopy showing AVM's in small bowel.

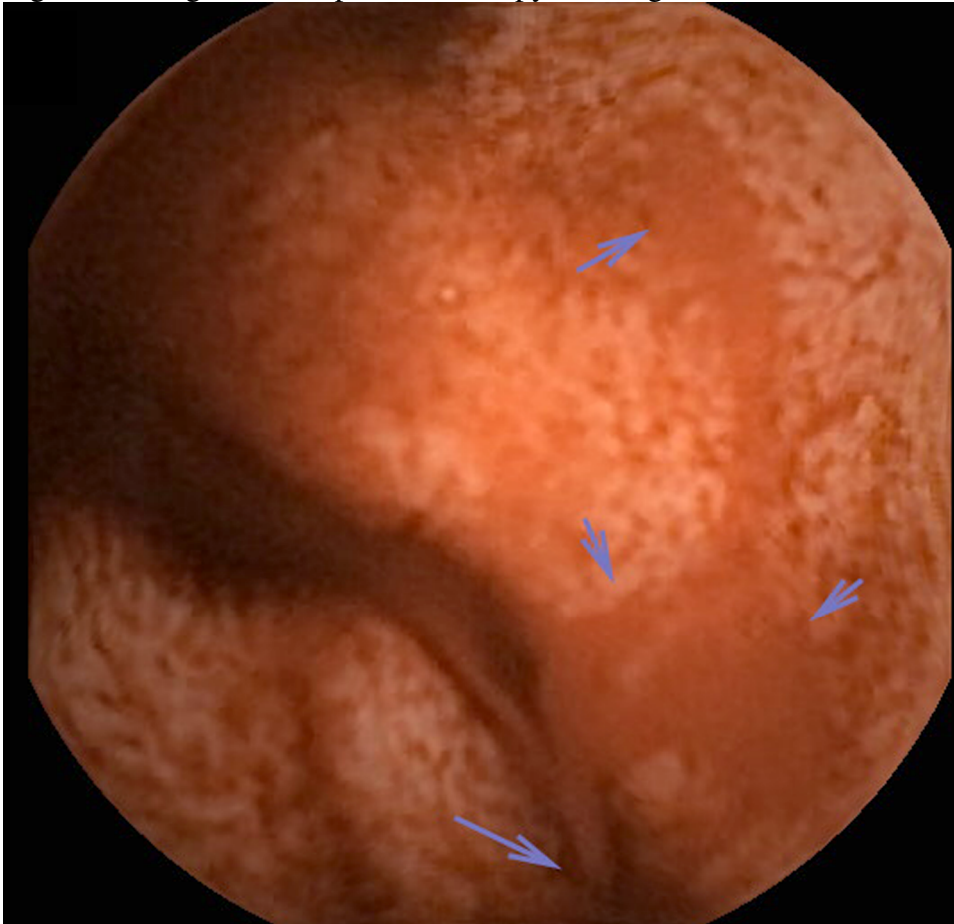


Figure 2: Discovery SB overtube advancing in the upper GI tract showing the pleating of bowel.



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