

## CASE REPORT

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# First report of robotic-assisted partial gastrectomy of a large lymphatic-venous malformation in a teenager: A case report

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## ABSTRACT

**Introduction:** Gastrointestinal vascular anomalies are rare in children. A subtype, lymphatic-venous malformations, is even rarer. These anomalies can result in serious sequelae such as bleeding. Management of these rare pathologies is challenging and may involve endoscopic, angiographic, or surgical management.

**Case Report:** We present the case of a 14-year-old female who presented to the hospital after hematemesis and was found to have a gastric vascular malformation. Workup included cross-sectional imaging, endoscopy, and angiography. After multidisciplinary discussion, definitive management was achieved with a robotic-assisted partial gastrectomy with longitudinal gastric closure. The surgical pathology was diagnostic of a lymphatic-venous malformation. No complications occurred in the perioperative period through 10 months of follow-up.

**Conclusion:** This is the first report of a robotic-assisted partial gastrectomy with supplemental use of indocyanine green and endoscopy for gastric lymphatic-venous malformation. Use of the robotic platform for minimally invasive resection is safe and can be considered for management of this rare pathology.

**Keywords:** Gastric lymphatic-venous malformation, Pediatric indocyanine green, Pediatric robotic-assisted partial gastrectomy, Pediatric vascular malformation

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## INTRODUCTION

Gastrointestinal (GI) vascular anomalies are exceedingly rare in children, accounting for a small fraction of GI bleeding etiologies [1]. An accurate prevalence is difficult to determine in children as they are often discovered only when a patient is being evaluated for a gastrointestinal bleed [2]. Pediatric gastric vascular anomalies, in particular, pose significant therapeutic challenges, especially if the malformation involves adjacent structures such as the esophagus or spleen [3]. We present a case of a pediatric gastric lymphatic-venous malformation (LVM) not amenable to endoscopic or other noninvasive angio-ablation methodologies. We describe the first pediatric case of a large gastric LVM managed successfully with robotic-assisted resection.

## CASE REPORT

A previously healthy 14-year-old female presented to the hospital after a syncopal event associated with generalized weakness, vague abdominal discomfort, nausea, and bloody emesis. Prior to presentation, the patient had a normal appetite and denied any abnormal stools. Initial vital signs included tachycardia without hypotension. Physical exam was notable for pallor but no abnormal abdominal findings.

A complete blood count (CBC) demonstrated a hemoglobin of 3.5 g/dL, hematocrit of 14%, white blood cell (WBC) count of 16.9 bil/L and normal platelet count. Due to her initial critically ill presentation, she was appropriately resuscitated with blood products, and after stabilization, underwent additional evaluation to identify the source of bleeding. Contrast-enhanced computed tomography abdomen/pelvis (CTAP) demonstrated an irregular thickening of the stomach measuring up to 1.9 cm with enhancement of the lateral-posterior gastric wall and a subtle focus of venous and arterial enhancement. A magnetic resonance imaging (MRI) of the abdomen with contrast confirmed lateral-posterior wall thickening of the stomach, measuring up to 2.4 cm in thickness, with extension into the adjacent omentum and spleen. The imaging differential diagnoses included malignancy versus vascular anomaly (Figure 1).

Esophagogastroduodenoscopy (EGD) demonstrated a large 13 cm × 6 cm, multilobular vascular lesion in the proximal body of the stomach, greater curvature, and fundus. The duodenum was normal. Biopsies were non-diagnostic demonstrating normal duodenal mucosa with reactive gastric and esophageal mucosa. Endoscopic ultrasound (EUS) revealed internal flow seen on Doppler. Upon completion of the endoscopy active bleeding was noted, consistent with the friable nature of the lesion. Due to hypotension, the patient was taken emergently to Interventional Radiology (IR) for possible embolization; however, celiac angiography showed no active extravasation, no intervention was performed and the patient was stabilized with medication administration.

Subsequently, her case was presented at the Vascular Anomalies Center multidisciplinary conference. Given the lesion's size, vascularity and proximity to the spleen, they recommended open surgical management over endoscopic or IR interventions. A local multidisciplinary discussion led by Pediatric Surgery with input from IR and Minimally Invasive Surgery (MIS) resulted in the decision to proceed with surgical intervention.

A robotic-assisted partial gastrectomy, omentectomy and EGD during the index admission was planned. After insufflation and standard robotic access, an EGD confirmed malformed gastric mucosa (Figure 2A). The endoscope was left in place to assist with the dissection. Indocyanine green (ICG) angiography showed no arterial-phase fluorescence within the vascular anomaly but highlighted surrounding tissues, delineating its borders (Figure 2B). Our ICG protocol included 5 mg

ICG injection followed immediately by 10 cc saline fast flush, with neutral field visualization and visualization of ingress.

The mass extended into the omentum and gastro-splenic fat, involving the short gastric arteries (Figure 3A). This necessitated a wider dissection, achieved with suture ligation, clips and a vessel sealer to ensure hemostasis. Robotic dissection continued to the left crus, providing excellent exposure of the vascular anomaly involving the greater curve. Posterior attachments to the pancreas were divided, and the vascular anomaly was isolated. We elected to devascularize the lesion by dividing the stomach around it to minimize bleeding. Using a vessel sealer, the anterior portion of the vascular anomaly was excised (Figure 3B). This facilitated circumferential excision of the lesion. Reconstruction was performed with the endoscope as a bougie along the lesser curve, guiding linear closure (Figure 3C). Longitudinal gastric closure was completed with a running full thickness layer of 2-0 Vicryl followed by a seromuscular running layer of 2-0 Stratafix from cardia to angularis with no noted narrowing at the angularis or antrum on completion (Figure 3D). An air insufflation leak test was negative, and a drain was placed in the lesser sac. Total console time was 199 minutes.

The patient required no intraoperative or postoperative transfusions. On postoperative day 3, a fluoroscopic upper gastrointestinal (UGI) study showed no leak. A small-volume, sugar-free, non-carbonated clear liquid diet was initiated and advanced to full liquids within two days. She was discharged home on postoperative day 6 on a bariatric full liquid diet, with the drain removed.

Pathology confirmed a large vascular malformation involving the mucosa, submucosa, muscularis, and peri-gastric soft tissue and omentum. It was composed predominantly of venous and lymphatic channels with a minor arterial component, diagnostic of LVM.

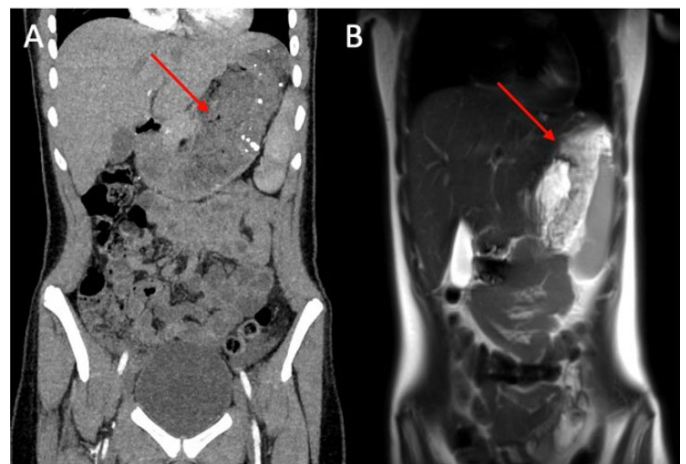


Figure 1: Computed tomography abdomen and pelvis with contrast and magnetic resonance imaging of the abdomen demonstrating the vascular malformation. CT (A) and MRI (B) demonstrating a thickened and enhancing lateral-posterior stomach with phleboliths (arrows).

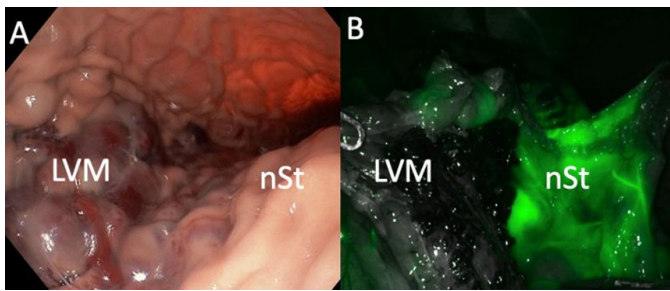


Figure 2: Intraoperative view of lymphatic-venous malformation. (A) Intraoperative esophagogastroduodenoscopy performed to demarcate the extent of invasion into the gastric mucosa. (B) Use of indocyanine green to better elucidate the extent of malformation prior to beginning the dissection off the greater curvature of the stomach. LVM: Lymphatic venous malformation; nSt: normal stomach mucosa.

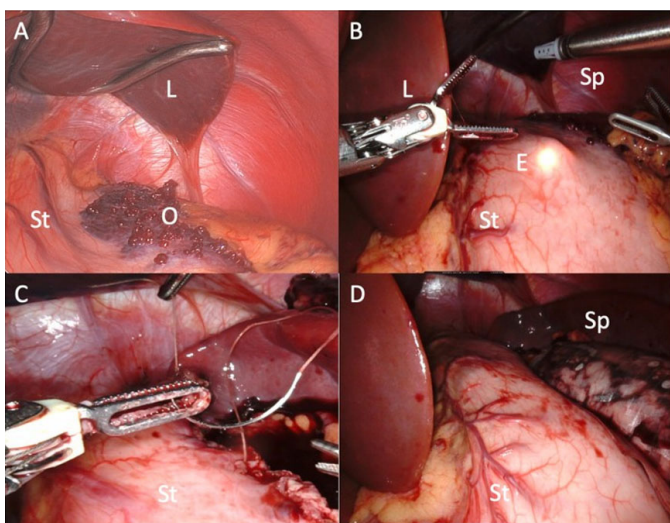


Figure 3: Robotic-assisted view of lymphatic-venous malformation resection. (A) Demonstration of the malformation involving the greater curvature of the stomach and the overlying omentum. (B) Use of the endoscope as a bougie to direct the dissection. (C) The stomach was primarily repaired with intracorporeal sutures. (D) Completion of the partial gastrectomy and omentectomy. D: Diaphragm; E: Endoscope; L: Liver; St: Stomach; Sp: Spleen.

She advanced to a regular diet at six weeks. She remained asymptomatic during 10 months in the outpatient setting but was lost to long-term follow-up.

## DISCUSSION

Vascular malformations are rare pathologies with limited understanding of their pathogenesis [4]. They are often seen in the head and neck and are associated with genetic conditions such as hereditary hemorrhagic telangiectasia and capillary malformation-arteriovenous malformation [4]. The predominant hypothesis of origin is that vascular malformations arise from errors in vascular morphogenesis, resulting in abnormal connections between arteries and veins that bypass the

capillary bed [5]. The International Society for the Study of Vascular Anomalies (ISSVA) Classification for Vascular Anomalies organizes vascular anomalies into vascular tumors, vascular malformations or potentially unique vascular anomalies [6]. The ISSVA further delineates malformations by flow state and major component [6].

Management of symptomatic pediatric gastrointestinal vascular anomalies can be challenging. Endoscopic therapies (argon plasma coagulation, laser ablation, or mechanical resection), and pharmacologic approaches (e.g., angiogenesis inhibitors) have been described, but definitive treatment often requires surgical resection [1, 7, 8]. Surgical resection of vascular malformations focuses on resection of all grossly abnormal tissue, unless the lesion is large and in a sensitive location benefitting from attempts at a stepwise size reduction with preoperative embolization and sclerotherapy [9]. Decreasing the size of the lesion if feasible preoperatively should decrease the risk for major blood loss [9]. The robotic platform has been previously safely utilized for the management of adult vascular anomalies in the lung, mediastinum and pelvis [10–12]. To date, robotic partial gastrectomy has not previously been reported as a management strategy for this condition in children or adults.

Robotic surgical technology has evolved since its inception in adults in 1997 and its first use in children in 2002 [13, 14]. In comparison to traditional laparoscopic gastrectomy, robotic-assisted gastrectomy in adults has recently been found to have fewer postoperative complications, less estimated blood loss, faster postoperative recovery, and lower conversion rate [15]. Its advantages—three-dimensional field of view, magnification, improved dexterity, tremor filtration, and consistent retraction—are particularly valuable in complex gastric resections [16]. Lesions of the gastric fundus and cardia are technically demanding to manage laparoscopically due to limited access, angulation, and suturing constraints. The robotic platform mitigated these challenges in our patient, enabling safe dissection and layered closure, and facilitated use of ICG to delineate the lesion's margins. With the integration of artificial intelligence into medical care, the future of managing this condition robotically may integrate imaging overlay for additional surgical decision-making support.

## CONCLUSION

This case highlights a rare large pediatric gastric LVM involving the overlying omentum. The robotic platform and the use of ICG facilitated the identification of the borders of the mass and provided technical advantages that enabled safe resection and reconstruction in a challenging region. To our knowledge, this represents the first documented pediatric case of robotic-assisted partial gastrectomy for a giant gastric LVM, demonstrating its feasibility and utility.

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Artificial Intelligence was not utilized in the creation or development of this work.

**Author Contributions**

Joyce McRae – Conception of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Steven L Raymond – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Amna Minhas – Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Andrei Radulescu – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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**Conflict of Interest**

Authors declare no conflict of interest.

**Data Availability**

All relevant data are within the paper and its Supporting Information files.

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