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Endoluminal Functional Imaging Demonstrates Need for Myotomy During Epiphrenic Diverticulectomy

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Epiphrenic diverticulum develops when elevated esophageal intraluminal pressure causes herniation of the mucosa and submucosa through an area of weakness in the muscularis layer. Treatment must address both the diverticulum and the underlying esophageal dysmotility. The endoluminal functional lumen imaging probe allows measurement of the lower esophageal sphincter pressures to achieve the ideal lower esophageal sphincter distensibility that prevents postoperative gastroesophageal reflux disease as well as diverticulum recurrence. We present the case of a 60-year-old woman with an epiphrenic diverticulum who underwent robot-assisted laparoscopic diverticulectomy with Heller myotomy and Dor fundoplication. The endoluminal functional lumen imaging probe was used for intraoperative monitoring.

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Epiphrenic diverticulum has an incidence of approximately 1 in 500,000 individuals per year.[1] These are categorized as false diverticula or pseudodiverticula as they do not involve all 3 layers of the esophagus. Epiphrenic diverticula most commonly develop when lower esophageal sphincter (LES) dysfunction or esophageal dysmotility elevates the esophageal intraluminal pressure, causing herniation of the mucosa and submucosa through an area of weakness in the muscularis layer. They are found within 10 cm of the gastroesophageal junction (GEJ). If left untreated, epiphrenic diverticula may enlarge, resulting in worsening dysphagia, gastroesophageal reflux disease, pain, and, in severe cases, fistulization to nearby structures.[2]

We present the case of a 60-year-old woman with a long-standing history of gastroesophageal reflux disease that was managed with a proton pump inhibitor and H_2 receptor blocker. She also reported progressively worsening dysphagia, belching, halitosis, and heartburn. Barium esophagography demonstrated mild dilation of the esophagus, mildly decreased esophageal motility, and a 2.5-cm right-sided epiphrenic diverticulum (Figure 1A) that was confirmed on esophagogastroduodenoscopy. The patient elected to undergo robot-assisted laparoscopic diverticulectomy, Heller myotomy, and Dor fundoplication (Video).

An 8-cm endoluminal functional lumen imaging probe (FLIP, 325N) was used for intraoperative impedance planimetry at each stage of the operation. The FLIP uses a balloon catheter to collect real-time esophageal cross-sectional area (mm^2) and manometry data (mm Hg). Distensibility index (DI; mm^2/mm Hg) is calculated by dividing the cross-sectional area at a given level of the esophagus by the median intraballoon pressure using a predetermined filling volume.

Before any surgical intervention, the patient's DI was found to be 0.4 mm^2/mm Hg with 30 mL in the balloon (which had adequate balloon pressure), consistent with LES dysfunction (Figure 2A). The DI <0.8 mm^2/mm Hg confirmed the need for Heller myotomy. The crura of the diaphragm were dissected, followed by circumferential dissection of the epiphrenic diverticulum to obtain adequate length to fully dissect the diverticulum (Figure 3A). Care was taken to preserve the anterior and posterior vagus nerves. A Heller myotomy was performed with a Harmonic scalpel (Ethicon), dividing the longitudinal and circular muscle layers of the esophagus a total of 6 cm above and 2 cm below the GEJ while leaving the mucosa and submucosa intact (Figure 3B). We placed an endoscope in the esophagus to ensure that the lumen was not narrowed when the diverticulum was resected with 2 white loads of the robotic stapler (Figure 3C). DI at the GEJ after Heller

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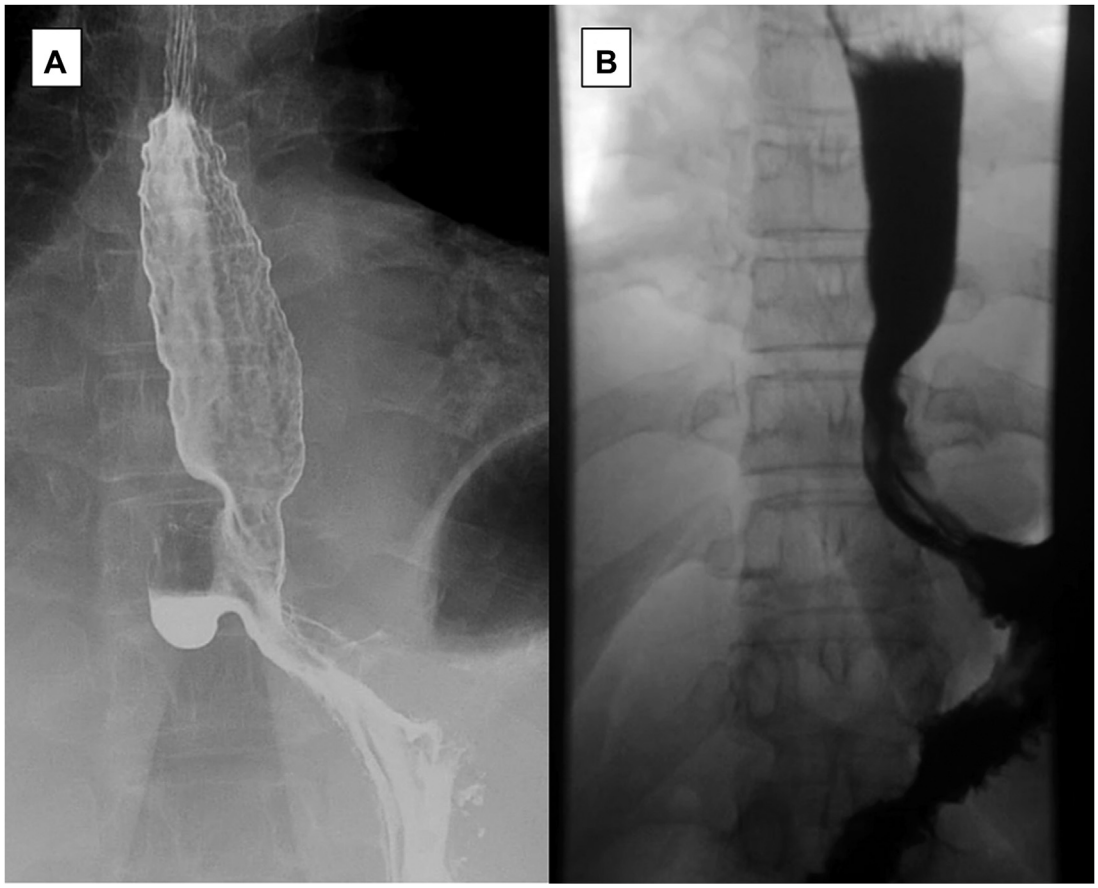

FIGURE 1 (A) Preoperative barium esophagogram; right-sided epiphrenic diverticulum filling with contrast material. (B) Postoperative esophagogram demonstrating resolution of epiphrenic diverticulum without evidence of extravasation of contrast material.

myotomy was found to be 2.3 mm^2/mm Hg, thus demonstrating that the myotomy was adequate (Figure 2B). A Dor fundoplication (180° anterior wrap) was performed to prevent postoperative gastroesophageal reflux after myotomy (Figure 3D). The final DI at the GEJ after fundoplication was 1.8 mm^2/mm Hg (Figure 2C), which confirmed that the fundoplication was not too tight.

The patient did well postoperatively. Postoperative esophagography demonstrated resolution of the epiphrenic diverticulum without evidence of extravasation of contrast material (Figure 1B). The esophagus was found to have normal motility and distensibility. Clear liquids were initiated on postoperative day 1. She was discharged on postoperative day 2 with a full liquid diet for 2 weeks. By postoperative week 4, she was tolerating a regular diet and reported a resolution of her reflux and dysphagia symptoms. Final pathologic examination demonstrated esophageal mucosa and submucosa and absent muscularis propria, consistent with a diagnosis of epiphrenic diverticulum. At 18 months after operation, the patient has not reported any symptoms of reflux or dysphagia.

COMMENT

In this case, we used real-time, objective manometric data to demonstrate a tight LES in the setting of epiphrenic diverticulum and the subsequent resolution of this abnormality after myotomy. Furthermore, FLIP is used to guide intraoperative decision-making, in this case ensuring both the adequacy of the myotomy and that the Dor fundoplication was not too tight. The ability to perform intraoperative esophageal impedance planimetry using FLIP is advantageous as it allows the intraoperative confirmation or diagnosis of achalasia.[3] In a study evaluating the FLIP measurements of patients with achalasia and patients with hiatal hernia, patients with DI <0.8 mm^2/mm Hg with 30 mL in the balloon had a >99% probability of having achalasia.[3]

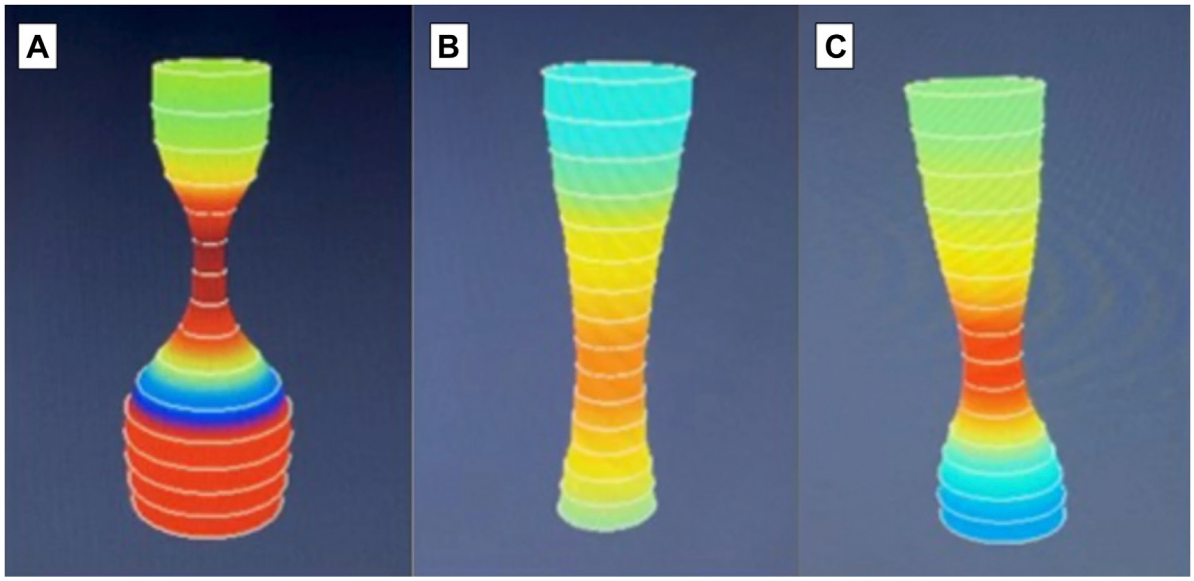

FIGURE 2 Intraoperative functional lumen imaging probe planimetry (A) before Heller myotomy (distensibility index [DI], 0.4 mm^2/mm Hg), (B) after Heller myotomy (DI, 2.3 mm^2/mm Hg), and (C) after Dor fundoplication (DI, 1.8 mm^2/mm Hg).

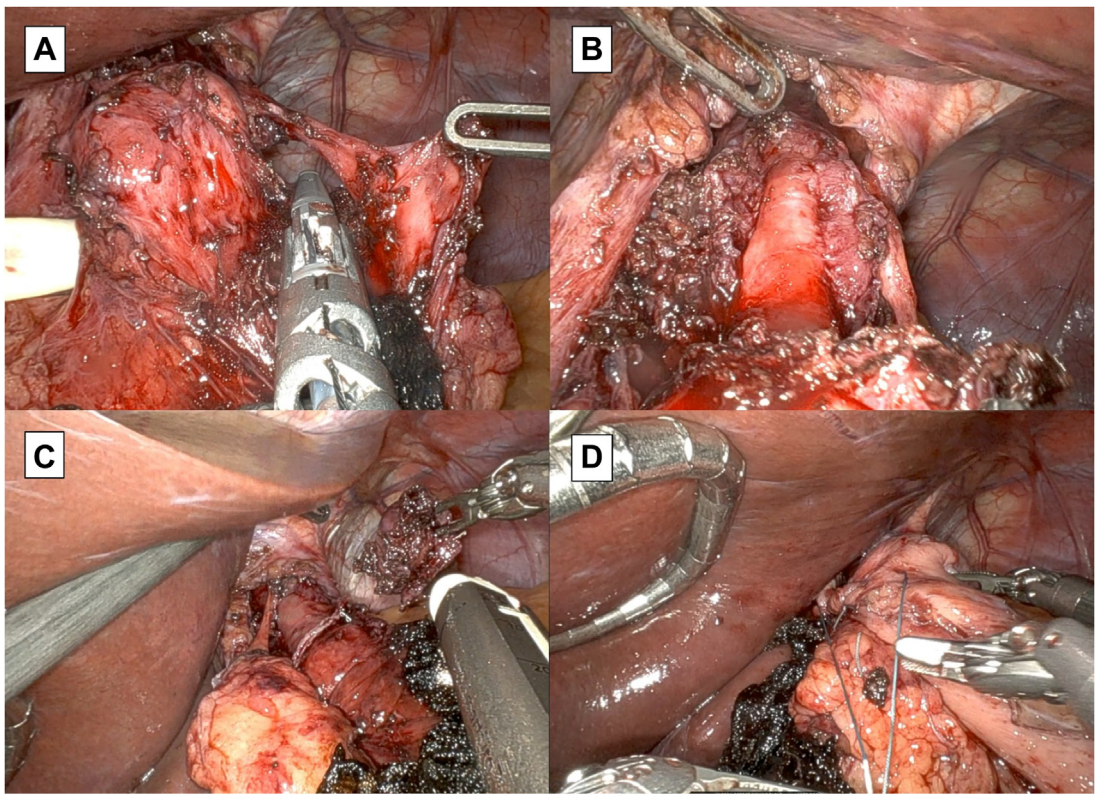

FIGURE 3 Intraoperative images. (A) Dissection of the epiphrenic diverticulum with preservation of the left/anterior vagus nerve. (B) Heller myotomy; muscularis propria layer divided with bipolar instrument with intact submucosal layer. (C) Epiphrenic diverticulum resected by robotic stapler (two 45-mm white loads). (D) Dor fundoplication; greater curvature of the stomach sutured to the right crus of the diaphragm.

Furthermore, FLIP values can be used to monitor how the compliance of the LES changes at each stage of surgical procedure as a result of both intrinsic (ie, before or after transection of the muscle layer) and extrinsic (ie, compression by the fundoplication) factors. Operations can be tailored to the individual patient on the basis of data provided by FLIP to achieve adequate LES distensibility and to avoid iatrogenic narrowing at the GEJ.

The use of a robot during this operation incurs additional costs compared with laparoscopic operation; however, we discovered that there are significantly fewer technical complications with the use of the robot compared with laparoscopic Heller myotomy and Dor fundoplication.[4] Thus, the robot improves clinical outcomes, adding value to the patient despite the cost.

The use of FLIP supports the need for myotomy in patients presenting with epiphrenic diverticulum and helps tailor the creation of the fundoplication. Further investigation is still needed to determine the optimal postoperative distensibility of the LES with FLIP for patients with differing degrees of impaired esophageal motility or LES dysfunction.

The Video can be viewed in the online version of this article [https://doi.org/10.1016/j.atssr.2023.04.008] on http://www.annalsthoracicsurgery.org.

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DISCLOSURES

Min P. Kim reports a relationship with Intuitive Surgical Inc that includes: consulting or advisory; with Olympus Corporation of the Americas that includes: consulting or advisory; with Medtronic that includes: consulting or advisory; and with AstraZeneca Pharmaceuticals LP that includes: consulting or advisory. Edward Chan reports a relationship with Intuitive Surgical Inc that includes: consulting or advisory; and with Olympus Corporation of the Americas that includes: consulting or advisory.

PATIENT CONSENT

The patient has given informed consent to the publication of the information discussed in this case report, and it has been approved by the institutional review board at Houston Methodist Research Institute.

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