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Diagnosis and treatment of gastric antral webs in pediatric patients

Ruchi Amin[1] · **Alfonso M. Martinez**[2] · **Marjorie J. Arca**[1]

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Abstract

Background Gastric antral webs are mucosal structures, varying from fenestrated diaphragms to mucosal crescents, resulting in varying degrees of foregut obstruction. Patients commonly present with vomiting, failure to thrive, and abdominal pain. Prevalence is unknown, and diagnosis can be difficult.

Methods We performed an IRB-approved retrospective review of patients from 4/1/2015–4/1/2018 at a Level I Children's Surgery Center undergoing gastric antral web resection. Data obtained included demographics, preoperative workup, surgical repair, and outcomes.

Results Twenty-one patients were identified; 67% were male with an average age of 30 months at diagnosis. Initial diagnosis was established by a combination of fluoroscopy and esophagogastroduodenoscopy (EGD) in all patients. Patients presented with emesis (76%), failure to thrive (57%), need for post-pyloric tube feeds (33%), and abdominal pain (14%). Web localization without intraoperative EGD ($n=3$) was initially challenging. As a result, intraoperative EGD was combined with operative antral web resection to facilitate web localization ($n=18$). Web marking techniques have evolved from marking with suture ($n=1$) and tattoo ($n=2$), to endoscopic clip application ($n=12$). All 21 patients underwent web resection, 2 were performed laparoscopically. Twenty underwent Heineke-Mikulicz pyloroplasty during the initial surgery. Average length of stay was 5.5 days. There were no intraoperative complications or deaths. Permanent symptom resolution occurred in 90% of patients immediately, with a statistically significant decrease in emesis ($p<0.001$), failure to thrive ($p<0.001$), and need for post-pyloric tube feeding ($p=0.009$) within 6 months of surgery.

Conclusion Gastric antral webs should be considered in the differential diagnosis for a child with persistent vomiting. Web resection with the use of intraoperative endoscopic localization can result in permanent symptom resolution in the majority of these patients.

Keywords Gastric antral web · Endoscopy · Heineke-Mikulicz pyloroplasty

Gastric antral webs (GAW) are mucosal structures, appearing as fenestrated diaphragms or mucosal crescents, typically located perpendicular to the long axis of the antrum, and approximately 1–2 cm proximal to the pylorus [1]. Patients can present with varying degrees of clinical and radiographic abnormalities, based on the degree of anatomic obstruction, consistency of enteric intake, and the ability of the stomach to overcome luminal compromise [2]. Infants and children in particular, often present with persistent postprandial vomiting, and failure to thrive or malnutrition [3].

Patients often undergo multiple diagnostic tests, and unsuccessful medical therapy before appropriate treatment is initiated. Contemporary endoscopic techniques such as needle-knife incision, balloon dilation, and triamcinolone injection have been used effectively in the adult population. However, repeat treatment may be needed with these methods, and a risk of perforation exists with thermal therapies [4]. The benefit of surgical intervention in patients with refractory disease has not been well described in the endoscopic era.

✉ Ruchi Amin
ramin520@gmail.com

Marjorie J. Arca
marca@chw.edu

[1] Children's Hospital of Wisconsin and Division of Pediatric Surgery, Department of Surgery, Medical College of Wisconsin, 999 N. 92nd St., C320, Milwaukee, WI 53226, USA

[2] Children's Hospital of Wisconsin and Division of Pediatric Gastroenterology, Department of Gastroenterology, Medical College of Wisconsin, Milwaukee, WI, USA

We describe a single institution experience in the management GAW in infants and children. We describe the evolution of esophagogastroduodenoscopy (EGD) for preoperative diagnosis, intraoperative identification, and later as an adjunct for web localization immediately prior to resection. We will describe presenting symptoms, treatment, and short- and medium-term outcomes.

Materials and methods

We conducted a retrospective review of patients who underwent surgical repair for GAW from 4/1/2015-4/1/2018 at the Children's Hospital of Wisconsin (CHW). Patients were identified using Pediatric and Infant Case Log and Outcomes (PICaLO), a comprehensive database of all general and thoracic surgical procedures performed by the Division of Pediatric Surgery faculty at CHW [5]. PICaLO uses REDCap™ [6] to collect demographic data, preoperative variables, and operative information, which are migrated weekly from the electronic medical record to the database. Surgical staff enters postoperative complications and occurrences after discussion at a weekly conference. Short and medium-term outcomes for these patients were obtained from the electronic health record (Epic Systems, 2015).

Demographic variables collected include age at diagnosis and treatment, gender, and co-morbidities. We recorded duration of time from start of symptoms to diagnosis, methods of diagnosis, techniques for web management/resection, and duration of hospital stay. Pre- and postoperative symptoms of appropriate weight gain, decrease in vomiting, and ability to tolerate gastric feeds were also identified.

Statistical analysis

Demographic and disease-related variables were described with the use of frequencies and percentages for categorical variables, and means and ranges for continuous variables. Statistical analysis was performed using Fischer's exact test. Statistical significance was defined as a p value < 0.05. Statistical analysis was performed using Microsoft Excel 2011 (version 14.7.3).

This study was approved by the CHW Institutional Review Board.

Results

Demographics

There were 21 patients who underwent surgical management of GAW during the study period. Fourteen (67%) were male with an average age at diagnosis of 30 months (range 0.7–142 months). Ten patients had operative American Society of Anesthesiologists (ASA) Physical Status II, 10 patients were ASA Class III, and 1 patient was ASA Class IV.

Symptoms

Sixteen patients presented with long-term emesis. Other presenting symptoms included failure to gain weight ($n = 12$), and abdominal pain ($n = 3$). Eight patients required supplemental tube feeds, of which six were on continuous post-pyloric feeds, and one patient was on continuous gastric feeds. One patient had the diagnosis of cyclic vomiting syndrome prior surgery.

The average length of symptoms ranged from 2 weeks to 11 years based on patient age, as all patients were noted to have some degree of feeding intolerance since either birth or infancy per chart review.

Diagnosis

An upper gastrointestinal (UGI) contrast study was performed in 21 patients. UGI fluoroscopy findings concerning for antral web included a thin radiolucent linear "knife-like" septae, 2–3 mm thick, and 1–2 cm proximal to the pylorus, projecting from the greater and lesser curvature; or the "double duodenal bulb" sign secondary to contrast filling the antrum distal to the web. The contrast study was interpreted as concerning for antral web in nine patients, normal in eight patients, and concerning for pyloric stenosis in one patient.

All patients underwent EGD. The diagnosis of antral web was made by the following findings noted during endoscopy: (a) if a circumferential diaphragm was noted with a central aperture through which the true pylorus can be identified; (b) a crescentic fold overhanding a long, narrow channel leading to the pylorus—most commonly noted at the lesser curvature area of the antrum and parallel to the incisura; or (c) circumferential redundant folds that did not resolve with insufflation or peristalsis were noted (Fig. 1) [7].

Previous interventions

Prior to definitive surgical resection, 47% ($n = 10$) of patients underwent botulinum toxin injection of the pylorus, and 38% ($n = 8$) underwent balloon dilation of the web. Two patients underwent pyloromyotomy for pyloric stenosis.

Endoscopic localization

The first three patients underwent laparotomy without intraoperative EGD. The next three patients underwent EGD prior to making incision to inform the surgeon of the relative distance of the web from the pylorus. All other

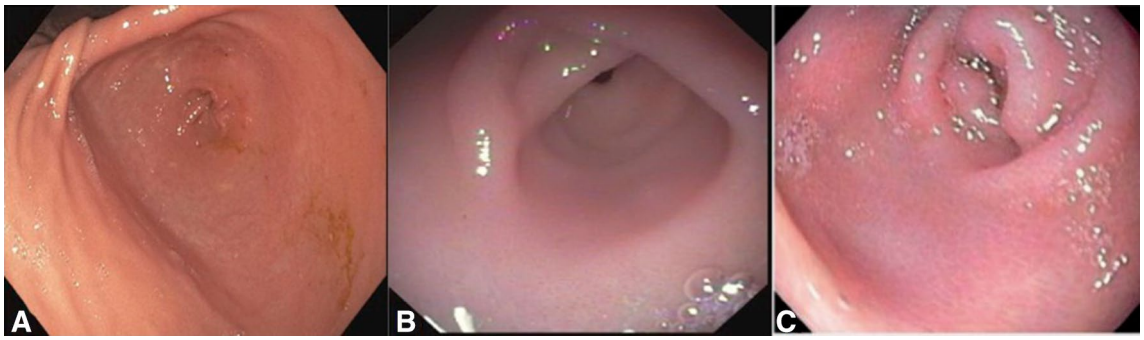

Fig. 1 Endoscopic findings of gastric antral webs: **A** circumferential diaphragm was with a central aperture proximal to true pylorus; **B** a crescentic fold hanging over a long, narrow channel proximal pylorus; or **C** circumferential redundant folds that do not resolve with insufflation or peristalsis

patients underwent intraoperative web localization using three methods:

1. Suture localization ($n=1$): During laparotomy, a thickened ridge of gastric tissue was palpated with a temporary marking suture placed externally. An intraoperative EGD identified the web internally while sutures were tugged on externally. Web margins marked with needle during endoscopic visualization.
2. Tattoo ($n=2$): Prior to making surgical incision for the laparotomy, EGD was performed to visualize the web. Methylene blue (dilution 1:10; several injections of 0.1 mL each) was injected into the web through the endoscope's therapeutic channel.
3. Endoscopic clip ($n=11$): Prior to making surgical incision, EGD was performed to visualize the antral web. Clips were used to mark the lateral edges of the web (Fig. 2A) to identify during operative resection (Fig. 2B).

Surgical repair

The principles of web resection were similar for both laparotomy and laparoscopic repairs. Both right upper transverse and upper midline incisions were used for the open approach, depending on the age of the child and preexisting surgical scars. For the laparoscopic procedure, a 4- or 5-mm angled scope was inserted in the umbilicus, with right lower quadrant and left upper or lower quadrant operating ports. The hepatic flexure was mobilized and surrounding adhesions were lysed to visualize and straighten the duodenal C-loop. In almost all of the patients, there were significant adhesions of the anterior stomach or proximal duodenum to the gallbladder. A horizontal gastrotomy traversing the antrum and pylorus was created. The mucosal web was identified using the methods discussed previously and resected. The edges were approximated using a running fine absorbable suture. A Heineke-Mikulicz pyloroplasty was performed. A decompressive orogastric or nasogastric tube was kept in place at

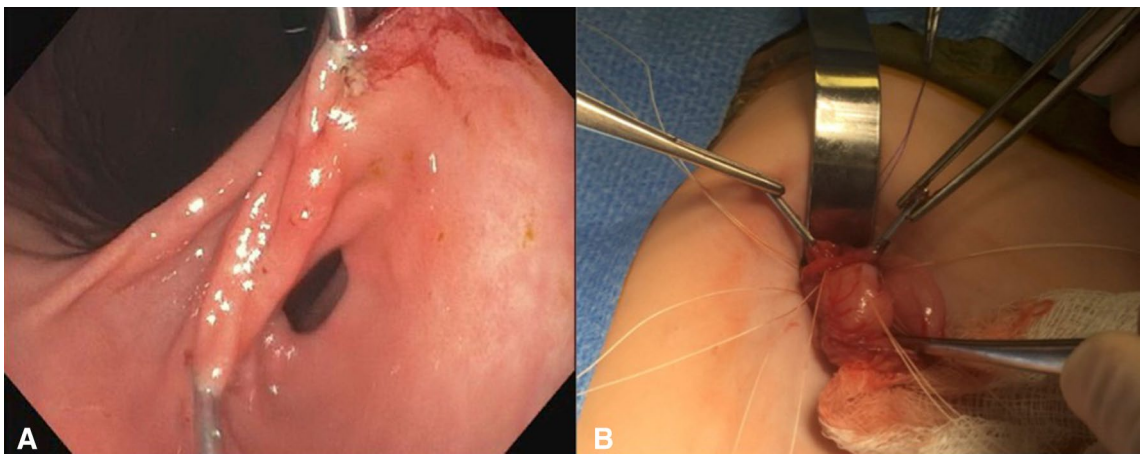

Fig. 2 **A** Endoscopic view of antral web with clips on either end; **B** localization of antral web using endoscopic clips using an open approach

the surgeon's discretion. Postoperatively, the patient was kept nil per os for 2–5 days. An upper GI contrast study was then performed to assess for patency or leaks with resumption of diet if there were no concerning findings.

Nineteen patients underwent open surgical web resection, and three had laparoscopic repair. All but one underwent Heineke-Mikulicz pyloroplasty during the initial surgery. The remaining patient required a pyloroplasty a few days after the operation.

Outcomes

The average perioperative hospital length of stay was 5.5 days (range 3–15 days). There were no intraoperative complications or deaths. Follow-up ranged from 3 to 75 months.

Eighteen patients (90%) had permanent resolution of presenting symptoms almost immediately, and all had symptom reduction within 6 months of surgery with statistically significant decrease in emesis ($p < 0.001$), increase in weight ($p < 0.001$), and ability to tolerate intragastric feedings or oral food ($p = 0.009$) (Table 1). One patient who was only able to have continuous gastric feedings and frequent vomiting preoperatively was able to tolerate oral feedings and bolus gastric feedings after surgery. However, she had recurrent vomiting 3 months after surgery, and required periduodenal adhesiolysis. This patient was eventually able to tolerate gastric feeds, but had inconsistent interest in oral feeding. Another patient continued to have some emesis postoperatively despite pyloroplasty, but this gradually resolved after realization that she has milk protein intolerance.

One patient was lost to follow-up after as the patient's entire care was transferred to another institution.

Table 1 Comparison of preoperative and postoperative symptoms in patients who underwent surgical repair for gastric antral web

Symptom	Preoperative ($n = 21$)	Postoperative ($n = 20$)[a]	p Value
Emesis	16 (76%)	2 (10%)[b]	< 0.001
Failure to gain weight	12 (57%)	0 (0%)	< 0.001
Post-pyloric feeds	7 (33%)	0 (0%)	0.009
Abdominal pain	3 (14%)	0 (0%)	0.232

[a]One patient was lost to follow-up as the patient's entire care was transferred to another institution

[b]One patient had complete resolution of symptoms postoperatively, but had recurrence of symptoms at 3 months, requiring periduodenal enterolysis. Although she was able to tolerate gastric feeds, she had resumption of preoperative oral aversion. Another patient did not have complete resolution of symptoms initially, but got much better once she was diagnosed with milk protein allergy

Discussion

GAWs present both a diagnostic and a therapeutic challenge. This retrospective study described the evolution of our institutional experience in 21 patients who were diagnosed with GAW using a combination of fluoroscopy and endoscopy. Outcomes after this procedure are promising, with symptom resolution seen in the majority of our patients.

Symptoms of GAW are consistent with partial gastric outlet obstruction such as emesis, postprandial bloating, and failure to thrive. Abdominal pain alone is an unlikely presenting symptom. Fluoroscopy and endoscopy are complementary diagnostic modalities in these patients. In our experience, it is common for contrast studies to be interpreted as normal since the volume instilled for the upper GI study does not reach the volume to adequately show the defect. Similarly, anatomic abnormalities on endoscopy can be subtle, and should be interpreted within the context of symptoms. Once a diagnosis is entertained, the gastroenterologist and surgeon share the decision for management with an endoscopic modality versus surgical intervention.

While there have been several reports of primary endoscopic management of these lesions [8–10], patients may require multiple treatment courses with only transient improvement in symptoms [4]. We have used endoscopic techniques relatively inconsistently, and found that they did not provide durable symptom alleviation. About half our patients who underwent endoscopic treatment ultimately required surgical resection for refractory disease. The methods for endoscopic treatment at our institution included Botulinum toxin injection and balloon dilation. We did not perform needle-knife incision with snare excision, or triamcinolone injections, which are alternative endoscopic therapies that have been described by others [4, 10]. A patient (11 year old) whom we diagnosed with an antral web sought treatment at another institution where a needle-knife incision was performed, with resolution of symptoms.

We found the use of intraoperative endoscopy to be invaluable in web localization. Our technique has evolved. The first three patients underwent EGD prior to incision simply to re-identify the GAW re-identification only. We quickly realized that gastric rugae in a non-distended stomach can assume the appearance of the mucosal web. In the next three patients, intraoperative EGD was performed once the incision was created. The duodenojejunal junction was controlled to prevent insufflation of the rest of the intestines. We used needle or suture localization, but this was difficult as well. Endoscopic tattooing was technically difficult in infants and small children. The dye

can extend beyond the web margins. Our current technique involves deployment of endoscopic clips on either end of the web margin. Typically, a larger endoscope was required for passage of the endoscopic clip applier. CO_2 is routinely used during endoscopy to prevent excessive intestinal distension during laparotomy.

Surgical resection was safe and provided durable symptom relief. In our series, all patients required pyloroplasty in addition to web resection as the web is located very close to the gastric outlet. In our series, patients who required post-pyloric tube feeding preoperatively were successfully transitioned to gastric feeding postoperatively. Some patients who were exclusively tube fed were able to eat orally. Patients who had failed to gain weight preoperatively were able to gain and maintain weight. Interestingly, none of our patients required fundoplication although most presented with symptoms that may be ascribed to gastroesophageal reflux disease.

Limitation of this retrospective single institution study is the predisposition to institutional biases and practices. For instance, the diagnosis of GAW is admittedly more commonly diagnosed in the last few years because of heightened provider awareness and comfort with the surgical management. Since we performed a pyloroplasty with all our antral web resections, it is unclear whether pyloroplasty alone would have yielded the same results. Additionally, our follow-up is relatively short, thus, reporting of longer-term outcomes would be desirable.

In conclusion, GAW should be considered in patients with vomiting, bloating, failure to thrive, and need for post-pyloric feedings. Its diagnosis relies on careful history, as well as both endoscopic and fluoroscopic findings. Surgical web resection and pyloroplasty provide a durable means to help treat these patients' symptoms.

Author contributions All authors made substantial contributions to the design, analysis, and interpretation of data for the work. All authors worked on drafting or revising the manuscript, and gave final approval of the version to be published. All authors are accountable for the work with regard to its accuracy and integrity.

Compliance with ethical standards

Disclosures Dr. Amin, Dr. Martinez, and Dr. Arca have no conflicts of interest or financial ties to disclose.

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