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Operative Technique

# Primary gastrojejunostomy tube placement using laparoscopy with endoscopic assistance: A novel technique

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ABSTRACT

*Background:* Gastrojejunostomy (GJ) tubes are commonly used to provide postpyloric enteral nutrition in pediatric patients who cannot tolerate gastric feeds. Most techniques depend on a preexisting gastrostomy tube (GT) site to convert to a gastrojejunostomy. Several minimally invasive techniques have been described; however, their risk profile varies widely.
*Description of the operative technique:* We present a technique for primary laparoscopic GJ tube placement that minimizes the risk of hollow viscus injury and the use of fluoroscopy through endoscopic assistance.
*Results:* Eleven GJ tubes were placed using this technique in patients ranging from 5 months to 17 years of age and weighing 6.3 to 46.0 kg. Endoscopy through the gastrostomy site allowed direct visualization of wire and tube placement. There were no intraoperative or postoperative complications within 30 days of operation. Use of fluoroscopy was limited with minimal total radiation exposure.
*Conclusion:* The described technique of laparoscopic primary gastrojejunostomy tube placement with endoscopic assistance was associated with a low complication rate and minimal use of fluoroscopy.
*Level of evidence:* IV



Establishing enteral feeding access is one of the most common procedures performed by pediatric surgeons. Although gastrostomy tubes (GTs) are more frequently placed, children who cannot tolerate gastric feeds often require placement of postpyloric feeding access. Gastrojejunostomy (GJ) tubes are performed in such patients with the most common indication being complicated gastroesophageal reflux disease (GERD) [1]. Previously, GJ tubes were placed primarily via an open procedure or secondary to a GT with exchange prolonged 6–8 weeks as the stoma matures [2]. This delays the initiation of feeds through the newly placed tube and necessitates extended use of a nasally placed postpyloric tube. More recently, a variety of techniques for minimally invasive primary placement have evolved including percutaneous placement as well as the use of laparoscopy, fluoroscopy and endoscopy. As techniques continue to develop and reported difficulties including intubation of the pylorus and prevention of tube dislodgement during placement are addressed, attempts should be made to decrease the use of fluoroscopy and therefore radiation exposure to pediatric patients. We present a novel technique for primary laparoscopic–endoscopic GJ tube placement that facilitates the above-mentioned difficulties while reducing radiation exposure by minimizing total fluoroscopy time.

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## 1. Materials and methods

### 1.1. Patient selection

At our institution, primary laparoscopic–endoscopic GJ tube placements have been performed by a collaborative team including a pediatric surgeon and gastroenterology endoscopist. Patients considered for placement of GJ tube require prolonged enteral nutrition and are unable to tolerate gastric feeds most commonly secondary to GERD or delayed gastric emptying. Additionally, patients have failed medical treatment as well as multiple nutrition strategies including continuous gastric feeds and formula changes. There are no specific contraindications to primary placement of a GJ tube at our institution including no lower limit of age or weight of the patient. We consider patients for primary GJ tube placement over permanent procedures such as Nissen fundoplication, which we reserve for patients with intractable reflux that is unlikely to improve over time.

### 1.2. Operative technique

The peritoneal cavity is accessed through an infraumbilical incision using a modified Hassan technique. The laparoscope is placed providing direct visualization of the stomach. An incision is made in the left upper quadrant where the intended gastrojejunostomy tube will be placed. A laparoscopic Allis clamp is then used to grasp the stomach along the greater curvature at a distance 2/3 of the way from the gastroesophageal junction to the pylorus. As initially described by Georgeson, the stomach is brought anteriorly to the abdominal wall, and two sutures are placed through the anterior abdominal wall and the stomach, thus tacking the stomach to the abdominal wall [3]. Between the two sutures, a needle is inserted under direct visualization into the stomach, which has been inflated with air by the anesthesia team via a nasogastric tube. Using Seldinger technique, the gastrostomy is dilated and a 20 Fr peel-away sheath (Cook Medical, Bloomington, IN) is left in place.

The gastroenterology endoscopist places a neonatal endoscope through the sheath, directly into the stomach before advancing the scope through the pylorus into the duodenum and jejunum (Fig. 1). A stiff glidewire with a soft angled tip (Terumo Medical, Somerset, NJ) is then passed through the endoscope and into the jejunum under direct visualization. The endoscope is carefully removed leaving the wire in place and the gastrojejunostomy tube is advanced over the wire through the peel-away sheath until fully inserted with the tip positioned in the jejunum (Fig. 2). The wire is removed and correct placement of the tube is confirmed by contrast injected into the jejunum on fluoroscopy. Once correct placement is established, the gastric balloon is inflated and the two gastric sutures are tunneled through the subcutaneous tissue and tied down. The laparoscope is again placed to visualize the stomach before closure of the infraumbilical incision. Both MIC™ GJ tubes (16 Fr) (Halyard Health, Alpharetta, GA) and AMT G-Jet™ buttons (14 Fr) (Applied Medical Technology, Brecksville, OH) are placed using this technique.

In smaller patients we sometimes use an alternative technique obtaining direct visualization via an esophagogastroduodenoscopy (EGD) when endoscopy through the gastrostomy was not effective. In these cases, a 16 Fr dilator with a glidewire is placed through the gastrostomy. A neonatal scope is passed through the oropharynx into the esophagus and stomach where the wire and dilator are visualized. The wire is then directed toward the duodenum and advanced under direct endoscopic visualization into the jejunum. The dilator is removed and the scope retracted into the stomach after which fluoroscopy is used to ensure the wire has remained in appropriate position. A GJ tube is passed over the wire with the tip positioned in the jejunum, confirmed with fluoroscopy. The gastric balloon is insufflated and the endoscope removed. The gastric sutures are tied down as detailed above and the stomach visualized with the laparoscope before closing the abdomen.

### 1.3. Postoperative management

After successful GJ tube placement, the gastric limb is left to gravity and the jejunal limb clamped until the following morning. Feeds are initiated on postoperative day 1 through the jejunal tube and increased per nutrition recommendation and as tolerated by the patient. Depending on the amount of gastric drainage overnight and the patient's underlying diagnosis, the gastric limb may be left to gravity or clamped at initiation of feeds. GJ tubes are exchanged routinely every 6 to 12 months.

### 1.4. Methods and statistical analysis

After approval by Columbia University's institutional review board, we performed a retrospective review of all cases of primary laparoscopic–endoscopic GJ tube placement at New York-Presbyterian Morgan Stanley Children's Hospital since initiation of the technique in November 2015 until December 2019. Cases were reviewed for sex, age and weight at time of placement, scope technique, duration of operation, duration of fluoroscopy and associated total radiation exposure, procedure success rate and complications. Complications included intraoperative as well as postoperative complications, defined as occurring within 30 days of the operation. Results of continuous variables are presented as medians with standard deviations and categorical variables as totals and percentages.

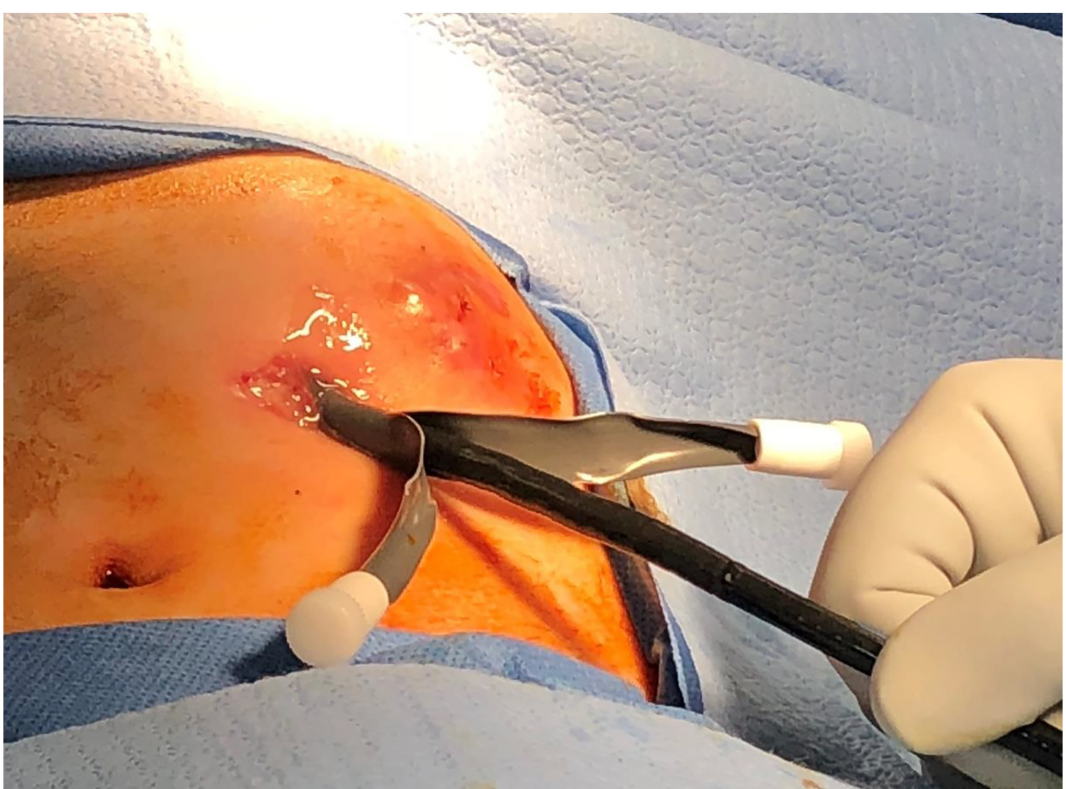

**Fig. 1.** Neonatal endoscope passed through the 20 Fr peel-away sheath, directly into the stomach.

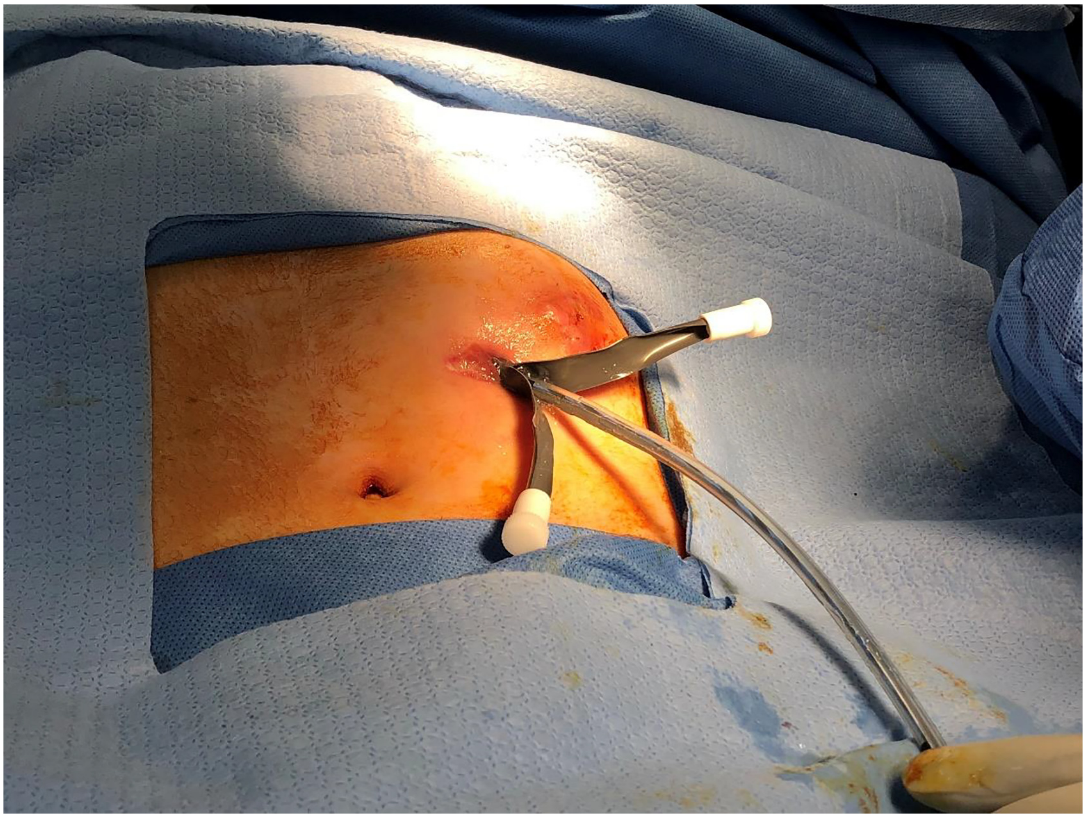

**Fig. 2.** A gastrojejunostomy tube is advanced over a glidewire and through the 20 Fr peel-away sheath.

## 2. Results

From 2015 to 2019, 11 patients underwent primary laparoscopic–endoscopic GJ tube placement at our institution. The overall median patient age at operation was 2.17 years ranging from 5 months to 17 years. Endoscope placement through the stomach was attempted in all patients, however if advancing the scope was met with difficulty, we performed the described esophageal approach. As seen in Tables 1 and 2, patients with EGD guidance were on average younger with median age at GJ tube placement 0.5 year while those with endoscopic guidance through the stomach have a median age of 2.25 years. Similarly, the median weight of patients with GJ tube placement with EGD assistance was 6.84 kg (range 6.35–21.4) while that for patients being scoped through the stomach was 12.95 kg (range 6.3–46.0). Out of the 11 patients, 2 (18.2%) were less than 6 months old and 5 (45.5%) weighed less than 10 kg. The most common primary indication for placement was GERD diagnosed in 9 (81.8%) patients with 2 patients requiring jejunal feeds secondary to complications from superior mesenteric artery syndrome (SMA syndrome). Multiple patients had additional diagnoses of gastroparesis, esophageal dysmotility, and previous aspiration. Comorbidities included a variety of significant neurologic impairments as well as severe pulmonary hypertension.

**Table 1**
Patient and procedure characteristics and associated procedure outcomes.

| | |
|---|---|
| GJ tube placement with scope through the stomach ($n = 8$) | |
| Sex | |
| Female [$n$ (%)] | 3 (37.5%) |
| Male [$n$ (%)] | 5 (62.5%) |
| Age at placement (years) [median (SD)] | 2.25 (6.61) |
| Weight (kg) [median (SD)] | 12.95 (16.5) |
| Indication for GJT | |
| GERD [$n$ (%)] | 6 (75%) |
| Other [$n$ (%)] | 2 (25%) |
| Operation time (min) [median (SD)] | 75.0 (13.2) |
| Fluoroscopy time (s) [median (SD)] | 5.1 (3.2) |
| Radiation exposure (mGy) [median (SD)] | 0.153 (0.096) |
| Operation Success [$n$ (%)] | 8 (100%) |
| Operative complications [$n$ (%)] | 0 (0%) |
| GJ tube placement with esophagogastroduodenoscopy ($n = 3$) | |
| Sex | |
| Female [$n$ (%)] | 0 (0%) |
| Male [$n$ (%)] | 3 (100%) |
| Age at placement (years) [median (SD)] | 0.5 (1.67) |
| Weight (kg) [median (SD)] | 6.84 (6.98) |
| Indication for GJT | |
| GERD [$n$ (%)] | 3 (100%) |
| Other [$n$ (%)] | 0 (0%) |
| Operation time (min) [median (SD)] | 86.0 (5.1) |
| Fluoroscopy time (s) [median (SD)] | Not Documented |
| Radiation exposure (mGy) [median (SD)] | |
| Operation success [$n$ (%)] | 3 (100%) |
| Operative complications [$n$ (%)] | 0 (0%) |

The median operation time for the laparoscopic–endoscopic GJ tube placement was 80 min (range 60–100). As expected, procedures were shorter when endoscopic guidance was successful through the gastrotomy, on average 11 min shorter (75.0 vs 86.0 min). Operative time decreased as we gained experience with the technique, with the most recent cases completed in less than 70 min. All operations resulted in successful placement of a GJ tube with minimal blood loss. Data on total fluoroscopy time were found in only 4 patient's charts with median fluoroscopy time and radiation exposure 5.1 s (range 4–12 s) and 0.196 mGy (range 0.119–0.358 mGy) respectively. None of our patients experienced an intraoperative or postoperative complication. There were no cases of bowel perforation, infection, bleeding or intussusception noted with an average follow-up time of 25 months.

## 3. Discussion

Gastrojejunostomy tubes are a widely accepted modality for providing enteral nutrition for patients with intolerance of gastric feeds.

**Table 2**
Patient and procedure characteristics with associated procedure outcomes.

| Patient number | Gender | Age (months) | Weight (kg) | Diagnosis | Size and brand of GJT | Interoperative complications | Scope technique | Operation time (min) | Total fluoroscopy time (s) | Total radiation exposure (mGy) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Male | 15 | 7.57 | GERD, delayed gastric emptying | 16 Fr MIC | None | Stomach | 70 | Unknown | Unknown |
| 2 | Female | 168 | 41.0 | SMA syndrome, dysmotility | 16 Fr MIC | None | Stomach | 100 | Unknown | Unknown |
| 3 | Female | 168 | 46.0 | GERD, dysmotility | 16 Fr MIC | None | Stomach | 90 | Unknown | Unknown |
| 4 | Female | 204 | 43.0 | SMA syndrome, neurodegenerative disease | 16 Fr MIC | None | Stomach | 80 | Unknown | Unknown |
| 5 | Male | 16 | 6.3 | GERD with previous aspiration, neurologic impairment | 14 Fr AMT G-Jet | None | Stomach | 90 | 4.0 | 0.119 |
| 6 | Male | 26 | 10.9 | GERD, severe neurologic impairment, seizure disorder | 16 Fr MIC | None | Stomach | 68 | 6.0 | 0.179 |
| 7 | Male | 5 | 8.8 | GERD with previous aspiration, neurologic impairment, seizure disorder | 16 Fr MIC | None | Stomach | 60 | 4.2 | 0.126 |
| 8 | Male | 28 | 15.0 | GERD, posterior fossa tumor | 16 Fr MIC | None | Stomach | 67 | 12.0 | 0.358 |
| 9 | Male | 5 | 6.35 | GERD, severe pulmonary hypertension | 16 Fr MIC | None | EGD | 77 | Unknown | Unknown |
| 10 | Male | 6 | 6.84 | GERD, aspiration, severe pulmonary hypertension | 16 Fr MIC | None | EGD | 89 | Unknown | Unknown |
| 11 | Male | 48 | 21.4 | GERD, neurologic impairment | 16 Fr MIC | None | EGD | 86 | Unknown | Unknown |

Although open techniques for placement have previously been described, less invasive primary placement procedures as well as secondary exchange of GT are now more commonly practiced. Multiple studies comparing these techniques emphasize the benefit of starting feeds through the GJ tube on postoperative day 1 with primary placement compared to a 6 to 8-week delay in use when GTs are exchanged for GJ tubes [2,4,5]. In such cases, nasojejunal (NJ) access is commonly obtained, however NJ tubes are associated with patient discomfort, nasal ulceration and tube dislodgement. Rate of incidental displacement of NJ tubes is noted to be approximately 40%–60% with reinsertion linked to further patient discomfort and radiation exposure to confirm tube replacement [6]. Additionally, some rehabilitation facilities do not accept patients with nasally placed postpyloric tubes, potentially delaying discharge from the hospital. The risks associated with NJ tube placement have led to an interest in perfecting the technique for primary GJ tube placement without the need for NJ access. Reported techniques include laparoscopy with fluoroscopic, endoscopic and ultrasound assistance as well as percutaneous placement. Jejunal perforation remains a dreaded complication during primary GJ tube placement with reported rates ranging from 1.1% to 2.1% [5,7–9]. Recent literature demonstrates a 4-fold higher rate of intestinal perforation in children <10 kg and a 7-fold higher rate in patients <6 kg or <6 months old [7,9,10]. We present a novel and successful technique for primary placement of GJ tubes without intestinal perforation in a population in which half of the patients are considered at highest risk.

The most notable novel aspect of our technique is the insertion of the endoscope directly into the stomach. For this part of the procedure, the gastroenterology endoscopist inserts and directs the scope through the gastrostomy. This technique was easily accomplished for most patients; however, transoral esophagogastroscopy was utilized when placement through the gastrostomy was unsuccessful. In our experience, the acute angle of the duodenal sweep in smaller children can be challenging with this approach and is more easily maneuvered with the scope placed orally. We now routinely approach scoping these patients directly through the mouth rather than after an attempt at scoping through the stomach. Castle et al. reported a combined laparoscopic–endoscopic technique for primary GJ tube placement in 2013 in which EGD is preformed and biopsy forceps used to grasp the tip of the tube, pulling it into the jejunum [4]. The inevitable bend in the tip of the scope observed while pulling the grasped tubing can add to the difficulty of intubating the pylorus and result in gastric perforation, as reported in the previously mentioned paper. The gastrostomy entry point for the scope minimizes this risk as the angle for the first portion of the duodenum is directly in line with the scope and the working distance is shorter. During our technique that utilizes oral insertion of the endoscope, we prefer to direct the wire from the gastrostomy through a dilator that is inserted and advanced to the proximal edge of the pylorus, thus providing guidance for the wire. The scope is then more easily able to provide a fulcrum against the wire and be manipulated into the duodenum. We feel this technique also minimizes injury to the stomach or duodenum. Although use of EGD to assist in primary placement of GJ tubes is described in previous studies, to our knowledge this is the first report of endoscopic guidance through the gastrostomy for GJ tube placement.

The utilization of direct visualization via endoscopy in our technique also allows for decreased dependence on fluoroscopy for confirmation of placement, thus reducing radiation exposure in this susceptible patient population. Children with chronic GJ tube dependence often experience minor complications such as tube dislodgement, obstruction, migration, leakage and balloon rupture requiring tube replacement with an annual average of 4.6 tube replacements per child [1]. Fluoroscopically guided exchange is the most widely accepted technique, resulting in continued radiation exposure with reported average fluoroscopy time and average radiation exposure for routine GJ tube exchange of 0.54 min and 1.82 mGy per exchange respectively and for GJ tube exchange secondary to mechanical complication ranging from 3.7 to 7.6 min and from 16.98 to 41.13 mGy respectively [11,12]. Although several studies have analyzed radiation exposure during GJ tube exchange as well as fluoroscopy time during placement of jejunal extension tubes through existing GT (an average of 8–9 min), we are unable to find any data addressing fluoroscopy time and amount of radiation exposure during the commonly used laparoscopic–fluoroscopic primary placement techniques with only brief mentions of estimated average time being less than a minute [13].

Among our patients, fluoroscopy data were retrievable for four patients. Median fluoroscopy time and radiation exposure were 5.1 s and 0.153 mGy respectively. Although we cannot directly compare these data to those from a technique without endoscopic assistance, it would be logical to assume that our technique, which uses a brief fluoroscopic episode for final confirmation of placement during contrast injection, would expose the patient to less radiation than a procedure that is dependent on extended fluoroscopy for placement of the wire and tube. Recently, a novel laparoscopic–fluoroscopic technique was described by LaPlant et al. in which fluoroscopy is used during 4 steps of the procedure, including when passing a glidewire into the jejunum, during placement of a peel-way sheath over the wire and into the pylorus, intermittently as the GJ tube is advanced over the wire as well as at the end of the procedure to confirm adequate placement [8]. Our technique provides endoscopic visualization and guidance of the glidewire into the jejunum, obviating the need for continuous fluoroscopic confirmation. In our technique, a fluoroscopic image is only used to confirm stable wire position after retraction of the endoscope when passed orally and final tube position, minimizing the amount of radiation exposure. As advances in medicine result in improved survival of children with a multitude of previously nonsurvivable conditions, radiation associated morbidities become more evident. In an attempt to raise awareness of the dangers of radiation exposure in medicine, the Image Gently campaign was initiated in 2009 to educate practitioners on reducing radiation in pediatric fluoroscopy procedures [14]. As most patients requiring GJ tubes undergo several procedures to maintain adequate postpyloric feeding access, efforts to reduce fluoroscopy time and therefore radiation exposure should be made, starting with initial placement. Although our study is limited by its retrospective nature and small sample size, we provide the first analysis of radiation exposure for primary GJ tube placement techniques and present a novel laparoscopic–endoscopic technique that limits use of fluoroscopy and has successfully been performed in children <6 months old and <10 kg without intestinal perforation.

## 4. Conclusion

We present the first series of patients undergoing laparoscopic primary GJ tube placement assisted by direct endoscopy via gastrostomy. We provide an alternative technique with low complication rate and minimal use of fluoroscopy. For smaller children, esophagogastric endoscopic assistance seems to be necessary, which was also safely accomplished. Primary GJ tube placement is an important procedure to offer patients who do not require permanent antireflux procedures, and can be performed safely even in smaller children.

## Funding

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## Declaration of competing interest

None.

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