

RESEARCH ARTICLE

Surgical Interventions for Infant and Childhood Gastroesophageal Reflux Disease

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Abstract

Gastroesophageal reflux (GER) is a common condition in infants, thought to be the result of transient lower esophageal sphincter relaxations which occur independent of swallowing. Most cases of GER are physiologic and generally resolve by early childhood. Gastroesophageal reflux disease (GERD) is diagnosed when symptoms persist or complications such as aspiration or esophagitis develop. Currently there is wide practice variation in the surgical treatment of severe infant and childhood reflux with multiple acceptable surgical approaches chosen based on individual disease characteristics as well as surgeon preference. In this review article we discuss the use of laparoscopic fundoplication, gastrojejunostomy and jejunostomy tube placement to mitigate the symptoms of GERD. Although these minimally invasive techniques have greatly advanced treatment in infants and children, a paucity of data exists comparing outcomes of each technique, resulting in a lack of consensus on best technique. Surgical approach to GERD treatment is an important area of research that needs further investigation.

Keywords: Gastroesophageal reflux disease (GERD), Fundoplication, Gastrojejunostomy tube, Jejunostomy tube

1. Introduction:

Gastroesophageal reflux (GER) is common in infants, however most cases spontaneously resolve by 18 - 24 months of life. Although less common, physiologic reflux can progress to gastroesophageal reflux disease (GERD) with persistent symptoms and development of associated complications. Although medical management, most notably with proton pump inhibitors, is the mainstay of treatment for symptomatic reflux, medications often do not resolve symptoms in pediatric patients and are associated with numerous potential complications. Anti-reflux surgery is employed for children whose symptoms do not respond to maximal medical management and remains one of the most common elective procedures performed by pediatric surgeons. Although symptomatic relief and prevention of associated complications with surgical intervention are well documented, there is significant variation in surgical approach in the pediatric population, largely due to lack of published literature comparing each technique. Continuous advances in the field of surgery have led to initially open approaches now largely replaced by minimally invasive techniques, leading to improved short-term outcomes including less post-operative pain, shorter length of stay and often decreased rates of infection while providing comparable long-term outcomes. In this review article we discuss current minimally invasive and laparoscopic approaches to anti-reflux surgery.

2. Fundoplication

Fundoplication is historically the most common anti-reflux surgery used in pediatric patients. Several techniques exist including open and laparoscopic approaches as well as a variety of different degrees of “wrapping” in the fundoplication determined by surgeon

comfort with minimally invasive techniques as well as patient neurologic status. Complete fundoplication includes the most commonly performed approach Nissen Fundoplication while partial techniques include Thal (270° anterior), Belsey (270° anterior, transthoracic approach), Dor (180-200° anterior), Lind (300° posterior) and Toupet (270° posterior). While laparoscopic Nissen fundoplication is the most common technique used for GERD in the pediatric population, comorbidities including achalasia and significant esophageal dysmotility require partial fundoplication techniques to prevent complications.

Currently, there is no consensus on how to best measure outcomes after fundoplication. Multiple single center retrospective reviews address resolution of GERD symptoms by parental report to include dysphagia, vomiting, postprandial abdominal pain and nutritional failure with subjective resolution in symptoms post fundoplication ranging from 65% - 87%.¹ Objective measures before and after fundoplication have also been analyzed with significant post-operative reduction in esophageal pH widely reported. In a retrospective review of 385 pediatric patients who underwent Nissen fundoplication for GERD, 97% of patients had a normal pH study 3 months post-op.¹ Similarly, in a prospective cohort study involving 127 patients, Capito et al. reported a decline in long term reflux index from 10% prior to fundoplication to 1.5% perioperatively.² In addition to gastrointestinal related symptoms, Valusek et al. analyzed improvement in related respiratory symptoms in pediatric patients at Children’s Mercy Hospital undergoing either open or laparoscopic fundoplication. In this population, 81 infants with acute life-threatening events (ALTE) defined as combination of apnea, color change (most commonly cyanotic), marked decrease in muscle tone, choking or gagging

secondary to GERD underwent fundoplication to determine efficacy in preventing recurrent ALTE. Three (3.7%) patients experienced a recurrent ALTE within an average of 57 month follow up time with mechanical causes of recurrent reflux experienced in all 3 patients (herniated fundoplication in 2 patients and pyloric stenosis diagnosed 1-week post-op in the third patient).³ After reoperation with redo fundoplication and pyloromyotomy respectively, ALTE did not recur during the duration of the study. Although studies report reduction in subjective symptoms, fundoplication has not been shown to decrease rates of recurrent pneumonia, apnea or hospitalizations.

Historically, open fundoplication was the preferred approach however with advances in minimally invasive techniques, laparoscopic fundoplication is now more frequently used. A systematic review and meta-analysis by Siddiqui et al. compared open and laparoscopic fundoplication from 4 retrospective and 2 prospective cohort studies amounting to 721 patients. Of these patients, 466 underwent laparoscopic approach and 255 underwent open technique. Among this data, laparoscopic approach resulted in a decrease in overall length of hospital stay by 1 day ($p < 0.01$), decreased time to first feed by 4 hours ($p < 0.001$), and a relative risk reduction of 2.9 for 30-day post-operative morbidity ($p < 0.01$).⁴ Additionally, there was no significant difference in operative time noted ($p = 0.35$) as well as no significant difference in GERD recurrence at 12 months ($p = 0.29$).⁴ A more recent meta-analysis by Ru et al. in 2016 that reviewed 9 studies including 557 patients receiving laparoscopic fundoplication and 359 receiving open fundoplication supports this data reporting less post-operative complications and time to first feed with comparable time to full feeds as well as recurrence requiring reoperation.⁵ In regard to post-operative complications, the

most common significant complication reported in this study was the incidence of small bowel obstruction. In the largest retrospective review looking at 1838 pediatric patients who underwent either laparoscopic or open fundoplication in Japan, Fujjogi et al. reports significantly less small bowel obstruction after laparoscopic approach ($p = 0.01$) which is echoed by several smaller case series.⁶

A population of pediatric patients crucial to discuss in regard to anti-reflux surgery is children with neurologic impairment (NI). Many neurologic conditions can contribute to feeding difficulties and malnutrition in infants and children secondary to impaired motor or swallowing function. Abnormal esophageal motility and function of the gastroesophageal sphincter with reflux are seen in up to 75% of patients with NI and nearly half of all pediatric fundoplications are performed in children with NI.¹ It is widely believed that anti-reflux surgery, specifically fundoplication, is less beneficial in children with NI with reports of decreased resolution of symptoms, increased rates of recurrence and increased rates of mortality.¹ It is important to note the lack of uniform preoperative evaluation leading to potential inappropriate patient selection as well as lack of consideration of natural progression of the underlying neurologic condition which might explain a historically poorer outcome in this cohort. In a prospective cohort study by Knatten et al. involving fundoplication in NI patients compared to neurologically normal patients, early complications, GERD recurrence and long-term parental satisfaction after fundoplication did not differ between the two patient groups.⁷ Additionally, in a study comparing fundoplication to GJ tube placement in 111 NI patients, Wales et al. reported no difference in rates of mortality or recurrent GERD however noted that patients in the GJ

group were more likely to continue taking anti-reflux medication post-operatively ($p < 0.05$). In regard to complications, fundoplication was noted to have increased prevalence of retching (36.5% vs 16.7%, $p = 0.03$) and dysphagia (12.7% vs 2.1%, $p = 0.08$) in this population however was associated with decreased incidence of post-operative bowel obstruction (7.9% vs 20.8%, $p = 0.06$).⁸ Data regarding outcomes of anti-reflux surgery in NI children remains inconclusive and requires further investigation.

3. Gastrojejunostomy Tube Placement

Gastrojejunostomy (GJ) tubes are an alternative approach that provide post-pyloric feeding access for patients who cannot tolerate gastric feeds, usually as a consequence of significant GERD. Previously, GJ tubes were placed primarily via an open procedure or secondary to a previously placed gastrostomy. Although placement of a percutaneous endoscopic gastrostomy (PEG) followed by exchange for a GJ tube is the least invasive approach to obtain post-pyloric feeds, exchange must occur after the stoma matures, delaying the initiation of feeds by 6-8 weeks.⁹⁻¹¹ 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. These approaches allow for immediate feeding however they do not mitigate the common struggle to intubate the pylorus and prevent tube dislodgement during placement. Additionally, jejunal perforation remains a dreaded complication during primary GJ tube placement, most notably in children < 10 kg or < 6 months of age, with reported rates ranging from 1.1 – 2.1%.¹¹⁻¹⁵

Our institution uses a novel laparoscopic-endoscopic GJ tube placement technique that obviates the above-mentioned difficulties

with no intra-operative complications to date. In this technique, a laparoscopy assisted gastrostomy is created after which an endoscope is passed either orally or through the gastrostomy and used to guide the guidewire and gastrojejunostomy tube into the jejunum while minimizing use of fluoroscopy. This technique provides a minimally invasive approach to post-pyloric feeding access using only a small umbilical incision and the GJ tube site. In addition to a quicker recovery time as seen with many laparoscopic techniques, this approach allows for use of the newly established feeding access within 12 hours of placement, obviating the 6-8 week delay in feeds experienced when a gastrostomy tube is replaced with a GJ tube.

Although GJ tube placement provides a minimally invasive technique for mitigating GERD symptoms, several risks and complications are associated with this approach. All variations of GJ tube placement require differing amounts of radiation exposure compounded by the radiation used during prophylactic replacement and complication related exchange. Accumulative exposure at a young age risks the development of a multitude of related morbidities. In a retrospective review by Wales et al., out of 48 patients receiving GJ tube placement for GERD, 85 % experienced GJ tube specific complications within a 3 year follow up period including breakage, blockage and dislodgement.⁸ Raval et al reports 4.6 tube replacements per year requiring fluoroscopy guidance with GJ tube placement compared to 1.5 tube replacements for SJT, resulting in increased radiation exposure.¹⁶ In addition to radiation exposure experienced with tube placement and exchange, Wales et al noted that 20.8% of patients receiving GJ tube developed bowel obstruction or intussusception while 8.3% eventually required fundoplication due to persistent

symptoms.⁸ When comparing jejunostomy to gastrojejunostomy tube placement, several retrospective reviews note the advanced minimally invasive techniques as well as ease of discontinuation of a GJ tube compared to a SJT. These advantages, however, may be offset by the increased number of manipulations per year with associated radiation exposure and subsequent hospitalizations seen in these patients compared with patients receiving SJT.

4. Jejunostomy Tube Placement

Surgical jejunostomy tube (SJT) placement is one of several approaches to mitigating the symptoms of GERD by providing post-pyloric feeding access with nutrition delivered directly into the jejunum. Initially, open techniques were utilized which have since evolved into preference toward minimally invasive techniques including laparoscopic jejunostomy tube placement. Additional minimally invasive approaches have developed with associated advances in endoscopic techniques, with direct percutaneous endoscopic jejunostomy as well as laparoscopic assisted percutaneous endoscopic jejunostomy gaining popularity with small case series reporting success in pediatric patients.¹⁷ As is seen with anti-reflux surgery in general, there is no consensus on the best approach to SJT placement, which is also often determined based on surgeon preference and disease characteristics. There are major complications reported with jejunostomy tube placement including small bowel volvulus with obstruction as well as small bowel perforation with reported rates ranging from 20% - 37%.¹⁷⁻²⁰ Although published data supports improvement in GERD symptoms with post-pyloric feeding, there are several common complications associated with long-term use of jejunal feeding tubes. Tube dislocation, leak,

kinking and blockage are commonly encountered and often require tube exchange, a procedure associated with potential incorrect placement as well as risk for recurrent kinking and dislocation. In addition to tube exchange for complications, accepted practice recommends prophylactic replacement of jejunostomy tubes every 6 months, resulting in recurrent interventions. Despite the associated complications, direct jejunal feeds are thought to be most beneficial in severely ill children with significant comorbidities or neurologic impairment, as rates of GERD recurrence as well as post-operative complications with the more commonly preferred fundoplication have been reported as highest in this patient population. Although techniques for SJT placement have become progressively less invasive, gastrojejunostomy tube placement is more commonly initially used to obtain post-pyloric feeding access.

5. Conclusion

Reflux is an exceedingly common condition in pediatric patients with anti-reflux procedures being one of the most frequent elective surgeries performed by pediatric surgeons. There currently is no consensus on surgical management with a wide variation of surgical techniques often chosen based on surgeon preference and patient disease characteristics. As with all interventions, each approach has inherent risks and differing degrees of benefit (table 1), however further research is necessary to determine best practice or establish guidelines for choosing surgical approach to treat infant and childhood GERD. Current literature consists of small case studies without comparison of each surgical technique. Surgical approach to GERD treatment is an important area of research that needs further investigation.

Table 1: Comparison of Pros and Cons of Minimally Invasive Surgical Techniques for Treatment of GERD.

	Fundoplication	Gastrojejunostomy	Surgical Jejunostomy
Invasive	Yes	Technique Dependent	Yes
Use of Radiation During Initial Procedure	No	Yes	No
Use of Radiation During Repair/Replacement	No	Yes	Yes
Revisions, Replacement, Repair	Less Frequent	Frequent	Frequent
Reversible	No	Yes	Yes (Requires Surgery)
Long-Term Success	Yes	No	Yes
Complications	Slipped Wrap Wrap Failure Surgical Site Infection Dysphagia Gas-Bloat Syndrome	Intestinal Perforation Intussusception Volvulus Small Bowel Obstruction Tube Dislodgement Tube Kinking Balloon Rupture Tube Leaking Surgical Site Infection Increased Exposure to Radiation	Intussusception Volvulus Small Bowel Obstruction Tube Dislodgement Tube Kinking Balloon Rupture Tube Leaking Surgical Site Infection Increased Exposure to Radiation

Comparison of Minimally Invasive Surgical Techniques for Treatment of GERD

6. Resources:

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