Surg Endosc (1996) 10: 1154–1157

Surgical Endoscopy

Laparoscopic fundoplication in infants and children

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Received: 22 March 1996/Accepted: 12 June 1996

Abstract

Background: Laparoscopic fundoplication is a new method for treating gastroesophageal reflux in children. We present 160 children with gastroesophageal reflux treated by laparoscopic fundoplication.

Methods: Patients underwent either a laparoscopic Nissen or Toupet fundoplication. Many patients also required gastrostomies and gastric outlet procedures.

Results: Twelve patients (7.5%) were converted to open fundoplication. Laparoscopic gastrostomies were placed in 112 patients (75.7%) and laparoscopic gastric outlet procedures in 62 patients (41.9%). Feedings were initiated by postoperative day 2 in 126 children (85.7%). Sixty-four percent were discharged by postoperative day 3. Complications occurred in 11 of 148 fundoplications (7.4%), in nine of 112 gastrostomies (8.0%), and in three of 62 gastric outlet procedures (4.8%). One patient died as a result of a surgical error in placing a gastrostomy (0.7%).

Conclusion: Laparoscopic fundoplication appears to foster a more rapid recovery and decreased hospital stay while maintaining complication rates similar to or better than open fundoplication.

Key words: Laparoscopy — Fundoplication — Gastroesophageal reflux — Gastrostomy — Antroplasty — Delayed gastric emptying

Laparoscopic surgery has become an attractive alternative for a variety of operative procedures which have conventionally been performed by open surgical techniques [2]. Fundoplication for the treatment of gastroesophageal reflux is now being performed laparoscopically for both adult and pediatric patients. Although the outcome of laparoscopic fundoplication in the adult population has been abundantly reported, only a few studies have discussed the results of laparoscopic fundoplication in children. This paper presents our results with laparoscopic fundoplication in 160 consecutive pediatric patients. Due to the high incidence of associated comorbidity, many of the patients presented here also required gastrostomy tube placement and gastric outlet procedures. Most of these additional procedures were also done laparoscopically at the time of fundoplication.

Presented at the annual meeting of the Society of American Gastrointestinal Endoscopic Surgeons (SAGES), Philadelphia, Pennsylvania, USA, 14–17 March 1996

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Method

We evaluated the first 160 consecutive pediatric patients who were taken to the operating room for laparoscopic fundoplication from January of 1992 through March of 1995. Twelve operations (7.5%) were converted to open fundoplication. Of the remaining 148 patients, 79 (53.4%) were males and 69 (46.6%) were females. One hundred seven (72.3%) of the patients were Caucasian, 40 (27.0%) were African-American, and one patient (0.7%) was Hispanic. The patients ranged in age from 1 month to 20 years. The average age was 6.5 years with a median of 5.5 years. All patients (100%) had gastroesophageal reflux documented by upper gastrointestinal barium swallow or 24-h pH monitor. Ninety-nine patients (66.9%) had severe neurologic impairment, 14 (9.5%) had mild neurologic impairment, and 35 patients (23.6%) had no neurologic deficit. Severe neurologic impairment was defined as the inability to self-feed or perform the activities of daily living whereas mild neurologic impairment was defined as a cognitive learning disability while still demonstrating the ability to self-feed and perform the activities of daily living. Ninety-patients (60.8%) were diagnosed with failure to thrive.

The attending surgeon was the same for all patients. The fundoplication employed was either a complete wrap (Nissen) or a partial wrap (Toupet) fundoplication. In the early months of our experience, we performed the Nissen fundoplication exclusively. As we gained experience and familiarity with the equipment and techniques, we began performing the Toupet fundoplication in selected patients. The Nissen fundoplication was selected for patients who had life-threatening gastroesophageal reflux or were unable to protect their airway. The Toupet fundoplication was performed in patients who had esophageal dysmotility or were at high risk for gas bloat syndrome. In addition to the fundoplication, a gastrostomy tube was placed if the patient was diagnosed with failure to thrive, if the patient was incapable of taking adequate nutrition orally, or suffered from primary aspiration. A gastric outlet procedure was performed if delayed gastric emptying was demonstrated by a radionuclide study. The time required to perform the surgery was defined as the total time from initiation of the first incision for trocar placement to closure of the last trocar site. Induction of anesthesia, sterile preparation, draping of the patient, and recovery time were not included in this time measurement.

Fundoplication

The patient is placed supine at the end of the table and in a reverse Trendelenburg position. A Maloney dilator is selected based on the child's

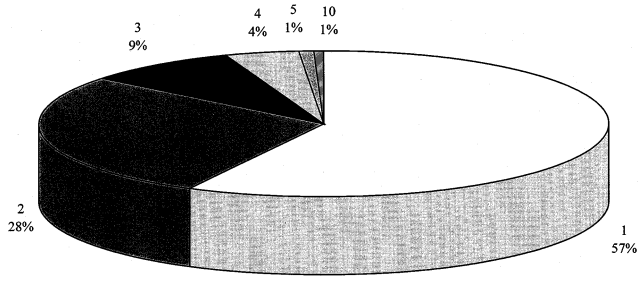

Fig. 1. Postop-day feeding initiated.

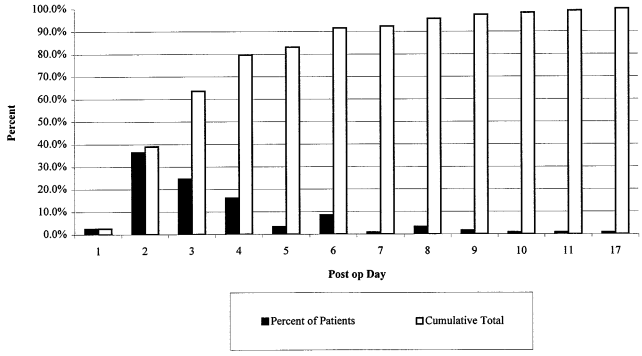

Fig. 2. Postop-day discharged.

size. The stomach is suctioned and the dilator is passed through the esophagus and into the proximal stomach. The dilator should minimally dilate the esophagus and pass easily without resistance. If resistance is encountered, a smaller dilator is selected. After sterile preparation and draping, four or five ports are inserted. A 30° scope affords excellent visualization of the hiatus. The gastrohepatic ligament is divided. Using blunt dissection, the right crus of the diaphragm is cleared followed by the left crus. Division of the short gastric vessels using electrocautery and clips is almost always performed to allow adequate mobilization of the fundus. The anesthesiologist retracts the Maloney dilator to a position proximal to the gastroesophageal junction and the surgeon develops a window behind the esophagus. The fundus is then pulled behind the distal esophagus and the anesthesiologist repositions the Maloney dilator into the stomach. For the Nissen fundoplication, the fundus is attached to the right crus and is wrapped and secured at the 9-o'clock position on the esophagus. Finally, the wrap is secured to the undersurface of the left diaphragm. In performing the Toupet fundoplication, the fundus is secured to the right crus and to the 8- and 12-o'clock positions of the esophagus creating a 260° wrap. Finally, the wrap is secured to the left crus at the 12- and 1-o'clock positions of the esophagus.

Gastrostomy

We have used a variety of techniques for laparoscopic placement of a gastrostomy tube including the T-fastener, U-stitch, and trocar techniques. We currently utilize the U-stitch technique as our preferred method. After completion of the fundoplication, the pneumoperitoneum is partially deflated. The anterior wall is grasped through a 3-mm left upper quadrant trocar site. A suture is passed through the abdominal wall using a standard needle driver and then hooked into the anterior wall of the tethered stomach. The needle is rotated back through the abdominal wall. This is repeated three more times to form a square of U-stitches. The stomach is insufflated through a nasogastric tube. A needle introducer is passed through the abdominal wall and stomach inside the U-stitches followed by the passage of a guide wire through the needle introducer. The tract is dilated over the guide wire and a catheter or button is placed over the wire. Finally, the U-stitches are secured over the wings of the button or bolster.

Outlet procedure

An antroplasty is our preferred laparoscopic technique for surgical treatment of delayed gastric emptying [6]. After completion of the fundoplication, a 3-cm linear incision is made in the distal antrum and spread with a pyloric spreader. After adequate separation of tissues, the incision is closed transversely with interrupted silk sutures.

Results

Twelve of 160 patients (7.5%) undergoing laparoscopic fundoplication were converted to open procedures. Seven patients were converted because of equipment problems and two patients had dense adhesions. Three patients (1.9%) were opened because of surgical errors. Two of these patients, one with a subphrenic vein bleed and the other with an incorrectly fastened fundoplication, had no postoperative morbidity from these technical errors. One complication occurred in the patients requiring open conversion (8.3%). This patient's esophagus was perforated while dissecting the hiatus and he required postoperative esophageal dilatations.

Of the 148 patients that underwent laparoscopic fundoplication, a Nissen fundoplication was performed in 114 patients (77.0%) and the Toupet fundoplication in 34 patients (23.0%). Gastrostomies were placed in 115 patients (77.7%). A gastrostomy was placed laparoscopically in 112 patients (75.7%) while three patients (2.0%) had open gastrostomies after completion of the laparoscopic fundoplication. One of these patients had severe kyphoscoliosis and another had a very acute costosternal angle, making laparoscopic positioning of the gastrostomy difficult. The camera light failed after completion of the fundoplication in a third patient, necessitating an open gastrostomy.

Laparoscopic gastric outlet procedures were performed in 62 patients (41.9%), and seven patients (4.7%) had open procedures performed through a small right subcostal incision after completion of the laparoscopic fundoplication. All seven of these open emptying procedures were performed during our early experience with the laparoscopic technique. The decision to perform this portion of the procedure by the open method was made preoperatively in all seven cases.

Feedings were successfully initiated on the 1st postoperative day in 85 patients (57.8%), and another 41 patients (27.9%) were fed by postoperative day 2 (Fig. 1). By postoperative day 5, all but one patient (99.3%) had started feeding. Some of our patients had been hospitalized for lengthy periods for a variety of ailments at the time gastroesophageal reflux was diagnosed. Those patients who were admitted to a medical service and returned to their service of origin after a few days of postoperative observation and recovery were eliminated from the postoperative-length-of-stay data analysis. Of the 118 patients remaining on the surgical service until discharge, 75 (63.6%) were discharged by postoperative day 3. Within 6 days, 108 patients (91.5%) had been discharged and all but one patient (99.2%) had been discharged by postoperative day 11 (Fig. 2).

Complications occurred in seven of 114 Nissen (6.1%) and four of 34 Toupet (11.8%) fundoplication patients for a total of 11 of 148 patients (7.4%). Incorporating the conversion complication, the total number of fundoplication complications is 12 of 160 patients (7.5%). These compli-

Table 1. Laparoscopic fundoplication and conversion complications

Fundoplication type	Complication	Number	Treatment/outcome
Nissen	Dysphagia	2	Esophageal dilatation
	Recurrent reflux	2	One open repair successful, one not
	Aerophagia (present pre-op)	1	Family taught use of nasogastric tube
	Hiatal hernia	1	Open repair
	Esophageal perforation	1	Intraop repair
Toupet	Pneumothorax	2	Intraop repair
	Aerophagia (present pre-op)	1	None, improved as patient grew
	Dysphagia	1	Esophageal dilatation
Conversion	Esophageal perforation	1	Intraop repair/postop dilatation
	Total conversion and fundoplication complications, $n = 160$	12 (7.5%)	

Table 2. Laparoscopic gastrostomy complications

Complication	Number (%)	Treatment/outcome
Cellulitis	3	IV antibiotics
G-tube site did not close after removal	2	Surgical closure of g-tube site
Small-bowel obstruction	2	One due to g-tube migrating past pylorus, one due to adhesions; both repaired with open surgery
Malpositioned g-tube	1	Repositioned g-tube
Gastric perforation	1	Death; patient expired postop day 5; g-tube through both anterior and posterior walls of stomach
Total gastrostomy complications, $n = 112$	9 (8.0%)	

Table 3. Laparoscopic gastric outlet procedure complications

Complication	Number (%)	Treatment/outcome
Dumping syndrome	2	Diet modification
Developed delayed gastric emptying 18 months postop after pyloromyotomy	1	Laparoscopic pyloroplasty
Total gastric outlet procedure complications, $n = 62$	3 (4.8%)	

Table 4. General complications

Complication	Number (%)	Treatment/outcome
Sepsis	2	IV antibiotics
Pneumonia	2	IV antibiotics
Total general complications, $n = 148$	4 (2.7%)	

cations are summarized in Table 1. Two patients developed recurrence of their reflux (1.4%). One occurred in a patient 1 year postop and was successfully treated using an open fundoplication. The other patient continued to have massive reflux despite redo open fundoplication (Table 2).

Other complications included nine of 112 patients (8.0%) with gastrostomy-related complications (8.0%), three of 62 patients (4.8%) with complications attributed to the emptying procedure (Table 3), and four of 148 patients (2.7%) with general postoperative complications (Table 4).

The only perioperative death occurred as result of a surgical error in laparoscopic placement of a gastrostomy tube. The gastrostomy tube was inadvertently placed through both the anterior and posterior wall of the stomach, which was not discovered at the time of the initial surgery. The patient was a severely neurologically disabled male with pronounced aerophagia. He developed massive gastric distention and perforated his stomach along the greater curvature. He later developed sepsis and expired on the 5th postoperative day.

Discussion

The first published report of laparoscopic fundoplication for the treatment of gastroesophageal reflux appeared in 1991 [5]. Since then, preliminary results in the adult population have been encouraging [11, 14, 16–18] with similar success reported in a few small series of pediatric patients [2, 9, 19]. Although gastroesophageal reflux is a common disorder in infants, the problem is frequently self-limited and improves with age [10, 20]. However, many children do not improve and continue to have significant morbidity. Some children progress and develop life-threatening gastroesophageal reflux, while others have chronic pulmonary problems including chronic aspiration, asthma, pneumonitis, and recurrent pneumonias. Additionally, neurologically impaired patients with gastrointestinal reflux may be unable to protect their airway and are at significant risk for aspiration. Unlike the adult population where reflux disease is generally self-limited, the significant comorbidity of the pediatric patient population with gastroesophageal reflux leads to longer hospitalizations and higher complication rates when compared to adult patients.

Many of these children have failure to thrive or have swallowing disorders and need gastrostomies for nutritional support. However, gastrostomy has been shown to exacerbate reflux in up to 70% of treated patients [1, 13]. Medical management has limited success in these patients and surgical intervention is frequently required.

There has been considerable debate over the necessity of performing gastric outlet procedures in patients with gastroesophageal reflux and delayed gastric emptying. Some authors have shown that concurrent presence of gastroesophageal reflux and delayed gastric emptying are interrelated [7]. However, other authors have shown no benefit from performing gastric outlet procedures in children requiring fundoplication [12]. We believe that delayed gastric emptying can exacerbate gastroesophageal reflux in some children and may also contribute to postoperative complications including retching and gastrostomy dysfunction. We perform a gastric outlet procedure if the gastric emptying is less than 50% after 2 h as demonstrated by radionuclide imaging.

Laparoscopic fundoplication complication rates for children are similar to those reported for open fundoplication [4]. Hospital stays after laparoscopic fundoplication are considerably shorter and patients return to school and regular activities sooner [2]. Reported reflux recurrence rates vary from 2% to 19% in children [3, 8, 15]. In one series of neurologically impaired children, the recurrence was 19% after fundoplication [15]. Most recurrences occurred within the first 2 years following fundoplication [3]. Our recurrence rate of 1.4% with an average follow-up of 18 months compares favorably to most reported series.

Conclusion

The laparoscopic approach to gastroesophageal reflux in children fosters a more rapid recovery and decreased hospital stay while maintaining low complication and recurrence rates. Long-term follow-up will be necessary in order to fully assess the results of laparoscopic treatment of gastroesophageal reflux in infants and children.

References

1. Berezin S, Schwarz S, Halata MS, Newman LJ (1986) Gastroesophageal reflux secondary to gastrostomy tube placement. Am J Dis Child 140: 649–701
2. Blucher D, Lobe TE (1994) Minimal access surgery in children: the state of the art. Int Surg 79: 317–321
3. Caniano DA, Ginn-Pease ME, King DR (1990) The failed antireflux procedure: analysis of risk factors and morbidity. J Pediatr Surg 25(10): 1022–1025, discussion 1025–1026
4. Collins JB, Georgeson KE, Vicente Y, Hardin WD Jr (1995) Comparison of open and laparoscopic gastrostomy and fundoplication in 120 patients. J Pediatr Surg 30(7): 1065–1070, discussion 1070–1071
5. Dallemagne B, Weerts JM, Jehaaes C, Markiewicz S, Lombard R (1991) Laparoscopic Nissen fundoplication: preliminary report. Surg Laparosc Endosc 1: 138–143
6. Fonkalsrud EW, Ament ME, Vargas J (1992) Gastric antroplasty for the treatment of delayed gastric emptying and gastroesophageal reflux in children. Am J Surg 164(4): 327–331
7. Fonkalsrud EW, Ellis DG, Shaw A, Mann CM Jr, Black TL, Miller JP, Snyder CL (1995) A combined hospital experience with fundoplication and gastric emptying procedure for gastroesophageal reflux in children. J Am Coll Surg 180(4): 449–455
8. Fung KP, Seagram G, Pasieka J, Trevenen C, Machida H, Scott B (1990) Investigation and outcome of 121 infants and children requiring fundoplication for the management of gastroesophageal reflux. Clin Invest Med 13(5): 237–246
9. Georgeson KE (1993) Laparoscopic gastrostomy and fundoplication. Pediatr Ann 22: 675–677
10. Glassman M, George D, Grill B (1995) Gastroesophageal reflux in children. Clinical manifestations, diagnosis, and therapy [review]. Gastroenterol Clin North Am 24(1): 71–98
11. Hinder RA, Filipi CJ, Wetscher G, Neary P, DeMeester TR, Perdikis G (1994) Laparoscopic Nissen fundoplication is an effective treatment for gastroesophageal reflux disease. Ann Surg 220(4): 472–483
12. Maxson RT, Harp S, Jackson RJ, Smith SD, Wagner CW (1994) Delayed gastric emptying in neurologically impaired children with gastroesophageal reflux: the role of pyloroplasty. J Pediatr Surg 29(6): 726–729
13. Mollitt DL, Gollasay S, Seibert JJ (1985) Symptomatic gastroesophageal reflux in childhood. Pediatrics 75(6): 1124–1126
14. O'Reilly MJ, Mullins SG (1993) Laparoscopic Nissen fundoplication: report of first 15 cases. J Laparoendosc Surg 3(4): 317–324
15. Pearl RH, Robie DK, Ein SH, Shandling B, Wesson DE, Superina R, McTaggart K, Garcia VF, O'Connor JA, Filler RM (1990) Complications of gastroesophageal antireflux surgery in neurologically impaired versus neurologically normal children [review]. J Pediatr Surg 25(11): 1169–1173
16. Peters JH, Heimbucher J, Kauer WKH, Incarbone R, Bremner CG, DeMeester TR (1995) Clinical and physiologic comparison of laparoscopic and open Nissen fundoplication. J Am Coll Surg 180(4): 385–393
17. Pitcher DE, Curet MJ, Martin DT, Castillo RR, Gerstenberger PD, Vogt D, Zucker KA (1994) Successful management of severe gastroesophageal reflux disease with laparoscopic Nissen fundoplication. Am J Surg 168: 547–554
18. Rattner DW, Brooks DC (1995) Patient satisfaction following laparoscopic and open antireflux surgery. Arch Surg 130(3): 289–294
19. Rothenberg SS (1994) Laparoscopic antireflux procedures and gastrostomy tubes in infants and children. Int Surg 79: 328–331
20. Sondheimer JM (1994) Gastroesophageal reflux in children. Clinical presentation and diagnostic evaluation [review]. Gastrointest Endosc Clin N Am 4(1): 55–74