Laparoscopic Nissen Fundoplication in Children:
A Single Surgeon’s Experience

Mary Ann Hopkins, MD, Gustavo Stringel, MD

ABSTRACT

Background and Objectives: Adult laparoscopic Nissen fundoplication has been steadily growing since its introduction to the United States in the 1990s. Its advantage over the traditional open approach is manifold. Application of laparoscopic fundoplication to children is slowly but surely following this trend. This study evaluates our initial experience with pediatric laparoscopic Nissen fundoplications.

Patients and Methods: We reviewed the records of 25 consecutive laparoscopic Nissen fundoplications performed by a single surgeon (GS) at our institution in the past three years. The patient ages ranged from 7 months to 18 years (mean, 7 years). All patients had documented gastroesophageal reflux disease. Complications from the reflux included vomiting in 15 patients, failure to thrive in nine, esophagitis in nine, and pulmonary symptoms in six.

Results: All Nissen fundoplications were performed laparoscopically without need for conversion to open technique. Blood loss was less than 50 cc in all cases. A tube gastrostomy was concurrently performed in 17. Mean operative time in all cases was 221 minutes. Average postoperative day on which feedings were begun was day 2, with an average resumption of regular feedings on postoperative day 3.5. Average date of discharge was postoperative day 6.8. Complications included difficulty controlling glucose in an insulin-dependent diabetic, and a lost needle, which added an additional hour to the operative time. There were eight admissions to the pediatric intensive care unit, all for observation secondary to their underlying medical problems. There was one postoperative death due to an underlying medical condition.

Conclusions: Laparoscopic Nissen fundoplication is a safe and effective treatment option for children suffering from significant reflux. Time to regular feeding, analgesia requirements and hospital stay are decreased when compared to traditional procedures. Laparoscopic Nissen fundoplication may well become the procedure of choice for pediatric gastroesophageal reflux disease.

Key Words: Laparoscopy, Nissen fundoplication, Gastrostomy.

INTRODUCTION

Gastroesophageal reflux disease is a common entity among children. Although medical treatment has improved over the last decade, failure of medical treatment remains common, especially among those who are neurologically impaired. This failure is likely due to the inability of medication to address the underlying functional abnormalities of the esophagus and the lower esophageal sphincter. The Nissen fundoplication has been used successfully to correct the underlying sphincter abnormality. Within the last decade, advances in fiber optics and laparoscopic instruments have made the laparoscopic approach to fundoplication possible.

Adult laparoscopic Nissen fundoplication has steadily gained acceptance in the surgical community. Although the learning curve is steep, and complications unique to laparoscopy occur, the advantages of minimal access surgery in children are clear. Even small infants are suitable candidates for laparoscopic fundoplication. Hospital length of stay is shortened, return to regular diet and activities of daily living are hastened, and postoperative analgesic requirements are decreased. In the present report, we describe a single surgeon’s experience with 25 consecutive laparoscopic Nissen fundoplications with or without laparoscopic-assisted gastrostomy tubes.

PATIENTS AND METHODS

The first 25 cases involving laparoscopic Nissen fundoplication in pediatric patients, performed at Westchester Medical Center, were reviewed. All patients had documented gastroesophageal reflux disease. Complications from the reflux included vomiting in 15 patients, failure to thrive in nine, esophagitis in nine, and pulmonary symptoms in six.

Results: All Nissen fundoplications were performed laparoscopically without need for conversion to open technique. Blood loss was less than 50 cc in all cases. A tube gastrostomy was concurrently performed in 17. Mean operative time in all cases was 221 minutes. Average postoperative day on which feedings were begun was day 2, with an average resumption of regular feedings on postoperative day 3.5. Average date of discharge was postoperative day 6.8. Complications included difficulty controlling glucose in an insulin-dependent diabetic, and a lost needle, which added an additional hour to the operative time. There were eight admissions to the pediatric intensive care unit, all for observation secondary to their underlying medical problems. There was one postoperative death due to an underlying medical condition.

Conclusions: Laparoscopic Nissen fundoplication is a safe and effective treatment option for children suffering from significant reflux. Time to regular feeding, analgesia requirements and hospital stay are decreased when compared to traditional procedures. Laparoscopic Nissen fundoplication may well become the procedure of choice for pediatric gastroesophageal reflux disease.

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Medical Center between May 1995 and September 1998, were reviewed (Table 1). Patient ages ranged from seven months to 18 years (mean, 7 years). There were 17 males and eight females. Complications of reflux disease included persistent vomiting in 15 patients, esophagitis in nine, failure to thrive in nine, respiratory symptoms in six, and stricture in one. All patients underwent an upper gastrointestinal series and nine had endoscopy with biopsy to document esophagitis. Eight patients underwent 24-hour pH probe analysis. Associated co-morbidities included cerebral palsy with mental retardation in 16 patients (two of whom were quadriplegics), seizure disorder in ten, microcephaly in three, and asthma in two. In addition, there was one each of the following disabilities: cranial facial syndrome, cystic fibrosis and bronchiectasis, Duchenne's muscular dystrophy, sleep apnea, sickle cell disease, insulin-dependent diabetes mellitus, congenital cytomegalovirus infection, and Wolff-Parkinson-White syndrome.

Operative Technique
All laparoscopic Nissen fundoplications were performed using general anesthesia with the patient in the supine position. An appropriately sized nasogastric tube and Foley catheter were placed. An infraumbilical 5 mm trocar for a 5 mm laparoscope was placed using an open technique. The abdomen was insufflated to a pressure of 12 to 13 mm Hg. Four additional 5 mm trocars were used. The positions of these four trocars were as follows: two were in the right and left anterior axillary line one to two finger-breadths below the costal margin, and the other two were placed in the right and left midclavicular line, again below the costal margin.

The patient was then placed in the reverse Trendelenburg position. The gastrohepatic ligament and the peritoneal reflection overlying the anterior esophagus were divided using scissors with electrocautery. The crura of the diaphragm was exposed. In the last five patients, the short gastric vessels were divided along the upper third of the greater curvature of the stomach. A quarter-inch Penrose drain was placed around the esophagus to facilitate the dissection of the gastroesophageal junction. This dissection was accomplished with both blunt and sharp dissection. The anterior and posterior vagus nerves were identified and left lying along the esophagus. The hepatic branches of the vagus nerve were carefully preserved. The Nissen fundoplication was constructed above these branches. When 3 to 5 cm of esophagus was comfortably lying free in the abdomen, a clamp was placed behind the esophagus from the far right trocar and used to grasp the fundus, which was then pulled behind the esophagus. (When the fundus is released, it should lie freely where it is placed to ensure that there will not be too much tension on the wrap.)

The crura was approximated using one to three interrupted 2-0 nonabsorbable sutures. No bougie was used because many complications of this procedure are directly attributed to it. Instead, an oral gastric tube size 12 to 18 French was used as a stent; the size depended on the age of the patient. The fundus was then brought back around the back of the esophagus, and two to three interrupted nonabsorbable sutures were used to create a 360-degree fundoplication. These sutures were placed through the left side of the fundus, the esophagus and the right side of the fundus, with care taken to avoid the anterior vagus nerve. All sutures were tied extracorporeally. After any blood or irrigation fluid that accumulated was aspirated and the Penrose removed, the fascia at all port sites 5 mm or larger was closed either with the Endoclose device or under direct vision using 0 or 2-0 Vicryl sutures. Subcuticular sutures were used to close the skin. The nasogastric tube was left in place until the following morning.

In patients with a gastrostomy, a postoperative nasogastric tube was not used. A laparoscopic gastrostomy was performed in 17 patients. In three patients, suturing was done with the Endostitch instrument (US Surgical Corporation, Norwalk, CT), which requires a 10 mm port.

RESULTS
There were no conversions in any of the 25 cases reviewed. Seven patients underwent Nissen fundoplication alone. Seventeen patients underwent Nissen fundoplication and tube gastrostomy. Additional procedures performed included bilateral inguinal herniorrhaphy in one, orchidopexy in one, therapeutic bronchoscopy in two, right inguinal herniorrhaphy in one, and intraoperative esophageal manometry in two patients.

Operative time ranged from 125 to 320 minutes. Average time for Nissen fundoplication alone was 185 minutes; for Nissen fundoplication and tube gastrostomy, the average time was 219 minutes. When Nissen fundoplication was combined with other procedures, the average time was 291 minutes (Table 2). In all cases, blood loss was
### Table 1.
Patients’ Characteristics.

| Age | Sex | Diagnosis            | Procedure | Operative Time | Complications                  | Outcome       |
|-----|-----|----------------------|-----------|----------------|--------------------------------|---------------|
|     |     |                      |           | Hrs:min        |                                |               |
| 7 M | m   | GER, HH, BIH, NI     | N, GT, BIH| 4:45           | None                          | Good          |
| 9 M | m   | GER, NI              | N, GT     | 3:15           | None                          | Good          |
| 1 Y | m   | GER, HH, NI          | N, GT     | 3:15           | None                          | Good          |
| 1 Y | m   | GER, NI              | N, GT     | 4:15           | None                          | Good          |
| 2 Y | m   | GER, HH, NI          | N, GT     | 3:10           | None                          | Good          |
| 2 Y | m   | GER, HH, RIH         | N, RIH    | 5:20           | None                          | Good          |
| 2 Y | f   | GER, HH              | N         | 2:05           | Dysphagia to solids, resolved in 2 weeks | Good |
| 2 Y | f   | GER, NI              | N, GT     | 3:45           | Gastrostomy infection, resolved in one week | Good |
| 2 Y | m   | GER, NI              | N, GT     | 4:20           | Death 6 days postop, unrelated to surgical procedure | Death |
| 2 Y | m   | GER, HH              | N         | 2:15           | None                          | Good          |
| 3 Y | m   | GER, NI              | N, GT     | 3:10           | Gastrostomy infection, minor no treatment needed | Good |
| 5 Y | f   | GER, NI              | N, GT     | 5:00           | Postop retching, resolved within 3 months | Good |
| 6 Y | m   | GER                  | N         | 3:50           | None                          | Good          |
| 6 Y | f   | GER, NI              | N, GT     | 2:25           | None                          | Good          |
| 7 Y | m   | GER                  | N, manometry | 5:00       | Dysphagia, resolved within 4 weeks | Good |
| 8 Y | f   | GER, NI              | N, GT     | 4:20           | None                          | Good          |
| 11 Y| m   | GER, Rumination      | N, manometry | 2:50       | Dysphagia, resolved with one dilatation | Good |
| 11 Y| f   | GER, HH              | N         | 2:10           | None                          | Good          |
| 12 Y| m   | GER, NI              | N, GT     | 4:05           | None                          | Good          |
| 12 Y| m   | GER, NI              | N, GT     | 5:05           | None                          | Good          |
| 14 Y| f   | GER                  | N         | 3:30           | Dysphagia, resolved within 4 weeks | Good |
| 14 Y| m   | GER, HH, NI          | N, GT     | 3:00           | Gastrostomy infection, no treatment needed | Good |
| 15 Y| m   | GER, HH, NI          | N, GT     | 4:25           | None                          | Good          |
| 16 Y| f   | GER, HH              | N, GT     | 2:50           | Hyperglycemia (diabetic)       | Good          |
| 18 Y| m   | GER, NI              | N, GT     | 3:20           | None                          | Good          |

GER=Gastroesophageal Reflux
HH=Hiatal Hernia
BIH=Bilateral Inguinal Hernia
NI=Neurologically Impaired
RIH=Right Inguinal Hernia
N=Nissen
GT=Gastrostomy Tube Placement
Table 2. Average operative time and standard deviation.

| Procedure                                | Average operative time | Standard deviation |
|-------------------------------------------|------------------------|--------------------|
| Nissen fundoplication alone               | 185                    | 65                 |
| Nissen fundoplication and Gastrostomy     | 219                    | 46                 |
| Nissen fundoplication plus other procedures| 291                    | 25                 |
| All cases                                 | 221                    | 59                 |

less than 50 cc. In the last five cases, the short gastric vessels were divided using bipolar cautery or the ultrasonic scalpel (US Surgical Corp). We found that this facilitated creating the wrap and ensured a loose fundoplication.

Postoperatively, patients received an average of seven intravenous or intramuscular doses of morphine or meperidine, including doses received in the recovery room. The nasogastric tube was removed in most of the patients by postoperative day 1, and feedings were begun on average by postoperative day 2. Mean length of time to resumption of either a regular diet or target tube feeding was three days. Patients were discharged between postoperative days 3 and 6. Several neurologically impaired children were hospitalized longer because of coexisting medical and social issues.

Three patients who underwent tube gastrostomy had minor wound infections. Four of all 25 patients experienced dysphagia within the first two weeks. Upper gastrointestinal studies in these patients showed narrowing at the area of the wrap. Of these patients, one required esophageal dilation once, after which the patient had no further symptoms. The dysphagia in the other three patients resolved within one month with conservative treatment. Two patients had persistent retching. One had esophageal dysmotility preoperatively that persisted postoperatively; the second patient had an upper gastrointestinal series that showed no reflux. One patient had gas-bloat syndrome, which spontaneously resolved within the first week. One patient had an upper respiratory tract infection 13 days after surgery that resolved with antibiotics (Table 1).

Other complications included hyperglycemia in a brittle insulin-dependent diabetic. Eight patients were admitted to the intensive care unit for observation because of their co-morbidities. There was one death, which occurred in a 2-year-old male with microcephaly, severe neurological impairment, Wolff-Parkinson-White syndrome and a seizure disorder. This patient died of his underlying disease on postoperative day 6. Postmortem examination revealed no abnormalities or infections related to his surgery, and the Nissen fundoplication was intact.

Follow-up ranged from 2 to 40 months. The average length of follow-up was 12.5 months. Three patients were lost to follow-up.

**DISCUSSION**

Laparoscopic Nissen fundoplication is difficult to learn and is accompanied by its own set of potential complications. Some of these complications are related to laparoscopy, and some are specific to the Nissen fundoplication. Although we did not experience any intraoperative complications, laparoscopy has unique complications such as organ and vascular injuries from trocar placement and unrecognized intestinal injuries from cautery or instrumentation. These complications are rare, and the safety of the laparoscopic procedure has been well documented.

The minimally invasive approach offers distinct advantages over the traditional laparotomy approach. Case controlled studies by Georgeson and Collins at the University of Alabama have compared laparoscopic Nissen fundoplication favorably to the open approach. Postoperative respiratory complications and ventilator dependence are significantly reduced. Children are able to return to baseline function and diet.
much sooner when the laparoscopic approach is employed. Although operative costs for laparoscopic procedures tend to be higher because of the longer operative time and more expensive equipment, especially disposable instruments, the overall costs may be more equivalent since hospital stay is reduced.

In the present series of 25 pediatric patients who underwent laparoscopic Nissen fundoplication, no conversions were required, and blood loss in all patients was minimal. There were no major intraoperative complications, though in one patient a needle was lost intraabdominally, the retrieval of which added an additional hour to the operative time. No injury occurred as a result of this incident.

Although in our use of laparoscopic Nissen fundoplication we initially did not divide the short gastric vessels, we now feel that dividing these vessels facilitates the fundoplication and allows for a loose fundal wrap. The advent of the 5 mm harmonic scalpel has made their division easy and safe. Although our operative time for Nissen fundoplication averaged 185 minutes, we feel this will improve with time as we get beyond the learning curve.

**CONCLUSIONS**

The present series demonstrates the feasibility of laparoscopic Nissen fundoplication in children. It appears to have low morbidity and mortality. Moreover, the rapidity with which patients are able to return to their baseline status is a major advantage in these children, who are often impaired. As smaller instruments and laparoscopes are improving in function and design, minimal access surgery may become even more “minimally invasive.”

Postoperative analgesia needs may be further reduced and return to function further hastened. Cosmesis will also be enhanced. Long-term results are not yet available in most studies. However, if long-term results, morbidity and mortality are comparable or improved when laparoscopic Nissen fundoplication is compared with open Nissen fundoplication, the laparoscopic procedure may well become the standard of care in pediatric patients.

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