

Effective Nissen Fundoplication Length and Bougie Diameter Size in Young Children Undergoing Laparoscopic Nissen Fundoplication

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Background/Purpose: Laparoscopic Nissen fundoplication (LNF) is utilized in the management of symptomatic gastroesophageal reflux disease (GERD) in children. An effective length of fundoplication and bougie size has never been established in infants and children requiring LNF for GERD. To determine this effective fundoplication length and appropriate bougie size, we analyzed all patients less than 15 kg undergoing LNF for GERD over a 2-year period.

Methods: Data recovered retrospectively included age, weight, gender, need for gastrostomy, length of postoperative hospitalization, operating time, bougie size, and fundoplication length.

Results: One hundred patients weighed less than 15 kg (mean, 7.23 kg). Mean operating time was 95 minutes (range, 31 minutes to 159 minutes). Gastrostomies were placed in 32 patients. Postoperative hospitalization averaged 1.8 days for elective LNF. Fundoplication length was measured in each

patient and averaged 2.06 cm. Bougie size varied from 22F to 42F, and the size utilized was based on the patient's weight. There were no instances of dysphagia or the need for esophageal dilatation postoperatively. Two patients have been seen for recurrent symptoms. One patient has required a second LNF, and the other has a normal upper gastrointestinal study and pH study.

Conclusion: This study of LNF in small children has shown that resolution of GERD symptoms in most patients can be accomplished with an average fundoplication length of approximately 2 cm and a graduated bougie size relative to the patient's weight.

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INDEX WORDS: Fundoplication length, bougie diameter, Nissen.

LAPAROSCOPIC NISSEN fundoplication (LNF) is performed commonly in infants and children. In many pediatric surgical centers it is the preferred approach for the surgical correction of gastroesophageal reflux disease (GERD). Intraabdominal esophageal length is known to correlate with GERD.¹ An adequate fundoplication length for preventing recurrent symptoms in infants and children has not been reported. Dysphagia results if the wrap created is too tight around the distal esophagus. A bougie is usually used to calibrate the esophageal lumen during LNF to prevent excessive luminal narrowing. The ideal bougie size for esophageal calibration in the pediatric population also is not known.

MATERIALS AND METHODS

With IRB approval, the charts of all patients weighing less than 15 kg undergoing LNF from October 1999 through December 2001 were reviewed.

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All operations were performed using a single 5-mm umbilical trocar for telescope access, and four 2.5-mm stab incisions for instrumentation. A standard Nissen dissection was performed in all cases with division of the short gastric vessels using cautery, crural identification, and esophageal mobilization. The esophageal hiatus was closed with a single or, occasionally, 2 silk sutures. The fundoplication was created around an esophageal bougie usually using 3 interrupted silk sutures. The most cephalad 2 sutures incorporated a portion of the anterior esophagus. All sutures were tied intracorporally. The length of the fundoplication was measured in reference to a 2-cm silk suture that was introduced into the abdomen and placed on the fundoplication. The fundoplication length and the bougie size utilized were recorded at the time of operation.

Retrospective data collection included pre-, peri-, and postoperative variables. Preoperatively, the patient's age, weight, and gender were recorded. Perioperatively, the bougie size, length of fundoplication, whether a gastrostomy was created, operating time, use of robotic telescopic assistance, and length of postoperative hospitalization was recorded. Finally, the charts were reviewed for subsequent reflux associated interventions (ie, repeat pH study, upper gastrointestinal contrast study, need for esophageal dilation, recurrent symptoms, and reoperation).

RESULTS

One hundred patients weighing less than 15 kg that underwent LNF constituted the study group. Patient weight ranged from 2.9 kg to 14.8 kg with a mean of 7.23 kg. Patient age ranged from 3 weeks to 63 months with a mean age of 10.4 months. There was a slight male predominance with 59 boys and 41 girls. Mean follow-up was 9.9 months. Indications for operation included fail-

Table 1. Recommended Bougie Size for Esophageal Calibration According to Patient Weight

Weight (kg)	Bougie Size
2.5-4.0	20-24
4.0-5.5	24-28
5.5-7.0	28-32
7.0-8.5	32-34
8.5-10.0	34-36
10.0-15.0	36-40

ure of medical management of GERD with weight loss, acute life-threatening respiratory events requiring hospitalization and monitoring, and neurologic impairment requiring feeding assistance and GERD control. No patients had esophageal atresia or tracheoesophageal fistula.

All operations were completed laparoscopically with robotic assistance (AESOP; Computer Motion, Santa Barbara, CA) utilized for voice-activated control of the operating telescope in the last 90 patients. In 32 patients, a laparoscopic gastrostomy also was required for swallowing or feeding disorders, and the U-stitch technique described by Georgeson was utilized.^{2,3} The mean operating time was 95 minutes with a range from 31 minutes to 159 minutes. The bougie size used for esophageal calibration ranged from 22F to 42F. Bougie size used was correlated to patient weight as a reference to esophageal size (Table 1). Fundoplication lengths varied from 1.5 cm to 2.9 cm and were between 1.5 and 2.0 cm for patients less than 3 kg. The mean fundoplication length in the series was 2.08 cm. Hospital stay averaged 1.8 days for patients undergoing elective LNF. Patients were considered to have undergone an elective LNF if they were admitted the day of the operation. Mean length of hospitalization after LNF for the entire study group was 3.2 days. Neonates returning to the neonatal intensive care unit after their LNF for ongoing management of multiple medical conditions were primarily responsible for this prolongation in the hospital stay.

Postoperative dysphagia requiring esophageal dilation did not develop in any patient. Two patients had recurrent symptoms consistent with GERD. One currently is symptom free 3 months after undergoing a second LNF. The other has undergone further evaluation including an upper gastrointestinal and pH study, results of which are both normal. He has not undergone a second fundoplication.

DISCUSSION

The importance of creating a fundoplication of adequate length around an appropriately sized esophageal lumen commonly is overlooked. The ramifications of recurrent GERD or dysphagia in the pediatric population are difficult to manage and can have serious sequelae.

Complications that result from recurrent GERD include poor feeding with malnutrition, respiratory complications, esophagitis, and possible mucosal injury leading to ulcer formation, stricture, or even Barrett's esophagus.⁴⁻⁹ Nissen fundoplication has been shown to increase the pressure of the lower esophageal sphincter (LES) and prevent GERD.¹⁰ However, the effectiveness of the LES as a barrier to GERD is known to be a function of not only the pressure it creates, but also its overall length, as well as the length of the intraabdominal esophagus. An overall LES length of greater than 2cm with an intraabdominal portion of at least 1 cm has been shown to be effective against GERD in adult patients.¹¹ During LNF, the extent of esophageal mobilization and the length of that mobilization, which is incorporated by the fundoplication, determine the intraabdominal esophageal length. Therefore, the identification of an adequate length for fundoplication is necessary to optimize the success of the LNF in preventing GERD. Based on this literature, we desired to create a fundoplication of approximately 2 cm and determine its effectiveness at controlling GERD.

Dysphagia results from esophageal obstruction leading to difficulty in swallowing. When it presents as a complication of LNF, it usually is the result of encroachment on the esophagus by the fundoplication, which was created too tight around the distal esophagus. It is not uncommon for patients to experience a period of mild dysphagia immediately after LNF. This mild dysphagia usually is attributable to the operative dissection and subsequent wrap edema and is self-limited in nature, usually disappearing by about 2 to 3 weeks after the LNF. No intervention should be required during this postoperative period, and the operative edema should resolve. Dysphagia that persists after this recovery period should be evaluated with an upper gastrointestinal contrast study specifically looking for an obstructive etiology. In patients who do not have a history of severe esophagitis or ulcer formation, a narrowing usually is identified in the distal esophagus at the site of the fundoplication. This narrowing of the esophageal lumen is almost always caused by excessive tightness of the fundoplication. Esophageal dilation may be needed to stretch the fundoplication to adequate size to allow swallowing to proceed without dysphagia. Care should be taken to calibrate the esophageal lumen correctly at the time of LNF to prevent this problem. We have created a table for bougie size according to the patient's weight (Table 1). Although this table was created on the basis of our personal experience and is arbitrary in nature, it has served efficiently as a guide for esophageal calibration resulting in control of GERD without complications, most specifically iatrogenic dysphagia. The inability to "burp" after LNF may lead to intermittent abdominal

discomfort in some patients. In our experience, no patient has required either hospitalization or an emergency room visit for this problem.

The adult literature reports troublesome dysphagia after Nissen fundoplication in 5% to 10% of patients.¹² Dysphagia as a complication after LNF may be more common in older patients because of the usual diet for that population. The diet of infants and small children is primarily liquids and soft foods that theoretically may traverse a narrow esophageal segment that would otherwise limit the progression of a more solid food bolus. However, even in our older patients requiring LNF, no patient has needed postoperative esophageal dilation.

The treatment of recurrent GERD or dysphagia in infants and children is difficult and requires either med-

ication or surgical intervention. Both avenues incur increased expense and parental/patient frustration. Optimizing surgical success for control of GERD and its complications requires the creation of an adequate length fundoplication around an ideal bougie size.

Despite the limitations of this study (specifically its retrospective nature, short follow-up, and selection of bougie size based on patient weight) our experience supports the creation of a fundoplication of approximately 2 cm as an effective length in preventing GERD in pediatric patients weighing less than 15 kg. In addition, the use of an esophageal bougie appropriately sized for the patient's weight optimizes the effectiveness of the LNF at controlling GERD without the development of dysphagia.

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