Jikeikai Med J 2013 ; 60 : 23-8

Laparoscopic Nissen Fundoplication in Neurologically Impaired Children

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ABSTRACT

Purpose : The aim of this study was to investigate the efficacy of laparoscopic fundoplication (LF) in neurologically impaired children with gastroesophageal reflux (GER) and to discuss, on the basis of our experience, the risk of surgery in neurologically impaired children.

Methods : Thirty-one neurologically impaired children who had undergone LF from 2000 through 2007 were reviewed. The reasons for conversion of LF to open procedures and for perioperative complications were assessed. The frequency of respiratory symptoms was compared before and after fundoplication.

Results : The LF procedure was completed as planned in 29 patients and converted to open procedures in 2. Twenty-seven patients underwent concomitant gastrostomy tube placement. Complications were intraoperative in 2 patients and postoperative in 12. The GER recurred in 3 patients. The mean incidence of respiratory symptoms was 5.7 times per patient in the year before fundoplication, but decreased significantly to 1.8 times in the year after fundoplication. One patient underwent laryngotracheal separation because of recurrent aspiration pneumonia even after LF.

Conclusions : Various degrees of neurological impairment can cause perioperative complications. Awareness of the risks of surgery in neurologically impaired children is important. The significant reduction in the rate of respiratory symptoms indicates the efficacy of LF in neurologically impaired children, but in some patients with GER and tracheal malfunction, respiratory resuscitation should also be considered to improve respiratory symptoms.

(Jikeikai Med J 2013 ; 60 : 23-8)

Key words : laparoscopy, fundoplication, gastroesophageal reflux, neurologically impaired children

INTRODUCTION

In neurologically impaired children, gastroesophageal reflux (GER) is common and may lead to various complications, such as vomiting, recurrent respiratory symptoms, reflux esophagitis, failure to thrive, and poor control of spasticity or epilepsy. Laparoscopic fundoplication (LF) has led to the widespread acceptance of surgical treatment for GER resistant to conventional medical therapy[1,2]. Although many studies have described the results of LF in children, few studies have involve only neurologically impaired children undergoing LF[3-5]. Some of these studies have shown that LF has limited efficacy for controlling respiratory problems in neurologically impaired children[6]. The aim of the present study was to investigate the efficacy of LF in neurologically impaired children with GER and to discuss, on the basis of our experience, the risk of surgery in neurologically impaired children.

Received for publication, May 17, 2013

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MATERIALS AND METHODS

From January 2000 through December 2007, 31 neurologically impaired children underwent LF with the Nissen procedure after medical treatment for GER had failed. The median age and body weight at operation were 8.9 years (range, 1 to 18 years) and 17.1 kg (range, 3.9 to 34.3 kg), respectively. Indications for surgery were recurrent respiratory symptoms, including aspiration pneumonia and respiratory distress ; persistent vomiting resistant to conservative medical therapy ; and difficulty of nasogastric tube insertion due to severe scoliosis. Preoperative examinations included upper gastrointestinal (UGI) series, 24-hour esophageal pH monitoring, and video fluoroscopy to evaluate aspiration and impaired swallowing. The mean follow-up time was 2.6 years (range, 1 to 8 years).

Preoperative Preparation

An enteral feeding tube was routinely placed into the proximal jejunum under fluoroscopic guidance before surgery to allow tube feeding to be restarted and antiepileptic medications to be administered as soon as possible after surgery in case gastric emptying was delayed after surgery.

Operative Technique

Patients were placed as close to the supine position as permitted by each patient's musculoskeletal deformity. After a regular-sized nasogastric tube was placed, a 5-mm, 30° laparoscope was inserted, under direct vision, in a supraumbilical 5-mm primary trocar. A total of 5 trocars (4×5 mm and 1×10 mm) were used, and the exact trocar sites were decided according to the type of musculoskeletal deformity in each patient. The 10-mm trocar site in the left upper quadrant was used for concomitant gastrostomy tube placement, if possible. All procedures were performed using a technique previously reported with mild modification[7]. Briefly, an adequate length of intra-abdominal esophagus was mobilized with a Penrose drain passed around the esophagus to facilitate its handling. The hepatovagal branch was preserved with the vagal trunks. Minimum sectioning of short gastric vessels to achieve a tension-free wrap, repair of the crus, and the formation of a short (2-3 cm) and floppy 360° wrap were performed with 2-0 nonabsorbable suture. To prevent migration of the wrap into the chest, 2 "shoulder stitches" were placed between both sides of the top of the wrap and the diaphragm, and an "anchor stitch" was placed between the posterior wall of the wrap and the crural repair portion. Finally, the anterior wall of the lower body of the stomach was pulled up through the 10 mm-trocar site in the left upper quadrant, and a gastrostomy tube was placed with the Stamm method.

Postoperative care

The gastrostomy tube was left on free drainage. Administration of antiepileptic medication from the enteral feeding tube was started immediately after surgery, and feeding through the tube was started on postoperative day 1. If gastric emptying was not delayed, the gastrostomy tube was lifted and left open, and feeding and administration of antiepileptic medication were started from the gastrostomy. Lifting and leaving open the tube prevents gas bloat syndrome during the early postoperative period. Once full feeding from the gastrostomy was established, the enteral feeding tube was removed, and the absence of GER was confirmed with a postoperative UGI series before discharge. About 3 weeks after surgery, the gastrostomy tube was changed to a gastrostomy button, which the patients' parents practiced handling. The patient was then ready to be discharged.

Clarification of the risk of surgery in neurologically impaired children

To clarify the risk of surgery in neurologically impaired children, the reasons for conversion of LF to an open procedure and any perioperative complications were assessed retrospectively.

Evaluation of the efficacy of LF in neurologically impaired children

Among patients who were cared for by their parents at home, the incidence of respiratory symptoms, including aspiration pneumonia and respiratory distress, was compared between the 1-year preoperative and postoperative periods. Statistical analysis was performed with Wilcoxon matched-paired analysis, and value of $p < 0.05$ was considered to indicate significance.

This research conforms to the provisions of the Declaration of Helsinki.

Results

Laparoscopic procedures were successfully completed in 29 of the 31 patients. Twenty-six patients underwent concomitant insertion of a gastrostomy tube. Tracheostomy and/or Broviac catheter insertion were conducted concurrently in 4 patients. The operative time ranged from 135 to 255 minutes (mean, 215 minutes) for LF ($n = 4$) and from 170 to 320 minutes (mean, 236 minutes) for LF with concomitant gastrostomy tube placement ($n = 21$).

In 2 patients (6.5%), LF was converted to an open procedure. One of these patients was our first to be treated with LF and had severe scoliosis and a giant hiatus hernia that required dissection. He was 17 years old at operation. The other patient was undergoing LF a second time and also had a large, tightly adherent hiatus hernia and severe scoliosis, which caused gastric perforation during dissection. She was 14 years old at operation.

There were 2 intraoperative complications and 12 postoperative complications (Table 1). Gastric perforation occurred in 1 patient who required conversion of LF to an open procedure. Diaphragm perforation was caused by a technical error, the contact of the active blade of laparosonic coagulating shears, and was repaired laparoscopically. The patient was 4 years old at operation. There was no blood transfusion during perioperative periods. All postoperative complications resolved without further surgery.

The absence of GER was confirmed with postoperative UGI series before discharge, but reflux symptoms recurred during follow-up in 3 patients (9.7%) (Fig. 1), who were 8, 14, and 17 years old at operation. The types of recurrence were disruption of wrap formation in 2 patients who required conversion of LF to open procedures, and wrap herniation into the chest in a patient who underwent LF. The first case of wrap disruption was recognized 6 years after fundoplication when percutaneous endoscopic gastrostomy was performed at another institution. Fundoplication was performed again with an open procedure in this patient. The second case of wrap disruption occurred 1 year after we performed LF. The initial LF in this patient had been performed 6 years earlier at another institution, and the second LF was performed at our institution. The final operation was performed with the conventional method. The wrap herniation in the last case of recurrence was diagnosed following a contrast study. However, the symptoms were mild, and the patient's parents did consent to fundoplication being performed again. Two patients died during follow-up from causes not related to LF. The recurrence rate after LF, excluding the 2 cases of conversion to open procedures and the 2 cases of death during follow-up, was 3.7% (1 of 27). Twenty patients were cared by their parents at home, and 11 were living in a hospital or in a specialized nursing facility. The mean incidence of respiratory

Table 1. Perioperative complications

Complication	Number of cases
Intraoperative	
gastric perforation	1
diaphragm perforation	1
Postoperative	
prolonged gastroparesis	2
atelectasis	3
pulmonary infection	2
reintubation	2
esophageal dilatation	1
convulsive seizure	2

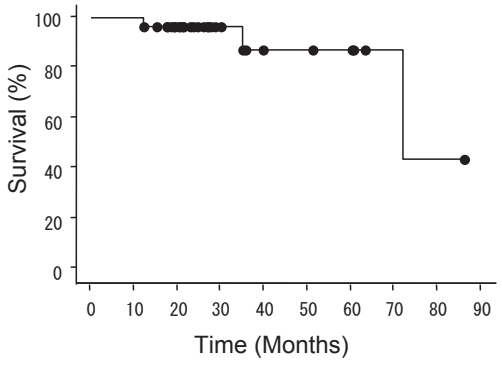

Fig. 1. Survival without recurrence of GER after fundoplication in neurologically impaired children ($n = 31$).

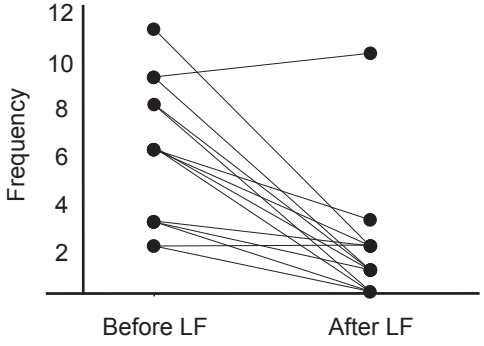

Fig. 2. Frequency of respiratory tract symptoms in the year before and the year after fundoplication.

symptoms in these 20 patients in the year before surgery was 5.7 times per patient, however the mean incidence in the year after surgery decreased significantly to 1.8 times ($p = 0.005$; Fig. 2). One patient underwent laryngotracheal separation (LTS), because of recurrent aspiration pneumonia, after LF.

DISCUSSION

Many studies have described the perioperative complications of LF in children, but few studies have reported solely on neurologically impaired children undergoing LF. Neurologically impaired children operated on for an LF should be considered separately from children not neurologically impaired, because the pathogenesis in these groups differ greatly. Pimpalwar et al.[3] have reported on the need for extreme caution during laparoscopic procedures for neurologically impaired children, because they have various degrees of scoliosis and chest deformity that displace the stomach, spleen, liver, and aorta and can cause hepatomegaly. These anatomical factors make it difficult to dissect and mobilize the intra-abdominal esophagus and to separate the short gastric vessels from the spleen, and limb deformity restricts instrumental manipulation ; thus, morbidity is increased in the perioperative period. Another reported problem is gaseous distention due to aerophagia, a common problem in neurologically impaired children, which prevents safe access to the upper part of the abdomen (by complicating the insertion of instruments and obscuring the surgical view).

In our series, conversion of LF to open procedures was required in 2 patients, and intraoperative complications developed in 2 patients. The main reasons for these conversions and complications were associated with the status of being neurologically impaired. The rate of conversion of LF to open surgery in neurologically impaired children series has been reported to 0% to 18%[3-6]. Although our conversion rate was 6.5%, which is similar to rates reported earlier, these complications occurred when we had less experience performing LF ; as our laparoscopic skill and understanding of the status of being neurologically impaired have improved, our complication rate has decreased. However, determining before surgery the stomach's position, in patients with or without scoliosis, and the presence of fixed limbs or chest deformity with regular X-ray films or contrast-enhanced CT is important for reducing operative complications and for performing LF successfully. Because fixed limbs can restrict instrumental manipulation outside the abdomen, port positions must be selected carefully to achieve safe access and to gain maximum surgical ability. Also, to change the position of a laparoscope from an umbilical site to a left-sided cannula is also useful for clear visualization of the surgical field.

Postoperative complications occurred in 12 cases in our series. Esophageal dilation was due to a technical problem early in our series and improved without further intervention. Prolonged gastric paresis (delayed gastric emptying) after fundoplication is more common in neurologically impaired children[8]. In our series prolonged gastroparesis occurred in 2 cases but improved with conservative treatment and without drainage. We usually do not perform pyloroplasty at the time of LF. In neurologically impaired children, gastric dysmotility is often present before surgery, and restarting tube feeding and administration of antiepileptic medication as soon as possible after surgery is important. Therefore, we preserve the vagal trunk (hepatic branch) to prevent or minimize prolonged gastroparesis and routinely place the enteral feeding tube into the proximal jejunum preoperatively, so that tube feeding can be started if gastric paresis is prolonged after surgery. Feeding through an enteral tube rather than a gastrostomy during the early postoperative period can also stabilize the gastrostomy tube site, and we did not have any gastrostomy-related problems, such as infection or leakage.

Half of the postoperative complications in our series were respiratory problems. Powers et al.[9] have reported that the laparoscopic approach resulted in less pulmonary compromise than open surgery in neurologically impaired children ; however, chest physiotherapy is important for reducing the rate of such postoperative complications, because neurologically impaired children often have compromised pulmonary mechanics. A possible explanation for the postoperative complications in our series was the patients' age at operation. In most reported series, the age at operation was 3.5 to 6 years and was lower than in our series[3-6]. Earlier intervention can be aggressive, but prolonged medical treatment can cause severe scoliosis, inflammatory changes around the intra-abdominal esophagus due to reflux esophagitis, a larger hiatal hernia, and chronic lung disease, which can increase perioperative complica-

tions.

Fundoplication has numerous benefits[10-12], such as reduced vomiting, improved pH monitoring score, increased body weight, and better nutrition, but some reports have documented its limited efficacy for treating respiratory problems in neurologically impaired children. Respiratory problems, including aspiration pneumonia and respiratory distress, are the most common cause of death in neurologically impaired children with GER[13]. In these children, oral and pharyngeal motor problems are common, and aspiration pneumonia is often associated with GER through aspiration of gastric contents and the direct aspiration of solids or liquids from mouth and pharynx[14]. Because repeated respiratory symptoms lead to repeated hospitalization and compromised quality of life for both patients and their parents, we evaluated the incidence of respiratory symptoms as an objective and more precise outcome of LF for neurologically impaired children with GER. Several previous studies have evaluated the incidence of respiratory symptoms before and after fundoplication in neurologically impaired children. Bui et al.[15] have reported that fundoplication with gastrostomy reduces, but does eliminate, the risk of respiratory symptoms. Srivastava et al.[16] have reported that fundoplication decreases the frequency of short-term hospital admissions for reflux-related respiratory symptoms. Goldin et al.[17] have shown that fundoplication performed before the age of 4 years decreases the frequency of hospitalization for reflux-related events, however, older children who underwent fundoplication after age 4 were hospitalized at greater rates after an antireflux procedure. Kawahara et al.[6] have reported that respiratory symptoms continued after LF in 16 of 31 subjects. Lee et al.[18] have reported that the frequency of hospital admission for respiratory symptoms was not changed by fundoplication.

In this review of our experience performing LF in neurologically impaired children, the incidence of respiratory symptoms was significantly decreased after LF. However, 2 patients showed no improvement in respiratory symptoms after LF. In 1 of these patients, preoperative evaluation showed both GER and moderate-to-severe direct aspiration, but the patient's parents did consent to LTS, so we performed LF first. A postoperative UGI series showed no recurrence of GER. Therefore, we subsequently performed LTS to improve the symptoms.

A possible reason that our findings differed somewhat from those of previous studies is that the varying severity of underlying neurologic disorders in these children complicates treatment and affects the outcome of LF. Other possible reasons for our differing findings are the low rate of GER recurrence and the short study period. In the study by Kawahara et al.[6] the median follow-up period was 3 years 2 months and the GER recurrence rate was 18%. Our study period was 1 year before and 1 year after fundoplication. The recurrence of GER has been suggested to be a factor in the repeated respiratory symptoms, which are the leading risk factor for the recurrence of GER. The longer follow-up period may affect the GER recurrence rate. However, further studies are needed to validate the long-term effectiveness of fundoplication in neurologically impaired children.

Takamizawa et al.[19] have recommended LTS as a primary surgical treatment for neurologically impaired children when intractable aspiration is present and have recommended simultaneous LTS and fundoplication with gastrostomy when impaired swallowing and GER are present. Although the relative timing of LF and LTS remains controversial, the primary cause of the main symptoms — GER or tracheal malfunction or both — must be assessed in each patient. Thus, indications for LF may differ depending on the patient's neurologic status. A prospective study is needed to investigate this relationship.

In conclusion, various degrees of neurological impairment may cause perioperative complications in children. Awareness of the risk of surgery in neurologically impaired children is essential for successful LF. The significant reduction in respiratory symptoms after LF indicates the efficacy of LF in neurologically impaired children with GER, but in some patients with GER and tracheal malfunction, respiratory resuscitation should also be considered to improve respiratory symptoms.

Authors have no conflict of interest.

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