Laparoscopic versus open management of hiatal hernia in children

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Objective
The aim of this study was to evaluate the safety and efficacy of laparoscopic fundoplication and compare it with the open procedure in the management of hiatal hernia (HH) in children.
Patients and methods
This comparative study was conducted on 20 patients younger than 18 years who underwent open or laparoscopic fundoplication between June 2006 and December 2014. The patients were followed up for 9–12 months.
Results
Among 20 patients there were 17 sliding, one paraesophageal, and two mixed HHs. Laparoscopic surgery (LS) was conducted in 12 patients and open surgery (OS) in eight patients. The operative time was shorter in the OS group (117.6±46.5 min) versus the LS group (168.3±61.2 min). The time to start oral intake and the time to full feeding were shorter in the LS group (2.0±0.8 and 8.5±3.6 days, respectively) versus the OS group (4.2±1.8 and 12.1±9.0 days, respectively). The length of hospital stay was shorter in the LS group (24.3±12.8 days) versus the OS group (56.2±45.7 days). There were no statistically significant differences in sex, age, or body weight between the two groups. One patient died after cardiac surgery. No recurrence was reported.
Conclusion
Laparoscopic fundoplication in children is safe and effective and it may be the treatment of choice for HH and gastroesophageal reflux disease in the future.

Keywords:
fundoplication, hiatal hernia, laparoscopy

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Introduction

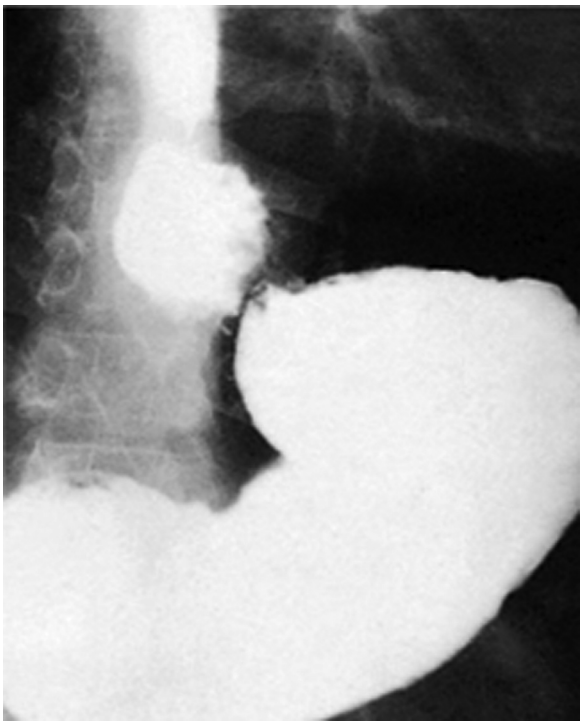
Hiatal hernia (HH) is an anatomic defect of the esophageal hiatus leading to herniation of the stomach in the posterior mediastinum. It usually produces symptoms of gastroesophageal reflux disease (GERD) and rarely results in incarceration of the stomach or other organs. Vomiting is the most common symptom in children. Other symptoms include dysphagia, regurgitation, failure to thrive, aspiration, apnea, and symptoms of esophagitis. There are four types of HH: type I (sliding HH), type II (paraesophageal HH), type III (mixed hernias, sliding and paraesophageal), and type IV (complex HH, which indicates paraesophageal HH combined with herniation of other organs).

The diagnosis of HH and GERD is made by using one or more of the three investigative tools (contrast study, upper gastrointestinal endoscopy, and pH study). The choice of first-line investigation is based on availability, expertise, and symptoms. Each has its advantages and disadvantages, and any one or all three may sometimes be necessary. Other tools may be added as necessary (Fig. 1).

Fundoplication is the gold standard procedure for HH and GERD. Soresi performed the first operation as a reduction of the stomach and approximation of the Crura in 1919 [1,2]. Nissen, Toupet, and Thal fundoplications are the most commonly used techniques and can be achieved by open surgery (OS) or laparoscopically [3].

The first report of a laparoscopic antireflux fundoplication in children was published 21 years ago by Lobe *et al.* [4]. Recently, numerous papers have been published to assess the results of different antireflux procedures [5–7]. However, there is little information on the long-term treatment outcomes of HH in children. There are two main laparoscopic antireflux fundoplications that are currently performed: the 'total wrap' technique, such as a Nissen fundoplication and the modified Nissen–Rossetti fundoplication, and the 'partial

Figure 1



Contrast study showing sliding hiatal hernia.

wrap' technique, such as the Thal fundoplication and the Toupet fundoplication. However, choosing the optimal fundoplication procedure remains controversial [8,9].

Patients and methods

Study population

After obtaining approval for the study protocol from the local ethical committee and fully informed written consent from parents the study was conducted with 20 patients (12 boys and eight girls). Eight underwent open fundoplication [five (75%) boys and three (25%) girls of a mean age of 60.5±60.8 months] and 12 underwent laparoscopic fundoplication [seven (58.3%) boys and five (41.7%) girls of a mean age of 90.6±60.3 months] from June 2006 to December 2014 in the Pediatric and Laparoscopic Surgery Departments, El-Minia University Hospital. Inclusion criteria for the study included patients under 18 years of age with proven HH that was unresponsive to medical treatment or who had serious complications such as apnea, aspiration pneumonia, failure to thrive, or large HH (herniation of more than 30% of the stomach). The study excluded recurrent and conversion cases. Outcomes assessed included operative time and postoperative issues: length of hospital stay, time to oral intake, time to full feeding, and complications. The follow-up period ranged from 9 to 12 months.

Surgical procedures

All procedures were performed with the patient positioned in a supine head-up position under general anesthesia. The basic technique consisted of reduction of herniated organs, crural repair, and fundoplication. For type II and type III HHs, the hernial sacs were removed and the hiatus was repaired using interrupted sutures of nonabsorbable suture material (4-0 Prolene; Ethicon) (Ohyon Medical Devices (Kunshan) Co., Ltd. Jiangsu, China (Mainland). No type IV HHs were reported in this study.

Eight cases were managed by OS and 12 by laparoscopic surgery (LS). Nissen fundoplications (360° wrap) were performed in 17 cases, whereas Thal fundoplication was performed in three cases only (anterior 180° wrap). The decision pertaining to the type of technique to be used was based on my preference and better experience in Nissen fundoplication.

In the open group we used a subcostal incision in three cases and transverse supraumbilical incision in five cases.

In the laparoscopic procedure, a pneumoperitoneum at 10–12 mmHg with CO_2 gas was established in the umbilical region with a 5-mm trocar placed in the lower umbilical region. After confirming the intraperitoneal cavity by 30° laparoscopy, the main working trocar was inserted in the right side of the patient and another 5-mm trocar for the operator was inserted in the left side. The first assistant used the 5-mm trocar inserted in the right subcostal area for traction of the liver. When traction of the stomach was needed, an additional 2- or 3-mm trocar was used. Complete reduction of the herniated organ was first performed and the hernial sac was removed. Tension-free crural repair was performed with 4-0 Prolene (Ethicon) (Fig. 2). Fundoplication was the next step and, if necessary, the short gastric vessels were dissected and ligated. For fundoplications, 4-0 Prolene or 3-0 Ethibond (Huaiyin Medical Instruments Co., Ltd., Jiangsu, China (Mainland) was used (Fig. 3).

In all children, 1–3 sutures were placed between the esophagus and the apex of the esophageal hiatus to ensure a section of intra-abdominal esophagus. The only difference between Nissen and Thal techniques is in the way the fundoplication was created.

Statistical analysis

Variables were compared using the two-tailed Student's t-test or the χ^2-test where appropriate. Summary data were presented as median (range) or number of patients (percentage of population).

Significance was defined as a *P*-value less than or equal to 0.05. Data were expressed as median values or mean ±SD, as stated. The SPSS software (version 18.0 for Windows; SPSS Inc., Chicago, Illinois, USA) was used for statistical analysis.

Results

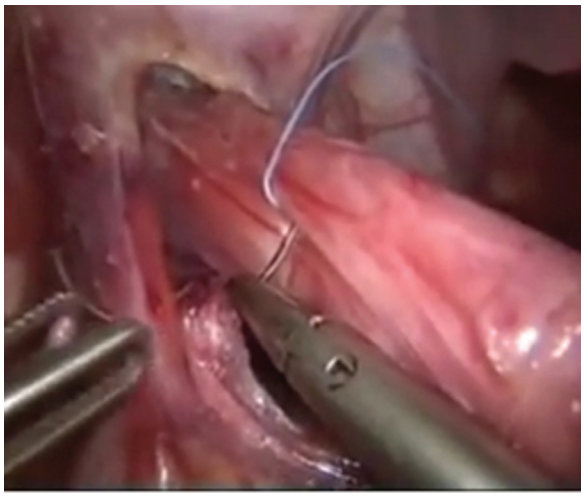
A total of 20 children, 12 boys and eight girls, were included in the study. The mean age was 78.6±60.8 months (range: 0.2–180 months) and the mean body weight was 16.4+7.01 kg (range: 2.5–26.4 kg). Two (10%) patients were neonates and five (25%) were infants. Type I (sliding) HH was the most common type (17 cases, 85%). There were no type IV HHs in this study (Tables 1 and 2).

The most common symptom in this study was vomiting (16 cases, 80%). Atypical symptoms such as cyanosis, dyspnea, and cough was present in five (25%) cases. Four (20%) patients had a history of pneumonia, and two (10%) patients had a history of failure to thrive.

The patients were classified into two groups: the OS group (eight cases) and the LS group (12 cases). Moreover, I used two types of fundoplication, Nissen (17 cases) and Thal (three cases). There were no statistically significant differences in the demographic findings (sex, age, body weight) and in the type of HH between the OS and LS groups. Little significant difference was observed as regards body weight. Patients converted from LS to OS were excluded in the study.

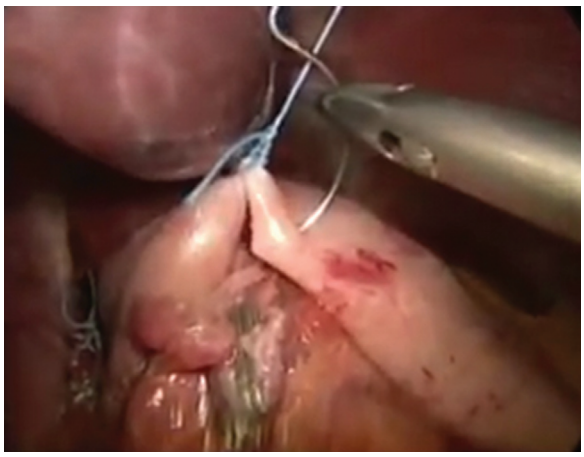
Fundoplication and gastrostomy was needed in seven (35%) patients, two in the open group and five in the laparoscopic group. These patients had either

Figure 2



Laparoscopic crural repair.

Figure 3



Laparoscopic Nissen fundoplication.

Table 1 Demographics data of patients with hiatal hernias

Demographics of patients	Open surgery (*n*=8)	Laparoscopic surgery (*n*=12)	*P*-value
Sex [*n* (%)]			
Male	5 (75)	7 (58.3)	0.19**
Female	3 (25)	5 (41.7)	
Age (mean±SD) (months)	60.5±60.8	90.6±60.3	0.28**
Birth weight (g)	2556.2±517.1	3525.8±233.8	0.000*
Body weight (kg)	14.9±10.1	17.4±4.1	0.46**

*Significant. **Nonsignificant.

Table 2 Types of hiatal hernias

Types of HHs	Open surgery (*n*=8) [*n* (%)]	Laparoscopic surgery (*n*=12) [*n* (%)]	*P*-value
Sliding	7 (87.5)	10 (83.3)	0.70**
Paraesophageal	0 (0.0)	1 (8.3)	–
Mixed	1 (12.5)	1 (8.3)	–
P-value	0.000*		

HH, hiatal hernia. *Significant. **Nonsignificant.

neurological deficits (six cases) or severe cardiac anomalies (in one of five patients). Pyloroplasty was performed in two (10%) patients of the open group because of the possibility of vagus nerve injury, and pyloroplasty and gastrostomy was performed only in one (5%) patient of the open group (Table 3).

In this study concomitant disease was found in 14 (70%) cases. Neurological problems were found in six (30%) patients and played a role in prolonged hospital stay and delaying time to full feeding. The most common problems were epilepsy (in two patients) and cerebral palsy (two patients). One patient had hydranencephaly and one had quadriplegia. Five patients had cardiac anomalies; one of them was severe Fallot's tetralogy. This patient was subjected to fundoplication and gastrostomy and died in the ICU from sepsis after cardiac surgery. One patient had esophageal atresia and two patients had Bochdalek's hernia repaired at the same time as fundoplication (Table 4).

No obvious bleeding was observed during surgery. The duration of operation in the OS group (range: 70–168 min) was shorter than that in the LS group (range: 110–230 min) with a significant difference (P=0.05).

Resumption of oral intake and a full amount of feeding began earlier in patients of the LS group compared with the OS group, with a significant difference only as regards the time to start oral intake (P=0.002) and nonsignificant difference as regards time to full feeding (P=0.22).

The length of hospital stay showed a significant difference between the two groups. In the LS group the length of hospital stay ranged from 7 to 40 days and in the OS group it ranged from 10 to 120 days (P=0.03) (Table 5).

In the early postoperative period, one patient had wound infection treated with broad-spectrum antibiotics, whereas in the long-term follow-up one patient had dysphagia (in the OS group) and three patients had upper abdominal pain and distension due to delayed gastric emptying (one patient in the OS group and two patients in the LS group). These patients were treated medically and no dilatation or intervention was needed because the symptoms were mild. No hernia recurrence appeared in either group (Table 6).

Discussion

The most common type of HH is a sliding HH (type I). This accounts for 95% of all HHs and is caused by weakness of the phrenoesophageal membrane around the esophagus. The stomach is partially herniated, and the gastroesophageal junction moves up and becomes located at the mediastinum [10,11].

Other types of HH include paraesophageal, mixed, and complex HH, which comprises mixed HH with herniation of other organs such as the colon, spleen, or small intestine.

HH is not a common disease in children. When medical treatment fails and in severe cases of sliding

Table 3 Operative techniques

Variables	Open surgery (n=8) [n (%)]	Laparoscopic surgery (n=12) [n (%)]	Total (n=20) [n (%)]
Type of fundoplication			
Nissen fundoplication	6 (75)	11 (91.7)	17 (85)
Thal fundoplication	2 (25)	1 (8.3)	3 (15)
HHRF only	4 (50)	7 (58.3)	11 (55)
HHRF with pyloroplasty	2 (25)	0 (0)	2 (10)
HHRF with gastrostomy	2 (25)	5 (41.7)	7 (35)
HHRF with pyloroplasty and gastrostomy	1 (12.5)	0 (0)	1 (5)

HHRF, hiatal hernia repair with fundoplication.

Table 4 Combined disease

Combined diseases	Open surgery (n=8) [n (%)]	Laparoscopic surgery (n=12) [n (%)]	P-value
Neurological	2 (25)	4 (33.3)	0.92**
Cardiac anomaly	2 (25)	3 (25)	0.59**
Esophageal atresia	1 (12.5)	0 (0.0)	–
Bochdalek's hernia	1 (12.5)	1 (8.3)	–
P-value	0.10**		

*Significant. **Nonsignificant.

Table 5 Perioperative findings

Perioperative findings	Open surgery (*n*=8)	Laparoscopic surgery (*n*=12)	*P*-value
Duration of operation (min)	117.6±46.5	168.3±61.2	0.05*
Length of hospital stay (days)	56.2±45.7	24.3±12.8	0.03*
Time to oral intake (days)	4.2±1.8	2.0±0.8	0.002*
Time to full feeding (days)	12.1±9.0	8.5±3.6	0.22**
Wound infections [*n* (%)]	1 (12.5)	0 (0)	–

*Significant. **Nonsignificant.

Table 6 Long-term outcomes

Long-term outcomes	Open surgery (*n*=8)	Laparoscopic surgery (*n*=12)	*P*-value
Median follow-up period (months)	10.6±1.3	10.5±1.0	0.93**
Dysphagia [*n* (%)]	1 (12.5)	0 (0.0)	–
Delayed gastric emptying [*n* (%)]	1 (12.5)	2 (16.6)	0.70**
Recurrence [*n* (%)]	0 (0)	0 (0)	–

*Significant. **Nonsignificant.

HH and in other types of HH, surgical intervention is the treatment of choice.

Although symptoms of HH may resolve after crural repair alone, fundoplication helps secure the stomach intra-abdominally by increasing the intra-abdominal esophageal length, and may be necessary to prevent postoperative reflux secondary to pre-existing anatomic abnormalities [12].

All types of transabdominal antireflux procedures contained a partial and total fundoplication. Typical procedures are the Nissen fundoplication, the Thal fundoplication, and the Toupet fundoplication, as well as the modified Nissen–Rossetti. All procedures aim to return the stomach back into the abdominal cavity, repair the hiatus, and expand the low segment of the esophagus to rebuild an antireflux hyperbaric zone.

Surgeons do not agree on the best antireflux procedure. Nissen fundoplication is the most famous and accepted procedure. Ceriati *et al.* [13] recommended a total 360° fundoplication for neurologically impaired children and partial fundoplication for neurologically normal children, whereas another group prefers partial fundoplication for all children with GERD.

Laparoscopic fundoplication is now widely used in many centers. Yagi *et al.* [14] previously described four patients aged between 30 days and 14 months, and van der Zee *et al.* [15] presented two patients of 9 and 14 months of age with Paraoesophageal Hernia (PEH), all of whom underwent successful laparoscopic hernia reduction, hiatal repair, and fundoplication [16].

The current study is a comparative study between open (eight cases) and laparoscopic (12 cases) fundoplication. I performed two kinds of fundoplication, Nissen in 17 of the current cases and Thal fundoplication in three cases only because I have better experience with Nissen fundoplication. I did not apply an artificial mesh or patch in this study.

Fullum *et al.* [17] reported in their nationwide study that the laparoscopic approach to HH was associated with a lower mortality in the uncomplicated group. However, they described that numerous studies have demonstrated the safety, efficacy, and durability of LS for HH [16].

In the current study significant differences were obtained as regards shorter period of hospital stay and shorter time to start oral intake in laparoscopic compared with open fundoplication. In contrast, significant differences were obtained in the form of shorter operative time in cases of OS.

Esposito *et al.* [5] have previously reported the following rates of dysphagia: four in 94 (4.3%) patients who received laparoscopic Nissen fundoplication and one in 48 (2.1%) patients who received Thal fundoplication. Kubiak *et al.* [8] reported dysphagia rates of 13.5 and 11.6% for each respective fundoplication, but the rates of severe dysphagia for Nissen and Thal were 10.1 and 1.7%, respectively (P=0.01). In the current study I reported only one case of mild dysphagia treated conservatively and improved with time. Large numbers of cases are required to obtain more accurate results.

No recurrence occurred in my study, either for HHs or for GERD. Longer follow-up periods may be needed to get better evaluations. Sometimes antiacid combination therapies (proton pump inhibitors and/or H2 blocker) could be used by physicians during follow-up [9,18].

In conclusion, as a treatment for HH in pediatric patients, the surgical outcomes of LS and OS are good. Laparoscopic repair is safe, feasible, and cost-effective and could be an optimal and practical choice of treatment as it gives better results as regards the length of hospital stay and time to start oral intake. More studies with a larger number of patients and longer follow-up periods will be required in the future to obtain more accurate results and to prove that LS for HH is the treatment of choice in pediatrics.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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