

ORIGINAL RESEARCH

Open Access



Comparative study of laparoscopic Nissen fundoplication versus Hill-Snow procedure for the treatment of gastroesophageal reflux disease in children: a single-blinded randomized controlled trial

Mostafa Ahmed Gad, Mohamad Mahmoud Qinawy* , Osama Abdelazim, Sherif Nabhan Kaddah, Mohamed Magdy Elbarbary and Mahmoud Asem Elfiky

Abstract

Background Gastroesophageal reflux disease (GERD) is a common condition in children. Complete fundoplication provides better reflux control but it results in more dysphagia and gas-bloat symptoms. Antireflux surgery without wrap has fewer adverse effects but a higher failure rate in controlling reflux. Until now, there is little evidence as to whether complete or partial fundoplication is the optimal procedure in this age group.

Objective This study aimed to compare the safety and efficacy of laparoscopic Nissen fundoplication versus Hill-Snow procedure among children with GERD.

Methods We conducted a randomized, single-blinded, comparative trial that included 40 children with a diagnosis of GERD, who were scheduled to undergo surgery. Children were randomly allocated to undergo laparoscopic Nissen fundoplication or Hill-Snow procedure.

Results While the incidence of postoperative dysphagia was similar between both groups, the duration of dysphagia was significantly shorter in the Hill-Snow group. Likewise, the incidence of bloating was significantly lower in the Hill-Snow group than the Nissen group (0% versus 55%, respectively). We found three recurrent Hill-Snow cases versus two recurrent Nissen cases. The operative time was significantly longer in the Hill-Snow procedure (150 ± 52 min) than in the Nissen group (120 ± 48 min).

Conclusions The Hill-Snow procedure is an effective alternative to Nissen fundoplication with no bloating and much less dysphagia, leading to faster recovery of ordinary eating patterns.

Keywords Laparoscopic Nissen fundoplication, Hill-Snow procedure, Gastroesophageal reflux, Children

Background

To date, laparoscopic Nissen fundoplication is the surgery of choice for GERD management in many surgical centers, with a reported success rate of 60–90% [1]. Nonetheless, Nissen fundoplication is associated with a high incidence of dysphagia and gas-bloat symptoms, leading to a delayed return of normal eating pattern [2]. On the other hand, adult studies proposed the Hill-Snow

*Correspondence:

Mohamad Mahmoud Qinawy
mohamad.qinawy@kasralainy.edu.eg
Department of Pediatric Surgery, Cairo University Children Hospital
(Abuelrish Hospital), Dr. Ali Ibrahim Street, Elmounira, Cairo, Egypt

operation as an effective alternative to the Nissen fundoplication in order to reduce the incidence of postoperative complications [3]. Hill-Snow procedure depends on restoring the angle of His and posterior fixation of the gastroesophageal junction (GEJ), leading to augmentation of the intrinsic pressure without wrapping; hence, restoring the normal function of the esophagus [3].

This comparative trial aimed to compare the safety and efficacy of laparoscopic Nissen fundoplication versus Hill-Snow procedure among children with GERD in terms of postoperative dysphagia, bloating, and recurrence of symptoms.

Methods

The institutional review board (IRB) committee approved the study's protocol before the patients' enrolment. All study procedures run in compliance with the ethical standards of the Declaration of Helsinki [4].

Study design and patients

We conducted a randomized, single-blinded, comparative trial that recruited children (aged less than 18 years old) with a GERD diagnosis that necessitates surgical intervention. Patients were recruited from the Pediatric Surgery Department of Cairo University Specialized Pediatric Hospital through the period from October 2018 till April 2020. Patients were included if they exhibited a poor response to medical treatment, had a symptomatic hiatus hernia, and/or presented with esophageal stricture or life-threatening symptoms. Exclusion criteria included cases with grade IV hiatus hernia, para-esophageal hernia, or recurrent GERD. Eligible patients were randomized using web-based software and closed envelopes to allocate patients in a 1:1 ratio to undergo either laparoscopic Nissen fundoplication or Hill-Snow technique.

Data collection and operative techniques

All patients underwent routine clinical examination and investigations, including contrast study and endoscopic examination. Patients were instructed to fast for at least 6 hours before the operation. All procedures were done under general anesthesia, and patients were positioned in frog-legged and lithotomy positions for small children and larger children, respectively. The table was set in reversed Trendelenburg position. A 5-mm 30° angled telescope optical trocar was inserted in the umbilicus using the Hasson's technique. Two working ports were introduced under vision in the left hypochondrium, and right hypochondrium at the midclavicular line in both groups. Then, a 5-mm grasper was inserted below the left costal margin for the stomach traction. Lastly, the liver was mostly retracted using a 2/0 suture or in grasper introduced in the epigastrium exposing the hiatus. Following

the inflation of the peritoneum by CO₂ (8–12 cm H₂O), left-sided dissection and division of the posterior gastrophrenic attachments anchoring the fundus to the diaphragm was done. The phreno-esophageal ligament was dissected toward the anterior wall of the esophagus toward the right crus (Fig. 1). After making a window behind the esophagus, a grasping forceps was inserted to expose the hiatus. The crura were approximated using 2/0 non-absorbable sutures.

In the laparoscopic Nissen fundoplication group, a 5-mm hook cautery or Harmonic scalpel was used to divide the short gastric vessels. Then, the mobilized fundus was passed through the window behind the esophagus to the right side. The “shoeshine” manoeuvre was performed with the fundoplication around the esophagus to ensure a loose, floppy, and symmetric fundoplication. Then, a 2/0 suture was used in a simple interrupted manner to bring the fundus around the esophagus. Another suture was placed to incorporate the wrap to the esophagus and crura, 1 cm superior to the first suture. A third suture was sometimes placed inferior to the first one (Fig. 2).

In the Hill-Snow group, the short gastric vessels were not divided. The distal abdominal esophagus was fixed by suturing the posteromedial wall of the gastroesophageal junction to the crural decussation and tendon just above the origin of the celiac trunk with two simple 2/0 silk sutures. Then, the angle of His was reconstructed by fixing the fundus to the abdominal esophagus and the diaphragm, thus ensuring that the abdominal esophagus was fixed to the abdominal cavity (Fig. 3).

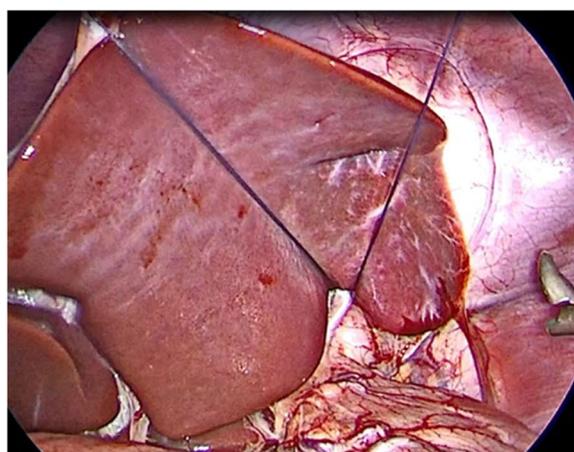
In both groups, the ports were removed, and the insertion sites were sutured using 3/0 absorbable sutures. All patients were followed up for 1 year after the operation.

Statistical analysis

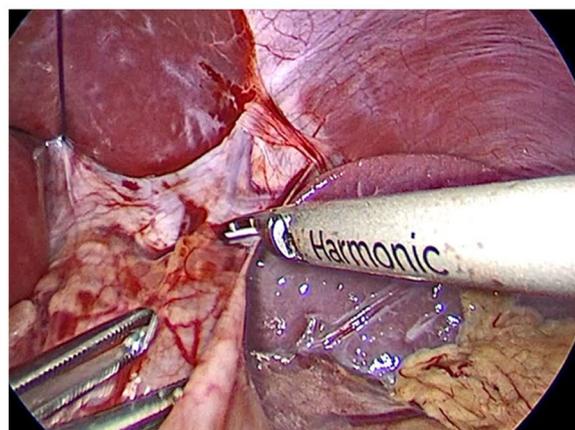
The analysis was performed using the Statistical Package for Social Sciences (SPSS) version 27. Summary statistics were used to describe the quantitative and qualitative data. The difference in the qualitative data between the laparoscopic Nissen fundoplication and Hill-Snow groups was assessed using the chi-square test. In contrast, the association between quantitative data was evaluated using the Mann–Whitney test. A *P* value of less than 5% was considered statistically significant.

Results

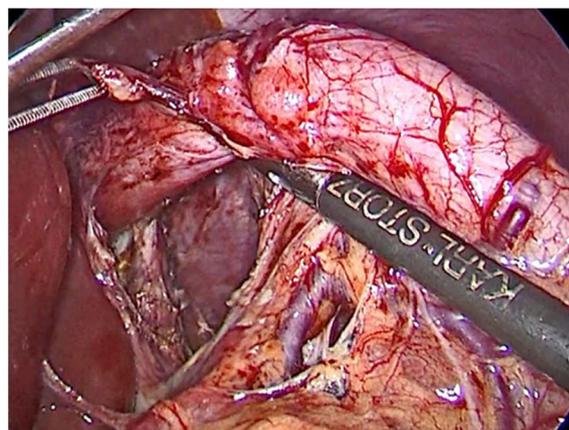
A total of 40 patients met the inclusion criteria and were recruited in the present study. The majority of patients were males (60%), and 12.5% of them had neurological symptoms. The median age was two years old, and the mean weight was 10.2 ± 5.9 kg (Table 1). Concerning the presentation of the GERD, we found that persistent



A



B



C

Fig. 1 **A** Retraction of the liver with a suture passing from abdominal wall to the diaphragm. **B** Dissection starting at the gastrophrenic ligament. **C** Completed esophageal and crural dissection

vomiting not responding to medical treatment was the most common presenting symptom found in all patients except for two patients who presented with anemia and chest problems. Recurrent chest infection was found in two cases. In nearly all cases, low body weight for age and nutritional deficiency were found (Table 2). About 95% of cases suffered from hiatal hernias. Almost two-thirds of the patients (70%) had type I hiatus hernia, and 25% had type III.

In terms of intraoperative data, the operative time (minutes) was significantly longer in the Hill-Snow group (156 ± 52) when compared to the Nissen Group (120 ± 48) (p value = 0.031). Intra-operative complications showed significant differences when comparing the two groups. In the Nissen group, there were two cases with iatrogenic left pleural perforation (10%), which was managed by intercostal tube insertion with no effect on the procedure. In the Hill-Snow group, there were no documented intraoperative complications.

The hospital stay time showed no statistical difference when the study groups were compared. The Hill-Snow group patients had a postoperative admission median of 4 days, while in the Nissen group, the median was 6 days (p value = 0.038).

In the early postoperative period, both dysphagia and bloating were lower in the Hill-Snow group as in two (10%) and three (15%) cases, respectively. Early bloating was significantly lower in the Hill-Snow group (p value < 0.001). Meanwhile, the Nissen group was as high as 7 (35%) and 15 (75%) cases, respectively. Early postoperative vomiting was encountered more in the Hill-Snow group, six cases (30%) versus two cases (10%) in the Nissen group (Table 3).

Although the incidence of postoperative dysphagia was statistically insignificant in both groups, the duration of dysphagia showed a statistically significant shorter duration in the Hill-Snow group compared to the Nissen group (p value > 0.001). The duration of dysphagia in the Hill-Snow group showed a median duration of seven days ranging from 0 to 25 days, while in the Nissen group, the median duration was as high as 40 days ranging from 10 to 70 days. No patients of the Hill-Snow group suffered from bloating. In contrast, 11 cases from the Nissen group (55% of patients) suffered from bloating to a variable degree throughout their postoperative course (p value < 0.001). Mild regurgitation in the follow-up period was reported more frequently in the Hill-Snow group, eight cases (40%) versus six cases (30%) in the Nissen group. The number of patients who had to use medications to overcome postoperative regurgitation or dysphagia (as prokinetic drugs or PPIs) was lower in the Nissen group (5 cases) when compared to the Hill-Snow (8 cases). Patients were followed up for a period of

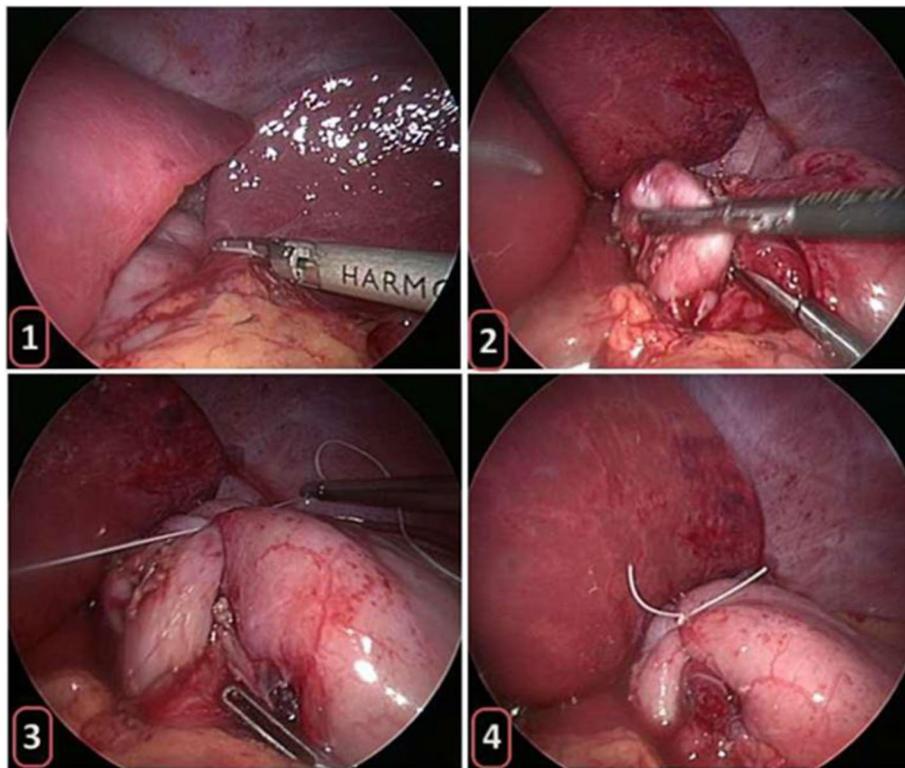


Fig. 2 1 Division of the short gastric vessels. 2 Pulling the fundus behind the esophagus. 3 First suture of the wrap. 4 Wrap completed

12 months. There were three recurrent Hill-Snow cases versus two Nissen cases which were related to persistent regurgitation. Redo surgery was done for two Hill-Snow cases while the other cases were controlled on PPIs (Table 4). Nissen fundoplication was done for one case and redo Hill-Snow procedure for the other.

Discussion

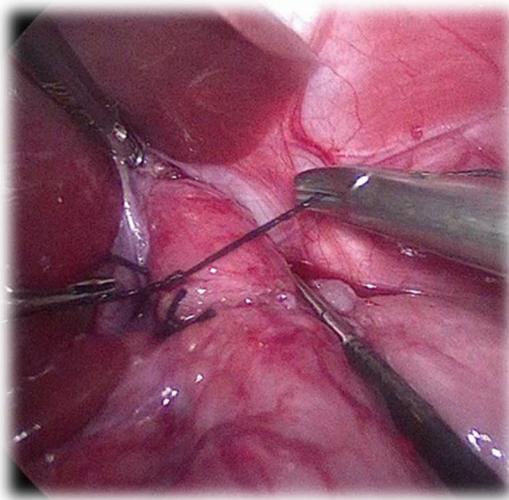
GERD is a commonly encountered disorder in the pediatric population, affecting nearly 7–20% of pediatric age group worldwide, and exerts substantial burden on the healthcare system. Although the management of GERD usually involves lifestyle changes and postural therapy, surgery may be required in the case of life-threatening complications. Previous reports showed that the Nissen fundoplication is associated with a high incidence of dysphagia and gas-bloat symptoms, leading to a delayed return of normal eating pattern [2]. Thus, Hill-Snow operation was proposed as an alternative to the Nissen fundoplication in order to reduce the incidence of postoperative complications. This comparative trial aimed to compare the safety and efficacy of laparoscopic Nissen fundoplication versus Hill-Snow procedure among children with GERD in terms of postoperative dysphagia, bloating, and recurrence of symptoms. To the best

of our knowledge, this is the first comparative trial that compared both techniques in the paediatric age group.

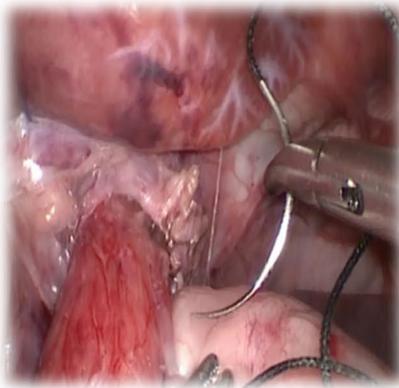
Dysphagia is a common complication following surgical intervention for GERD. It is proposed that early dysphagia is closely related to the postoperative edema, while late dysphagia is more likely to reflect improper approximation of the crura or tight wrap [5]. The risk factors for postoperative dysphagia usually include neurological disorders, such as cerebral palsy [6]. In the present study, the Hill-Snow group patients demonstrated a lower incidence of early post-operative dysphagia and epigastric distension during their post-operative admission. Moving to the outpatient follow-up observations, the incidence of postoperative dysphagia was statistically insignificant in both groups, but the duration of dysphagia was significantly shorter in the Hill-Snow group, highlighting the earlier improvement of dysphagia.

In the present study, post-prandial epigastric fullness and discomfort; also described as bloating or gas bloat syndrome, was not encountered during the follow up of patients after Hill-Snow. In comparison, 55% of Nissen fundoplication patients suffered from bloating to a variable degree throughout their postoperative course.

In terms of recurrence rate in the present study, there were three recurrent Hill-Snow cases versus two Nissen



1



2



3

Fig. 3 1 Posterior esophago-cardioplexy. 2 Accentuation of angle of His. 3 Fixation of the gastric fundus to the diaphragm

Table 1 Demographic data of both studied groups

| Variables | | Nissen | | Hill-Snow | |
|----------------------------|----------------|--------------|-------|----------------|-------|
| | | Count | % | Count | % |
| Gender | Males | 10 | 50.0% | 14 | 70.0% |
| | Females | 10 | 50.0% | 6 | 30.0% |
| Neurological status | Impaired | 4 | 20.0% | 1 | 5.0% |
| | Normal | 16 | 80.0% | 19 | 95.0% |
| Age in months | Median (range) | 25 (10 -132) | | 18.5 (6 - 144) | |
| Weight in Kg | Mean ± | 9.9 ± 6.1 | | 10.6 ± 6.1 | |

Table 2 Presentations of GERD in the studied cases

| Symptoms | Number of cases | % |
|--|-----------------|-------|
| Anemia, melena | 1 | 2.5% |
| Hematemesis and melena | 3 | 7.5% |
| Vomiting and hematemesis | 8 | 20% |
| Choking with chest symptoms and feeding problems | 1 | 2.5% |
| Dysphagia (esophageal stricture) | 3 | 7.5% |
| Fever and bleeding and vomiting | 1 | 2.5% |
| Hematemesis only | 9 | 22.5% |
| Pulmonary symptoms | 1 | 2.5% |
| Persistent vomiting only | 13 | 32.5% |

cases. Recurrence occurred about six months postoperatively. This was confirmed by contrast study and endoscopic examination. Two Hill-Snow cases required surgical correction due to complete failure of the procedure. Recurrent Nissen cases were controlled on PPIs. It is to be noted that recurrent cases of Hill-Snow group were in the first ten cases. This may be attributed to the learning curve that increases gradually.

In the current study, Hill-Snow procedure was associated with significantly longer operative time than in Nissen fundoplication. Such findings run in line with a previous retrospective chart review noting that the mean operative time following Nissen fundoplication was almost 109 min, with dramatic reduction in the operative time with increased learning curve [7]. However, it should be noted that despite the shorter operative time in the Nissen fundoplication group, the rate of intraoperative complications was numerically higher in the Nissen group (10% compared to 0% in the Hill-Snow group). The encountered complications were in the form of two cases of iatrogenic left pleural perforation that was suspected by desaturation left pleural perforation and confirmed by chest X-ray. In a previous report by Esposito et al., nearly 5% of the patients underwent Nissen fundoplication had intraoperative complications. However, the rate among

Table 3 Early postoperative observations for studied groups

| | | Nissen | | Hill-Snow | | P value |
|-----------------|-----|--------|-------|-----------|-------|---------|
| | | Count | % | Count | % | |
| Early dysphagia | Yes | 7 | 35.0% | 2 | 10.0% | 0.127 |
| | No | 13 | 65.0% | 18 | 90.0% | |
| Early bloating | Yes | 15 | 75.0% | 3 | 15.0% | <0.001 |
| | No | 5 | 25.0% | 17 | 85.0% | |
| Early vomiting | Yes | 2 | 10.0% | 6 | 30.0% | 0.235 |
| | No | 18 | 90.0% | 14 | 70.0% | |

Table 4 Late postoperative assessment

| | | Nissen | | Hill-Snow | | P value |
|-------------------|-----|--------|-------|-----------|--------|---------|
| | | Count | % | Count | % | |
| Dysphagia | Yes | 5 | 25.0% | 3 | 15.0% | 0.695 |
| | No | 15 | 75.0% | 17 | 85.0% | |
| Bloating | Yes | 11 | 55.0% | 0 | 0.0% | <0.001 |
| | No | 9 | 45.0% | 20 | 100.0% | |
| Dumping | Yes | 5 | 25.0% | 1 | 5.0% | 0.182 |
| | No | 15 | 75.0% | 19 | 95.0% | |
| Vomiting | Yes | 6 | 30.0% | 8 | 40.0% | 0.507 |
| | No | 14 | 70.0% | 12 | 60.0% | |
| Ability to blench | Yes | 12 | 60.0% | 16 | 80.0% | 0.168 |
| | No | 8 | 40.0% | 4 | 20.0% | |
| Recurrence | Yes | 2 | 10.0% | 3 | 15.0% | 1 |
| | No | 18 | 90.0% | 17 | 85.0% | |
| Need for PPIs | Yes | 5 | 25.0% | 8 | 40.0% | 0.311 |
| | No | 15 | 75.0% | 12 | 60.0% | |

infants approached 9.7 to 15.6% in other reports [8]. Of note, the present study did not observe any case that needed conversion to open approach. The current literature indicates that the rate of conversion in the setting of GERD range from 0 to 7.5% [9]. The rate of intraoperative complications was reflected on the duration of hospital stay in the present study which was slightly longer in the Nissen group.

Conclusions

Based on the present study findings, the Hill-Snow procedure is an effective alternative to Nissen fundoplication with no bloating and much less dysphagia, leading to faster recovery of ordinary eating patterns. Further clinical observations are needed to validate these findings and improve the surgical management of GERD in the paediatric population.

Abbreviations

GERD Gastroesophageal reflux disease
PPI Proton pump inhibitors

Acknowledgements

None.

Authors' contributions

Mohamed Qinawy collected the data and converted the thesis into a manuscript. Mostafa Gad revised the manuscript. Mohamed Elbarbary developed the idea of the research. Osama Abdelazim and Mahmoud Elfiky verified the analytical methods. Sherif Kaddah supervised the project. All authors discussed the results and contributed to the final manuscript. All authors read and approved the final manuscript.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

The institutional review board committee approved the study's protocol before the patients' enrolment. All study procedures run in compliance with the ethical standards of the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Received: 14 June 2022 Accepted: 22 November 2022

Published online: 07 February 2023

References

1. Rybak A, Pesce M, Thapar N, Borrelli O. Gastro-esophageal reflux in children. *Int J Mol Sci.* 2017;18(8):1671.
2. Esposito C, Roberti A, Turrà F, Escolino M, Cerulo M, Settimi A, Farina A, Vecchio P, Di Mezza A. Management of gastroesophageal reflux disease in pediatric patients: a literature review. *Pediatr Health Med Ther.* 2015;6:1.
3. Snow LL, Weinstein LS, Hannon JK. Laparoscopic reconstruction of gastroesophageal anatomy for the treatment of reflux disease. *Surg Endosc.* 1995;9(7):774–80.
4. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA.* 2013;310(20):2191–4.
5. Allal H, Captier G, Lopez M, Forgues D, Galifer RB. Evaluation of 142 consecutive laparoscopic funduplications in children: effects of the learning curve and technical choice. *J Pediatr Surg.* 2001;36(6):921–6.
6. Lopez M, Kalfa N, Forgues D, Guibal MP, Galifer RB, Allal H. Laparoscopic redo fundoplication in children. Failure causes and feasibility. *J Pediatr Surg.* 2008;43(10):1885–90.
7. Rothenberg SS. The first decade's experience with laparoscopic Nissen fundoplication in infants and children. *J Pediatr Surg.* 2005;40(1):142–7.
8. Esposito C, Montupet P, van Der Zee D, Settimi A, Paye-Jaouen A, Centonze A, Bax NK. Long-term outcome of laparoscopic Nissen, Toupet, and Thal antireflux procedures for neurologically normal children with gastroesophageal reflux disease. *Surg Endosc Other Interv Tech.* 2006;20(6):855–8.
9. Lobe TE. The current role of laparoscopic surgery for gastroesophageal reflux disease in infants and children. *Surg Endosc.* 2007;21(2):167–74.

Publisher's note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Submit your manuscript to a SpringerOpen[®] journal and benefit from:

- Convenient online submission
- Rigorous peer review
- Open access: articles freely available online
- High visibility within the field
- Retaining the copyright to your article

Submit your next manuscript at ► [springeropen.com](https://www.springeropen.com)
