

## ORIGINAL ARTICLE

# Comparison of laparoscopic Toupet and laparoscopic Nissen funduplications in neurologically normal children

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**Abstract**

**Introduction:** We compared laparoscopic Toupet fundoplication (LTF) and laparoscopic Nissen fundoplication (LNF) in neurologically normal children.

**Methods:** Forty neurologically normal children who were followed up for more than 3 years after LTF ( $n = 22$ ) or LNF ( $n = 18$ ) were reviewed retrospectively. LTF and LNF were performed between 2006 and 2012.

**Results:** There were no significant differences in gender (LTF, 15 male and 7 female patients; LNF, 12 male and 6 female patients), mean age at surgery (LTF vs LNF: 2.5 vs 2.3 years), mean weight at surgery (LTF vs LNF: 9.6 vs 8.9 kg), preoperative symptoms, preoperative pH monitoring (pH <4) (LTF vs LNF: 26.7% vs 21.8%), mean operative time (LTF vs LNF: 117 vs 126 min), postoperative recommencement of enteral feeding (LTF vs LNF: 3.7 vs 3.8 days), or duration of hospitalization (LTF vs LNF: 5.5 vs 6.3 days). Intraoperative complications were esophageal trauma (LTF;  $n = 1$ ; 4.5%) and liver trauma (LNF;  $n = 1$ ; 5.6%) ( $P = 0.70$ ). Post-LTF complications were wrap stenosis ( $n = 1$ ; 4.5%), and post-LNF complications were wrap stenosis ( $n = 1$ ; 5.5%) and gastric outlet obstruction ( $n = 1$ ; 5.5%) ( $P = 0.43$ ); all were managed conservatively. No case required conversion to open repair. There was no recurrence after LTF, but there were three cases (16.7%) after LNF ( $P = 0.08$ ). Reoperation was performed at 4, 11, and 13 months, respectively.

**Conclusion:** Despite LTF and LNF appearing to be equally effective, three LNF cases required reoperation.

**Introduction**

The Nissen fundoplication is the most commonly performed laparoscopic fundoplication for the surgical treatment of gastroesophageal reflux (GER) disease in all age groups (1). However, for patients with weak esophageal peristalsis documented preoperatively, a partial wrap has often been used as an alternative technique for controlling postoperative dysphagia (2). Some reports have criticized the use of partial wraps in children because of higher long-term failure rates compared with the Nissen approach, especially when reflux is severe (3,4).

The results of antireflux procedures in neurologically impaired children are generally considered to be worse than in neurologically normal children. However, studies do not usually categorize patients according to neurological impairment, so data on GER surgery outcomes do not reflect differences in patients because they are all assessed together. As a result, there have been few reports comparing long-term outcomes of different antireflux procedures in only neurologically normal children or only neurologically impaired children in the international literature (5,6).

Here, we analyzed outcomes after two different antireflux procedures, Nissen fundoplication and Toupet

funduplication, in a series of neurologically normal children.

## Methods

We performed a retrospective cohort study of all neurologically normal children who underwent laparoscopic Toupet funduplication (LTF) or laparoscopic Nissen funduplication (LNF) at Shizuoka Children's Hospital (SC) or Juntendo University Hospital (JU) between 2006 and 2012. Since 1987, these hospitals have maintained a close working relationship involving staff secondment and patient referrals. Many members of surgical staff at both hospitals trained under the same supervisors, and technical educational exchange is common and encouraged to improve the quality of care at both centers. Joint meetings to plan treatment strategies are frequent, and research is often conducted at both centers. Despite the common protocol for treating GER at both centers, LTF is preferred at SC and LNF is preferred at JU for no specific reasons.

Among the pediatric patients in this study, the indication for surgery was generally GER refractory to medical management associated with failure to thrive. Before being evaluated for surgery, all patients were managed medically for at least 4 weeks with aggressive use of H<sub>2</sub> blockers and promotility agents, in addition to having thickened feeds. Patients were excluded from this study if they were neurologically impaired, were older than 16 years of age at the time of surgery, or had had previous antireflux surgery.

All basic surgical techniques used, including dissection of the short gastric vessels, adequate dissection around the crus and preparation of a 3–4-cm length of abdominal esophagus, and suturing and pexing between the left and right crura and between the crus and esophagus with one or two absorbable sutures, were the same in principle. The primary difference was the use of partial wraps (LTF) using three absorbable sutures in two lines or complete wraps (LNF) using three absorbable sutures. All surgery was performed by trainees (eight at SC; six at JU) who were supervised by board certified pediatric surgeons (three at SC; two at JU) with regular rotation of staff between the two institutions. Resumption of enteral feeding is prolonged purposely at both centers to decompress the hiatus in the early postoperative period and stabilize the operative site. All antireflux medications were ceased postoperatively.

All cases were followed up for at least 3 years postoperatively. Parameters assessed in this study included intraoperative factors (conversion to open surgery, complications, and operative time) and postoperative factors (time taken to resume enteral feeding, early

postoperative complications, and length of hospitalization). Long-term factors assessed included recurrence, postoperative complications, and overall surgical outcome. Only patients who became symptomatic postoperatively with vomiting, pneumonia, or dysphagia were assessed for recurrence by performing an upper gastrointestinal contrast study and 24-h pH monitoring.

Data were analyzed using standard statistical methods. Demographic data were compared using the Student's *t*-test. The  $\chi^2$  test or Fisher's exact test was used to analyze the incidence of complications. For all statistics, 0.05 was used to determine significance. Institutional research ethics approval was obtained (2013-2036).

## Results

A total of 40 consecutive patients were studied in this series: 22 who had LTF at SC and 18 who had LNF at JU. During the study term, 142 cases were excluded because of neurological impairment and being older than 16 years of age. There were no significant differences between the groups in terms of gender (LTF, 15 male and 7 female patients; LNF, 12 male and 6 female patients), mean age at surgery (LTF vs LNF:  $2.5 \pm 3.3$  vs  $2.3 \pm 2.3$  years), and mean weight at the time of surgery (LTF vs LNF:  $9.6 \pm 4.3$  vs  $8.9 \pm 2.4$  kg), preoperative symptoms, preoperative pH monitoring (pH < 4) (LTF vs LNF: 26.7% vs 21.8%), and incidence of very low birth weight (LTF vs LNF: 2 vs 1 [9.1% vs 5.6%]). There was also no significant difference in incidence of associated anomalies, including cardiac anomalies (LTF vs LNF: 8 vs 4 [36.4% vs 22.2%]) and esophageal atresia (LTF vs LNF: 7 vs 9 [31.8% vs 50.0%]). In addition, some subjects had pneumonia (LTF vs LNF: 7 vs 4 [31.8% vs 22.2%]) and poor weight gain (LTF vs LNF: 3 vs 2 [13.6% vs 11.1%]) (Table 1). Gastrostomies were present preoperatively (LTF vs LNF: 11 vs 11 [50.0% vs 61.1%]).

Mean operative time was not significantly different between the two groups; LTF took 117 min (range, 72–205 min) and LNF took 126 min (range, 97–220 min). Intraoperative complications were esophageal muscle layer trauma (LTF,  $n = 1$  [4.5%]) and a mild liver laceration (LNF,  $n = 1$  [5.6%]) ( $P = 0.70$ ). There were no conversions to open surgery in either group. Postoperative complications were wrap stenosis requiring bougienation (LTF,  $n = 1$  [4.5%]) and one case each of wrap stenosis and gastric outlet obstruction managed by duodenal tube insertion (LNF,  $n = 2$  [11.1%]) ( $P = 0.43$ ). All postoperative complications were managed conservatively. Resumption of enteral feeding (LTF vs LNF:  $3.7 \pm 1.9$  vs  $3.8 \pm 1.5$  days) and duration of postoperative hospitalization (LTF vs LNF:  $5.5 \pm 1.5$  vs  $6.3 \pm 2.9$  days) were similar.

**Table 1** Demographics

Demographics	LTF (n = 22)	LNF (n = 18)	P-value
Mean age (years)	2.5	2.3	0.8
Gender (n)	15 M/7 F	12 M/6 F	0.9
Mean weight (kg)	9.6	8.9	0.6
Associated anomalies (n)			
Cardiac	8 (36.4%)	4 (22.2%)	
Esophageal atresia	7 (31.8%)	9 (50.0%)	
Preoperative symptoms (n)			
Vomit	22 (100%)	18 (100%)	
Pneumonia	7 (31.8%)	4 (22.2%)	
Poor weight gain	3 (13.6%)	2 (11.1%)	
Low birth weight (n)	2 (9.1%)	1 (5.6%)	0.6
Preoperative 24-h pH monitor	26.7%	21.8%	0.2

F, female patients; M, male patients.

There were three recurrences among the LNF patients (16.7%) identified at 2, 10, and 11 months after primary fundoplication, respectively; reoperation occurred at 4, 11, and 13 months after surgery, respectively, in patients who were 15, 20, and 23 months of age, respectively, at the time of surgery. All three had sliding hernias, two with partial wrap disruption. One case of recurrence also had esophageal stenosis, and another had anorectal malformation. There were no recurrences after LTF. The requirement for reoperation was not significantly different between the groups ( $P = 0.08$ ) (Table 2).

## Discussion

There is a general consensus that antireflux procedures performed in neurologically impaired children are not as successful as those performed in neurologically normal

**Table 2** Outcomes

Outcomes	LTF (n = 22)	LNF (n = 18)	P-value
Mean operative time (min)	117	126	0.5
Mean blood loss (mL)	8.5	7.4	0.5
Conversion (n)	0	0	
Complications (n)			
Intraoperative	1 (4.5%)	1 (5.6%)	0.8
Esophageal trauma	1	0	
Liver trauma	0	1	
Postoperative	1 (4.5%)	2 (11%)	0.4
Wrap stenosis	1	1	
Gastric outlet obstruction	0	1	
Mean time to oral intake (POD)	3.7	3.8	0.9
Mean LOS (POD)	5.5	6.3	0.3
Mean follow-up period (years)	5.4	5.1	0.6
Recurrence (n)	0	3 (16.7%)	0.08

LOS, length of stay; POD, postoperative day.

children, but there is no apparent difference in recurrence rates based on neurological impairment (5). The majority of studies on antireflux procedures in children reported in the literature include both neurologically normal and impaired subjects. With such a broad base of subjects, results can become biased because of numerous variables. With this in mind, we chose to minimize variables and conduct a retrospective assessment of the prognosis of antireflux surgery in neurologically normal children to compare the antireflux procedures directly.

As background, we reviewed reports on GER surgery in neurologically normal adults. In one adult study, it was noted that belching was more frequent after LTF than after LNF, which could indicate that there is less pressure at the surgical site after LTF; this study also found that more patients had to undergo reoperation after LNF than after LTF (7). A recent meta-analysis found that Toupet fundoplication was favored because it had a lower incidence of postoperative dysphagia, reoperation, belching, and abdominal bloating (8). In fact, LTF has been reported to reduce postoperative dysphagia and gas-related symptoms when compared with LNF.

Interestingly, we identified three recurrences only among LNF patients. Although the difference in recurrence between the two groups was not statistically significant, we hypothesize that belching may be implicated because it eases the urge to cough. Thus, there may be less pressure buildup around the operative site after LTF, which helps prevent suture dehiscence and slipping that could cause recurrence of GER (9). With this in mind, we also prefer to delay the commencement of enteral feeding at both our centers to prevent extra physical stress on the operative site. Decompression of the gastrointestinal tract in the early postoperative period would seem to be beneficial logically, but we have no direct proof of this from our series because it is not easy to evaluate belching in children.

Some reports have criticized the use of partial wraps in children because of higher long-term failure rates than after Nissen fundoplication, especially when reflux is severe (3,4). Technically, the partial Toupet wrap requires more suturing than the full Nissen wrap, which we believe helps prevent partial disruption, suture dehiscence, and slipping. However, there is a theoretical risk for perforation with extra suturing, and the wrap may be difficult for less experienced surgeons to master. Fein and Seyfried compared laparoscopic Nissen and laparoscopic partial fundoplication and found that the most relevant factor for selecting which procedure to perform was the surgeon's personal experience, which was a very common approach (10). The subjective nature of choosing which procedure to perform cannot be over emphasized, but we feel our findings may be useful to

surgeons who are comfortable performing both procedures and who are at a loss for an objective reason to choose one over the other.

Our study has several limitations. We did not perform postoperative contrast studies or pH monitoring in all cases, only in those in whom recurrence appeared probable. Our series was small for a multicenter series. Our technique of dissecting the intraabdominal esophagus for 3–4 cm may be considered outdated by some surgeons because the current trend is for dissection to focus on the crura and the gastroesophageal junction, but we believe minimal dissection does not allow free mobilization.

We previously reported a relatively low recurrence rate after GER surgery involving similarly extensive dissection in neurologically impaired children (9). Although our current series of neurologically normal cases is small compared with adult series in the literature (11–14), we believe the common training programs at both centers are consistent enough to minimize technical bias. As such, the negative aspects of treatment—specifically, the three recurrences among the LNF patients (although not statistically significant)—are a reasonable basis for recommending LTF as our preferred procedure of choice for treating GER in neurologically normal children. A longer follow-up with a larger sample size is required to confirm the relevance of recurrence as a detrimental factor after LNF.

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### Ethical statement

Institutional research ethics approval was obtained from Shizuoka Children's Hospital and Juntendo University Hospital (2013-36).

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