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REVIEW ARTICLE

Complete Versus Partial Fundoplication in Children with Gastroesophageal Reflux Disease: Results of a Systematic Review and Meta-analysis

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Abstract Complete fundoplication (Nissen) has long been accepted as the gold standard surgical procedure in children with therapy-resistant gastroesophageal reflux disease (GERD); however, increasingly more evidence has become available for partial fundoplication as an alternative. The aim of this study was to perform a systematic review and meta-analysis comparing complete versus partial fundoplication in children with therapy-resistant GERD. PubMed (1960 to 2011), EMBASE (from 1980 to 2011), and the Cochrane Library (issue 3, 2011) were systematically searched according to the PRISMA statement. Results were pooled in meta-analyses and expressed as risk ratios (RRs). In total, eight original trials comparing complete to partial fundoplication were identified. Seven of these studies had a retrospective study design. Short-term (RR 0.64; p=0.28) and long-term (RR 0.85; p=0.42) postoperative reflux control was similar for complete and partial fundoplication. Complete fundoplication required significantly more endoscopic dilatations for severe dysphagia (RR 7.26; p=0.007) than partial fundoplication. This systematic review and meta-analysis showed that reflux control is similar after both complete and partial fundoplication, while partial fundoplication significantly reduces the number of dilatations to treat severe dysphagia. However, because of the lack of a well-designed study, we have to be cautious in making definitive conclusions. To decide which type of fundoplication is the best practice in pediatric GERD patients, more randomized controlled trials comparing complete to partial fundoplication in children with GERD are warranted.

Keywords Fundoplication · Antireflux surgery · Children · Pediatric · Systematic review · Meta-analysis

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Introduction

Gastroesophageal reflux disease (GERD) in children is defined as pathologic reflux of gastric contents into the esophagus causing symptoms.[1,2] Antireflux surgery, by means of (laparoscopic) fundoplication is reserved for pediatric patients with severe GERD resistant to medical treatment.[2–4] Overall success rates of antireflux surgery are generally good, with a median short-term reflux control of 86 % (57–100 %).[5] However, antireflux surgery can also lead to complications,[6] such as postoperative dysphagia in up to 33 %[5] and gas bloat syndrome in up to 11 %[7,8] of patients.

Several different types of fundoplication are performed in pediatric GERD patients.[9] Complete posterior (Nissen) fundoplication (360°) is performed in up to two thirds of children undergoing antireflux surgery.[7] However, it may be associated with a higher risk of postoperative dysphagia compared to a partial fundoplication (<360°).[5,10] A partial

fundoplication can be constructed by wrapping the fundus either anterior (Thal) or posterior (Toupet) around the esophagus. Until now, partial fundoplication has not been widely used because it is still thought to have less effective reflux control.[11,12] In the past, it was therefore reserved for patients without a history of life-threatening events or patients with signs of esophageal dysmotility to reduce the risk of postfundoplication complaints.[11–15]

Recent meta-analyses and comparative studies in adult GERD patients have demonstrated that partial fundoplication significantly reduces the risk of postoperative dysphagia and gas bloat syndrome compared to complete fundoplication, while providing excellent reflux control.[16–18] Several retrospective studies tried to address this question in pediatric GERD patients, but the first randomized controlled trial comparing Nissen to Thal fundoplication was published only recently.[10,19] These studies, individually, are not able to conclude which type of fundoplication is the best procedure in the pediatric GERD population.

Therefore, the current study aimed to compare complete fundoplication to partial fundoplication in pediatric GERD patients in a systematic review and to perform a meta-analysis on all available literature.

Methods

Search Strategy

This systematic review was conducted according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) statement.[20,21]Using predefined search terms PubMed (1960 to 2011), EMBASE (from 1980 to 2011), and the Cochrane Library (issue 3, 2011) were systematically searched until March 16, 2011 to identify all articles comparing complete to partial fundoplication in children with GERD. For PubMed, the following search terms were used: (child*[Title/Abstract] OR infant*[Title/Abstract] OR adolescent*[Title/Abstract] OR pediatric*[Title/Abstract] OR paediatric*[Title/Abstract]) AND (nissen[Title/Abstract] OR toupet[Title/Abstract] OR thal[Title/Abstract] OR antireflux*[Title/Abstract] OR antireflux*[Title/Abstract] OR fundoplication[Title/Abstract] OR fundoplication[MeSH Terms]) AND gastroesophageal reflux[MeSH Terms]. The same search strategy was used in EMBASE (replacing "[Title/Abstract]" by; "ti,ab" and "[MeSH Terms]" by/exp). Human, child and adolescent were used as search limits in both databases. In addition, the Cochrane Library was manually searched. Language restrictions and time horizons were not applied (Fig. 1).

Study Selection Criteria

Each article was independently assessed for eligibility using the following predefined criteria:

- Study population: neurologically normal (NN) and impaired (NI) infants and children (0–18 years) undergoing primary antireflux surgery for GERD, irrespective of prior or concomitant gastrostomy placement.
- Intervention: complete fundoplication documented as open or laparoscopic posterior 360° complete fundoplication, irrespective of division of the short gastric vessels[22] and partial fundoplication as open or laparoscopic posterior (Toupet) or anterior (Thal or Watson) partial fundoplication.
- Study outcomes: at least one of the outcome measures reported below.
- Study design: originally published articles.

Studies were excluded from analysis if they allocated patients to either surgical technique based on patient characteristics, if they did not meet the inclusion criteria, or if primary outcome parameters of interest were not reported. In case of multiple studies reporting on an overlapping population, only the study with the largest patient population was included.

Outcomes of Interest

Primary outcomes of interest were descriptive symptoms or standardized questionnaires on GERD, 24-h (with or without multichannel intraluminal impedance) pH monitoring, postoperative dysphagia and dilatations for dysphagia. Secondary outcomes of interest were surgical reinterventions (and reasons for reintervention), manometry, gastroscopy, inability to belch, gas bloat syndrome, quality of life, patient satisfaction, in-hospital complications, mortality, operating time and length of hospital stay. A follow-up time of less than 6 months was considered short-term follow up, while a follow-up time of more than 12 months was considered long-term follow-up.

Data Extraction

Titles and abstracts of all retrieved records, and subsequently full-text articles (full-texts were obtained for articles that appeared potentially relevant), were examined independently by two authors (F.M. and B.B.) according to the PRISMA statement.[20,21]A cross-reference check of included articles was performed to identify articles possibly missed by our search strategy. The following data were extracted separately by the same two authors for all studies meeting the inclusion criteria: study population characteristics, study design, surgical method, duration of follow-up, number of participating subjects and events for each of the study outcomes of interest.

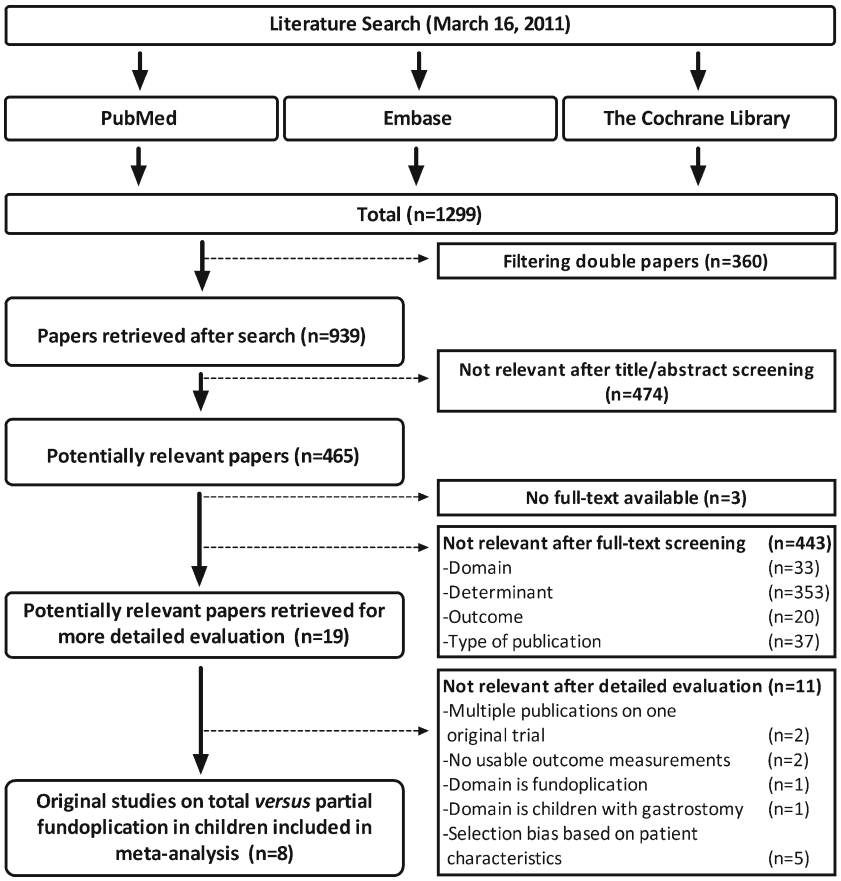

Fig. 1 Flow-chart illustrating details of the search strategy and the study selection process according to the PRISMA statement

In case of discrepancies, a third author (MvH-L.) was consulted and agreement was reached by consensus.

Methodological Quality

Using predefined criteria, two authors (F.M. and B.B) included studies and assessed their methodological quality and risk of bias according to the PRISMA statement[20,21] and the Cochrane Collaboration's tool for risk of bias assessment.[23]

Statistical Analysis

Inter-rater agreement was assessed using κ statistic. If more than two studies reported on one of the outcomes of interest, studies were pooled in a meta-analysis. Subgroup analysis was performed to compare specific types of surgical techniques. Surgical techniques of interest were complete posterior (Nissen), partial posterior (Toupet), and partial anterior (Thal) fundoplication.

Results were presented as risk ratios (RRs) with 95 % confidence intervals (CI). Data were pooled using the Mantel–Haenszel random-effects meta-analysis model.[24] The random-effects model was chosen to take into account suspected heterogeneity caused by differences in study design and patient population, as it generates a more conservative estimate than an analysis using the fixed-effects model.[25] Studies were weighted on sample size and the number of events. Trials with zero events in one arm were included in the analysis by adding a continuity correction of 0.5 to all cells in the two-by-two table for that study. Trials with zero events in both arms were excluded from the meta-analysis. Heterogeneity was calculated using Higgins χ^2 test (χ^2 p value>0.1)[26] and inconsistency in study effects was quantified by I^2 values (I^2>50 %).[23,27] Funnel plots were used to help identify the presence of publication or other types of bias.[28]All analyses were performed using the Review Manager software (version 5.1.7) provided by the Cochrane Collaboration.

Results

In total, 939 potentially relevant publications were identified. After title/abstract and full-text screening we selected eight original studies that met the inclusion and exclusion criteria

(Fig. 1).[9,10,19,29–34] Inter-rater agreements were high for both title/abstract (κ=0.91) and full-text (κ=0.83) screening. Included studies were published between 1994 and 2011 and reported on a total of 1 183 (588 complete and 595 partial fundoplications) children. Most studies only reported data on short-term follow-up. We detected a wide range in follow-up duration (0–192 months) and age at time of surgical intervention (7 days–21 years) between the included studies (Table 1).

The overall methodological quality of included studies was generally poor. All except one of the included studies used a retrospective cohort design. Only Kubiak et al.[10,19] randomly allocated patients to either complete or partial fundoplication. Three studies[10,19,29,31] performed investigation techniques and/or questionnaires according to a predefined study protocol and only five studies reported data on the number of patients lost to follow-up. The potential threats to validity are summarized in Table 1.

Results of Primary Outcomes

Meta-analysis could be performed on all primary outcomes, except for 24-h pH monitoring. None of the studies used standardized reflux questionnaires. Only the absence or presence of reflux symptoms was reported. Short-term (RR 0.64; p=0.28; Fig. 2a) and long-term (RR 0.85; p=0.42; Fig. 2b) subjective reflux control was similar for complete and partial fundoplication.

The relative risk of developing postoperative dysphagia in children who underwent complete fundoplication was 2.56 compared to partial fundoplication; however, this was not statistically significant (p=0.13; Fig. 3a). Analysis of uniformity among the reported results showed excessive heterogeneity for postoperative dysphagia (I^2=61 %). This was probably caused by the high dysphagia rates for both complete and partial fundoplication in the study performed by Kubiak et al.[10] Follow-up time of studies reporting on postoperative dysphagia varied widely (2 months–16 years). Only three studies reported on dysphagia more than 12 months after operation. These studies also found a higher rate of postoperative dysphagia after complete fundoplication compared to partial fundoplication (18.5 % vs. 11.3 %; p=0.21), however this was not significantly different. Partial fundoplication was associated with significantly fewer endoscopic dilatations to treat severe dysphagia (RR 7.26; p=0.007; Fig. 4) compared to complete fundoplication.

Only one study published total acid exposure times, measured by 24-h pH monitoring per different type of surgical technique.[31] Patients who underwent a Thal fundoplication had a higher acid exposure time before operation and at short-term (6 months) and long-term (12 months) follow-up (Table 2). However, in this study no statistical significant differences were found.

To identify possible selection bias funnel plots were constructed. The funnel plot on dysphagia indicated a lack of larger studies in favor of a partial fundoplication, but it is unclear whether this is due to publication bias or other mechanisms. Other funnel plots did not show clear evidence of publication bias and none of the studies lay outside the 95 % CI limits.

Results of Secondary Outcomes

In three of the secondary outcomes (i.e., reintervention rate, gas bloat syndrome and in-hospital complications) a meta-analysis was possible.

The relative risk to develop postoperative gas bloat syndrome comparing complete to partial fundoplication was 2.01. However, this was not statistically significant in the meta-analysis (10.1 % vs. 5.1 %; p=0.18).

Reintervention rates after complete and partial fundoplication were similar, but meta-analysis demonstrated a non-significant trend slightly in favor of a complete fundoplication (4.7 % vs. 5.9 %; RR 0.58; p=0.08).

The percentage of patients with in-hospital complications was also similar after both procedures (11.0 % vs. 9.2 %; RR 1.12; p=0.65). Two[19,33] of the six studies reporting on reintervention rates published their indications for reintervention. An ineffective wrap was seen in eight patients (complete n=2; partial n=6), recurrence of hiatal hernia in seven patients (complete n=2; partial n=5), recurrence of reflux in four patients (complete n=1; partial n=3) and a bowel obstruction in one patient (complete fundoplication). One study specified in-hospital complications, reporting in both complete and partial fundoplication two patients with intraoperative bleeding and one patient with a bowel perforation.[10,19]

Four studies recorded length of hospital stay. In three of these four studies, an open[12,30,34] and in one a laparoscopic technique was used[10,19]. In two studies,[12,30] length of hospital stay was significantly longer after complete fundoplication (p<0.01). This was due to delay in resumption of oral feedings and changes in hospital discharge policy over time. In the other studies[10,19,34] hospital stay also appeared longer after complete fundoplication; however, this difference was not statistically different.

Only two studies reported on operating time[10,19,30]. Ceriati et al.[30] reported a significantly longer operating time constructing a complete fundoplication than a partial fundoplication (180 vs. 120 min; p<0.001), whereas in the study by Kubiak et al.[10,19] operating time was similar after both procedures (102 vs. 109 min; p=NS). Only one study reported on esophageal motility[29] showing significantly higher postoperative LES pressures after complete fundoplication. None of the included studies reported data on upper endoscopy, inability to belch, quality of life or patient satisfaction.

Table 1 Clinical trials (in chronological order) comparing complete to partial fundoplication in pediatric GERD patients

Study	Year	Period	Technique	*n*	FU (months) in mean or range	Patients	Age (years) in mean (SD) or median (range)	Risk of bias summary				
								Prospective	Randomization	Study conducted according to protocol	Complete report on lost to follow-up	Potential other bias
Kazerooni et al.[32]	1994	1974–1991	NF ThF	126 34	50.4	All	0.8 (SD 0.6)	−	−	−	−	(a)
Ceriati et al.[30]	1998	1977–1995	NF ThF	27 20	32	Only NI	0.5–20	−	−	−	NA	(b)
Strecker-McGraw et al.[33]	1998	1983–1997	ONF OThF TouF ThF	135 195 16 16	NR–3	All	0.02–15	−	−	−	NA	(a)
Bacewicz et al.[29]	2004	1982–1998	NF TouF	30 16	18–192	All	6 (0.08–17)	−	−	+	−	(d)
Esposito et al.[9]	2006	1993–2004	LNF LTouF LThF	90 96 48	60	No NI	0.4–16	−	−	−	NA	(a)
Goessler et al.[31]	2007	1985–1999	NF TouF ThF	15 4 25	28.8	Only NI	12.2 (SD NR)	−	−	+	NA	(a)
Wagener et al.[34]	2007	1995-2002	ONF OWF	76 55	0-90	All	0.04 – 16.9	−	−	−	+	(a, b, e)
Kubiak et al.[10,19]	2011	1998–2007	LNF LThF	89 86	30 (1–109)	All	3.1 (0.1–21.0)	+	+	+	−	(c, f)

FU follow-up; *NR* not recorded; *NA* not applicable (none lost to follow-up); Patients: *NI* neurologically impaired; *All* neurologically normal and impaired; Techniques: *L* Laparoscopic; *O* open=-conventional; *NF* Nissen fundoplication; *TouF* Toupet fundoplication; *ThF* Thal fundoplication; *WF* Watson fundoplication; Potential other bias: *a* Patient number imbalance between groups; *b* Time horizon determines surgical technique; *c* Statistically significant baseline imbalance neurological impairment versus neurologically normal developed patients; *d* Not all patient underwent investigation techniques; *e* OWF performed by a single surgeon, while ONF was performed by four surgeons; *f* Statistically significant baseline imbalance in weight at time of operation b) Nissen versus Toupet

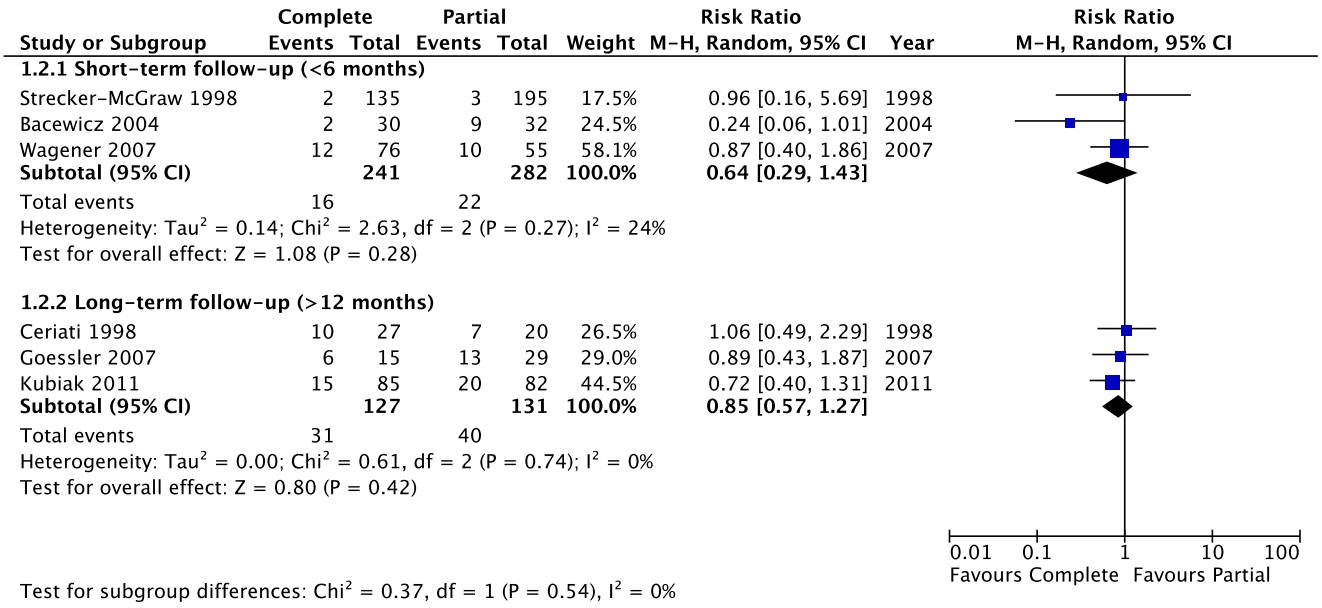

Fig. 2 Meta-analysis of subjective recurrence of reflux after **a** short-term (<6 months) and **b** long-term (>12 months) follow-up following complete versus partial fundoplication. Risk ratios are shown with 95 % confidence intervals (Mantel–Haenszel random-effects model)

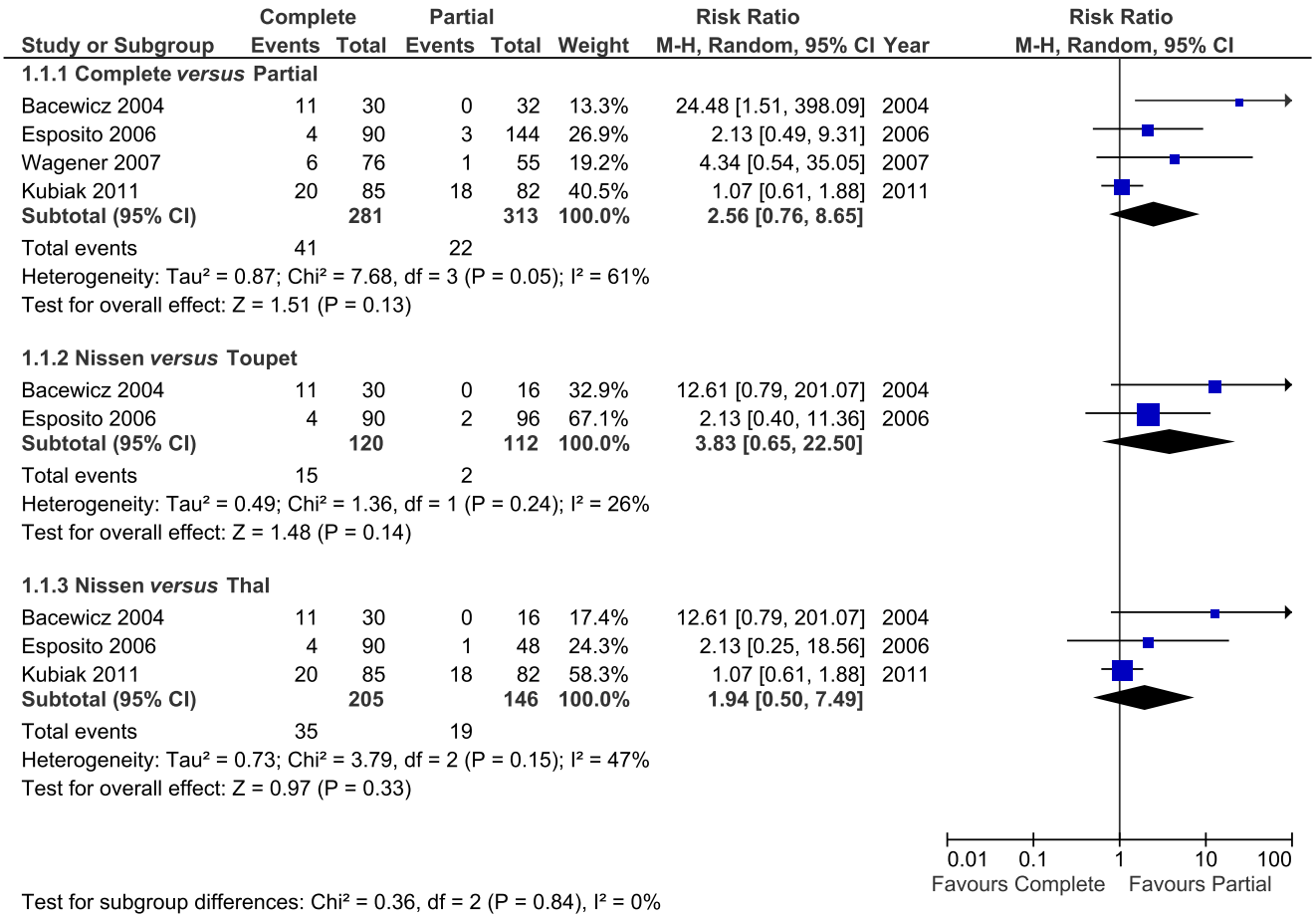

Fig. 3 Meta-analysis of postoperative dysphagia following **a** complete versus partial; **b** Nissen versus Toupet, and **c** Nissen versus Thal fundoplication. Risk ratios are shown with 95 % confidence intervals (Mantel–Haenszel random-effects model)

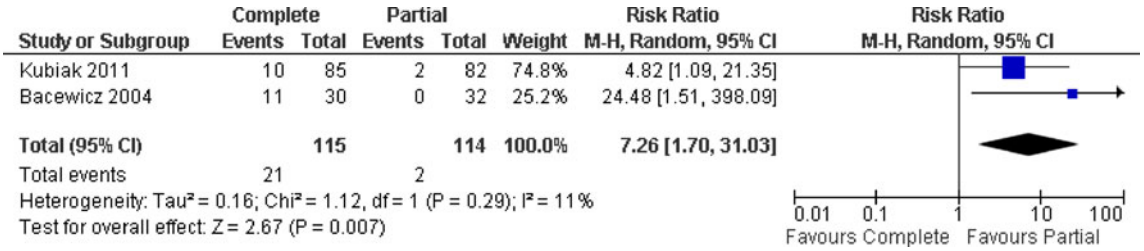

Fig. 4 Meta-analysis of dilatations for dysphagia following complete versus partial fundoplication. Risk ratios are shown with 95 % confidence intervals (Mantel–Haenszel random-effects model)

After constructing funnel plots we did not identify evidence indicating publication bias for these secondary outcomes and none of the studies lay outside the 95 % CI limits.

Subgroup Analysis of Specific Types of Fundoplication

Nissen Versus Toupet Fundoplication

Three studies[9,29,31] reported separate data comparing Nissen to Toupet fundoplication. However, only one study[29] with a limited number of patients reported separate data on short-term (93.3 % vs. 93.8 %; p=0.96) reflux control. One other study[31] reported separate data on long-term reflux control, 60.0 % after Nissen versus 83.3 % after Toupet (p=0.64), but also had a limited number of patients.

Two studies published data comparing Nissen and Toupet by incidence of postoperative dysphagia.[9,29] These studies reported on a total of 232 children (120 Nissen and 112 Toupet fundoplication). The relative risk of developing postoperative dysphagia was 3.83 after complete fundoplication compared to partial fundoplication; however, this was not statistically significant (12.5 % vs. 1.8 %; p=0.14).

Finally, reintervention rates were similar after both procedures (2.9 % vs. 2 %; RR 1.03; p=0.97).

Nissen Versus Thal Fundoplication

Six studies[9,10,19,29–33] reported data comparing Nissen to Thal fundoplication. Two studies[29,33] reported on short-term reflux control, comparing a total of 165 children who underwent Nissen fundoplication to 211 with a Thal fundoplication. In this subgroup analysis, a non-significant trend towards better short-term reflux control (97.6 % vs. 94.8 %; RR 0.36; p=0.08) after Nissen fundoplication was identified. Three studies[10,19,22,31] investigated reflux control after long-term follow-up. These three studies reported on a total of 254 children (127 in either arm). Meta-analysis of studies reporting on long-term subjective reflux control resulted in similar results after Thal and Nissen fundoplication (75.6 % vs. 69.3 %; RR 0.76; p=0.26).

Postoperative dysphagia was not significantly different after Nissen and Thal fundoplication (17.1 % vs. 13.0 %; RR 1.94; p=0.33). Comparing reintervention rates showed a non-significant trend in favor of Nissen fundoplication (4.7 % vs. 6.9 %; RR 0.54; p=0.06).

Directly comparing Thal to Toupet fundoplication was not possible, since none of the included studies reported useable data on the primary endpoints.

Funnel plots did not demonstrate clear evidence of publication bias and none of the studies lay outside the 95 % CI limits.

Discussion

For many years, Nissen fundoplication was considered the gold standard for treatment of severe GERD in pediatric patients. Recent meta-analyses of several randomized controlled trials (RCTs) on antireflux surgery have suggested, however, that partial fundoplication should be the therapy of first choice in refractory adult GERD patients.[16,17] Unfortunately, data in the pediatric literature is scarce: several individual retrospective studies and only one RCT have been published comparing complete Nissen to partial Thal fundoplication. Our systematic review and meta-analysis of these studies found similar short- and long-term reflux controls after both complete and partial fundoplication, whereas

Table 2 Total acid exposure time by 24-h pH monitoring

Study	Technique	*n*	Acid exposure time preoperative (%, SD)	Acid exposure time after 6 months FU (%; SD)	Acid exposure time after 12 months FU (%; SD)
Goessler et al.[31]	NF	15	17.7±2.5	4.0±1.9	3.6±0.7
	TouF	4	12.6±0	2.8±0.2	3.9±0.8
	ThF	25	22.6±3.0	6.7±1.2	13.6±3.0

FU follow-up; *SD* standard deviation; *NF* Nissen fundoplication; *TouF* Toupet fundoplication; *ThF* Thal fundoplication

partial fundoplication required significantly fewer dilatations to treat severe postoperative dysphagia than did complete fundoplication.

In this meta-analysis the relative risk of postoperative dysphagia in patients who underwent complete fundoplication was 2.6 compared to those who underwent partial fundoplication. This was, however, not statistically significant (p=0.13), which was probably due to excessive heterogeneity between study results. This heterogeneity was caused by the only RCT that was included in our meta-analysis. Exclusion of this RCT would result in less heterogeneity and a significant difference (p=0.04) in favor of partial fundoplication. However, the RCT by Kubiak et al.[10,19] was well-designed and it is therefore not justifiable to exclude this study from meta-analysis. Severe postoperative dysphagia requiring endoscopic dilatation occurred significantly less frequently after partial fundoplication than after complete fundoplication. This statistically significant relative risk observed after meta-analysis is further strengthened by uniformity in reporting study results (I^2=11 %).

In order to evaluate whether an anterior Thal or posterior Toupet fundoplication had different outcomes when compared to the posterior, complete Nissen fundoplication, subgroup analysis was performed. This analysis showed similar reflux control after Toupet compared to Nissen fundoplication. Comparing Thal to Nissen fundoplication demonstrated that short-term reflux control was slightly less effective (<3 %) after Thal fundoplication, but studies with long-term follow-up showed similar reflux control after both techniques. Postoperative dysphagia occurred less frequently after both Toupet and Thal compared to Nissen fundoplication, although these differences were not significant. These subgroup analyses are restricted by a small number of studies. Also with regard to reflux control, a limited number of patients, especially in the Toupet group, were included in the studies. Finally, we did not find studies that directly compared Toupet to Thal fundoplication, therefore differences in efficacy and adverse events between these two techniques cannot be directly evaluated.

Meta-analysis of revisional surgery showed a non-significant trend in favor of complete fundoplication (RR 0.58; p=0.08). Subgroup analysis suggested that this was mainly based on a large number of reinterventions in the Thal group, whereas Toupet fundoplication required a similar number of reinterventions as Nissen fundoplication.

In-hospital complication rates were comparable in both complete and partial fundoplication. Unfortunately, only one study[10,19] specified in-hospital complications, therefore the severity of these complications in both groups is unknown.

Only two retrospective studies used objective gastroesophageal function tests. Basewicz et al.[31] demonstrated a higher total acid exposure time after Thal fundoplication than after both Nissen and Toupet fundoplication in a small group of patients. However, this difference was not statistically significant. Goessler et al.[29] measured a higher LES pressure after complete fundoplication. Nonetheless, as is known from the adult literature, a high LES pressure is not associated with more effective reflux control or more postoperative dysphagia after antireflux surgery.[35,36] The role of manometry in children requires further study.

A number of issues need to be considered regarding the conclusions of this systematic review on complete versus partial fundoplication in pediatric GERD patients. Firstly, the majority of the included studies in this review were retrospective in design, which resulted in limited access to study outcomes and various forms of bias. Second, in five[9,31–34] of the eight included studies, significantly more patients had undergone a complete fundoplication. Third, several studies have shown that individual experience in performing antireflux surgery may influence the outcome,[37,38] however, none of the studies reported on differences in experience or learning curves between the two techniques. There was also a lack in data on randomization with regard to individual surgeons, as only one study reported if the procedures were (randomly) allocated to a surgeon. Therefore, at this moment, we cannot draw any conclusion on effects of individual practice and expertise.

Fourth, patient populations among the different studies were heterogeneous. Some authors have suggested that the efficacy of antireflux surgery is lower in neurologically impaired (NI) children than in normally (NN) developed children, because of concurrent gastrointestinal dysmotility in NI children.[4,39–41] In our systematic review, two studies reported only on NI children.[30,31] These studies compared Nissen fundoplication to mainly Thal (Toupet n=4) fundoplication, demonstrating an overall long-term reflux control of approximately 60 % after both procedures. Recently, a retrospective study reporting on long-term follow-up of only NN children after antireflux surgery showed reflux control in up to 80 % of patients after 10 years follow-up.[42] Contradictory to these results, the only published systematic review that included merely prospective studies on pediatric antireflux surgery could not distinguish a difference in reflux control between NI and NN children.[5] Furthermore, the eight studies in this review included patients who were treated between 1974 and 2007. Indications for antireflux surgery varied over the years and despite recent guidelines of the NESPHGAN,[2] an unequivocal definition of therapy-resistant GERD in children does not exist. This results in a large variety of patients included in this systematic review. Finally, both conventional and laparoscopic surgical approaches were included in this review and meta-analysis. Currently, a laparoscopic approach is the gold standard, since reflux control and postoperative dysphagia[43] are similar in both procedures and laparoscopic surgery may result in less postoperative pain, faster recovery, shorter hospital stay, and better cosmesis.[43–46]

This systematic review and meta-analysis showed that reflux control is similar after both complete and partial fundoplication,

while partial fundoplication significantly reduces the number of dilatations to treat severe dysphagia. However, because of the lack of a well-designed study, we have to be cautious in making definitive conclusions. To decide which type of fundoplication is the best practice in pediatric GERD patients, more randomized controlled trials comparing complete to partial fundoplication in children with GERD are warranted.

Finally, considering the trend shown in this systematic review in favor of Toupet fundoplication compared to Thal fundoplication, perhaps future research should particularly focus on investigating this specific type of fundoplication.

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