

# Laparoscopic fundoplication: Nissen versus Toupet two-year outcome of a prospective randomized study of 200 patients regarding preoperative esophageal motility

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## Abstract

**Objective** To determine the influence of preoperative esophageal motility on clinical and objective outcome of the Toupet or Nissen fundoplication and to evaluate the success rate of these procedures.

**Summary background data** Nissen fundoplication (360°) is the standard operation in the surgical management of gastroesophageal reflux disease (GERD). In order to avoid postoperative dysphagia it has been proposed to tailor antireflux surgery according to pre-existing esophageal motility. Postoperative dysphagia is thought to occur more commonly in patients with esophageal dysmotility and it has been recommended to use the Toupet procedure (270°) in these patients. We performed a randomized trial to evaluate this tailored concept and to compare the two operative techniques concerning reflux control and complication rate (dysphagia).

**Methods** 200 patients with GERD were included in a prospective, randomized study. After preoperative examinations (clinical interview, endoscopy, 24-hour pH-metry and esophageal manometry) 100 patients underwent either a laparoscopic Nissen procedure (50 with and 50 without motility disorders), or Toupet (50 with and 50 without motility disorders). Postoperative follow-up after two years included clinical interview, endoscopy, 24-hour pH-metry, and esophageal manometry.

**Results** After two years 85% (Nissen) and 85% (Toupet) of patients were satisfied with the operative result. Dysphagia was more frequent following a Nissen fundoplication compared to Toupet (19 vs. 8,  $p < 0.05$ ) and did not correlate with preoperative motility. Concerning reflux control the Toupet proved to be as good as the Nissen procedure.

**Conclusion** Tailoring antireflux surgery according to the esophageal motility is not indicated, as motility disorders are not correlated with postoperative dysphagia. The Toupet procedure is the better operation as it has a lower rate of dysphagia and is as good as the Nissen fundoplication in controlling reflux.

**Keywords** GORD · GERD · Abdominal

In 1991 the first fundoplication was performed in the laparoscopic technique [1, 2]. It was the renaissance of surgical therapy for gastroesophageal reflux disease (GERD). Meanwhile the importance of this operation has increased dramatically.

Nissen first described this operation as a total fundoplication in 1956 [3], while Toupet preferred a variation using a partial wrap which surrounded the esophagus by 270° [4]. Despite many successful laparoscopic operations the postoperative problems were the same as known previously, namely dysphagia and recurrence of reflux.

Soon the so-called tailored concept was introduced. It proposed a partial or total fundoplication depending on the presence or absence of pre-existing esophageal motility disorders [5–8]. The Nissen procedure seemed to be the more-successful technique regarding control of reflux in several studies [1, 9–14] and was chosen in general. On the other hand a higher rate of dysphagia was observed after

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Nissen fundoplication [15–21]. It was concluded that there is a special risk for dysphagia in patients who presented preoperatively with motility disorders. Hence, these patients were treated with a partial wrap [5–8]. The authors followed this concept for several years, until increasing evidence accumulated that this concept might be invalid [16, 17, 20, 22–25]. We observed that dysphagia also developed after a Toupet procedure and that Nissen funduplications in our series had a higher rate of recurrent reflux disease than the Toupet procedure. So we decided to evaluate this tailored concept by comparing the two operations depending on esophageal motility, in a prospective, randomized trial with long-term postoperative follow up. Operative results as well as four month follow-up data have been reported previously [26, 27]. The aim of the present study was to evaluate the two-year follow-up outcome.

## Methods

### Patient selection and preoperative investigation

Two-hundred patients with GERD entered into this study. All patients displayed a typical history and presented with the report at least one endoscopic examination. Esophageal manometry (eight channel, Medtronic, Düsseldorf, Germany) and pH-monitoring for 24 hours (Standard Instruments, Karlsruhe, Germany) were performed in our hospital by one of the authors. Esophageal motility disorders were defined as mean contraction amplitude less than 40 mmHg and/or failed primary peristalsis of 10 wet swallows in more than 40%. The result of the pH-monitoring was described by the DeMeester score (pathological >14.7) and the cumulative duration of reflux episodes in percent (pathological >5.2% during 24-hours pH-metry with pH < 4). Only patients with a pathological 24-hour pH-monitoring and/or endoscopically proven esophagitis were included. Patients were excluded from the study if they had previous antireflux surgery or if they required a concurrent abdominal procedure at the same time. Additional exclusion criteria were pregnancy and age < 18 years.

### Patient assignment

The patients were stratified into two groups according to esophageal motility. One group consisted of 100 patients with normal motility, while in the other group 100 patients with esophageal motility disorders were included. In each group patients were randomized to undergo either Nissen or Toupet fundoplication (Fig. 1). The study protocol had been approved by the local ethics committee and is in

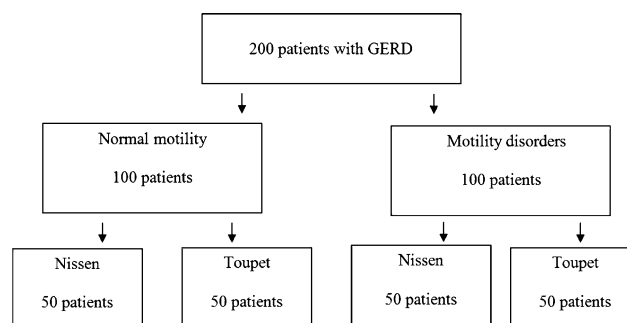
accordance with the ethical standards of the Helsinki declaration of 1975. All patients were admitted to the study only after being instructed properly about the trial and signing the appropriate informed consent form. Randomization was performed by opening one of 200 sealed envelopes in the operating room after general anesthesia had been induced.

### Endoscopy

Endoscopic investigation of the esophagus and the upper gastrointestinal tract was carried out during the last six months before, and two years after the operation. Olympus video endoscopes or GIF-Q140 endoscopes were used.

### Esophageal manometry

Manometry was performed before the operation and two years afterwards. A low-compliance, pneumohydraulic capillary infusion system (Arndorfer Medical Specialties, Greendale, WI, USA) and an eight-channel water-perfused catheter (Medtronic, Düsseldorf, Germany) were used. Proton-pump inhibitors were discontinued five days before diagnostic procedures, whereas histamine blockers and prokinetic agents were discontinued on the day of manometry. Patients were asked to fast the night before the examinations. Manometric evaluation of the lower esophageal sphincter (LES) pressure was performed with the stationary pull-through procedure according to the guidelines of the American Association of Gastroenterology. LES was measured at mid-expiration. Data were recorded and analyzed using the Polygraph software program (Medtronic, Düsseldorf, Germany). In addition, intra-abdominal and overall length of the LES, relaxation of the LES, and motility of the esophageal body were measured. For analysis of esophageal body motility, contractile response to at least 10 wet swallows was evaluated and the presence of simultaneous, interrupted contractions or



**Fig. 1** Study design 33 × 210 mm (96 × 96 dots per inch, DPI)

1x months	1x week	>1x week	>1x day		mild	moderate	severe	
1	2	3	4	X	1	2	3	= Score

**Fig. 2** Dysphagia and heartburn were scored using a scale by multiplication of the frequency and intensity. A Score greater than two was defined as clinically relevant. 350 × 66 mm (96 × 96 DPI)

aperistalsis were noted. We considered esophageal body motility to be normal if 60% or more of the contractions demonstrated normal primary peristalsis, with mean distal amplitude greater than 40 mmHg at the distal sites. The mean contraction amplitude of 10 sequential wet swallows in the distal esophagus (3 and 5 cm above LES) was determined omitting nonconducted waves. The criteria for defining motility disorders in the present study were based on data from Kahrilas et al. [28] and on our institutional experience with 40 healthy probands (no medication, GERD or dysphagia).

#### 24-hour pH monitoring

A glass pH probe (Standard Instruments, Karlsruhe, Germany) or bipolar antimony electrode (Medtronic, Düsseldorf, Germany) was placed 5 cm above the manometrically determined upper boarder of the LES. It was connected to a portable data logger (DL 70 Standard Instruments, Karlsruhe, Germany). Data were processed and analyzed with a scoring system (DeMeester) that uses the following six parameters for calculation: a) cumulative total percentage time pH < 4, b) cumulative percentage time pH < 4 while upright, c) cumulative percentage time pH < 4 while supine, d) number of reflux episodes (pH < 4), e) number of reflux episodes lasting > 5 min, and f) longest reflux episode. All 24-hour pH measurements were performed during the hospital setting.

#### Operating technique

The operations were performed by two surgeons who each had experience with more than 300 laparoscopic funduplications prior to the study. Five trocars were used. First, the crura were dissected, then the short gastric vessels were divided. A posterior hiatoplasty was sutured with two stitches of nonabsorbable material. The Nissen fundoplication was about 2 cm long, secured with two stitches and floppy. A 36 Ch nasogastric tube was placed in the esophagus for calibration. In patients who were operated according to the Toupet technique, the posterior wrap was fixed to the right crus and afterwards to the right side of the esophagus. The corresponding part of the fundus was then fixed to the left side of the esophagus.

#### Postoperative care

Patients received liquids at the first postoperative day, soup on day 2, soft diet on day 3, and a normal diet on day 4. Patients were normally discharged on day 5.

#### Clinical and objective follow-up

Two years after the operation patients were re-examined by answering a standardized questionnaire including symptoms of recurrent reflux, dysphagia, gas bloat and belching. Endoscopy, esophageal manometry, and 24-hour pH-monitoring were also performed after two years. The examinations were done by an independent investigator, who was unaware of the details of the surgical procedure and the preoperative findings. Patients also ranked the outcome of surgery using a modified Visick grading (score 1–4) and were asked to score the outcome as very satisfied, satisfied, unsatisfied or very unsatisfied.

A relapse of GERD was defined as either pathological endoscopic or pH-monitoring findings independent of clinical symptoms.

Clinical reflux symptoms (heartburn) and dysphagia were defined as clinically relevant with a score > 2 points (Fig. 2).

#### Statistical analysis

The aim of this study was to assess the success rate (concerning reflux) and the complication rate (dysphagia) of a Nissen fundoplication compared to the Toupet procedure in the subgroups with and without esophageal motility disorders two years postoperatively, and to determine whether preoperative esophageal motility disorders have an impact on clinical and manometric outcome.

Before commencing the study it was determined that 200 patients (50 in each group) would be needed to demonstrate a 20% difference in these outcome measures at a significance level of  $p < 0.05$ .

A two-tailed Mann–Whitney test and the Wilcoxon test were used to assess the significance of nonparametric data sets. Fisher's exact test was used to compare categorical data. Nonparametric data are expressed as median values (range); parametric data are expressed as mean values ( $\pm$

**Table 1** Degree of inflammation and other findings at the last endoscopy prior to surgery (mainly under medication). There were no significant differences between the groups

Esophagitis (Savary–Miller classification)	Normal motility ( <i>n</i> = 100)			Motility disorders ( <i>n</i> = 100)		
	Total	Nissen ( <i>n</i> = 50)	Toupet ( <i>n</i> = 50)	Total	Nissen ( <i>n</i> = 50)	Toupet ( <i>n</i> = 50)
0	24	10	14	27	15	12
1°	41	20	21	37	17	20
2°	25	15	10	26	12	14
3°	8	4	4	7	5	2
4°	2	1	1	3	1	2
Barrett's esophagus	6	3	3	14	9	5
Hiatal hernia	81	38	43	85	44	41

SD). All tests were performed using the statistical software Statview. Significance was defined as  $p < 0.05$ .

## Results

### Patient population

There were 79 female and 121 male patients with a median age of 56 (20–80) years. The body mass index was 26.4 (18.9–40.4). Patients presented with a history of GERD lasting from 0.2 to 50 years (median seven years). The average duration of treatment with proton pump inhibitors was 24 (0.2–180) months.

### Indications for surgery

Patients were referred for a variety of reasons. Forty-two percent had persisting reflux symptoms under medication. In 30.5% of cases life-long medical treatment was not accepted. In 12.5% of patients a recurrence of reflux after termination of medical treatment was recorded. Six percent would not continue to take proton-pump inhibitors (PPI) because of side-effects and 5.5% were afraid of malignancy. In 3.5% of cases, patients could not get a prescription from their family practitioner due to tighter budgeting.

### Preoperative characteristics

The groups were comparable according to pH-monitoring, manometry results, and endoscopically proven esophagitis (Savary–Miller grade 1–4) (Table 1) with the exception of LES pressure which was higher in the group with normal motility than in the group with motility disorders. There was a higher rate of dysphagia in

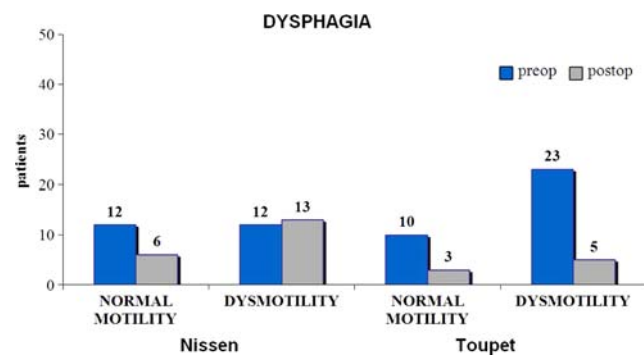
patients with motility disorders than in patients with normal motility (Fig. 3).

### Surgery

The median operative time was 45 min in the Nissen group and 50 min in the Toupet group, and ranged from 30 to 105 min. All operations were finished laparoscopically.

### Early hospital outcome

There were no major intraoperative complications. The postoperative morbidity was 3%. There were two supraumbilical wound infections. Two patients needed blood transfusions. One postoperative bleeding in the Toupet group necessitated reintervention. There were no mortalities. The median length of postoperative hospital stay was five days (3–23). All patients were free of reflux symptoms at discharge.



**Fig. 3** Preoperative dysphagia was significantly higher in the dysmotility group versus normal motility ( $p < 0.05$ ). Postoperative the dysphagia rate was significantly higher after Nissen fundoplication versus Toupet ( $p < 0.05$ ). 286 × 246 mm (96 × 96 DPI)

**Table 2** Two years postoperatively 170 (85%) of the patients were very satisfied or satisfied with the operative result. The outcome was independent of the preoperative proven motility and also of the chosen operative technique. There were no significant differences between the groups

	Normal motility ( <i>n</i> = 100)			Motility disorders ( <i>n</i> = 100)		
	Total	Nissen ( <i>n</i> = 50)	Toupet ( <i>n</i> = 50)	Total	Nissen ( <i>n</i> = 50)	Toupet ( <i>n</i> = 50)
Very satisfied/satisfied	87%	84%	90%	83%	86%	80%
Unsatisfied/very unsatisfied	13%	16%	10%	17%	14%	20%

### Early postoperative clinical outcome

Independent of the planned follow-up, 33 patients presented with new onset dysphagia one week after hospital discharge. Dysphagia was present in the group with normal motility in 19 patients (Nissen 14, Toupet 5) and in the group with motility disorders in 14 patients (Nissen 9, Toupet 5). So, at this time, 23 patients with a Nissen fundoplication and 10 patients with a Toupet fundoplication suffered from dysphagia. The severity of their dysphagia varied, but 14 patients with a Nissen fundoplication and five patients with a Toupet fundoplication required endoscopic dilatation. Four patients with a Nissen fundoplication required several bouginages.

Preoperative data as well as early postoperative clinical outcome have been reported elsewhere [26, 27].

### Follow-up after two years

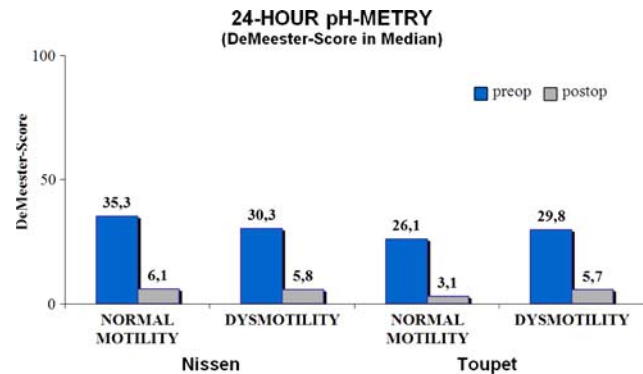
After two years all 200 patients were available for follow-up. Of these patients 178 consented to undergo gastroscopy and 144 patients approved to undergo esophageal manometry and 24-hour pH-metry.

### Satisfaction

Eighty-five percent of the patients were satisfied with the operative result. There was no significant difference between the groups with and without motility disorders (83 vs. 87%) as well as in the subgroups (motility disorders – Nissen vs. Toupet; normal motility – Nissen vs. Toupet) or between patients (regardless of motility disorders) who underwent a Nissen or a Toupet operation (85 vs. 85%) (Table 2).

### Dysphagia

After two years 27 patients complained of moderate to severe dysphagia (20 patients with a score of 3–6 and seven patients with a score of 7–12). Among these patients, nine



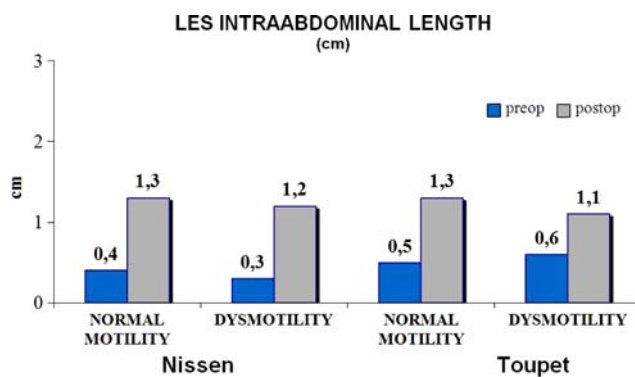
**Fig. 4** After two years 144 patients underwent 24-hour pH-metry. The DeMeester score (normal value < 14.7) decreased significantly after Nissen and Toupet fundoplication ( $p < 0.001$ ). 288 × 247 mm (96 × 96 DPI)

presented preoperatively with a normal motility and 18 with motility disorders. In both groups with and without motility disorders dysphagia occurred more often after a Nissen fundoplication than after a Toupet fundoplication (13 vs. 5 and 6 vs. 3, respectively). Accordingly dysphagia was seen more often in the total group of Nissen patients than in the total group of Toupet patients (19 vs. 8,  $p < 0.05$ ) (Fig. 3).

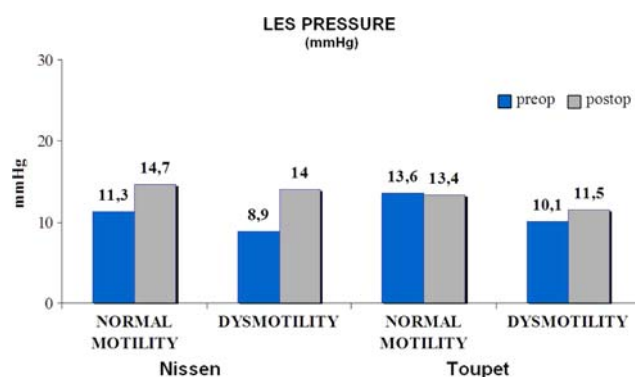
### Twenty-four-hour pH-metry and manometry

The median DeMeester score and number of reflux episodes decreased in all patients (29.6 vs. 4.3% and 10.8 vs. 4.6%, respectively) (Fig. 4).

The intra-abdominal length of the LES increased after all procedures significantly (0.5 cm vs. 1.3 cm,  $p < 0.001$ ) as well as the LES resting pressure (11.0 vs. 13.5 mmHg). There were no differences between the groups with and without motility disorders, in the subgroups or the Nissen versus Toupet groups. The only manometrically proven difference between the groups was seen in the LES pressure. The postoperative LES resting pressure was significantly higher in the total Nissen group in comparison to the total Toupet group (14.4 vs. 12.5 mmHg,  $p < 0.05$ ) (Figs. 5, 6).



**Fig. 5** After two years 160 patients underwent manometry. LES intraabdominal length (normal value > 1 cm) increased significantly after Nissen and Toupet fundoplication ( $p < 0.001$ ). 301 × 229 mm (96 × 96 DPI)



**Fig. 6** After two years 160 patients underwent esophageal manometry. The LES pressure (normal value: 13.8–28.8 mmHg) Nissen fundoplication significantly ( $p < 0.001$ ). 407 × 327 mm (72 × 72 DPI)

#### Recurrence of reflux

Clinical complaints in terms of reflux were reported by 42 out of 200 patients: 21 patients with preoperative normal motility and 21 with motility disorders. Both groups with and without motility disorders presented with more clinical complaints of reflux in the Nissen group than in the Toupet group (12 vs. 9 and 13 vs. 8, respectively). Therefore the clinical complaints of reflux were higher in the Nissen group than in the Toupet group but did not reach statistical significance (Table 3).

The 24-hour pH-monitoring showed pathological findings in 52 patients. Among those patients 25 had had a normal motility and 27 motility disorders. In the group with and without motility disorders there were more pathological pH-monitoring findings in the Nissen group than in the Toupet group (15 vs. 12 and 15 vs. 10, respectively). Accordingly more pathological pH-monitoring results were found in the total group of patients who had a Nissen fundoplication than in patients who had a Toupet fundoplication. Five additional patients displayed endoscopic proof of reflux esophagitis but normal pH-metry values (Table 3).

Upper gastrointestinal endoscopy showed inflammation of the esophagus in 35 patients: 16 patients with normal motility, and 19 with motility disorders.

In the group with motility disorders the endoscopically proven esophagitis was equally displayed in the Nissen and the Toupet group (10 vs. 9), whereas in the group without motility disorders esophagitis was present more often after a Nissen fundoplication than after a Toupet fundoplication (10 vs. 6). Hence, the endoscopically proven reflux esophagitis was more frequent after a Nissen fundoplication than after a Toupet fundoplication in the total group (20 vs. 15, n.s.) (Fig. 7, Table 3).

#### Gas bloat and belching

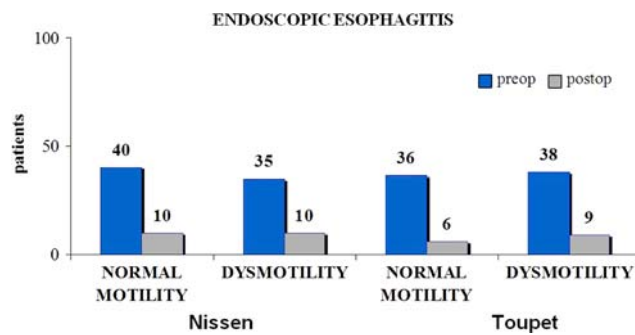
Clinical complaints in terms of gas bloat were slightly increased in both groups with and without motility disorders and also in the Nissen and Toupet groups. Preoperatively 50% of patients suffered from major gas bloat, whereas postoperatively 53% complained about major bloating. In the Nissen group 25% and in the Toupet group 13% complained about inability to belch. There was no difference in the groups with and without motility disorders. No patient complained about major belching.

#### Re-operation

Nineteen patients required re-operation because of an unsatisfying result. All the re-operations were performed

**Table 3** Signs of recurrent reflux two years postoperatively. The differences between the groups were not statistically significant. (One patient appears several times in case of multiple pathological findings.)

	Normal motility			Motility disorders		
	Total	Nissen	Toupet	Total	Nissen	Toupet
Clinical symptoms (out of $n = 200$ )	21	13	8	21	12	9
Path endoscopy (out of $n = 178$ )	16	10	6	19	10	9
Path pH-metry (out of $n = 144$ )	25	15	10	27	15	12



**Fig. 7** Preoperative ( $n = 200$ ) and postoperative ( $n = 178$ ) endoscopic findings according to Savary–Miller 1–4°. Endoscopically proven esophagitis decreased significantly after Nissen and Toupet Fundoplication ( $p < 0.001$ ). 407 × 329 mm (72 × 72 DPI)

laparoscopically. Among those patients 15 had a Nissen procedure and four had a Toupet procedure ( $p < 0.05$ ). Thirteen patients described recurrent reflux symptoms and all showed endoscopic signs of esophagitis. In six patients a conversion of a total fundoplication into a partial fundoplication was necessary because of prolonged dysphagia.

Re-operation showed that in nine patients with a total fundoplication and in one patient with a partial fundoplication the wrap was still intact. In all cases the wrap herniated because of a disruption of the hiatoplasty. After repositioning of the stomach and the wrap into the abdomen the diaphragm was closed with a prolene mesh.

## Discussion

This is the first randomized study to compare the long-term effects of esophageal motility and partial or total laparoscopic fundoplication on clinical outcome. This study focused on an optimal standardized comparison of the two different antireflux procedures to learn more about the precise mechanical consequences that a surgeon can cause when applying these procedures. Furthermore we focused on reflux control, troublesome side-effects such as dysphagia and gas bloat, as well as the current discussion on the usefulness of a tailored approach.

The findings of this study led to the following conclusions: (1) Esophageal motility disorder does not affect postoperative clinical outcome and requires no tailoring of surgical management; (2) the Toupet procedure is more effective in the control of reflux; (3) postoperative dysphagia is significantly higher after Nissen fundoplication; and (4) Toupet fundoplication reduces the rate of reoperation due to mechanical failure.

The Nissen procedure was considered the most successful in terms of reflux control [11, 29, 30], and was

therefore more often performed than partial fundoplication. However, this theory has been challenged lately, shifting the attention to postoperative failures due to mechanical problems (dysphagia), rather than worries about the recurrence of disease. Patients with preoperative evidence of esophageal motility disorders appeared to suffer from postoperative dysphagia more frequently, so that the choice between total or partial fundoplication was made according to the absence or presence of impaired esophageal peristalsis at the preoperative manometric assessment [31, 32]. The results of several nonrandomized trials did not confirm this concept [16, 33, 34]. None of these three randomized trials of laparoscopic fundoplication techniques stratified according to preoperative esophageal motility, so valid information about the tailoring concept is not available [35, 36]. The present study exceeds all other randomized investigations in terms of numbers of study population.

The tailored approach is not supported by our postoperative outcome data. In the present study preoperative manometric assessment of esophageal motility does not correlate with the postoperative outcome and should not be regarded as indication for the choice of operative technique. Lundell et al. reported similar results after retrospectively analyzing their manometric data [17, 25].

Furthermore, the Nissen fundoplication leads to worse outcome with regards to reflux recurrence when compared to the Toupet procedure, even though this trend was not statistically significant. This is a somewhat novel finding since the Nissen procedure is supposed to be superior in terms of effective reflux control. Still these results can probably be explained by lower mechanical failure rate due to more-effective fixation of the fundic wrap and closure of the crurae after the Toupet procedure.

Patients with motility disorders had significantly more sphincter incompetence on manometric studies preoperatively (92 vs. 80%) than those with normal motility. Both Nissen and Toupet fundoplication significantly increased the postoperative LES intra-abdominal length but a significantly increased LES pressure was only seen after Nissen fundoplication, and not Toupet, after two years. This is contradictory to a slightly higher reflux recurrence in the Nissen group. Hence, there are discrepancies of manometric results in comparison with pH-metry findings. It can be speculated that patients with a disrupted hiatoplasty (which was the most common finding at reoperation in the Nissen group) might have normal LES pressures due to an intact fundic wrap but still suffer from reflux recurrence due to crural disruption.

In the first postoperative weeks more patients suffered from dysphagia after a Nissen fundoplication and required endoscopic dilatation more often. These early postoperative problems after a Nissen fundoplication have been

reported from many other series [37–39]. In the case of early postoperative dysphagia we prescribe propulsiva. If this medication is not successful we control our fundoplication endoscopically. Even if we do not find a stenosis we tend to dilate the fundoplication because we have good experience concerning symptom control.

We were impressed by the fact that 57 out of our 200 patients suffered from dysphagia preoperatively. Fundoplication, whether Nissen or Toupet, improved this symptom. Postoperatively only 27 patients suffered from dysphagia. Regarding one of the main questions that led to this study, comparison of the complication rate of the two operative techniques, the Nissen fundoplication was significantly more often followed by dysphagia than the Toupet procedure.

In an animal model, overcorrection of the LES pressure was found after the Nissen fundoplication. This correlates with our clinical findings [40].

Patients with preoperative motility disorders had greater prevalence and severity of respiratory symptoms and heartburn and were more often refractory to medical treatment. Although motility disorders affected clinical symptoms of the disease, they did not affect the outcome after either Nissen or Toupet fundoplication in that relief of heartburn, reflux control on 24-hour pH-monitoring and healing of esophagitis were similar in patients with normal motility and motility disorders.

A fundamental question that has rarely been addressed is the extent to which the gas bloat symptoms and belching typically seen after laparoscopic fundoplication are already present before operation in patients with chronic GERD [17]. No randomized clinical trial has evaluated the ability to belch and gas bloat problems after Nissen and Toupet fundoplication. In our study preoperatively 50% of the patients complained about gas bloat. This slightly increased after two years to 53%. In some patients fundoplication procedures impair the ability to belch and thereby to relieve bloating [41]. The inability to belch occurred in about 25% of patients in the Nissen group and in 13% in the Toupet group. A tendency to fewer gas bloat symptoms after Toupet fundoplication with a short- and long-term follow up has also been reported in the literature [42, 43].

Concerning reflux control 85% of our patients were satisfied with the operative result after two years. This excellent result of clinical outcome did not correlate to the worse findings in the pH-metry and endoscopy follow-up. Fifty-two patients showed pathologic pH-metry studies, 35 exhibited pathologic endoscopy. According to our study criteria (reflux recurrence is defined as pathologic finding in pH-metry and/or endoscopy). Fifty-seven patients had a recurrence of GERD. From today's point of view this definition of recurrent reflux is not correct. As the

indication for therapy in GERD depends mainly on clinical symptoms, success should also be measured the same way. Regarding this concern we would like to point out that 83% of the patients with recurrence of GERD (according to our definition) were satisfied with the operative result after two years.

Most recent series of laparoscopic antireflux surgery reported a certain amount of adverse outcomes requiring subsequent surgical revision [12, 37, 44–46]. The incidence varies with the length of postoperative follow-up and the criteria used for reporting. An incidence of 2–6% at short-term follow-up is common [39, 46–49]. Early identification of these problems may facilitate early laparoscopic repair [50]. In our series re-operation was significantly higher after Nissen fundoplication mainly because of mechanical failure.

Reoperation showed that in nine patients who underwent a Nissen fundoplication the wrap was still intact but it herniated into the chest because of a disruption of the hi-atoplasty. This was less common in the Toupet group. This might be due to the fact that the fundic wrap is additionally sutured to the crurae and this avoids sliding into the chest. Persisting dysphagial symptoms were adequately improved in re-operated patients in whom the Nissen fundoplication was taken down and changed into a partial fundic wrap. This experience is in line with other studies [23, 38, 39, 44].

The re-operation rate is three times higher in this group compared to 2,000 patients we have operated on apart from this study. There are two potential reasons for this surprising fact: firstly, in our endoscopic controls we found patients without symptoms but inflammation of the esophagus. Such a patient would not have presented himself outside the study, but we tended to re-operate to achieve good results. Secondly, there was a group of patients with mild symptoms of reflux and/or dysphagia, in which we found objective criteria for unsuccessful surgical therapy. Also in this group we recommended re-operation.

Eighty-five percent of our patients reported good or excellent results after two years regardless of the chosen procedure. Surprisingly patients in our Nissen group had an equally high satisfaction rate, although we found worse objective results in our study. Other studies from the literature reported equally good results for reflux surgery [17, 25, 35].

In conclusion the Toupet fundoplication seems to be the better operative procedure for patients suffering from GERD. In our hands the Toupet fundoplication became the procedure of choice for surgical treatment of GERD due to its ease of application, excellent patient satisfaction, well-documented curative outcome, low dysphagia rate, and low levels of side-effects.

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