

Long-term Control of Gastroesophageal Reflux Disease Symptoms After Laparoscopic Nissen-Rosetti Fundoplication

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Laparoscopic fundoplication is the gold standard surgical treatment for gastroesophageal reflux disease, although some patients develop recurrence or collateral symptoms related to surgery. The aims of this study were to describe the long-term symptoms control in patients undergoing laparoscopic fundoplication, to analyze the patterns of failure and to correlate postoperative symptoms with anatomic and physiologic findings. Extensive preoperative and postoperative work-up including symptom questionnaire, barium meal, endoscopy, manometry, and 24-hour pH-metry were performed in 130 consecutive patients undergoing laparoscopic fundoplication. Mean follow-up was 52 months. After laparoscopic fundoplication, 117 patients (90%) were asymptomatic with Visick grade I and II symptoms reported by 124 patients (95%). On evaluation, 119 (92%) patients were satisfied and willing to repeat surgery. Two failure patterns, anatomic abnormalities (wrap migration into the chest or down onto the stomach with or without repair disruption) and functional (incompetence of antireflux mechanism), were reported in 17 patients. Reflux can be controlled in up to 90% of patients with gastroesophageal reflux disease with relatively few complications and a high degree of patient satisfaction. The most common cause of recurrent symptoms is an anatomic failure of the fundoplication. (J GASTROINTEST SURG 2006;10:863–869) © 2006 The Society for Surgery of the Alimentary Tract

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Laparoscopic fundoplication has become the gold standard surgical treatment to control gastroesophageal reflux disease (GERD).^{1–13} Surgical series have shown an 80–90% success rate.^{1–3,6,8,9,14–16} On the other hand, 10–20% of patients develop recurrence of GERD or collateral symptoms related to the surgical procedure,^{16–23} although the mechanisms of failure remain unclear. Identification of the cause of failure and the management of these patients are challenging problems.

Most reports describe the preoperative work-up of the patients but few perform anatomic and physiologic studies (barium meal, upper gastrointestinal endoscopy,^{16,22,23} manometry, and/or 24-hour pH recordings^{17,22–27}) undertaken on a regular basis during follow-up that could explain the causes of failure.

The aims of this study, therefore, were to describe the long-term symptoms control in a group of 130

patients undergoing laparoscopic Nissen-Rosetti fundoplication (LNRF) for GERD, to analyze the patterns of failure, and to correlate postoperative symptoms with anatomic and physiologic findings.

MATERIAL AND METHODS

From September 1995 to December 2002, 130 consecutive patients undergoing LNRF for GERD were included in the study. All the patients had symptomatic GERD. The indications for surgery were (1) GERD that was refractory or incompletely controlled with medical therapy and (2) GERD that was medically controlled but patients expressed the wish to avoid life-long therapy. Patients with previous antireflux surgery or with esophageal stricture < 10 mm were excluded.

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Clinical and Functional Evaluation

Symptoms. A standard questionnaire was used to collect data assessing the presence of GERD (heartburn, regurgitation, or dysphagia). Symptoms were rated on a scale (Table 1) with a maximum severity score of 17. At the postoperative follow-up, questions concerning side effects (persistent difficulty in swallowing, fullness, bloating, diarrhea, inability to belch or vomit) were also registered.

Barium Meal. Barium esophagography was performed to obtain information about the anatomy of the gastroesophageal junction and esophageal emptying.

Endoscopy. Upper gastrointestinal endoscopy was performed using Olympus panendoscopes (models GIF 100, 140, and 160). Endoscopic findings were graded according to the MUSE (metaplasia, ulcer, stenosis, erosion) classification reported by Armstrong et al.²⁸

Esophageal Function Tests. Esophageal function tests were performed in all patients as described elsewhere.^{24,29} Esophageal manometry was performed using a continuously perfused three-lumen catheter. Basal lower esophageal sphincter pressure was determined by the station pull-through technique. The

presence and amplitude of peristalsis in the body of the esophagus were evaluated after wet swallows. The diagnostic criteria for motility disorders were based on the lower and upper limits (5th and 95th percentiles, respectively) of motor variables obtained in 79 control subjects studied in our laboratory.²⁴

Ambulatory 24-hour intraesophageal pH-metry was performed after manometric location of the lower esophageal sphincter, with an antimony pH electrode (Zinetics 24ME multiuse pH Catheter, model 91-9011; Medtronic, Copenhagen, Denmark) connected to a portable pH-meter (Digitrapper MK III; Synectics Medical, Sweden). All pH recordings were analyzed by computer using the Esophagogram software program, version 5.70C2 (Synectics Medical, Stockholm Sweden). The 24-hour pH results were considered diagnostic of GERD if one of the three indices for percent time of esophageal exposure to acid during the overall 24-hour, upright, and recumbent periods exceeded the 95th percentile values (pH < 4 for more than 4.6%, 6.0%, and 1.9% of the time, respectively) derived from previous studies in 39 healthy controls.²⁹ An overall assessment of the procedure was obtained with the DeMeester score.

Surgical Procedure

The same group of surgeons using a standardized technique performed all procedures. After incision of the phrenoesophageal ligament, the distal esophagus was completely mobilized and a wide retrosophageal window was made. A crural repair, posterior to the esophagus, using two or three nonabsorbable sutures, was made. Short gastric vessels were divided in all patients, except in 16, allowing full fundus mobilization. A 360° tension-free, 2-cm-long wrap was created using the anterior wall of the gastric fundus (Rosetti modification). The wrap was fixed with three nonabsorbable sutures that included the anterior esophageal wall. In all patients, the fundoplication was constructed around a 56 F Maloney dilator.

Follow-up. A physician not participating in the diagnosis or treatment of GERD carried out the clinical evaluation, using the questionnaire described above every 3 months during the first year, every 6 months for 3 years, and yearly thereafter. The most recent evaluation was used for data analysis except when symptomatic recurrence had occurred earlier. A modified Visick grading scheme assessed clinical results. Patients were also asked for a personal assessment of the operation. In patients who did not attend the clinical controls, the questionnaire was undertaken by telephone.

Table 1. Symptom scoring

Symptom	Score
Heartburn	
Never	0
Occasionally	1
Seasonally	2
Daily (daytime)	3
Daily (daytime/nighttime ≤1 day/week)	4
Daily (daytime/nighttime >1 day/week)	5
Daily (daytime/nighttime)	6
Regurgitation	
Never	0
Occasionally	1
Daily (daytime)	2
Daily (daytime/nighttime ≤1 day/week)	3
Daily (daytime/nighttime >1 day/week)	4
Daily (daytime/nighttime), cough, and/or dyspnea	5
Dysphagia	
Never	0
<1 day/week	1
>1 day/week	2
Daily	3
Every Meal	4
Every swallow	5
Unable to eat	6

Patients were invited to undergo full postoperative testing, including barium meal, endoscopy, esophageal manometry, and 24-hour pH recording, 12 months after surgery. The same work-up was proposed when recurrence of GERD was suspected.

Statistical Analysis

After validation of the data and a consistency analysis, the analysis of variance or nonparametric test (Wilcoxon) was used for statistical comparison of continuous variables. The χ^2 or Fisher exact test was used to compare categorical variables. The two-tailed Student's *t*-test was used to compare mean and standard deviation values. All tests were performed using the statistical software package SPSS 10.0 for Windows (SPSS, Chicago, IL). The significance level was set at $P < 0.05$.

RESULTS

One hundred thirty patients (66 men and 64 women; mean age, 49 years) were included. Nineteen patients (15%) had previous abdominal surgery, but no patient had undergone prior antireflux surgery.

The mean postoperative follow-up of the series was 52 months. The number of patients at risk included in the study at 12, 36, and 60 postoperative months was 130, 102, and 70, respectively. Data were available for 128, 93, and 58 patients in each postoperative period (99%, 92%, and 83%, respectively).

Preoperative Findings

In addition to clinical evaluation, and as part of the preoperative work-up, a barium meal was carried out in all patients. Moreover, endoscopy was performed in 126 (97%), and esophageal manometry and 24-hour pH-metry were carried out in 111 (85%) patients.

On preoperative evaluation, all patients (100%) had heartburn, 91 (70%) had referred regurgitation episodes, and 20 (15%) had a varying degree of non-obstructive dysphagia.

Preoperative barium meal showed 104 patients (80%) with type I hiatus hernia, 8 (6%) with type II, and 14 (11%) with type III. In four patients, no hernia was found.

At the preoperative upper endoscopy, 58 patients (46%) had erosive esophagitis. Barrett's esophagus, esophageal ulcers, and mild stenosis were observed in eight, four, and four patients, respectively.

The main preoperative manometric and pH-metric values are depicted in Table 2.

Surgical Complications

Fundoplication was completed laparoscopically in all except four patients (conversion rate to open operation, 3%) with extensive adhesions from previous operations.

No postoperative mortality occurred. Complications developed in 16 (12.5%) patients. Two patients developed pneumothorax during hiatus dissection, both treated with pleural drainage. There were two bleeds in the early postoperative period, one intra-

Table 2. Results of manometry and 24-hour pH-metry in the whole series and in patients in whom both studies were available in preoperative and postoperative periods

Parameter	Overall series (n = 111)	Series with preoperative and postoperative data (n = 79)		P
		Preoperative	Postoperative	
Manometric data				
LESp* (mm Hg)	12 ± 1	12.1 ± 1	17.8 ± 1	<0.05
Peristalsis amplitude (mm Hg)				
Upper third	55 ± 3	54 ± 3	48 ± 3	NS
Middle third	48 ± 3	48 ± 3	55 ± 3	NS
Lower third	67 ± 3	66 ± 3	80 ± 5	<0.05
Primary peristalsis (%)	90	90	90	NS
Simultaneous waves (%)	17	15	16	NS
pHmetric data				
Reflux time (%)	9.5 ± 1	9.4 ± 1	0.7 ± 1	<0.05
DeMeester score (n)	30 ± 4	30 ± 4	2 ± 3	<0.05

Values given as mean ± SEM.

LESp = lower esophageal sphincter pressure.

*P values between preoperative and postoperative values.

abdominal and one incisional treated conservatively. One patient had early migration of the wrap requiring reoperation. There were four wound infections. One patient developed atelectasia, and one had urinary infection. During follow-up, five patients were found to have incisional hernias in the port orifices.

Postoperative Findings

Symptoms. LNRF was associated with a statistically significant decrease in the heartburn, dysphagia, and regurgitation scores at 12, 36, and 60 months of follow-up (Fig. 1). After the surgical procedure, 117 patients (90%) were completely asymptomatic regarding their primary GERD symptoms on the last follow-up.

On the other hand, 13 (10%) patients had persistent or recurrent symptoms related to GERD after LNRF: heartburn in eight (6%) patients (two associated with regurgitation episodes) and persistent or newly developed dysphagia in five (4%) patients (Table 3). Heartburn had recurred in two patients at 6 months of follow-up, in one patient at 9 months, in one patient at 12 months, and in four patients at 36 months.

All patients in this series presented with varying degrees of dysphagia in the early postoperative (<4 weeks) period, but no specific treatment was needed. In five (4%) patients, the dysphagia episodes persisted or reappeared during follow-up.

Symptoms probably related to the surgical procedure included diarrhea in 10 patients (8%; transient in 9 and permanent in 1), postprandial fullness or bloating in 19 (15%) patients, and inability to belch or vomit in 59 (45%) patients.

Barium Meal. At the 12-month postoperative follow-up, 105 (81%) patients agreed to undergo a barium meal. We found anatomic abnormalities in nine (9%) patients: in four (4%), the fundoplication had migrated to the thorax (in one, this anomaly was associated with a gastric volvulus), in three (3%) patients a slipped fundoplication was observed, in one (1%) patient there was a wrap malposition with esophageal torsion, and one (1%) patient had early disruption of the fundoplication (Table 3).

Upper Endoscopy. Forty-six of our 130 patients had repeated endoscopy at 12 months. Before operation, 23 (50%) of these had esophagitis. On the following examinations, four (9%) had esophagitis. One of these patients did not have esophagitis before operation.

Esophageal Function Tests. Esophageal manometry and 24-hour pH-metry were carried out in 79 (71%) of 111 patients during the follow-up. Results are shown in Table 2. The mean lower esophageal sphincter pressure increased from 12.1 ± 1 mm Hg before operation to 17.8 ± 1 mm Hg, and 24-hour pH reflux time decreased from $9.4 \pm 1\%$ to $0.7 \pm 1\%$. In six patients, a pathologic reflux ($>4.6\%$ of recording time) was found within 12 months. In three additional patients, GERD

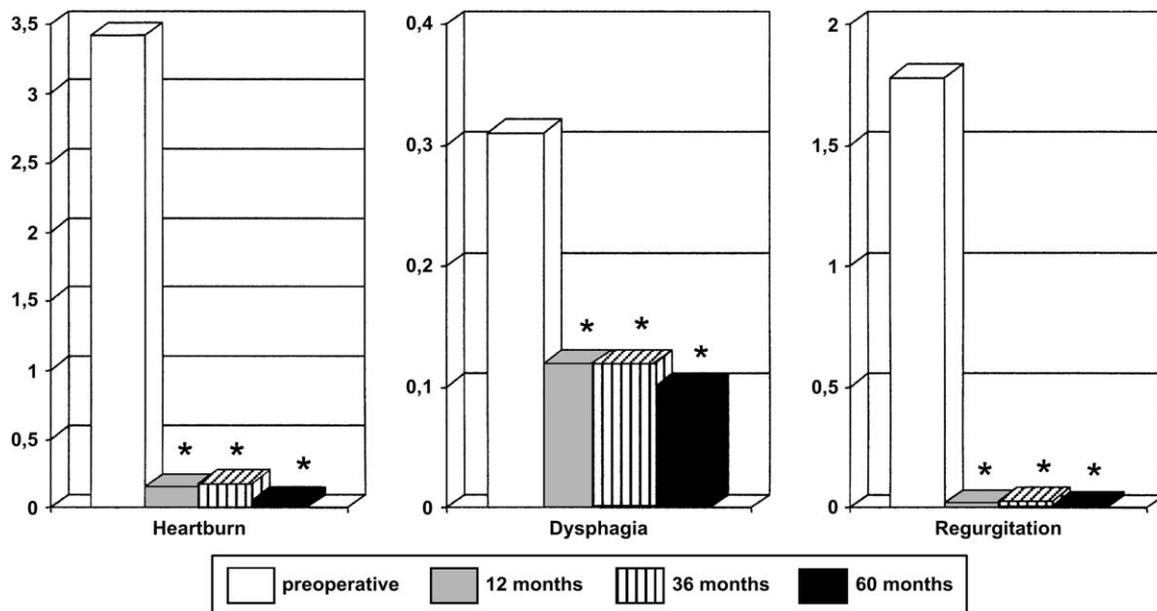


Fig. 1. Preoperative and postoperative symptom scores for heartburn, dysphagia, and regurgitation ($*P < 0.05$ versus preoperative values).

Table 3. Characteristics of 17 patients with some clinical, radiological, or functional alteration on follow-up

Patient	Symptom	Follow-up (mo)	Barium meal	Endoscopy	Manometry	pHmetry	Outcome
1	Heartburn*	6	Slippage	Esophagitis	Normal	Reflux	Reoperation
2	Heartburn	6	Migration	Normal	Normal	Normal	Reoperation
3	Heartburn*	9	Normal	Esophagitis	Normal	Reflux	PPI
4	Heartburn	12	Migration	Normal	Normal	Normal	Reoperation
5	Heartburn	36	Normal	Esophagitis	Normal	Reflux	PPI
6	Heartburn	36	Migration	Normal	Normal	Normal	PPI
7	Heartburn	36	Normal	Normal	IEM	Reflux	PPI
8	Heartburn	36	Slippage	Normal	IEM	Reflux	Reoperation
9	Dysphagia	0	Normal	Normal	IEM	Normal	CIS + RN
10	Dysphagia	1	Torsion	Normal	Normal	Normal	Reoperation
11	Dysphagia	3	Disruption	Normal	Normal	Normal	Reoperation
12	Dysphagia	12	Normal	Normal	Normal	Normal	CIS + RN
13	Dysphagia	36	Migration + volvulus	Normal	Normal	Normal	Reoperation
14	No	12	Slippage	Normal	Normal	Reflux	PPI
15	No	12	Normal	Esophagitis	Normal	Reflux	PPI
16	No	12	Normal	Normal	Normal	Reflux	PPI
17	No	12	Normal	Normal	Normal	Reflux	PPI

PPI = proton pump inhibitors, IEM = ineffective esophageal motility, CIS + RN = cisapride + ranitidine.

*Regurgitation associated.

symptoms recurred later and the 24-hour pH recording was then abnormal.

Correlations Between Postoperative Symptoms and Tests

Table 3 shows the correlation between symptoms (heartburn, dysphagia, or none) related to GERD and functional abnormalities detected after fundoplication.

All patients with heartburn had at least one radiologic, endoscopic, or functional abnormality. In five patients, the barium meal showed a fundoplication defect (migration of the wrap into the chest in three patients, and in two, a slippage down onto the stomach). Reflux was present by 24-hour pH-metry in five patients (in two, motility disorders were also observed). In addition, three patients had erosive esophagitis on endoscopy. Two patients with heartburn also reported regurgitation (1.5%). Four of eight patients with heartburn needed reoperation to restore normal anatomy, whereas in the other four, symptoms were controlled with acid suppression medication.

In three of the five patients with postoperative dysphagia, an anatomic failure was detected in the postoperative barium meal and a redo procedure was performed (Table 3). One further patient with dysphagia had a persistent motility disorder.

Four asymptomatic patients had pathologic reflux on 24-hour pH-metry. One of these had erosive esophagitis, and one, a slippage of the fundoplication.

At the last follow-up, 20 patients (15%) were on antisecretory treatment: 10 (8%) because of GERD and 10 (8%) because they were taking nonsteroidal anti-inflammatory drugs.

Degree of Satisfaction

A functional status of Visick grades I and II, asymptomatic or mild symptoms only, was reported by 124 patients (95%). Minor symptoms were rarely volunteered by the patients and were discovered only by specific leading questions. At the time of evaluation, 119 patients (92%) were satisfied with the surgical results and would be willing to undergo the same surgery again.

DISCUSSION

The present study reports a high frequency of symptomatic cure of GERD after laparoscopic fundoplication and a high degree of patient satisfaction with relatively few collateral effects. Although conservative treatment continues to be the gold standard for patients with nonerosive GERD, the introduction of laparoscopic techniques has led to resurgence in the use of antireflux surgery.^{3,8,9} Many centers that have introduced this procedure over the past 15 years have reported an increase in the referral of patients controlled by maintenance antisecretory therapy who want to avoid long-term medication and choose to undergo laparoscopic surgery because

of the significant reduction in morbidity, postoperative pain, hospital stay, and earlier return to normal activity compared with open surgery.^{7,10,11}

Studies with long-term follow-up (more than 10 years) have shown success rates of 80–90% with open fundoplication in the treatment of GERD.^{27,30} In our experience, symptomatic control and satisfaction degree after open surgery was 92% at 20 years.³⁰ The success rate of the laparoscopic procedure, which differs only in its surgical approach, should be similar, but there are few reports objectively documenting the medium-/long-term results.^{2,6,9,14,15,31} As in other series, our study reports good clinical results after laparoscopic fundoplication,^{2,5–7,10,12} despite recurrent heartburn in 6% of the patients and dysphagia in 4%. Eight percent of our patients reported diarrhea and 45% were unable to belch or vomit. Despite these symptoms, 95% of our patients were satisfied with the outcome and would make the same decision again, even in the patients requiring reoperation. Similar results have been reported by other authors.^{14,15,19,30}

A controversial issue is the use of extensive esophageal tests in preoperative and postoperative evaluation. Some authors have demonstrated that preoperative esophageal studies, other than those required to make an accurate diagnosis, were of no value in deciding the suitability of patients for surgical correction of reflux.³⁰ Postoperative studies are not performed on a regular basis because of patient refusal, particularly when symptom free, and because their utility has not been proved.^{2,17,19,21,24} However, these studies are mandatory when untoward symptoms appear. Nonetheless, despite our efforts to carry out an extensive follow-up of all patients, 40% of the patients refused to undergo the tests, particularly when free of symptoms.

As in other studies, endoscopic improvement was significant.^{27,32,33} Erosive esophagitis disappeared in the majority of patients. Regarding esophageal manometry, the present data corroborate earlier reports of an increase in lower esophageal sphincter pressure and esophageal contraction amplitude following antireflux surgery.^{2,24,27,34} Moreover, 24-hour pH monitoring demonstrated normalization of acid exposure in 89% of patients tested. Four patients without GERD symptoms still had pathologic reflux but not as severe as before operation. The reduced reflux may explain the resolution of symptoms, although one of the four still had esophagitis.

Analysis of the 13 patients who had recurrent or persistent symptoms indicated two patterns of failure.³⁵ The most common cause of anatomic abnormality was the migration of the wrap into the chest or down onto the stomach (slippage) with or without disruption of the repair. The second was a functional

failure, the incompetence of the antireflux mechanisms despite a satisfactory appearing wrap. In this scenario, a careful barium study should be first performed on reappearance of symptoms. Endoscopy can be complementary to esophagogram in identifying anatomic reasons for failed fundoplication.³³ Ambulatory 24-hour pH-metry is essential for documenting the presence of reflux when there is no evidence of anatomic failure on barium study and/or endoscopy.^{2,5,6,14,27} Manometry is also essential in patients with persistent dysphagia.^{17,19,24,25}

CONCLUSION

If patients with GERD are properly selected and have been thoroughly informed about the operation and the possible side effects and the wrap is loosely fashioned, control of the reflux can be achieved in up to 90% of the patients with relatively few complications and a high degree of patient satisfaction. The most common cause of recurrent symptoms is anatomic failure of the fundoplication.

REFERENCES

1. Baigrie RJ, Cullis SN, Ndhuni AJ, Cariem A. Randomized double-blind trial of laparoscopic Nissen fundoplication versus anterior partial fundoplication. *Br J Surg* 2005;92:819–823.
2. Bammer T, Hinder RA, Klaus A, Klingler PJ. Five- to eight-year outcome of the first laparoscopic Nissen fundoplications. *J GASTROINTEST SURG* 2001;5:42–48.
3. Cookson R, Flood C, Koo B, Mahon D, Rhodes M. Short-term cost effectiveness and long-term cost analysis comparing laparoscopic Nissen fundoplication with proton-pump inhibitor maintenance for gastro-oesophageal reflux disease. *Br J Surg* 2005;92:700–706.
4. Gotley DC, Smithers BM, Rhodes M, Menzies B, Branicki FJ, Nathanson L. Laparoscopic Nissen fundoplication: 200 Consecutive patients. *Gut* 1996;38:487–491.
5. Hinder RA, Filipi CJ, Wetscher G, Neary P, DeMeester TR, Perdiks G. Laparoscopic Nissen fundoplication is an effective treatment for gastroesophageal reflux disease. *Ann Surg* 1994;220:472–481.
6. Lafullarde T, Watson DI, Jamieson GG, Myers JC, Game PA, Devitt PG. Laparoscopic Nissen fundoplication: Five-year results and beyond. *Arch Surg* 2001;136:180–184.
7. Laine S, Rantala A, Gullichsen R, Ovaska J. Laparoscopic vs conventional Nissen fundoplication. A prospective randomized study. *Surg Endosc* 1997;11:441–444.
8. Mahon D, Rhodes M, Decadt B, Hindmarsh A, Lowndes R, Beckingham I, Koo B, Newcombe RG. Randomized clinical trial of laparoscopic Nissen fundoplication compared with proton-pump inhibitors for treatment of chronic gastro-oesophageal reflux. *Br J Surg* 2005;92:695–699.
9. Olberg P, Johannessen R, Johnsen G, Myrvold HE, Bjerkeset T, Fjosne U, Petersen H. Long-term outcome of surgically and medically treated patients with gastroesophageal reflux disease: A matched-pair follow-up study. *Scand J Gastroenterol* 2005;40:264–274.

10. Richards KF, Fisher KS, Flores JH, Christensen BJ. Laparoscopic Nissen fundoplication: Cost, morbidity, and outcome compared with open surgery. *Surg Laparosc Endosc* 1996;6:140-143.
11. Trullenque R, Torres T, Marti E, Martinez M, Trullenque R, Delgado F. Cirugía de la enfermedad por reflujo gastroesofágico: estudio comparativo entre los abordajes abierto y laparoscópico. *Rev Esp Enferm Dig* 2005;97:328-337.
12. van der Peet DL, Klinkenberg-Knol EC, Eijbouts QA, van den Berg M, de Brauw LM, Cuesta MA. Laparoscopic Nissen fundoplication for the treatment of gastroesophageal reflux disease (GERD). Surgery after extensive conservative treatment. *Surg Endosc* 1998;12:1159-1163.
13. Watson DI, Jamieson GG, Lally C, Archer S, Bessell JR, Booth M, Cade R, Cullingford G, Devitt PG, Fletcher DR, Hurley J, Kiroff G, Martin C, Martin IJ, Nathanson LK, Windsor JA. Multicenter, prospective, double-blind, randomized trial of laparoscopic Nissen vs anterior 90 degrees partial fundoplication. *Arch Surg* 2004;139:1160-1167.
14. Anvari M, Allen C. Five-year comprehensive outcomes evaluation in 181 patients after laparoscopic Nissen fundoplication. *J Am Coll Surg* 2003;196:51-57.
15. Kamolz T, Granderath FA, Schweiger UM, Pointner R. Laparoscopic Nissen fundoplication in patients with nonerosive reflux disease. Long-term quality-of-life assessment and surgical outcome. *Surg Endosc* 2005;19:494-500.
16. O'Hanrahan T, Marples M, Bancewicz J. Recurrent reflux and wrap disruption after Nissen fundoplication: Detection, incidence and timing. *Br J Surg* 1990;77:545-547.
17. Anvari M, Allen C. Esophageal and lower esophageal sphincter pressure profiles 6 and 24 months after laparoscopic fundoplication and their association with postoperative dysphagia. *Surg Endosc* 1998;12:421-426.
18. Bais JE, Horbach TL, Masclee AA, Smout AJ, Terpstra JL, Gooszen HG. Surgical treatment for recurrent gastro-oesophageal reflux disease after failed antireflux surgery. *Br J Surg* 2000;87:243-249.
19. Contini S, Zinicola R, Bertele A, Nervi G, Rubini P, Scarpignato C. Dysphagia and clinical outcome after laparoscopic Nissen or Rossetti fundoplication: Sequential prospective study. *World J Surg* 2002;26:1106-1111.
20. Dallemagne B, Weerts JM, Jehaes C, Markiewicz S. Causes of failures of laparoscopic antireflux operations. *Surg Endosc* 1996;10:305-310.
21. Hunter JG, Swanstrom L, Waring JP. Dysphagia after laparoscopic antireflux surgery. The impact of operative technique. *Ann Surg* 1996;224:51-57.
22. Stein HJ, Feussner H, Siewert JR. Failure of antireflux surgery: Causes and management strategies. *Am J Surg* 1996;171:36-39.
23. Watson DI, Jamieson GG, Devitt PG, Matthew G, Britten-Jones RE, Game PA, Williams RS. Changing strategies in the performance of laparoscopic Nissen fundoplication as a result of experience with 230 operations. *Surg Endosc* 1995;9:961-966.
24. Grande L, Lacima G, Ros E, Pujol A, Garcia-Valdecasas JC, Fuster J, Visa J, Pera C. Dysphagia and esophageal motor dysfunction in gastroesophageal reflux are corrected by fundoplication. *J Clin Gastroenterol* 1991;13:11-16.
25. Hunter JG, Trus TL, Branum GD, Waring JP, Wood WC. A physiologic approach to laparoscopic fundoplication for gastroesophageal reflux disease. *Ann Surg* 1996;223:673-685.
26. Martinez de Haro L, Parrilla P, Ortiz MA, Morales G, Videla D, Cifuentes J, Garay V. Antireflux mechanism of Nissen fundoplication. A manometric study. *Scand J Gastroenterol* 1992;27:417-420.
27. Martinez de Haro LF, Ortiz A, Parrilla P, Garcia Marcilla JA, Aguayo JL, Morales G. Long-term results of Nissen fundoplication in reflux esophagitis without strictures. Clinical, endoscopic, and pH-metric evaluation. *Dig Dis Sci* 1992;37:523-527.
28. Armstrong D, Bennett JR, Blum AL, Dent J, De Dombal FT, Galmiche JP, Lundell L, Margulies M, Richter JE, Spechler SJ, Tytgat GN, Wallin L. The endoscopic assessment of esophagitis: A progress report on observer agreement. *Gastroenterology* 1996;111:85-92.
29. Grande L, Culell P, Ros E, Lacima G, Pujol A, Garcia-Valdecasas JC, Fuster J, Visa J, Pera C. Comparison of stationary vs ambulatory 24-hour pH monitoring systems in diagnosis of gastroesophageal reflux disease. *Dig Dis Sci* 1993;38:213-219.
30. Grande L, Toledo-Pimentel V, Manterola C, Lacima G, Ros E, Garcia-Valdecasas JC, Fuster J, Visa J, Pera C. Value of Nissen fundoplication in patients with gastro-oesophageal reflux judged by long-term symptom control. *Br J Surg* 1994;81:548-550.
31. Ludemann R, Watson DI, Jamieson GG, Game PA, Devitt PG. Five-year follow-up of a randomized clinical trial of laparoscopic total versus anterior 180 degrees fundoplication. *Br J Surg* 2005;92:240-243.
32. Contini S, Bertele A, Nervi G, Zinicola R, Scarpignato C. Quality of life for patients with gastroesophageal reflux disease 2 years after laparoscopic fundoplication. Evaluation of the results obtained during the initial experience. *Surg Endosc* 2002;16:1555-1560.
33. Jailwala J, Massey B, Staff D, Shaker R, Hogan W. Post-fundoplication symptoms: The role for endoscopic assessment of fundoplication integrity. *Gastrointest Endosc* 2001;54:351-356.
34. Chrysos E, Tsiaoussis J, Zoras OJ, Athanasakis E, Mantides A, Katsamouris A, Xynos E. Laparoscopic surgery for gastroesophageal reflux disease patients with impaired esophageal peristalsis: Total or partial fundoplication? *J Am Coll Surg* 2003;197:8-15.
35. Soper NJ, Dunnegan D. Anatomic fundoplication failure after laparoscopic antireflux surgery. *Ann Surg* 1999;229:669-676.