Chapter 5
Gastroesophageal Reflux Disease: Treatment

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Abstract A laparoscopic total fundoplication has become the gold standard for the surgical treatment of gastroesophageal reflux disease. Short-term outcomes are excellent, with lower perioperative morbidity and faster recovery than conventional open total fundoplication. Long-term follow-up studies have shown similar symptom control between the two approaches. A laparoscopic partial fundoplication is performed in selected patients to reduce the incidence of postoperative dysphagia and gas-related symptoms. The sphincter augmentation device, a new minimally invasive antireflux procedure, has been recently proposed as an alternative to laparoscopic fundoplication.

Keywords Gastroesophageal reflux disease • Total fundoplication • Partial anterior fundoplication • Partial posterior fundoplication • Sphincter augmentation device

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Conflict of Interest
The authors have no conflicts of interest to declare.

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P.M. Fisichella et al. (eds.), *Esophageal Diseases*,
DOI 10.1007/978-3-319-04337-1_5,

Introduction

Treatment options for GERD include medical therapy, such as proton pump inhibitors (PPIs) and H_2-blockers, and laparoscopic fundoplication. However, antisecretory medications improve or eliminate heartburn by changing the pH of the gastric refluxate, but they do not stop reflux. Laparoscopic fundoplication stops any type of reflux by restoring the competence of the lower esophageal sphincter (LES), decreasing the number of transient LES relaxations, and improving quality of esophageal peristalsis.

The last 20 years have witnessed a shift in the treatment of gastroesophageal reflux disease (GERD). While in the past the main indication for antireflux surgery was the absence of a good response to antisecretory medications, currently the best indication for surgery is instead a good control of symptoms with PPIs.

A laparoscopic total fundoplication (LTF) is considered today the gold standard for the surgical treatment of GERD, with better short-term outcomes and similar reflux control compared to open fundoplication. Control of reflux is not influenced by both pattern of reflux (i.e., upright versus supine) and patient's age. However, a small but significant incidence of postoperative dysphagia and gas-related symptoms is reported after this procedure. A laparoscopic partial fundoplication (LPF) has been proposed to minimize these side effects. However, the long-term outcomes are controversial, since some randomized clinical trials, mainly from Australia, found similar reflux control but higher incidence of dysphagia and gas-related symptoms after LTF, while several studies from the United States reported similar dysphagia rates after the two procedures, but a better reflux control after LTF.

The sphincter augmentation device (MSA) with the LINX Reflux Management System (Torax Medical) is a new minimally invasive antireflux procedure that has been recently proposed as alternative to laparoscopic fundoplication.

This chapter will review the current status of treatment of GERD, describing our surgical technique and focusing on surgical outcomes of both laparoscopic fundoplication and MSA.

Medical Therapy

PPIs are the main stem of medical therapy. These medications have been proved to be the most effective medical treatment for GERD in terms of esophagitis healing and symptom relief. However, esophagitis and symptoms tend to recur after discontinuation of therapy, and increasing doses to maintain healing of esophagitis are required in about 50 % of patients on maintenance PPIs.

Wileman et al. have recently published a meta-analysis of randomized or quasi-randomized controlled trials comparing medical management to laparoscopic fundoplication for GERD in adults. They found that laparoscopic fundoplication is more effective than medical therapy in improving symptoms and quality of life in the short to medium term.

While surgery aims to restore the competence of the LES, acid-suppressing medications can only modify the pH of the gastric refluxate. However, reflux still occurs because of an incompetent LES and ineffective esophageal peristalsis. In addition, medical therapy is largely ineffective for the treatment of the extra-esophageal manifestations of GERD due to the upward extension of the refluxate. Finally, PPIs can interfere with calcium absorption causing osteoporosis and fractures and cause C. difficile infection and abnormal cardiac activity due to decreased magnesium levels.

Surgical Treatment

Indications for Antireflux Surgery

(a) Pathologic gastroesophageal reflux documented by 24-h ambulatory pH monitoring and/or combined multichannel intraluminal impedance and pH testing (MII-pH)
(b) Heartburn and regurgitation not completely controlled by medications
(c) Respiratory symptoms thought to be induced by gastroesophageal reflux
(d) Desire of the patient to stop chronic use of PPI
(e) Poor patient's compliance with medical treatment
(f) Cost of medical therapy
(g) Development of osteoporosis
(h) C. difficile infections, pneumonia, or hypomagnesemia
(i) Young patients in whom life-long medical treatment is not advisable

Laparoscopic Total Fundoplication

Positioning of the Patient on the Operating Table

- The patient lies supine on the operating table in low lithotomy position with the lower extremities extended on stirrups with knees flexed 20–30°.
- A bean bag is inflated to avoid sliding of the patient as a consequence of the steep reverse Trendelenburg position used during the entire procedure.
- Pneumatic compression stockings are used to reduce the risk of deep venous thrombosis that is associated with both increased abdominal pressure secondary to pneumoperitoneum and the decreased venous return secondary to the steep reverse Trendelenburg position.
- An orogastric tube is placed to decompress the stomach, and it is removed at the end of the procedure.
- The surgeon stands between the patient's legs, while the first and second assistant stand on the right and left side of operative table, respectively (Fig. 5.1).

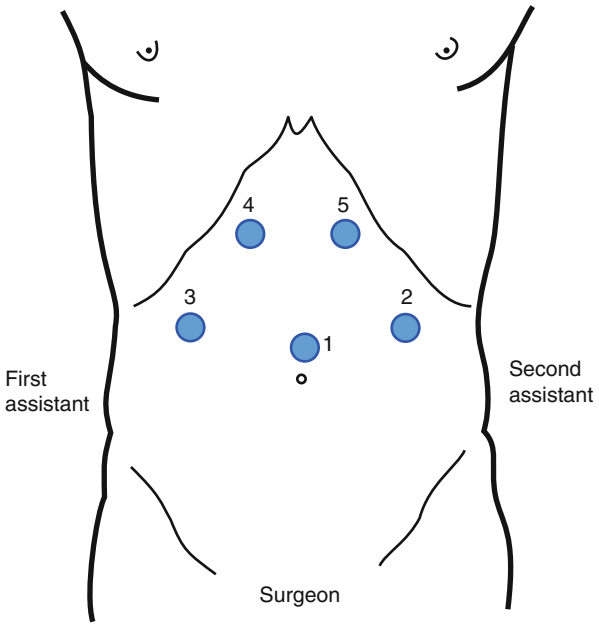

Fig. 5.1 Trocars' placement. Trocar *1* 30° camera, Trocar *2* Babcock clamp, Trocar *3* liver retractor, Trocar *4* and *5* dissection and suturing instruments

Table 5.1 Instrumentation for laparoscopic fundoplication

Five 10-mm ports
0° and 30° scope
Graspers and needle holder
Babcock clamp
L-shaped hook cautery with suction-irrigation capacity
Scissors
Laparoscopic clip applier
Electrothermal bipolar vessel sealing system
Liver retractor
Suturing device
2-0 silk sutures
Penrose drain
56 French esophageal bougie

Instrumentation for Laparoscopic Fundoplication

The instruments that are required for the procedure are listed in Table 5.1.

Step 1: Placement of trocars

- A five-trocar technique is used for the procedure (Fig. 5.1).
- Trocar 1 is placed 14 cm inferior to the xiphoid process, in the midline or 1–2 cm to the left of the midline to be in line with the esophagus. Extreme care must be taken when positioning this trocar, since the insertion site is just above the aorta and its bifurcation. In order to increase the distance between the abdominal wall

and the aorta, therefore reducing the risk of vessel injuries, the abdomen is initially inflated by using a Veress needle to a pressure of 15 mmHg. Then, an optical port with a 0° scope is placed under direct vision. Once this port is placed, the 0° scope is replaced with a 30° scope, and the other trocars are inserted under laparoscopic vision.

- Trocar 2 is placed in the left midclavicular line at the same level with trocar 1, and it is used for insertion of a Babcock clamp, for a grasper to hold the Penrose drain placed around the esophagus, or for devices used to divide the short gastric vessels.
- Trocar 3 is placed in the right midclavicular line at the same level of the other two trocars, and it is used for the insertion of a retractor to lift the left lateral segment of the liver.
- Trocars 4 and 5 are placed under the right and left costal margins, so that their axes form an angle of about 120° with the camera. They are used for the dissecting and suturing instruments.

Step 2: Division of gastrohepatic ligament; identification of right crus of the diaphragm and posterior vagus nerve

- The gastrohepatic ligament is divided, beginning above the caudate lobe of the liver, where the ligament is usually very thin, until the right crus of the diaphragm is identified. An accessory left hepatic artery originating from the left gastric artery is frequently present in the gastrohepatic ligament. It may be divided with no clinical consequences if this vessel limits the exposure.
- The right crus is separated from the right side of the esophagus by blunt dissection, the posterior vagus nerve is identified, and the right crus is dissected inferiorly toward the junction with the left crus. The use of a bipolar instrument allows to perform a safer right crus dissection than the electrocautery, with a reduced risk of injury to the posterior vagus nerve due to the lateral spread of the monopolar current.

Step 3: Division of peritoneum and phreno-esophageal membrane above the esophagus; identification of the left crus of diaphragm and anterior vagus nerve

The peritoneum and the phreno-esophageal membrane above the esophagus are transected with the electrocautery, with identification of the anterior vagus nerve. To avoid injury to the anterior vagus nerve or the esophageal wall, the nerve should be left attached to the esophageal wall, and the peritoneum and the phreno-esophageal membrane should be lifted from the wall by blunt dissection before they are divided.

- The left crus of the diaphragm is dissected bluntly downward toward the junction with the right crus.

Step 4: Division of short gastric vessels

The short gastric vessels are taken down all the way to the left pillar of the crus, starting at the level of the middle portion of the gastric body and continuing upward until the most proximal short gastric vessel is divided.

Possible complications during this step of the procedure are bleeding, either from the short gastric vessels or from the spleen, and damage to the gastric wall.

Step 5: Creation of a window between gastric fundus, esophagus, and diaphragmatic crura; placement of Penrose drain around the esophagus

- A Babcock clamp is applied at the level of the esophagogastric junction and the esophagus is retracted upward.
- A window is opened by a blunt and sharp dissection under the esophagus, between the gastric fundus, the esophagus, and the left pillar of the crus.
- The window is then enlarged, and a Penrose drain is passed around the esophagus, incorporating both the anterior and the posterior vagus nerves.

The two main complications that can occur during this part of the procedure are:

1. Creation of a left pneumothorax
2. Perforation of the gastric fundus

Step 6: Closure of crura

- Interrupted 2-0 silk sutures are tied intracorporeally to close the diaphragmatic crura.
- Retraction of the esophagus upward and toward the patient's left with the Penrose drain is essential to provide proper exposure.
- The first stitch should be placed just above the junction of the two pillars.
- Additional stitches are placed 1 cm apart, and a space of about 1 cm is left between the uppermost stitch and the esophagus.

Step 7: Insertion of the bougie into esophagus and across the esophageal junction

- After removal of the orogastric tube, a lubricated 56 French bougie is inserted down the esophagus through the esophagogastric junction by the anesthesiologist. Lubrication of the bougie and slow advancement of the bougie reduce the risk of esophageal perforation.
- The crura must be snug around the esophagus but not too tight: a closed grasper should slide easily between the esophagus and the crura.

Step 8: Wrapping of gastric fundus around the lower esophagus

- The surgeon gently pulls the gastric fundus under the esophagus with two graspers. The use of atraumatic graspers during this step of the procedure reduces the risk of damage to the gastric wall. Delivering the fundus under the esophagus and checking for the origins of the transected short gastric vessels help evaluate whether the wrap is going to be floppy. If the wrap remains to the right side of the esophagus and does not retract back to the left, then it is floppy and suturing can be performed. If not, the surgeon must make sure that the upper short gastric vessels have been transected and the posterior dissection completed.
- The left and right sides of the fundus are wrapped above the esophagogastric junction. A Babcock clamp introduced through trocar 2 is used to hold the two flaps together during placement of the first stitch.
- The two edges of the wrap are secured to each other by three 2-0 silk placed at 1 cm of distance from each other (Fig. 5.2).

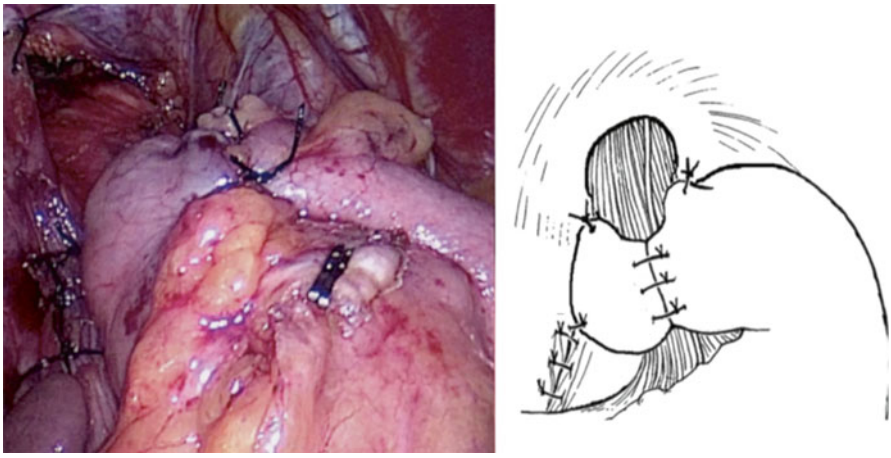

Fig. 5.2 Total fundoplication

- The wrap should be long no more than 2–2.5 cm.

Step 9: Final inspection, removal of instruments and trocars from the abdomen, and closure of the port sites

The instruments and the trocars are removed from the abdomen under direct vision, and the trocars sites are closed.

Laparoscopic Partial Fundoplication

The first six steps are identical to those of a LTF.

(a) *Partial posterior fundoplication*

- The delivered gastric fundus is gently pulled under the esophagus using two graspers.
- Three 2-0 silk sutures are placed on each side of the wrap between the muscular layers of the esophageal wall and the gastric fundus, leaving 80–120° of the anterior esophageal wall uncovered.
- Two coronal stitches are placed between the top of the wrap, the esophagus, and the right or left pillar of the crus.
- One additional stitch is placed between the right side of the wrap and the closed crura.
- The resulting wrap measures about 240–280° (Fig. 5.3).

(b) *Partial anterior fundoplication*

- It is a 180° anterior fundoplication.
- Two rows of sutures (2-0 silk) are used. The first row is on the left side of the esophagus and consists of three stitches. The top stitch incorporates the

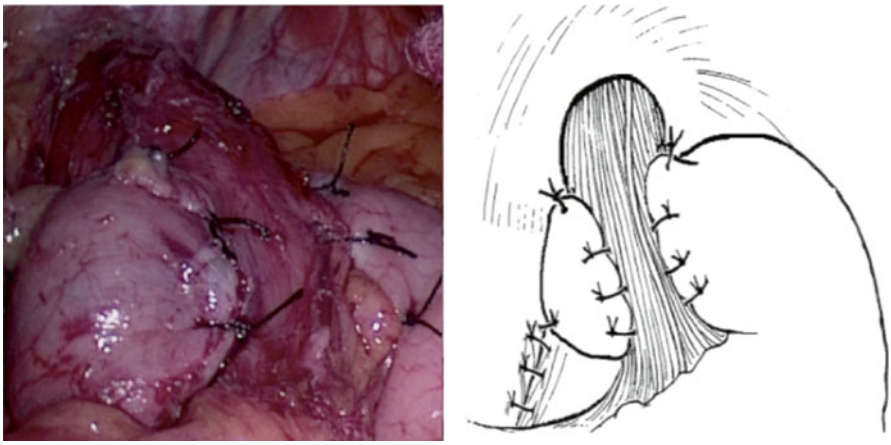

Fig. 5.3 Partial posterior fundoplication

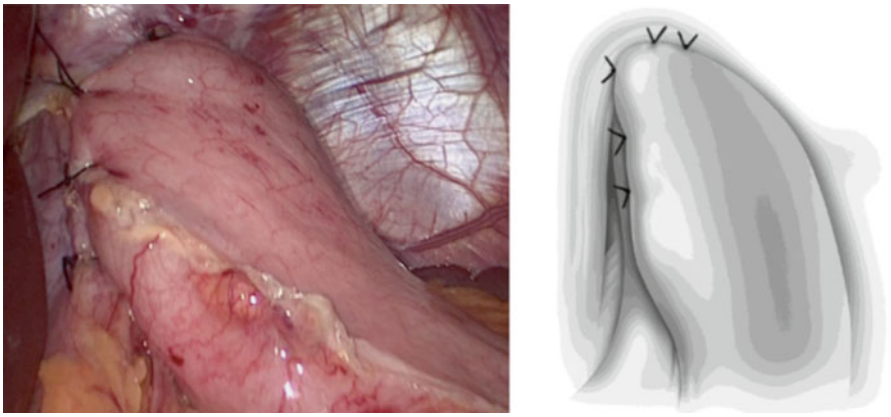

Fig. 5.4 Partial anterior fundoplication

fundus of the stomach, the left side of the esophageal wall, and the left pillar of the crus. The second and third stitches incorporate the gastric fundus and the muscular layer of the left side of the esophagus.

- The fundus is then folded over the esophagus so that the greater curvature of the stomach is next to the right pillar of the crus.
- The second row of sutures on the right side of the esophagus consists of three stitches between the fundus and the right pillar of the crus.
- Finally, two additional stitches are placed between the fundus and the rim of the esophageal hiatus to eliminate any tension from the fundoplication (Fig. 5.4).

Postoperative Course

- Patients start a soft diet the morning of the first postoperative day.
- Patients are instructed to avoid meat, bread, and carbonated beverages for the following 2 weeks.
- About 85 % of patients are discharged within 23 h, and 95 % of patients are discharged within 48 h.
- Most patients resume their regular activity within 2 weeks.

Postoperative Complications

- Esophageal or gastric perforation may occur during any step of the dissection and is secondary to traction or inadvertent electrocautery burns.
- Clinical signs of a leak usually appear during the first 48 h with peritoneal signs in case of spillage limited to the abdomen or shortness of breath and a pleural effusion if spillage also occurs in the chest.
- A contrast study with a water-soluble contrast agent is necessary to detect the site of the leak.
- A reoperation with direct repair is the optimal management of the leak.

Short-Term Outcomes

Some degree of transient dysphagia is very common after LTF. If dysphagia persists beyond 6–10 weeks, one or more of the following causes should be considered:

1. A too tight or too long (i.e., >2.5 cm) wrap. In case of a too tight wrap, the treatment modality of choice is endoscopic dilatation; redo surgery should be considered in case of failure of endoscopic treatment.
2. Lateral torsion of the wrap to the right with corkscrew effect secondary to tension from intact short gastric vessels or to a small gastric fundus.
3. A wrap made with the body of the stomach rather than the fundus.
4. Choice of the wrong procedure. A partial wrap is preferable in case of severely impaired or absent esophageal peristalsis, reducing the incidence of postoperative dysphagia and gas bloat syndrome.

Long-Term Outcomes: Laparoscopic Total or Partial Fundoplication?

An LPF (posterior, 180° anterior, and 90° anterior) has been proposed as an alternative to LTF to minimize or prevent postoperative dysphagia and gas-related symptoms.

Anterior (180° and 90°) LPF vs. LTF

Some randomized controlled trials (RCTs) have compared LTF to an anterior 180° or 90° LPF. Based on the evidence currently available, there are no differences in incidence of heartburn and use of PPIs after anterior 180° LPF and LTF, while they are higher after 90° anterior LPF than LTF at 5-year follow-up. Dysphagia is less common after LPF (180° and 90° anterior) than LTF at 5 years after surgery. The long-term outcomes at 10-year follow-up are similar.

These results should be interpreted with caution, since 24-h pH monitoring was not used in these studies to objectively assess the incidence of gastroesophageal reflux at long-term follow-up. It is known that ambulatory 24-h pH monitoring is positive for pathological gastroesophageal reflux in less than 40 % of patients with recurrent heartburn. On the other hand, 5-year follow-up studies have shown that LPF achieves a less effective control of reflux than LTF, with recurrent reflux detected by pH monitoring in more than 50 % of patients after LPF.

Posterior LPF vs. LTF

The effect of a posterior LPF as an alternative to LTF has been investigated in terms of incidence of postoperative dysphagia and wind-related symptoms. Based on the results of several RCTs, similar control of reflux and overall patient satisfaction are achieved after the two procedures. Postoperative dysphagia, inability to belch, gas bloating, need for endoscopic dilatations, or surgical reoperations are more common after LTF. However, these initial mechanical advantages seem to disappear over time.

The interpretation of these data may be biased by the short-follow-up, small sample sizes of the studies and lack of postoperative objective evaluation of reflux with 24-h pH monitoring. Indeed, the results of large comparative studies suggest poorer long-term control of reflux after partial LPF.

LPF: Anterior or Posterior?

Based on the similar reflux control and reduced postoperative dysphagia after LPF, Hagedorn et al. randomized 47 patients to an anterior 120° LPF and 48 patients to a posterior (Toupet) LPF. Reflux control was significantly better at 24-h pH monitoring after posterior LPF. Postoperative dysphagia and ability to belch were similar between the two groups.

In conclusion, an LTF is the procedure of choice for the surgical treatment of GERD, while an LPF (either anterior 180° or posterior) should be performed only in patients with severe impairment of peristalsis and in patients with achalasia.

Laparoscopic Magnetic Sphincter Augmentation (MSA)

Recently, magnetic sphincter augmentation (MSA) with the LINX Reflux Management System (Torax Medical) is a minimally invasive operation that increases the sphincter barrier with a standardized, reproducible, and reversible laparoscopic procedure, without altering the gastric anatomy. The device consists of a series of magnetic beads interlinked with independent titanium wires that create a dynamic flexible and expandable ring mimicking the physiological movement of the esophagus. Main indications are GERD confirmed by 24-h ambulatory pH monitoring and incomplete symptom relief despite maximum medical therapy.

The results of two single-institution studies show that the laparoscopic implantation of MSA is easy and safe. Postoperatively, the esophageal acid exposure decreases, reflux symptoms improve, and the majority of patients stop PPIs. However, only large RCTs with long follow-up comparing MSA and laparoscopic fundoplication will clarify the role of this device in the treatment of GERD.

Summary

- PPIs are the main stem of medical therapy.
- Acid-suppressing medications can only modify the pH of the gastric refluxate, while surgery restores the competence of the LES.
- A laparoscopic total fundoplication is considered today the gold standard for the surgical treatment of GERD, with better short-term outcomes and similar reflux control compared to open fundoplication.
- A small but significant incidence of postoperative dysphagia and gas-related symptoms is reported after LTF.
- A LPF (either anterior 180° or posterior) should be performed only in patients with GERD with severe impairment of peristalsis and in patients with achalasia.
- Magnetic sphincter augmentation (MSA) is a new minimally invasive operation that increases the sphincter barrier without altering the gastric anatomy.

Selected Reading

1. Baigrie RJ, Cullis SNR, Ndhluni AJ, Cariem A. Randomized double-blind trial of laparoscopic Nissen fundoplication versus anterior partial fundoplication. Br J Surg. 2005;92:819–23.
2. Bonavina L, Saino G, Lipham JC, Demeester TR. LINX(®) Reflux Management System in chronic gastroesophageal reflux: a novel effective technology for restoring the natural barrier to reflux. Therap Adv Gastroenterol. 2013;6:261–8.
3. Bonavina L, Saino G, Bona D, Sironi A, Lazzari V. One hundred consecutive patients treated with magnetic sphincter augmentation for gastroesophageal reflux disease: 6 years of clinical experience from a single center. J Am Coll Surg. 2013;217:577–85.

4. Broeders JA, Rijnhart-de Jong HG, Draaisma WA, Bredenoord AJ, Smout AJ, Gooszen HG. Ten-year outcome of laparoscopic and conventional nissen fundoplication: randomized clinical trial. Ann Surg. 2009;250:698–706.
5. Broeders JAJL, Mauritz FA, Ahmed Ali U, Draaisma WA, Ruurda JP, Gooszen HG, Smout AJ, Broeders IA, Hazebroek EJ. Systematic review and meta-analysis of laparoscopic Nissen (posterior total) versus Toupet (posterior partial) fundoplication for gastro-oesophageal reflux disease. Br J Surg. 2010;97:1318–30.
6. Broeders JA, Broeders EA, Watson DI, Devitt PG, Holloway RH, Jamieson GG. Objective outcomes 14 years after laparoscopic anterior 180-degree partial versus Nissen fundoplication: results from a randomized trial. Ann Surg. 2013;258:233–9.
7. Cai W, Watson DI, Lally CJ, Devitt PG, Game PA, Jamieson GG. Ten-year clinical outcomes of a prospective randomized clinical trial of laparoscopic Nissen versus anterior 180° partial fundoplication. Br J Surg. 2008;95:1501–5.
8. Dallemagne B, Weerts J, Markiewicz S, Dewandre JM, Wahlen C, Monami B, Jehaes C. Clinical results of laparoscopic fundoplication at ten years after surgery. Surg Endosc. 2006; 20:159–65.
9. Engström C, Lönroth H, Mardani J, Lundell L. An anterior or posterior approach to partial fundoplication? Long-term results of a randomized trial. World J Surg. 2007;31:1221–5.
10. Galvani C, Fisichella PM, Gorodner MV, Perretta S, Patti MG. Symptoms are a poor indicator of reflux status after fundoplication for gastroesophageal reflux disease: role of esophageal functions tests. Arch Surg. 2003;138:514–8.
11. Ganz RA, Peters JH, Horgan S, Bemelman WA, Dunst CM, Edmundowicz SA, Lipham JC, Luketich JD, Melvin WS, Oelschlager BK, Schlack-Haerer SC, Smith CD, Smith CC, Dunn D, Taiganides PA. Esophageal sphincter device for gastroesophageal reflux disease. N Engl J Med. 2013;368:719–27.
12. Hagedorn C, Jönson C, Lönroth H, Ruth M, Thune A, Lundell L. Efficacy of an anterior as compared with a posterior laparoscopic partial fundoplication: results of a randomized, controlled clinical trial. Ann Surg. 2003;238:189–96.
13. Herbella FA, Tedesco P, Nipomnick I, Fisichella PM, Patti MG. Effect of partial and total laparoscopic fundoplication on esophageal body motility. Surg Endosc. 2007;21:285–8.
14. Horgan S, Pohl D, Bogetti D, Eubanks T, Pellegrini CA. Failed antireflux surgery. What have we learned from reoperations? Arch Surg. 1999;134:809–17.
15. Horvath KD, Jobe BA, Herron DM, Swanstrom LL. Laparoscopic Toupet fundoplication is an inadequate procedure for patients with severe reflux disease. J Gastrointest Surg. 1999;3: 583–91.
16. Khajanchee YS, O'Rourke RW, Lockhart B, Patterson EJ, Hansen PD, Swanstrom LL. Postoperative symptoms and failure after antireflux surgery. Arch Surg. 2002;137:1008–14.
17. Lord RV, Kaminski A, Oberg S, Bowrey DJ, Hagen JA, DeMeester SR, Sillin LF, Peters JH, Crookes PF, DeMeester TR. Absence of gastroesophageal reflux disease in a majority of patients taking acid suppression medications after Nissen fundoplication. J Gastrointest Surg. 2002;6:3–9.
18. 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° fundoplication. Br J Surg. 2005;92:240–3.
19. Makris KI, Cassera MA, Kastenmeier AS, Dunst CM, Swanström LL. Postoperative dysphagia is not predictive of long-term failure after laparoscopic antireflux surgery. Surg Endosc. 2012;26:451–7.
20. Meneghetti AT, Tedesco P, Galvani C, Gorodner MV, Patti MG. Outcomes after laparoscopic Nissen fundoplication are not influenced by the pattern of reflux. Dis Esophagus. 2008;21:165–9.
21. Morgenthal CB, Shane MD, Stival A, Gletsu N, Milam G, Swafford V, Hunter JG, Smith CD. The durability of laparoscopic Nissen fundoplication: 11-year outcomes. J Gastrointest Surg. 2007;11:693–700.
22. Nijjar RS, Watson DI, Jamieson GG, Archer S, Bessell JR, Booth M, Cade R, Cullingford GL, Devitt PG, Fletcher DR, Hurley J, Kiroff G, Martin IJ, Nathanson LK, Windsor JA. International

Society for the Diseases of the Esophagus-Australasian Section. Five-year follow-up of a multicenter, double-blind randomized clinical trial of laparoscopic Nissen vs anterior 90 degrees partial fundoplication. Arch Surg. 2010;145:552–7.
23. Oleynikov D, Eubanks TR, Oelschlager BK, Pellegrini CA. Total fundoplication is the operation of choice for patients with gastroesophageal reflux and defective peristalsis. Surg Endosc. 2002;16:909–13.
24. Patterson EJ, Herron DM, Hansen PD, Ramzi N, Standage BA, Swanström LL. Effect of an esophageal bougie on the incidence of dysphagia following Nissen fundoplication: a prospective, blinded, randomized clinical trial. Arch Surg. 2000;135:1055–61.
25. Patti MG, Arcerito M, Feo CV, De Pinto M, Tong J, Gantert W, Tyrrell D, Way LW. An analysis of operations for gastroesophageal reflux disease. Identifying the important technical elements. Arch Surg. 1998;133:600–6.
26. Patti MG, Robinson T, Galvani C, Gorodner MV, Fisichella PM, Way LW. Total fundoplication is superior to partial fundoplication even when esophageal peristalsis is weak. J Am Coll Surg. 2004;198:863–9.
27. Patti MG, Gasper WJ, Fisichella PM, Nipomnick I, Palazzo F. Gastroesophageal reflux disease and connective tissue disorders: pathophysiology and implications for treatment. J Gastrointest Surg. 2008;12:1900–6.
28. Spence GM, Watson DI, Jamiesion GG, Lally CJ, Devitt PG. Single center prospective randomized trial of laparoscopic Nissen versus anterior 90 degrees fundoplication. J Gastrointest Surg. 2006;10:698–705.
29. Tedesco P, Lobo E, Fisichella PM, Way LW, Patti MG. Laparoscopic fundoplication in elderly patients with gastroesophageal reflux disease. Arch Surg. 2006;141:289–92.
30. Thompson SK, Jamieson GG, Myers JC, Chin KF, Watson DI, Devitt PG. Recurrent heartburn after laparoscopic fundoplication is not always recurrent reflux. J Gastrointest Surg. 2007;11:642–7.
31. Watson DI, Jamieson GG, Pike GK, Davies N, Richardson M, Devitt PG. Prospective randomized double-blind trial between laparoscopic Nissen fundoplication and anterior partial fundoplication. Br J Surg. 1999;86:123–30.
32. 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 CJ, Martin IJ, Nathanson LK, Windsor JK. International Society for Diseases of the Esophagus–Australasian Section. Multicenter, prospective, double-blind, randomized trial of laparoscopic Nissen vs. anterior 90 degrees partial fundoplication. Arch Surg. 2004;139:1160–7.
33. Watson DI, Devitt PG, Smith L, Jamieson GG. Anterior 90° partial vs Nissen fundoplication–5 year follow-up of a single-centre randomised trial. J Gastrointest Surg. 2012;16:1653–8.