Chapter 1
Laparoscopic Fundoplication

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1.1 Introduction

Gastroesophageal reflux disease (GERD) is a frequent disorder worldwide, especially in developed countries. In the United States, it is estimated that around 20% of the adult population is affected by GERD, with increasing incidence rates in the last decades mostly due to the epidemic of obesity [1]. The economic impact of this disease is alarming, with direct health care costs of approximately $10 billion per year (being proton pump inhibitors (PPI) the largest contributors to these expenses) [2, 3].

The main purpose of treatment of GERD is to control symptoms, improve patients' quality of life, and prevent GERD-related complications such as bleeding, esophageal stenosis, Barrett's esophagus and/or esophageal adenocarcinoma.The vast majority of patients respond adequately to lifestyle modifications and PPI. A small percentage of patients, however, are candidates for antireflux surgery due to the following reasons: partial control of symptoms (e.g. regurgitation or cough) with medication, presence of large hiatal hernia, poor patients 'compliance with medical therapy, refusal to be on long-term medical treatment, or complications related to medical therapy [4].

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A careful patient selection, a complete preoperative work-up, and a properly executed operation are key for the success of antireflux surgery [5–7].

1.2 Clinical Presentation

Heartburn, regurgitation, and dysphagia are considered typical symptoms of GERD. In addition to the typical symptoms, patients with GERD can present with atypical symptoms such as cough, wheezing, chest pain or hoarseness. These symptoms represent extraesophageal presentations of the disease, including respiratory disorders such as asthma, as well as ear, nose, and throat abnormalities such as laryngitis. As a clinical diagnosis of GERD based on symptoms is often incorrect, a complete diagnostic work-up is necessary in patients undergoing antireflux surgery.

1.3 Preoperative Work-up

Besides a complete history and physical evaluation, several tests should be performed preoperatively:

Upper endoscopy: An upper endoscopy is often the first test used to determine the severity of esophagitis (Table 1.1). The endoscopy is also useful for diagnosing GERD-related complications such as strictures, Barrett´s esophagus or cancer, and may exclude other pathologies such as eosinophilic esophagitis, gastritis or peptic ulcer.

Barium esophagram: This test does not provide objective evidence of GERD but rather provides valuable anatomical information (i.e. presence and size of hiatal hernia, degree of esophageal shortening and presence of a diverticulum or strictures).

Esophageal manometry: Although the esophageal manometry has limited valued for the diagnosis of GERD, it plays an important role during the preoperative evaluation of these patients for three reasons: (a) it is necessary for the correct placement of the pH monitoring probe (5 cm above the upper border of the lower esophageal sphincter); (b) rules out primary esophageal motility disorders (mainly achalasia) that present with similar symptoms to those with GERD; (c) helps tailoring the type of fundoplication (total vs. partial) based on the peristaltic coordination and contractile force of the esophageal body.

Table 1.1 Los Angeles classification of esophagitis

Los Angeles classification of esophagitis	
Grade A	Mucosal breaks ≤ 5 mm long, none of which extends between the tops of the mucosal folds
Grade B	Mucosal breaks > 5 mm long, none of which extends between the tops of two mucosal folds
Grade C	Mucosal breaks that extend between the tops of ≥ 2 mucosal folds, but which involve < 75% of the esophageal circumference
Grade D	Mucosal breaks which involve ≥ 75% of the esophageal circumference

Ambulatory pH monitoring: This study is the gold standard for the diagnosis of GERD because it objectively determines pathologic acid exposure and correlates specific symptoms with episodes of reflux. Acid suppression medications should be discontinued before the test (H2 blocking agents for 3 days and PPIs for 7 days).

1.4 Surgical Technique

1.4.1 Positioning of the Patient and Surgical Team

After induction of general endotracheal anesthesia, an orogastric tube is inserted by the anesthesiologist to keep the stomach decompressed. The patient is positioned supine in low lithotomy position with the lower extremities extended on stirrups, with knees flexed 20°–30°. The surgeon stands between the patient's legs, and the first and second assistants on the left and right side of the operating table, respectively (Fig. 1.1).

Troubleshooting: Pneumatic compression stockings are always used as prophylaxis against deep vein thrombosis because the increased abdominal pressure secondary to the pneumoperitoneum and the steep Trendelenburg position required during the procedure decrease venous return.

1.4.2 Trocar Placement

A total of five 10 mm ports are used for the operation. The 1st port is placed in the midline or slightly to the left of the midline, about 14 cm below the xiphoid process. This port is used for insertion of the scope. The 2nd and 3rd ports are placed under the right and left costal margins so that their axes and the scope form an angle of about 120° (these ports are used for dissecting and suturing instruments). The 4th port is placed in the right midclavicular line at the same level of the 1st (this port is used for the liver retractor). The 5th port is placed in the left midclavicular line at the same level of the 1st (mainly used by the first assistant) (Fig. 1.2).

Troubleshooting: Care must be taken when introducing the first port in the supraumbilical area because this site is just above the aorta and its bifurcation. We recommend using an optical trocar to obtain access. A common mistake is to place the trocars too low, which can make the operation more difficult.

1.4.3 Division of the Gastrohepatic Ligament

Once the left segment of the liver is retracted, the gastrohepatic ligament is divided starting above the caudate lobe of the liver towards the right crus (Fig. 1.3). The right crus is then separated from the lateral aspect of the esophagus with blunt

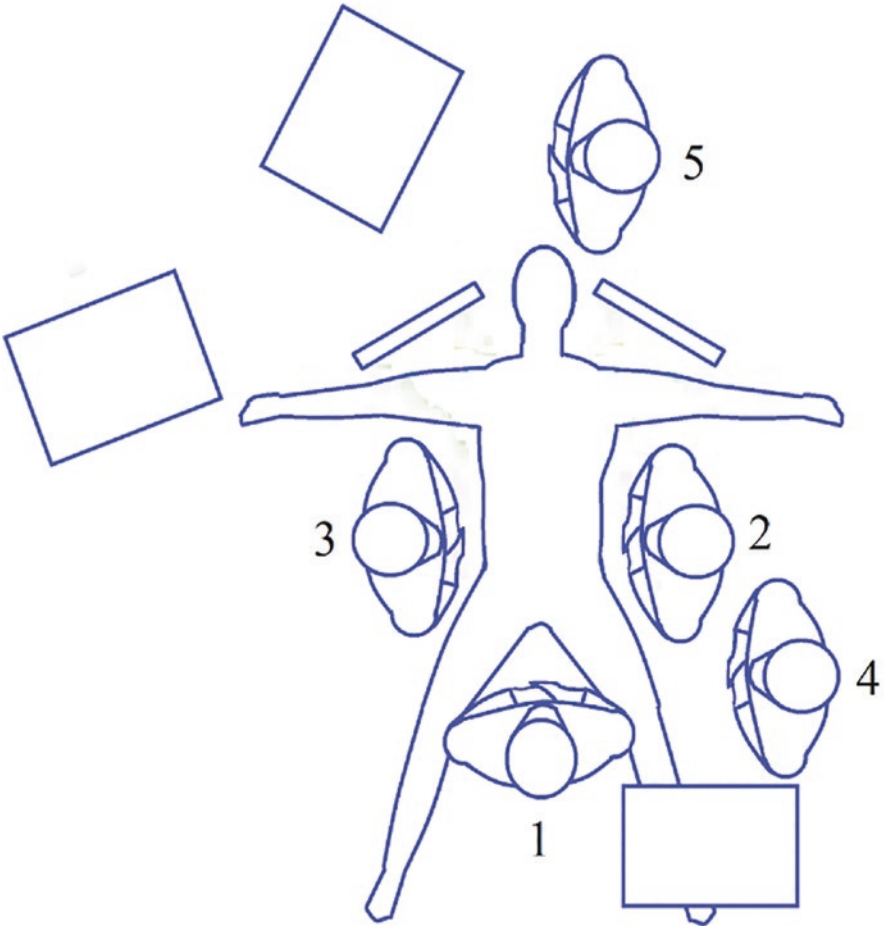

Fig. 1.1 Positioning of the patient and surgical team. (1) surgeon, (2) first assistant, (3) second assistant, (4) scrub nurse, and (5) anesthesiologist

maneuvers and the posterior vagus nerve is identified. The right crus should be dissected all the way down towards the junction with the left crus (Fig. 1.4).

Troubleshooting: An accessory left hepatic artery originating from the left gastric artery may be encountered during this step of the procedure. If this vessel limits the exposure, it can usually be safely divided.

1.4.4 Division of the Phrenoesophageal Membrane

The phrenoesophageal membrane is incised and divided with electrocautery above the esophagus (Fig. 1.5). The anterior vagus is identified and left attached to the esophageal wall. The left pillar of the crus is separated from the esophagus, and dissected bluntly downward toward the junction with the right crus.

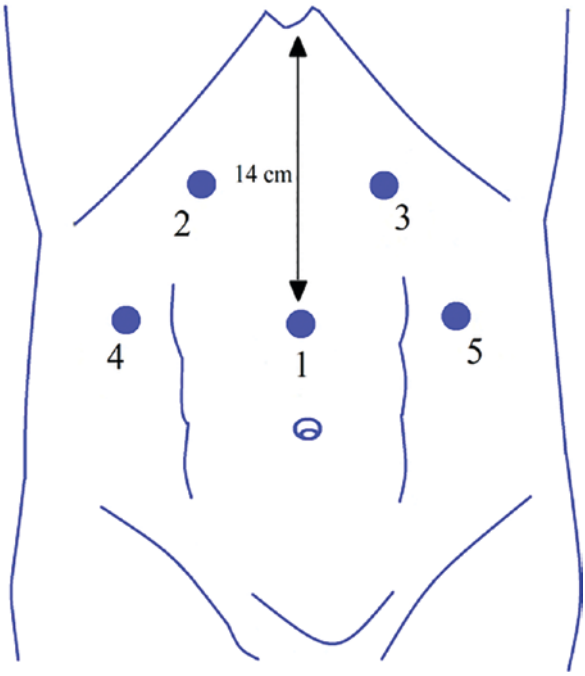

Fig. 1.2 Ports placement for laparoscopic fundoplication

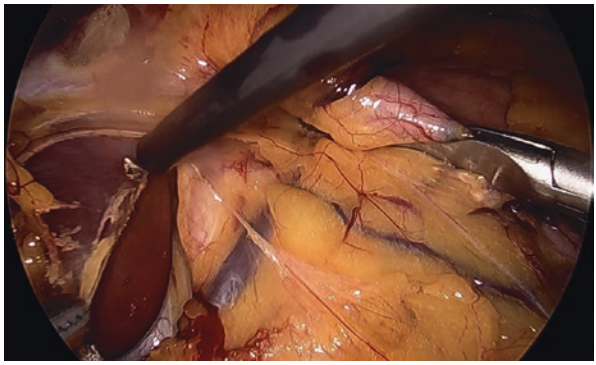

Fig. 1.3 Division of the gastrohepatic ligament

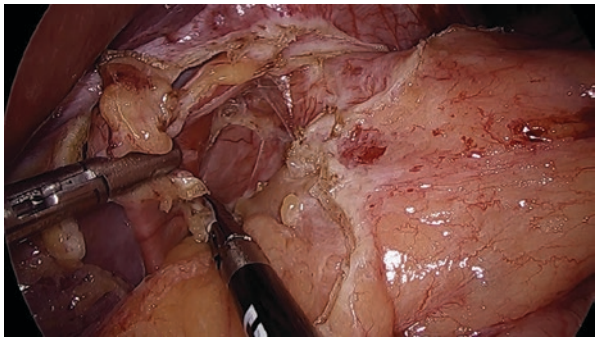

Fig. 1.4 Dissection of the right crus

Troubleshooting: Leaving the anterior vagus nerve attached to the esophagus while lifting the peritoneum and phrenoesophageal membrane away from the esophagus prevents injuring the nerve.

1.4.5 Division of Short Gastric Vessels

Starting from a point midway along the greater curvature of the stomach, the short gastric vessels are taken down with a vessel sealing system towards the fundus and all the way to the left pillar of the crus. This will allow performing a tension-free fundoplication afterwards (Fig. 1.6).

Troubleshooting: Excessive traction of the short gastric branches should be avoided to prevent bleeding from the spleen.

1.4.6 Placement of Penrose Drain and Mediastinal Dissection

A window is opened by blunt dissection under the esophagus, between the gastric fundus, the esophagus, and the left pillar of the crus (Fig. 1.7). The window is then enlarged and a Penrose drain is passed around the esophagus, incorporating both

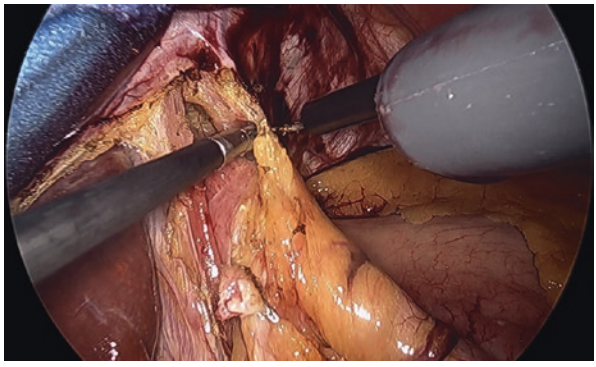

Fig. 1.5 Division of the phrenoesophageal membrane

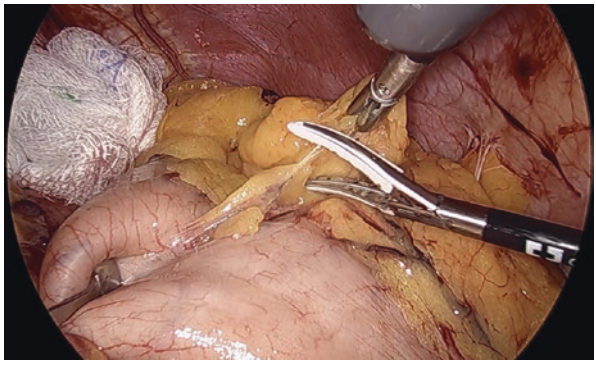

Fig. 1.6 Division of short gastric vessels

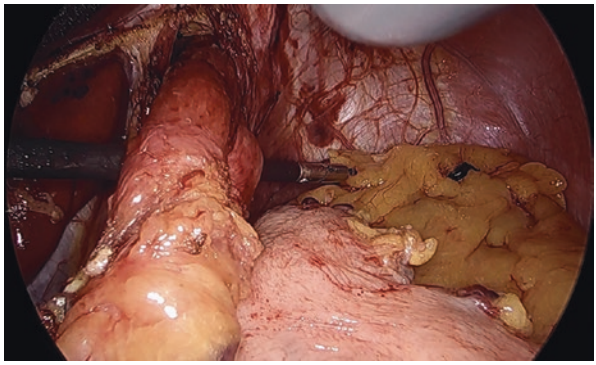

Fig. 1.7 Posterior window behind the esophagus that will be used to place the Penrose drain

anterior and posterior vagus nerves. Retracting the esophagus away from the hiatus with the Penrose drain will help performing mediastinal dissection in order to obtain at least 3 cm of esophagus below the diaphragm.

Troubleshooting: Secure the Penrose drain with a large clip or a loop suture tie. If the pleura is opened during mediastinal dissection, the anesthesiologist should be promptly notified. Reducing pneumoperitoneum pressure, if needed, is usually enough to avoid respiratory events.

1.4.7 Closure of the Esophageal Hiatus

A proper exposure of the hiatus is achieved retracting the esophagus upward and toward the patient's left with the Penrose drain. The closure of the diaphragmatic crura is done with interrupted non-absorbable sutures (e.g. 2-0 silk). 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 (Figs. 1.8 and 1.9).

Troubleshooting: When placing the stitches to approximate the crura, care must be taken to avoid injuring the inferior vena cava and the aorta. The closure of the crura should not be too tight, and a close grasper should slide easily between the esophagus and the crura.

1.4.8 Fundoplication

The fundus is passed behind the gastroesophageal junction and a "shoe-shine" maneuver is performed to verify sufficient fundic mobilization and to avoid having part of the gastric fundus above the wrap (Fig. 1.10). There are two main types of fundoplication during an antireflux operation: total 360° fundoplication (Nissen fundoplication) or partial posterior 240° fundoplication (Toupet fundoplication). Previous studies have shown that both types control abnormal reflux similarly [8, 9]. Therefore, we

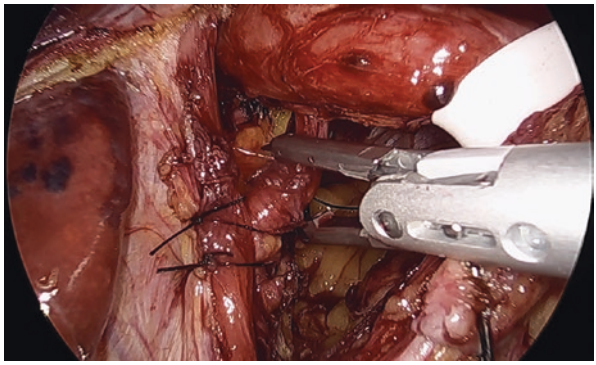

Fig. 1.8 Closure of the hiatus with interrupted non-absorbable sutures

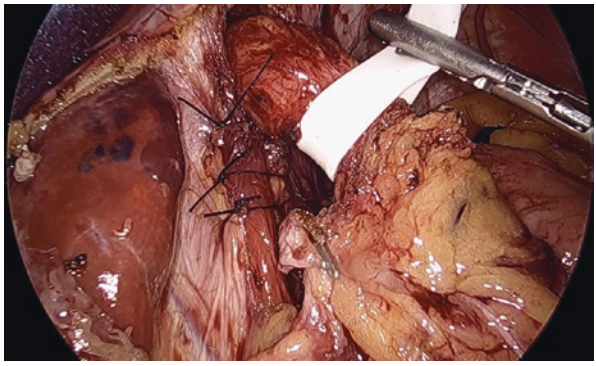

Fig. 1.9 Hiatus adequately closed

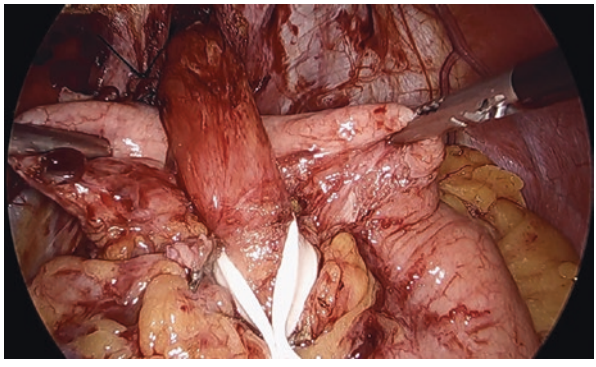

Fig. 1.10 "Shoe-shine" maneuver to verify sufficient fundic mobilization

believe the choice of the type of the wrap should be based on the surgeon's own training and experience. In patients with severely impaired esophageal motility in the preoperative esophageal manometry, we prefer performing a partial fundoplication.

Total 360° Fundoplication: A bougie is inserted into the esophagus to decrease the risk of postoperative dysphagia. The gastric fundus is pulled under the esophagus, and the left and right sides of the fundus are wrapped with a Babcock above the esophagogastric junction during the placement of the first stitch. We use 3 stitches

of non- absorbable material (2-0 silk or polyester) at 1 cm intervals to approximate the right and left side of the fundoplication. The goal is to create a short (about 2 cm in length) and floppy wrap (Figs. 1.11 and 1.12).

Partial Posterior Fundoplication: This wrap is created by placing 6 stitches of non- absorbable material (2-0 silk or polyester). The right and left sides of the fundus are separately sutured to the esophagus, leaving 120° of the anterior esophageal wall uncovered. Three sutures are placed on each side between the muscular layers of the esophageal wall and the gastric fundus (Fig. 1.13).

Troubleshooting: Obtaining a free-tension wrap is critical for the success of the operation.

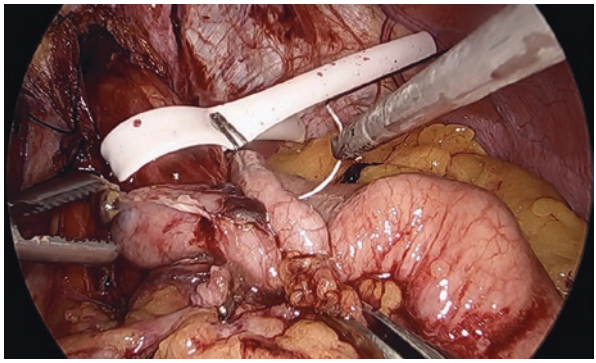

Fig. 1.11 First stitch of the total 360° fundoplication

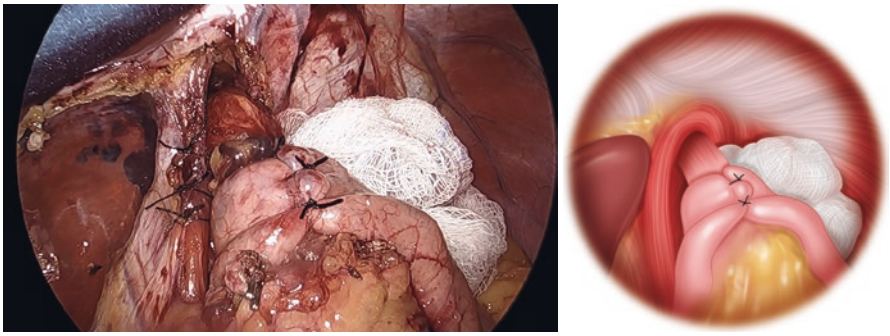

Fig. 1.12 Completed total 360° fundoplication

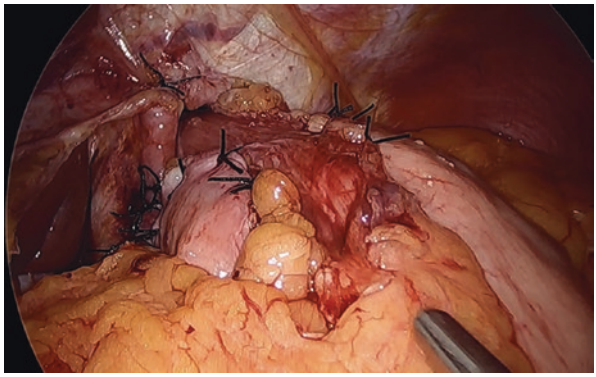

Fig. 1.13 Completed partial posterior fundoplication

1.4.9 Final Inspection

The Penrose drain is cut and passed out of the abdomen. In case a bougie was used for a total fundoplication, it is smoothly removed from the esophagus by the anesthesiologist. After adequate hemostasis is achieved, the liver retractor, instruments and trocars are removed from the abdomen under direct vision. All the port sites should be closed.

1.5 Postoperative Care

Patients are fed the morning of the first postoperative day with clear liquids and then soft diet. Most patients are discharged within 48 hours with instructions to avoid meat, bread, and carbonated beverages for the following two weeks. Regular activities are usually resumed within two weeks. Acid-reducing medications should be discontinued after 6 weeks at the latest.

Conflict of Interest The authors have no conflict of interest

References

1. El-Serag HN, Sweet S, Winchester CC, et al. Update on the epidemiology of gastro-esophageal reflux disease: a systematic review. Gut. 2014;63:871–80.
2. Sandler RS, Everhart JE, Donowitz M, Adams E, Cronin K, Goodman C, Gemmen E, Shah S, Avdic A, Rubin R. The burden of selected digestive diseases in the United States. Gastroenterology. 2002;122:1500–11.
3. Shaheen NJ, Hansen RA, Morgan DR, et al. The burden of gastrointestinal and liver diseases, 2006. Am J Gastroenterol. 2006;101(9):2128–38.

4. Schlottmann F, Herbella FA, Allaix ME, et al. Surgical treatment of gastroesophageal reflux disease. World J Surg. 2017;41(7):1685–90.
5. Schlottmann F, Strassle PD, Patti MG. Antireflux surgery in the USA: influence of surgical volume on perioperative outcomes and costs—Time for centralization? World J Surg. 2018;42(7):2183–9.
6. Patti MG, Schlottmann F, Farrell TM. Fundoplication for gastroesophageal reflux disease: tips for success. J Laparoendosc Adv Surg Tech A. 2017;27(1):1–5.
7. Patti MG, Schlottmann F. Recurrence of reflux after laparoscopic antireflux surgery. JAMA. 2018;319(1):82–3.
8. Booth MI, Stratford J, Jones L, et al. Randomized clinical trial of laparoscopic total (Nissen) versus posterior partial (Toupet) fundoplication for gastro-oesophageal reflux disease based on preoperative oesophageal manometry. Br J Surg. 2008;95(1):57–63.
9. Shan CX, Zhang W, Zheng XM, et al. Evidence-based appraisal in laparoscopic Nissen and Toupetfundoplications for gastroesophageal reflux disease. World J Gastroenterol. 2010;16(24):3063–71.