



# Laparoscopic Toupet fundoplication for gastroesophageal reflux disease and hiatus hernia: proposal for standardization using the “critical view” concept

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## Abstract

Laparoscopic Toupet fundoplication has gained progressive consideration in the management of patients with gastroesophageal reflux disease and hiatus hernia. Previous studies showed equivalent results in terms of reflux control with lower rate of side effects compared to the Nissen fundoplication. However, multiple technical variations may account for the long-lasting reputation of decreased durability and poor long-term reflux control. Inspired by the “critical view” concept, a step-by-step laparoscopic Toupet fundoplication is described and illustrated. During the study period, 2012–2017, 348 consecutive patients underwent laparoscopic Toupet fundoplication according to a standardized procedure. A large hiatus hernia was present in 39% of patients, and 14% had volvulus of the intrathoracic stomach. Sixty-four (18.4%) patients had one or more previously failed antireflux procedures. The median follow-up was 37 months (range 12–61). The Gastroesophageal Reflux Disease Health-Related Quality of Life score significantly improved compared to baseline ( $p < 0.001$ ), and 77% of patients were off proton-pump inhibitors. The proposed standardization of the Toupet fundoplication based on a “critical-view” concept may help to improve reproducibility, clinical outcomes, and teaching of this procedure.

**Keywords** Hiatal hernia · Gastroesophageal reflux disease · Laparoscopy · Toupet fundoplication · Crural repair

## Introduction

André Toupet described the partial posterior fundoplication technique in 1963 in an effort to reduce the incidence of postoperative dysphagia, regurgitation, and gas-bloat symptoms that frequently occurred after Nissen fundoplication. The original operation, performed through a midline laparotomy, consisted of mobilization of the distal esophagus and gastric fundus without dividing the short-gastric vessels. The angle of His was restored and the gastric fundus was fixed to the esophagus and to the diaphragmatic crura. The hiatus was buttressed with the fundus, but the crura were not approximated with sutures [1, 2]. With the advent of

minimally invasive surgery, the laparoscopic Toupet fundoplication (LTF) has gained progressive consideration in the management of patients with gastroesophageal reflux disease and hiatus hernia. Systematic reviews and randomized clinical trials have shown equivalent results in terms of reflux control and a lower rate of side effects compared to the Nissen fundoplication [3, 4]. However, multiple technical variations of the LTF related to the extent of fundic dissection, the degree of the wrap (180° vs 270°) and the type of gastro-phrenopexy may account for the long-lasting reputation of decreased durability and poor long-term reflux control [5, 6].

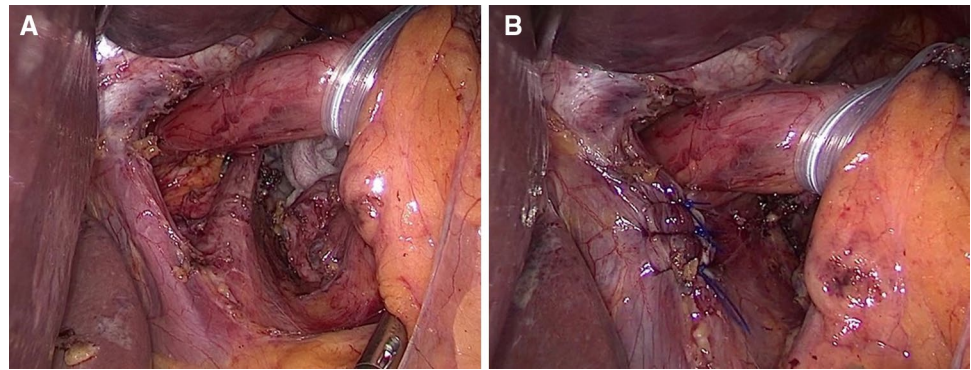
The critical view of safety is a well-known and widely applied method of target identification in biliary and colorectal surgery [7, 8]. This concept can intuitively be translated to any other surgical procedure in an effort to standardize and make the operation safer, easier to train and teach, more reproducible, and possibly more effective. We describe the technical aspects of the LTF and suggest a standardization of the procedure based on a “critical-view” approach in an effort to increase intra- and inter-individual reproducibility and to facilitate effective teaching.

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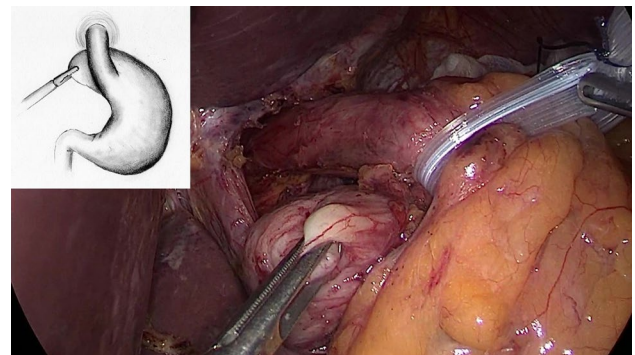
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**Fig. 1** The right and left diaphragmatic crura dissected free to create a retroesophageal window; lower mediastinal dissection is performed to gain an adequate length of intra-abdominal esophagus (a). Posterior hiatoplasty with interrupted non-absorbable stitches (b)

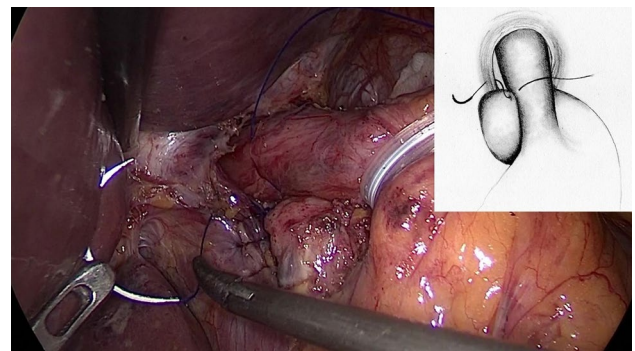


## Surgical technique

The patient is placed in the lithotomy position with legs apart and reverse Trendelenburg. The pneumoperitoneum is established at 13 mmHg. Five trocars and a 30° laparoscope are routinely used. The gastrohepatic ligament is opened above the hepatic branch of the vagus nerve. By dividing the peritoneal reflection, the anterior aspect of the esophagogastric junction and the angle of His are exposed. The phrenoesophageal ligament is divided just lateral to its esophageal insertion to release axial tension and gain at least 3 cm of intra-abdominal esophagus under no traction. The esophagus is dissected circumferentially en bloc with the vagal nerves, and an adequate retroesophageal window is created to accommodate the fundoplication. The lower mediastinum is dissected free from the fibro-areolar tissue. If present, a posterior lipoma is removed to clearly expose the pre-aortic plane. Care is taken to avoid opening the pleural cavities and pericardial injury. In case of hiatal hernia > 3 cm, complete reduction of the hernia sac is mandatory (Fig. 1a). Fundic mobilization is necessary to obtain a tension-free fundoplication. At least three short gastric vessels should be divided using ultrasonic scissors to ensure that both the anterior and posterior fundic walls are mobile. A posterior crural repair is then performed using 2-0 polypropylene (Prolene®, Ethicon) or polyester (Ethibond®, Ethicon) sutures that include adequate bites of muscle and overlying fascia. The pneumoperitoneum is kept to 8 mmHg to facilitate approximation of crura and prevent muscle tears during knot-tying (Fig. 1b). In case of very large (> 5 cm) hiatal hernia with apparently weak crura, the repair is reinforced with a U-shaped biosynthetic mesh [9, 10]. No endoluminal bougies are used throughout the procedure. The fundus is rotated anticlockwise through the retroesophageal window. A “shoe-shine” maneuver allows to tailor the wrap ensuring that there is no radial tension. Incremental adjustments of the fundus may be required until it lies loose but no redundant across the hiatus (Fig. 2). Mild air insufflation through the nasogastric

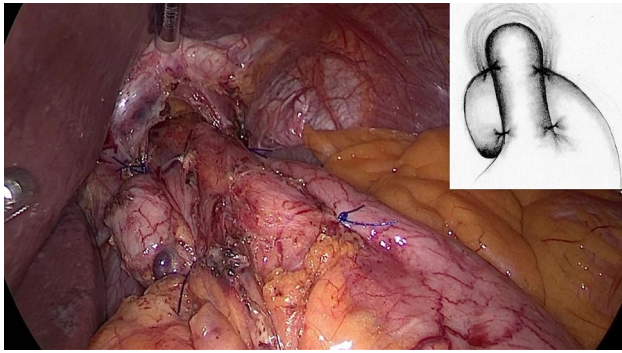


**Fig. 2** The fundus is pulled anticlockwise behind the esophagus and a “shoeshine” manoeuvre is performed to tailor the fundoplication

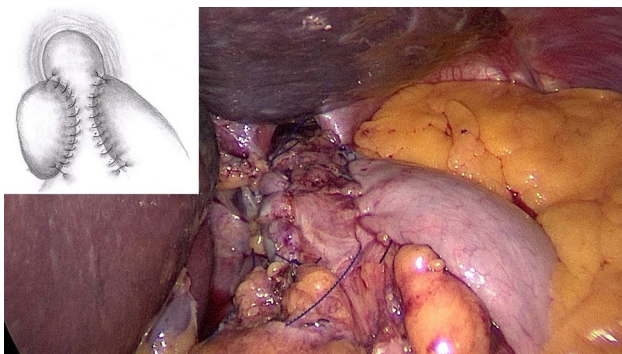


**Fig. 3** The first cephalad suture at 10 o’clock anchors the fundus and the right diaphragmatic crus to the right side of the esophagus

tube allows to visualize the shape of the fundus and the symmetry of the valves, and to choose the proper sites for the application of the sutures. To stabilize the wrap in place and to reduce further manipulations of the gastric fundus, four 2-0 polypropylene “cardinal” stitches are placed. The two most cephalad sutures include on each side the esophagus, the gastric fundus, and the crus (Fig. 3). The caudad sutures are placed 4 cm distally at the level of the esophagogastric junction. This “critical-view” of the key anatomical landmarks allows to assess



**Fig. 4** The four “cardinal stitches” secure the gastric fundus to the esophagus and to the crura. This allows to assess the geometry of the fundoplication and ensures that the esophagus is not twisted



**Fig. 5** The completed 270° laparoscopic Toupet fundoplication

the geometry of the fundoplication and ensure that the esophagus is not twisted (Fig. 4). A running barbed suture (2-0 polybutester, V-Loc®, Medtronic) is used to further secure the gastric wall to each side of the esophagus taking care not to include the anterior vagus nerve in the sutures (Fig. 5).

## Results

Between January 2012 and December 2017, 348 LTF were performed according to the standardized “critical view” concept. Preoperative workup included routine upper gastrointestinal endoscopy and contrast swallow-study; esophageal manometry, 24-h pH study, and chest CT scan were performed selectively. A very large (> 5 cm) hiatus hernia was present in 136 patients (39%), and 49 patients (14.1%) had volvulus of the intrathoracic stomach. Sixty-four (18.4%) patients had one or more previously failed antireflux procedures. Barrett’s esophagus and ineffective esophageal motility were documented in 19% and 26% of patients, respectively. The median operative time was 122 min (range 55–240) in primary procedures, and

170 min (90–490) in revisional procedures. There were no conversions to an open procedure. An average of 3 sutures were used to approximate the hiatus. A bio-synthetic mesh was added for crural augmentation in 177 (51%) patients. The most common associated procedure was cholecystectomy ( $n = 14$ , 4%). No intraoperative complications occurred. All patients received triple therapy with metoclopramide, ondansetron, and dexamethasone to prevent postoperative nausea and vomiting. The median postoperative stay was 1.8 days (range 1–4). The overall complication rate was 2.3% and included pneumonia ( $n = 3$ ), atrial fibrillation ( $n = 2$ ), pulmonary embolism ( $n = 2$ ), and pleural empyema ( $n = 1$ ). There was no mortality. The median follow-up was 37 months (range 12–61). The GERD-Health-Related Quality of Life (GERD-HRQL) score significantly improved compared to baseline ( $p < 0.001$ ), and 77% of patients were off proton-pump inhibitors at the latest follow-up. Four (1.1%) patients required endoscopic pneumatic dilation because of persistent dysphagia. Thirteen (3.7%) patients presented with symptomatic small hiatus hernia (> 2 cm) over the follow-up. The overall patient satisfaction rate was 95%.

## Conclusions

Laparoscopic fundoplication is a complex surgical procedure that requires a well-defined learning curve [11]. A clear field of view is important for the preparation of the retroesophageal window and the crura, for the dissection of the fundic wall, and for the construction of a symmetric wrap without losing spatial orientation. The need for gastric manipulation and for suturing on both sides of the esophagus increase the technical difficulties of the LTF compared to the Nissen fundoplication. Although experienced surgeons may compensate for the lack of stereoscopic depth perception on a two-dimensional display, laparoscopic proficiency and visual cues are often decreased or lost during the procedure and this adds to surgeon’s fatigue [12, 13]. Therefore, reinforcing or developing alternative visual cues may be important, especially for the trainee surgeons. It has previously been shown that training in laparoscopic antireflux surgery under supervision of expert surgeons can reduce the impact of inexperience and improve surgical outcomes [14]. Three-dimensional cameras and robotic platforms have been used to improve depth perception and increase dexterity, but results on clinical outcomes have so far been inconclusive and a small advantage has been demonstrated only in revisional fundoplication procedures [15]. We advocate a “critical view” approach to overcome the technical difficulties of LTF and make this operation more reproducible and teachable.

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## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflicts of interest.

**Ethical approval** Institutional Review Board (IRB) approved the study (Protocol HSD 0044,2018).

**Research involving human participants and/or animals** The study including human participants has been performed in accordance with the ethical standards of the Declaration of Helsinki and its later amendments.

**Informed consent** Informed consent was obtained from all patients prior to all surgical procedures.

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