A MODIFIED NISSEN - TOUPET PROCEDURE FOR THE TREATMENT OF GASTRO-ESOPHAGEAL REFLUX DISEASE AND HIATAL HERNIA: HOW I DO IT

G. Pavy 1, R. Moldovanu 1,2
1. L’Hôpital Privé Arras les Bonnettes, France
2. “Gr.T. Popa” University of Medicine and Pharmacy Iaşi, Romania

A MODIFIED NISSEN - TOUPET PROCEDURE FOR THE TREATMENT OF GASTRO-ESOPHAGEAL REFLUX DISEASE AND HIATAL HERNIA: HOW I DO IT (Abstract): The laparoscopic fundoplication became the standard treatment for gastro-esophageal reflux disease and hiatal hernia. Nissen and Toupet techniques are the most used surgical procedures. Which of these techniques is superior is a subject of debate. The Nissen procedure appears to be associated with a higher rate of postoperative morbidity (postoperative dysphagia, gas bloat syndrome). It is classically considered the Nissen procedure allows a superior reflux control compared with the Toupet operation. We present our laparoscopic technique which combines the two procedures and which was associated along the time with a low rate of postoperative morbidity and a good reflux control.

KEY WORDS: LAPAROSCOPIC FUNDOPLICATION; NISSEN; TOUPET

Correspondence to: Dr. Gérard Pavy, Pole Chirurgie Arras les Bonnettes, L’Hôpital Privé Arras les Bonnettes; 2 Rue du Dr Forgeois; BP 20990; 62012 ARRAS Cedex; Phone: 0033 (0) 3 21 60 20 20; e-mail: gerard.pavy@gmail.com*

INTRODUCTION

Laparoscopic fundoplication is the gold standard procedure for the gastro-esophageal reflux disease (GERD) and hiatal hernia [1]. As for the others operations, the minimally invasive approach has some advantages: shorter hospital stay, reduced morbidity, and less postoperative pain [2,3,4]. The long term results after this type of surgery are also very good from point of view of gastro-oesophageal reflux control, postoperative dysphagia [5,6] and quality of life [7,8].

The most used techniques for reflux laparoscopic surgery are Nissen (360° fundoplication) and Toupet (270° posterior wrap) [1,4,9]. Toupet procedure was classically considered less effective for the control of gastro-esophageal reflux and Nissen operation associated with a higher rate of postoperative morbidity (gas bloat syndrome and dysphagia) [10,11]. From these reasons a so-called tailored concept was introduced: partial or total fundoplication depending on the presence or absence of pre-existing esophageal motility disorders [4,10,12]. Apparently, the Toupet technique is also more appropriate to control the GERD in children [13].

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SURGICAL TECHNIQUE BACKGROUND

The original Nissen procedure, as was described in 1956 [1,14], consists in wrapping the stomach fundus around the last 6 cm of the esophagus; the gastric short vessels were conserved and the diaphragmatic hiatus remains intact [1,14,15]. The most important modifications of the Nissen technique were (Fig. 1A): shortening the fundoplication to 2 cm (“floppy Nissen”) and division of the short gastric vessels [15,16]. The stability of the fundoplication could be ensured passing the sutures through the esophageal wall [14]. The original Nissen uses anterior or the posterior gastric wall to construct the fundoplication; Rossetti modified the technique using only the anterior wall of the stomach for the fundoplication [17]. Using this procedure and without division of the short gastric vessels Rossetti and Hall reported very good long term results in a series of 590 patients [18]. The first series of Nissen procedure performed by laparoscopic approach was reported in 1991 [19].

Toupet proposed a partial fundoplication constructing a 270° posterior wrap (Fig. 1B) [20]. The original procedure has been described as complementary to a Heller oeso-gastro-myotomy and the diaphragmatic hiatus remained intact [20]. The gastric wrap is sutured to the right pillar of the diaphragm and to the right side of the esophageal wall; the lowest stitch fixes the gastric fundus the median arcuate ligament approximately as in Hill’s technique [21]; the left hemi fundus is also sutured to the left diaphragmatic pillar and to the left side of the esophageal wall [20]. The most important modifications of the Toupet technique, mostly achieved after the implementation of laparoscopic approach, were a simplified suturing pattern [22], the closure of diaphragmatic hiatus and the division of the short gastric vessels if necessary [23].

![Fig. 1 Types of fundoplication procedures](image)

A Nissen; B Toupet; C The combined technique

SURGICAL PROCEDURE

Principles

The basic principles of the fundoplication procedures were early described by Belsey: (1) to restore the length of intraabdominal esophagus and, (2) to use the simplest means of maintaining this segment intraabdominally [24].
During the years, these principles evolved; actually, the principles of laparoscopic reflux surgery are: (1) tension-free repositioning of the gastroesophageal junction (along with 2 cm of lower esophagus in a subphrenic position); (2) the use of the gastric fundus to create the fundoplication (and especially the anterior wall) [1,12,16,19,22].

Our technique follows the above mentioned principles and combines the two procedures (Fig. 1C). After the exposure of the diaphragmatic hiatus and the eso-gastric junction we close the diaphragmatic hiatus and construct a posterior gastric wrap sutureing the fundus to the right diaphragmatic pillar as in Toupet technique. Then, we complete the anti-reflux mechanism by a short anterior gastric wrap constructed from the anterior gastric wall which is sutured to the posterior gastric flap like in the Nissen technique.

**Anatomical landmarks**

The left hepatic lobe covered the hiatal region and, it’s cephalad retraction is mandatory to perform the reflux surgery. The anatomical landmarks are then accessible; these could be classified in superficial and profound. The superficial landmarks are: lesser omentum (pars flacida and pars condensa), phrenoesophageal membrane, gastro splenic ligament and short gastric vessels [1,22,25,26]. We note the presence of the hepatic branch of the vagus nerve and an accessory left hepatic artery to the pars condensa [1,22,25,26].

After the opening of lesser omentum, the profound landmarks are also accessible; the right diaphragmatic pillar is the most important because it guide the dissection of the diaphragmatic hiatus [1,22,25,26]. The others important profound anatomical landmarks are: the left diaphragmatic pillar, esophagus and posterior vagus nerve [1,22,25,26]. The left diaphragmatic artery has multiple variants and it is possible to be in contact with left diaphragmatic pillar [1,22,25,26]. Aorta is not directly visualized during the hiatal dissection; however its position is important to be known during the hiatal repair [25]. During the complete mobilization of the esophagus, the left pleura is sometimes visualized and could be injured [1,22].

**Anesthesia and the operative room set-up**

General anesthesia has been performed; then the patient is placed in supine position, in a 30-40° reverse Trendelenburg (Fowler) tilt with both arms and inferior limbs in abduction (Fig.2 A). The patient is securely positioned by sitting to the table (Fig. 2 A). A gastric tube it is placed to decompress the stomach.

A two monitors high definition laparoscopic equipment has been used and placed to the head of the table on the patient’s left side.

The surgeon operates between the legs of the patient and the assistant stands on the patient's right side.

**Trocars and instruments**

Five trocars has been used: one of 10 mm (optical) and four of 5 mm (for the instruments) (Fig. 2 B). One of the 5 mm trocar is a piston valve trocar to pass the loop which will suspend the gastro-esophageal junction. The laparoscopic instruments used were: monopolar disposable scissor, monopolar hook, bipolar grasper, two atraumatic fenestrated graspers, Babcock grasper, dissection grasper, a disposable suction-irrigation device and a needle holder. A 30° laparoscope and a 3 CCD high definition
camera have been used. The standard instrument box also includes “classical” instruments: graspers (two Kelly and two Halsted), Farabeuf retractors, scissors and Hegar needle-holder.

![Fig. 2 Operation room set-up (A) and trocars placement (B)](image)

**Trocars placement**

After the establishing of a carbon dioxide pneumoperitoneum using the Verres needle the trocars were placed as follows (Fig. 2B):

- the 10 mm optical trocar: supraumbilically at the half distance between the umbilicus and the xiphoid process;
- the two operating 5 mm trocars: at the intersection of the midclavicular costal border, 2-4 cm under the costal margin;
- the other two 5 mm trocars (used for the retractors): were paramedianly placed to the proximity of xiphoid process.

The operating trocars were inserted under laparoscopic view control.

To minimize the risk of cardiac compression, pneumomediastinum and hypercapnia we are using a maximal intraperitoneal pressure of 12 mm Hg.
Exposure of the hiatal region

To assure a good exposure of the eso-gastric junction and of the hiatal region, the left lobe of the liver is retracted cephalad and to the patient’s right using the Babcock grasper introduced through the trocar placed on the left of the xiphoid process (Fig. 3); the Babcock grasper is then locked in this position on the upper part of the right diaphragmatic pillar (Fig. 3 B, C). The giant hiatal hernia with large hiatal defect facilitates the identification of the right diaphragmatic pillar (Fig. 3D).

Fig. 3 Anatomical landmarks and hiatal region exposure:
before (A) and after the use of Babcock grasper (B,C,D)
1 left hepatic lobe; 2 lesser gastric curvature; 3 lesser omentum; 4 gastroplenic ligament; 5 left diaphragmatic vessels; 6 Spiegel lobe visualised through the transparency of pars flacida

Division of the lesser omentum

The aim of this step is to identify the right diaphragmatic pillar, “the essential anatomic landmark” for the dissection of the esophagus [1]. Some authors prefer the division of the lesser omentum from the pars condensa to avoid the injuries of the hepatic branch of the vagus nerve and an accessory left hepatic artery [1,19,22].
We usually start by opening the pars flacida of the lesser omentum (Fig. 4 A, B). The pars condensae is then completely divided (Fig. 4 C, D).

**Dissection of the diaphragmatic pillars**

The posterior peritoneum is then divided and the right diaphragmatic pillar is completely exposed (Fig. 5 A, B). This dissection is facilitated by retraction the stomach caudally and to the left. Using traction-contratractions maneuvers and sharp and blunt dissection, the both diaphragmatic pillars are completely exposed (Fig. 5 C, D).

**Retroesophageal window**

Then, a window is created through the gastrophrenic ligament (Fig. 6). A tape loop is then passed through the piston valve trocar placed on the right of the xiphoid process, around the esophagus (Fig. 7).
It permits to mobilize the gastroesophageal junction in different directions during the procedure and avoid the traumatic grasping of the organs.

Completing the hiatal dissection
The aims of this step were described by Dallemagne [1]:
- to completely free the lower esophagus and cardia on their anterior and posterior walls;
- to enlarge the retroesophageal window of sufficient size to allow passage of the gastric fundus;
- to sufficiently mobilize the esophagus to obtain a minimum 2 cm segment of esophagus inside the abdominal cavity in a tension-free manner.

The phrenoesophageal membrane is opened transversally along the anterior border of the hiatal orifice (Fig. 7 C, D). The esophagus and the diaphragmatic pillar are completely liberated using blunt dissection (Fig. 8 A). Cardia is also completely liberated by division of the posterior attachments.
**Cruroplasty**

The esophagus is caudally and anteriorly lifted using the loop.

The diaphragmatic pillars are sutured using interrupted monofilament 2/0 non-absorbable sutures (Fig. 8). Usually two or three sutures were placed to repair the hiatal defect (Fig. 8 D). We use extracorporeal knot, tied outside the body and then slipped inside using a push rod.

**Fundoplication’s creation**

Using the loop, the esophagus is anteriorly retracted.

Through the retroesophageal window, the anterior wall of the gastric fundus is passed until to the right diaphragmatic pillar (Fig. 9 A, B). The valve is tailored without tension towards the spleen.
If the wrap seems tight, the stomach should be pulled back into its normal position, and a spot should be chosen further distally on the anterior gastric wall. If necessary, the division of gastro-splenic ligament and some short gastric vessels may be performed (Fig. 11).

The posterior valve is then sutured to the right pillar by three interrupted monofilament 2/0 non-absorbable stitches (Fig. 9 C, D). The first stitch is carefully passes in the upper part of the right diaphragmatic pillar, to avoid the injury of the inferior vena cava or left suprahepatic vein. The lowest stitch fixes the gastric fundus to the median arcuate ligament approximately as in Hill’s technique [21].

A short anterior valve (about 2 cm long) is then constructed, using the anterior wall of the gastric fundus and fixed to the posterior valve using two interrupted monofilament 2/0 non-absorbable sutures (Fig. 10). These sutures didn’t pass through the esophagus wall.

Fig. 7 The tape loop pass (A, B)and division of the phrenoesophageal membrane (C, D)
1 right pillar; 2 left pillar; 3 esophagus; 4 phrenoesophageal membrane
**Intraoperative complications**

Gastric or esophageal perforations are rare (about 1% [27] but with a potential mortality of over 25% if are not intraoperatively recognized [28]. In this reason, we recommend to perform a blue methylene test to the naso-gastric tube in case of doubt or after difficult esophageal dissection. The treatment consists in primary closure covered with the gastric valve; postoperatively, the naso-gastric tube is maintained 7-10 days and removed after a radiological exam.

Hemorrhage is more frequent and could be originated from accessory left hepatic artery, left diaphragmatic artery, liver or spleen laceration, short gastric vessels [27,28]. The bleeding control is achieved using bipolar or monopolar coagulation, Ligasure device or fibrin glue [28].

Pneumothorax has a incidence of about 3% [1,27]; usually is on the left side due to the injury of the left pleura during the posterior dissection of the esophagus. A thoracic drainage could be necessary [15].

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**Fig. 8 The complete dissection of hiatal region** (note the two pillars, esophagus and the large retroesophageal window (A)); **cruroplasty** (the stitches (B, C) and the final aspect (D)).
Subcutaneous emphysema and vagus nerve trauma are rarely noted in the literature [1, 15, 27].

Postoperative follow up
The naso-gastric tube is removed in the first postoperative day, and fluid intake begins. The solid intake started in the second postoperative stay. The patient is usually discharged in the third postoperative day. A mild dysphagia for solids is usually encountered in the first 4 to 6 postoperative weeks. In terms of reflux control, our patients declared immediate complete disappearance of the symptoms and no proton-pump inhibitor therapy was further necessary.

DISCUSSIONS
As mentioned above, it is classically stated that Toupet procedure is less effective for the control of gastro-esophageal reflux and Nissen operation is associated with a higher rate of postoperative morbidity [10, 11] and especially early postoperative dysphagia [10, 11, 29].
In a recent prospective randomized study, concerning the long-term follow-up, the quality of life is improved for the most of the patient and 85% of them were declared satisfied by the operation, both after the Toupet and Nissen operation [10].

However, the same study [10] noted a higher rate of postoperative dysphagia two years after Nissen procedure demonstrated by manometry (higher pressure of lower esophageal sphincter); the recurrence of the reflux (demonstrated by pH-monitoring and endoscopy (esophagitis)) was surprisingly more frequent after Nissen procedure then after the Toupet technique. The reoperation rate due to the recurrence of the symptoms and mechanical failure was also higher after Nissen procedure [10]. The described technique combines the advantages of the Nissen and Toupet procedures and is associated with a low rate of postoperative morbidity. However we have to note a mild early postoperative dysphagia which appears in some cases as after Nissen procedure but it is transitory and totally disappears in 4-6 weeks.

Fig. 10 Fundoplication – the anterior valve construction
The anterior gastric wall is anteriorly wrapped around the esophagus (A, B); the anterior valve is then sutured to the posterior valve (C); final aspect (D); arrows show the traction direction.
From point of view of surgical tips and tricks we always use a Babcock grasper fixed to the right diaphragmatic pillar, to retract the hepatic left lobe.

**Fig. 11 Tips and tricks during the laparoscopic reflux surgery**
A, B Division of the gastrosplenic ligament; C, D Aberrant left hepatic artery divided during the section of the pars condensa; E, F Giant hiatal hernia – dissection of the hernia’s sac
1 aberrant left hepatic artery; 2 incision line for the giant hiatal hernia; 3 hernia’s sac
This simply method allows: a good exposure of the hiatal region; serves as landmark for the right diaphragmatic pillar and inferior vena cava which is situated laterally; permits to operate with only one assistant.

Usually the lesser omentum is divided from the pars flacida until the right side of the esophagus; this large opening of the lesser omentum facilitates the diaphragmatic pillar’s dissection, the creation of the retroesophageal window and the esophagus mobilization. Therefore, the hepatic branch of left (anterior) vagus nerve is also divided. There are a few data in the literature concerning this issue; however, Morton JM et al [30] found the hepatic branch preserving has “no clear benefit with regard to early postoperative gallbladder function”.

A recent study also noted “no clinical significance” after the hepatic vagal denervation, from point of view of hepatic and gallbladder function [31]; however, the authors reported a reduction in the size of the gallbladder and, consequently, recommend the cholecystectomy during the same operation to avoid the choledocolithiasis [32]. Much more, a trunkal vagotomy could be performed to provide an adequate esophageal length without delayed gastric emptying, dumping syndrome, or other side effects [33].

An aberrant left hepatic artery is present into the pars condensa (Fig. 11 C, D, E) in 8% of the cases [34], but some authors consider a higher incidence, of about 25% [35]. The small vessels may be divided during the opening of lesser omentum with no clinical significance, but some patients may have temporarily elevated liver enzymes (Fig. 11 C, D) [34,35]. However the presence of a large artery suggests a complete replaced hepatic artery, and so, the vessel should be preserved to avoid ischemic damage of the liver [34,35]. As other authors [15], we always use a tape loop passed around the esophagus to mobilize the esogastric junction; this maneuver diminishes the traumatic injuries of the esophagus and the stomach.

From point of view of cruroplasty we carefully pass the first stitch to the point where the two diaphragmatic crura join in front of the aorta to avoid an aortic injury. However, if this it is happened, the stitch should be removed, and pressure using a sponge or even the stomach should be placed over the aorta for at least 10 min [35]. The stitch tying in the aortic wall could lead further bleeding [35]. Even we don’t use a dilator, it is recommended in the literature to use a 56-60F dilator to calibrate the cruroplasty [27,35].

For the patients with giant hiatal hernia the sequence of operations steps are different [22]; after the division of the lesser omentum, the hiatal dissection starts by opening the sac (peritoneum) at the anterior edge of the esophageal hiatus [22,35] even the stomach can’t be caudally retracted (Fig. 11 E, F). Then, the hernia sac is gradually detached from the mediastinum until the esophagus are identified [22]. The hernia sac is then detached from the right and the left diaphragmatic pillar and gradually mobilized from the esophagus wall [22].

In the obese patients the accumulation of fat in the omentum and gastrospenic ligament and perihialtally tends to obscure the anatomical landmarks, and the procedure is more difficult [15].

The use of extracorporeal knots decreasing the operation time and allows a better control of the knot tying.
CONCLUSION

Our technique combines the advantages of the Nissen and Toupet procedures with a lower rate of postoperative morbidity. The patients have a good reflux control and less of dysphagia. The recognition and exposure of anatomical landmarks are essentially for a safe reflux surgery and good short and long-term results.

REFERENCES


