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Laparoscopic Nissen fundoplication: technique and preliminary results

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Between May 1991 and November 1992, 80 consecutive patients with gastro-oesophageal reflux disease underwent laparoscopic Nissen fundoplication. The technique used was exactly the same as for the conventional open approach. There were no deaths but there were four peroperative complications: one gastric perforation, two pleural perforations and one hepatic laceration. Three conversions to laparotomy were necessary, one because of a defective needle holder and two as a result of left hepatic lobe hypertrophy. The duration of operation ranged from 40 to 300 (median 150) min. The median postoperative stay was 3 days, but increased to 10 days in two patients who developed pulmonary infection. One major postoperative complication (necrosis of the wrap) required a laparotomy on day 8 after operation. No recurrence of heartburn has been observed and there were no instances of long-term dysphagia after surgery. These findings indicate that laparoscopic Nissen fundoplication can be performed safely if the team is well trained.

Nissen fundoplication is an operation in which the surgical procedure itself, namely the fundoplication, is relatively limited. Indeed, the dissection is extraluminal, hence the gut wall itself is not involved. The difficult part of the operation lies in achieving access to the oesophageal hiatus. This exposure leads to parietal injury disproportionate with the simplicity of the actual procedure. Moreover, sustained traction on the costal margin is necessary for good visualization throughout the operation. Recovery time is conditioned by the extent of the trauma inflicted to achieve good exposure. Access by a laparoscopic approach limits trauma to the abdominal wall and could therefore diminish the postoperative morbidity rate and hospitalization time.

Patients and methods

Between May 1991 and November 1992, 80 consecutive patients (46 men) with gastro-oesophageal reflux disease (GORD) with ages ranging from 17 to 75 (median 48) years were treated by the senior author (G.B.C.) by means of a Nissen fundoplication using a laparoscopic approach. No open elective Nissen procedures were performed in this period. Most patients were referred from gastroenterologists. Contraindications were those to general anaesthesia and grade 4 oesophagitis (endobrachyoesophagus, chronic distal ulceration, fibrotic stricture). Some 66 patients were classified as American Society of Anesthesiologists grade I, 12 as grade II and two as grade III. A total of 31 patients had undergone previous abdominal surgery. Fifty-eight patients had a hiatal hernia diagnosed by endoscopy. Ten patients presented with grade 3 oesophagitis (confluent ulceration but no stenosis) as determined by endoscopy and heartburn. Of 59 patients with grade 2 oesophagitis (oedema and non-confluent ulceration of the distal oesophagus), 54 had associated heartburn and five atypical symptoms (regurgitation-related symptoms of the upper and lower respiratory tract). Surgical indications in 11 with grade 1 oesophagitis (mucosal erythema and oedema) and heartburn were: (1) persistence of grade 2 or 3 oesophagitis despite 6–24 (median 12) months' treatment with H_2-receptor blocking drugs and/or prokinetic agents followed by omeprazole for 6–24 (median 12) months with subsequent improvement of oesophagitis to grade 1 but continuing severe heartburn in eight; (2) Barrett's oesophagitis in two with heartburn; and (3) incapacitating regurgitation in one with neurodystrophy. The duration of medical therapy, consisting of H_2-receptor blocking agents, omeprazole or cisapride, ranged from 6 to 90 (median 24) months. Some 35 patients received omeprazole for a median of 14 (range 6–24) months.

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Preoperative evaluation included a barium swallow and gastroscopy in all patients. Manometry (Arndorfer Medical Specialties, Greendale, Wisconsin, USA) was performed in 41 of the 80 patients and 24-h pH recording (Sandhill, Littleton, Colorado, USA) in 34.

Operative procedure

The patient is anaesthetized with endotracheal intubation and a nasogastric sump tube inserted. The patient lies supine, thighs fully abducted and slightly bent. The operating table has a 20° reversed Trendelenburg tilt. The surgeon stands between the patient's legs, the first assistant on the patient's left side and second assistant on the right. Laparoscopic Nissen fundoplication is performed via five cannulas (*Fig. 1*): one of 10 mm well above the umbilicus, one of 5 mm in the right subcostal area, one of 5 mm in the left subcostal area, one of 10 mm between the first and third cannulas and one of 10 mm under the xiphoid appendage. These allow the introduction of a 0° angled laparoscope (Olympus Optical, Tokyo, Japan), a probe to retract the liver, a grasping forceps, a coagulation hook and a second grasping forceps. The second assistant retracts the left hepatic lobe to expose the oesophageal hiatus.

The first step of the procedure (*Fig. 2*) is dissection of the oesophageal hiatus. The first assistant grasps the upper part of the lesser curvature with the grasping forceps. The lesser omentum is severed with the coagulation hook, sacrificing the hepatic fibres of the vagus nerve whenever this appears necessary for good mobilization of

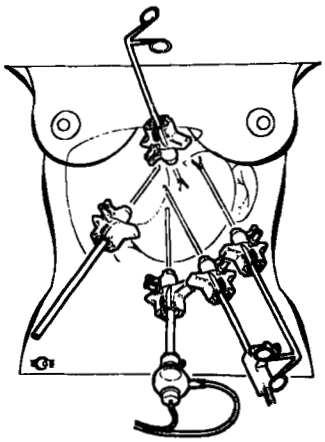

Fig. 1 Placement of cannulas for laparoscopic Nissen fundoplication

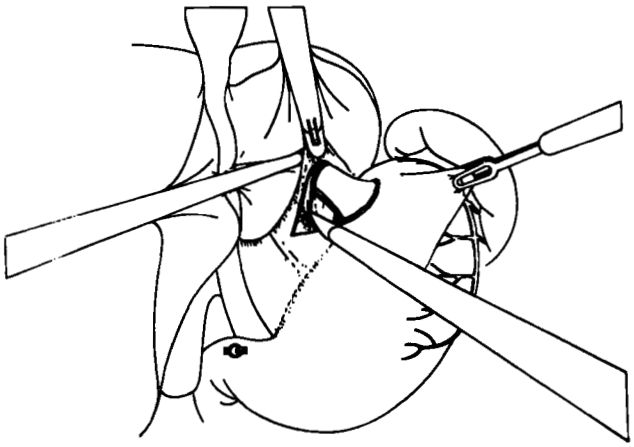

Fig. 2 Exposure and dissection of the oesophageal hiatus

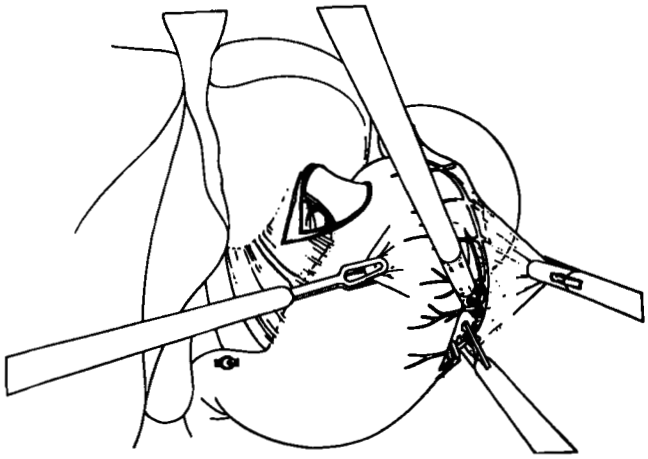

Fig. 3 Devascularization of the greater curvature. The short gastric vessels are divided between clips after isolation using a coagulation hook

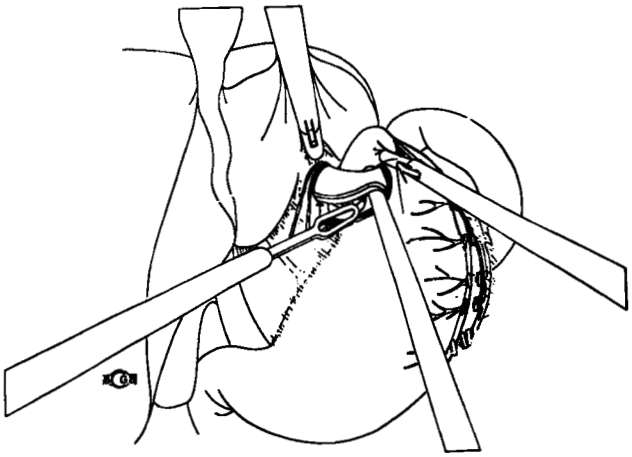

Fig. 4 Fundoplication. Retro-oesophageal placement of the wrap

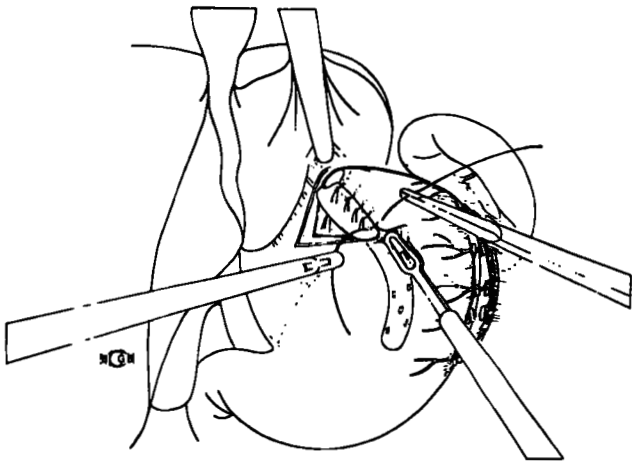

Fig. 5 The 5-cm wrap is secured with five interrupted stitches tied with an intracorporeal knotting technique. A 33-Fr Maloney dilator in the oesophagus prevents excessive narrowing

the oesophagus. The retrogastric cavity and right pillar of the hiatus are exposed after incision of the lesser omentum. The phreno-oesophageal ligament is incised and coagulated up to the anterior wall of the oesophagus. This manoeuvre is completed along the right pillar. The retro-oesophagus is dissected at this time. Any hiatal hernia can be reduced with the grasping forceps while freeing the perioesophageal adhesions. The posterior vagus nerve is easily identified. Further dissection of the retro-oesophageal adhesions reveals the left pillar of the hiatus and joins with the already severed phrenogastric ligament exposing the upper part of the spleen.

The next step of the procedure is mobilization of the greater curvature (*Fig. 3*). The middle of the stomach is pulled to the right with the grasping forceps. The gastrosplenic ligament is exposed by countertraction, using the second forceps. The short vessels are isolated with a coagulation hook. Haemostatic control is obtained with clips. Mobilization of the greater curvature is achieved by division of the upper five short vessels. Complete mobilization of the fundus is obtained.

Fundoplication (*Fig. 4*) is performed as for conventional open operation. A 33-Fr Maloney dilator is introduced into the oesophagus. The fundus at the greater curvature is grasped, passed to a second forceps inserted behind the oesophagus and pulled until the right side of the oesophagus is reached. Mobilization of the fundus and retro-oesophageal dissection must be thorough enough so that the wrap stays in place by itself, without having to maintain tension. Interrupted sutures of 2/0 silk biting through the stomach, the anterior wall of the oesophagus and the gastric wrap are then placed. The 5-cm long gastric wrap is fixed by five stitches using intracorporeal knotting (*Fig. 5*). A continuous suture secured with a clip was performed in the first ten patients. The Maloney dilator is removed and a regular nasogastric tube inserted before the end of the procedure. No external drains are left.

A barium meal was given on the first day after operation and the nasogastric tube withdrawn after verifying that no stenosis or fistula had occurred and that gastric emptying was normal. Discharge from the hospital was usually permitted on day 3 after surgery. A strict liquid diet was prescribed for 3 weeks.

Follow-up

Follow-up was carried out 1 week, 1 month, 3 months and 1 year after operation. A standard questionnaire was completed at each examination. Objective evaluation with barium meal, fibreoptic endoscopy, 24-h pH recording and manometry was performed after 3 months. Endoscopy and barium meal were repeated after 1 year. Preoperative and postoperative endoscopies were performed by the referring gastroenterologists.

Data were analysed using the Wilcoxon signed rank test.

Results

The duration of operation ranged from 40 to 300 (median 150) min. Three conversions to laparotomy were necessary; one

Table 1 Symptoms recorded at follow-up

	Follow-up		
	1 month ($n=74$)	3 months ($n=53$)	1 year ($n=10$)
Heartburn	0	0	0
Epigastric pain	6	1	0
Dysphagia	10	0	0
Gas bloat	6	2	0
Diarrhoea	1	0	0

because of technical problems (a non-functioning needle holder) and two as a result of a hypertrophied left hepatic lobe.

There were four peroperative complications. One gastric perforation was treated by laparoscopic intracorporeal suture and two pleural perforations, each associated with a large hiatal hernia, were managed using a chest drain. One hepatic laceration caused by a trocar was coagulated with the hook.

The nasogastric tube was removed after a median of 2 (range 1–8) days. Bowel sounds were present after a median of 1·6 (range 0–4) days. The barium meal performed on day 1 showed normal post-Nissen extrinsic compression on the distal oesophagus, but no leakage or reflux in any patient. The duration of hospital stay ranged between 2 and 10 (median 3) days. Two patients developed pulmonary infection, which prolonged their stay to 10 days. There were no perioperative deaths. One major perioperative complication occurred. A cirrhotic patient developed necrosis of the wrap with perforation and peritonitis and was readmitted on day 8 after surgery. At laparotomy the wrap was taken down and the stomach sutured with no ill-effects.

Some 74 patients have been seen at 1 month, 53 at 3 months and ten at 1 year after operation (*Table 1*). One patient was readmitted at 6 months because of intense postprandial epigastric pain and weight loss of 18 kg. At endoscopy, the silk running suture on the oesophagus appeared to have migrated inside the lumen and undigested food had clogged around it, causing permanent traction on the suture thread. This thread was cut endoscopically and the symptoms subsided. One patient developed incisional hernia at a midline cannula insertion site. There was no incidence of recurrent heartburn. Ten patients had temporary (first month) dysphagia for liquids and one severe dysphagia requiring dilatation in the third week; however, no patient had dysphagia for more than 3 months after surgery. In one of six patients with transient postprandial epigastric discomfort, symptoms persisted for 6 months. Six other patients experienced gas bloat, which persisted for up to 6 months in two. Two patients experienced excessive salivation for 2 months and one diarrhoea for 2 months.

Of 35 gastroscopies performed after 3 months, 33 were normal and two showed asymptomatic grade 1 oesophagitis. In one of these two patients the mucosal lesions completely subsided after 1 year and in the other, with Barrett's oesophagus, oesophagitis persisted for more than 6 months. Twenty-two manometry studies documented an increase in lower oesophageal sphincter pressure from a mean(s.e.m.) of 13·4(1·5) mmHg before surgery to 31·0(2·5) mmHg after operation ($P=0·0004$). Fifteen 24-h pH recordings were performed and showed a reduction in the proportion of time at pH < 4 per 24 h from a mean(s.e.m.) of 10·4(2·1) per cent before operation to 1·6(0·5) per cent after surgery ($P=0·0015$). The number of reflux episodes per 24 h exceeding 5 min decreased from a mean(s.e.m.) of 3·6(0·9) before operation to 0·3(0·2) after surgery ($P=0·002$).

Discussion

Visualization of the oesophageal hiatus and of the posterior wall of the oesophagus is poor with laparotomy, irrespective of the incision used. The obesity of most patients suffering from GORD only accentuates the problems of adequate exposure[1]. At laparoscopy, however, dissection of the oesophageal hiatus is facilitated by the magnified image, which can demonstrate the entire dissection including that of the back wall of the oesophagus. A large-bore nasogastric tube should therefore not be placed during the dissection before retro-oesophageal placement of the wrap. Cirrhosis of the liver and left lobe hypertrophy are relative contraindications because retraction of the liver is difficult in such cases and exposure of the hiatus poor.

In patients with a very large hernia, gastric perforation and pleural laceration are possible complications as dissection of the hernia sac is tedious[2]. Pleural laceration occurred in two patients early in the present series. Despite the presence of a pneumoperitoneum of 14 mmHg, no ill-effects were registered and ventilation of the patients remained optimal throughout the procedure. Dissection of the sac is performed by gentle traction and division of all adhesions well inside the abdominal cavity, under direct vision, thus avoiding intramediastinal 'blind' dissection. If the hepatic branches of the vagus nerve preclude safe (i.e. clearly seen) strictly intra-abdominal progressive dissection of the oesophagus – as is often the case – the authors prefer to sever them despite the increased risk of postoperative cholecystolithiasis because the risk relating to poor visualization of the retro-oesophageal dissection is considered too high. It is possible that use of an angled laparoscope could help to avoid this problem.

Dissection of the greater curvature has to be complete and must involve all the uppermost short gastric vessels. It is, however, straightforward and becomes cumbersome only when a haematoma appears in the gastrosplenic ligament after accidental tear of a short gastric vessel. This problem is obviously worse in the obese patient. The fundoplication itself is usually simple. While the surgeon is performing the suturing, the assistant can easily pull the oesophagus downwards by grasping the upper part of the stomach and pulling it distally.

Good results have been described with a short floppy wrap[3]. In the present series, however, a relatively long, but very loose, wrap attached to the oesophagus was constructed as this has been the authors' practice in open surgery and in their experience is not associated with postoperative long-term dysphagia. The operation time, which is an important factor because of possible metabolic acidosis, reduced venous return and impaired pulmonary compliance, should be kept reasonably short[4,5]. Improvements in surgical technique, as well as increased experience, reduced the operating time to acceptable levels, comparable to that of open surgery; the mean operating time for the last ten patients was 87 min.

Postoperative pain was minimal because surgical trauma on the abdominal wall and retraction of the costal margin are greatly reduced compared with the open procedure. Similar improvement has been noted in other laparoscopic *versus* conventional surgery[6–8]. On day 1 after operation all patients were out of bed and walking, complaining only of the discomfort caused by the nasogastric tube. Early ambulation probably improves pulmonary function[9]. Patients were discharged after a median of 3 days, comparing favourably with the open Nissen procedure for which the postoperative hospital stay in Europe[10] is usually 10 days.

There was no recurrent heartburn in the present series with short follow-up. Transient dysphagia seems to be minimal compared with that reported in the literature[3,11]. The liquid diet, however, probably reduces the number of complaints.

Most endoscopies performed at 3 months showed complete regression of the oesophageal mucosal lesions. The small number of patients who underwent postoperative manometry and 24-h pH recording precludes any valid conclusions. However, correction of these parameters is consistent with reported results[12–14] of classic Nissen fundoplication.

Laparoscopic Nissen fundoplication appears to be a promising technique because it reduces the perioperative morbidity rate and hospital stay while the short-term functional results seem to equal those of the open procedure[15]. This is not unexpected as the approach differs but not the procedure itself.

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