The Effect of Surgery on Pressure and Motility

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INTRODUCTION

An analysis of the effects of surgery on the function of the esophagus and lower esophageal sphincter (LES) is complicated by the many variables that must be addressed. These include the technical aspects of the fundoplication itself (laparoscopic vs. open, complete vs. partial wrap, closure of the crura, etc.), the interval between operation and assessment, and the preoperative esophageal function. These variables will be assessed in regards to the effects of fundoplication on esophageal peristaltic function and the LES pressure and physiology.

TRADITIONAL (OPEN) FUNDOPICATION

The influence of open fundoplication on esophageal and LES function has been an area of active interest for many years. In 1974, DeMeester et al. performed a small prospective randomized trial comparing Nissen fundoplication (360° wrap), Hill repair (lesser curvature placation and posterior gastropexy to the preaortic fascia), and the transthoracic Belsey repair (270° fundoplication with crural buttressing) in patients with gastroesophageal reflux disease (GERD). Fifteen patients in each group were studied before and at approximately six months postoperatively. Following each operation, LES pressure was noted to increase along with a corresponding lengthening of the intraabdominal segment of the LES [1]. Nissen fundoplication resulted in a slightly greater postoperative LES pressure (26 ± 8 mm Hg) compared to both the Belsey (21 ± 7 mm Hg) and Hill procedures (20 ± 6 mm Hg). In a subsequent study, Stein and associates assessed 40 patients before and at a mean of 30 months following “short, floppy” Nissen fundoplication [2]. LES pressure in these patients tended to be low preoperatively and normalized along with an increase in both the total length and the intraabdominal length of LES. In the subgroup of patients with a mild diminution in mean amplitude of esophageal peristalsis preoperatively, postoperative function was improved but did not attain normal levels.

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bAbbreviations: LES, lower esophageal sphincter; GERD, gastroesophageal reflux disease.
Those with mean amplitude levels < 35 mm Hg did not improve, resulting in a high incidence of dysphagia. This lack of postoperative improvement was ascribed by the authors to submucosal deposition of collagen with a decrease in esophageal muscle fibers [2].

In a small randomized prospective trial comparing Nissen fundoplication to the Toupet procedure (transabdominal posterior 270° wrap), Thor and Silander studied 31 patients before, and at more than five years postoperatively [3]. Compared to preoperative measurements, there was no change in peristaltic function in either group. The Nissen fundoplication resulted in slightly greater mean postoperative LES pressure (19.5 ± 1.6 mm Hg), than did the Toupet procedure (16.9 ± 2.2 mm Hg). Vassilakis and colleagues assessed esophageal and gastric physiology before and at 6 to 9 months following Nissen fundoplication in 35 patients [4]. LES pressure increased significantly, as did the amplitude of esophageal peristalsis at both 5 and 10 cm above the manometrically defined LES. Using scintigraphic techniques, there was no postoperative change in esophageal transit, but both the lag phase and $T_{1/2}$ of gastric emptying of solids was accelerated.

In another manuscript describing the influence of Nissen fundoplication on LES function, Ireland et al. studied 18 patients before and at 4 to 28 months following surgery [5]. Mean LES pressure increased from 10.9 mm Hg to 14.5 mm Hg postoperatively. Swallow-induced LES relaxation was rendered incomplete, while both swallow-induced and transient LES relaxation were incomplete postoperatively, associated with a decrease in the frequency of transient LES relaxation associated with gastroesophageal reflux [5].

Watson et al. have described a novel technique for treatment of GERD, utilizing crural closure with intraabdominal fixation of the esophagus and a 120° anterolateral fundoplication [6]. Utilizing this technique in 100 patients studied before, and at 3 months after surgery, LES pressure increased to a minimal, but significant degree (from 9.4 ± 1.2 mm Hg to 11.2 ± 1.3 mm Hg). The intraabdominal length of the LES increased by 50 percent, and swallow-induced LES relaxation was improved. The influence of this operation, which includes closure of the diaphragmatic crura, on the function of the “diaphragmatic crural sling” has also been assessed before and after surgery [7]. In patients with GERD undergoing the Watson procedure, the manometrically determined crural pressure increased from 7.1 mm Hg to 11.6 mm Hg postoperatively (p < 0.02; 7).

Although the postoperative interval to follow-up in the above studies has varied from 3 months to 10 years, an additional report sequentially measured LES pressure in a small group of patients with GERD undergoing a variety of fundoplications [8]. In this study the patients were assessed preoperatively and at a mean of 8 months postoperatively; a subgroup was studied again after 4 to 7 years. In the late follow-up group, mean preoperative LES pressure of 8.7 mm Hg increased to 16.4 mm Hg at 8 months and then decreased to 10.9 mm Hg at late follow-up.

**OPEN VERSUS LAPAROSCOPIC FUNDOPICATION**

The emergence of laparoscopy has led to a renewed interest in operative therapy of GERD. However, few studies have compared laparoscopic and open fundoplication in regards to physiology of the esophagus and LES. One small non-randomized study suggested that laparoscopic total fundoplication caused a greater increase in LES pressure while inhibiting complete relaxation of the LES to a greater degree than open fundoplication [9]. However, the study groups were small, the interval to postoperative follow-up was markedly different in the two groups, and the patients in the laparoscopic fundoplication group encompassed the “learning curve” of the authors. A randomized
prospective trial of laparoscopic versus open Nissen fundoplication has subsequently been reported [10]. At 1 year postoperatively, the increase in postoperative LES pressure was slightly, but insignificantly, greater in the laparoscopic group. All other outcome measures were similar in the two groups.

Most other studies of laparoscopic fundoplication reveal postoperative physiology similar to that seen following open fundoplication, with increased LES pressure and either no change or enhancement of the peristaltic performance of the esophagus. Once again, laparoscopic total fundoplication appears to augment LES pressure to a greater degree than partial fundoplication. In a non-randomized comparison of laparoscopic Toupet and Nissen fundoplications, Bell et al. showed postoperative LES pressure to be significantly greater following the Nissen fundoplication (27 ± 4 mm Hg) than following Toupet fundoplication (18 ± 5 mm Hg) [11]. The prevalence of complete LES relaxation decreased slightly from 95 percent to 89 percent in both groups. In this series, mean amplitude of distal esophageal peristaltic pressure was also increased to a greater extent following the Nissen fundoplication (115 ± 40 mm Hg) than following Toupet fundoplication (69 ± 20 mm Hg). In another non-randomized comparison of laparoscopic Toupet and Nissen fundoplications, Lund et al. described postoperative LES pressure to be 15 ± 2 mm Hg following Nissen fundoplication compared to 11 ± 2 mm Hg following the Toupet fundoplication [12]. Thus, it appears as though laparoscopic and open fundoplication result in similar effects on esophageal and LES function, and that total fundoplications augment LES pressure to a greater degree than partial fundoplications.

EFFектS OF OPERATION ON PATIENTS WITH POOR PREOPERATIVE PERISTALTIC FUNCTION

A number of investigators have described the influence of fundoplication on esophageal physiology in GERD patients with poor preoperative esophageal function. In 300 patients undergoing either laparoscopic Nissen or Toupet fundoplications studied at one year postoperatively, Hunter and associates revealed that 47 percent of patients with “impaired peristalsis” improved, whereas 13 percent exhibited worse postoperative function [13]. In patients with low preoperative esophageal contraction amplitude, 75 percent improved and 10 percent worsened. Patti et al. described the outcome of laparoscopic Toupet fundoplication in patients with GERD and abnormal esophageal peristalsis [14]. Mean LES pressure increased from 8 ± 1 mm Hg to 12 ± 1 mm Hg and LES length increased from 1.7 ± 0.2 cm to 3.1 ± 0.2 cm. Although the degree of LES relaxation did not change, mean distal esophageal peristaltic amplitude increased from 32 ± 3 mm Hg to 49 ± 4 mm Hg and esophageal clearance time decreased from 1.2 ± 0.2 min to 0.7 ± 0.2 minutes. Lund and coworkers also studied 43 patients before and at 6 months following laparoscopic Toupet fundoplication in patients with GERD and “poor esophageal body motility” [12]. Both LES pressure and the intraabdominal length of LES more than doubled, as did the vector volume of the LES. Amplitude of peristalsis in the esophageal body increased from a mean of 28 ± 3 mm Hg to 40 ± 3 mm Hg. The percentage of simultaneous peristaltic
contractions decreased from 25 to 2.6 percent. Aye et al. assessed the influence of the laparoscopic Hill repair on esophageal function in patients with normal and abnormal esophageal function preoperatively [15]. LES pressure was increased in both groups, and 43 percent of patients with abnormal motility normalized at postoperative follow-up.

In addition to Stein et al.'s report of dysphagia and unchanged peristaltic function in patients with low amplitude esophageal contractions undergoing Nissen fundoplications [2], Lund and associates also noted total fundoplication to result in poorer results than partial fundoplication in those with abnormal peristaltic function [12]. However, two other reports have documented improved esophageal function in patients with disordered esophageal motility undergoing Nissen fundoplications. Ortiz Escandell et al. studied 12 patients with hypomotility before, and at a mean of 3.5 years following Nissen fundoplication [16]. LES pressure and length increased and mean esophageal contractile amplitude improved from 15 to 28 mm Hg. Half of the patients regained normal peristaltic function. Baigrie and coworkers reported 31 patients with disordered peristalsis undergoing laparoscopic Nissen fundoplication [17]. Mean LES pressure increased from 6.6 to 19 mm Hg and improved peristalsis was seen in 78 percent of the patients.

CONCLUSIONS

Based on the existing literature, several conclusions may be drawn concerning the effect of surgery on LES pressure and esophageal motility: Laparoscopic and open fundoplications appear to result in similar changes in performance of the esophagus and lower esophageal sphincter. Total fundoplication results in higher postoperative LES pressure than the various partial fundoplications. Fundoplication may inhibit transient LES relaxation and, when combined with crural repair, augments the pressure of the crural sling. Total fundoplication may cause dysphagia due to outflow resistance in patients with poor esophageal peristalsis. Partial fundoplications appear to improve esophageal physiology in most patients with disordered preoperative motility. Further studies are needed to elucidate the precise mechanism of action of antireflux surgery and to ascertain the long term results, given the recent renewed interest in operative therapy of gastroesophageal reflux disease.

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