Review

A relic or still relevant: the narrowing role for vagotomy in the treatment of peptic ulcer disease

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Abstract

BACKGROUND: Given the rise of medical treatment for peptic ulcer disease (PUD), surgical treatment is necessary only in select cases and emergencies. The authors assess the current relevance of surgical vagotomy to treat PUD and its complications.

DATA SOURCES: Although historically significant, selective and highly selective vagotomy is very technically challenging, and highly selective vagotomy has a relatively narrow indication and high recurrence rates. Vagotomy and gastrectomy is associated with significant side effects. Two types of vagotomy remain relevant, within a narrow scope. Truncal vagotomy and pyloroplasty is safe and efficacious through a laparoscopic approach in certain emergent cases. Vagotomy and Roux-en-Y gastrojejunostomy can be used to treat severe PUD refractory to medical management.

CONCLUSIONS: The role of vagotomy in the management of PUD has a rich history but predated pharmacologic control of acid and understanding of the role of \textit{Helicobacter pylori} in the disease. Thus, the current role of vagotomy is significantly limited. Specifically, the emergent use of truncal vagotomy is warranted for patients who are either resistant or allergic to proton pump inhibitors.

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The landscape for the treatment and management of peptic ulcer disease (PUD) has drastically changed over the past 50 years. Treatments started as primarily dietary and evolved through a period of surgical predominance to the current treatment landscape that relies mostly on medical management. In this report, we review the increasing evidence supporting a diminished, yet necessary, role for surgery in the management of PUD. Specifically, the role of vagotomy is examined and reevaluated in the surgical management of complicated PUD.

History of Vagotomy

The role of surgery in the treatment of PUD dates back to Andre Latarjet, who in 1922 reported the first human vagotomy in a study of 24 patients.\textsuperscript{1} However, given the high rates of delayed gastric emptying, \textless 100 operations were performed between 1922 and 1940. Instead, there was growing focus on the role of gastric resection during this time.\textsuperscript{2,3} However, Lester Dragstedt revived the role of vagotomy in the management of PUD and published his findings from \textgreater 200 thoracic vagotomies in 1947. Dragstedt’s work was greatly influenced by growing scientific data that supported the idea that vagal denervation could...
favorably reduce acid secretion and thereby improve the clinical course of duodenal ulcers. The following decades saw the rise of vagotomy with various modifications. In 1953, an evaluation of 200 patients undergoing vagotomy (and 40% with gastrectomy) showed excellent results in 93.4% of patients. Dragstedt et al. also went on to publish a critical evaluation of 100 patients undergoing truncal vagotomy and pyloroplasty. Thus, from the rejuvenation of vagotomy in 1947 by Dragstedt, vagotomy in combination with either pyloroplasty or antrectomy, started to become the gold standard for the treatment of PUD and its most common complications, including bleeding and obstruction.

However, by the 1970s and 1980s, H2 receptor antagonists for gastric acid suppression and proton pump inhibitors (PPIs) were introduced, forever changing the treatment of the disease. In a landmark report, the results of a double-blind controlled trial of cimetidine showed ulcer healing in 66% of patients within 6 weeks. Concurrently, Drs Barry Marshall and Robin Warren completely altered the conventional wisdom regarding the etiology of PUD by proving that *Helicobacter pylori* was found in the stomachs of 75% to 85% of patients with PUD. Their discovery earned them the Nobel Prize in medicine in 2005 and ushered in a paradigm shift in both the understanding and treatment of PUD. In the United States, *H pylori* infection and the use of nonsteroidal anti-inflammatory drugs are the predominant causes of PUD, accounting for 48% and 24% of cases, respectively. Specific to *H pylori*, the pathophysiology of PUD is now firmly based on the fact that *H pylori* infection and concurrent inflammation cause increased levels of gastrin release and decreased gastric mucous and duodenal mucosal bicarbonate. The decline of protective factors and increased secretion of gastric acid is instrumental in the ability of *H pylori* infection to cause PUD.

Given the discovery of the crucial role of *H pylori* in the etiology of PUD, the decrease in the incidence of *H pylori* infection secondary to improved sanitation, and the exponential rise of PPIs in the management of the same, the continued role and importance, if any, of surgical vagotomy in the treatment of PUD is brought into question. Numerous studies have firmly established the positive effect of vagal stimulation on gastric acid secretion compared with the antisecretory effects of PPIs. In the remainder of this article, we review the current roles of various types of vagotomies and explore current patterns of practice for the treatment and management of the most common presentations of PUD, including bleeding, obstruction, and perforation.

**Types of Vagotomy for Peptic Ulcer Surgery**

**Selective vagotomy**

The first truncal vagotomy dates back to Latarjet in 1921, and the procedure gained popularity through the work of Dragstedt in 1943. However, given the lack of a drainage procedure, one third of patients developed delayed gastric emptying after truncal vagotomies. Thus, Dragstedt advocated the addition of a drainage procedure, and the next 30 years also saw a progressive refinement of the vagotomy to increase selectivity.

Selective vagotomy, defined as the division of vagal fibers to the stomach with preservation of the hepatic and celiac branches, dates back to 1922 and was first described by Wertheimer and Latarjet. In 1947, Jackson and Franksson, independently, introduced selective posterior vagotomy and total anterior vagotomy. This was followed, in 1948, by 2 significant advances. First, Moore was responsible for a selective vagotomy that included total denervation of the stomach with preservation of the hepatic and celiac supplies of the vagus, resulting in fewer postvagotomy side effects. Franksson also performed a selective anterior and posterior vagotomy with preservation of the pyloric ramus without drainage. Work on refinement of the selective vagotomy technique continued, and in 1963, a study presented results from 52 patients who underwent selective gastric vagotomy. It confirmed that selective vagotomy, by preserving enervation of the gallbladder, pancreas, and major parts of the intestine, was associated with less diarrhea and dumping syndrome compared with truncal vagotomy alone. It was also considered to be at least as effective as truncal vagotomy in establishing full vagal denervation. A 1969 study confirmed that selective vagotomy is capable of reducing the incidence of dumping syndrome but is unable to control duodenal ulcer diathesis given the high secretory potential of the innervated antrum of the stomach.

Although it is of historical significance, there are very few practicing physicians who use selective vagotomy. This operation did not gain wide clinical acceptance because it was much more challenging than truncal vagotomy, and it was unclear that the scientific advantages of the operation translated to actual clinical benefit. Selective vagotomy appears to have no role in the current management of PUD.

**Highly selective vagotomy (HSV)**

Given the interest in combating delayed gastric emptying and reducing the need for drainage procedures, continued emphasis was placed on increasing the selectivity of the vagotomy operation. HSV was first introduced by Griffith and Harkins in 1957. A landmark report from 1970, “Highly Selective Vagotomy Without a Drainage Procedure in the Treatment of Duodenal Ulcer” by Johnston and Wilkinson, provided significant evidence to support the continued role of HSV in the treatment of PUD. Technically they described selective denervation of the parietal cell mass by dividing the nerve branches of the anterior and posterior vagus as they enter the stomach. Because these nerves are mingled with their blood supply, this was usually accomplished by close devascularization of the lesser curvature of the stomach from just above the gastroesophageal junction to the “crow’s foot” on the antrum. They defined the clinical indication for HSV as chronic PUD and treated 25 patients.
with HSV without drainage. Their results proved that HSV was able to cure the ulcer effectively without the side effects of dumping and diarrhea associated with other vagotomy operations. The early postoperative outcomes included no deaths, and within a 3-month to 11-month follow-up period, 23 of 25 patients were free of side-effects. The early conclusion from this work was that HSV, by denervating the parietal cell mass but leaving the antrum innervated, might be sufficient in curing patients with chronic duodenal ulcers.22

The first large series of HSV patients shed further light on HSV and its outcomes. Specifically, early postoperative outcomes were best defined by Macintyre et al23 in “Highly Selective Vagotomy 5-15 Years On.” The report included data from 307 patients who underwent HSV for duodenal ulcer between 1973 and 1983 without operative mortality. Of these, 92.2% were followed up prospectively for ≥5 years. Recurrent ulcer was diagnosed in 17.3%, increasing from 13.2% at 5 years to 19.4% at 12 years. However, despite the high recurrence rate, the operation was successful in controlling ulcer symptoms in approximately 90% of patients and produced mild to moderate postvagotomy symptoms in only 5% of patients.

The laparoscopic approach to HSV has been by published by several authors. In general, the indication for laparoscopic vagotomy remains the same as for open surgery: failure of medical therapy. Additionally, the goals of the laparoscopic approach include pylorus preservation, low to zero mortality, and very few side effects. HSV associated with pyloric stenosis can be treated with laparoscopic HSV and pyloroplasty.24

With regard to laparoscopic HSV, the first case report comes from 1992, with the explicit aim of determining whether the laparoscopic approach to HSV might be associated with low morbidity, negligible pain, short hospital stay, reduced time away from work, minimal postoperative gastrointestinal complaints, and low recurrence rates and thus may serve as an alternative to open HSV.25 A follow-up study published in 1994 and another in 1999 followed 35 and 33 patients, respectively, who underwent laparoscopic HSV for recurrent duodenal ulcer disease. The studies confirmed initial hypotheses that laparoscopic HSV was both safe and efficacious. Initial follow-up data showed no mortalities, similar results from postoperative gastric acid secretion studies as those obtained after open HSV, and 2 clear advantages from laparoscopic HSV.26

The documented long-term benefit of HSV rests on its low mortality (.1% to .3%) and morbidity (5%) rates.29 Specifically, the preservation of vagal innervation to the distal part of the stomach greatly limits the occurrence of dumping syndrome and diarrhea.30–32 However, the success of HSV is related to the operative experience of the surgeon, and the major detractor of HSV is its relatively high recurrence rate of approximately 5% to 30%.28,30,33 HSV is probably not suitable for patients with intractable duodenal ulcer disease, PUD causing gastric outlet obstruction, fundic peptic ulceration, and perforated PUD with >24 hours of soilage.30 The patients who are classically considered to be candidates for HSV are few and far between, and their inherent pathophysiology tends to be associated with an inordinately high recurrence rate. Therefore, because of the steep learning curve and the narrow indication, plus the potential recurrence rates, HSV will likely disappear from the surgical “playbook” for PUD.

Truncal vagotomy and pyloroplasty

In addition to increasing the selectivity of vagotomy, other types of vagotomy also attempted to provide definitive relief from chronic ulcers without significantly disturbing the normal functions of digestion.

Vagotomy and pyloroplasty was first reported by Weinberg in 1956 and further refined and popularized by Holle and Hart in 1967, with the explicit goal of attempting to prevent gastric stasis. The clinical indication for vagotomy and pyloroplasty was chronic duodenal ulcers, refractory to other treatments. Weinberg et al reported the first large series of vagotomy and pyloroplasty patients in 1956. The goal of the vagotomy and pyloroplasty was to “obtain permanent healing with minimum disturbance of function of digestion.” Two hundred patients were followed for early postoperative outcomes. Overall, 89.5% were considered to have “good outcomes.” There was a 5% incidence of recurrence and a 5.5% incidence of postoperative sequelae (including diarrhea and dumping syndrome). Last, the mortality rate was <.5%. The long-term benefit of vagotomy and pyloroplasty was the focus of a study looking at 182 patients for 5 to 8 years after truncal vagotomy and pyloroplasty. The study confirmed 1 death, reduced frequency of dumping syndrome and diarrhea, but an increased recurrence risk of 6.7% to 7.3%. Thus, the authors recommended reconsidering vagotomy and pyloroplasty as a gold standard for definitive acid reduction.

Further research from Emos and Eriksson, in 1992, presented results from a 12-year prospective and randomized trial to compare and contrast selective proximal vagotomy with and without pyloroplasty. The ulcer recurrence rate was lower (13%) in patients who underwent selective proximal vagotomy with pyloroplasty. Additionally, Visick I and II results (excellent and good) were achieved in 75% of patients who underwent pyloroplasty, compared with only 54% of patients who underwent selective proximal vagotomy alone. Thus, the researchers concluded that the addition of pyloroplasty was advantageous and that although dumping was more frequent with pyloroplasty, it was considered to only be a “mild problem” by patients.24
Truncal vagotomy is a safe operation. It can be done by almost every general surgeon and can usually be done laparoscopically with minimal morbidity. Because of its reasonable safety profile, vagotomy and pyloroplasty will continue to be used in selected patients in urgent and emergent conditions predominantly.

Vagotomy and gastrectomy (Billroth I or II)

Vagotomy and gastrectomy gained popularity during the early 1960s in response to the adverse outcomes associated with vagotomy or gastrectomy alone. The first successful partial gastrectomy alone dates back to Billroth in 1881.

The clinical indication for selective vagotomy and gastrectomy was first defined by Hamilton et al in a large comparative study of vagotomy and emptying procedure versus subtotal gastrectomy in 1961. The authors concluded that the actual ulcer recurrence rate was 12% for vagotomy and 8% for gastrectomy. However, the mortality rate was 1.0% for vagotomy and 3.0% for gastrectomy. Thus, given these early postoperative outcomes, the authors concluded that vagotomy should continue to be used for poor-risk patients or in cases of duodenal compromise. However, in all other cases, vagotomy and gastrectomy was preferred to subtotal gastrectomy. Since the 1960s, vagotomy and gastrectomy has shown limited long-term benefit in patients with duodenal ulcers causing intractable pain. Additionally, the laparoscopic approach to vagotomy and gastrectomy has been by published by several authors and confirms that the laparoscopic approach has the advantages of minimal access approach.

However, vagotomy and gastrectomy has several documented disadvantages. It has a higher mortality rate compared with other vagotomy types and a 5% to 10% incidence of dumping syndrome, diarrhea, delayed gastric emptying, and afferent or efferent limb problems. Vagotomy and antrectomy has the greatest ability to control acid secretion long term because of the elimination of gastrin and the denervation of the parietal cell mass. The reported ulcer recurrence rate for vagotomy and antrectomy, 5%, is probably low for patients operated on today but is lower than recurrence rates reported for vagotomy and pyloroplasty. Other than total gastrectomy, vagotomy and antrectomy is the most aggressive form of surgical control of ulcer diathesis.

Clinical Presentations and the Role of Vagotomy

The role of vagotomy for bleeding peptic ulcer disease

The most common presentation of PUD is bleeding, occurring in roughly 15% to 20% of patients with PUD. Most concerning, it is the most common indication for surgery and most common cause of mortality in patients with PUD. Overall, 80% of bleeding peptic ulcers can resolve spontaneously with medical treatment alone. However, in cases of actively bleeding vessels, visible vessels, or adherent clots, endoscopic intervention is recommended. In experienced hands, there is consensus that initial homeostasis can be achieved by the use of singular or combined endoscopic methods, including injection, thermocoagulation, or mechanical treatment with endoclips or band ligation. In the case of continued bleeding, studies have shown that repeated endoscopic treatment, after initial treatment, can achieve permanent bleeding control and reduce the need for surgery, morbidity, and mortality, relative to a single trial. However, after initial endoscopic homeostasis, roughly 10% to 25% of patients with bleeding ulcers will rebleed. This bleeding generally occurs within 48 to 96 hours of the initial intervention and is most commonly associated with gastric ulcers and duodenal ulcers along the posterior wall. Ultimately, 10% to 20% of patients admitted for bleeding peptic ulcers, resulting in upper gastrointestinal bleeds, require surgical intervention. Specifically, surgery is warranted when a bleeding peptic ulcer is refractory or inaccessible to initial therapeutic endoscopy. Thus, when endoscopic methods fail after 2 attempts, patients should undergo surgical oversewing of the bleeding ulcer or angiographic embolism. However, it is recommended that surgery be considered after the first rebleed for both elderly patients and those with severe comorbid conditions.

Before proceeding to surgery, some centers will attempt embolization (usually of the gastroduodenal artery), in the hope of controlling the bleeding without the morbidity of an operation. The choice of surgery versus embolization is often made on the basis of the clinical condition of the patient and the expertise available.

Studies have compared 2 different types of surgical approaches for bleeding peptic ulcers: vagotomy and drainage and vagotomy and resection. Specifically, surgical outcomes were compared for 907 patients who underwent either procedure. The investigators concluded that there were no statistically significant differences in 30-day mortality, morbidity, or rebleeding rates between surgical groups. However, vagotomy and resection was associated with a longer postoperative hospital stay compared with vagotomy and drainage.

At the time of surgery (most commonly done open, although laparoscopic approaches have been described), the duodenum is opened and the ulcer is oversewn. The opening in the duodenum is often made through a pyloroplasty type of exposure, which facilitates closure of the duodenum. The use of truncal vagotomy in this setting should be reserved for a small group of patients who have ulcer production that cannot be controlled by medication (ie, those allergic or nonresponsive to PPIs). There is currently no indication for selective or HSV in the setting of bleeding PUD.

Gastric ulcers that bleed occur in patients with relatively low acid production and therefore require resection to stop bleeding, not acid reduction. When surgery is required,
the most common operation is distal gastrectomy for those ulcers in the lower half of the stomach. For bleeding ulcers in the upper stomach, gastric wedge is usually optimal. Vagotomy is rarely indicated in bleeding gastric ulcers because there is little or no need for acid reduction in patients with bleeding gastric ulcers.

The role of vagotomy in perforations from peptic ulcer disease

Perforations occur in 2% to 10% of peptic ulcers and are mostly found on the anterior wall (60% of cases) and occasionally in the immediate prepyloric area. Mortality rates can be as high as 30% to 50% in elderly patients. In addition to their incidence, location, and mortality risk in select populations, the most notable feature of perforations is their ability to spontaneously seal themselves off. This occurs in approximately half of all cases, and some of these cases require no surgical therapy. Criteria for spontaneous sealing, as documented on a Gastrografin upper gastrointestinal series, include the following: demonstration of an ulcer, filling of the duodenum, and lack of spillage of the contrast directly into the peritoneal cavity. However, it is noteworthy that failure to demonstrate spillage in the absence of filling of the duodenum is not sufficient to establish self-sealing. In patients who have demonstrated self-sealing and are clinically improving, nonoperative management has been documented to be successful.

The perforated ulcers that do not seal by themselves, however, do necessitate additional treatment and management. Surgical options include laparoscopic or open closure or Graham patch for the vast majority of patients with perforated duodenal ulcer disease. For patients with perforated gastric ulcers, anatomic gastric resection or gastric ulcer excision may be necessary. There is evidence that delaying laparotomy beyond 12 hours of symptom onset can worsen outcomes.

Vagotomy has very little role in the routine management of perforated PUD. Relative contraindications to the addition of vagotomy to a simple Graham patch include complicating medical morbidity, preoperative shock, severe generalized peritonitis, or the presence of an intra-abdominal abscess. Additionally, omeprazole has proved efficacious in the early postoperative period to facilitate ulcer healing. In the past, it had been recommended that in otherwise healthy patients with histories of chronic ulcer and minimal peritoneal contamination, Graham patch plication should be paired with a definitive antiulcer procedure (eg, vagotomy and drainage, HSV, proximal gastric vagotomy in addition to omental patch closure). In experienced hands, these procedures are not associated with increased mortality, morbidity, or recurrence compared with truncal vagotomy and pyloroplasty or resection. Today, there is very little indication to add vagotomy to the simple patch procedure. With the use of PPIs and through H pylori eradication, most patients will have a sufficiently low recurrence, thereby greatly limiting the justification for vagotomy. Patients who might benefit from vagotomy during the surgical treatment of perforated PUD include stable patients with minimal soiling who are resistant or allergic to PPIs and those with known high recurrence rates on the basis of history (cigarette or aspirin abusers).

Patients with perforated gastric ulcers (perforations proximal to the immediate prepyloric position) are treated in a similar fashion to bleeding gastric ulcers in the same location. Again, vagotomy is rarely indicated in the case of perforated gastric ulcers.

Laparoscopic repair of perforated ulcers has been shown to be safe and effective, and the specific type of laparoscopic repair generally depends on the nature of the perforated ulcer. Ulcers with viable opposable edges benefit from suture repair of the duodenal wall and omental patch, while ulcers with friable edges benefit from repair with omental patch alone. Overall, all types of laparoscopic repair of perforated duodenal ulcers have been shown to be associated with shorter operative times, reduced pain perception postoperatively, reduced postoperative analgesia, earlier ambulation, lower incidence of respiratory infection, shorter hospital stays, and earlier return to baseline level of physical activity.

Additionally, consensus has developed regarding those patients who should not be treated laparoscopically. Specifically, open exploration is indicated for Boey score >3 (associated with preoperative blood pressure <100 mm Hg, delayed presentation >24 hours, and major medical illness), age >70 years, and symptoms persisting for >24 hours.

Vagotomy for gastric outlet obstruction

PUD can also present as gastric outlet obstruction, with an incidence of 5% to 8%. Esophagogastroduodenoscopy or gastroduodenoscopy is used to establish the diagnosis and determine the exact site, cause, and degree of obstruction. In general, ≥72 hours of nasogastric tube decompression, to evacuate the stomach contents, is recommended before considering any surgical intervention for gastric outlet obstruction secondary to PUD. Chronic obstruction can be treated with endoscopic balloon dilatation or surgery (vagotomy and pyloroplasty, antrectomy, or gastroenterostomy). However, it is noteworthy that there is a general dearth of long-term follow-up data on this patient population, and patients often require repeated dilations.

Overall, the role of surgery in obstructive PUD seems to be limited to patients in whom conventional medical treatment fails and those in whom attempts at endoscopic dilation fail. The ideal operation should be able to both diagnose and treat the condition by relieving the obstruction and controlling the underlying ulcer disease. Additionally, it should have low associated mortality and morbidity rates and negligible late-onset side effects. For older patients who are nonsmokers and do not take aspirin, an outlet procedure such as a laparoscopic gastrojejunostomy is often the simplest operation to relieve this obstruction. If the obstruction is not associated with active ulceration,
vagotomy does not need to be added and further acid secretion can be controlled with a daily PPI. Addition of vagotomy to a chronically obstructed stomach can lead to chronic gastroparesis, which may be poorly tolerated and not well controlled by medications.

In younger patients who smoke and/or use aspirin, at least a vagotomy and antrectomy is needed. Lesser operations are likely associated with recurrence, unless there is certainty that the patient will stop using both cigarettes and aspirin.

Vagotomy and intractable pain from peptic ulcer disease

PUD associated with intractable pain usually warrants either an open approach or a laparoscopic vagotomy and antrectomy. More selective operations are associated with recurrent disease. These patients invariably use and abuse cigarettes and/or aspirin and have a very high recurrence rate. HSV or vagotomy and pyloroplasty is rarely appropriate because of the recurrence rate. Even with vagotomy and gastric resection, the recurrence rates remain unacceptably high.23,37,50

Conclusions

The role of vagotomy in the management of PUD has a rich history but predated pharmacologic control of acid and understanding of the role of H. pylori in the disease. Our current recommendations for the use of vagotomy in these patients as summarized in Fig. 1 are much narrower than previous reported: (1) Vagotomy alone without major gastric resection has little or no role in intractable PUD, because of high recurrence rates. (2) Selective vagotomies have little or no role in the modern management of any surgical complications of PUD. (3) Emergent use of truncal vagotomy is necessary only for patients resistant or allergic to PPIs. (4) Truncal vagotomy with antrectomy should be used to treat resistant or complicated PUD in patients expected to have high recurrence with less aggressive forms of medical and surgical therapy.

References


