



Parietal Cell Vagotomy versus Vagotomy-antrectomy: Ulcer Surgery in the Modern Era

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Abstract. Patients with peptic ulcer occasionally develop complications that require surgical intervention, despite the advances in medical treatment and changes in the natural history of disease. The clinical surgeon must make a decision about performing “selective vagotomy antrectomy versus highly selective vagotomy,” based on the information discussed herein. The goals for operative treatment remain safe correction of the presenting problem, avoidance of perioperative morbidity and mortality, and freedom from disabling postoperative side effects. This paper addresses broad aspects of the details of surgical interventions; because most operative procedures are performed in urgent circumstances in patients who often have a variety of conditions, it is not surprising that there is no best operation suited to every complication of ulcer.

Peptic ulcer complications present unique challenges for digestive surgeons in the modern era. Although the incidence of surgical emergencies has markedly diminished in recent times, some patients still require elective, urgent, or emergent intervention for complications of ulcers [1, 2]. Despite evidence that *Helicobacter pylori* infections are a critical component in ulcer pathogenesis, and despite the availability of more specific and effective medical treatments, some patients with bleeding, perforation or obstruction of the gastric outlet require surgical treatment [3, 4].

Modern physicians, the first to have the benefit of recent discoveries concerning *Helicobacter* in ulcer pathogenesis, now aim medical treatments at the chronic infection that causes the ulcer, leading to prompt and lasting cure in most patients [4, 5]. Some, however, do not respond to treatments, for reasons which may be obvious, such as chronic use of nonsteroidal anti-inflammatory drugs (NSAIDs), or obscure, as in those with *Helicobacter*-negative ulcer conditions [4].

Questions of pathogenesis are of secondary importance when a patient presents with a surgical complication; at that time the main concern is appropriate treatment of the presenting problem. Surgeons must address the issue of whether to perform parietal cell vagotomy or vagotomy-antrectomy. The goals for operative treatment remain safe correction of the presenting problem, avoidance of perioperative morbidity and mortality, and freedom from disabling postoperative side effects. The subsequent discus-

sion addresses broad aspects of the technical issues surgeons must consider when planning surgical interventions. Treatments must be based on the pathophysiology of the presenting problem and the age and status of the patient undergoing surgery. Because most of these operative procedures are performed in urgent circumstances in patients who may have other illnesses, it is not surprising that there is no best operation suited to every ulcer complication.

Vagotomy Techniques

Although vagotomy techniques have not changed substantially in recent years, they deserve reiteration periodically for the particular benefit of surgical trainees who, because of a declining incidence of ulcer operations, have not had the same opportunities to refine their technical skills as did previous generations of surgeons. Several recent books originating in our medical center illustrate the types of vagotomy [6, 7]. These textbooks contain a wealth of material, including historical aspects of gastric surgery, insights by the originator of the selective and parietal cell vagotomy, and presentations by many surgeons who introduced refinements in the currently performed operations for gastric and duodenal ulcers.

Truncal Vagotomy

Truncal vagotomy (TV) has been performed in a systematic way for 60 years, beginning with the Dragstedt school in Chicago. Prior to its introduction, an effective ulcer operation by definition required about 70% gastric resection, and there were substantial numbers of perioperative problems. Following the introduction of TV, there were several effective operations for ulcer, including TV with pyloroplasty or TV with antrectomy (TV-A), both of which were generally effective but were not associated with the same risk of postoperative complications. The avoidance of gastric resection and its associated (and inevitable) morbidity and mortality stands out as the major advantage of operations that incorporate TV. TV performed with pyloroplasty (TV-PyP) or gastroenterostomy has a recurrent ulcer risk of 10%, which is good but not outstanding; TV-A has a recurrent ulcer risk of $\leq 1.0\%$, accounting for its

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present position as the “gold” standard operation for duodenal ulcer.

The past records of TV-A and TV-PyP are well known to surgeons based on a steady stream of clinical reports about ulcer operations when these operations were commonly performed in all medical centers. Although these results may not be strictly applicable to modern patients, they provide a rational basis for decisions that must be made in urgent circumstances.

Truncal vagotomy still has a major role in the primary treatment of ulcers, especially in emergent or urgent circumstances or for treatment of recurrent ulcers; the latter can often be treated successfully by a transthoracic vagotomy. Other forms of vagotomy, including selective vagotomy or parietal cell (highly selective) vagotomy, are less frequently performed in current times, even by enthusiastic supporters of these physiologically “superior” procedures, owing to the urgent circumstances surrounding the presentation of modern patients with ulcer complications. This is unfortunate, as the emergence of minimally invasive techniques for vagotomy, which are mentioned subsequently, has added a positive dimension to elective ulcer surgery.

Selective Vagotomy

The evolution of surgical procedures for chronic duodenal ulcer proceeded rapidly in the aftermath of Dragstedt’s reintroduction of vagotomy [8, 9]. When TV was found to delay gastric emptying, it was combined with either pyloroplasty or partial gastric resection. During the late 1940s and early 1950s vagotomy techniques became more “selective,” with the goal of preserving function in the liver, gallbladder, and other splanchnic organs, including parts of the stomach [2]. Selective gastric vagotomy (SV) was more generally effective in denervating the stomach than TV because it required meticulous periesophageal dissection; as a result, SV with pyloroplasty was more effective for treating ulcers than TV with pyloroplasty. Despite this advantage, SV was not popular in North America, partially because surgeons believed the operation to be needlessly complex [10–13].

Selective vagotomy has several theoretic advantages compared to TV: preservation of vagal innervation to the gallbladder and the celiac plexus, and more reliable denervation of the gastric parietal cell mass. The clinical results after SV showed a lower ulcer recurrence rate than after TV (when SV-PyP was compared to TV-PyP), avoidance of gallbladder dysmotility and gallstones, and possible avoidance of postvagotomy diarrhea, a low-incidence problem that may have been mostly related to dumping syndrome. Most U.S. surgeons apparently found SV needlessly complicated, despite its theoretic advantages; as a result, SV was not the operation of choice in most medical centers. Both TV-A and SV-A were uniformly more effective in curing ulcers than proximal gastric vagotomy (PGV)/parietal cell vagotomy (PCV) and would never have been supplanted as the “best” ulcer operations except for their postoperative side effects, which are serious in some individuals [11, 12].

Parietal Cell Vagotomy

Parietal cell vagotomy (PCV), also known as proximal gastric vagotomy (PGV) or highly selective vagotomy (HSV), divides the preganglionic vagus fibers to the acid-producing portion of the stomach [14]. When the operation was performed according to

anatomic landmarks, the term HSV was utilized; in contradistinction, the term PCV had a connotation that intraoperative pH testing was used as a guide to completion of the operation [9, 10, 15–17]. The major advantages of PCV/PGV are safety of performance and the absence of postoperative symptoms; however, the risk of recurrent ulcer is highly variable among reports, ranging from 1% to 30%. Most U.S. surgeons have not been attracted to ulcer operations with such variable results and have not been enthusiastic about this operation. More recently, the “extended” HSV (EHSV), developed in the experimental laboratory on the basis of operating room observations during tests for completeness of vagotomy, has been shown to be more than 95% effective in curing ulcers [6, 15–17]. Most recently, EHSV has been performed by minimally invasive techniques in carefully selected patients with ulcer, encouraging the surgeons who have used this operation for years that there is still a target group who can benefit from it. Although effective, the future of EHSV is still unclear; there are fewer candidates for elective operation and a declining number of surgeons who are experienced with its use.

Choice of Operation for Complications (Table 1)

There is still considerable controversy about the choice of operation for ulcer complications, as shown by the divergent paths that guide individual surgeons in their choice of operation for these common emergencies. The choice of operation is influenced by the type and severity of pathology, the condition of the patient, and the subjective bias of the operator (Table 1). In general, patients who are near death and have serious co-morbidities undergo less invasive operations; whether this approach lessens the overall mortality associated with ulcer complications in this cohort is unclear. For example, approximately 10% of patients with perforated ulcer die as a result of multiple organ failure following perforated ulcers; the surgeon who routinely performs gastric resection in such patients may be criticized for doing “too much” in a situation when a lesser operation might have sufficed. In this modern world, such concerns cannot be minimized; therefore it seems obvious a priori that minimal procedures will continue to have a role in the treatment of such patients.

In some areas, gastric resection (Billroth I or II) is a mainstay of treatment for almost all complications, whereas in others these procedures are reserved for specific problems. For example, although most patients with a duodenal ulcer can be treated without resection, the presence of a giant gastric ulcer or a type IV gastric ulcer makes the use of a gastric resection of some type almost mandatory. The fact that surgeons continue to debate the relative merits of operations lends support to my belief that there is no single approach that is ideal for all patients. The modern surgeon must be prepared to individualize the treatment for ulcer complications based on the individual patient’s unique presentation, anatomic findings, and physiologic condition.

Gastric Resection for Duodenal Ulcer

Beginning in the late 1800s, gastric resection was performed in Europe, where the operation was introduced for treatment of obstructing gastric cancer. Because these patients had far-advanced disease, operations that could relieve obstruction had a definite place in the surgical clinic. At the time, ulcers were not nearly as common as they became during the early twentieth

Table 1. Surgical treatment of ulcers.

Ulcer complication	Compromised patient	Ideal surgical candidate
Perforated ulcer	Omental patch Ulcer excision with omental patch	Omental patch alone Ulcer excision with patch TV/SV + PyP EHSV with/without PyP TV/SV + Billroth I/II resection
Obstructing ulcer	HSV + PyP/ gastrojejunostomy TV/SV + PyP TV/SV + Billroth I/II resection	EHSV + PyP/gastrojejunostomy (open or laparoscopic) TV/SV + PyP (open or laparoscopic) TV/SV + Billroth I/II resection
Bleeding duodenal ulcer	TV/SV + pyloroplasty TV/SV + Billroth I/II resection	EHSV + PyP (oversew ulcer) TV/SV + Pyp (oversew) TV/SV + Billroth I/II resection
Bleeding gastric ulcer	Oversew/excise bleeding point TV/SV + PyP + oversew/excise bleeding point or TV/SV + Billroth I/II resection	EHSV + Pyp (oversew ulcer) TV/SV + PyP (oversew) TV/SV + Billroth I/II resection
Marginal ulcers after TV-PyP or TVA	Repeat TV (abdominal or transthoracic)	

HSV: highly selective vagotomy; TV/SV: truncal vagotomy/selective vagotomy; TVA: truncal vagotomy antrectomy; EHSV: extended highly selective vagotomy; PyP: pyloroplasty.

century, when surgical treatment was the only truly effective treatment for ulcer complications. Between 1920 and 1960 the great surgeons of preceding generations discovered safe ways to remove parts of the stomach and to perform gastrointestinal anastomosis; in the process they continued the search for “better” operations for ulcer, including variations such as sleeve resection of the stomach, suprapyloric antrectomy, near-total gastrectomy, and subtotal gastrectomy. During this interval it became clear to many surgeons and patients that surgical cure of the ulcer was sometimes the beginning of a lifelong saga of digestive complaints, collectively referred to as the postgastrectomy syndrome. The important message up until 1969 was that ulcer could be cured, and that the best overall approach was a combination of TV with limited gastric resection. On average, the recurrence rate for duodenal ulcer (TV without resection) was 10%, with most of the recurrences ascribed to incomplete vagotomy or excessive acid secretion from other causes. The “combined operation” (TV with 25–50% resection) was found to have a low recurrence rate (< 1%), and was eventually recognized as the best overall operation for ulcer with respect to recurrence [8, 11, 12].

Several distinguished surgical clinics, including the Edwards Clinic in Nashville, the Harkins Clinic at the University of Washington in Seattle, and others, were innovative in terms of investigating the problems associated with these operations. The group in Seattle became best known for the “combined” operation, the TV-A, which was regarded as the best operation for ulcer for almost 30 years, despite its association with dumping, diarrhea, and other postgas-

trectomy symptoms [8]. TV-A cured ulcers best and was (and is) popular with surgeons; as a result, despite its somewhat tarnished status, it continues as the “gold standard” in ulcer surgery, a position it has occupied for more than 30 years.

Although the postoperative difficulties after TV-A are not particularly serious in most patients, many surgeons underestimate their importance. The patient who suffers from dumping, diarrhea, or alkaline reflux cannot usually be treated effectively and is a persistent problem in the clinic and in the minds of the entire gastroenterologic team. Avoidance of these complications was the major impetus for the development of alternative operations that do not have the same potential for causing these problems [8, 9, 11, 12]. A new approach, a primary prevention of postoperative problems, became the focus of Harkin’s pupil, Nyhus, who introduced the PGV into clinical practice in the United States when he came to the University of Illinois at Chicago [8].

PCV, PGV, HSV, EHSV

In 1957 the experimental basis for “highly” selective vagotomy (HSV), which preserved antral innervation, was reported in Seattle [14]. HSV was favorably reported in Munich, Leeds, and Copenhagen by surgeons who had studied with Harkins or visited Seattle to become familiar with this “new” operation [9]. In Europe the PGV (or PCV as it was called by those who used intraoperative pH testing to determine the completion of vagotomy) became popular between 1970 and 1985 and was widely accepted there; American surgeons, in contrast, were often reluctant to utilize HSV, an operation associated with an excessive ulcer recurrence rate compared to TV-A. This attitude has continued to be prevalent currently, at a time when the EHSV has been reported to have a much lower recurrence rate than previously reported for PCV or PGV. However, times have changed, and with the decreased incidence of acute ulcer complications surgeons are inclined to perform the operations with which they are most familiar and with which they have the most experience. Interestingly, in a recent survey polling graduates of American training programs, the average number of HSV procedures was less than 1.0 case per resident.

During the 1990s there was general agreement among surgical gastroenterologists that the HSV or its “extended” version (EHSV), which many have adopted, is the procedure of choice for intractable duodenal ulcer or its complications [6, 9–11, 18]. In the United States, however, HSV continues to be less widely applied than in Europe for two main reasons. The first is that many operations for ulcer are performed for bleeding or perforation; these patients are not ideal candidates for an operation that requires more time than the standard TV. The second reason is that many of the patients who require operative treatment have a markedly scarified pyloroduodenal passage, a known risk for recurrent ulcer [19–21]. Because it was previously thought that such individuals require pyloric reconstruction or gastrojejunostomy and that these procedures negate any advantages of the HSV, obstructed patients have usually been treated by alternative operative procedures. Interestingly, there is now ample clinical evidence showing that this view, though logical, is incorrect. The preservation of antral innervation allows effective gastric emptying, and does not let bile acids pool in the stomach; also, early dumping syndrome is mild and often transient in these patients. The advantages of HSV are maintained, therefore, even when

performed in conjunction with pyloroplasty or gastroenterostomy [12, 20–23].

Because operations for duodenal ulcer will continue to be needed in some patients, and because the results after HSV are superior to TV-A in most patients, it is appropriate to reiterate and review the status of this procedure [11, 24, 25]. This is particularly evident in view of the increasing popularity of laparoscopic techniques for duodenal ulcer. In my view, EHSV can and should be performed by this route whenever possible; the use of modern surgical techniques allows surgeons to perform precisely the same techniques used for open surgery [25, 26]. Less effective forms of vagotomy, which were not first-line procedures at open surgery, have been relegated by most surgeons to the secondary position they richly deserve.

The HSV operation has been more successful recently owing to more complete division of preganglionic gastric vagal nerves (see Current Performance of EHSV, below) and the liberal use of pyloric reconstruction in patients with juxtapyloric ulcers. Interestingly, the first clinical reports of HSV from Munich described a low incidence of recurrent ulcers (1.8%). This low rate was achieved with attention to myriad technical details supplemented by the liberal use of pyloric reconstruction (“form and function pyloroplasty”) [8, 9].

Pyloric Reconstruction during HSV and EHSV

One of these in the first large clinical applications of HSV was that pyloric fibrosis and stenosis required specific treatment, which varied according to the extent of disease in a specific patient. The term “form and function pyloroplasty” describes the approach that at one extreme consisted of excision of a small amount of the anterior pyloric ring and at the other resulted in excision of most of the pyloric ring. This was a radical departure from the original concept of HSV but was ideally suited to the preservation of whatever function might remain in the antral-pyloric region. In retrospect, Holle’s recognition and treatment of the pyloric muscle abnormality helps explain the remarkable success of his early work, which provided the inspiration for the operative approach for the diseased pylorus that we recommend today [27]. In almost every report comparing HSV or EHSV with or without pyloric reconstruction, those that addressed the diseased pylorus had superior functional results and lower ulcer recurrence rates [6, 15, 18, 22]. Originally, patients had excisions ranging from a small segment of the anterior pyloric ring to more extensive resections of the pyloroduodenal segment resembling minigastrectomy. In my practice, I have used this information to mandate “treatment” of any pyloric ring showing evidence of ulcer disease or reaction to disease. Now, as then, something is done to ensure that pyloric stenosis is absent postoperatively. Surgeons around the world resisted this approach initially but eventually learned that the incidence of postoperative ulcers was always lower when complementary pyloric reconstruction was employed.

Current Performance of EHSV (Areas of Vagotomy)

The University of Illinois at Chicago was the site of several innovations regarding ulcer disease between 1970 and 1990 [8, 9, 15, 17]. Our goal was the performance of a more effective and complete vagotomy; the intraoperative congo red test, introduced

Table 2. Minimally invasive procedures for ulcer.

Operation	Surgical issues
Bilateral truncal vagotomy	Requires PyP or gastrojejunostomy
Anterior highly selective vagotomy + posterior TV	Requires PyP or gastrojejunostomy; incomplete vagotomy when done at open surgery
Anterior linear gastrectomy + posterior TV	
Anterior seromyotomy + posterior TV	
EHSV	Often requires PyP/gastrojejunostomy for pyloric deformity or gastric outlet obstruction
Omental patch for perforated ulcer	Cannot address pyloric obstruction or second sites of narrowing of gastric outlet

at the University of Illinois by Kusakari, provided the clinical stimulus for neuronal tracing experiments showing that several parts of the stomach, especially the greater curve, were innervated by preganglionic vagal efferent nerves [15, 17]. HSV, as performed in many clinics reporting a high recurrence rate, was thus revealed to be deficient in several “areas”; EHSV provided more effective experimental and clinical vagal denervation of the stomach, and clinical application of EHSV resulted in a documented 5-year recurrence rate in our clinic of less than 2.0%.

The performance of EHSV alone or EHSV plus pyloric reconstruction has been the author’s choice for all duodenal and prepyloric ulcers presenting at the Cook County Hospital, University of Illinois Hospital, and West Side V.A. Medical Center for more than 20 years. Successful treatments in these operative candidates was achieved without the use of antibiotics aimed at eradicating *Helicobacter* species, which have recently been identified as a major cause of ulcer persistence. Although these bacteria must be targeted in all treatment regimens for most peptic ulcerations of the stomach and duodenum, it is not known whether elimination of any *Helicobacter* infection is effective for ulcers that have led to destruction of the microarchitecture of the gastric and duodenal walls [4, 5]. As to the risk of postoperative ulcer recurrence, it must also be kept in mind that recurrent ulcers are usually treated effectively with medical means and do not often bleed or perforate; undoubtedly, the ability to evaluate such patients for *Helicobacter* infection adds another important tool to the armamentarium of the practitioner, although some patients continue to require treatment.

Current Status of EHSV and HSV

Minimally invasive ulcer surgery has been performed in several medical centers, including our own, with good to outstanding results (Table 2) [26–28]. The first operations performed by this approach were TV done as an isolated procedure or as part of a modified selective vagotomy. Specifically posterior TV has been performed in conjunction with anterior HSV or seromyotomy in an attempt to have the best of both worlds regarding the lack of side effects of HSV combined with the ease of performance of posterior TV. The major issues with these procedures remain theoretic, as the numbers of patients treated are small; however, in clinical application this approach has not been as successful as

Table 3. Laparoscopic operations for ulcer: 1994–1997.

Procedure	No.	Results
Transthoracic truncal vagotomy	4	Good
Stapled linear gastrectomy + posterior TV	3	Good
Anterior seromyotomy + posterior TV	1	Good
EHSV	7	Good
EHSV PyP	3	Good
EHSV + gastrojejunostomy	2	Good

the EHSV, and it is unlikely that the current version will prove more successful. Interestingly, technical developments since the advent of laparoscopic tools have allowed surgeons to perform the usual operations with absolutely minimal amounts of blood loss and with the same overall results as those achieved at open surgery. Our own evolution of operations for ulcer shows the same trend, namely a progression from the simpler procedures to the more complex, with overall success in the clinical application of these procedures (Table 3).

Conclusions

Despite a noticeable decrease in the absolute number of surgical complications of duodenal ulcer, there are still many patients who require definitive treatment. Patients with chronic ulceration continue to be at risk for complications, especially those with previous hemorrhage or symptoms of obstruction. Other patients in high risk subgroups include those undergoing chronic treatment with antiinflammatory drugs, usually taken to retard platelet aggregation or as a remedy for chronic arthritic conditions. If operation is required for any of these patients, vagotomy of some type is part of the treatment; EHSV provides the best overall operative treatment and can be safely performed in most patients, excluding only those who are unstable or have severe concomitant medical conditions that preclude the extra time (approximately 30–45 minutes) required for its performance. Patients who are critically ill should be subjected to prompt control of the presenting problem using the least invasive means.

Although the role of open operations for ulcer complications is well established, there is increasing interest in laparoscopic approaches for treating ulcer complications. A precise role for laparoscopic ulcer procedures is not clear at this time and beyond the scope of this presentation, but there are many indications that highly selected patients benefit greatly. Although there were early reports of a variety of laparoscopic procedures (including anterior seromyotomy-posterior TV, HSV, EHSV, and even bilateral TV without drainage), most surgeons are returning to their “roots” and prefer to use operations they have performed for years. Because there is a diminishing ulcer incidence in most areas of the world, it is unlikely that these various procedures will ever be tested “head to head,” as operations were compared in the past. Our bias that laparoscopic EHSV will emerge as the laparoscopic procedure of choice is a hopeful statement that modern surgeons will adopt this procedure. In this light, perhaps the greatest challenge is to the teaching centers, which have a responsibility to show resident surgeons the best of the old as well as the new.

Résumé

En dépit des progrès du traitement médical et des changements dans l'histoire naturelle de la maladie, des complications de la maladie ulcéreuse nécessitant un traitement chirurgical se voit toujours de temps à autre. Le chirurgien doit décider entre une vagotomie sélective/antrectomie et une vagotomie ultra-sélective. Le but du traitement opératoire est une correction sûre du problème, en minimisant la morbidité et la mortalité périopératoires, et en évitant des effets postopératoires indésirables. La discussion qui suit traite des aspects généraux concernant les détails techniques des interventions chirurgicales; puisque la plupart des procédés sont réalisés dans un climat d'urgence, chez des patients ayant une variété de conditions pathologiques, on ne s'étonnera pas qu' aucune des interventions proposées ne soit adaptée à chaque complication de la maladie ulcéreuse.

Resumen

A pesar de los cambios registrados en la historia natural de la enfermedad úlcero-péptica y de los avances obtenidos en su tratamiento médico, algunos pacientes desarrollan complicaciones que requieren una intervención quirúrgica. El cirujano debe decidir el tipo de operación más adecuado y, en este manuscrito se discuten ampliamente las diferentes opciones quirúrgicas. Los objetivos del tratamiento quirúrgico siguen siendo: seguridad, corrección del problema que se presente, evitar la morbimortalidad perioperatoria y los efectos secundarios postoperatorios. En la subsiguiente discusión se tratan, ampliamente, los diferentes aspectos de las técnicas quirúrgicas, ya que muchas de las intervenciones han de realizarse de urgencia en pacientes en diferentes condiciones y estado, por lo que la técnica quirúrgica habrá de individualizarse para cada paciente.

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