



## Proximal Gastric Vagotomy: Does It Have a Place in the Future Management of Peptic Ulcer?

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**Abstract.** Proximal gastric vagotomy (PGV) is a modification of truncal vagotomy, which was introduced by Dragstedt for the treatment of duodenal ulcer (DU) in 1943. It is a technically demanding operation; but when performed by an experienced surgeon, it is safe and gives a cure rate for DU of more than 90%, with minimal side effects. The operation permanently alters the natural history of the disease and may be used for gastric ulcer (GU), with ulcer excision; but it is not as effective. Further adaptations, such as posterior truncal vagotomy with anterior seromyotomy, were introduced to simplify and shorten the operation, but they did not receive wide acceptance. Recently, with the identification of *Helicobacter*, it was found that DU can also be cured by eliminating the infection. PGV is therefore used electively in patients with persistent DU that is not *Helicobacter*-positive or in the few in whom *Helicobacter* cannot be eliminated. In patients with bleeding or perforated DUs, PGV may be used in conjunction with underrunning the vessel or patching the perforation. However, few surgeons doing emergency peptic ulcer surgery have experience with PGV, so simple suture followed by medical treatment is the safest option. Because elective PGV is now a rare procedure, patients should be referred to a center with special expertise. If *Helicobacter* becomes resistant to antibiotics in the future, surgery may be needed regularly again, but the technical nuances would have to be relearned.

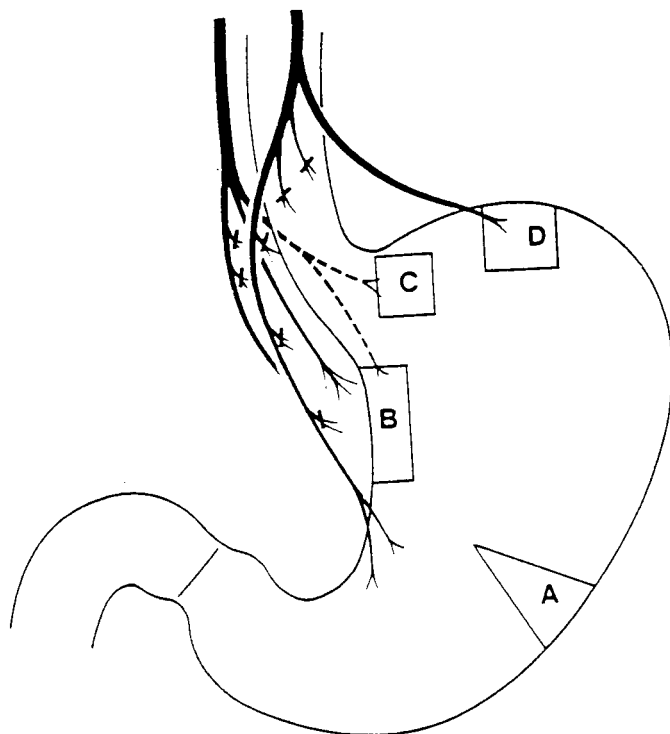
Truncal vagotomy was first introduced into clinical practice by Dragstedt in 1943 [1]. The operation was performed through the chest, and it was seen as a safe alternative to partial gastrectomy, which carried significant mortality in patients with long-standing disease and some degree of gastric outlet obstruction. Some (but not all) of Dragstedt's patients needed a later gastrojejunostomy for delayed gastric emptying. It therefore became normal practice when truncal vagotomy was performed through the abdomen for a drainage procedure, pyloroplasty or gastrojejunostomy, to be added. Vagotomy fulfilled Dragstedt's aim of being a safe alternative to gastrectomy; but it had a rather high recurrent ulcer rate, and some patients still suffered from dumping syndrome, diarrhea, and bile reflux. In one of the classic prospective randomized surgical trials, vagotomy/pyloroplasty was compared with partial gastrectomy and with vagotomy/antrectomy for treatment of duodenal ulcer [2]. It found that the recurrent ulcer rate was least (0%) but side effects greatest with the most radical operation (i.e., vagotomy/antrectomy), and that vagotomy/pyloroplasty had the highest recurrence rate (10%) but the fewest side effects.

On the assumption that total vagotomy of the whole of the derivatives of foregut and midgut was the main cause of the side effects, a modification was devised by Griffith [3] in which only the

stomach was denervated, leaving the nerves to the liver and intestine intact. This was named "selective vagotomy." However, because a pyloroplasty or gastroenterostomy was still required, the side effects remained (even if reduced to some extent), and this modification did not become generally used. In the meantime, Holle et al. [4] had devised an even more selective operation in which the proximal part of the stomach, which contained the parietal cells, was denervated, leaving the muscular antrum, which is important for gastric emptying, still innervated. However, they still performed a pyloroplasty, which was responsible for some continued side effects (dumping and diarrhea). It was Johnston in England [5] and Amdrup in Denmark [6] who completed the evolution of vagotomy by avoiding a drainage procedure altogether. This operation was initially called "highly selective vagotomy" to distinguish it from selective vagotomy, but other names include "proximal gastric vagotomy" and "parietal cell vagotomy." The anatomic and physiologic bases were sound in that gallbladder emptying, for example, is unaffected [7], but bile reflux into the stomach did not differ regardless of whether there was a pyloroplasty [8].

### Technical Considerations of Proximal Gastric Vagotomy

The two challenges to the surgeon are (1) to ensure that the relevant part of the stomach is completely denervated and (2) that the junction between parietal cell and muscular antrum is correctly identified so the antral muscle remains innervated. The problem is that there is no visual demarcation line. Johnston decided that denervation to within 6 cm of the pylorus on the lesser curve was likely to denervate nearly all the parietal cells. Later studies with an intragastric pH probe [9] confirmed this level, which usually meant that only one distal branch of the nerve of Latarjet remained. These studies suggested the importance of denervation 6 cm up the esophagus and 6 cm out along the fundus of the stomach from the esophageal angle to make sure vagal branches were divided. Proximal gastric vagotomy (PGV) was more technically demanding than truncal vagotomy and took longer to perform. Initially some surgeons obtained high early recurrence rates because they did not appreciate some of the technical aspects [9] (Fig. 1) During the 1980s the operation was well established worldwide in major centers for elective long-term



**Fig. 1.** Four areas that are difficult to denervate during proximal gastric vagotomy. A: greater curve at antral/body junction; B: posterior aspect of lesser curve; C: posterior aspect of cardia; D: superior aspect of fundus. (From Johnson [9], with permission.)

treatment of duodenal ulcers (and some gastric ulcers), although many surgeons preferred truncal vagotomy and pyloroplasty in the emergency situation for speed and certainty. The alternative long-term treatment was with H<sub>2</sub>-receptor blockers and more recently proton pump inhibitors.

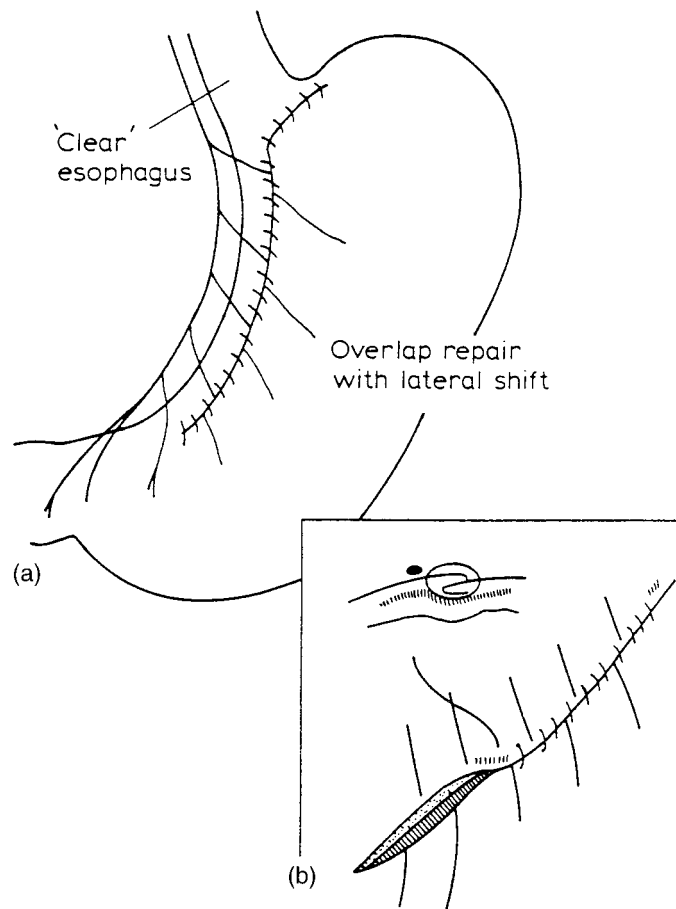
#### Further Modifications

Because of the difficulty of ensuring complete parietal cell denervation and to try to speed the operation, two further modifications were introduced. First was posterior truncal vagotomy and anterior highly selective vagotomy [10], which has the theoretic disadvantage that complete denervation of the antrum occurs in about 3% of patients in whom the total supply to the antrum comes from the posterior vagus. This could lead to delayed gastric emptying but may not be significant in the absence of duodenal narrowing. Second, Taylor introduced posterior truncal vagotomy and anterior seromyotomy [11] (Fig. 2) in which the nerve branches were divided within the gastric muscle just to the left of the lesser curve.

Some surgeons used a stapling and cutting device close to the lesser curve to speed dissection and claimed equally good results. However, neither this nor seromyotomy were widely adopted by surgeons.

#### Evidence of the Effectiveness of PGV

The primary aim of any long-term treatment of peptic ulcer is, first, to keep the ulcer healed to prevent life-threatening compli-



**Fig. 2.** Lesser curve seromyotomy: overlap repair with lateral shift. a. Extent of incision through muscle. b. Technique of overlap repair. (From Taylor [28], with permission.)

cations and, second, to relieve symptoms. There have been several well conducted prospective randomized trials of PGV versus truncal vagotomy or selective vagotomy and antrectomy as well as series of patients followed for many years [12]. A meta-analysis of 12 trials [13] concluded that the likelihood of recurrence was greater after PGV but adverse long-term side effects were greater after truncal vagotomy and pyloroplasty. All studies show that PGV is a safe operation with no mortality in large collective series because there is no anastomosis and the stomach is not opened. The only significant early complication was necrosis of the lesser curve, which was rare but could lead to gastric leaking if not appreciated at the time. Jordan and Thornby [14], comparing selective vagotomy and antrectomy with PGV, found the former had a lower recurrence rate but more side effects. After PGV there is significant dumping in about 1% of patients and troublesome diarrhea in  $\leq 3\%$ .

There has almost always been unhealthy stress in the surgical literature on ulcer recurrence rather than ulcer cure. Moreover, it has always been assumed that a recurrent ulcer is always a disaster, and the patient has been classified as Visick grade 4 [15]. However, many ulcers in the normal population are both transient and asymptomatic, and so are recurrences after operation, especially if they have been looked for by routine gastroscopy (which

is not normally performed in the general population). If the Visick grading is modified to group patients with recurrent ulcers into those who required treatment and those who did not, and if complications of ulcers are also recorded (which any long-term treatment is designed to prevent), the success rate up to 14 years after PGV is high [12]. It must not be forgotten that “dyspepsia” is common within the normal population, and a fascinating study found that the Visick grading after PGV was just as good as that after hernia repair [16].

### Standard Technique

The standard technique is to divide all the branches of both vessels and nerves entering the lesser curve of the stomach the lower 6 cm of the esophagus and the medial part of the fundus of the stomach. Although attempts were made to divide the nerves without the vessels, it is difficult. The only way to ensure that no nerves are entering these parts of the stomach is to divide all structures that are connected. The vessels are ligated or clipped, although heavy clips may fall off fragile vessels. Rosati et al. [17] recommended, in addition, division of the gastric epiploic vessels on the greater curve at the antral body junction because a few nerve fibers enter the antrum and then pass back up to supply the distal parietal cell mass. Whether this measure is necessary in all cases is doubtful; but there are problems in a small proportion of patients in whom it may be important.

### Aids to Complete Denervation

There is good evidence that the success of PGV (or any type of vagotomy) depends on the completeness of the denervation of the parietal cells. The problem is that the fine vagal branches are hardly visible, and the area of the gastric parietal cell mass cannot be seen by looking at the outside of the stomach. The vagus nerve, as its name implies, is variable (“wandering”). PGV is possible only because the body and fundus contain the parietal cells; and the antrum, with its muscular mill, is responsible for solid gastric emptying. However, the boundary between the two is variable.

Two techniques have been used to try to establish this boundary and check the completeness of the vagotomy. The Grassi test [18, 19] uses a pH probe inserted in the stomach through a gastrotomy after the surface of the stomach had been washed with saline. The congo red [20] test sprays the mucosal surface with congo red dye, which turns black in acidic areas and can be viewed with a gastroscope at operation without opening the stomach. Both tests depend on the physiologic phenomenon that the parietal cells become temporarily completely unresponsive to a circulating gastrin. The Burge [21] test relies on residual contraction of the stomach during stimulation of the vagal trunk, if the muscle is still innervated; the test is useful for truncal vagotomy or selective vagotomy but does not identify *where* the vagotomy was complete. For PGV a clamp had to be placed across the stomach to eliminate the effect of the antral contraction, so it could not be used to delineate the antrum–body junction.

The other method of quality control is to perform a pentagastrin-stimulated acid secretion test or an insulin secretion test *after* the operation. A poor reduction in peak acid output in response to the pentagastrin or an early positive insulin test are predictors of recurrent ulcer; but nothing can be done about it 1 week after the procedure, except to observe the patient more closely. The

insulin test has some risks, and patients feel quite ill with the hypoglycemia; hence it was abandoned in many places.

### Regeneration of Nerves?

That there was an increase in the recurrence of duodenal ulcer with time and an increase in the positive rate with the insulin test suggested that divided nerves might regenerate. This possibility led to the extreme of placing the left lobe of the liver through the hiatus on the lesser curve after the operation. The concept of nerves crossing large gaps by sprouting is not supported by the facts, but it is possible that a small nerve left in one part of the parietal cell mass could spread the innervation to other parts with time. Experimental studies shows that it appears to take place in a proximal to distal manner rather than the other way around, so adequate denervation in the upper part of the stomach is particularly important. In any one patient it is impossible to say how much innervation of parietal cells is sufficient to lead to recurrent ulcer because there is no absolute threshold of acid secretion that leads (or does not lead) to ulcer formation—the ulceration has a multifactorial basis.

### Parietal Cell Vagotomy for Gastric Ulcer

Most of the experience with PGV is when it is used to treat duodenal ulcer, resection by the Billroth I method being the standard treatment for gastric ulcer in the past. Prospective randomized trials found that PGV and ulcer excision was not as effective as Billroth I for preventing recurrence of gastric ulcer, but it caused fewer side effects [22]. Because of the concern about malignancy, gastric ulcers should always be biopsied or excised. However, PGV has never been widely accepted for gastric ulcer but has been reserved as an alternative in the high risk patient.

### Pyloric and Prepyloric Ulcers

For some reason PGV without drainage has not been a successful procedure for pyloric or prepyloric ulcers, whereas vagotomy with some drainage procedure has been. The full explanation for this difference is not known.

### Change in the Natural History of Duodenal Ulcer Disease

Duodenal ulcer has a natural cycle of healing and relapse; and treatment by acid-inhibitory drugs, whether H<sub>2</sub>-receptor antagonists or proton pump inhibitors, was effective only while they were being taken, with a high relapse rate when they were stopped. Until the discovery of the association between *Helicobacter pylori* and ulcer disease, only continuous acid suppression treatment or permanent surgical acid suppression altered the natural history of the disease. Whether operation was as effective when the ulcer failed to heal with H<sub>2</sub>-receptor blockers (nonresponders) as when the ulcer healed but relapsed on stopping the drugs (relapsing responders) was a subject of some discussion. Primrose et al. [23] found a greater recurrence rate after PGV for nonresponders, but long-term follow up by Wilkinson et al. [12] found no difference. When proton pump inhibitors were introduced, there was an even smaller number of patients whose ulcers failed to heal initially.

### **Helicobacter Eradication**

By the mid-1990s evidence was accumulating that *Helicobacter* eradication leads to a low duodenal ulcer recurrence rate in the long term [24] unless there are other factors such as the use of nonsteroidal inflammatory drugs (NSAIDs). In this context it is important to ask whether PGV eradicates *Helicobacter*. A systematic review of 36 studies [25] found that the incidence of persistent infection after PGV was 71% to 95%, whereas after partial gastric resection it could be as low as 25% presumably due to the effect of refluxed bile. Hence it is clear that PGV effectively prevents more than 90% of duodenal ulcer relapses by suppressing gastric acid secretion without altering *Helicobacter* status.

### **Present Place of PGV**

Whereas most patients respond well to *H. pylori* eradication and do not require surgery, there are a number of situations that still present problems and where PGV should be considered.

1. *Patients in whom Helicobacter cannot be eliminated.* In a few instances several courses of "triple therapy" cannot eliminate *Helicobacter*. Alternatively, therapy may suppress it, but it subsequently reestablishes itself. The whole question of antibiotic resistance could be significant in the not too distant future.

2. *Peptic ulceration in the absence of H. pylori: use of NSAIDs.* Most cases of peptic ulceration in the absence of *Helicobacter* are associated with the use of NSAIDs, particularly in the elderly. Many of these patients cannot stop taking these drugs because they become incapacitated by their arthritis. Codeine-based analgesics do not solve the problem. Prostaglandin E<sub>1</sub> analog misoprostol was claimed to counteract this effect. In an intriguing study (albeit in dogs) [26] found that neither PGV nor misoprostol alone prevented gastric mucosal ulceration, but the combination of the two did (but it did not prevent duodenal ulcer). This is particularly relevant to the emergency situation (see below). The other well known but rare cause of recurrent ulceration is Zollinger-Ellison syndrome. Obviously PGV is not appropriate in such patients, who require either removal of the gastrinoma or total gastrectomy.

3. *Treatment of complications.* Although the incidence of elective surgery for peptic ulcer has diminished dramatically in recent years, the number of operations for bleeding or perforation has changed little [27]. Indeed, it has increased in the elderly, many of whom are on NSAIDs and have no warning symptoms before the complication arises (i.e., the complication is the first presentation). The *H. pylori* status is therefore not known. The alternative strategies in these circumstances are as follows.

a. Close the perforation or undersew the bleeding vessel and treat initially with proton pump inhibitors followed later by *H. pylori* elimination (after a breath test or biopsy to confirm its presence).

b. Close the perforation or undersew the bleeding vessel and perform a definitive ulcer-reducing operation. The decision here is which operation to perform. There are competing demands for a quick operation to reduce the time in the operating room versus long-time side effects such as dumping or diarrhea. Truncal vagotomy/pyloroplasty (either across the perforated duodenal ulcer or to close the opening used to undersew the bleeding vessel) is superficially attractive and is quick and technically not demanding, but the 10% incidence of diarrhea may be debilitating in an elderly patient with a poor anal sphincter. Proximal gastric vagotomy could be performed after closure of the ulcer with an omental

patch or of the duodenotomy used to undersew the bleeding vessel. There is good evidence that the ulcer recurrence rate after emergency PGV is no higher than after elective PGV [14]. The problem is for the expertise to be available in the emergency situation. A sick patient who has bled or perforated is not an ideal subject for training junior surgeons in technical details. If truncal vagotomy is performed, gastrojejunostomy is a better drainage procedure than pyloroplasty because it can be closed later if dumping or diarrhea prove to be a problem.

### **Organizational Issues**

As PGV is performed only occasionally in the average hospital, expertise must be concentrated. We do not want to go through the learning curve all over again with the high recurrence rate seen during the 1970s. The technique requires good understanding of anatomy and meticulous attention to detail. Unless some of the new-generation gastric surgeons learn the operation, the ulcer recurrence rate could be high. It is a safe operation, however. The impact of laparoscopic techniques is discussed elsewhere in this issue.

### **Financial Aspects**

Operation is far less expensive in the long run than a continued high (or low) dosage of H<sub>2</sub>-receptor blockers or proton pump inhibitors. After about 3 years of drugs, operation becomes the least expensive option. However, it is certainly no less expensive than the standard regimen for eliminating *H. pylori*.

### **Conclusions**

There are sound theoretic reasons for continued limited use of PGV in the management of peptic ulcer, particularly duodenal ulcer. Few patients are being referred for elective surgery, so surgical experience is being lost. The patients who are referred tend to be those who are resistant to all types of medical therapy (and who may need a more radical operation) or are elderly, unfit patients who cannot come off their NSAIDs. Moreover, many operations are performed on ill patients who require an emergency operation. There is little place for PGV today. The lack of training among the new generation of surgeons makes PGV inadvisable as an occasional operation in difficult surgical circumstances. However, if *Helicobacter* antibiotic resistance becomes a problem, surgeons may have to relearn this technique because unhealed peptic ulceration is a life-threatening disease.

### **Résumé**

La vagotomie proximale (PGV) est une modification de la vagotomie tronculaire, intervention introduite par Dragstedt pour le traitement de l'ulcère duodénal en 1943. Il s'agit d'un procédé techniquement difficile, mais lorsqu'il est réalisé par un chirurgien expérimenté, cette opération est sûre et on peut espérer un taux de guérison de plus de 90% avec des effets secondaires minimales. L'intervention modifie de façon permanente l'histoire naturelle de la maladie. Elle peut être utilisée dans l'ulcère gastrique, combinée à l'excision de l'ulcère, mais là, son efficacité est moindre. D'autres modifications sont la vagotomie tronculaire postérieure combinée à la séromyotomie antérieure pour simplifier et réduire la longueur de l'intervention, mais, cette intervention n'a pas été d'une très grande popularité. Plus récemment, avec l'identification de l'*Helicobacter*, on peut espérer soigner et guérir l'ulcère duodénal en éliminant l'infection. La

vagotomía proximal es, así, utilizada de manera electiva en los pacientes que tienen un úlcera duodenal persistente, *Helicobacter* negativo, o en esos pacientes, poco numerosos, para los que no se puede eliminar el *Helicobacter*. En los pacientes que tienen un úlcera duodenal hemorrágica o perforada, la vagotomía proximal puede ser utilizada en conjunto con la sutura del vaso o con la sutura de la perforación. Sin embargo, entre los cirujanos que se refieren a tratar los úlceras en urgencia, pocos de ellos tienen una experiencia suficiente de esta intervención de nuestros días. La sutura simple, seguida de un tratamiento médico, es una opción segura. Debido a la rareza de la indicación de este procedimiento, los autores piensan que es mejor referir a estos pacientes a los centros que tienen la experiencia necesaria. Si el *Helicobacter* resulta resistente a los antibióticos en el futuro, la cirugía podría, de nuevo, convertirse en un procedimiento, pero en ese momento, es necesario enseñar de nuevo, las suturas técnicas de esta operación.

### Resumen

La vagotomía gástrica proximal (PGV), modificación de la vagotomía troncular, fue introducida por Dragstedt en 1943, como tratamiento de la úlcera duodenal (DU). Es una operación técnicamente difícil pero, que en manos de cirujanos expertos muestra ser segura, permitiendo la curación de más del 90% de la DU, con efectos secundarios mínimos. Esta intervención, unida a la extirpación de la úlcera gástrica también se ha empleado en el tratamiento de la úlcera de estómago (GU) pero con resultados poco efectivos. Otras variantes surgidas posteriormente tales como, la vagotomía troncular posterior asociada a una seromiotomía anterior, que simplifica y acorta el tiempo operatorio, no han sido ampliamente aceptadas. En la actualidad, con la identificación del *Helicobacter*, la úlcera duodenal puede curarse con la simple eliminación de la infección producida por dicho germen. Por esto, la PGV se utiliza electivamente en pacientes con úlceras duodenales (DU) persistentes, *Helicobacter* negativo o en aquellos, pocos casos, en los que no se consigue la erradicación del *Helicobacter*. En úlceras sangrantes o perforadas, la PGV puede emplearse asociada a la sutura del vaso sangrante o del cierre de la perforación. En la actualidad, pocos cirujanos tienen la experiencia suficiente como para utilizar la PGV en una intervención de urgencia por perforación o hemorragia ulcerosa. De ahí, que lo más seguro es suturar la perforación o ligar el vaso sangrante, instaurando el pertinente tratamiento médico. Dado que la PGV electiva se ha convertido en una rara técnica quirúrgica, los pacientes que requieran esta intervención deberían ser remitidos a centros en los que exista una especial experiencia al respecto. Cuando en el futuro el *Helicobacter* sea resistente a los antibióticos, el tratamiento quirúrgico volverá a practicarse de forma rutinaria, aunque los matices técnicos habrán de volverse a aprender.

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