Selective and highly selective vagotomy with and without gastric drainage

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Selective vagotomy and highly selective vagotomy are operations designed to interrupt the vagal nerve supply to the stomach either totally or partially without disturbing vagal innervation to the remaining abdominal viscera. They have been done with and without drainage procedures.[1–4]

In this brief review both of these operations will be described. The theoretical reasons for their use and the techniques will be discussed, and the results of laboratory studies and clinical experiences for each type of vagotomy will be summarized.

The three types of vagotomy are truncal, selective, and highly selective. In the standard or truncal vagotomy, two or more vagal trunks are divided as they enter the abdominal cavity at or below the esophageal hiatus *(Fig. 1)*. The selective vagotomy preserves the hepatic branch of the left, or anterior vagus nerve and the celiac branch of the right, or posterior nerve, achieving total gastric denervation, but leaving hepatic, biliary, and visceral vagal fibers intact *(Fig. 2)*. The highly selective vagotomy denervates only the proximal stomach (including the parietal cell mass) leaving antral innervation intact via the nerves of Latarjet *(Fig. 3)*.

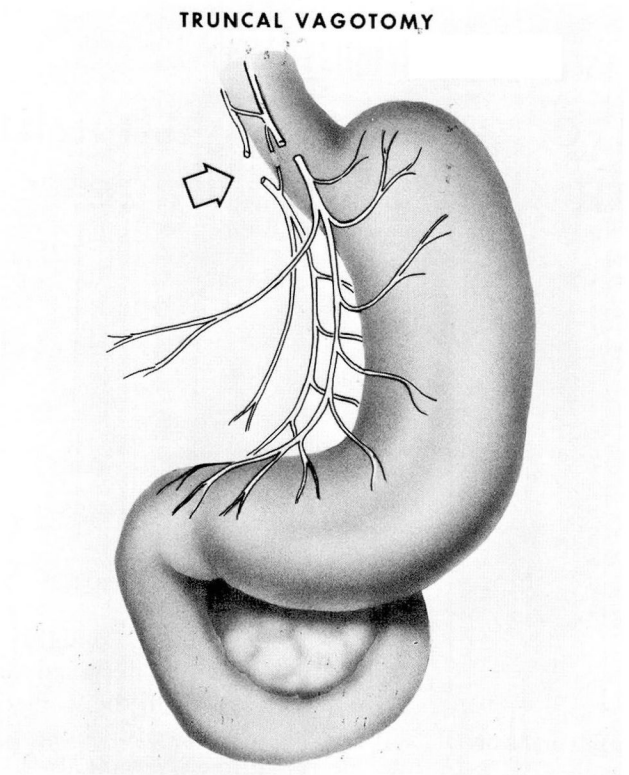

Fig. 1. Standard or truncal vagotomy.

Even though truncal vagotomy remains the standard operation in the United States after 33 years of clinical trials, there have been theoretical and practical objections to its use since its introduction.[5] These objections have been based on the premise that it is illogical and perhaps not necessary to denervate the abdominal viscera just to reduce gastric acidity. Some of these objections are based on the physiologic consequences of gastric and extragastric vagal denervation which have been well summarized by Ballinger[6] and more recently by Johnston.[7] The effects of complete gastric vagotomy (truncal or selective) include faster emptying of liquids and slower emptying of solids,[8] increased intragastric pressure[8] and increased gastric transmural pressure,[8] decreased acid secretion, and decreased pepsin secretion,[9] and increased levels of serum gastrin.[10] Truncal vagotomy may be accompanied by an increased volume of the resting gallbladder,[11, 12] a change in maximal contraction of the gallbladder (slower onset and shorter duration),[13] a decrease in hepatic bile flow,[14] and secretion of bile that is more lithogenic.[15] A higher incidence of gallstones is said to follow truncal vagotomy,[16] but this has not been confirmed based on retrospective reviews with their obvious limitations.

The effects of vagotomy on pancreatic secretion are variable.[17, 18] A decreased enzyme output following vagal stimulation has been reported

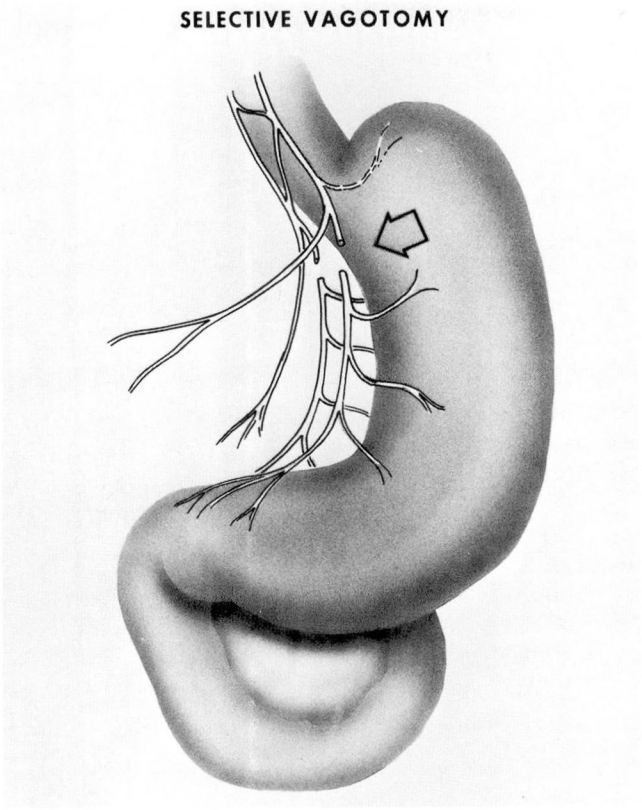

Fig. 2. Selective vagotomy.

after truncal vagotomy, and pancreatic secretion itself may be increased, decreased, or remain unchanged.[6] These effects are of questionable clinical significance.

The effects of vagotomy on the small intestine have included uncoordinated motor activity,[6] mucosal changes secondary to decreased blood flow,[19] decrease in mucosal enzymes, an increase in bacteria in the small bowel,[20, 21] and changes in B-12, fat and iron absorption,[6, 17–20] which clinically may result in diarrhea and steatorrhea.

Despite this large number of questionable side effects, the practical points raised against truncal vagotomy have been twofold. (1) A 15% to 30% incidence of incomplete nerve resection as proven by Hollander testing. (2) A 20% to 60% incidence of diarrhea following truncal vagotomy.[22, 23]

Selective vagotomy

What does selective vagotomy offer? When first described in 1948, it was hoped that selective vagotomy would reduce the incidence of recurrent ulcer and incomplete vagotomy and diarrhea. The technique has been well described by Griffith[24] who stated that the operation begins at the gastric cardia (not at the hiatus) where all vagal fibers join. After identifying and preserving both the hepatic branch of the left vagus nerve

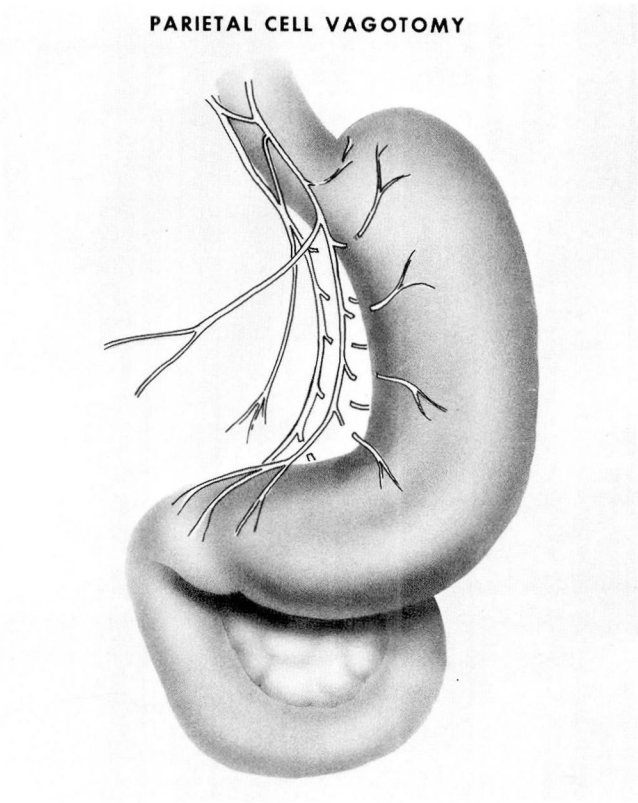

Fig. 3. Parietal cell or highly selective vagotomy.

and the celiac branch of the right vagus nerve, both trunks are transected beneath this point.

Does selective vagotomy allow for more complete vagotomies? Comparable reports of postoperative ulcer recurrences and Hollander tests in series of patients who underwent selective and truncal vagotomy have been published. In nearly all reports positive early Hollander tests were found less frequently after selective than after truncal vagotomy. In nearly every report results were better after selective than after truncal vagotomy.[25–32] Two reports showed that a very satisfactory result could be obtained with either truncal or selective vagotomy but even in one of these reports, after a training period of 11 selective vagotomies only two of the next 150 had early positive Hollander tests (1.5%), whereas a 6% figure of positive Hollander tests following truncal vagotomy remained unchanged.

What are the reasons for this? Could the reasons be related to technique? Could many of these reports have been published by inexperienced vagotomists? How important is inexperience as a factor? In a delightful study by Johnston and Goligher,[33] postoperative insulin tests were compared after vagotomies were done by consultant surgeons and registrars. Of 346 vagotomies done by consultants, 18% were incomplete; of 312 vagotomies done by registrars, 12% were incomplete. The ability to per-

form complete vagotomy varied from surgeon to surgeon regardless of his status. Other reasons for the higher incidence of incomplete vagotomy following truncal division are based on anatomic and physiologic factors.

1. Sawyers and Scott[34] believe that the extra time and effort required for selective vagotomy account for more complete division of vagal fibers.

2. Griffith[24] believes that because the dissection begins lower on the esophagus where fewer fibers are missed, the results are better.

3. Experimental and indirect clinical evidence suggests that selective vagotomy, by leaving pyloroduodenal innervation intact, allows release of a humoral inhibitor of gastric secretion.[35] Lower levels of serum gastrin after selective vagotomy rather than after truncal vagotomy have been explained by this innervation which may allow release of gastrin inhibitors.

The second presumed advantage of selective vagotomy is that diarrhea occurs less frequently than after truncal vagotomy. Diarrhea after truncal vagotomy without an accompanying drainage procedure was noted in 25 of 61 cases reported by Dragstedt et al[36] in 1947. In the now famous prospective Leeds-York Study[37] in which 360 males underwent elective duodenal ulcer surgery by one of three operations, one of the few significant differences observed was a lower incidence of diarrhea after subtotal gastric resection than after vagotomy operations.

The reported incidence of diarrhea in similar series of patients who underwent truncal and selective vagotomy with similar drainage procedures has been summarized. In these reported series the drainage procedure was identical for truncal vagotomy and selective vagotomy. The incidence of diarrhea after truncal vagotomy and drainage in 1,230 patients was 24.6%, but in 830 patients undergoing selective vagotomy it was 12.3%. In all studies (14 were cited), the incidence of diarrhea was less after selective than after truncal vagotomy, but the 12.3% incidence of diarrhea following selective vagotomy may still be unacceptably high. Although diarrhea is troublesome in less than 5% of patients, the fact that parameters do not exist preoperatively for predicting and identifying susceptible patients may make some physicians wary of these operations. Whether this high incidence reported from many European countries reflects a greater incidence, a more objective and thorough assessment of postvagotomy function, or differences in patient population, cannot be stated with certainty, although the detail and manner of follow-up in some reports seem more objective and thorough than that in similar studies from the United States.

Is an accompanying drainage procedure necessary with selective vagotomy? Opinions vary. Wastell et al,[1] DiMiguel,[2] and Clarke et al[3] observed that more than 50% of patients who had selective vagotomy without drainage had gastric stasis necessitating a drainage operation in many. Other large series[4] showed that in nonobstructed ulcer patients selective vagotomy without drainage could be accomplished with a stasis rate of 11%.

Highly selective vagotomy

The second and newer operation to be summarized is the highly selective vagotomy.[38] It has also been called parietal cell vagotomy,[39] super-

selective vagotomy, partial gastric vagotomy,[40] ultraselective vagotomy,[41] and proximal gastric vagotomy.[42]

This operation is designed to denervate the parietal cell mass leaving the antral nerves of Latarjet intact. Leaving the vagus intact to the antrum seems contrary to popular teaching, since the increased gastric pH has been thought to release gastrin and cause hyperacidity. This is more theoretical than observed.[43]

Parietal cell vagotomy was first proposed by Griffith and Harkins[40] in 1957. In their paper on partial gastric vagotomy, the procedure was performed in 10 dogs, and satisfactory gastric emptying and secretory studies were observed. The investigators concluded that clinical applications seemed feasible. More recently the differences between truncal, selective, and highly selective vagotomy on gastric pressures and emptying were studied by Wilbur and Kelly.[8] Highly selective vagotomy preserved gastric emptying and motility better than truncal vagotomy or selective vagotomy. The only functional abnormality after highly selective vagotomy was quicker emptying of liquids from the stomach than after truncal or selective vagotomy. The reasons for this may be that with proximal gastric denervation the fundus of the stomach does not relax to accommodate ingesta. Control of emptying of liquids is regulated by the fundus. Gastric transmural pressure increases rapidly and the stomach empties liquids into the duodenum more rapidly. Since emptying of solids is regulated by the antrum[9] this is not altered by highly selective vagotomy.

The techniques of this operation have been described by several surgeons.[38, 44, 45] At operation the nerves of Latarjet must be identified, and all structures between these nerves and the lesser curvature are divided. When one does this operation initially there is concern that some important gastric fibers may be missed, although this has not been borne out in reports. It is important that technical details be meticulously followed; unsatisfactory results may be due to technical failures. The very benign postoperative course experienced by these patients has been observed by many.

Who is eligible for parietal cell vagotomy? In 1970[37, 46] it was suggested that thin patients with nonobstructing, noncomplicated duodenal ulcers would be an ideal group, but in 1973[38, 47] these indications were extended to some patients with perforated, obstructed, and hemorrhagic ulcers. Some patients with gastric ulcers have also been included.[48] To date more than 5,000 highly selective vagotomies have been done.[49] In evaluating this operation we want to ask of it what should be asked of all ulcer operations. As summarized by Priestley,[50] (1) the patient should survive the operation; (2) the ulcer should heal if it has not been removed; (3) recurrent ulcers should be prevented; and (4) the patient should remain free of any unpleasant gastrointestinal symptoms.

Is this a safe operation? Of the 5,539 operations summarized by Johnston, the operative mortality has been 0.37%.[49]

What is the incidence of recurrent ulcer? One hundred five patients have been followed for 2 or more years and 206 for 4 or more years. During this period three patients required a gastric drainage procedure and three patients had suspected (but

not proven) duodenal ulcers, making a total of 1.3% for suspected or proven recurrence.[51] In the most recent publication, Johnston et al[52] noted a recurrence rate of 1.0% in 100 patients followed 5 or more years.

What about gastrointestinal dysfunction? The incidence of undesirable side effects after subtotal gastric resection, vagotomy and antrectomy, and vagotomy and gastroenterostomy has been reported by Goligher et al.[37] When the side effects are compared with those after parietal cell vagotomy (done by the same surgeons) diarrhea, bile vomiting, and dumping each occur less often.[7] A significantly higher incidence of good or excellent results follows this operation when it is compared to other gastric operations for duodenal ulcer.[7, 53]

What about the increased incidence of diarrhea? In a study reported by Johnston et al[22] the results of highly selective vagotomy, truncal vagotomy, and selective vagotomy were evaluated with control patients. The incidence of diarrhea was significantly less after highly selective vagotomy. The incidence of diarrhea was 24% after truncal vagotomy and pyloroplasty (6% severe), 18% after selective vagotomy and pyloroplasty (2% severe), and 2% after highly selective vagotomy. In the control group of 50 patients who had inguinal herniorrhaphy or saphenous vein ligation, 4% had episodic diarrhea. The incidence of diarrhea was increased in all groups by giving hypertonic glucose. This was due to increased gastric emptying and transit due to hypertonic glucose.

Is dumping seen less often after highly selective vagotomy? The same patients and controls were queried regarding dumping, defined as an early postprandial vasomotor reaction.[53] The incidence at 1 year was 20% after truncal vagotomy and pyloroplasty, 34% after selective vagotomy and pyloroplasty, and 6% after highly selective vagotomy; and at 2 to 4 years was 11% vagotomy and drainage, 25% selective vagotomy and drainage, and 6% highly selective vagotomy. The incidence in control patients was 4%. These figures are not wholly comparable, since in the first two operations the pyloric canal was disrupted. Again, a test meal showed increased incidence of dumping in all groups, but it was highest in the selective vagotomy group. Others have observed this and relate it to the release of vagally controlled vasoactive substances with selective vagotomy that are absent after truncal vagotomy.[54, 55]

What about secretory studies? The mean values for basal and maximal acid output at 1 week, 2 to 3 months, and 12 to 24 months after highly selective vagotomy have been studied.[56] The basal acid output was decreased 92% in 1 week, 86% in 2 to 3 weeks; acid output between 3 months and 1 year was statistically significant. Similarly, a fall, then significant rise in maximal acid output has been observed. These authors noted similar changes following truncal vagotomy and selective vagotomy and the significance of these changes is not known. Even for patients who are hypersecretors the 5-year follow-up of 100 patients has shown no higher incidence of ulcers after highly selective vagotomy.[52]

The last question about parietal cell vagotomy operation is whether a drainage procedure is necessary. Science and surgery agree, since stasis

has occurred in less than 270 of the reported cases.[49] To further prove this point, Clarke et al[3] and Wastell et al[1] studied two groups of patients who underwent highly selective vagotomy with and without pyloroplasty. Secretory studies after insulin and pentagastrin were similar as were changes in serum gastrin. The gastrin response to a protein meal was two times as great after highly selective vagotomy without drainage.[57] Motility and emptying seemed better when pyloroplasty was omitted.

Summary

Two operations, selective gastric vagotomy (total gastric denervation) and highly selective vagotomy (partial gastric denervation) have been reviewed.

The advantages of selective vagotomy over truncal vagotomy are due to better results with postoperative Hollander tests and less diarrhea. There is a higher incidence of dumping; a drainage procedure may possibly be omitted if obstruction is absent. The patients should be followed closely because gastric stasis requiring a drainage procedure may develop.

A newer operation, highly selective vagotomy (parietal cell vagotomy) has also been reviewed. Its theoretical advantages have been reviewed and available clinical trials summarized. After this operation the results of secretory studies are satisfactory and there is a very low incidence of diarrhea, dumping, and other unpleasant gastrointestinal complications when compared to other ulcer operations. The longest follow-up, however, has been only 4 years.

Will this become the standard ulcer operation or will it fall by the wayside? The answer is not yet known, but all gastric surgeons should heed Sir Ogilivie—[58] "Every operation for ulcer appears to be a success until it is found out." Time will tell.

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