Progress in Surgery

Editors: M. Allgöwer (Basel), S.-E. Bergentz (Malmö), R.Y. Calne (Cambridge) and U.F. Gruber (Basel)

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Highly Selective Vagotomy[1]

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Introduction

The stomach is first and foremost a muscular bag, which is equipped with a sphincter at either end. The cardiac sphincter prevents reflux of

1 A full account and explanation of the section on the scoring system is in press, to be published in Gastroenterology.

gastric content into the oesophagus. The pyloric sphincter prevents reflux of duodenal content into the stomach and also assists in the regulation of gastric emptying. The muscular bag has two principal functions. Firstly, it acts as a reservoir or 'hopper', which receives and holds the meal by means of receptive relaxation and accommodation to distension in the body and fundus. Secondly, it 'mills' and grinds solid food into smooth chyme, which will be suitable for digestion and absorption in the small intestine. The gastric antrum is the mill of the stomach. Of central importance to the function of the mill is the terminal antral contraction, which permits the stomach to discriminate between solids and liquids, liquid chyme passing onwards, while solid particles are actively retropelled into the body of the stomach to undergo further triturition [CARLSON *et al.*, 1966]. Emptying of a meal from the stomach is gradual and orderly, being controlled in large measure by the antropyloroduodenal segment, which is itself under the control of nerves and hormones.

All the standard operations for duodenal ulcer destroy or severely impair these principal functions of the stomach. Partial gastrectomy removes the pyloric sphincter, the antral mill and much of the body of the stomach, so that capacity for food is diminished, the meal leaves the stomach in a poorly regulated manner and bile is able to regurgitate freely into the gastric remnant. Vagotomy combined with antrectomy (V-A) has similar disadvantages: although more of the stomach remains, the accompanying vagal denervation impairs accommodation to distension, so that capacity for meals may be little greater than after resection of two thirds of the stomach without vagotomy. Complete gastric vagotomy, whether truncal or selective, with a drainage procedure (V-D), has been regarded in the past as a conservative operation because, it was said, it 'preserves the gastric reservoir'. What V-D does in fact is to destroy or bypass the pyloric sphincter, destroy or bypass the terminal antral contraction, cut the motor nerve supply to the antral mill, elevate serum gastrin concentration, and render the stomach incontinent of liquids. For good measure, in the course of truncal vagotomy (TV) the parasympathetic nerve supply to the biliary tract, pancreas, small intestine and much of the large intestine is also severed. It is perhaps small wonder that the clinical achievements of this 'conservative' operation have been so modest [GOLIGHER *et al.*, 1968a, b; COX, 1968; JORDAN and CONDON, 1970; POSTLETHWAIT, 1973; JORDAN, 1974a].

Vagal denervation of the extragastric viscera, while technically convenient, was always patently illogical and unnecessary. Today there is much

evidence that vagal denervation of the antral mill (which is alkaline, not acid) is also unnecessary, and that destruction of the terminal antrum and pylorus with all their intricate mechanisms is equally unnecessary. In the past, the antral mill was always vagally denervated 'to cut down gastrin release'. Since the advent of radioimmunoassay of gastrin, however, it has been found that vagal denervation of the antrum does not reduce circulating gastrin levels: in fact, after TV or selective vagotomy (SV) gastrin levels increase significantly. If, on the other hand, the antrum is left innervated, but the parietal cell mass is vagally denervated, circulating levels of gastrin are no higher than after TV or SV. Hence, for the first time in the 90-year history of surgery for ulcer, there is reason to believe that the antrum, pylorus and duodenum can be left completely intact, that vagal denervation can be confined to the acid-secreting part of the stomach, the parietal cell mass, and that none of the stomach needs to be resected. The clinical significance of this is that peptic ulcers can now probably be cured with less risk to life, fewer side-effects and fewer long-term metabolic sequelae than ever was possible in the past. Such is the potential of highly selective vagotomy (HSV) without a drainage procedure, which was introduced into clinical practice in Leeds and Copenhagen 6 years ago [JOHNSTON and WILKINSON, 1970; AMDRUP and JENSEN, 1970]. In this review, HSV is compared with the standard operations for ulcer, at the physiological and clinical level.

HSV – Definition and Rationale

Definition. In HSV, only the acid-secreting part of the stomach, the parietal cell mass, is denervated [GRIFFITH and HARKINS, 1957; AMDRUP and GRIFFITH, 1969]. The main parasympathetic nerve supply to the antral mill via the nerves of Latarjet is preserved and the terminal antrum and pyloric sphincter are left intact. The hepatic and coeliac vagal fibres are also preserved as in the performance of bilateral SV.

Rationale. It is quite clear by now that the results of the standard operations for duodenal ulcer leave considerable room for improvement. For example, in the prospective random trial of partial gastrectomy (PG), truncal vagotomy and antrectomy (TV-A) and truncal vagotomy and gastro-enterostomy (TV-GJ) which was conducted by GOLIGHER *et al.* [1968a] in Leeds and York, only 70% of patients were found to have achieved a really good clinical result 5–8 years after TV-GJ. The results

of PG and of TV-A were somewhat better, but were still far from brilliant. Truncal vagotomy and pyloroplasty (TV-P) was subsequently found to yield results which were no better than those of TV-GJ [GOLIGHER *et al.*, 1968a, b; GOLIGHER *et al.*, 1972]. In similar trials, COX [1968] found no significant difference between the clinical results of TV-GJ and those of PG, while JORDAN and CONDON [1970], POSTLETHWAIT [1973] and JORDAN [1974a] found that TV-A gave better overall results than did TV-P. Prospective random trials have vindicated the claims of GRIFFITH [1969] and BURGE [1964] that bilateral SV is followed by significantly less diarrhoea than is TV [SAWYERS *et al.*, 1968; KENNEDY *et al.*, 1973], but the *overall* clinical results after SV-D are disappointingly similar to those of TV-D [MASON *et al.*, 1968; KENNEDY *et al.*, 1973]. Finally, long-term follow-up of patients after TV-D indicates that loss of weight and iron-deficiency anaemia are common sequelae [DELLIPIANI *et al.*, 1969; WHELDON *et al.*, 1970], and that the incidence of pulmonary tuberculosis may be as high as 7% [WHELDON *et al.*, 1970]. These nutritional problems were found to be most severe in patients who had low levels of acid secretion after vagotomy and were least common in patients with incomplete vagotomy [WHELDON *et al.*, 1970]. The results of V-D have thus proved disappointing. There is no evidence that V-D produces better clinical results than does V-A or PG. Its main advantage compared with these operations is that it is somewhat safer in the hands of relatively inexperienced surgeons.

It was clear that V-D, V-A and PG shared a common defect. Each of these operations destroys the normal mechanism whereby gastric emptying is regulated, so that side-effects such as dumping and diarrhoea become inevitable. It seemed to me that the results of surgery for duodenal ulcer would improve significantly if the terminal antrum and pyloric sphincter could be kept intact. This led to the formulation of the three main concepts or hypotheses upon which HSV is based:

(1) Side-effects of gastric surgery will be minimised if well-controlled gastric emptying can be achieved through an intact pylorus. If this is to happen, preservation of the vagal nerve supply to the gastric antrum is essential.

(2) The gastric antrum can be left innervated with impunity. Provided that it remains in the 'acid stream', it will not release excessive amounts of gastrin.

(3) A vagotomy which is confined to the parietal cell mass preserves protective and inhibitory mechanisms which are sacrificed by TV-D.

These concepts have been discussed at length in previous publications

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[JOHNSTON and WILKINSON, 1970; JOHNSTON *et al.*, 1971; JOHNSTON, 1974]. The fundamental change from orthodox thinking was the hypothesis that the vagally innervated antrum would not release excessive amounts of gastrin, provided that it remained exposed to the inhibitory influence of the 'acid stream'. This idea was based upon previous reports that vagal release of gastrin (in dogs) was very difficult to demonstrate when the antrum remained in continuity with the acid stream [BURSTALL and SCHOFIELD, 1953, 1954; PE THEIN and SCHOFIELD, 1959]. Also, OLBE [1966] reported that sham feeding released very little gastrin from the antrum *in situ*. He found that, after antrectomy in Pavlov pouch dogs, only tiny amounts of gastrin (less than one third of the threshold dose) were needed to restore the acid response of the pouch to sham feeding, to pre-antrectomy levels. Thus OLBE's findings suggested that vagal release of gastrin in the dog was relatively unimportant.

Operative Technique

This has been described in detail elsewhere [JOHNSTON and WILKINSON, 1970; JOHNSTON, 1975]. Little selection of cases for HSV is necessary (vide infra) and the author has treated a virtually consecutive series of patients with duodenal ulcer since January 1969. Thus the presence of very gross ulceration with considerable scarring of the duodenum is not a contra-indication to the use of HSV. Addition of a drainage procedure is not required if the patient has been able to eat normally in the intervals between attacks of pain. If, however, he has clinical symptoms and signs of pyloric stenosis, a drainage procedure should probably be added, though for the past 3 years the author has been carrying out a clinical trial in which these patients are treated merely by HSV plus digital dilatation of the stenosis via a gastrotomy [JOHNSTON *et al.*, 1973b]. Of the 25 patients treated in this way, 2 have subsequently required re-operation because of re-stenosis, but it is a remarkable fact that gastric retention did not recur in the re-maining 23 patients.

Two assistants are required, one to hold the stomach and the other to retract the liver. Good access to the upper abdomen is obtained by means of a long midline epigastric incision from the xiphoid process to 3–5 cm below the umbilicus. The edges of the wound are retracted by a self-retaining abdominal retractor. Access to the abdominal oesophagus is greatly improved if a metal hook is inserted under the xiphoid notch and

strong traction exerted towards the head of the operating table [GOLIGHER, 1974]. This upward retraction of the rib cage is rendered more effective if the table is tilted about 15 ° head up, which has the added advantage that the other viscera are induced to fall away from the stomach and oesophagus. In order that optimum access to the abdominal oesophagus may be obtained, the left lobe of the liver is next mobilised by division of the left triangular ligament, care being taken to avoid damage to the inferior phrenic vein. The diagnosis of chronic duodenal ulceration is confirmed, the stomach and oesophageal hiatus are assessed carefully, and a full laparotomy is carried out. The next step is to mobilise the distal half of the greater curvature of the stomach by division of the gastrocolic omentum outside the gastroepiploic arcades. The gastroepiploic vessels are preserved so that interference with the stomach's blood supply will be kept to a minimum. Such mobilisation of the greater curve confers the advantage that the posterior nerve of Latarjet can then usually be seen and this of course makes it easier to preserve. In addition, each of the major vessels entering the lesser curve on its posterior aspect can be ligated and divided precisely, close to the stomach, while the nerve is kept in view and thus preserved. Another advantage of this approach is that the stomach, which itself is the main 'retractor' in HSV, is easier to grip and pull upon if part of the greater curvature has been mobilised.

The next step is to identify the anterior nerve of Latarjet, which is usually easy to see as it runs down in the lesser omentum parallel to the lesser curvature and terminates by passing onto the musculature of the antrum 5 or 6 cm from the pylorus. This nerve is constant in position as it runs in company with the descending branch of the left gastric vein (fig. 1, 2). In obese subjects it may be seen more readily if the stomach is put on the stretch by traction on the greater curvature. Dissection begins just proximal to the point where the nerve passes onto the antrum and proceeds upwards along the lesser curvature. The nerve of Latarjet usually terminates in two or three major terminal branches and all of these should be preserved. Thus there is no question of measuring off any arbitrary length such as 6 or 7 cm from the pylorus and beginning the dissection there. What one does is to identify the terminations of the nerve of Latarjet and begin the dissection proximal to them. The blood vessels enter the lesser curvature above the incisura angularis in two main leashes, an anterior and a posterior. These leashes or flaps should be dealt with separately. Dissection begins near the incisura. A curved haemostat is gently insinuated beneath each major vessel, a ligature is passed, seized in the jaws of the

Fig. 1. This shows the anterior nerve of Latarjet, running down parallel to the lesser curvature, close to the vein, and terminating by crossing onto the musculature of the antral region as two major terminal branches. The nerve is fairly constant in position. Both major terminal branches are preserved in the course of HSV, the dissection commencing at the incisura, immediately proximal to the more proximal of the two terminal branches.

haemostat, drawn under the vessel and the vessel is tied in continuity on the lesser omental side and then clamped close to the lesser curvature. The vessel is then divided (fig. 3). This method is felt to be preferable to the application of two haemostats and division of the vessel between them, because it ensures that the vessel cannot slip from a clamp and retract into the fat of the lesser omentum where it cannot be pursued and clamped for fear that the nerves of Latarjet will be damaged. In addition, a haemostat placed on the lesser omental side may inadvertently crush one of the nerves

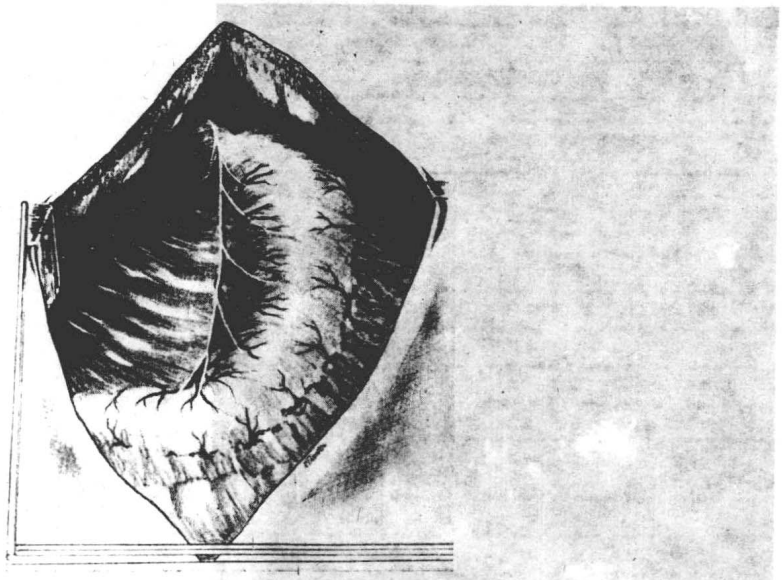

Fig. 2. This shows the anterior vagal trunk giving off hepatic fibres and continuing parallel to the lesser curvature as the anterior nerve of Latarjet. The HSV dissection begins near the incisura just proximal to the two major terminal branches.

of Latarjet or, when lifted up, it may tent up a nerve and cause it to be trapped in the ligature. Each vessel should be ligated individually, because if large bites of tissue are taken the pedicle has a broad base and the ligature is more likely to slip when strong traction is exerted on the stomach during the oesophageal dissection. Loose areolar tissue between the blood vessels is clamped in a haemostat, coagulated with diathermy and then divided. My practice is to divide the anterior leaf of the lesser omentum in

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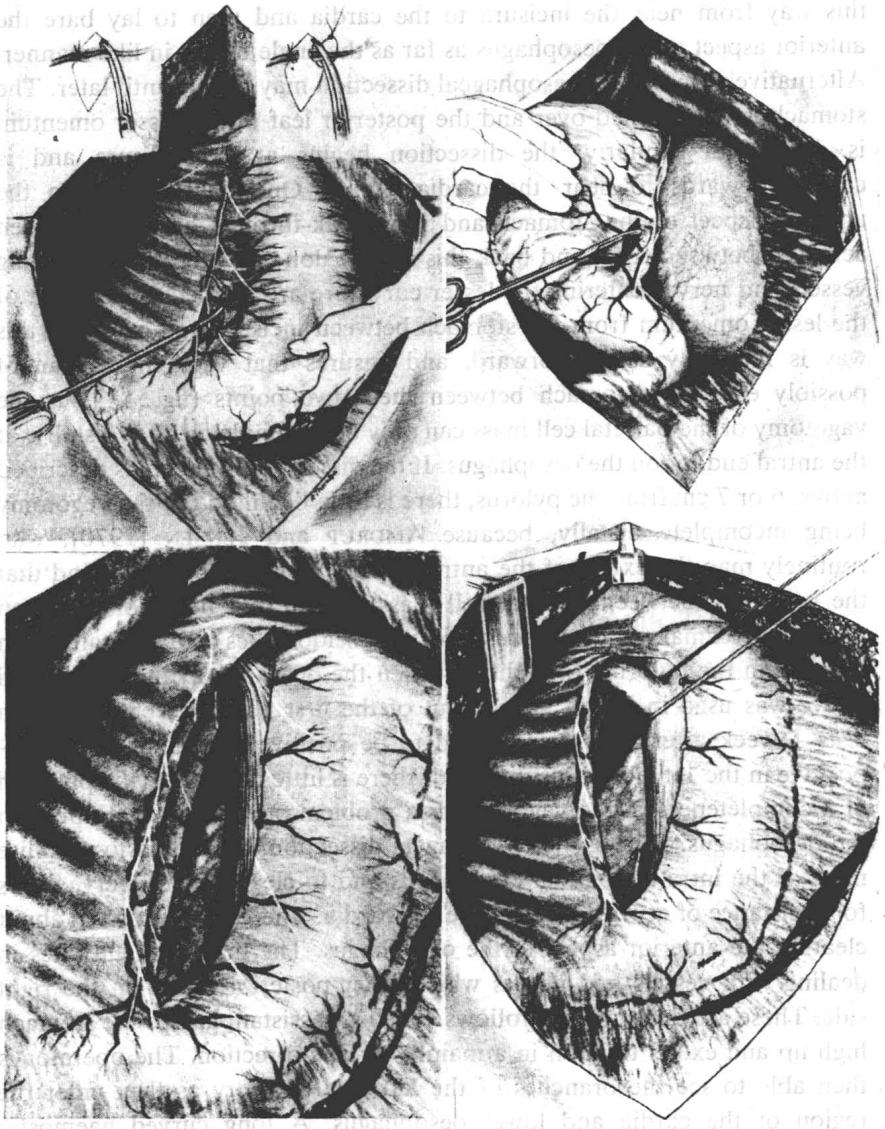
Fig. 3. The HSV dissection has begun at the incisura. The method of ligating vessels in continuity on the omental side is shown. This is done to reduce the chances of the nerve being damaged, or of a vessel slipping from a clamp and causing a haematoma in the fat of the lesser omentum.

Fig. 4. The stomach has been turned over after mobilisation of the distal greater curve, and the posterior leaf of the lesser omentum is divided between incisura and cardia, sparing the posterior nerve of Latarjet, which is shown. The gastroepiploic arcade is preserved, not divided as this picture might suggest.

Fig. 5. The lesser curve has been separated completely from the lesser omentum between incisura and cardia. Note the neurovascular bundle running to the antrum in the free



border of the lesser omentum, and the two leaves of the lesser omentum. Clearance of the oesophagus has begun. Vagotomy can be incomplete only on the oesophagus, or beyond the incisura.

Fig. 6. Traction on the rubber sling improves access to the posterolateral aspects of the oesophagus. Note that the vagal trunks with their hepatic and coeliac branches are swept upwards and to the operator's left, out of harm's way. 5 or 6 cm of oesophagus are cleared of all vessels and nerve fibres.

this way from near the incisura to the cardia and then to lay bare the anterior aspect of the oesophagus as far as the angle of His in like manner. Alternatively, the entire oesophageal dissection may be left until later. The stomach is then turned over and the posterior leaf of the lesser omentum is dealt with similarly: the dissection begins at the incisura and is carried upwards to near the cardia (fig. 4). One then returns to the anterior aspect of the stomach and if a break-through has not yet been achieved between front and back this is now done and the few remaining vessels and nerves entering the lesser curvature are divided. Separation of the lesser omentum from the stomach between incisura and cardia in this way is relatively straightforward, and ensures that vagal fibres cannot possibly enter the stomach between these two points (fig. 5). Thus the vagotomy of the parietal cell mass can only be incomplete either distally, at the antral end, or on the oesophagus. If the dissection is begun as described above, 6 or 7 cm from the pylorus, there is little likelihood of the vagotomy being incomplete distally, because AMDRUP and JENSEN [1970], who routinely map the extent of the antrum at the time of operation, find that the boundary between parietal cell mass and antrum lies 8 or 9 cm on average proximal to the pylorus and very seldom lies more distally than 6 cm from the pylorus. In addition, when the operative method described above was used in Leeds, only 3 out of the first 100 consecutive insulin tests 1 week after HSV were found to be positive and none was early-positive in the 1st h after insulin. Thus there is little doubt that the problem of incompleteness of the vagotomy is a problem of missed vagal fibres on the oesophagus. During the oesophageal dissection, the aim is to mobilise most of the intra-abdominal oesophagus and to clear it of all nerve fibres for a distance of at least 5 cm above the cardia. There is no problem about clearing the anterior aspect to the oesophagus. The main difficulty lies in dealing with vessels and nerves which enter posteriorly and on the right side. These are dealt with as follows. The first assistant grasps the stomach high up and exerts traction in a mainly vertical direction. The operator is then able to see the branches of the left gastric artery as they enter the region of the cardia and lower oesophagus. A long curved haemostat (Roberts') is then passed under each vessel, which is ligated in continuity, clamped and divided as described above. When the cardia and the lowermost 2 cm or so of the oesophagus have been cleared in this way, it becomes possible to pass two fingers behind the lower oesophagus from its left side and to encircle it with a soft rubber tube which is then used to provide strong traction (fig. 6). More vessels and nerves are then ligated and

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