IT is now generally accepted that some form of vagotomy is the best operation for chronic duodenal ulcer and there is a minority view that it is also appropriate for gastric ulcer. The surgeon has several alternative forms of vagotomy and types of drainage available and it is the purpose of this paper to review the current status of these different procedures.

With any operation there are three requirements. First, the mortality must be minimal. In our series during the past ten years there have been 1,033 vagotomies of various types with two deaths, a rate of 0.19 per cent. There are many other published series with a comparably low mortality. Secondly, there must be an acceptably low incidence of recurrent ulcer and, thirdly, undesirable side effects should, as far as possible, be eliminated. It is these second and third points which demand our attention.

Truncal vagotomy (T.V.) in which both anterior and posterior vagi are completely divided at the level of the hiatus, has been associated with gastrojejunostomy (G.J.) and more commonly with pyloroplasty (P). Many years ago a curious form of episodic diarrhoea became apparent as an important side effect. The

| Table 1 |
| --- |
| **Truncal versus Selective Vagotomy** |
| **Controlled Trials** |
|  | Diarrhoea | Recurrent symptoms |
|  | T.V. | S.V. | T.V. | S.V. |
| **KRAFT et al** | 37 | 27 | 12 | 5 |
| **Michigan** |  |  |  |  |
| **SAWYERS et al** | 21 | 12 | 1 | 0 |
| **Tennessee** |  |  |  |  |
| **KENNEDY et al** | 28 | 8 | 9 | 2 |
| **Belfast** |  |  |  |  |
| **KRONBERG et al** | 46 | 12 | 8 | 5 |
| **Copenhagen** |  |  |  |  |
|  | 29.5 | 15.3 | 5.9 | 2.8 |
cause is unknown, though uncontrolled emptying of the stomach plays a part (McKelvey, 1970) and deficiency of Ig A may be significant (McLaughlin et al, 1976). It was thought that denervation of the small bowel and biliary tract might be important and thus the limitation of vagotomy to the gastric branches, selective vagotomy (S.V.) was widely practised. In four controlled trials (Table 1) the incidence of diarrhoea was diminished when compared with the incidence after T.V. and drainage. Somewhat surprisingly, each trial showed a lower incidence of recurrent ulcer after S.V.

Another troublesome symptom has been dumping, less common and less severe than after gastrectomy, but present in about one-third of all cases in a number of carefully conducted, prospective studies. A third problem has been bile reflux and bile vomiting. In three controlled trials (Table 2) there has been a higher incidence after gastro-jejunostomy but this only reached statistical significance in the Glasgow trial. The type of vagotomy was not important.

**Table 2**

| Bile Vomiting       | Gastrojejunostomy (n=330) | Pyloroplasty (n=367) |
|---------------------|---------------------------|----------------------|
|                     | %                         | %                    |
| Kay et al (T.V.)    | 16.0                      | 6.0 (p<0.01)         |
| Glasgow             |                           |                      |
| Goligher et al (T.V.) | 14.5                  | 10.1                |
| Leeds               |                           |                      |
| Kennedy et al (S.V.) | 10.4                   | 8.7                 |
| Belfast             |                           |                      |

When we look at the influence of the drainage on the rate of recurrence (Table 3) in nearly two thousand patients from six centres, we see that the recurrence after G.J. is about a third of that after pyloroplasty. This phenomenon has no logical explanation, though it must be remembered that G.J. alone cures about half of all duodenal ulcers. Antrectomy, coupled with either S.V. or T.V., gives a remarkably low rate of ulcer recurrence. It is, however, more likely to cause side effects and, if routinely used, might reintroduce a mortality problem.

At this point we may conclude that neither truncal nor selective vagotomy, combined with pyloroplasty or gastro-jejunostomy, meets all three of the defined requirements of an ideal ulcer operation. In the early days of T.V. no drainage was used but too many patients developed trouble from stasis. In 1969 Burge proposed that, when there was no outlet stenosis, S.V. could be used without drainage. Unfortunately this thesis did not prove to be correct.

In order to reinforce the effectiveness of vagotomy combined with pyloroplasty, Holle (1964) advocated preservation of the innervation of the pylorus and antrum by carefully dissecting out the nerves described by Latarjet fifty years ago. It was
left to Amdrup (1970) and Johnston (1970) independently to do the same limited vagotomy, but also to omit any drainage procedure. They respectively called this operation “parietal cell vagotomy” and “highly selective vagotomy”. It has many other names, among them:—acid fundic, gastric proximal, proximal gastric vagotomy (P.G.V.). In the U.K. P.G.V. is the approved name, though highly selective vagotomy (H.S.V.) is often used. This operation has obvious attractions. It is gastrointestinal non-invasive (the gut is not opened) thus lessening the risk of infection, and side effects attributable to the drainage procedure should be eliminated. Early uncontrolled data led to many enthusiastic reports, claiming that dumping and diarrhoea were both virtually eliminated.

In an attempt to evaluate this new operation we have conducted a random controlled trial of P.G.V. without drainage against S.V. and G.J. There were 50 cases in each group and 99 were followed for a maximum of four years and a minimum of one year. There was only one proven recurrence in each group. Dumping and diarrhoea were almost eliminated and the incidence of minor symptoms did not differ from that of patients with no known gastrointestinal disorder. The future looked rosy but at the same time the results of a very similar trial were published from Denmark (Kronborg and Madsen, 1975). Here 50 patients with P.G.V. were compared with 50 having S.V. and P. The follow up time was the same and again there was a highly significant diminution in dumping and diarrhoea. But there was one big difference from our trial—a recurrent ulcer rate of 22 per cent after P.G.V. and eight per cent after S.V. and P.
Table 4

Prospectively Studied Vagotomies
(Kennedy and Johnston)

| Operation    | Number | Mean follow up | Recurrences | Percentage |
|--------------|--------|----------------|-------------|------------|
| T.V. + P.    | 50     | 5+             | 3           | 6          |
| S.V. + P.    | 99     | 5+             | 7           | 7          |
| S.V. + G.J.  | 117    | 4              | 2           | 1.7        |
| P.G.V.       | 132    | 2              | 7           | 5.3        |
|              | 398    |                | 19          | 4.8        |

Since publishing the interim results of our trial we have seen further recurrences. Our overall recurrence rate for P.G.V. is now 5.3 per cent (Table 4). Superficially this seems to compare well with the rate after V. and P. but it should be noted that the follow up time of the latter cases is much longer, ranging from five to ten years.

In an attempt to discover the true recurrence rate I have collected information from 19 European surgeons (Table 5), showing a rate of 3.2 per cent. The follow up time was quite short in many instances and the ultimate recurrence rate will almost certainly be considerably higher. The survey confirmed the low mortality of P.G.V. and was reassuring in showing only an 0.2 per cent need to reoperate for failures of gastric drainage.

Table 5

Collected European P.G.V. Data

|               | Number | Percentage |
|---------------|--------|------------|
| Operations    | 4724   |            |
| Deaths        | 14     | 0.3        |
| Lesser curve necrosis | 11  | 0.2        |
| Reoperation for drainage | 14  | 0.3        |
| Recurrent ulcer | 152 | 3.2        |

The incidence of the mysterious and dreaded complication of lesser curve necrosis was also very low. The reason why the lesser curve occasionally breaks down is not known, though chronic renal failure may be associated. As a prophylactic measure it is recommended that the serosal coat should be reconstructed over the bared lesser curve musculature, a very simple modification.
The reported rates of recurrence after P.G.V. have varied widely and one wonders if all surgeons are performing precisely the same operation. Amdrup (1970) has defined the parieto-antral junction with a pH probe; Johnston (1970) has preserved the whole of the terminal "crow's foot" of the anterior nerve of Latarjet and we have measured 6 cm. back from the pyloric ring. Thus the amount of stomach left innervated may have varied. It may be that thorough clearing of the distal 5 cm. of oesophagus is the really important factor.

Recurrences are usually attributable to incomplete denervation of the parietal cell mass due to overlooking one or more vagal fibres. To avoid this Burge (1969) designed an intra-operative electrical test of vagal integrity but this has found little favour. Grassi (1975) has used a pH probe to define areas of high acidity and found that there is always an intact vagal fibre leading to such an area. There is also the suggestion that cut fibres may sprout and lead to re-innervation.

Much attention has been directed to the hormone gastrin; if the antrum is left innervated, could the release of gastrin be enhanced? It has been shown that gastrin levels rise after all forms of vagotomy, probably due to loss of the inhibitory effect of acid. Our data (Hayes, 1975) indicate that the rise in basal levels is no greater after P.G.V. than after S.V. and drainage. Stadil and his colleagues (1974) also showed that the response to a protein meal stimulus is no greater after P.G.V.

Recently there has been much interest in the concept of G cell hyperplasia. Some recurrences are due to this phenomenon and would have been better treated by antrectomy in the first instance. It has been shown that those with high basal acids have a higher risk of recurrence, but measurement of gastrin should be a more precise indicator. Alternatively the G cell population can be estimated by immunoperoxidase staining or immunofluorescent techniques.

P.G.V. has been designed to avoid rapid gastric emptying but occasionally emptying may be unduly slow, perhaps because of too much denervation, and the patient then complains of fullness, vomiting or even gastric ulceration; a secondary drainage operation will be required. Patients with pyloric stenosis are usually given a drainage procedure but Johnston and Imperati (1974) have described dilatation of the stenosis with a finger or even with Hegar's dilators. Division of the stricture longitudinally, closing it like a Heineke-Mickulicz pyloroplasty, can be done without damaging the pylorus. This procedure has been called duodenoplasty by Tanner and shown to give good results (Kennedy, 1976).

In the emergency situation vagotomy with drainage can be used for perforated duodenal ulcer, and it is perfectly possible to close a perforation and complete the operation with a P.G.V. Bleeding duodenal ulcers demanding emergency surgery virtually always involve the gastro-duodenal artery. Duodenotomy, suture of the bleeding point and completion with P.G.V. without pyloroplasty is a sound procedure.

S.V. and T.V. with drainage have been widely used in the treatment of gastric ulcer; recently P.G.V. without drainage has also been used. These conservative operations are attractive but a careful trial conducted by Duthie has failed to
show any advantage over orthodox Billroth I gastrectomy. Most surgeons will be deterred by the fear of missing a gastric cancer.

When gastric ulcer is combined with a duodenal ulcer, some form of vagotomy is quite acceptable, though excision biopsy of the gastric ulcer is mandatory.

CONCLUSION

The increasingly conservative approach to ulcer surgery in recent years has gone a long way to allaying the physician’s fears of seeing his patient transformed into a gastric cripple, let alone the foundation of a tombstone. The surgeon is much closer to his El Dorado. Undesirable side effects and risk have been virtually eliminated by P.G.V. The one remaining query is the recurrence rate. This may well turn out to be around ten per cent. If so, no harm will have been done these patients who will simply need antrectomy and conversion to truncal vagotomy. Perhaps the H₂ receptor blockers, currently undergoing clinical trials, will prove suitable for this group.

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