

## Extensive pharyngo-oesophageal reconstruction using multiple jejunal loops

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**Summary**—Two patients underwent subtotal pharyngo-oesophageal reconstruction using jejunum transferred by means of microvascular anastomosis. In both cases, two sets of vascular anastomoses were required, one in the lower neck and the other at the mid-sternal level. In the first patient, a continuous length of jejunum was employed but this led to great redundancy of the bowel on account of coiling as a result of its mesenteric attachment. In the second case, two isolated loops were employed with minimal redundancy. An anatomical study on three fresh cadavers indicated that the maximum defect which can be bridged by a single loop of jejunum lies between 15 and 20 cm. No particular part of the jejunum or ileum seems particularly advantageous in terms of its ability to span large defects.

The use of isolated loops of jejunum as free tissue transfers is beginning to gain wide acceptance as the method of choice in the reconstruction of pharyngeal and upper oesophageal defects (Hester *et al.*, 1980; Seidenberg *et al.*, 1959). The problem with the jejunum is that due to its mesenteric attachment, a single loop is unable to bridge a defect greater than 15 to 20 cm in length (Harashina *et al.*, 1981). The mesenteric attachment prevents the unravelling of the jejunum into the straight tube

which is required to reconstruct a long defect (Fig. 1). Furthermore, it is questionable whether a single jejunal vascular pedicle can supply more than one loop of bowel due to the configuration of the mesenteric vascular architecture (Fig. 1).

### Anatomical Work

An anatomical investigation was performed on the small intestines of three fresh cadavers in order to

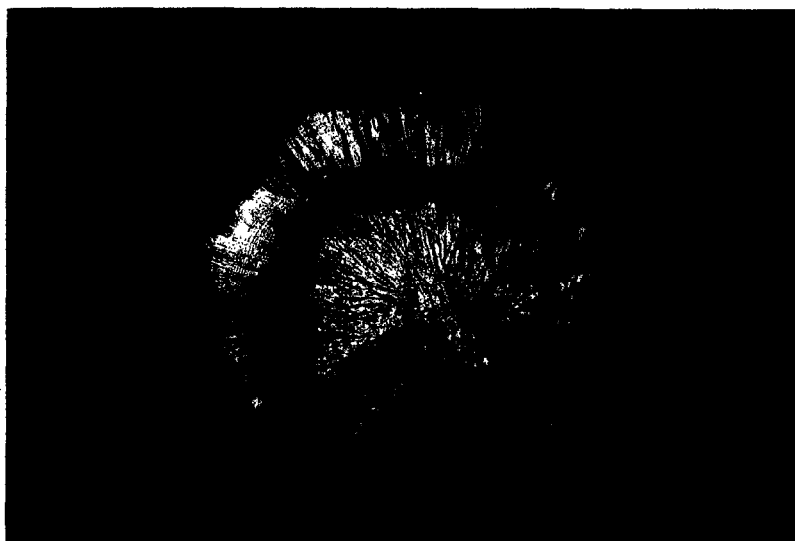


Fig. 1

Figure 1—A 40 cm length of jejunum from a fresh cadaver showing how the mesenteric attachment prevents it from becoming a straight tube.

determine (i) that part of the small intestine most favourable in terms of obtaining lengthy straight segments for tubular reconstructions and (ii) the maximum defect reasonably bridged by a single loop of jejunum. The small bowels were inflated with water to such an extent that the loops of jejunum and ileum would spontaneously uncoil when each was isolated. Then, working from the ligament of Treitz all the way along the intestine as far as the ileocaecal valve, specific lengths of bowel were taken on the anti-mesenteric border. These "arc" lengths were compared to the corresponding chord lengths as measured on the mesenteric border. The chord length represents the maximum defect which a specific arc of bowel can span (Fig. 2). Arc lengths of 10, 20, 30 and 40 cm were taken progressively along the entire length of the bowel and compared with the corresponding chord lengths.

It was at once obvious that with increasing lengths of bowel there was proportionately less increase in the chord length (Fig. 3). It was interesting that no particular part of the jejunum or ileum was particularly favourable in its ratio of chord to arc length (Fig. 4). Furthermore, the maximum chord length obtainable seemed to plateau out around 15 cm as the arc length increased (Fig. 5). Increasing the arc length beyond 40 cm tended to take the measurements into a second loop of jejunum and cause great redundancy in the total segment.

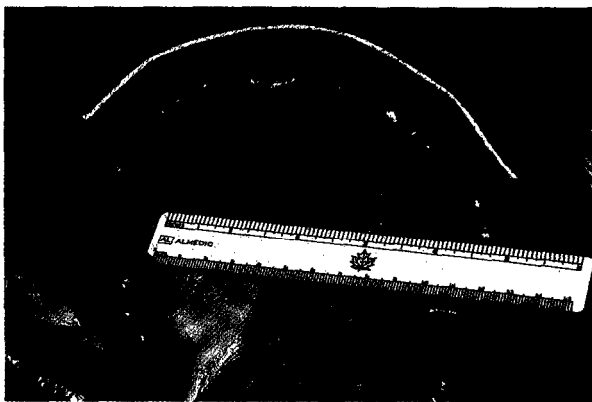


Fig. 2

Figure 2—A loop of jejunum fully extended with a length of string along the antimesenteric border denoting a specific arc length. The equivalent chord length is the distance between the two black pins on the mesenteric border, is less than the arc length and represents the maximum defect which can be bridged by the specific arc length of bowel.

In summary, it seems that no particular segment of the jejunum or ileum is particularly advantageous in terms of obtaining long straight segments of bowel and it would appear that the maximum defect bridgeable by a single loop of bowel is approximately 15 cm (although in clinical practice this may be increased by cross-hatching the peritoneal component of the mesentery).

It was with these findings in mind that we approached pharyngo-oesophageal reconstruction in two clinical cases.

#### Case 1 (Fig. 6)

A 28-year-old male swallowed concentrated sulphuric acid which resulted in extensive destruction of the oesophagus and stomach. The patient had a stormy course in hospital, undergoing a number of operations to excise necrotic tissue and to drain the peritoneal cavity. He was given a feeding jejunostomy and the stomach remnant was drained through a gastrostomy. The patient developed a pharyngeal fistula in his neck. After the patient was stabilised an attempt was made to reconstruct the oesophagus by means of colonic interposition. Due to the extensive scarring in the posterior mediastinum, this was passed through the anterior mediastinal route. Unfortunately the colon underwent ischaemic necrosis and required removal. Six months later the patient was referred for microvascular reconstruction. He had good speech and normal swallowing, although the swallowed fluids emerged through the pharyngeal fistula in the neck.

A decision was made to construct a roux-en-Y of jejunum, bringing it up to the neck via the subcutaneous route and performing a revascularisation of the proximal segment in the neck. In practice it was found impossible to mobilise the jejunum sufficiently to obtain the relatively simple reconstruction envisaged. It was necessary to perform a vascular anastomosis not only in the neck but also in the midsternal region and here the internal mammary vessels were utilised. The roux-en-Y was constructed in the abdomen and a pharyngeal-jejunal anastomosis in the neck. A great deal of jejunum (most of it redundant) had been brought up into the subcutaneous plane of the chest in order to bridge a defect perhaps less than a third of its length. Nevertheless, the patient went on to heal and eventually he was able to eat a normal diet. The peristalsis of the jejunum can be observed directly when the patient eats but otherwise the reconstruction is unobtrusive.

#### Case 2 (Fig. 7)

A 48-year-old female patient, who suffered congenital oesophageal structure and had undergone repeated dilatation since childhood, developed malignant cells in routine washings and underwent an oesophagectomy

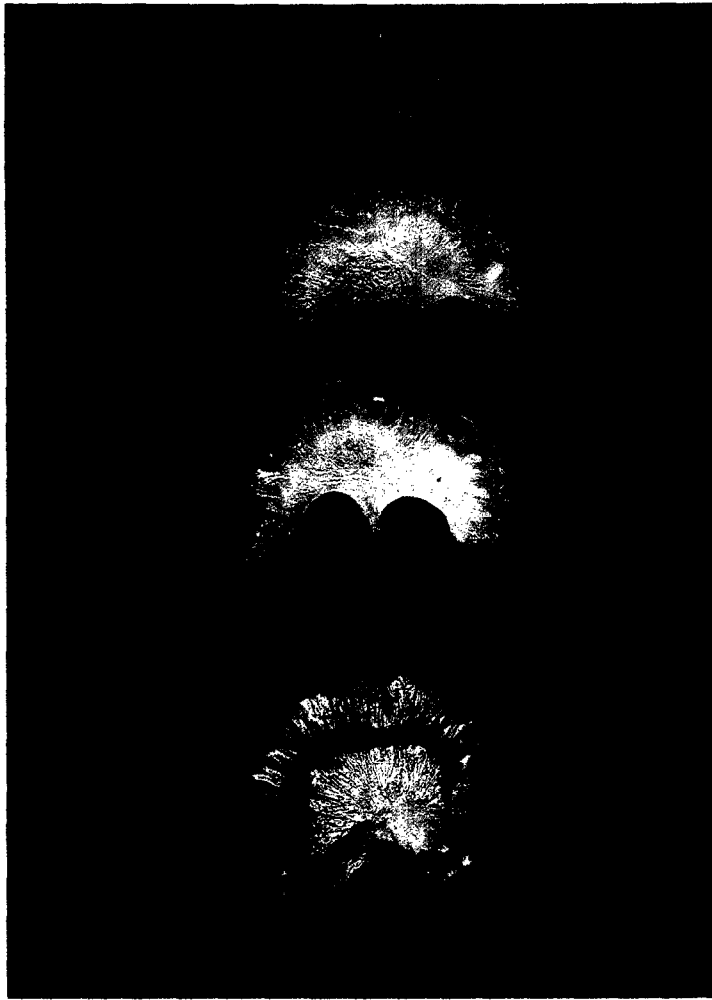


Fig. 3

Figure 3—10, 20, 30 and 40 cm lengths of fresh bowel at full stretch illustrating the law of diminishing returns.

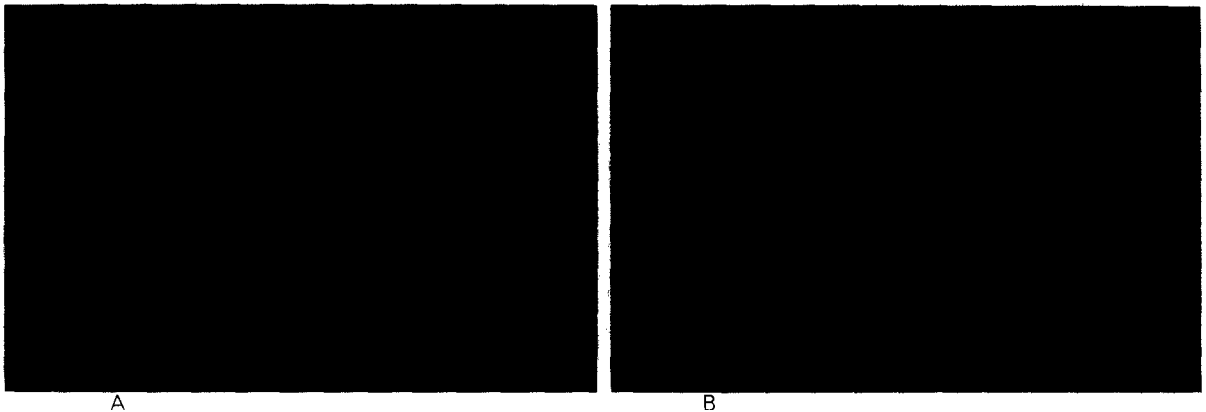


Fig. 4

Figure 4—(A) Chord length plotted against successive 10 cm arc lengths from the ligament of Treitz (left) to the ileocaecal junction (right). All three cadavers are shown. Note that no particular area gives a particularly favourable chord length. (B) The same graph with chord lengths plotted against 20 cm arc lengths. No area of the intestine was favourable. Plots with 30 cm and 40 cm arcs were not significantly different.

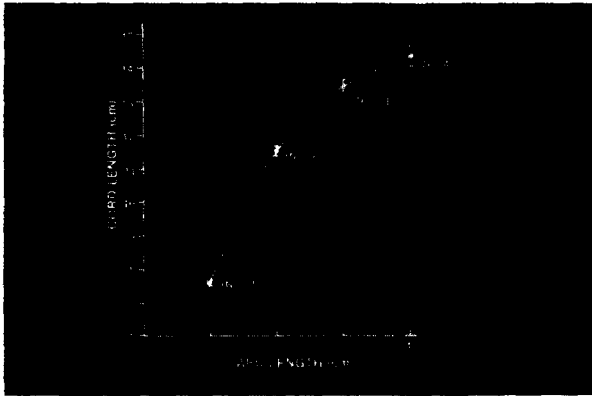


Fig. 5

Figure 5—Chord length plotted against arc length using all the recorded measurements. Note the small range of spread at each of the four major points and that as arc length increases, chord length tends to plateau out. The maximum defect which can be bridged by a single loop of small intestine would appear to be 15 cm although this may be increased to 20 cm by cross-hatching the serosal surface of the mesentery (Harashina *et al.*, 1981).

with gastric pull-up. Unfortunately, this operation failed and the patient went on to develop mediastinitis. Some months later she underwent a colon interposition via the retrosternal route and this also failed. She was ultimately referred for microvascular reconstruction.

Once again, reconstruction was planned using jejunum in the form of a roux-en-Y. On mobilising the jejunum, it became clear that a single loop could not be brought up to sufficient length without at least two microvascular anastomoses. A single length of jejunum with pedicles anastomosed in the neck and at the midsternal level would have easily bridged the defect but with great redundancy of jejunum. The solution was to perform the reconstruction with two single loops, each on its own vascular pedicle and each with a chord length between 15 and 20 cm. The loops were placed in such a way as to form an "S", so minimising redundancy in the jejunum and providing a near rectilinear reconstruction of the pharyngo-oesophagus. Three bowel anastomoses were performed: superiorly to the pharynx, inferiorly to the stomach remnant and, at the midsternal level, to each other. Vascular anastomoses were performed superiorly to the transverse cervical artery and the external jugular vein, and at the midsternal level the internal mammary vessels were used. Ischaemia time for the second segment was no longer than that for the first, since it was not detached until after the first segment had been vascularised. Postoperatively the patient developed a small fistula at the lower bowel anastomosis but this cleared up on conservative therapy and she is now eating and drinking naturally without restriction.

## Discussion

It is clear from the two cases presented here that the entire pharyngo-oesophagus can be reconstructed subcutaneously with two isolated loops of jejunum arranged in the shape of an "S". Two sets of microvascular anastomoses are required but this does not necessarily mean a long ischaemia time for the second loop. Each loop of jejunum is isolated and, while one is being transplanted, the other is left to perfuse on its abdominal mesenteric attachment. Each loop is thus transplanted sequentially with no more than the usual ischaemic time for a free jejunal reconstruction.

From the anatomical work, it would appear that any part of the jejunum or ileum would be suitable for transplantation in terms of obtaining a reasonable, straight segment. However, the longer vascular arcades in the proximal jejunum facilitate the

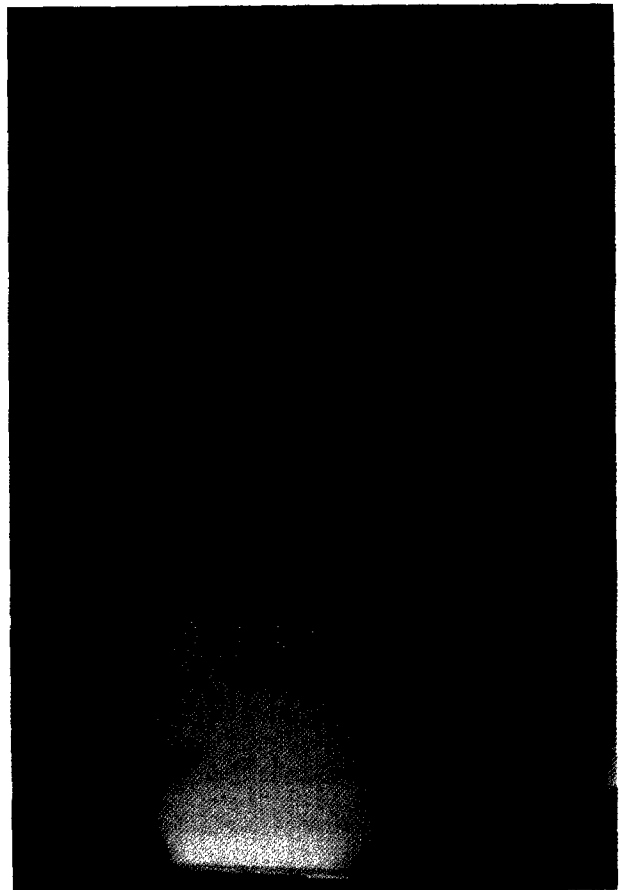


Fig. 6

Figure 6—Case 1. A postoperative barium swallow. Note the redundant coils of jejunum.

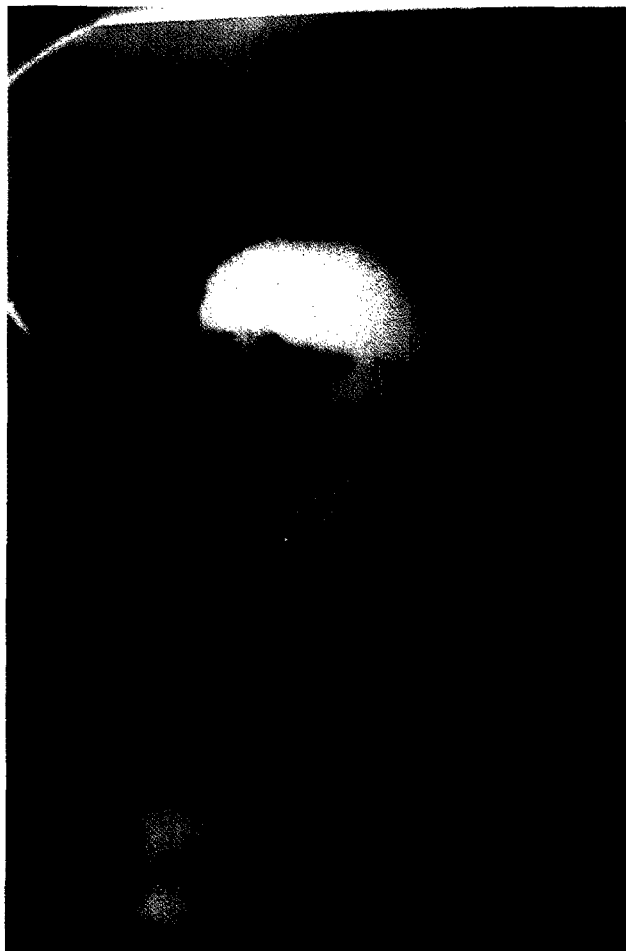


Fig. 7

Figure 7—Case 2. Postoperative barium swallow showing the more direct course of the reconstructed oesophagus. Compare with Fig. 6.

identification and dissection of a pedicle. It was clear from both the experimental and the clinical experience that the jejunum could not be straightened out due to its coiled nature produced by the mesenteric attachment. The mesenteric attachment could not be released without devascularising a segment of bowel. Transplantation of a single

length of jejunum with two sets of microvascular anastomoses leads to excessive redundancy in the transplanted segment. It is much more efficient to transplant two separate segments of jejunum if a defect of greater than 20 cm needs to be bridged.

The place of this form of reconstruction in the armamentarium of the reconstructive surgeon still remains to be defined. In the cases presented here other methods of bowel transfer were not available or had already been used. It is proposed that this operation is superior to the formation of a pharyngo-oesophagus using skin tubes and is probably safer than colonic interposition. The gastric pull-up is likely to remain the procedure of choice in those cases where it is possible.

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