Jejunal Interposition for Esophageal Replacement

William A. Cooper and Joseph I. Miller, Jr

The evolution of operations on the esophagus date back to Billroth in 1877.[1] Roux[2] in 1907 was the first to describe use of the small bowel for esophageal replacement. The development of these techniques in the early part of the twentieth century paralleled those that used stomach and colon.[3]

In 1942, Reinhoff[4] successfully replaced the esophagus with a jejunal pedicle graft. Merendino and Dillard[5] followed in 1955 with the use of jejunal interposition for peptic stricture of the distal esophagus. As the techniques of microsurgical anastamosis became more readily available, Jurkiewicz and colleagues[6,7] reported excellent results with free jejunal transfer for cervical esophageal replacement.

Jejunal interposition for esophageal replacement can be performed for cervical esophageal replacement but is primarily indicated for lower esophageal replacement. This procedure may be done as a (1) free jejunal graft, (2) an intact loop, (3) a pedicled interposition, or (4) a Roux-en-Y. Free jejunal grafts may be used for hypopharyngeal and upper esophageal replacement. The focus of this article will be lower third esophageal replacement.

In general, jejunum is the third choice for esophageal replacement after stomach and colon. The use of jejunum may be undertaken in benign or malignant disease. The jejunum should be considered for esophageal replacement under the following circumstances: (1) distal esophageal disease, (2) stomach not available because of prior surgery or resection, (3) colon not available, (4) patients older than 60 years of age because of the unreliable colonic blood supply (Table 1).

Contraindications to the use of jejunum include the overall poor health of the surgical candidate, a history of inflammatory bowel disease, diverticular disease, and neoplasms of the small bowel. Dense adhesions, peritonitis, or multiple prior intra-abdominal procedures may halt mobilization of the jejunum.

TABLE 1. Common Indications for the Use of Jejunum for Esophageal Replacement

Distal esophageal pathology—benign or malignant
Stomach not available
    Prior surgery limiting mobility
    Prior resection—concerns with blood supply
Elderly patients with prior colon resection or poor blood supply
Cervical esophageal replacement
    Free jejunal transfer
    Possibly Roux-en-Y in a child

Advantages to the jejunum are its availability and reliable transport of food. The diameter and wall thickness of the jejunum closely resembles that of the esophagus. Its isoperistaltic placement provides some defense against gastroesophageal reflux.

The major disadvantage to the use of jejunum is its arterial supply. Variations in the jejunal arcades may limit the amount of length that can be gained when the jejunum is used as an interposition or Roux limb.

Anatomical Considerations

The jejunum has approximately 12 to 15 branches from the superior mesenteric artery. Each one of these contributes to secondary arcades that then form a marginal branch near the mesenteric border of the bowel wall. Small vasa recta from this marginal branch then penetrate the bowel on its mesenteric side (Fig I). These give rise to an extensive network of submucosal capillaries that supply the various layers of the bowel. Jejunal branches in the proximal jejunum tend to be long and straight. Therefore, this segment is most suitable for mobilization.

Preoperative Evaluation

Preoperative evaluation, as always, begins with a thorough history and physical examination. Particular attention should be given to any history of inflammatory bowel disease, peptic ulcer disease, or symptomatology that suggests the presence of an inflammatory or neoplastic condition.

The physiological and functional status of the patient should be determined with emphasis on cardiopulmonary and nutritional reserve. Appropriate evaluation should be performed when clinically indicated.

Patients with neoplasms should routinely undergo evaluation for extent of disease before surgery.

Contrast radiography and endoscopy of the upper gastrointestinal tract are performed routinely as part of the evaluation of esophageal disease. Biopsy of any suspicious lesions should be performed to rule out malignancy or an inflammatory process.

Arteriography is not performed routinely. It is indicated in all patients ≥60 years of age. It may also be helpful when symptoms suggest chronic mesenteric ischemia or in patients with severe peripheral vascular disease, coronary artery disease, or prior abdominal vascular surgery.
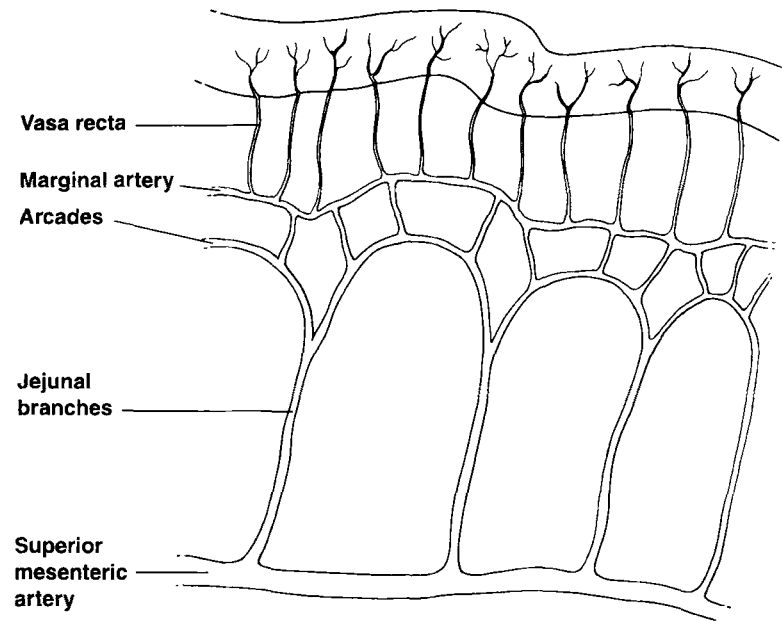
Fig I.   Jejunal arterial anatomy. Jejunal vessels originate from the superior mesenteric artery and form primary arcades. These arcades then branch into secondary arcades that give rise to vasa recti that then encircle the bowel from the mesenteric side.

Patients selected for surgery undergo bowel preparation starting with a liquid diet 48 hours before surgery. Mechanical preparation consists of magnesium citrate the night before surgery. Antibiotic bowel preparation of neomycin and erythromycin base is administered routinely. Patients hospitalized the night before surgery are given intravenous fluids during the time that they are not able to take anything by mouth. This may alleviate dramatic hemodynamic fluctuations at the time of anesthetic induction. A second or third generation cephalosporin is given within 1 hour of the start of the procedure. All patients receive an epidural catheter for postoperative pain control.

SURGICAL TECHNIQUE
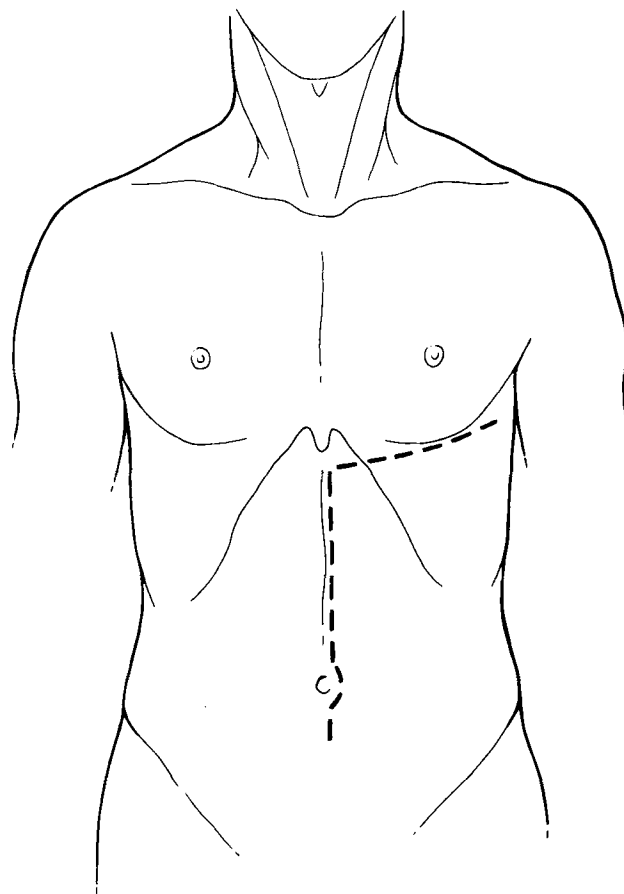
1 **Incisions.** Because the vast majority of jejunal interpositions are for distal esophageal disease, a left thoracoabdominal incision provides adequate exposure to the lower esophagus and abdomen.
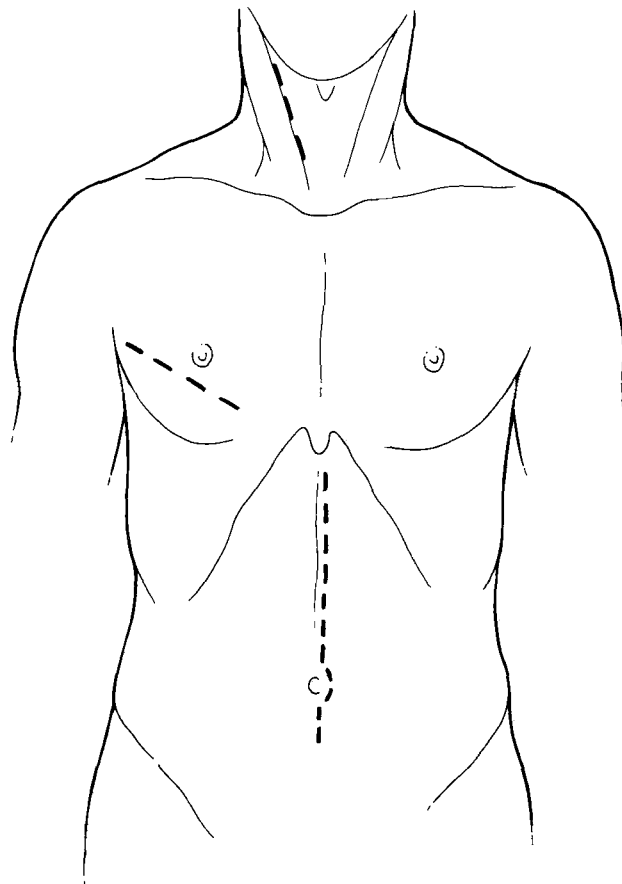
2 Alternatively, if a complete esophagectomy is planned, a right thoracoabdominal or separate abdominal and right thoracotomy incisions can be used. In the case of free jejunal transfer, a cervical incision will be required.

Positioning. The patient is positioned partial right lateral decubitus for left thoracoabdominal approach or partial left lateral decubitus for right thoracoabdominal approach. The patient is prepped throughout the abdomen and thorax.

The operation begins in the abdomen with a midline incision from the xiphoid process to just above the umbilicus. The incision may be extended as needed to gain adequate exposure of the abdominal contents. Rarely should this incision need to be extended more than just below the umbilicus.

The abdominal cavity is then thoroughly explored for any unsuspected pathology and to assess the quality of the jejunum.
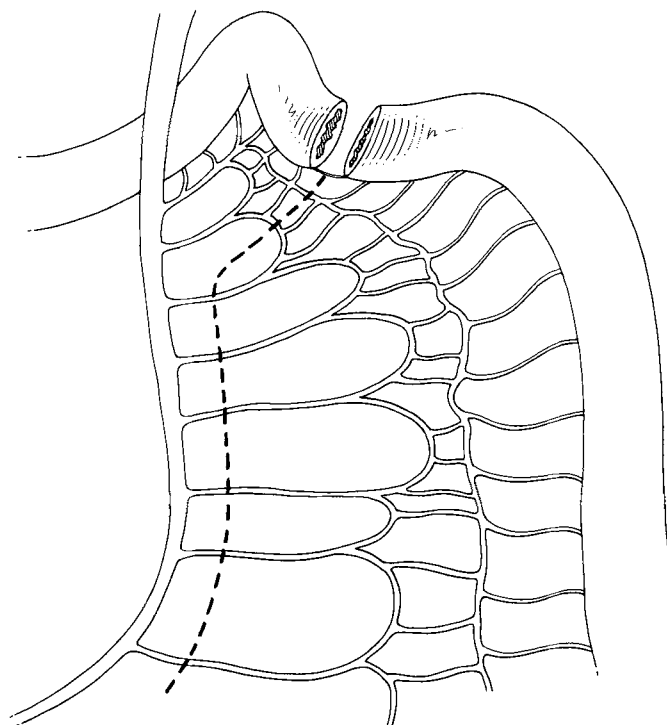
3 The Roux-en-Y. When the stomach is not available for jejunal interposition, the Roux limb serves as an alternate technique. Mobilization of the jejunum begins approximately 15 to 20 cm distal to the ligament of Treitz. The first two jejunal arcades are preserved in order to ensure adequate blood supply to this proximal end that will be re-anastamosed to the distal portion of the Roux limb.

Transillumination of the mesentery gives a guide to the adequacy of the jejunal arcades. Once a line of resection has been chosen, the bowel is then divided with an Ethicon GIA 7.5-mm stapler (Ethicon, Cincinnati, OH). At the line of division of the bowel, the dissection proceeds toward the base of the mesentery. Jejunal branches are then clamped with bulldog clamps to assess their ability to provide adequate blood supply to the segment of jejunum selected. Once this is determined, the vessels are divided individually as close to the base of the mesentery as possible and ligated with 2-0 silk sutures. Care should be taken to avoid violation of secondary arcades.
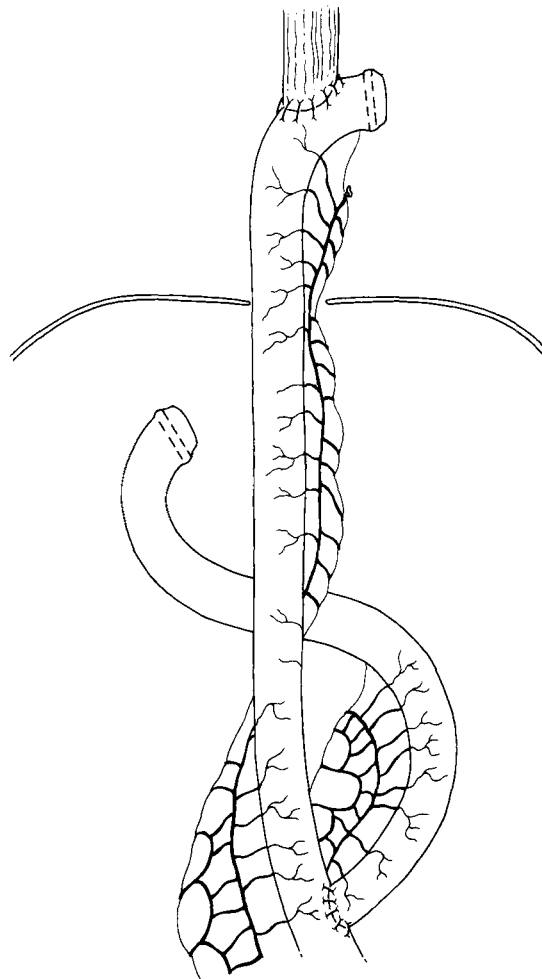
4 Typically a Roux limb will reach comfortably to the lower esophagus in adults. Additional length may be gained by scoring the mesentery or as a last resort, by division of secondary arcades.

The Roux limb is then tunneled retrolic to the left of the middle colic vessels, through the esophageal hiatus of the diaphragm and into the left chest.

Exposure of the distal esophagus for resection can be obtained by extending the abdominal incision into the left thorax or by separate thoracotomy incision. A thoracoabdominal incision will require phrenotomy and reconstruction in most cases.

After completion of the resection, the anastamosis is carried out in a two-layer fashion of either interrupted silk for both layers or an outer layer of silk and an inner layer of absorbable chromic or polyglycolic acid suture. Our preference is a two-layer technique using 3-0 silk (see **11A-C**). Various stapling techniques are also reasonable alternatives. However, we prefer the handsewn anastamosis.

As shown, the anastomosis is always performed in an end-to-side fashion. A very short (no more than 2 cm) distance from the end of the Roux limb is chosen as the site of the anastamosis.
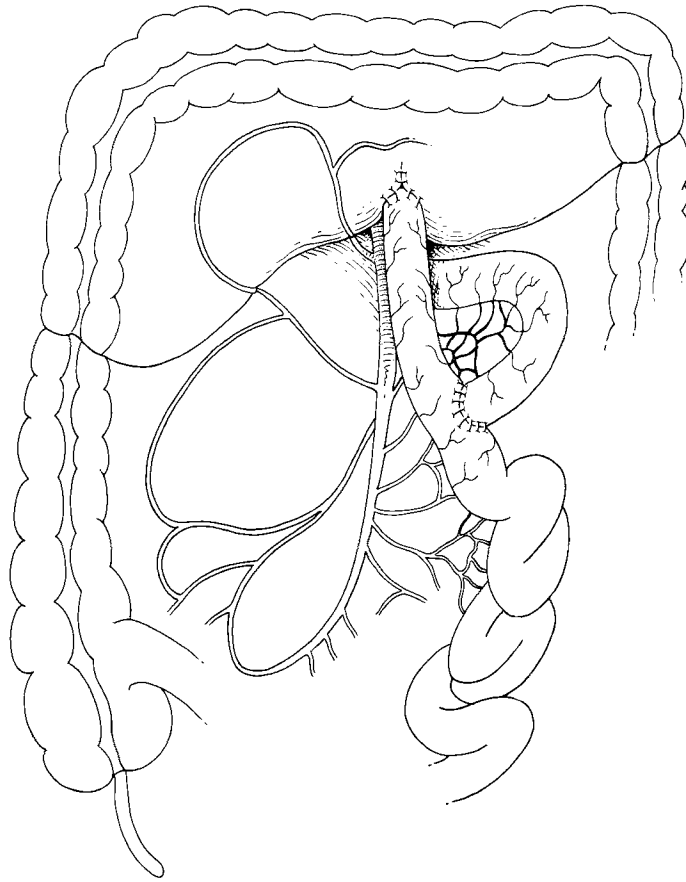
5 After completion of the anastamosis, the defect in the transverse mesocolon is then closed around the Roux limb with interrupted 3-0 silk sutures. The continuity of the small bowel is then re-established through completion of the jejunojejunostomy. This is usually done in two layers or in a stapled fashion. Placement of a 14F feeding jejunostomy tube is highly recommended.
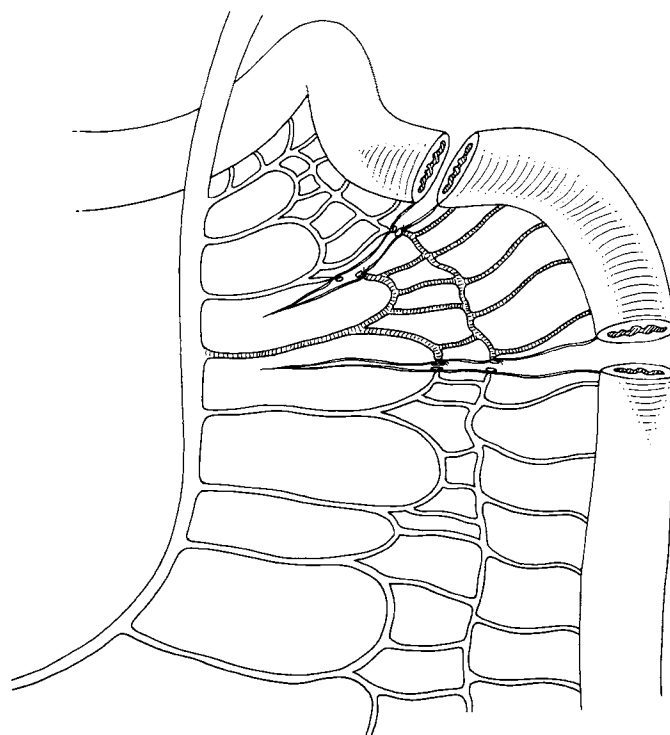
6 **The interposition.** The short segment jejunal interposition may be used when the stomach is available. Frequently, these patients have had distal gastric resection that may preclude mobilization of the stomach into the chest.

A left thoracoabdominal approach is selected for this particular operation. The operation begins with celiotomy and abdominal exploration.

Mobilization of the jejunal interposition follows the same principal as outlined earlier in the Roux-en-Y technique. Preservation of the most proximal arcades ensures adequate blood supply to the proximal jejunum.

Transillumination helps with identification of a segment of bowel suitable for interposition. Test clamping of the jejunal vessels to this segment helps in the selection process. The segment is usually limited to a single jejunal vessel as a pedicle. A 10 to 20 cm segment is frequently all that is required.

A GIA stapling device is used to divide the interposition at its proximal and distal end. The mesenteric dissection then proceeds toward the base of the mesentery.
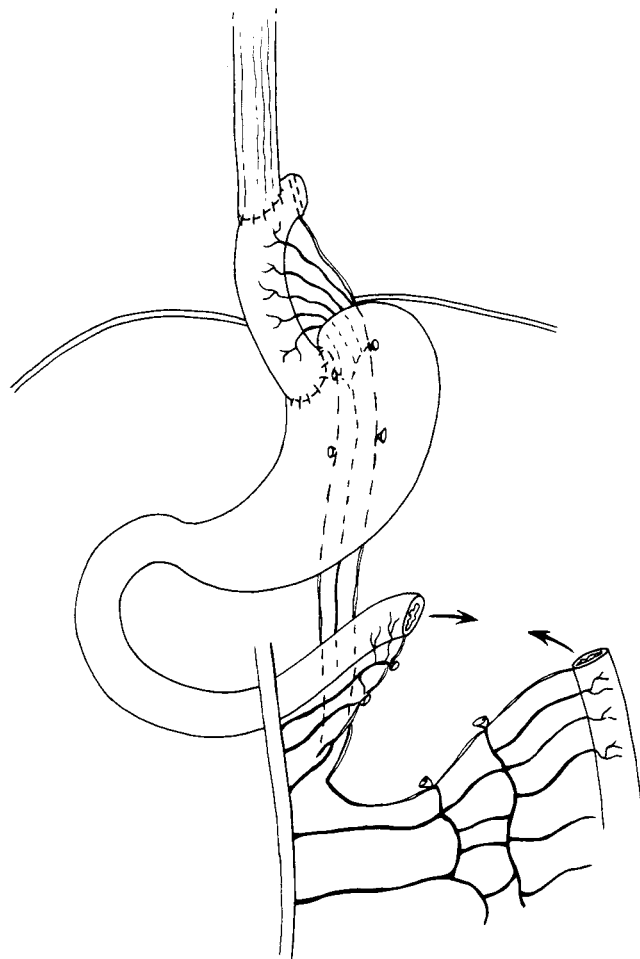
7 Esophagectomy proceeds through the left chest and the remaining esophagus prepared for anastamosis to the jejunum.

The interposition is then brought through the transverse mesocolon in a retrocolic position and into the left chest. The interposition is always placed in an isoperistaltic fashion. The proximal anastmosis is then created end-to-side in at least two layers or is stapled. The distal portion of the jejunal interposition is then anastamosed to the stomach in a two-layer technique.

Frequent evaluation of the blood supply to the interposition is mandatory at all steps in this operation.
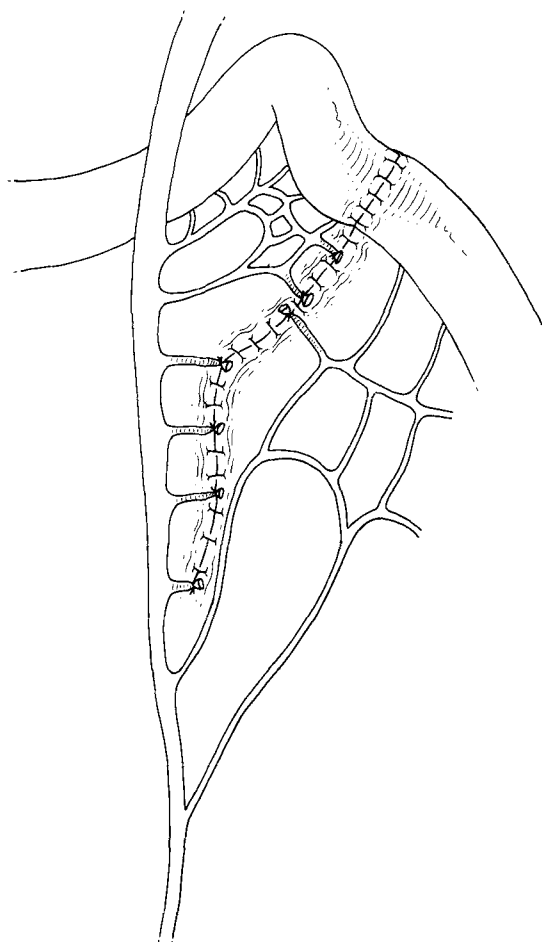
8 After completion of the jejunal interposition, intestinal continuity is re-established with an end-to-end jejunojejunostomy. A feeding jejunostomy is placed for postoperative nutrition.

Free jejunal interposition. This technique is primarily used for isolated cervical esophageal replacement. Pioneered by M.J. Jurkiewicz,[8] the free jejunal transfer is widely accepted as an excellent conduit for replacement of the upper esophagus. This may be carried out at the time of initial tumor resection or delayed. A left-sided dissection in the neck is routinely performed first to ensure that the neck is indeed suitable to receive the jejunal transfer. Branches of the external carotid artery and vein are carefully preserved as recipient vessels of their corresponding jejunal branches.

Once the decision is made to proceed with transfer, a midline laparotomy is performed. It is also worthwhile to prepare one thigh as a potential donor site if split-thickness skin grafting in necessary.

9 After thorough exploration through a midline laparotomy, a segment of jejunum 15 to 20 cm from the ligament of Treitz is chosen. Once the length of jejunum is determined, the bowel is divided with a GIA stapler device. Simultaneously, the vessels in the neck are being prepared for anastamosis to the jejunal vessels. The graft jejunal vessels are not ligated until the neck is prepared to receive the transfer.
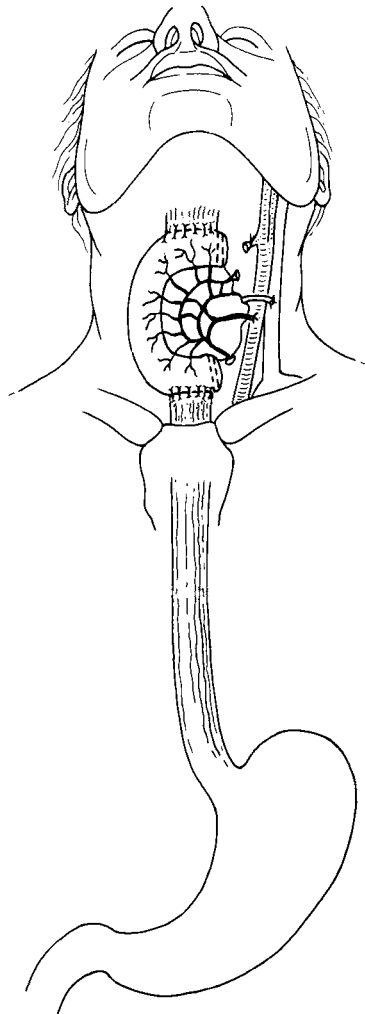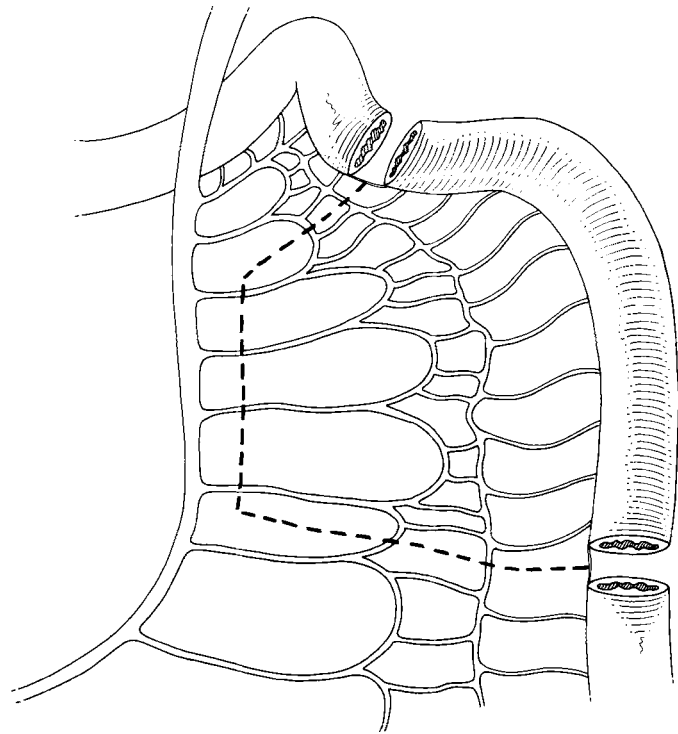
10 The jejunal branch artery and vein are then ligated and flushed with heparinized saline. The jejunal segment is then brought into the neck and placed in an isoperistaltic fashion. The proximal bowel anastamosis is performed in two layers. The operating microscope is then brought onto the field. The vascular venous then arterial anastamoses are performed using 9-0 or 10-0 polypropylene suture. The distal intestinal anastamosis is completed in two layers end-to-side. Redundant mesentery may be used to cover the vascular anastamoses and exposed vessels in the neck.

The neck incision is partially closed. A split thickness skin graft is placed over a small window in the incision for continuous monitoring of the integrity of the jejunal transfer. A feeding jejunostomy is performed after completion of the jejunojejunostomy in the abdomen.
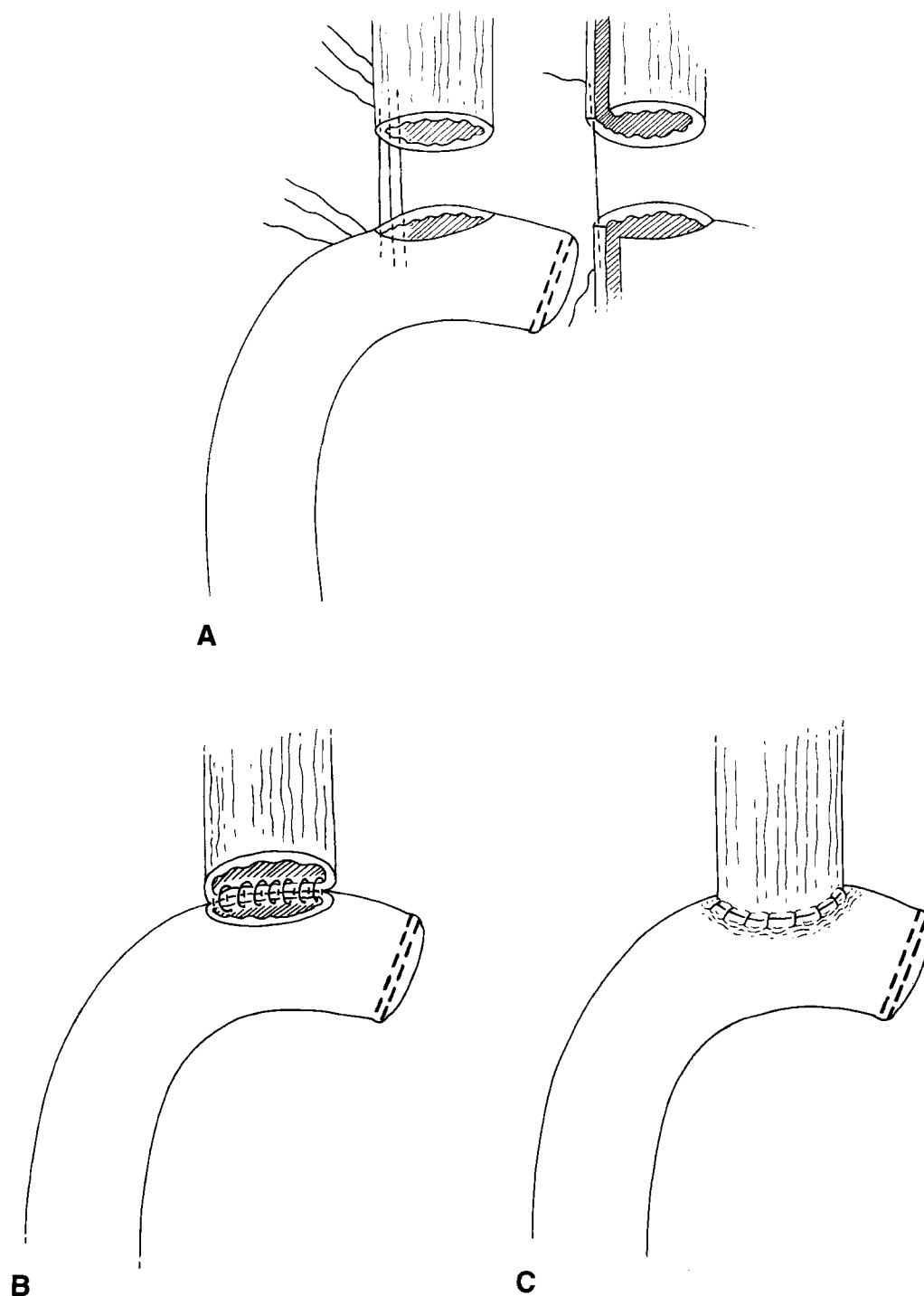
11 The esophagojejunostomy. We perform the esophagojejunostomy in two layers using interrupted 3-0 silk. The two viscera are prepared for anastamosis by removal of the staple lines on each end (esophageal and jejunal). (A) The outer, posterior line of sutures are placed first. These sutures are taken through the seromuscular layer of the jejunum and then through the muscular wall of the esophagus. The knots are placed on the outside. (B) The inner layer incorporates all layers of the esophagus and jejunum. Because the esophageal mucosa has a tendency to retract, particular attention must be given to this layer. These sutures are tied with the knots to the inside. (C) The completed anastomosis.

Postoperative Care

All patients are placed in the intensive care unit in the immediate postoperative period. Jejunal feeding is begun on the third or fourth postoperative day. A barium swallow is performed on the eighth postoperative day. In the case of the jejunal Roux-en-Y and interposition to the lower esophagus, at least one thoracostomy tube is left in place until after the barium study.

Complications

The most feared of the complications is an anastamotic leak or loss of vascular supply to the jejunal segment. In the free jejunal transfer, the skin graft allows ready access and continuous monitoring of the graft. Complete loss of the graft requires its removal and replacement or permanent cervical esophagostomy.

An anastamotic leak in the neck can frequently be managed with drainage and maintenance of adequate nutrition. Anastamotic leaks in the chest may require debridement if systemic sepsis develops. However, often these leaks will close if adequate drainage is established through the thoracostomy tube. Antibiotics may be needed to control sepsis. Maintenance of adequate nutrition is imperative in all cases.

Anastamotic strictures can usually be managed with careful endoscopic dilation. We do not routinely dilate in the postoperative period unless a stricture develops. Patients often have minor swallowing difficulty after these procedures that respond to dietary manipulation.

Conclusion

Jejunal interposition is a valuable replacement conduit for the lower esophagus. Free jejunal transfer may be used as a conduit in cervical esophageal replacement. Jejunum serves as a reliable transporter of a food bolus and is an effective barrier against acid or alkaline reflux. The jejunum is similar in quality and caliber to the esophagus. The blood supply is its major limiting factor as a more widely acceptable esophageal replacement conduit. Despite its limitations, it remains a viable adjunct in the armamentarium of the thoracic surgeon.

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