Esophageal Anastomosis

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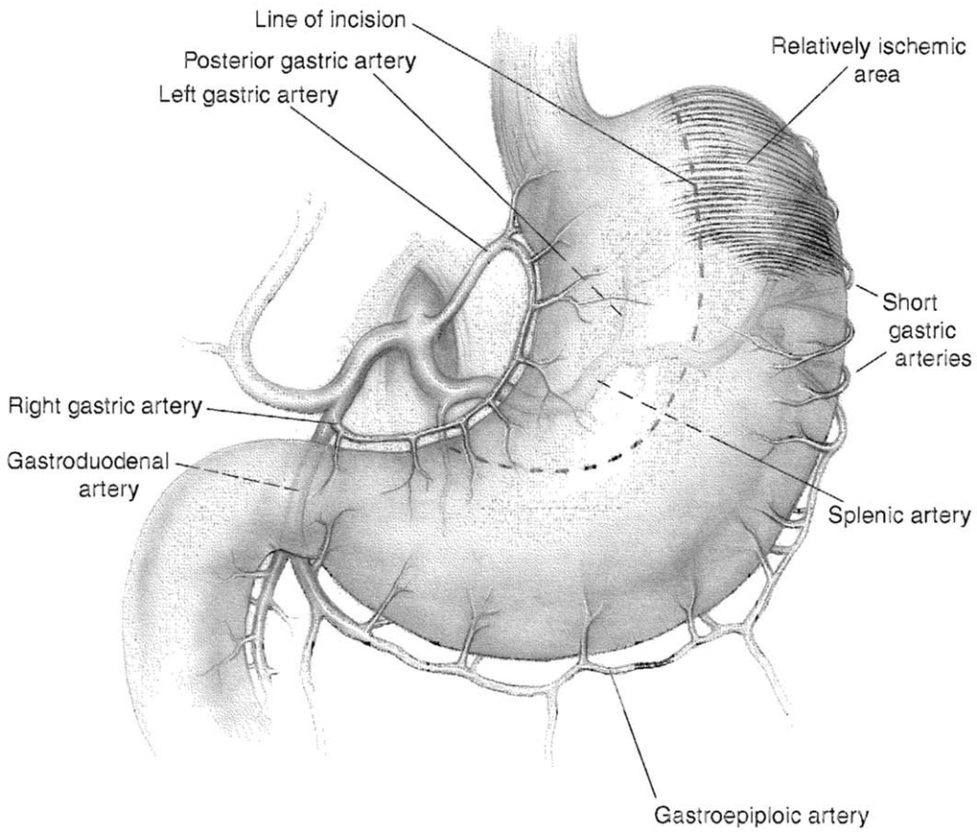
Esophageal resection involves the anastomosis of a proximal esophageal segment with either the distal esophagus or an interposed gastrointestinal conduit. Short-segment resections of the esophagus with esophago-esophagostomy are unusual for several anatomic reasons. First, the segmental blood supply to the esophagus limits the mobility of the proximal and distal esophagus. Second, the intrinsic muscular tone of the esophagus places bidirectional tension on the anastomosis. Finally, most esophageal problems that are potentially amenable to a segmental resection, such as rings or short strictures, are effectively treated with endoscopic approaches. As a result, the esophageal anastomosis generally involves use of an interposition graft of stomach, jejunum, or colon.

The most important consideration in an esophageal anastomosis is the blood supply of the conduit. Replacement of the esophagus requires a conduit with a sufficient blood supply to heal an anastomosis at its most ischemic extreme. In contrast to the segmental blood supply of the native esophagus, the interposition graft must provide its own axial blood supply. For example, the stomach interposition graft is based on the gastroepiploic artery (Fig 1). The short gastric arteries, and occasionally the posterior gastric artery,[1,2] normally supply the distal portion of the gastric "tube."[3] The adequacy of the blood supply to this region is the primary determinant of anastomotic leaks and strictures.[4]

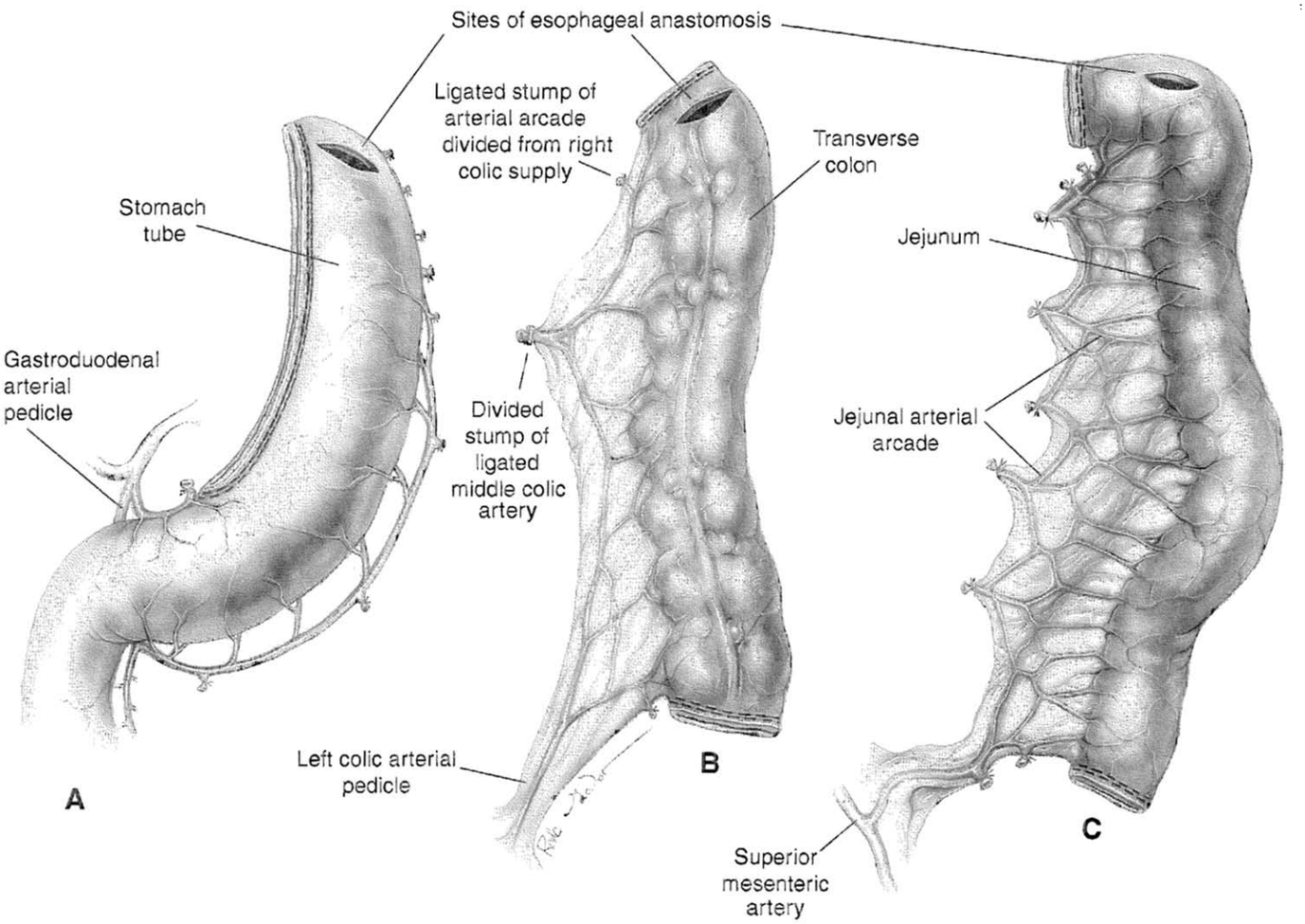
Another anatomic consideration is the location of the anastomosis. In most cases, the anastomosis can be performed at the level of either the thoracic or cervical esophagus. Cervical esophageal anastomoses have the advantage of minimizing the length of residual esophagus. Most studies of esophageal cancer suggest that the length of the surgical margin correlates with anatomic



1 Blood supply to the stomach.

recurrence.[5] Furthermore, esophageal carcinoma in the context of Barrett's epithelium is frequently multifocal.[6] Near-total removal of the esophagus may contribute to regional control of the disease and also to decreased risk of local recurrence. An additional functional benefit of minimizing the length of residual esophagus is decreased reflux. Because of the favorable pressure-volume relationships of most conduits, reflux and regurgitation are lower when the length of the residual esophagus is minimized. Finally, anastomotic complications such as leakage and stricture are arguably less morbid in the neck.[7]

SURGICAL TECHNIQUE

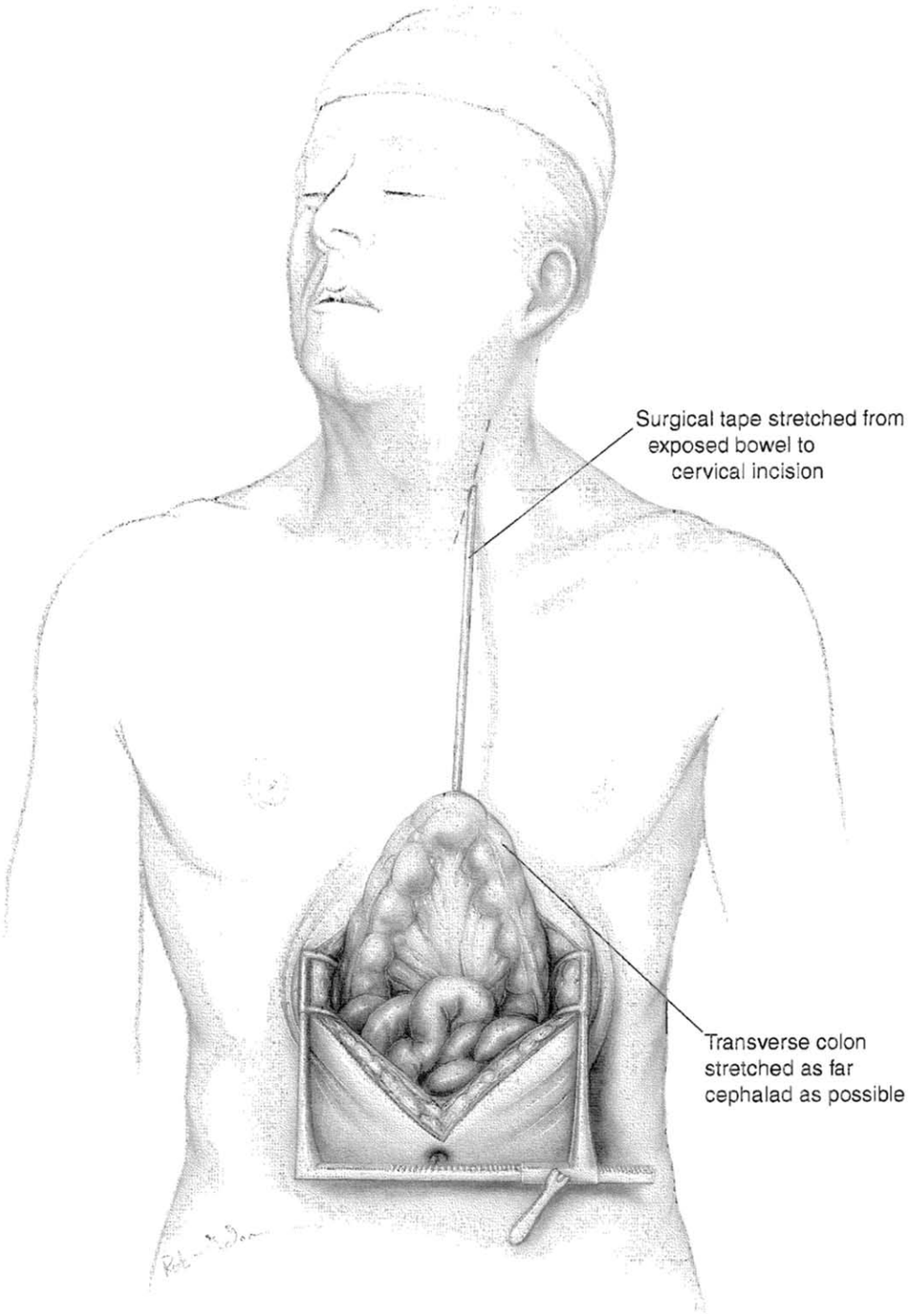


2 See legend on opposite page.

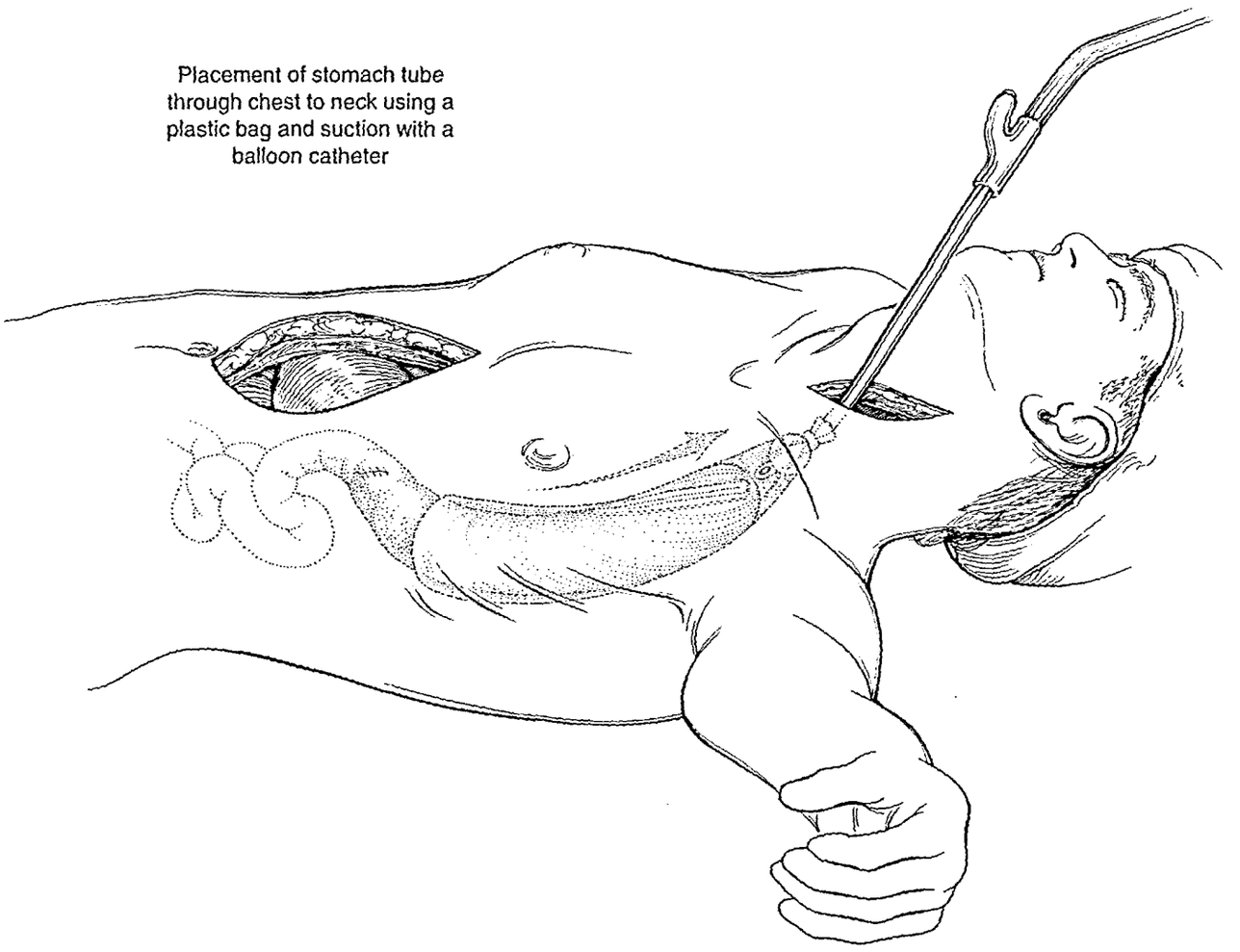
2 The preferred conduit for esophageal anastomosis is the stomach (A). The stomach is a hearty organ that is generally resistant to surgical injury and torsion. Also, operations using a gastric conduit require only a single anastomosis, whereas jejunal or colonic conduits require an additional jejuno-jejunostomy or colo-colostomy. Preparation of the gastric conduit includes the careful preservation of the gastroepiploic arcade as well as division of the left gastric and short gastric arteries. Because esophageal anastomoses involve bilateral vagotomy, a minority of patients will develop impaired emptying without a drainage procedure.[8] Either pyloroplasty or pyloromyotomy can improve postoperative gastric emptying.[9]

Alternative conduits are the colon (B) and jejunum (C). The description of a "left" colon interposition graft refers to the blood supply of the colon; the segment of bowel used as the conduit is the transverse colon and a portion of the right colon. Preparation of the colon interposition focuses on preserving the arterial arcade. Some authors have advocated dividing the middle colic artery at its base to maximize collateral perfusion.[10] Similarly, jejunal interposition grafts preserve the mesenteric arterial arcade.[11] Although the arterial interconnections in the small bowel arcade are less predictable, the vessels can be readily identified by transillumination.

To minimize anastomotic complications, the interposition graft must have sufficient length to provide a tension-free anastomosis. The gastric conduit can provide this length, particularly when combined with an extensive Kocher maneuver and constructed as a narrow tube along the greater curvature of the stomach. We favor constructing a narrow tube, because the perfusion of the entire conduit depends on microvascular collaterals from the gastroepiploic artery,[12,13] and a narrow conduit minimizes the dependency of the lesser curvature of the stomach on these collateral vessels. An opposing argument is that the entire stomach should be used as an interposition graft to decrease the risk of anastomotic leakage. A plausible explanation for this potential advantage is that the use of the entire stomach effectively prevents the stomach's "low-perfusion" zone of the stomach from being incorporated in the esophageal anastomosis. We prefer to aggressively mobilize the gastric conduit, deliver as much length as possible into the neck, and remove the redundant gastric conduit *in situ*.

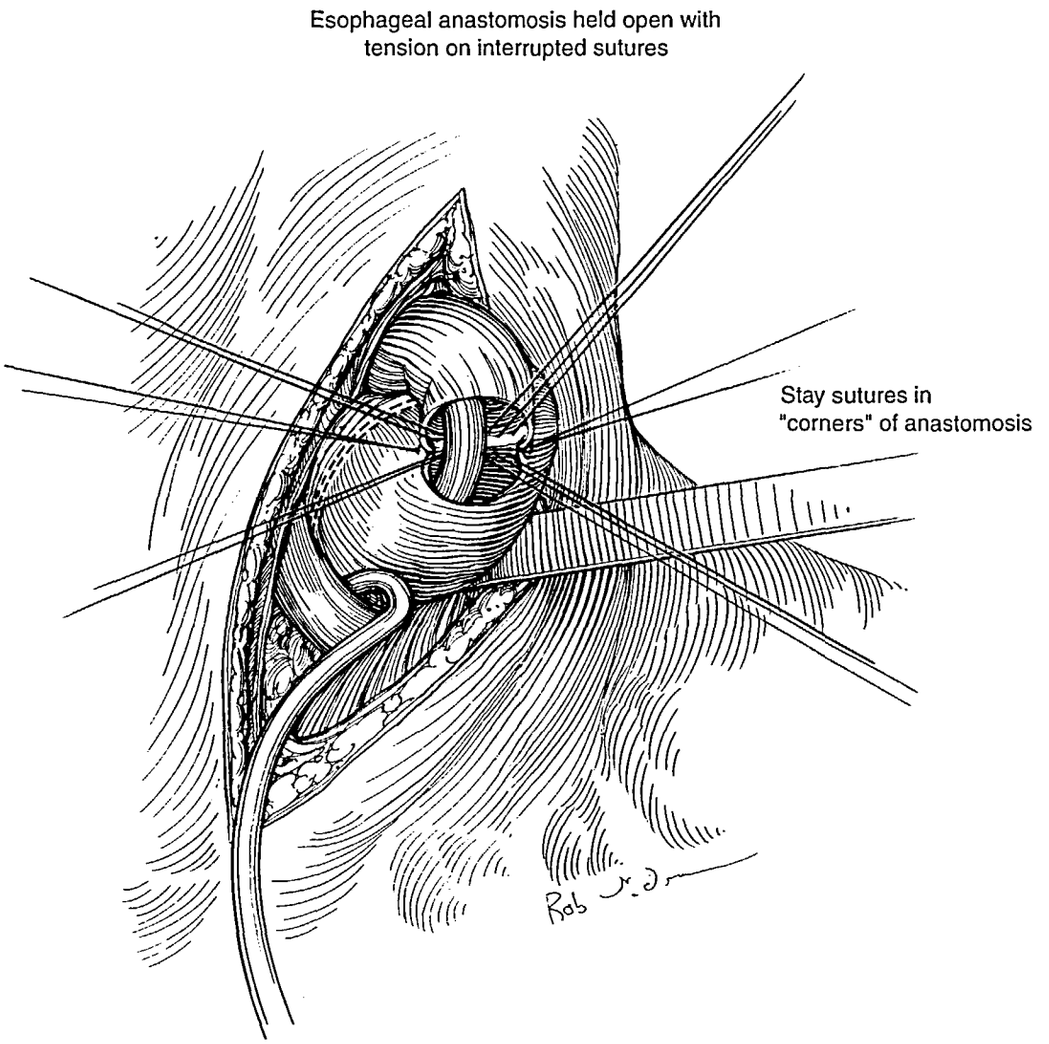


3 For alternative conduits, the appropriate length of jejunum or colon can be readily measured. The proximal portion of the potential bowel graft is stretched cephalad as far as possible on the anterior chest wall. The length of the interposition graft is then measured from this point to the level of the planned esophageal anastomosis. The measured distance is transposed to a length of bowel using a surgical tape. The jejunum and colon are divided at this point.

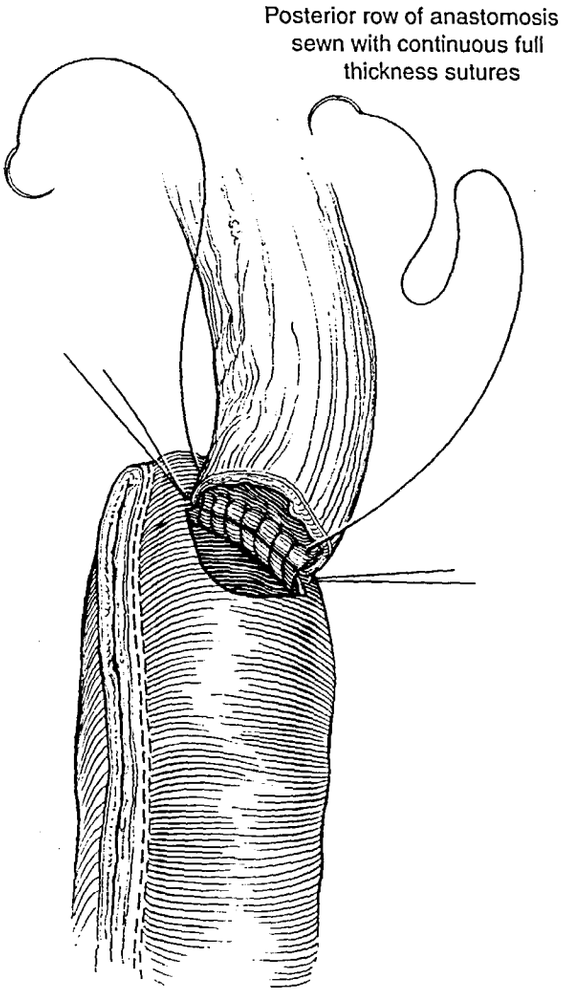


4 All three conduits are delivered to the neck through the posterior mediastinum. To minimize trauma to microvascular collaterals and torsion of the blood supply, we use a vacuum-bag technique. The conduit is placed in a plastic arthrotomy or video endoscopy bag. A 30-cc Foley catheter is passed from the neck through the esophageal hiatus. The balloon of the Foley catheter is inserted through the apex of the arthrotomy bag, the balloon is inflated, and a tie is placed at the base of the balloon. The tie must provide an airtight external seal, yet permit creation of a vacuum through the central lumen of the Foley catheter. When vacuum is applied to the Foley catheter, the plastic bag collapses around the conduit. The vacuum maintains traction and orientation of the conduit as it is delivered into the neck.

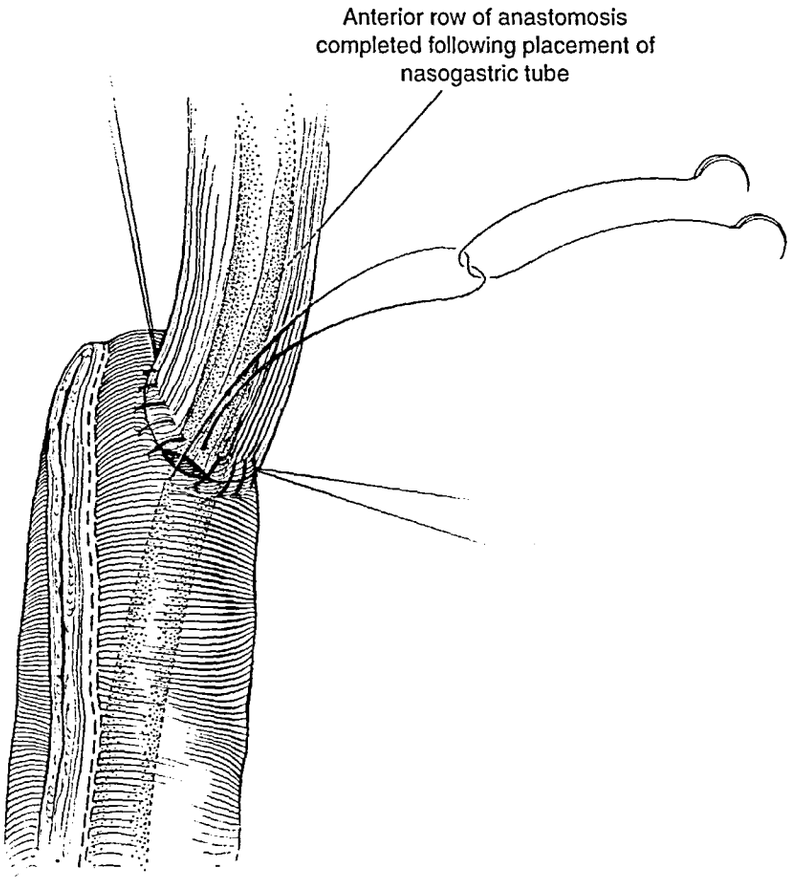
If the blood supply is adequate, the specific technique for esophageal anastomosis can be tailored to the surgeon's preference. For a hand-sewn anastomosis, a linear enterotomy is made with electrocautery on the anterior surface of the conduit. Placing the enterotomy on the anterior surface ensures that any anastomotic leak can easily drain through the cervical incision. Many patients with a functional vagotomy and/or obstruction of the esophagus experience overgrowth of anaerobic bacteria in the gastric conduit. To minimize contamination at the anastomosis site, penicillin is instilled into the stomach at the beginning of the operation. In addition, metronidazole is included in the perioperative antibiotic regimen.



5 The hand-sewn anastomosis can be constructed with any of the three conduits and using either an interrupted or a running technique. Stay sutures are used to align the anastomosis and evert the mucosa. The principal consideration of the interrupted anastomosis is mucosal approximation without strangulation. The interrupted sutured technique uses a single layer of nonabsorbable 3-0 suture. In most cases, a full-thickness simple suture produces adequate mucosal apposition. The suture must be of sufficient depth to withstand the gravitational tension on the anastomosis produced in the upright position. Because of reports of vertebral osteomyelitis,[14] tacking sutures from the conduit to the prevertebral fascia, designed to minimize anastomotic tension, are no longer used. The suture is tied with sufficient tension to gently approximate the walls of the esophagus and conduit.

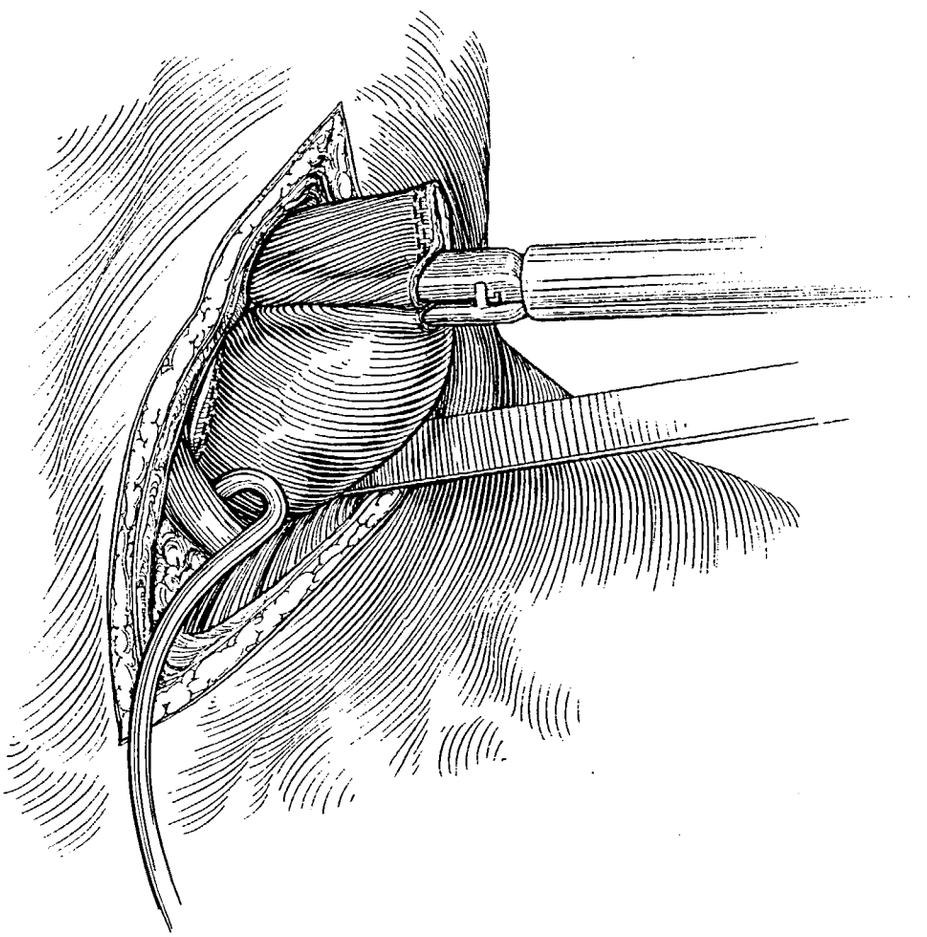


6 An anastomosis constructed with a running technique is performed with similar considerations. The stay sutures are used to align the anastomosis and also prevent purse-string narrowing.



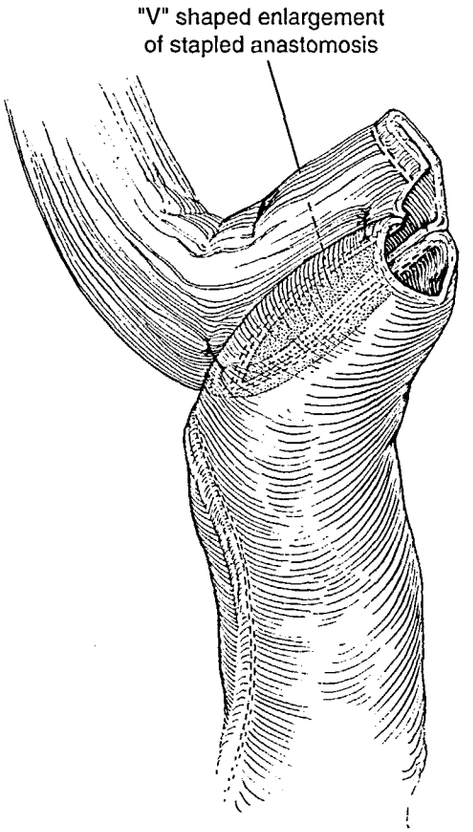
7 The anastomosis is constructed using double-armed 3-0 monofilament suture. The challenge of the running technique is to produce a gentle mucosal approximation. Particularly in a teaching setting, the tendency is toward overtightness and borderline strangulation. The stay sutures are incorporated into the anastomosis for additional support and tension reduction.

Stapled anastomosis of stomach tube and cervical esophagus

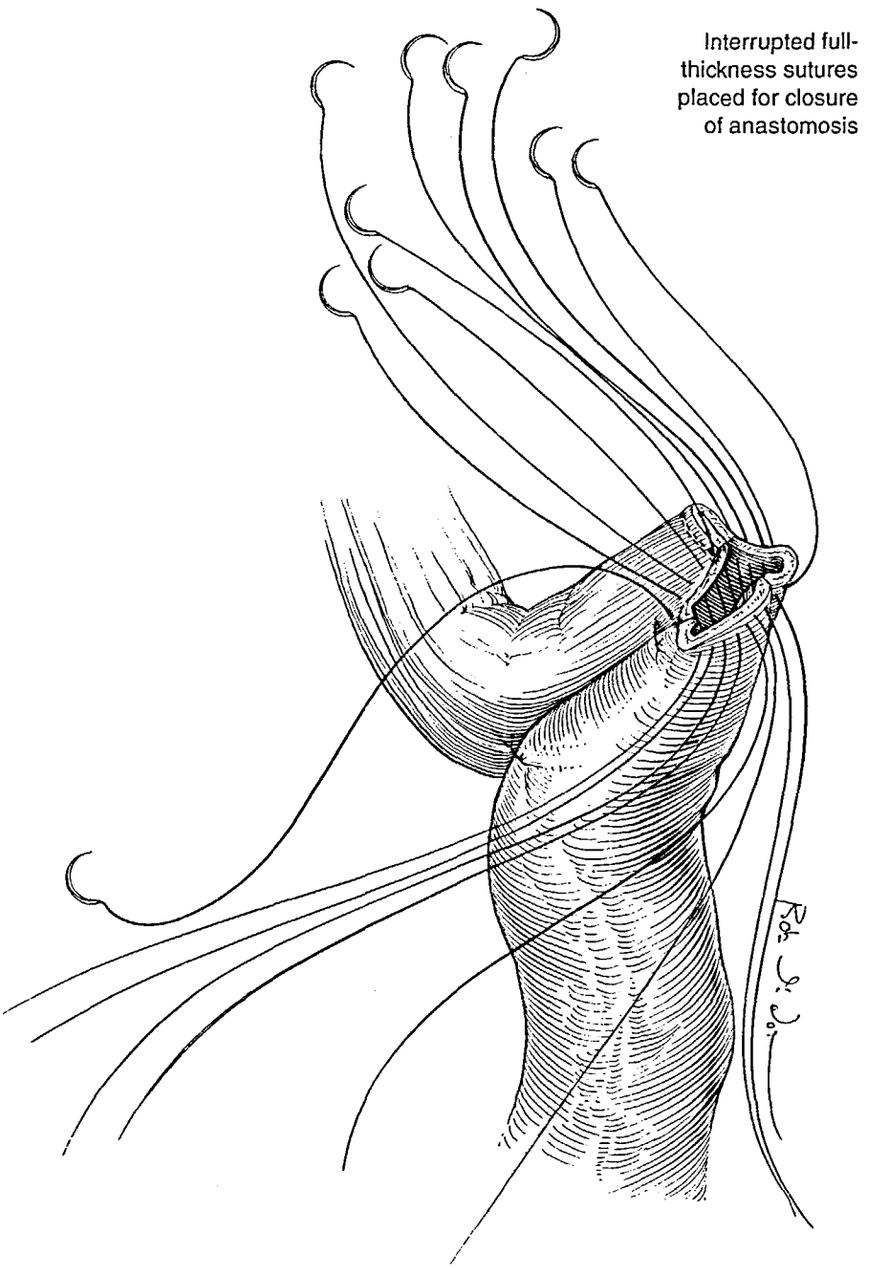


8 A simple alternative technique, a stapled functional end-to-end anastomosis, can be performed expeditiously with minimal contamination.[15] A disadvantage of this approach is that it leaves an unusually long proximal esophageal segment. Therefore, the technique is inappropriate for a patient with a proximal esophageal carcinoma or proximal severe dysplasia. Another disadvantage of this approach is that the cephalad portion of the gastric conduit can persist as a small blind pouch. In the event of a postoperative stricture, anastomotic dilatation may require a guidewire or endoscopic visualization.

After the conduit is delivered into the neck, the posterior aspects of the conduit and esophageal segment are juxtaposed. The orientation of the esophagus and conduit can be maintained with stay sutures.



9 A limited gastrotomy is created in the conduit, and a V-shaped functional end-to-end anastomosis is created with a 30- to 45-mm endoscopic stapler. An endoscopic stapler is used because of its relatively small profile and short blunt ends. The resulting V-shaped lumen can be directly examined and the nasogastric tube passed distally.



10 The "exit gap" of the stapler is closed using interrupted 3-0 nonabsorbable suture. The hand-sewn closure is used to maximize the anastomotic cross-sectional area and minimize the "blind pouch" of the conduit. In most cases, the gap is closed transversely.

Regardless of the anastomotic technique, a nasogastric tube is used to decompress the conduit and limit the risk of aspiration for a minimum of two days. The closed-suction drain is placed through the base of the wound for two days and then gradually removed.

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