Pilot study on preventing anastomotic leakage in stapled gastroesophageal anastomosis

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Keywords
Anastomotic leakage; esophageal cancer; stapled anastomosis.

Abstract
Background: This study explored how to improve the surgical technique to reduce or avoid anastomotic leakage.

Methods: From January 2012 to December 2016, 101 consecutive patients with cancer of the esophagus or gastroesophageal junction underwent stapled gastroesophageal anastomosis. The procedure included creating a tube-type stomach, fixing an inserted anvil, inspecting mucosa-to-mucosa alignment in the lumen under direct vision after firing the stapler, and, if found, manually repairing a rupture of the mucous membrane of the anastomosis.

Results: A rupture of the mucous membrane of the anastomosis was found in four out of the 101 patients and manually repaired. No postsurgical anastomotic leakage occurred. All patients recovered well and the average postoperative stay was 10.4 days. There was no mortality within 30 days after surgery.

Conclusion: It is critical to inspect the integrality of the luminal mucous membrane of the anastomosis under direct vision in order to prevent anastomotic leakage in surgical resection of esophageal and gastroesophageal junction malignancies.

Introduction
Gastroesophageal anastomotic leakage is a serious complication of esophagectomy, with a reported incidence ranging from 3–5\% to more than 10\%\textsuperscript{1,2,3} How to reduce postsurgical anastomotic leakage poses a significant challenge. While some studies have demonstrated that the use of staple-assisted anastomosis significantly reduces the occurrence of gastroesophageal anastomotic leakage,\textsuperscript{1} others have reported no significant benefit of the use of staples.\textsuperscript{4} In addition to the common risk factors for anastomotic leakage reported in the literature, there may also be areas for improvement.\textsuperscript{5,6} Our group has been exploring ways to improve the surgical technique to reduce or even avoid anastomotic leakage. From 2012 to 2016, we performed consecutive mechanical gastroesophageal anastomoses in 101 patients. No anastomotic leakage occurred in our series and we report our findings as follows.

Methods
Patient selection
One hundred and one patients with cancers involving the esophageal or gastroesophageal junction were consecutively enrolled in our study from January 2012 to December 2016. Among these subjects, 17 were women and 84 were men, with a mean age of 62.9 years (range 42–78 years). There were 75 patients with esophageal cancers and 26 with gastroesophageal junction cancers. Pathology results showed 22 cases of adenocarcinoma, 72 of squamous cell carcinoma, 1 small cell carcinoma, 1 leiomyosarcoma, 1 squamous epithelium epithelioid hyperplasia (preoperative diagnosis of squamous cell carcinoma during upper endoscopy), 3 carcinoma in situ, and 1 case of malignant melanoma. Comorbidities included 28 cases of hypertension, 2 coronary artery disease, 3 arrhythmia, 7 diabetes, 8 post-chemotherapy, 5 cerebrovascular disease, and 1 case...
of post renal transplantation. The same surgeon performed all surgeries.

Surgical procedure

In our cohort, the surgical approaches used included 57 cases of the Ivor-Lewis approach, 7 with the three-incision-right chest approach, 31 below-arch anastomosis via left thoracotomy, 4 anastomosis via the left chest left neck, and 1 case of total gastrectomy and esophageal jejunum anastomosis. Among these cases, two required concomitant coronary artery bypass grafting, 1 concomitant lung lobectomy, 1 concomitant partial hepatic resection, and 1 case required concomitant splenectomy and distal pancreatectomy.

The anastomosis was performed using a circular stapler (Panther Healthcare, Beijing, China). Selection of the stapler was based on the diameter of the esophageal lumen and esophageal wall thickness. Size 24# or 26# staplers were generally selected.

All surgeries were performed under general anesthesia with double-lumen endotracheal intubation. The anastomosis included the following steps:

1. Removal of esophageal cancer, followed by creation of a tube-type stomach using the straight-line incisional device. The tube-type stomach has a width of about 4–5 cm. A 3-0 absorbable suture was used in a continuous manner to strengthen the gastric serosa. Creation of the tube-type stomach makes it easy to pull the stomach up to the neck without significant tension, the benefit of which has been confirmed in various studies.

2. Insertion of anvil of the stapler: Our approach includes the use of the purse clamp, in which a straight needle reserves the purse string suture and the esophagus is cut off, followed by anvil insertion into the esophageal end and tightening of the purse string suture. At this time, the distance between the “in and out” sites of the strings is significant (Fig 1a). To address this issue, we reconnect one end of the purse string into a small round needle and make a full circular suture along the pulse string line toward the opposing end of the purse string to avoid esophageal mucosal rupture when the knot is made (Fig 1b). If the purse shape is still not optimal, that is, if the anastomosis does not tighten, the anastomosis should be strengthened using a silk or Prolene suture to ensure that the stapler anvil is stable and closely fits with the esophageal mucosa.

3. Anastomosis: The stapler channel is created at the top of the tube-type stomach by making a 2 cm cut in the gastric wall. The stapler is then inserted and pierced through the appropriate location of the greater curvature of the stomach (i.e. to ensure that the distance between the gastric closure and anastomosis is > 1 cm) to complete mechanical anastomosis.

Results

In our cohort of 101 patients with malignancies of the esophagus or gastroesophageal junction undergoing surgical
resection, four cases were found to have incomplete intra-luminal anastomosis and rupture of the gastroesophageal junction during intraoperative examination, thus additional sutures were used locally to reinforce the anastomotic site. Postoperatively, no anastomotic leakage occurred in our whole cohort. Complications included three cases of anastomotic stenosis (improved after dilatation), one myocardial infarction, one pulmonary embolism, one case of respiratory distress requiring mechanical ventilation for four days, and one case of lymphatic leakage. Patients were discharged after an average hospitalization duration of 10.4 days. No postoperative mortality occurred within 30 days.

Discussion

Post-surgical anastomotic leakage can be caused by a variety of reasons, including: systemic issues such as malnutrition, hypertension, and diabetes; local issues such as poor blood supply, infection, and radiotherapy; and surgical issues such as high anastomotic tension and surgical error. A traditional surgical approach often encompasses manual suture via either intermittent varus anastomosis or continuous mattress anastomosis. Because of the variable suture angles, limited surgical field, and mucosal ductility, unequal needle spacing or an irregular anastomosis edge increase the risk of postsurgical anastomotic leakage.

The advantage of mechanical over manual anastomosis is that the anastomosis is generally more uniform with the mechanical approach. After application of the stapler, tension around the anastomosis site is usually more evenly distributed. In addition, the orderly arrangement of the staples at the anastomosis usually allows better blood supply. Traditionally, the anastomosis is generally considered satisfactory if the annular tissue at both ends of the anastomosis is intact (Fig 3). However, because of a variety of reasons, including edema, variable firing range of the stapler, and the unmatched thickness of the opposing anastomotic ends, mucosal rupture at the anastomosis site can occur. Our group identified a total of four cases (4%) of anastomotic mucosal rupture by intraoperative intraluminal examination. We repaired the mucosal rupture by intraluminal mucosal sutures and were eventually able to avoid anastomotic leakage in all four cases. Interestingly, the rate of our observed mucosal rupture at the anastomosis site is similar to the reported incidence of anastomotic leakage. Therefore, it is plausible that ensuring mucosal integrity at the anastomosis site during surgery may prevent postoperative anastomosis leakage. However, if there is no reliable contact at both ends, how can we ensure satisfactory healing? In addition to addressing the various common risk factors for anastomosis leakage, including malnutrition and high anastomosis tension, we believe that maintaining mucosal integrity at the anastomosis site by direct intraoperative inspection and necessary repair is also imperative to prevent anastomosis leakage. Indeed, in our series, it was not necessary for us to check the integrity of the annular tissue retrieved from the staplers after the staples were applied. Importantly, several risk factors may render the intraluminal mucosal suture difficult because of a suboptimal surgical field and limited spaces, including gastric secretion and bleeding. Therefore, suction is often needed during suturing. Small suture needles, such as the 5-0 Vicryl (Ethicon Inc., New Jersey, NJ, USA), can also help to ease the suturing process. However, if it is too difficult to achieve the above measure or there is a significant risk of incomplete anastomosis, a suture involving the whole wall of the esophagus at the corresponding location of the anastomosis can be used. Even in these cases, it is still essential to ensure the integrity of the mucosa at the anastomosis site.
Multiple techniques have been attempted in recent years to reduce the incidence of anastomotic leakage, including the creation of a tube-type stomach, anastomotic omental embedding,7,8,10 stapler anvil purse string suture reinforcement, indwelling mediastinal drain to ensure no space around the anastomosis site, and a reduction in infection rate. Here, we propose that it is also crucial to maintain direct contact of the mucosa at both ends of the anastomosis to promote satisfactory healing. Because stapler-assisted anastomosis is actually equivalent to a whole-layer varus suture, theoretically, both ends of the mucosa are not in direct contact. However, because the close proximity between the two ends of the anastomotic mucosa is well maintained by the staples, this absence of direct mucosal contact did not result in any clinically significant consequence. Nevertheless, if mucosal rupture does occur around the staple site because of local edema, brittle tissue, or excessive crushing, the mucosa will tend to retract, which will lead to a defect in tissue integrity and increase the risk of anastomotic leakage.

In our cohort, both intrathoracic and cervical anastomosis was performed, and there was no significant difference in clinical outcome between the two locations. We suggest the use of a purse clamp to maintain the flatness of the esophageal end and the uniformity of the distance from the purse-string to ensure that the force of anastomosis will be evenly distributed after launch of the stapler.

In our cohort of patients with esophageal or gastro-esophageal junction malignancies, we are able to reduce the incidence of postsurgical gastroesophageal anastomotic leakage by directly inspecting mucosal integrity at the anastomosis site during surgery and repairing mucosal rupture by intraluminal mucosal sutures if necessary. To our knowledge, this unique surgical approach has not been reported as a method for prevention of postsurgical anastomotic leakage. As this is a single center experience, multicenter trials are needed to validate our approach.

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Disclosure
No authors report any conflict of interest.

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