

• Technology and Methods •

# Modified application of circular stapler to cervical esophagogastric anastomosis after esophagectomy for esophageal cancer

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**[Abstract]** **Background and Objective:** Anastomotic leakage and fibrous stenosis are significant complications of the cervical esophagogastric anastomosis although cervical esophagogastric anastomosis appears to decrease morbidity as compared with intrathoracic anastomosis. We modified the techniques of cervical esophagogastric anastomosis using circular stapler after resection of esophageal carcinoma, and evaluated its efficacy. **Methods:** Between October 2006 and April 2008, 127 patients underwent esophagectomy using gastric tissues positioned in the original esophageal bed as esophageal substitute for reconstruction. Cervical esophagogastric anastomosis using circular stapler was performed in all patients. The occurrence of postoperative complications was recorded and analyzed. **Results:** No operation-related death and no anastomotic hemorrhage occurred. Anastomotic leakage developed in one patient (0.8%) because of instrumental failure; five patients (3.9%) developed fibrous stenosis that required stricture dilation. **Conclusion:** Modified mechanical cervical esophagogastric anastomosis using circular stapler is effective and safe, and can reduce the occurrence of postoperative anastomotic complications.

**Key words:** esophageal neoplasm, surgical operation, cervical esophagogastric anastomosis, circular stapler, complication

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Subtotal esophagectomy and cervical esophagogastric anastomosis are the preferred surgical procedures for esophageal carcinoma, and are widely recommended due to their multiple advantages. Anastomotic leakage and fibrous stenosis are significant complications of cervical esophagogastric anastomosis.<sup>1</sup> Ever since circular stapler was put into application, the incidence of esophagogastric anastomotic leakage has been decreased. However, routine application of anastomotic stapler in the neck is inconvenient due to narrow surgical field, most surgeons still perform artificial anastomosis. Recently, our department has slightly modified the application of new circular stapler in cervical anastomosis for esophageal carcinoma patients and revealed good efficacy. Hereunder, we reported the modified application.

## Materials and Methods

**Clinical data.** Between October 2006 and April 2008, a total of 127 patients underwent cervical esophagogastric anastomosis

using circular stapler in Henan Provincial Tumor Hospital. Of the 127 patients, 91 were men and 36 were women, aged 38-76 years, with a median age of 60 years. Before operation, esophageal carcinoma was confirmed by esophageal barium contract X-ray and biopsy under fibrogastroscope plus pathology. Among all esophageal carcinoma lesions, two were at cervical esophagus, 12 at upper thoracic esophagus, 104 at middle thoracic esophagus, eight at lower thoracic esophagus, and one at the esophagus and cardia. Among all patients, 119 underwent esophagectomy with left cervico-thoracic dual incisions plus left cervical anastomosis; three underwent esophagectomy with right cervico-thoraco-abdominal triple incisions plus right cervical anastomosis; five underwent esophagectomy with mid-abdominal and left cervical incisions and inverted stripping of the esophagus plus left cervical anastomosis. Circular staplers were used in the cervical esophagogastric anastomosis of all patients, among which 78 were given KYGW-23.5 stapler and two were given KYGW-25.5 stapler (by Kangdi Stapler Company), 45 were given SDH-25 stapler and two were given SDH-21 stapler (by Johnson & Johnson Company, US). Tumor volume ranged from 1.0 cm × 0.5 cm × 0.5 cm to 10 cm × 6 cm × 5 cm; the median maximal tumor diameter was 5 cm. According to TNM staging criteria by UICC (1997), 14 cases were at stage I, 45 at stage II A, 19 at stage II B, and 49 at stage III. Nine patients were given preoperative half-dose radiotherapy (40 Gy, 4 weeks).

**Surgical procedures.** After tracheal intubation and general anesthesia, the esophagus and stomach were fully isolated (by different approaches as in different surgical procedures, which were not further described herein), and then the pylorus and duodenal bulb were separated. The esophagus was resected from the cardia and markers of greater and lesser gastric curvatures were made on the apex of the gastric fundus. Cervical incision was made along medial margin of the sternocleidomastoid muscle. Then cervical esophagus was isolated and exposed; thoracic esophagus was pulled out via cervical

incision. A longitudinal incision was made on the esophagus at 2-3 cm distal from the predefined anastomotic stoma. Anastomotic stapler of varied sizes was selected depending on the volume of the esophageal cavity. The anvil of the anastomotic stapler was placed into the esophageal cavity. Pouch suture was made at 0.5 cm distal from the predefined anastomotic stoma, using 10-0 suture threads. The pouch was then ligatured and the esophagus was resected and removed. The stomach was pulled out of the cervical incision through thoracic entrance and esophageal bed. A small incision was made on the anterior gastric wall and a small hole was made by puncture on the posterior gastric wall at 2 cm from the apex of the gastric fundus. Using a curved forceps, a hollow anvil tube was placed into the gastric cavity via the small hole; the body of anastomotic stapler was placed in via the incision on anterior gastric wall and was connected to the hollow anvil tube; the nut was then tightened. After confirming that no adjacent tissue was tangled around the anastomotic stoma, the anastomosis was completed. The nut was then loosened and the anastomotic stapler was removed. The anastomosis stoma was examined, and complementary suture was performed given unsatisfactory anastomosis. The incision on the anterior gastric wall was sutured by stapler. A circular vertical inverting mattress suture, that is, "telescope embedding", was performed on esophageal and gastric tissues above and below the anastomotic stoma.

## Results

Of all patients in our study, one had extensive incomplete anastomosis between the esophagus and anterior and posterior gastric walls due to mechanical failure (the titanium nail of KYGW-23.5 stapler was absent). Although the anastomosis was repaired, severe anastomotic leakage occurred at Day 2 after operation and was cured by repeated drainage and replacement of dressing. No anastomotic failure or leakage was observed in other patients. During operation, esophageal muscular and mucosal layer avulsion occurred in three patients, of them, two

were given KYGW-25.5 stapler. Recurrent laryngeal nerve injury occurred in five patients. Anastomotic stenosis occurred in five patients, among which, two patients who were given SDH-21 stapler showed significant anastomotic stenosis at two weeks after operation; all these patients experienced improvement after stricture dilation. No postoperative anastomotic hemorrhage, intrathoracic hemorrhage or death was observed. All patients could adopt semi-fluid diet was adopted at the time of discharge, and regular diet within one month after operation. Postoperative pathology revealed one case of concurrent carcinoma of the esophagus and gastric cardia, one case of carcinosarcoma, two cases of adenosquamous carcinoma, three cases of neuroendocrine carcinoma and six cases of simple adenocarcinoma; the remaining cases were all esophageal squamous cell carcinoma. No residual cancer was seen in the surgical margins.

## Discussion

Since 1980s, anastomotic stapler was used in the intrathoracic esophagogastric anastomosis in China. Since anastomotic stapler has numerous advantages, for example, it delivers secure and reliable anastomosis, it is easy to use and time-saving and induces less postoperative complications,<sup>2</sup> it has been widely used nowadays. Thereafter, the incidence of anastomotic leakage has been decreased to 0.7%-11.2%.

Currently, subtotal esophagectomy and cervical esophagogastric anastomosis are considered the preferred surgical procedures for esophageal carcinoma. However, cervical esophagogastric anastomosis was mostly established by artificial suture using surgical threads in the past, which caused inadequate secure and frequent postoperative complications, especially anastomotic leakage with an incidence as high as 6.9%-30.0%. The healing of anastomosis is related to many factors. In general, the occurrence of anastomotic leakage is mostly related to anastomotic techniques. Nevertheless, artificial anastomosis can never be as precise as mechanical anastomosis, and errors are unavoidable. Hence, most researchers believe that the application of circular stapler can drastically

decrease the occurrence of anastomotic leakage,<sup>2</sup> but specific manipulations could be considerably different. Mechanical cervical anastomosis can be done through many approaches with different specific manipulations. Common approaches are as follows: (1) Left thoracic single incision is made and cervical esophagus is pulled to thoracic apex for mechanical esophagogastric anastomosis, which is known as super-cupula pleurae anastomosis.<sup>3</sup> This is an easy way to perform anastomosis, but it is intrathoracic anastomosis rather than cervical anastomosis. In addition, esophageal resection can only be performed on defined esophagus segment, which makes it unsuitable for upper thoracic and cervical esophageal carcinoma. On the other hand, no incision is made on the neck, which baffles early recognition and management when postoperative anastomotic leakage occurs. Such approach doesn't fully exemplify the superiority of cervical anastomosis. (2) Left cervico-thoracic dual incisions are made. After the esophagus is resected via cervical incision, an anvil is placed in and the anastomotic stapler is situated into the stomach via the cardia inside the thoracic cavity; the stomach is then pulled through thoracic entrance and to the neck for esophagogastric anastomosis.<sup>4</sup> Such approach permits adequate resection length of the esophagus, but the anastomotic stapler has to go through thoracic entrance and then connect to the anvil in the neck; the narrow thoracic entrance makes it difficult to accomplish anastomosis. Therefore, such approach requires highly proficient skills and is especially difficult to be performed in obese patients or patients with a short neck. Furthermore, when anastomosing, gastric fluid can leak through the cardia and then contaminate the thoracic cavity. The stomach is not situated on the esophageal bed in the thoracic cavity, which is not in accordance with human physiology and anatomy, and may affect respiration and circulation. After operation, patients are prone to have symptoms such as fullness and distention, chest distress and dyspnea after meals. (3) Right cervico-thoraco-abdominal triple incisions<sup>5</sup> or left cervico-thoracic dual incisions<sup>6</sup> are performed for esophagectomy. The stomach is pulled to the neck; a small incision is made on anterior gastric

wall, through which the anastomotic stapler is situated into the stomach. Then cervical esophagogastric anastomosis is performed on posterior gastric wall. This approach is similar to that in our study and maintains most advantages of cervical anastomosis. Although the cervical space is narrow, the incisions are superficial and most procedures can be performed under direct visualization, which make it highly safe and convenient.

When performing cervical procedures, most surgeons finish transversal esophageal resection before placing in the anvil. In such a process, the esophageal mucosa tends to retract, which leads to poor approximation of esophageal and gastric mucosa and subsequent anastomotic failure. We suggest making longitudinal incision on distal end of anastomosis and placing in the anvil firstly, then performing pouch suture and resecting the esophagus. Thus, retraction or omission of esophageal mucosa can be avoided. In addition, we first make the incision on anterior gastric wall, and then use a curved forceps to puncture through posterior gastric wall and lead the hollow anvil tube into the gastric cavity. By this way, the esophagus and posterior gastric wall are basically fixed, anastomosis can be completed by simply connecting the body of the anastomotic stapler under direct visualization. This makes the connecting much easier, simpler and more flexible than using an anvil-extending rod. Different from the approaches adopted by most surgeons, the anastomosis is performed in location other than the apex of gastric fundus, which makes adequate space for the embedding and reduces tension of the anastomosis; however, it requires more extensive isolation of the stomach. Since the space is narrow in cervical anastomosis, it is necessary to separate cervical muscles and blood vessels carefully. Particularly, thyroid gland at the medial side of the incision is prone to be tangled in the anastomotic stoma and affects the anastomosis. One way to prevent this is to isolate the esophagus to the adequate length and to carefully examine surrounding tissue when anastomosing. In early stage of our study, a few thyroid gland tissues were pinned into the anastomosis in two patients, which

however didnt result in anastomotic failure.

In the past years, the anastomotic staplers that made in China had a relatively lengthy hollow anvil tube, which made it rather difficult to perform esophagogastric anastomosis in the narrow cervical field.<sup>6</sup> Chunwei et al. even developed a special anastomotic stapler for cervical anastomosis.<sup>7</sup> Researchers in other countries even successfully performed cervical anastomosis using endoscopic soft-shaft circular stapler.<sup>8</sup> With the popularized application of new disposable curved stapler made in China (Kangdi) and in other countries (Johnson & Johnson), a shorter hollow anvil tube and a curved body of the anastomotic stapler have significantly improved the problem. Meanwhile, two rows of titanium nails interlacedly arranged as concentric circles have also drastically improved the safety of the anastomosis. In our study, only one patient (0.8%) developed anastomotic leakage due to mechanical failure, with a rate low than that resulted from artificial cervical anastomosis performed in our hospital since 1998 (2.4%-3.2%). In 1997, Collard et al.<sup>9</sup> in Belgium put side-to-side stapled esophagogastric anastomosis, also known as "Collard anastomosis", into clinical application. "Modified Collard anastomosis"<sup>10</sup> and complete mechanical Collard anastomosis<sup>11</sup> were later developed based on this approach. Previous studies suggested that side-to-side mechanical esophagogastric anastomosis was easy and simple to be performed and could effectively reduce the occurrence of anastomotic leakage and stenosis.<sup>1, 10, 11</sup>

It is necessary to note that mechanical anastomosis is just one option for anastomosis and is irrelevant to the surgical procedures performed in the thoracic and abdominal cavity. As long as the esophagus and stomach are fully exposed in cervical field, the space is adequate for anastomosis, and carefully separating the surrounding tissues favors the efficacy of anastomosis. In our study, eight patients underwent cervico-thoraco-abdominal triple incisions plus right cervical anastomosis, or mid-abdominal and left cervical incisions, inverted stripping of esophagus plus left cervical

anastomosis. Surgical procedures in the thoracic and abdominal cavities were greatly varied but the cervical procedure was basically identical. In all these patients, anastomosis was successfully performed and no complications occurred. In the meantime, mechanical cervical anastomosis favors radical resection of tumors. Among all patients in our study, including two with cervical esophageal carcinoma and 12 with upper thoracic esophageal carcinoma, no residual cancer was seen in the surgical margin.

In conclusion, the application of circular stapler in cervical esophagogastric anastomosis can fully play the advantages of cervical anastomosis. Given appropriate manipulation, adequate exposure and proper selection of anastomotic stapler, satisfactory treatment outcomes of anastomosis can be achieved and the incidence of postoperative complications can be significantly reduced.

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