

# Cervical triangulating stapled anastomosis: technique and initial experience

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**Objective:** To explore the safety and efficacy of modified cervical triangulating stapled anastomosis (TSA) for gastroesophageal anastomosis (GEA) in minimally invasive esophagectomy (MIE).

**Methods:** From January 2013 to November 2013, eighty-four patients who underwent three-stage MIE was enrolled. During the cervical stage, either circular stapled (CS) or triangulating stapled (TS) anastomosis was applied for GEA. Clinical features were collected and compared to identify the differences between the two groups.

**Results:** A total of 84 patients were included in this study. The clinical characteristics were close between the two groups. Intra-operatively, the duration of GEA was close between the two groups ( $18 \pm 3.4$  vs.  $17 \pm 2.7$  min,  $P=0.139$ ). Post-operatively, Cervical anastomotic leakage occurred in one (3.0%) of the 33 TS patients, but in six (11.8%) of the 51 CS patients ( $P=0.312$ ). The incidence of anastomotic stenosis was 0.0% and 13.7% in the TS and CS groups, respectively ( $P=0.069$ ). The overall incidence of postoperative complications was significantly lower in TS than that in CS (15.2% vs. 35.3%,  $P=0.043$ ). There was no difference in the median length of hospital stay or perioperative mortality rate between the two groups.

**Conclusions:** TSA is a safe and effective alternative for GEA, which would probably lower the incidence of leakage and stenosis following MIE. Further studies based on larger volumes are required to confirm these findings.

**Keywords:** Esophageal cancer (EC); minimally invasive esophagectomy (MIE); gastroesophageal anastomosis (GEA); triangulating stapled anastomosis (TSA)

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## Introduction

Despite the technical advances in gastric conduit formation or anastomotic methods, the anastomotic complications following the surgical resection of esophageal cancer (EC) have continued to perplex thoracic surgeons (1-6).

Triangulating stapled (TS) anastomosis for GEA has been shown to be associated with lower incidence of anastomotic complications (7-10). However, there was only one previous report comparing the results of TS with circular stapled (CS) anastomoses, and partially due to the limited number of patients, the incidence of anastomotic leak of both TS and CS was undesirable (TS, 2/8, 25.0% vs.

CS, 1/12, 8.3%) (7).

In this report, we describe our surgical technique of TSA in the cervical part and examine its efficacy in compared with circular staplings.

## Patients and methods

### Patients

From January 2013 to November 2013, a total of 84 EC patients underwent minimally invasive esophagectomy (MIE) at Zhongshan Hospital of Fudan University were included in this retrospective study. The study was approved

**Table 1** Clinical characteristics

Characteristics	TS (n=33)	CS (n=51)	P
Age [range], years	61 [46-79]	61 [45-75]	0.862
Sex (male/female)	27/6	41/10	0.871
Comorbidity, n (%)	7 (21.2)	9 (17.6)	0.684
Neoadjuvant therapy, n (%)	5 (15.2)	3 (5.9)	0.158
Location (U/M/L)	2/21/10	7/36/8	0.198
Pathological stage, n (%)			0.919
0-I	14 (42.4)	20 (39.2)	
II	10 (30.3)	15 (29.4)	
III-IV	9 (27.3)	16 (31.4)	

TS, triangulating stapled; CS, circular stapled.

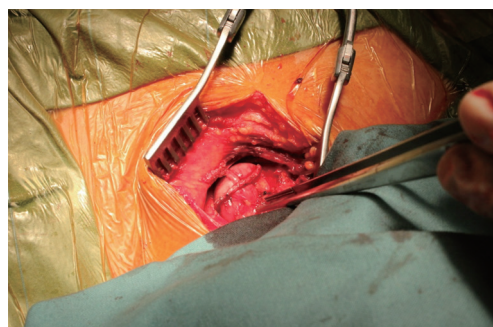


**Figure 1** The distal esophagus and proximal gastric conduit were cut open, and the first stapling was applied to the posterior wall of the remnant esophagus and the gastric conduit in an inverted fashion by the linear cutter.

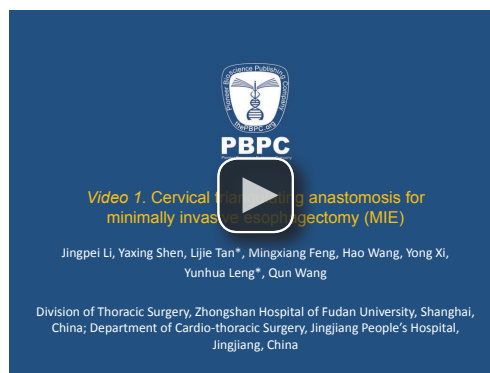


**Figure 2** The second and third stapling was applied to the anterior wall of the remnant esophagus and the gastric conduit in an extroverted fashion by the linear stapler with stay sutures.

by the hospital ethics committee, and a waiver for individual patient consent for this retrospective study was also obtained from the ethics committee. All patients were diagnosed as EC by endoscopic biopsy. Physical examination, standard



**Figure 3** Completion of end to end triangulating anastomosis.



**Figure 4** Cervical triangulating anastomosis for minimally invasive esophagectomy (MIE).

laboratory tests, electrocardiogram, and lung function test were performed in all patients. Preoperative staging was determined by enhanced thoracic and abdominal CT. According to the clinical findings, T1-3N0M0 EC patients were selected as candidates for MIE. The clinic characteristics of patients were shown in *Table 1*.

### Surgical techniques

All operations were three-stage MIE, which was described in previous publications (11,12). The operation was performed by the same surgeon (L.T). A 3.0 cm wide gastric tube formed by linear staplers (TLC75, Ethicon Endosurgery, Cincinnati, OH, USA) was used for alimentary reconstruction. GEA was performed by cervical end to side CS anastomosis until July 2013 or a more proximal anastomosis which was difficult for TS (CS group, n=51) and by the cervical TSA after August 2013 (TS group, n=33).

For the cervical TS, our surgical technique was basically similar to previous reports (7-9), in which an end-to-end GEA was performed using three linear staplers (*Figures 1-4*). The formed gastric tube was pulled up to the left neck

**Table 2** Postoperative event

Characteristics	TS (n=33)	CS (n=51)	P
Time for GEA, min	18±3.4	17±2.7	0.139
Length of stay [range], days	10 [7-28]	10 [7-62]	0.799
Complications, n (%)	5 (15.2)	18 (35.3)	0.043
Mortality, n (%)	0 (0.0)	1 (2.0)	0.825
Gastrointestinal complication, n (%)	1 (3.0)	13 (25.5)	0.006
Anastomotic leakage	1 (3.0)	6 (11.8)	0.312
Anastomotic stricture	0 (0.0)	7 (13.7)	0.069
Pulmonary complication, n (%)	3 (9.1)	8 (15.7)	0.586

TS, triangulating stapled; CS, circular stapled; GEA, gastroesophageal anastomosis.

through posterior mediastinal route. After two-thirds of the superior end of gastric tube was cut off by tissue scissor, three suspension sutures through the whole layer were added to secure the first anastomosis which was applied to posterior wall of the remnant esophagus and the gastric tube in an inverted fashion (*Figure 1*). Then these sutures were pulled up and completely removed with a linear stapler (ATB 45, Ethicon Endosurgery, Cincinnati, OH, USA). After two-thirds of the superior end of gastric tube was cut off by tissue scissor, three suspension sutures through the whole layer were added to secure the first anastomosis which was applied to posterior wall of the remnant esophagus and the gastric tube in an inverted fashion. Then these sutures were pulled up and completely removed with a linear stapler (ATB 45, Ethicon Endosurgery, Cincinnati, OH, USA). The second and the third anastomosis were performed in the same manner using the second and third linear staples; however, these were done in an everted instead of in an inverted fashion. At last, interrupted sutures of the serosa were performed between the anastomosis which was covered with the attached omenta. Then the triangulating shaped end-to-end anastomosis was completed between the remnant esophagus and the gastric tube in the cervical region. A closed suction drain was placed in the anastomotic region (13).

### Statistical analysis

Differences between the TS and CS were assessed using the Wilcoxon rank sum test for continuous variables, the chi-square or Fisher exact tests for categorical variables. For all calculations, a P value of <0.05 was considered to be significant. Statistical computations were all performed by SPSS software, version 19.0 (SPSS, Inc, Chicago, IL, USA).

## Results

In this study, eighty-four patients were enrolled, including 68 men (81%) and 16 women (19%). The median age was 61 years (range, 45-79 years). Sixteen patients presented with significant comorbidity and eight patients received neoadjuvant therapy. There were no significant differences in clinical characteristics between two groups (*Table 1*).

None of the procedures were converted to thoracotomy. Postoperative pathology reported that all cases were squamous cell carcinoma. The overall incidence of postoperative complications was significantly lower in TS than that in CS (15.2% *vs.* 35.3%,  $P=0.043$ ). There was no significant difference in length of hospital stay, and mortality rate between two groups (*Table 2*).

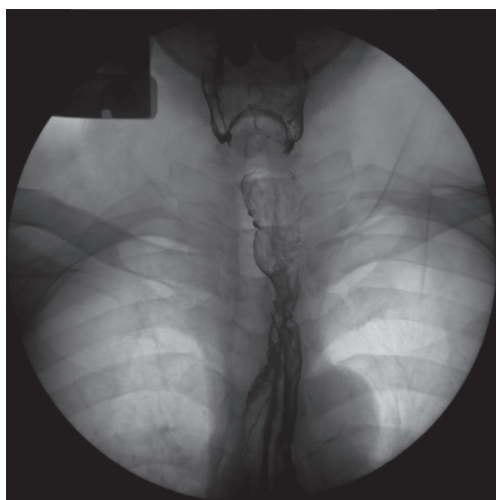
No difference was found for the mean time of GEA. In TS, there was only one minor leakage, which healed after 16 days of drainage. Of the six cases of leakage in the CS group, five (83.3%) were minor or moderate, and resolved after inserted drainage from a cervical drain. However, One of these six patients in CS died of severe anastomotic leak during the perioperative period. Anastomotic leakage tended to occur less frequently in TS than in CS, although the difference was not significant (3.0% *vs.* 11.8%,  $P=0.312$ ).

Patients who suffered swallowing dysfunction following the operation would receive endoscopic examination, and the stenosis was defined to the cases when endoscopic dilation at the anastomotic portion was required. Post-operative stenosis was found in 0.0% and 13.7% for the TS and CS anastomosis, respectively (*Table 2*).

## Discussion

In this study, modified TS anastomosis was introduced to the gastroesophageal anastomosis (GEA) during MIE, and it was found to be superior to CS anastomosis in the incidence of postoperative complications. The overall gastrointestinal complication was significantly lower in TS following the surgery, which suggested TSA as a safe and effective alternative for GEA.

The gastric tube is the most commonly used conduit for the GEA. The major complications after GEA, including anastomotic leakage and anastomotic stricture, are frequently encountered, which would prolong patients' hospital stay, compromise quality of life, and even be life-threatening (1,2,14,15). However, previous studies, either on gastric formation or anastomotic methods, were based



**Figure 5** Esophageal Barium swallows examination in a patient three months after triangulating stapled anastomosis (TSA).

on improvements of blood supply in the reconstruction of gastric conduits and the outcome was less promising (2,4-6).

There are encouraging results of TS anastomosis in both colo-colonic (16,17) and GEA (8,9). Theoretically, this end to end anastomosis preserves the integrity of vascular network of the gastric wall, which provides more blood supply to the anastomotic site. Furthermore, it allows reserving longer gastric tube and bringing less tension to the anastomotic site and it would be ideal for the passage of food. Finally, our modification that only two-thirds of the proximal gastric conduit was cut open for the GEA, which may ease the procedure of the first stapling for the anastomosis, and it would be convenient for further adjustment before the first linear stapler was fired. As in our study, anastomotic leak in TS had the tendency of reduction compared with CS.

Conventionally, anastomotic stenosis after CS anastomosis occurs in 12.3-20% (18,19), which remains considerable concerns for this technique. The cause may include that all the layers of alimentary tract are punched out, which led to unexpected exposure to the inner lumen of the alimentary tract for the muscular layer (7). It is easily understood that this would increase the incidence of stenosis. For TSA, however, only one third of the anastomotic site is inverted, which theoretically may greatly eliminate the adverse effect caused by CS anastomosis. As a result, there was no anastomotic stenosis in TS (*Figure 5*), compared with 13.7% in CS (*Table 2*).

Additionally, other series reported reducing the time to perform GEA by using the TSA (7). Since this was

our initial experience, the recorded time for GEA had no significant difference between two groups.

However, the limitations of our study include its nonrandomized retrospective study design and its lack of exploration of the long-term effects of TSA, especially on quality of life analysis. To minimize technical bias, all operations were performed under the guidance of one single experienced surgeon. We chose to include patients only in whom the esophageal bed was used as the route for the conduit pull-up, since the retrosternal route has been reported to be longer in length than the posterior route (20).

In conclusion, the TSA is a safely and effectively alternative method for cervical GEA. Further randomized controlled trials are needed to confirm this conclusion.

## Conclusions

TSA is a safe and effective alternative for GEA, which would probably lower the incidence of leakage and stenosis following MIE. Further studies based on larger volumes are required to confirm these findings.

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