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Creation of the ideal gastric tube: Comparison of three methods: A prospective cohort study

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HIGHLIGHTS

- We herein compare three methods of gastric tube creation.
- Using radial type staplers, we can create a durable gastric tube.
- We also reduce the number of staplers and therefore reduce operative cost.

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ABSTRACT

Introduction: Various types of staplers are used for gastric tube formation after esophagectomy. Using a stapling device, a gastric tube can safely be created in a short amount of time. The problems with gastric tube creation using only linear type staplers include staple overlap as well as the problem of cost associated with using multiple staplers. To address this, both linear and radial type staplers have been introduced. We herein compare three methods of gastric tube creation.
Methods: From 2012 to 2014, 62 patients with esophageal cancer underwent esophagectomy with gastric tube reconstruction. We evaluated and compared the mean number of stapler loads and cost in each groups.
Results: The mean number of stapler loads was 6.24 in method A, 5.16 in method B, and 4.33 in method C. The mean cost accounting for total staple fires per case was 3116.07 dollars in the method A group, 2576.74 dollars in the method B group, and 2447.78 dollars in the method C group. Anastomotic leaks developed in 4 cases in the method A group and in 3 cases in the method B group. There were no anastomotic leaks in the method C group.
Conclusion: We hypothesize that by using radial type staplers, we can create a durable gastric tube and reduce the number of staplers and therefore reduce operative cost.

1. Introduction

After esophagectomy, gastrointestinal reconstruction can be performed using the stomach, the small intestine, or the colon. The stomach is the ideal choice for reasons of flexibility and simplicity. In general, there are two methods when using the stomach as a conduit, namely through use of the whole stomach or through formation of a gastric tube [1–3]. Each has advantages and disadvantages in regards to blood flow, capacitance volume, and length. We prefer the gastric tube method, except in patients with gastric cancer or patients with a history of gastrectomy. The main reason we prefer this method is that it provides adequate length. Using a linear cutting-stapler, creating a gastric tube is easy and quick. An ideal gastric tube has adequate length and is parallel to the greater curvature. Various devices have been developed for the purpose of creation of the ideal gastric tube. Therefore, there are a number of technical considerations in the creation of a gastric tube.

Staplers come with either two or three rows of staples; since 2011 we have used the three-row stapler. The problems with gastric tube creation using only linear type staplers include staple overlap as well as the problem of cost associated with using multiple staplers [4,5]. To address this, both linear and radial type staplers have been introduced [6,7]. With two kinds of staplers, we have created gastric tube with three methods. We examined outcomes and costs associated with these three stapling methods for creation of a gastric tube after esophagectomy.

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2. Methods

From 2012 to 2014, 90 patients with esophageal cancer underwent surgical operation in our hospital. 62 patients with esophageal cancer, underwent esophagectomy with gastric tube reconstruction, were evaluated in this study. We divided the study period into three, and was subjected to three methods every 8 months. We used the staplers for formation of a gastric tube. The stapler was fired to divide the stomach from the lesser curvature along the axis of the greater curvature creating a 3- to 5-cm wide tube. The distance between the incision and the pylorus was approximately 5 cm, at which point the third branch of the right gastric artery was preserved(Fig 1). We used the Endo-GIA™60 with Tri-staple™ and the GIA™ Radial Reload for the radial stapler (Covidien, Tokyo, Japan). One surgeon performed all of the procedures. The follow-up periods of the course of all patients were less than 6 months.

2.1. Method A

The first incision with the linear stapler was made along the direction of the greater curvature, near the right angle of the lesser curvature. The next staplers were fired parallel to the greater curvature and directed towards the cardia. The angle between the first 2 staple lines was nearly 90°.

2.2. Method B

The first staple load is in the direction of the terminal point of the second load in method A. Subsequently, the stapling is continued parallel to the greater curvature as in method A.

2.3. Method C

We use the radial stapler for the first staple load. With this stapler, we staple the gastric wall to the estimated gastric tube width. Then, a linear stapler is applied tangentially to the area of the separated line. Depending on the individual shape of the stomach, the separation after the second stapler uses either a radial or linear type stapler. An angle of less 20° between the staple load angles is desirable. In cases involving angles of greater than 20°, we often use the radial type stapler. In all cases, the formation of the gastric tube had been made by one surgeon.

Statistical analysis was performed using Mann–Whiney test. And $P < 0.05$ was comsidered statistically significant.

3. Results

The number of cases performed with each method included 25 in the group with method A, 19 with method B, and 18 with method C. Age and gender did not differ significantly between groups. The retrosternal route was chosen in about half the cases in each group. No difference between groups was observed in the oncologic stage of esophageal cancer, pre-operative therapy, or the extent of lymphadenectomy (Table 1). Anastomotic leaks developed in 4 cases in the method A group and in 3 cases in the method B group. There were no anastomotic leaks in the method C group (Table 2). The mean number of stapler loads was 6.24 in method A, 5.16 in method B, and 4.33 in method C, and this difference was statistically significant (A vs B,C: B vs C $p > 0.01$). In the method C, we used a radial type stapler once in 7 cases and twice in 11 cases. The cost of each stapler is 499.37 dollars for the linear type and 606.67 dollars for the radial type. The mean cost accounting for total staple fires per case was 3116.07 dollars in the method A group, 2576.74 dollars in the method B group, and 2447.78 dollars in the method C group. This was a statistically significant difference comparing method A to methods B and C ($p > 0.01$) (Table 3). Lembert suture at the intersection of staplers was performed in methods A and B, but not

Table 1
Clinicopathorogical characteristics in three groups.

	Method A (25)	Method B (19)	Method C (18)
Age (years)			
Range	55–75	51–88	47–82
Median	67	69	68
Gender			
Male	24	17	15
Female	4	2	3
Stage			
0,1,2/3,4	12/12	13/6	11/7
Pre-operative therapy			
Chemotherapy	16	12	6
Chemo-radiotherapy	2	1	2
Lymph node dissection			
2 Fiels	9	10	12
3 Fields	16	9	6
Reconstruction routes			
Subcutaneous	6	5	3
Retrosternal	15	10	8
Posterior mediastinal	3	4	7
Post-operative complications			
All	13	12	6
Leakage	4	3	0

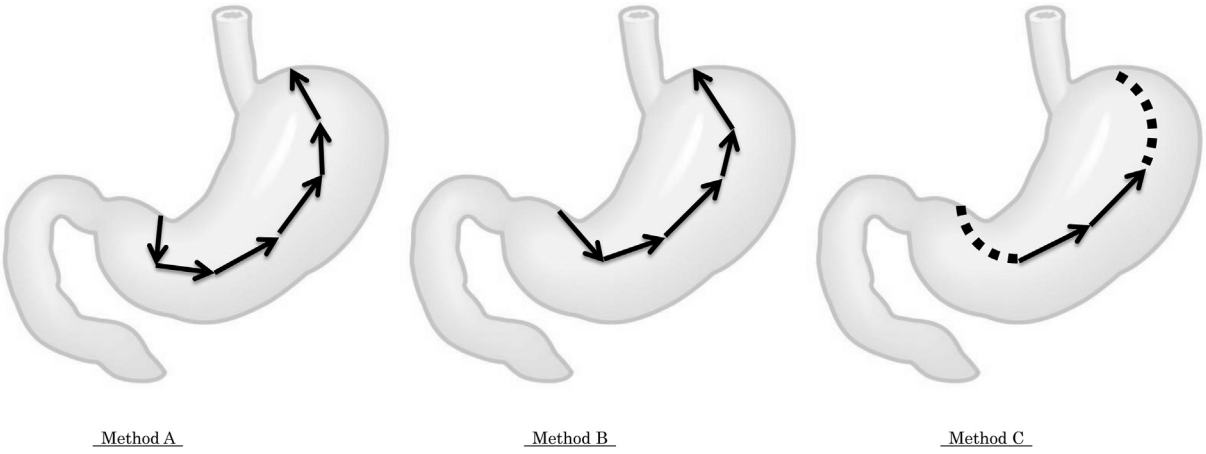

Fig. 1. Three stapling methods for creation of a gastric tube after esophagectomy.

Table 2
Postoperative complications in three groups.

	Method A (25)	Method B (19)	Method C (18)
All	13	12	6
Respiratory complication	7	3	2
Cardiovascular dysfunction	1	3	1
Recurrent nerve paralysis	5	2	3
Wound infection	0	1	1
Chylothorax	0	1	0
Leakage	4	3	0

Table 3
The number and cost of staplers in three groups.

	Method A (25)	Method B (19)	Method C (18)	p-value
Number of stapler				
Mean	6.24	5.16	4.33	A vs B,C B vs C > 0.01
Median	6	5	4	
Cost				
Mean (dollars)	3116.07	2576.74	2447.78	A vs B,C > 0.01

with method C.

4. Discussion

The stomach is the first choice for a conduit after esophagectomy. A variety of staplers can be used for formation of a gastric tube, which is ideally made along the axis of the greater curvature keeping a fixed width. There are a number of technical considerations in the creation of a gastric tube:

① There is individual difference in stomach morphology.
② The depth of the first staple load from the lesser curvature.
③ In the proximal stomach, the staple line orientation frequently changes.
④ The intersection of the staple lines is vulnerable to ischemia.

The method of cutting deeply to the planned part of the width is method A. On the other hand, since the second firing of the stapler is at a right angle to the first load, the stomach is distorted and leads to a suboptimal gastric tube. This method is not recommended.

Method B was developed to improve upon method A. While a longer distance is needed to achieve appropriate tube width, the insertion angle of the second stapler can be made smaller. However, this can lead to uneven staple overlap. In cases involving a greater than 20° change in orientation, there is trouble inserting the stapler, and the gastric wall becomes distorted and bunched. This problem prompted the development of method C. The radial stapler used in method C was originally developed for separation of the rectum, but is now used in multiple applications in a variety of surgeries.

The suture separation of this stapler is carried out at the form of one fourth of circles. We use the GIA™ Radial Reload (Covidien, Tokyo, Japan) for the first staple load [7]. Next, a linear stapler can be set tangentially to the arc of the staple line. In many cases this can be used sequentially rather than switching back to linear staplers. We almost always used two loads of the radial stapler in our cases.

Creation of a gastric tube by any of these methods requires multiple staple loads. Staplers are expensive and for that reason it is important to choose the proper point of transection and use as much of the stapler length as possible. We prepare measuring strips to size the distance to be stapled prior to firing each load. In this manner we can minimize the number of stapler loads used per case. Furthermore, smoothness of the intersection may contribute to better blood flow in the gastric tube [8].

5. Conclusions

We had created a gastric tube with only linear staplers for a long time. With linear staplers, we have carried out a variety of ideas for creating a smooth gastric tube (Method A, B). However, including the problem of intersection of staplers, it was not the a satisfactory method. We first use the radial stapler to create a gastric tube. We have used this method in 18 cases so far, without complications, including no leaks. This is a useful and effective technique to create a durable gastric tube and minimize cost associated with staple loads.

Ethical approval

Nagoya City University.

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Author contribution

Study concept and design: Kimura M, Kuwabara Y, Mitsui A.
Data analysis, writing paper: Kimura M.

Conflicts of interest

None.

Guarantor

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