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ORIGINAL ARTICLE

Modifications in retrosternal reconstruction after oesophagogastrectomy may reduce the incidence of anastomotic leakage

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Abstract

OBJECTIVES: The retrosternal route has been an alternative for oesophageal reconstruction after oesophagectomy. But the longer route and the higher incidence for cervical anastomotic leakage compared with the posterior mediastinal approach have always hampered its wider use. However, with the recent work reported by Chen and colleagues, the anterior route has been confirmed to provide the shortest physiological distance for oesophageal reconstruction using the stomach. Furthermore, improving the original surgical procedures seemed to improve outcomes. This research aims to evaluate whether modification of the original surgical standard of alimentary tract reconstruction after oesophagectomy can reduce the incidence of anastomotic leakage.

METHODS: One hundred and two patients were divided into the research group and the control group. Subjects in the research group received the improved three-incision oesophagectomy (right chest/belly/left neck) after which the alimentary tract reconstruction was achieved by using a gastric conduit positioned through the retrosternal route. Patients in the control group received the original surgical procedures. Parameters such as the incidence of anastomotic leakage, pneumonia, length of hospital stay, ICU stay and pathological staging were compared between the two groups.

RESULTS: No significant statistical differences were found in parameters such as age, gender, height, weight, comorbidities, location and length of the tumour and final pathological staging of the patients between the two groups. Similarly, intraoperative and postoperative information such as operating time, hospital stay, pneumonia and volume of blood loss are comparable between the two groups. The incidence of anastomotic leakage was, respectively, 4.84% (3/62) in the research group and 20% (8/40) in the control group. The incidence of anastomotic leakage in the research group was lower than the one in the control group, and the difference was statistically significant ($P = 0.037$).

CONCLUSIONS: Modifications of the original surgical standard including expanding the retrosternal tunnel, widening the gastric tube, resection of the sternothyroid muscle and fixation of the gastric tube, contribute to decreasing the incidence of cervical anastomotic leakage.

Keywords: Retrosternal reconstruction • Oesophagogastrectomy • Anastomotic leakage • Technical modification • Original surgical standard

INTRODUCTION

Orringer and Sloan [1] first introduced retrosternal reconstruction after oesophagogastrectomy using a gastric conduit in 1975. However, this anterior approach has been considered to be inferior to the posterior mediastinal approach as it was believed to be a longer route [2, 3], which might produce higher anastomatic tension and increase the incidence of anastomotic complications. But recently it has since been demonstrated that substernal reconstruction is actually a shorter route for oesophageal reconstruction using the stomach, when compared with the traditional posterior mediastinal location both on living people and cadavers [4, 5].

The use of the anterior substernal route is associated with a relatively high incidence of cervical anastomotic leak rate of 19–70% [1, 6–9]. After the demonstration that the retrosternal route is shorter than the posterior mediastinal route, we began to develop this technique in our practice, with several technical modifications that seemed to improve outcomes [10]. In order to assess the potential advantages of this approach, we analysed the outcomes of patients after oesophagectomy and retrosternal gastric reconstruction, with attention to the effects of the technical modifications.

MATERIALS AND METHODS

This study was approved by the Institutional Ethics Committee of the Shanghai Cancer Center of Fudan University.

Subjects

From May 2007 to March 2009, 102 patients underwent McKeown (3-incision) oesophagectomy with reconstruction using a gastric conduit positioned through the retrosternal route. This time frame was divided into two periods: May 2007–February 2008, during which patients were treated with our original surgical approach (controls, $n = 40$); and March 2008–March 2009, during which we employed the technical modifications (research group, $n = 62$).

All patients with T1-3N0-1 who were considered operable were consecutively included in this study. Patients treated with induction therapy were excluded. Patients were preoperatively staged according to protocol, which included computed tomography scan of the chest and abdomen, radiograph of the digestive tract with barium ingestion, regular or ultrasonic oesophagogastroduodenoscopy, and ultrasound of the neck in all patients. In addition, patients completed respiratory function tests and a cardiologic assessment to determine the surgical risk.

Surgical procedure

All patients received retrosternal gastric reconstruction after McKeown oesophagectomy. The patient is placed supine. Through an upper midline abdominal incision, the gastrocolic ligament is opened from the origin of the right gastroepiploicartery to the short gastric vessels. The left gastric vein and artery are isolated and closed, and celiac tripod and cardiac lymphadenectomy are performed. A gastric tube is then formed by stepwise stapling along the greater curvature toward the fundus-corpus region using a linear stapling device and all tributaries of the right gastric vessels were preserved according to the fundus rotation gastroplasty method [11]. The third jejuna loop is isolated and used to insert a tube for enteral nutrition. At this point, a left cervicotomy is performed along the anterior margin of the sternocleidomastoid muscle. The platysma was incised and the digastric muscle was cut off. The cervical oesophagus was dissociated among the carotid artery, internal jugular vein and the left thyroid gland. The gastric tube was drawn to the left neck through the retrosternal approach, and an end-to-end oesophagogastric anastomosis was completed with a double-layer manual suture. A cervical drainage tube was placed. Then the patient was positioned in left lateral decubitus. A right thoracotomy with a muscle sparing incision was made in the fourth intercostals space. After ligating and dissecting the azygos vein, the oesophagus was resected and mediastinal lymph nodes were dissected. We do not routinely close the oesophageal hiatus. Thoracic drainage tubes are inserted, and the operation is finished.

Modification of the original surgical standard

The improved surgical standard included the following aspects:

(i) The retrosternal tunnel was established under direct visualization, and the tunnel was expanded as much as possible to allow the entry of the surgeon's forearm.
(ii) The width of the gastric tube was made about 4 cm.
(iii) The part of the sternothyroid muscle inside the sternum was incised instead of removing the left sternoclavicular joint, hereby increasing the anteroposterior diameter of the superior aperture of thorax.
(iv) The apex of the gastric tube was fixed with the surrounding tissues at the neck, and the other end under the diaphragm was immobilized with peripheral peritoneum (see Fig. 1).

After surgery, all patients were transferred to the intensive care unit. If their clinical condition was satisfactory, they returned to the ward the next morning. The enteral feeding was implemented on the first or second day postoperatively. On the fifth postoperative day, the patients underwent a barium study for assessment of oesophagogastric anastomotic integrity and evaluation of the gastrointestinal function; if no complication emerged, they began oral feeding on the same day. Any anastomotic insufficiency by clinical or radiological evidence was scored as such, and the cervical wound was managed by simple drainage.

Statistical analysis

The patients' baseline characteristics were compared. Proportions and percentages were used to summarize the

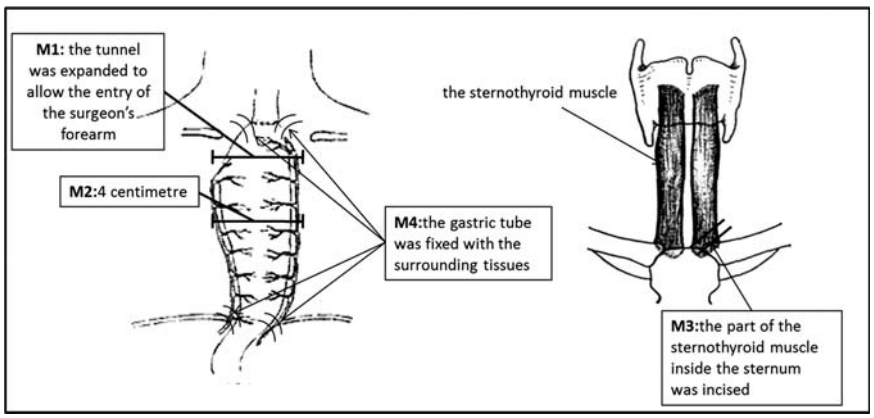

Figure 1: Four modifications in this study were described above; M represented modification.

categorical variables, whereas descriptive statistics with mean values (±SD) were used for numerical variables.

The primary outcome of this study was the incidence of anastomotic leakage. The minor outcome was anastomotic stricture, length of ICU stay, length of hospital stay and pulmonary infection.

The Pearson chi-square test and Fisher's exact test were used to determine the statistical significance of each of the categorical variables. Student *t*-test was used to compare the mean values of the numerical variables between the two groups. A *P*-value of less than 0.05 was considered significant. The statistical results were expressed by 95% confidence intervals.

RESULTS

Patient characteristics

One hundred and two patients who underwent McKeown (3-incision) oesophagectomy with reconstruction using a gastric conduit positioned through the retrosternal route, from May 2007 to March 2009, were included in this study. Forty patients were treated with our original surgical approach as the control group, while 62 patients received the modified surgical approach as the research group. There were 74 males and 28 females with a mean age of 58.20 years (range, 32–75). All patients were diagnosed as oesophageal squamous carcinoma preoperatively. And there were five upper thoracic oesophageal carcinomas, 59 middle thoracic lesions and 38 lower thoracic lesions. The mean length of the tumour was 34 mm (range, 10–55). Patients' baseline parameters, mentioned above, were comparable between the control group and the research group with no significant differences emerging. Also, the height, weight and comorbidities of patients were similarly comparable in the two groups (Table 1).

Table 1: Demographic characteristics of subjects in the two groups

	Research group ($n = 62$)	Control group ($n = 40$)	*P*-value
Sex			0.852
Male	44 (71.0%)	30 (75.0%)	
Female	18 (29.0%)	10 (25.0%)	
Age (years)[a]	57.27 ± 6.69	58.35 ± 8.19	0.412
Height (cm)[a]	164.89 ± 6.10	165.55 ± 5.97	0.628
Weight (kg)[a]	60.32 ± 11.04	60.30 ± 9.87	0.647
Sites of neoplasm oesophagus			0.647
Upper	3 (4.8%)	2 (5.0%)	
Middle	38 (61.3%)	21 (52.5%)	
Lower	21 (33.9%)	17 (42.5%)	
Length of tumour (mm)[a]	32.19 ± 17.78	36.00 ± 15.31	
Comorbidities			0.993
Yes	17 (27.4%)	11 (27.5%)	
No	45 (72.6%)	29 (72.5%)	

[a]Mean ± SD.

Operation parameters

All 102 patients received the R0 resection of McKeown oesophagectomy. In the control group, 40 original McKeown oesophagectomies were conducted. A total of 946 lymph nodes were removed, in which 120 lymph nodes were positive. And 64 modified three-incision oesophagectomies with retrosternal alimentary tract construction were undertaken in the research group. A total of 1457 lymph nodes were dissected, in which 124 lymph nodes were involved. The overall mean operating time was 292.46 min (range, 210.47–300.62), comparatively 289.3 min in the research group and 294.2 min in the control group. The average period of ICU stay was 1.52 days in the research group and 1.96 days in the control group. And the mean hospital stay length was 18.04 days in the former group and 19.15 days in the latter group. The mean postoperative oral feeding length was 6.23 days in the research group and 6.87 days in the control group. There were three cases of anastomotic leakage in the research group and eight cases in the control group. All anastomotic leakage patients were successfully treated with simple drainage for the cervical wound. There were three cases of bronchopneumonia in the research group and two cases in the control group. There was one gastric emptying dysfunction case in each of the two groups. Among three cases of anastomotic leakage in the research group, two patients suffered from anastomotic stricture. While three anastomotic stricture cases occurred in the control group. The intraoperative and postoperative parameters mentioned above were comparable between the two groups except for anastomotic leakage incidence. The incidence of anastomotic leakage was, respectively, 4.84% (3/62) in the research group and 20% (8/40) in the control group. The incidence of anastomotic leakage in the research group was lower than the one in the control group, and the difference was statistically significant ($P = 0.037$) (Tables 2 and 3).

All surgical complications were successfully treated without mortality in the two groups. And two patients with postoperative anastomotic stricture finally received stent placement, while the other three patients undertook the oesophageal dilation postoperatively.

DISCUSSION

The stomach has become the 'first choice' as the oesophageal substitute for alimentary tract reconstruction after oesophagectomy [12]. Of the three anatomical reconstruction routes (the retrosternal route, the posterior mediastinum approach and the anterior subcutaneous one), the substernal route and the posterior mediastinal approach are most commonly applied. Although several cardiovascular complications have been reported [13], retrosternal reconstruction can reduce postoperative oesophageal reflux [14] and gastrectasis. In addition, for patients with advanced stage tumour, this anterior approach can reduce the damage to the gastric tube caused by radiotherapy [15], thereby ensuring an adequate radiation dose.

However, cervical anastomotic leak has always been one of the major complications associated with this anterior reconstruction approach. Although it is still controversial whether the overall incidence of perioperative complications increases in association with this route [16–18], some studies [7–9] have indicated that the incidence of anastomotic leakage was higher than

Table 2: Intraoperative and postoperative data

	Research group ($n = 62$)	Control group ($n = 40$)	*P*-value
Operating time (min)[a]	289.3 ± 13.55	294.2 ± 15.19	0.090
Volume of blood loss (ml)[a]	387.10 ± 416.21	322.75 ± 155.61	0.320
ICU stay (days)[a]	1.52 ± 0.73	1.96 ± 0.67	0.420
Hospital stay (days)[a]	18.04 ± 0.68	19.15 ± 0.85	0.161
Postoperative oral feeding (days)[a]	6.23 ± 1.02	6.87 ± 0.98	0.472
Mean number of dissected lymph nodes	23.50 ± 10.02	23.65 ± 9.57	0.940
Mean number of involved lymph nodes	2.00 ± 3.61	3.00 ± 4.16	0.202
Pathological staging			0.408
I	23 (37.10%)	11 (27.50%)	
II	23 (37.10%)	14 (35.00%)	
III	16 (25.80%)	15 (37.50%)	
T stage			0.213
1a	10	3	
1b	7	3	
2	19	8	
3	25	24	
4a	1	2	
N stage			0.881
0	32	18	
1a	14	10	
1b	12	8	
2	4	4	

[a]Mean ± SD.

Table 3: Surgical complications

	Research group ($n = 62$) (%)	Control group ($n = 40$) (%)	*P*-value
Anastomotic leakage	3 (4.84%)	8 (20.0%)	0.037
Bronchopneumonia	3 (4.84%)	2 (5%)	1.000
Gastric emptying dysfunction	1 (1.62%)	1 (2.5%)	1.000
Anastomotic stricture	2 (3.22%)	3 (7.5%)	0.613

that of oesophageal reconstruction through the posterior mediastinal tract. A recent study [19] showed that the incidence of anastomotic leakage of substernal reconstruction after oesophagectomy is 19.4% in China. There are concerns that early-stage (<7days) anastomotic leakage may increase perioperative mortality [20], and how to reduce the incidence of anastomotic leaks has always been a priority for studies in the field of oesophageal surgery.

In this study, we modified the original surgical procedures and our results showed that these modifications seem to reduce the incidence of the cervical anastomotic leakage to some extent. First, we partly incised the sternothyroid muscle to expand the thoracic inlet, which can improve the blood supply of the gastric fundus. Since Liebermann-Meffert *et al*. [21] found that 20% of the gastric fundus relied on vascular inside the gastric wall, although most blood supply of the gastric tube came from the right gastroepiploic artery. And the blood supply to the anastomosis stoma was mainly provided by the local micro-vascular network in the fundus ventriculi. The high incidence of cervical anastomotic leakage is probably caused by the increased pressure around the anastomosis stoma due to compression of the surrounding dense tissues, which deteriorates the blood supply in that region, leading to local ischaemia and hypoxia. Abo and colleagues used to expand the thoracic inlet by resecting the manubrium sterni during the oesophageal reconstruction through the anterior approach [22, 23]. Orringer and Sloan [1] expanded the thoracic inlet by resecting the left sternoclavicular joint, which is still used by some clinicians. However, these procedures seem to be greatly invasive and may cause some serious complications. Partial resection of the sternothyroid muscle which can also expand the thoracic inlet and decrease the pressure caused by muscle contraction seems to be minimal invasive and effective. Additionally, we expand the retrosternal tunnel under direct visualization until the tunnel can 'accommodate' the surgeon's forearm. This change ensures less pressure from bilateral lung, and thus the blood supply of the gastric tube will be improved.

Moreover, we widen the gastric tube to 4 cm. Liebermann *et al*. showed that the right gastroepiploic vessel could nourish the stomach transversely to approximately 4 cm [19]. This wide gastric tube retained a greater microvascular network in the gastric fundus, rendering further improvement of both arterial and venous blood supply. In addition, a narrow gastric tube indicates a few cases of postoperative reflux oesophagitis and promises a better life quality for patients [24]. Furthermore, we fixed the gastric tube at the upper and lower retrosternal tunnel. This fixation can prevent the falling of the gastric tube, and thus reduces tension in the oesophagogastric anastomosis, which may improve the blood supply to some extent. Besides, this procedure could prevent the distortion of the gastric tube from its non-physiological position.

Although these modifications seem to decrease the incidence of cervical anastomosis leakage in this study, there really exist some limitations which should be noted. The most important limitation of this research is that it is a retrospective non-randomized study and the two surgical techniques in this study were historically compared. To the extent that prospective randomized controlled trials remain the gold standard for proving therapeutic efficacy, the current study was not designed to resolve that issue. However, most would agree that this study has really had a positive impact on improvements for anastomotic complications, especially for cervical anastomotic leakage. Selection bias, often the culprit in such instances, cannot be inferred by us since both demographic characteristics and intraoperative or postoperative data are comparable between the two groups. However, a pre-referral bias cannot reasonably be excluded. And results of more prospective researches should be discussed further when adequate data are collected and analysed.

Approaches to alimentary tract reconstruction vary a lot in the field of oesophageal cancer surgery. Although most researchers believe that the retrosternal tract increases the incidence of anastomotic leakage, compared with the traditional posterior mediastinal approach [7–9], our results showed that after modifying the original surgical procedure, the incidence of cervical

anastomotic leakage was close to or even lower than that of intra-thoracic anastomotic leakage reported elsewhere [25]. This may support the application of cervical anastomosis, especially when reconstructing the alimentary tract through the retrosternal route.

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