Nutritional Benefit of Remnant Gastric Preservation in Patients with Esophageal Cancer Undergoing Radical Esophagectomy and Right Colon Interposition

Junya Kitadani

Wakayama Medical University

Toshiyasu Ojima (✉ tojima@wakayama-med.ac.jp)

Wakayama Medical University

Keiji Hayata

Wakayama Medical University

Taro Goda

Wakayama Medical University

Akihiro Takeuchi

Wakayama Medical University

Masahiro Katsuda

Wakayama Medical University

Shinta Tominaga

Wakayama Medical University

Naoki Fukuda

Wakayama Medical University

Tomoki Nakai

Wakayama Medical University

Shotaro Nagano

Wakayama Medical University

Hiroki Yamaue

Wakayama Medical University

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Abstract

Background

This retrospective study aimed to investigate the short-term surgical outcomes and nutritional status of right colon interposition in patients with esophageal cancer who could not undergo gastric tube reconstruction.

Methods

64 patients underwent subtotal esophagectomy with reconstruction using right colon interposition for esophageal cancer at Wakayama Medical University Hospital between January 2001 and July 2020.

Results

18 patients had cologastrostomy and 46 patients had colojejunostomy. The median operation time in the cologastrostomy group was significantly shorter than that in the colojejunostomy group (494 minutes vs. 600 minutes; $P = 0.0013$). And, the median amount of blood loss in the cologastrostomy group was significantly less than that in the colojejunostomy group (209 ml vs. 485 ml; $P = 0.037$). The perforation of colon graft was observed in 3 patients (7%) and colon graft necrosis was observed in 1 patient (2%) were each observed in the gastrojejunostomy group. Median body weight change in one year after surgery in the cologastrostomy group was significantly less than that of the colojejunostomy group (93.6% vs. 86.8%; $P = 0.041$). Further, each of median serum total protein level and serum albumin level in one year after surgery in the cologastrostomy group was significantly higher than that of the colojejunostomy group (7.0g/dL vs. 6.5g/dL, $P = 0.024$, 3.9g/dL vs. 3.6g/dL, $P = 0.045$).

Conclusions

Subtotal esophagectomy with reconstruction using right colon interposition is a safe and feasible procedure for the patients with esophageal cancer in whom gastric tubes cannot be used.

Cologastrostomy with preserving remnant stomach had benefits of the surgical outcomes and the postoperative nutritional status.

Introduction

Esophageal cancer is the fifth leading cause of cancer-related death for men and the eighth for women worldwide [1]. Although esophagectomy with a two- or three-field lymph node dissection is still considered to be a potentially curative treatment, it is highly invasive and there is a high rate of morbidity, despite improvements in surgical technique and postoperative management [2–5]. Gastric tubes are generally used for the reconstruction after esophagectomy, they provide abundant blood flow and can be

safely pulled-up to the neck [6, 7]. However, in cases with a previous history of gastrectomy, or with synchronous gastric cancer, gastric conduit cancer, or with loss of a gastric tube, instead of the stomach, colon interposition or pedicled jejunal flap reconstruction with microvascular anastomosis (MVA) are performed [8–23]. In our institute, right colon interposition is the first choice when gastric tube reconstruction is not possible. Advantages of right colon interposition are that Bauhin valve prevents regurgitation, there is a reservoir-like capacity in the cecum, and the closeness of the diameter of the terminal ileum and esophagus [24]. On the other hand, there are disadvantages including many variations of mesenteric blood vessels, which may cause ischemia, and a comparatively more complicated procedure with multiple anastomoses [22]. There is currently no consensus as to whether MVA should be routinely performed. In previous reports, colon interposition with MVA was not particularly less likely to result in anastomotic leakage [15, 19]. We have therefore adopted right colon interposition without MVA. Series of subtotal esophagectomy with reconstruction using right colon interposition without MVA for esophageal cancer have not been widely reported [10, 14, 16, 25]. This retrospective study aims to investigate the short-term surgical outcomes of right colon interposition in patients with esophageal cancer who cannot undergo gastric tube reconstruction. In particular, we investigated the effect of cologastrostomy on the nutritional status when the residual stomach could be preserved.

Materials And Methods

Patients

This retrospective cohort study was conducted at the Wakayama Medical University Hospital (WMUH), Wakayama, Japan. This study was in agreement with the guidelines of the institutional ethics committee (approval number 3291) and was conducted in accordance with the Declaration of Helsinki. 64 patients underwent subtotal esophagectomy with reconstruction using right colon interposition for esophageal cancer at WMUH between January 2001 and July 2020. All consecutive patients were included in this retrospective study. Clinicopathologic factors were evaluated retrospectively based on hospital records, including age, sex, history of gastrectomy, type of previous gastrectomy and surgical factors including operation time and blood loss. Branches of the superior mesenteric artery including the right colic artery and the ileocolic artery (ICA) were evaluated using dynamic computed tomography (CT). Clinical and pathological stages were determined according to the TNM classification (UICC 8th edition) [26]. The severity of the postoperative complications after operation was estimated according to the Clavien-Dindo classification [27].

Surgical procedures

Until May 2010, 38 patients underwent open right transthoracic esophagectomy with two-field (total mediastinal, perigastric and coeliac regions) or three-field (adding supraclavicular and cervical paratracheal regions) lymph node dissections. The subsequent 26 patients underwent minimally-invasive thoracoscopic esophagectomy [5, 28]. The esophagus is transected with a linear stapler in the thoracic cavity depending on the location of the tumor. A midline incision is made in the upper abdomen to

remove the section of the esophagus containing the tumor. Kocher mobilization is performed to mobilize the duodenum and right colon from the retroperitoneum. The appendix is removed to prevent appendicitis. The colon interposition was performed as the following principles: (i) use the right hemicolon; (ii) preserve the right colic artery, as well as the right branch of the middle colic artery; (iii) dissect the ICA; (iv) trim the mesentery along the marginal vessels and transect the ileum with a linear stapler 20 cm from the ileum end; (v) lift the graft in the retrosternal route; (vi) do not perform supercharge or superdrainage unless the blood flow in the graft is clearly poor; (vii) anastomose cervical esophagus and ileum at the neck, and the remnant stomach and colon (Fig. 1a), or the jejunum and colon (Fig. 1b); (viii) anastomose the anal-side transverse colon and ileum; (ix) insert a 16 Fr nasal tube into the colon graft and a 12 Fr feeding tube into the jejunum 30 cm from the Treitz ligament. Until 2012, all patients underwent total gastrectomy and colojejunostomy. On the other hand, after 2013, the patients were intentionally stomach-preserving and underwent cologastrostomy.

Nutritional status and follow-up

Food intake was usually started on the 8th day if there were no anastomotic leakage or severe dysphagia. Nutrition through a feeding jejunostomy or a feeding gastrostomy was continued for an average of 3 months until enough food intake was achieved. Follow-up was conducted every three months to measure body weight change, serum total protein and albumin values. Follow-up included systematical clinical examination and thoraco-abdominal dynamic CT scan and upper endoscopy every six month.

Statistical analyses

All statistical analyses were carried out using the JMP Pro 14.1 (SAS Institute Inc., Cary, NC, USA). Categorical variables were assessed using Chi square method. Continuous variables were evaluated using the Wilcoxon signed-rank test. Statistical significance was defined as a P value < 0.05 .

Results

Patient characteristics

Total 64 patients who underwent right colon interposition in patients with esophageal cancer were eligible for this retrospective study, of which, 18 patients had cologastrostomy (Fig. 1a) and 46 patients had colojejunostomy (Fig. 1b). Cologastrostomy and colojejunostomy were performed via hand sewn or functional end to end anastomosis. Table 1 showed the comparison of patient characteristics between the cologastrostomy group between the colojejunostomy group. Age, gender, location of esophageal tumor, pathological stage, receiving neoadjuvant therapy had no significant difference. There were more history of total gastrectomy and synchronous disease in the colojejunostomy group than that in the cologastrostomy group ($P = 0.0002$).

Table 1

Comparison of patient characteristics between the Cologastrostomy group and Colojejunostomy group

Categories	Cologastrostomy group (n = 18)	Colojejunostomy group (n = 46)	<i>P</i> value
Age, median, years	69.5 (52–84)	68 (56–81)	0.129
Gender			0.513
Male	18 (100%)	44 (96%)	
Female	0 (0%)	2 (4%)	
Location of esophageal tumor			0.254
Ut	1 (6%)	3 (6%)	
Mt	15 (83%)	27 (59%)	
Lt	2 (11%)	15 (33%)	
Ae	0 (0%)	1 (2%)	
pStage (TNM classification 8th edition)			0.121
0	1 (6%)	1 (2%)	
I	7 (39%)	9 (20%)	
II	6 (33%)	10 (22%)	
III	3 (16%)	21 (46%)	
IV	1 (6%)	5 (10%)	
Neoadjuvant therapy			0.876
Chemotherapy	4 (22%)	8 (17%)	
Chemoradiotherapy	1 (6%)	2 (5%)	
None	13 (72%)	36 (78%)	
History of gastrectomy			0.0002
Total gastrectomy	0 (0%)	7 (15%)	
Distal gastrectomy	17 (94%)	17 (37%)	
Synchronous gastric cancer or ulcer	1 (6%)	22 (48%)	
<i>Ut</i> upper thoracic esophagus, <i>Mt</i> middle thoracic esophagus, <i>Lt</i> lower thoracic esophagus, <i>Ae</i> abdominal esophagus			

Surgical outcomes and postoperative complications

Comparison of surgical outcomes between the cologastrostomy group and colojejunosomy group were shown in Table 2. The median operation time in the cologastorostomy group was significantly shorter than that in the colojejunosomy group (494 minutes vs. 600 minutes; $P=0.0013$). And, the median amount of blood loss in the cologastorostomy group was significantly less than that in the colojejunosomy group (209 ml vs. 485 ml; $P=0.037$). In all cases, right colon interposition was performed through the retrosternal route. The right colic artery was present in 26 patients (40%) and was preserved in these cases. No patients were performed MVA. There were no differences of the complications with higher than Clavien-Dindo grade II or those with higher than Clavien-Dindo grade IIIa between the cologastrostomy group and colojejunosomy group. Early or late perforation of colon graft was observed in 3 patients (7%) and colon graft necrosis was observed in 1 patient (2%) were each observed in the gastrojejunosomy group. Two patients in the gastrojejunosomy group had graft loss, and both underwent second-stage jejunal reconstruction. There was no mortality in our consecutive series. The median post-operative hospital stay was not significantly different between the cologastrostomy group and the colojejunosomy group (29 days vs. 29 days; $P=0.307$).

Table 2

Comparison of surgical outcomes between the Cologastrostomy group and Colojejunostomy group

Categories	Cologastrostomy group (n = 18)	Colojejunostomy group (n = 46)	<i>P</i> value
Operation time, median, min	494 (363–622)	600 (295–860)	0.0013
Blood loss, median, ml	209 (50–685)	485 (35-1500)	0.037
Lymph node dissection			0.272
Two-field	13 (72%)	26 (57%)	
Three-field	5 (28%)	20 (43%)	
Reconstruction route			1.000
Retrosternal	18 (100%)	46 (100%)	
Posterior mediastinum	0 (0%)	0 (0%)	
Percutaneous	0 (0%)	0 (0%)	
Anastomosis method (neck)			0.068
Hand sewn anastomosis	2 (11%)	10 (22%)	
Circular stapler	7 (39%)	27 (59%)	
Functional end to end anastomosis	9 (50%)	9 (19%)	
Postoperative complications			
Overall morbidity (C-D grade $\geq$ 2)	10 (55%)	32 (69%)	0.289
Overall morbidity (C-D grade $\geq$ 3a)	7 (39%)	28 (61%)	0.112
Anastomotic leakage	2 (11%)	7 (15%)	1.000
Anastomotic stenosis	4 (22%)	19 (41%)	0.246
Respiratory complications	2 (11%)	9 (20%)	0.713
Recurrent nerve paralysis	3 (17%)	8 (17%)	1.000
Ileus	0 (0%)	2 (4%)	1.000
Reconstructive colon perforation	0 (0%)	3 (7%)	0.553
Reconstructive colon necrosis	0 (0%)	1 (2%)	1.000
<i>C-D</i> Clavien-Dindo classification			

Categories	Cologastrostomy group (n = 18)	Colojejunostomy group (n = 46)	<i>P</i> value
Hernia of the graft	0 (0%)	1 (2%)	1.000
Graft loss	0 (0%)	2 (4%)	1.000
Arrhythmia	1 (6%)	3 (7%)	1.000
Chylothorax	1 (6%)	1 (2%)	0.487
Pneumothorax	1 (6%)	2 (4%)	1.000
Mortality	0 (0%)	0 (0%)	1.000
Post-operative hospital stays, median, days	29 (20–49)	29 (16–250)	0.307
<i>C-D</i> Clavien-Dindo classification			

Nutritional comparison between the cologastrostomy group and the colojejunostomy group

Nutritional comparisons about body weight change, serum total protein level and serum albumin level at one year after esophagectomy and colon interposition between the cologastrostomy group and the colojejunostomy group were shown in Fig. 2.

Median body weight change in one year after surgery in the cologastrostomy group was significantly less than that of the colojejunostomy group (93.6% vs. 86.8%; $P = 0.041$).

Further, each of median serum total protein level and serum albumin level in one year after surgery in the cologastrostomy group was significantly higher than that of the colojejunostomy group (7.0g/dL vs. 6.5g/dL; $P = 0.024$, 3.9g/dL vs. 3.6g/dL; $P = 0.045$).

Discussion

This retrospective study showed that esophagectomy and right colon interposition without MVA for patients with esophageal cancer was feasible and safe and without mortality. Cologastrostomy with preserving remnant stomach had benefits of short operation time, a little amount of intraoperative blood loss and postoperative good nutritional status.

The rate of anastomotic leakage in our study was 14%, which was similar to the previously reported rate of anastomotic leakage in colon interposition with MVA [8, 12, 15, 19]. In our series, the retrosternal route was always selected so that the distance of the reconstruction route would be as short as possible. In addition, the retrosternal route has better cosmetic results than the subcutaneous route. Our previous study proved that the postoperative anastomotic leakage was independent prognostic factor in right

colon interposition for the patients with esophageal cancer [29]. Although there were no differences of the complications between the cologastrostomy group and the colojejunosomy group, very critical complications as perforation and necrosis of colon graft were not observed in the cologastrostomy group. This reason was considered why preserving remnant stomach prevented from abnormal expansion of colon graft. If gastrectomy for gastric cancer was preceded, the lymph node dissection of the lesser curvature side and the supra-pancreatic area has already been completed. If the previous surgery is performed for a benign disease or a simultaneous ulcer, we think that only lymph node dissection should be added. There was no difference in recurrence rate and survival rate between the total gastrectomy group and the remnant stomach-preservation group in this study (data not shown).

Nutritional status about body weight change, serum total protein level and serum albumin level at one year after esophagectomy and colon interposition in the cologastrostomy group were better than those in the gastrojejunosomy group. In the surgical procedure for gastric cancer, total gastrectomy has been shown in the previous reports to have disadvantages regarding nutritional status, including body weight loss [30, 31]. Furthermore, the remnant stomach may be associated with postoperative appetite stimulation because gut hormones as ghrelin are secreted [30, 32].

In cases when gastric tube reconstruction could not be performed, no clinical trials have yet ascertained whether colon interposition or pedicled jejunal flap reconstruction is better [8–10, 12–25, 33]. Pedicled jejunal flap reconstruction may be a promising procedure because fewer anastomoses are needed than in colon interposition. Creating a sufficient length of jejunal graft is sometimes difficult, however, especially in obese patients [22]. Surgical outcomes and quality of life of colon interposition and jejunal reconstruction will be examined in a prospective cohort study based in multiple centers.

Several limitations associated with this study warrant mention. First, if the previous surgery was total gastrectomy, or if simultaneous gastric cancer required total gastrectomy, the stomach could not be preserved inevitably. The patients were allocated to the two groups according to the sequential nature of the surgery. Secondly, the number of patients with esophageal cancer in whom gastric tubes could not be used was relatively small, so only a small number of patients were eligible for this retrospective study, which was based in a single center. A prospective study will overcome the limitations of the retrospective design and selection bias.

Conclusion

Subtotal esophagectomy with reconstruction using right colon interposition is a safe and feasible procedure for the patients with esophageal cancer in whom gastric tubes cannot be used. Cologastrostomy with preserving remnant stomach had benefits of the surgical outcomes and the postoperative nutritional status.

Abbreviations

MVA
microvascular anastomosis
WMUH
Wakayama Medical University Hospital
ICA
ileocolic artery
CT
computed tomography

Declarations

Ethics approval and consent to participate

This study was approved by the Wakayama Medical University Institutional Review Board. All procedures were undertaken in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions. Informed consent to be included in the study, or the equivalent, was obtained from all patients.

Consent for publication

Not applicable.

Competing Interests

The authors declare no competing interests.

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Authors' Contributions

JK designed the study and wrote the initial draft of the manuscript. JK and TO contributed to data interpretation and critical revision of the manuscript. All the other authors (KH, TG, AT, MK, ST, NF, TN, SN and HY) contributed to data collection and interpretation and critical review of the manuscript. All authors have read and approved the final version of the manuscript and have agreed to be accountable for all aspects of the study, ensuring that any queries related to the accuracy or integrity of any part of the work are answerable.

Data availability / Availability of Data and Materials statement

The datasets generated and/or analyzed during the current study are not publicly available due to hospital regulations but are available from the corresponding author on reasonable request.

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Figures

Figure.1

a.

b.

Figure 1

A schematic illustration of the right colon interposition without MVA through the retrosternal route. **(a)** Anastomosis of cervical esophagus and ileum at the neck is performed, and if the stomach can be preserved, gastrocolostomy is performed. **(b)** If the stomach cannot be preserved, ileocolostomy is performed.

Figure 2

Nutritional comparison between the cologastrostomy group and the colojejunosotomy group. (a) Median body weight change in one year after surgery in the cologastrostomy group was significantly less than that of the colojejunosotomy group (93.6% vs. 86.8%; $P=0.041$). (b) Median serum total protein level in one year after surgery in the cologastrostomy group was significantly higher than that of the colojejunosotomy group (7.0g/dL vs. 6.5g/dL; $P=0.024$). (c) Median serum albumin level in one year after surgery in the

cologastrostomy group was significantly higher than that of the colojejunosomy group (3.9g/dL vs. 3.6g/dL; $P=0.045$).