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ORIGINAL ARTICLE

Feasibility of esophageal reconstruction using a pedicled jejunum with intrathoracic esophagojejunostomy in the upper mediastinum for esophageal cancer

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Abstract
Objective An alternative conduit is needed when the gastric tube cannot be used as an esophageal substitute for reconstruction after esophagectomy. We adopted pedicle jejunal reconstruction with intrathoracic anastomosis in the upper mediastinum under such circumstances. The aim of this study was to evaluate the feasibility of this technique.
Methods Two hundred and ten patients with esophageal cancer underwent esophagectomy and reconstruction from 1998 to 2013. Among them, 6 patients underwent colon interposition (colon group) and 13 underwent jejunum reconstruction (jejunum group) including 8 thoracoscopic anastomosis. The operative results of both groups were compared with those of 191 gastric tube reconstructions (stomach group).
Results The operative times in the colon and jejunum groups were significantly longer than that in the stomach group ($P = 0.001$ and $P = 0.018$, respectively). The colon group showed more operative blood loss and more frequent anastomotic leakage and ischemic stenosis of the conduit than did the stomach group (1605 vs. 530 g, $P = 0.007$; 50 vs. 12.6 %, $P = 0.035$; 16.7 vs. 0 %, $P = 0.03$, respectively). There was no anastomotic leakage, conduit necrosis and mortality in the jejunum group. Ischemic stenosis of the conduit occurred more frequently in jejunum group than in the stomach group (23.1 vs. 0 %, $P < 0.001$). However, the stenosis could be managed safely with endoscopic treatment. Patient survival in the colon and jejunum groups was consistent with that in the stomach group.
Conclusions Pedicle jejunal reconstruction with intrathoracic anastomosis can be performed safely under thoracotomy or thoracoscopic surgery when stomach cannot be used as an esophageal substitute after esophagectomy.

Keywords Esophageal cancer · Jejunal reconstruction · Posterior mediastinal route · Intrathoracic anastomosis

Introduction

Surgical resection is the primary therapy for locoregional disease in patients with esophageal cancer because of its superior and more durable results in terms of locoregional control and curability compared with nonoperative methods. In cases of esophageal resection, the gastric tube is usually selected as the primary conduit. However, the stomach cannot always be used because of a prior gastrectomy or the coincidence of a gastric disorder, including gastric cancer. Esophageal reconstruction with organs other than the gastric tube involves complicated surgical procedures and is associated with higher operative morbidity and mortality rates than is gastric tube reconstruction [1–3]. However, resection followed by reconstruction should be considered as a reliable therapeutic modality because of its favorable patient prognosis [2].

The pedicled colon segment is a widely accepted substitute for the gastric tube in cases of esophageal reconstruction in which the stomach is not available. The

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usefulness of reconstruction with the pedicled jejunum has also been reported in recent years. The jejunum is uniquely suited for esophageal reconstruction because it is relatively abundant, does not require formal preparation, is typically free of disease, has a lumen size similar to that of the esophagus, has intrinsic peristalsis [4], and may not undergo senescent lengthening to the extent seen in the colon. However, the extension length of the pedicled jejunum is limited owing to poor marginal vessel connection. An initial report of the jejunal conduit showed high rates of postoperative gangrene and mortality (22.2 and 46.5 %, respectively) [5]. Therefore, it has been used for lower anastomosis (e.g., intrathoracic anastomosis after partial resection of the lower esophagus). One effective method for creation of a long-segment jejunal conduit is microvascular augmentation (supercharging), which was first reported in 1946 by Longmire and Ravitch [6]. A recent study showed that the jejunum was superior to the colon for reconstruction after esophagectomy along with gastrectomy with respect to both the short-term results (less anastomotic leakage and shorter hospital stay) and long-term results (less body weight loss) [7]. This report also showed no postoperative gangrene and operative mortality after jejunal reconstruction. On the other hand, anastomotic leakage was seen in 6 of 25 cases (24 %). Although a disadvantage of this subcutaneous reconstruction method is that it is the longest route, jejunal reconstruction after esophagectomy has generally been performed by lifting the conduit via the subcutaneous route because of easier maintenance of postoperative complications (e.g., anastomotic leakage and intestinal necrosis) compared with posterior mediastinal reconstruction and the convenience of microvascular anastomosis with the internal thoracic vessels [3, 6–9]. Several authors have reported use of the retrosternal route in jejunal reconstruction [4, 10, 11]. Although the posterior mediastinal route has the advantage of involving the shortest distance, there have been few reports of jejunal reconstruction through this route [4, 12].

We have historically selected colon interposition when the gastric tube could not be used after esophagectomy. However, the postoperative course was not satisfactory. Thus, we have changed our preferred procedure to pedicled jejunal reconstruction. To maintain the circulation in the jejunal conduit, we paid special attention to avoid damaging the perijejunal vascular anastomosis. To overcome the limitation of the extension length, we chose the posterior mediastinal route and created the anastomosis in the upper mediastinum. As a result, we could alleviate the complicated microvascular anastomosis.

To date, there have been no reports on intrathoracic esophagojejunostomy in the upper mediastinum after esophagectomy and total gastrectomy. The aim of this study was to evaluate the efficacy of pedicled jejunal reconstruction with intrathoracic anastomosis by comparing its outcomes with those of our other reconstructions.

Methods

Patients

In total, 210 patients with thoracic esophageal cancer underwent radical subtotal esophagectomy with reconstruction in our department from 1998 to 2013. Nineteen (9.0 %) of these patients underwent reconstruction with an organ other than the stomach. From 1998 to 2003, five patients underwent esophagectomy with colon reconstruction. From 2004 onward, 14 patients with esophageal cancer in whom the gastric tube could not be used underwent operations. Among them, 13 patients were considered to be candidates for jejunal reconstruction, and 1 patient underwent colon reconstruction because of tumor extension to the cervical esophagus. Therefore, 6 patients underwent reconstruction using the colon (colon group, 31.6 %), and 13 patients underwent reconstruction using the jejunum (jejunum group, 68.4 %). From December 2009 onward, mediastinal dissection procedures were performed by thoracoscopic surgery in nine patients. Eight of these nine patients underwent thoracoscopic intramediastinal esophagojejunostomy, and the remaining patient underwent colon interposition through the subcutaneous route. Of the 19 patients, 11 (57.9 %) had undergone previous gastrectomy, while the remaining 8 underwent total gastrectomy together with esophagectomy because of simultaneous gastric cancer that had arisen in a location in which the gastric tube could not be created after resection. We compared the operative outcomes of colon and jejunum group with those of 191 patients reconstructed by gastric tube (stomach group).

Surgical procedure

All patients underwent entire mediastinal lymph node dissection and esophageal resection under right thoracotomy (10 patients) or thoracoscopic surgery (9 patients) as previously described [13]. Upper abdominal lymph node dissection including the perigastric and celiac nodes was performed. The whole stomach was removed from eight patients who underwent synchronous gastrectomy. Of the 11 patients who had undergone prior gastrectomy, the remnant stomach was preserved in 3 patients (2 patients, Billroth-II reconstruction; 1 patient, jejunal pouch reconstruction), while it was removed in all 8 patients who underwent Billroth-I reconstruction. Cervical node dissection (i.e., three-field lymph node dissection) was performed

in patients with upper esophageal tumors and those with upper mediastinal node metastasis.

In the colon group, the operation was started with the thoracic procedure and continued with the abdominocervical procedure. The ileum and right colon were mobilized from the retroperitoneum to create an esophageal substitute. The ileocecal artery and vein and the terminal ileal vessels were resected from their beginning, and the ileum was resected at the feeding lesion of the ileocecal vessel. Upon resection of the right colic artery and vein, the ileum and right colon were lifted using the middle colic artery and vein as a pedicle. The right side of the colon, including terminal ileum, was lifted via the subcutaneous (2 patients) or retrosternal (4 patients) route. The terminal ileum was anastomosed at the anal end of the esophagus, mostly by hand sewing (Albert–Lembert method) or, rarely, by circular stapling (25 mm diameter). When the blood circulation seemed to be unsatisfactory, supercharged anastomosis of the terminal jejunal vessels to the cervical vessels (transverse cervical artery and internal cervical vein) was performed (2 patients).

In the jejunum group, the operation was started with the abdominal procedure and continued with thoracic dissection and intrathoracic anastomosis. In the supine position

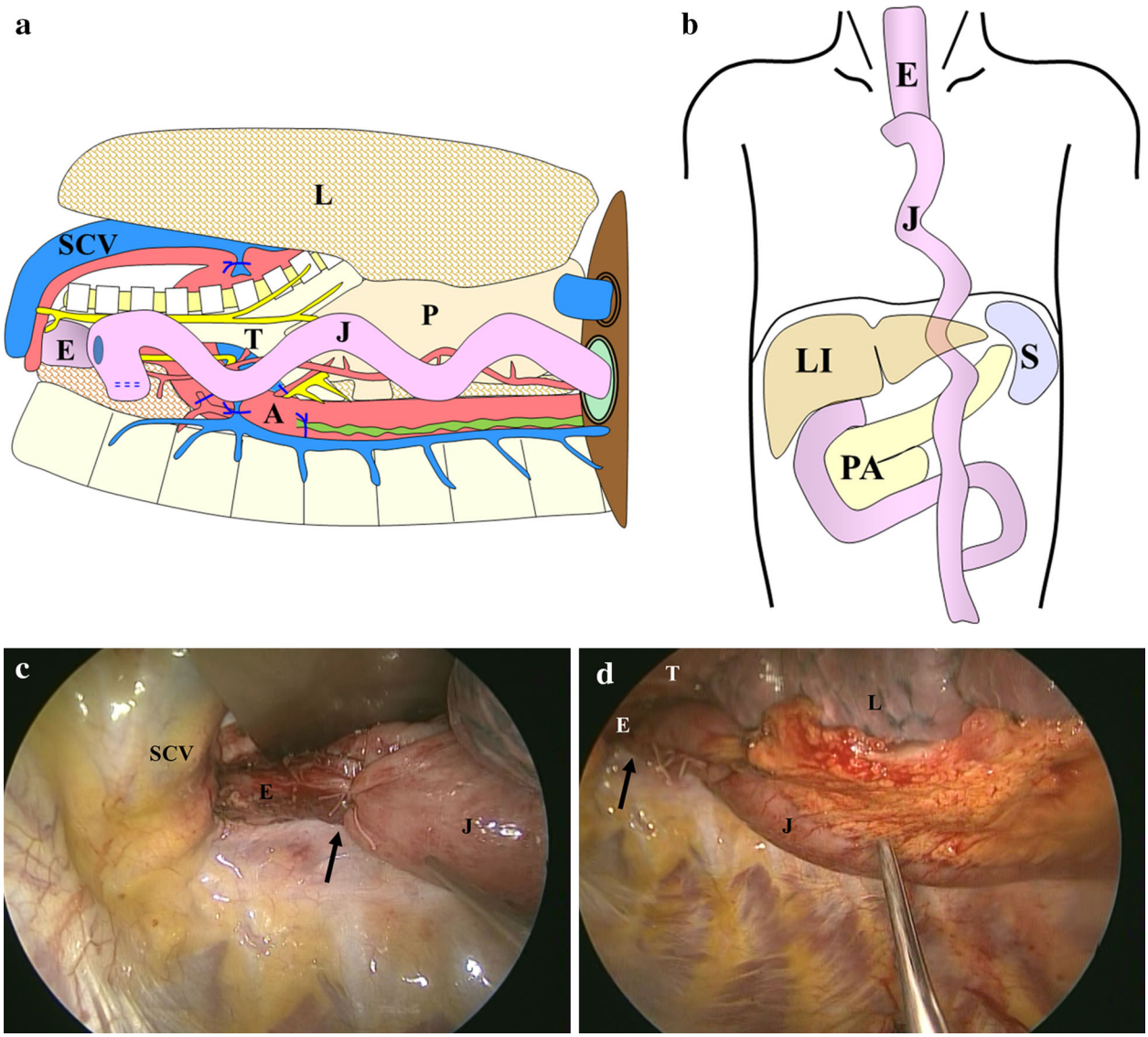

Fig. 1 Schematic illustration and final appearance after pedicle jejunal reconstruction with intrathoracic anastomosis after esophagectomy and total gastrectomy. **a** Schematic illustration of intrathoracic esophagojejunal anastomosis. **b** The reconstruction was performed by the Roux-en-Y method without vascular reconstruction. **c**, **d** Final appearance after thoracoscopic intrathoracic esophagojejunal anastomosis. *Arrow* indicates the esophagojejunostomy site. *A* aorta, *E* esophagus, *J* jejunum, *L* lung, *LI* liver, *P* pericardium, *PA* pancreas, *S* spleen, *SCV* subclavian vein, *T* trachea

after laparotomy, the regional vascular anatomy around the jejunum was observed to confirm the availability of jejunal construction using transillumination as described by Blackmon et al. [4]. After total gastrectomy with abdominal lymph node dissection, transhiatal lower mediastinal dissection was performed through a laparotomy. The first branch vessel beyond the ligament of Treitz was preserved to create a pedicled jejunal conduit. In most cases, the fourth branch of the superior mesenteric artery functioned as the distal vascular pedicle to the mobilized jejunal conduit. After demonstration of adequate collateral circulation by test clamping, the proximal mesenteric vessels of the jejunal segment were ligated and divided close to their origin. The intact vessel network between each vessel was preserved, if at all possible, to allow blood flow in the jejunum. The ileum and right colon were mobilized from the retroperitoneum to free the fixation of the mesentery at the right lower retroperitoneum. In this technique, the highest point of the jejunal conduit shifts cranially without further ligation of vascular loops between the sacrificed jejunal arteries or veins in the mesentery. Thus, this technique effectively overcomes the limitation of the extension length of the jejunal conduit by elongation of the pedicle. After tentative abdominal closure, the patient was situated in the left lateral oblique position. Esophagectomy and upper and middle mediastinal dissection were performed in the left lateral position by bed rotation. The reconstruction procedure was performed in the left lateral oblique position under re-laparotomy. The pedicled jejunal conduit was inserted into the right thoracic cavity from the enlarged esophageal hiatus and placed in the upper mediastinum. End-to-side intrathoracic esophagojejunostomy was performed by circular stapling (25-mm diameter). Reconstruction with the pedicled jejunal conduit was performed by the Roux-en-Y method without vascular reconstruction (Fig. 1). In cases of thoracoscopic performance of the thoracic procedures, thoracoscopic esophagojejunal anastomosis was simultaneously performed. We used a 25-mm transorally inserted anvil (OrVil; Covidien, Mansfield, MA, USA) as reported by Nguyen et al. [14]. A circular stapler (EEA XL, 25 mm; Covidien) was introduced into the jejunal conduit from the oral end of the conduit. The indication for pedicled jejunal reconstruction with intrathoracic anastomosis was localization of the oral side of the tumor within the thoracic esophagus. The degree of lymph node metastasis was not considered in the indication criteria.

Results

The backgrounds of the three groups were almost same; however, the colon group included more early stage patients in comparison to the stomach group. Colon and jejunum group had more patients with gastric cancer in comparison to the stomach group (Table 1). Thoracoscopic dissection procedures were performed in one (16.7 %) and eight (61.5 %) patients in the colon and jejunum groups, respectively. In the colon group, the right hemicolon was elevated through a subcutaneous and retrosternal route in two and four patients, respectively. Thoracoscopic intrathoracic anastomosis was performed in all eight patients who underwent thoracoscopic dissection in the jejunum group. Eleven of the 19 patients underwent prior gastrectomy. The reason for performing gastrectomy and the particular reconstruction method were not different between colon and jejunum groups (Table 2). Operative outcomes of the colon and jejunum group were compared with stomach group (Table 3). The operative times in the colon and jejunum groups were significantly longer than that in the stomach group ($P = 0.001$ and $P = 0.018$, respectively). The colon group showed more blood loss than did the stomach group ($P = 0.007$). However, blood loss in the jejunum group was consistent with that in the stomach group. There was no significant difference in the number of dissected mediastinal lymph nodes among the three groups. With respect to postoperative complications, anastomotic leakage was observed in three patients (50 %) in the colon group. Conversely, no anastomotic leakage occurred in the jejunum group. The incidence of anastomotic leakage was higher in the colon group than in the stomach group ($P = 0.035$). No patients developed necrosis of the conduit in the colon and jejunum groups. The incidence of stenosis of the reconstructed conduit secondary to ischemic change was significantly higher in the colon group (16.7 %, $P = 0.03$) and jejunum group (23.1 %, $P < 0.001$) than in the stomach group. Acute respiratory distress syndrome occurred more frequently in the colon and jejunum groups than in the stomach group (colon group, 50 %, $P = 0.004$; jejunum group, 23.1 %, $P = 0.04$). One patient with liver cirrhosis in the colon group died of postoperative liver failure during the perioperative period. However, there was no mortality in the jejunum group. The overall 5-year survival rates were similar among the three groups (stomach group, 62.8 %; colon group, 50.0 %; jejunum group, 68.8 %). Patient survival in the colon and jejunum groups was not different from that in the stomach group ($P = 0.751$ and $P = 0.954$, respectively).

Discussion

In the present study, we demonstrated favorable short- and long-term operative results of esophagectomy with pedicled jejunal reconstruction and intrathoracic anastomosis in

Table 1 Backgrounds and surgical procedures of patients with esophageal cancer who underwent esophagectomy with reconstruction

	Esophageal substitute				
	Gastric tube ($n = 191$)	Colon ($n = 6$)	P value[a]	Jejunum ($n = 13$)	P value[a]
Gender					
Male	156	5		12	
Female	35	1	0.698[b]	1	0.294[b]
Age, mean (range)	65 (36–83)	68 (68–70)	0.237[c]	68 (48–75)	0.959[c]
Main location of tumor					
Upper esophagus	29	1		0	
Middle esophagus	97	3		6	
Lower esophagus	65	2	0.995[d]	7	0.185[d]
Cancer stage					
I	61	1		4	
II	40	3		2	
III	86	2		7	
IV	4	0	0.041[d]	0	0.881[d]
Adjuvant therapy					
None	93	4		5	
Preoperative	62	1		5	
Postoperative	36	1	0.654[d]	3	0.774[d]
Gastric cancer					
Absent	184	3		4	
Present	7	3	0.002[b]	9	<0.001[b]
Lymph node dissection					
Two field	70	3		9	
Three field	121	3	0.394[b]	4	0.020[d]
Thoracic procedure					
Thoracotomy	26	5		5	
Thoracoscopic dissection	165	1	<0.001[b]	8	0.031[b]
Thoracoscopic anastomosis	5	0	0.855[b]	8	<0.001[b]
Route of reconstruction					
Subcutaneous	0	2		0	
Retrosternal	19	4		0	
Mediastinal	172	0	<0.001[d]	13	0.269[b]
Site of anastomosis to esophagus					
Neck	184	6		0	
Upper mediastinum	7	0	0.803[b]	13	<0.001[d]
Supercharge and drainage					
Present	0	2		0	
Absent	191	4	0.001[b]	13	>0.999[d]

[a] Compared with results of gastric tube reconstruction

[b] Fisher's exact test

[c] Mann–Whitney U test

[d] χ^2 test

the upper mediastinum. Jejunal reconstruction was superior to colon interposition in terms of the less operative blood loss and a lower incidence of anastomotic leakage.

The jejunal blood supply is supported by several jejunal arteries and veins. Generally, the first portion of the jejunum used as a graft has more than three jejunal arteries. These mesenteric vessels connect with one another, forming a vascular loop through the collateral vessels. Therefore, several main jejunal arteries and veins must be sacrificed to create a jejunal conduit of adequate length. At least the second and third jejunal vessels must be severed to create a long jejunal graft [3, 4, 7]. In such conditions, the length to which the pedicled jejunum can be extended is limited by the mesentery, which is restricted to the length of the pedicled vessels and vascular loops between the sacrificed jejunal arteries or veins. To overcome the

limitation of pedicled jejunal reconstruction with respect to extension length, we chose the posterior mediastinal route, which is the shortest reconstruction route, and focused on the intrathoracic esophagojejunal anastomosis. Intrathoracic anastomosis, first reported by Lewis [15], is applicable to most cases of thoracic esophageal cancer because the majority of such cancers arise in the middle-to-lower thoracic esophagus. A randomized controlled study showed comparable short- and long-term outcomes after cervical and intrathoracic esophagogastric anastomosis [16]. A further procedure to improve the extension length of the conduit is mobilization of the right colon and ileum from the retroperitoneum. According to this technique, the superior mesenteric artery and vein proximal to the pedicled jejunal vessels can be used as a portion of the pedicle, which thus helps to elongate the pedicle. As a result, we successfully completed high intrathoracic jejunal anastomosis cranial to the azygos vein in all patients. Ascioti et al. [12] reported a case of jejunal reconstruction through the posterior mediastinal route with cervical anastomosis and microvascular anastomosis. To perform cervical microvascular anastomosis, transection of the communication between the main jejunal vessels may be necessary to elongate the mesentery. However, we preserve the intact vessel network between each vessel if at all possible. As shown in the present study, microvascular anastomosis is not essential for jejunal reconstruction.

Three patients (50 %) in the colon group developed anastomotic leakage. One patient in the colon group with liver cirrhosis died of liver failure after the operation. This patient did not show anastomotic leakage, and the cause of death might have been unrelated to the performance of reconstruction. Severe surgical stress associated with the procedure, however, might have adversely affected the postoperative clinical course. Conversely, no anastomotic leakage occurred in the jejunal group. Three patients (23.1 %) developed postoperative delayed ischemic change in the jejunal conduit. The ischemic change was diagnosed by postoperative endoscopy. Fortunately, no subsequent anastomotic leakage or conduit necrosis occurred. However, all three of these patients showed subsequent ischemic stenosis that was successfully managed by endoscopic

Table 2 Backgrounds of patients with esophageal cancer who underwent prior gastrectomy

	Esophageal substitute		Total	*P* value
	Colon ($n = 4$)	Jejunum ($n = 7$)		
Reason of gastrectomy				
Gastric cancer	1	3	4	
Gastric leiomyoma	0	1	0	
Peptic ulcer	2	3	6	
Gastric stenosis	1	0	1	0.462[a]
Reconstruction method after gastrectomy				
Billroth-I	1	7	8	
Billroth-II	2	0	2	
Jejunal pouch interposition	1	0	1	0.027[a]

[a] χ^2 test

Table 3 Comparison of operative outcomes of esophagectomy with reconstruction according to the esophageal substitute

	Esophageal substitute				
	Gastric tube ($n = 191$)	Colon ($n = 6$)	*P* value[a]	Jejunum ($n = 13$)	*P* value[a]
Operation time (min), median (range)	602 (390–950)	870 (620–1267)	0.001[b]	715 (468–1019)	0.018[b]
Blood loss (g), median (range)	530 (100–6580)	1605 (490–3480)	0.007[b]	730 (350–2090)	0.19[b]
Number of dissected mediastinal lymph node, median (range)	31 (7–99)	32.5 (18–41)	0.73[b]	27 (12–54)	0.142[b]
Postoperative complication (%)					
Anastomotic leakage	24 (12.6)	3 (50)	0.035[c]	0	0.186[c]
Ischemic stenosis of conduit	0	1 (16.7)	0.03[c]	3 (23.1)	<0.001[c]
Pneumonia	45 (23.6)	3 (50)	0.156[c]	3 (23.1)	0.635[c]
Acute respiratory distress syndrome	10 (5.2)	3 (50)	0.004[c]	3 (23.1)	0.04[c]
Operative mortality (%)	4 (2.1)	1 (16.7)	0.145[c]	0	0.767[c]
Overall 5-year survival rate (%)	62.8	50.0	0.751[d]	68.8	0.954[d]

[a] Compared with results of gastric tube reconstruction

[b] Mann–Whitney *U* test

[c] Fisher's exact test

[d] Log-rank test

dilation therapy. Two of these three patients had undergone preoperative chemotherapy comprising docetaxel, cisplatin, and 5-fluorouracil. Preoperative chemotherapy might induce toxic insult to the microvasculature by endothelial injury and cause subsequent thrombotic microangiopathy in the conduit [17]. Further attention, including anticoagulant therapy, may be needed to maintain sufficient circulation in the conduit. The usefulness of indocyanine green (ICG) fluorescence imaging for evaluation of the hemodynamics in the gastric conduit was recently reported [18]. The application of ICG fluorescence imaging might be useful to evaluate the blood flow in the jejunal conduit. Further studies are needed to clarify the usefulness of such imaging for this purpose.

The mediastinal lymph node dissection was performed using the combination of a transhiatal approach in the lower mediastinum and a transthoracic approach in the upper and middle mediastinum. We attempted to dissect all regional mediastinal lymph nodes as performed in radical esophagectomy. As a result, the number of retrieved mediastinal lymph nodes in the colon and jejunum groups was identical to that in our method of radical esophagectomy with gastric reconstruction. Long-term survival was consistent among the three groups.

From November 2009 onward, we performed thoracoscopic dissection in patients who were candidates for esophagectomy with total gastrectomy among those who had undergone prior gastrectomy or who had a concurrent gastric disorder, including gastric cancer. Thoracoscopic dissection was performed in 1 of 6 patients in the colon group and in 8 of 13 patients in the jejunum group, as described previously [19]. In cases of jejunal reconstruction, thoracoscopic intrathoracic anastomosis was performed concomitantly with the thoracoscopic dissection procedure. Although the combination of thoracoscopic dissection and anastomosis is a difficult and complex procedure, thoracoscopic surgery is possible in all such cases. We successfully performed end-to-side hemidouble stapling in all cases. Use of this thoracoscopic procedure could minimize chest wall injury and may contribute to the maintenance of postoperative pulmonary function.

We abandoned the application of this technique in one patient with tumor extension to the cervical esophagus. We now perform colon reconstruction through the subcutaneous route with microvascular surgery in such cases. Insufficient vessel communication around the colon sometimes causes complications associated with an insufficient blood supply [20]. Microvascular surgical techniques are useful to support circulation in the pedicled colon conduit [21]. When blood insufficiency in the jejunal conduit is confirmed during the operation, additional microvascular anastomosis may not be possible during posterior mediastinal reconstruction. Therefore, conversion to the anterior mediastinal route with additional microvascular anastomosis or new creation of a colon conduit might be necessary in such cases.

Conclusion

Pedicle jejunal reconstruction with intrathoracic anastomosis is a safe procedure after esophagectomy for patients with esophageal cancer in whom the stomach cannot be used as a reconstruction conduit because of prior gastrectomy or the coincidence of a gastric disorder. This procedure can also be performed thoracoscopically.

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Conflict of interest The authors declare no conflict of interest.

References

1. Davis PA, Law S, Wong J. Colonic interposition after esophagectomy for cancer. Arch Surg. 2003;138:303–8.
2. Wada H, Doki Y, Nishioka K, Ishikawa O, Kabuto T, Yano M, et al. Clinical outcome of esophageal cancer patients with history of gastrectomy. J Surg Oncol. 2005;89:67–74.
3. Yasuda T, Shiozaki H. Esophageal reconstruction using a pedicled jejunum with microvascular augmentation. Ann Thorac Cardiovasc Surg. 2011;17:103–9.
4. Blackmon SH, Correa AM, Skoracki R, Chevray PM, Kim MP, Mehran RJ, et al. Supercharged pedicled jejunal interposition for esophageal replacement: a 10-year experience. Ann Thorac Surg. 2012;94:1104–11 (discussion 11–3).
5. Ochsner A, Owens N. Anterothoracic oesophagoplasty for impermeable stricture of the oesophagus. Ann Surg. 1934;100:1055–91.
6. Longmire WP, Ravitch MM. A new method for constructing an artificial esophagus. Ann Surg. 1946;123:819–34.
7. Doki Y, Okada K, Miyata H, Yamasaki M, Fujiwara Y, Takiguchi S, et al. Long-term and short-term evaluation of esophageal reconstruction using the colon or the jejunum in esophageal cancer patients after gastrectomy. Dis Esophagus. 2008;21:132–8.
8. Iwata N, Koike M, Kamei Y, Tanaka C, Ohashi N, Nakayama G, et al. Antethoracic pedicled jejunum reconstruction with the supercharge technique for esophageal cancer. World J Surg. 2012;36:2622–9.
9. Okumura Y, Mori K, Yamagata Y, Fukuda T, Wada I, Shimizu N, et al. A two-stage operation for thoracic esophageal cancer: esophagectomy and subsequent reconstruction by a free jejunal flap. Surg Today. 2014;44:395–8.
10. Maier A, Pinter H, Tomaselli F, Sankin O, Gabor S, Ratzenhofer-Komenda B, et al. Retrosternal pedicled jejunum interposition: an alternative for reconstruction after total esophago-gastrectomy. Eur J Cardiothorac Surg. 2002;22:661–5.
11. Barzin A, Norton JA, Whyte R, Lee GK. Supercharged jejunum flap for total esophageal reconstruction: single-surgeon 3-year experience and outcomes analysis. Plast Reconstr Surg. 2011;127:173–80.
12. Ascioti AJ, Hofstetter WL, Miller MJ, Rice DC, Swisher SG, Vaporciyan AA, et al. Long-segment, supercharged, pedicled

jejunal flap for total esophageal reconstruction. J Thorac Cardiovasc Surg. 2005;130:1391–8.
13. Ninomiya I, Osugi H, Fujimura T, Kayahara M, Takamura H, Takemura M, et al. Results of video-assisted thoracoscopic surgery for esophageal cancer during the induction period. Gen Thorac Cardiovasc Surg. 2008;56:119–25.
14. Nguyen NT, Nguyen XM, Masoomi H. Minimally invasive intrathoracic esophagogastric anastomosis: circular stapler technique with transoral placement of the anvil. Semin Thorac Cardiovasc Surg. 2010;22:253–5.
15. Lewis I. The surgical treatment of carcinoma of the oesophagus; with special reference to a new operation for growths of the middle third. Br J Surg. 1946;34:18–31.
16. Walther B, Johansson J, Johnsson F, Von Holstein CS, Zilling T. Cervical or thoracic anastomosis after esophageal resection and gastric tube reconstruction: a prospective randomized trial comparing sutured neck anastomosis with stapled intrathoracic anastomosis. Ann Surg. 2003;238:803–12 (discussion 12–4).
17. Blake-Haskins JA, Lechleider RJ, Kreitman RJ. Thrombotic microangiopathy with targeted cancer agents. Clin Cancer Res. 2011;17:5858–66.
18. Kumagai Y, Ishiguro T, Haga N, Kuwabara K, Kawano T, Ishida H. Hemodynamics of the reconstructed gastric tube during esophagectomy: assessment of outcomes with indocyanine green fluorescence. World J Surg. 2014;38:138–43.
19. Ninomiya I, Okamoto K, Fujimura T, Fushida S, Osugi H, Ohta T. Oncologic outcomes of thoracoscopic esophagectomy with extended lymph node dissection: 10-year experience from a single center. World J Surg. 2014;38:120–30.
20. Cerfolio RJ, Allen MS, Deschamps C, Trastek VF, Pairolero PC. Esophageal replacement by colon interposition. Ann Thorac Surg. 1995;59:1382–4.
21. Saeki H, Morita M, Harada N, Egashira A, Oki E, Uchiyama H, et al. Esophageal replacement by colon interposition with microvascular surgery for patients with thoracic esophageal cancer: the utility of superdrainage. Dis Esophagus. 2013; 26:50–6.