Diseases of the Esophagus (2013) **26**, 50–56
DOI: 10.1111/j.1442-2050.2012.01327.x

DISEASES OF THE ESOPHAGUS

Original article

Esophageal replacement by colon interposition with microvascular surgery for patients with thoracic esophageal cancer: the utility of superdrainage

H. Saeki,[1] M. Morita,[1] N. Harada,[1] A. Egashira,[1] E. Oki,[1] H. Uchiyama,[1] T. Ohga,[1] Y. Kakeji,[1] Y. Sakaguchi,[2] Y. Maehara[1]

[1]*Department of Surgery and Science, Graduate School of Medical Sciences, Kyushu University, and* [2]*Department of Gastroenterological Surgery, National Kyushu Cancer Center, Fukuoka, Japan*

SUMMARY. **Replacing the thoracic esophagus with the colon is one mode of reconstruction after esophagectomy for esophageal cancer. There is, however, a high incidence of postoperative necrosis of the transposed colon. This study evaluated the outcomes of colon interposition with the routine use of superdrainage by microvascular surgery. Twenty-one patients underwent colon interposition from 2004 to 2009. The strategy for colon interposition was to: (i) use the right hemicolon; (ii) reconstruct via the subcutaneous route; (iii) perform a microvascular venous anastomosis for all patients; and (iv) perform a microvascular arterial anastomosis when the arterial blood flow was insufficient. The clinicopathologic features, surgical findings, and outcomes were investigated. The colon was used because of a previous gastrectomy in 18 patients (85.7%) and synchronous gastric cancer in three patients (14.3%). Eight patients (38.1%) underwent preoperative chemoradiotherapy including three (14.3%) treated with definitive chemoradiotherapy. Seven patients (33.3%) underwent microvascular arterial anastomosis to supplement the right colon blood supply. Pneumonia occurred in four patients (19.0%). Anastomotic leakage was observed in five patients (23.8%); however, no colon necrosis was observed. The 3-year and 5-year overall survival rates were both 50.6%. Colon interposition with superdrainage results in successful treatment outcomes. This technique is one option for colon interposition employing the right hemicolon.**

KEY WORDS: **colon necrosis, esophageal reconstruction, right hemi-colon, supercharge, superdrainage.**

INTRODUCTION

Surgery for esophageal cancer remains the standard therapy providing the best chance for cure.[1] Resection and reconstruction of the esophagus is, however, among the most invasive treatments for cancers of the gastrointestinal tract. Although the surgical techniques and perioperative management of esophageal surgery have improved, the morbidity and mortality rates are comparatively high.[2–5]

Gastric tubulization has received wide acceptance by most surgeons performing esophageal surgery.[2] Advantages of this technique include ease of preparation, a robust vascular supply, and adequate length to extend into the neck. The stomach, therefore, has become the logical first choice for esophageal replacement. In cases with a history of gastrectomy, concurrent gastric disease, or cancer involvement of the stomach, the colon or jejunum is used instead of the stomach as an esophageal substitute. A colon graft is generally preferred over the jejunum, as it is easier to mobilize; however, debates surround the surgical procedures, mortality, morbidity, and outcomes of colon interposition for the treatment of esophageal cancer.[6–24] A notable criticism is the high rate of postoperative leakage and colon necrosis associated with this strategy.

In our institute, colon replacement of the esophagus is the standard choice for gastrointestinal reconstruction after resection of primary esophageal

Address correspondence to: Dr. Hiroshi Saeki, MD, PhD, Department of Surgery and Science, Graduate School of Medical Sciences, Kyushu University, 3-1-1 Maidashi, Higashi-ku, 812-8582 Fukuoka, Japan.
Email: h-saeki@surg2.med.kyushu-u.ac.jp
Sources of support: This work was supported in part by a Grant-in-Aid from the Ministry of Education, Culture, Sport, Science and Technology of Japan.
Disclosure of potential conflicts of interest: No potential conflicts of interest were disclosed.

cancer, if the stomach is unacceptable. Microvascular surgical techniques, venous anastomosis (superdrainage) and arterial anastomosis (supercharge), were introduced as early as 2004 when replacement of the esophagus with the colon was performed. The arterial circulation in these intestinal conduits brought up to the neck are usually sufficient without the use of supercharge in many cases. In such a situation, our opinion is that the most important means of improving blood circulation is to avoid venous congestion by superdrainage. Use of the right hemicolon as a reconstruction organ requires the ileocolic vessels to be ligated and divided to bring the proximal part of the right hemicolon up to the neck. The accompanying vascular pedicle consists of the middle colic vessels. Superdrainage is performed by anastomosing the ileocolic vein or terminal ileal vein to a vein in the neck, such as the anterior jugular vein or the external jugular vein.

This report describes a retrospective evaluation of the outcomes of colon interposition with the routine use of superdrainage by microvascular surgery on esophageal replacement in patients with esophageal cancer in this institute.

PATIENTS AND METHODS

Patients

One hundred ninety-five patients with esophageal cancer were surgically treated in this department from April 2004 to December 2009. Twenty-two of those patients (11.3%) underwent colon interposition. Among them, one patient who also had a jejunal free flap between the esophagus and a colon graft of insufficient length was excluded from this study. The characteristics of these 21 patients are summarized in Table 1. The male/female ratio was 20:1, with an average age of 67 years at the time of surgery. The cancer was located in the upper thoracic esophagus in eight (38.1%) patients, the middle thoracic esophagus in seven (33.3%), and the lower thoracic esophagus in six (28.6%). Nine patients (42.9%) were in tumor, node, metastasis (TNM) clinical stage I/II, and 12 (57.1%) in stage III/IV. Colon interposition was performed because of a history of gastrectomy in 18 patients (85.7%) and synchronous gastric cancer in three patients (14.3%). Neoadjuvant chemoradiotherapy was administered to five patients (23.8%), definitive chemoradiotherapy to three patients (14.3%), and no preoperative therapy in 13 patients (61.9%).

Table 1 Background data for patients who underwent colon interposition with microvascular anastomosis for esophageal cancer

Factor	Cases ($n = 21$)
Male/female	20/1
Age (mean)	67 (53–90)
Location of tumor	
Upper	8 (38.1)
Middle	7 (33.3)
Lower	6 (28.6)
Reason for colon interposition	
History of gastrectomy	18 (85.7)
Synchronous gastric cancer	3 (14.3)
Clinical TNM stage	
I, II	9 (42.9)
III, IV	12 (57.1)
Preoperative therapy	
Neoadjuvant chemoradiotherapy	5 (23.8)
Definitive chemoradiotherapy	3 (14.3)
None	13 (61.9)

The data in parentheses are percentages. TNM, tumor, node, metastasis.

Surgical procedure

A schematic illustration of the colon interposition with microvascular surgery was shown in Figure 1. The strategy for colon interposition incorporated the following principles: (i) use the right hemicolon; (ii) preserve the right colic artery, as well as the middle colic artery, if there was adequate mobilization of the colon; (iii) preserve as much of the terminal ileum as possible; (iv) reconstruct via the subcutaneous route; (v) adopt superdrainage for all patients regardless of the intraoperative macroscopic findings; and (vi) adopt supercharge when the arterial blood flow was insufficient.

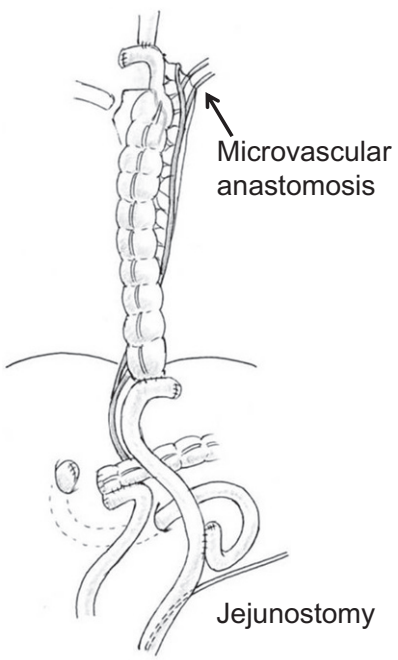

Fig. 1 A schematic illustration of the colon interposition with microvascular surgery. A microvascular venous anastomosis ('superdrainage') is added between the ileocolic vein or terminal ileal vein, and a cervical vein. An artery of the conduit is microscopically anastomosed to a cervical artery ('supercharge') only in the event of insufficient backflow of the ileocolic artery.

With the patient in the left lateral position, an anterolateral skin incision or a longitudinal skin incision on the anterior axillary line was placed, and a thoracotomy performed through the fourth or fifth intercostal space. An esophagectomy as well as a mediastinal lymphadenectomy was performed. The esophagus was divided, with a linear stapler above or below the tumor, depending on its location, and the chest closed. After the position was changed to the supine position, the abdomen was opened by an upper midline incision. The right hemicolon was mobilized. The appendix was resected, and its root was buried with purse string sutures.

The ileocolic artery and vein were divided at their origin at the superior mesenteric artery and vein, respectively. In cases in which the length of the ileocolon graft was inadequate to reach the neck, the right colic vessels were divided. The transverse colon was divided, preserving the middle colic artery and vein. A T-shaped skin incision was made on the neck. The right hemicolon with the terminal ileum was brought up to the neck in an isoperistaltic fashion through a subcutaneous route. An esophagoileostomy was performed with a circular stapler when the 25 mm of anvil was easily inserted into the remnant esophagus. When it was difficult, the anastomosis was performed with hand-sewn sutures. This judgment depended on the operator. The colon was then anastomosed to either the remnant stomach or a Roux-en-Y loop of the jejunum.

Superdrainage was routinely added between the ileocolic vein or terminal ileal vein, and a cervical vein, such as the anterior, external, or internal jugular vein. We selected an outflow vein with strong flow. The flexible venous walls were easier to manipulate than the more rigid arterial walls. In many cases, veins were reconstructed by direct end-to-end anastomosis. Veins were anastomosed in an end-to-side manner when the internal jugular vein was selected as an outflow vein. The vein graft was interposed between the veins when the distance between the veins was too long.[25] For instance, an inferior mesenteric vein (IMV) graft, approximately 10 cm in length, was harvested from the mesocolon and immersed in heparinized saline. The proximal end of the IMV graft was anastomosed to a cervical vein, and the distal end was anastomosed to a vein of the conduit. After the completion of the vein anastomoses, the clamps on these vessels were released. The ileocolic artery or terminal ileal artery was microscopically anastomosed to a cervical artery for supercharge when the backflow of the ileocolic artery was insufficient. The artery graft was also applicable if the distance between the arteries was too long. We used neither antiplatelet nor anticoagulation therapy routinely.

A scheduled two-stage operation was performed in nine recent patients, as recently described.[26] The first-stage operation consisted of a resection of the thoracic esophagus, cervical esophagostomy, and tube jejunostomies. The distal part of the esophagus was cut with a linear stapler at the level of the esophagocardial junction. The upper thoracic esophagus was also cut with the same stapler. A minimal laparotomy was performed, and two 10F tubes were inserted into the jejunum about 30 cm distal to the Treiz ligament. A tube for enteric feeding was placed into the distal part of the jejunum, while another was placed into the proximal jejunum for decompression to avoid excessive pressure in the distal margin of the esophagus. The second-stage operation was usually performed 3 weeks after the first-stage operation. The reconstructive procedures were the same as for the one-stage operation. Cervical lymphadenectomy was performed at the second-stage operation to preserve the vascular structure.

Staging of the tumor and statistical analysis

The staging of the tumor was based on the TNM classification defined by the Union for International Cancer Control,[27] and depth of invasion and lymph node metastasis were defined by the clinical findings. The survival curve was plotted according to the Kaplan–Meier method. The median follow-up periods were estimated using the reversed Kaplan–Meier function.[28] The data were analyzed using the StatView software package (Abacus Concepts, Inc., Berkeley, CA, USA).

RESULTS

Microvascular anastomosis

Superdrainage was performed in all 21 patients. Supercharge was performed in seven patients (33.3%). The right colic artery was preserved in 10 patients (47.6%), while the artery was sacrificed or absent in the remaining patients.

The vessels used for superdrainage and supercharge are listed in Table 2. The anterior jugular vein

Table 2 Vessels used for superdrainage and supercharge

Superdrainage ($n = 21$)		
Outflow vein	Anterior jugular vein	8 (38.1)
	External jugular vein	7 (33.3)
	Internal jugular vein	3 (14.3)
	Transverse cervical vein	2 (9.5)
	Superficial cervical vein	1 (4.8)
Inflow vein	Ileocolic vein	19 (90.5)
	Terminal ileal vein	2 (9.5)
Supercharge ($n = 7$)		
Inflow artery	Transverse cervical artery	6 (85.7)
	Ileocolic artery	1 (14.3)
Outflow artery	Ileocolic artery	5 (71.4)
	Terminal ileal artery	2 (28.6)

The values in parentheses are percentages.

Table 3 Morbidity and mortality of the patients

Factor	Cases ($n = 21$)
Overall morbidity	9 (42.9)
Anastomotic leakage	5 (23.8)
Colon necrosis	0 (0)
Pneumonia	4 (19.0)
Ventricular tachycardia	1 (4.8)
Mortality	1 (4.8)

The values in parentheses are percentages.

was used in eight patients as the outflow vein (38.1%) and the external jugular vein in seven patients (33.3%). The ileocolic vein was used as the inflow vein in 19 patients (90.5%). The interposition of a vein graft was needed in five patients (23.8%). The IMV was used for interposition in two patients, the anterior jugular vein in two patients, and the gonadal vein in one patient.

The transverse cervical artery was used as the inflow artery in all patients except for one patient who underwent the anastomosis between the ileocolic artery and terminal ileal artery. The transverse cervical artery was preferred because it is outside the field of resection. The ileocolic artery was used as the outflow artery in five patients (71.4%) and the terminal ileal artery in two patients (28.6%). The interposition with the transverse cervical artery graft was needed in one patient.

Mortality and morbidity

The median time of the one-stage operation was 835 minutes (range 738–1113 minutes). In the two-stage operation, the median time of the first-stage operation was 387 minutes (range 265–435 minutes), and of the second-stage operation was 700 minutes (range 626–958 minutes). Morbidity and mortality are summarized in Table 3. Overall morbidity occurred in nine patients (42.9%). Anastomotic leakage was observed in five patients (23.8%); however, there was no colon necrosis. We evaluated the status of the anastomosis clinically because subcutaneous graft failure could be diagnosed on physical exam of the anterior neck. We performed an esophagogram or endoscopy to confirm the diagnosis of anastomotic leakage or to check the degree of leakage when anastomotic failure was suspected. We have previously reported the simple method of repairing an esophageal anastomotic leak via the subcutaneous route using a pectoralis major myofascial flap.[29] Although one patient was managed conservatively, the remaining four patients with an anastomotic leak in the present study were treated with a pectoralis major flap. Although pneumonia was observed in four patients (19.0%), it was uniformly nonfatal. One patient died due to acute cardiac failure because of sudden ventricular tachycardia on the third postoperative day; thus, the overall mortality rate was 4.8%.

Survival

The survival curve of the 21 patients who underwent colon interposition with microvascular surgery for esophageal cancer is shown in Figure 2. The median length of follow-up was 23.3 months (range 2.6–65.2 months). Thirteen patients (61.9%) are still alive, while seven patients (33.3%) died of esophageal cancer and one patient died due to the previously described complication. The 3-year and 5-year overall survival rates were both 50.6%.

DISCUSSION

The present study evaluated outcomes following the replacement of the esophagus with a colon graft incorporating microvascular anastomoses for superdrainage. Microvascular anastomoses have been utilized for some time in this setting to improve perfusion. Previous reports support the effectiveness of supercharge when the thoracic esophagus is replaced with the colon.

Shirakawa *et al.* reported that the supercharge technique for colonic interposition reduced perioperative complications and improved patient quality of life.[6] Fujita *et al.* compared the postoperative courses, morbidity, and mortality rates of the patients who underwent colon interposition with and without supercharge.[7] They found that supercharge resulted in a lower incidence of necrosis of the colon graft and less risk of leakage in the esophagocolostomy. The ileocolic artery or the terminal ileal artery was reconstructed in seven selected patients using the supercharge technique in the current series (33.3%). The

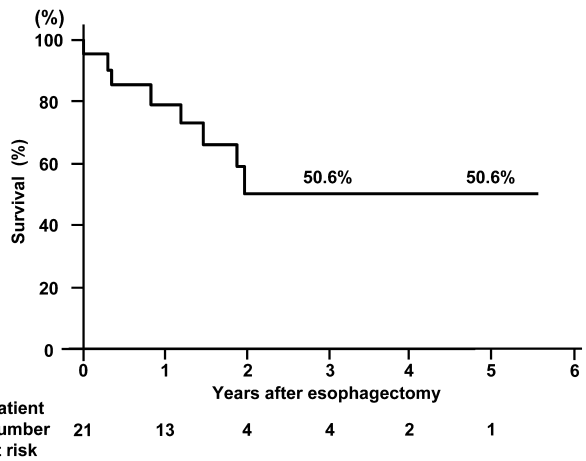

Fig. 2 The survival curve of the 21 patients who underwent colon interposition with microvascular surgery among the patients with esophageal cancer. The 3-year and 5-year overall survival rates were both 50.6%.

arterial flow in the right hemicolon and the terminal ileum brought up to the neck is more stable than the frequently tenuous venous flow. Performing the supercharge technique of the ileocolic artery is not always necessary in such esophageal replacements, as previously reported.[30] While perfusion is critical, amelioration of vascular congestion may also play a role in whether a graft survives.

Kono *et al*. reported that transient bloodletting of the short gastric vein in the gastric tube during esophagectomy improved the microcirculation of the oral side of the gastric tube.[31] Based on our own experience, the most important means of improving the blood circulation is to avoid blood congestion. As the present study is retrospective, it lacks a formal control group. As a comparator group, we retrospectively investigated the outcomes of all 17 patients with esophageal cancer who received colon interposition at our institute between 1995 and 2004. During this period, we did not perform microvascular anastomoses. Anastomotic leakage and colon necrosis were observed in seven (41.2%) and two (11.8%) patients, respectively. Because this comparison is historical and multifactorial, we cannot draw any definitive conclusions. As expected, the graft failures resulted from arterial occlusion, venous congestion, technical problems during harvesting, the length of the graft, tension, the length of the operation, and medical comorbidities. Learning curves likely also influenced the surgical outcomes. However, while our results do suggest that superdrainage may contribute to a better outcome for patients who undergo colon interposition, further studies are needed to establish this technique as the standard of care.

The current recommended strategy for reconstructing the ileocolic vessels is to first perform superdrainage of the ileocolic vein to the jugular vein in all patients followed by a macroscopic inspection for pulsatile blood flow in the marginal arteries of the terminal ileum. The ileocolic artery remains untouched if a pulsatile feeding artery at the tip of the colon graft is confirmed. The ileocolic artery is only reconstructed using the cervical arteries in a direct end-to-end anastomosis when an adequate pulsatile blood flow cannot be confirmed. While reports do describe the use of a microvascular anastomosis for selected patients based on the macroscopic findings during surgery,[8] there are no useful preoperative or intraoperative parameters that objectively confirm the presence of venous congestion or arterial flow at the tip of colon graft. The routine use of microvascular surgery during colon interposition is considered to be advocated in such a situation.

We elected to interpose the vessel graft when the distance between the vessels was too long.[25] Some surgeons have reported the simultaneous use of supercharge and superdrainage using the internal thoracic artery and vein, or the thoracoacromial artery and cephalic vein. The internal thoracic vascular bundle is accessed by removing the cartilage of the second and third ribs. The thoracoacromial artery and cephalic vein are approached by dividing the clavicular attachment of the pectoralis major muscle.[6,7] We believe that these procedures are time-consuming and invasive in contrast with harvesting a graft. For example, the IMV graft may be harvested from the mesocolon in under 10 minutes.[25] Although an additional anastomosis is required for this procedure, adequate blood drainage is accomplished by directly anastomosing a drainage vein to the internal jugular vein.

The operative procedure evaluated in the present study had acceptable rates of complications. The two-stage operation, in particular, was routinely adopted for recent patients, as it reduced the overall procedural risks, and we have recently reported a two-stage operation that is less invasive for high-risk patients.[26] There were no cases of colon graft necrosis in the current study, which suggests that vascular flow was consistently adequate. Anastomotic leakage was observed in five patients (23.8%), a rate somewhat higher than was previously reported (Table 4). Based on our previous reports, high surgical stress is associated with an increased risk of anastomotic leakage.[4,32] The risk of anastomotic leak, however, is impacted by other clinical factors, such as medical comorbidities and preoperative chemoradiotherapy.[33] There were no factors strongly associated with anastomotic leakage in the present study. Further studies are required to determine whether improvements in the two-stage procedure, including reduced invasiveness, will translate into improved surgical outcomes.

The choice of graft site (right hemicolon, ascending-transverse colon, or left colon) generally depends on the specific surgeons or institute. Each has its relative merits. The left colon is an optimal graft, as it enables an isoperistaltic reconstruction and has a high degree of mobility. In this institute, however, the right hemicolon is used as it has several advantages over the left. Less dissection is required to mobilize the right than the left colon. The length of the terminal ileum is adjustable, and the anastomosis is facilitated because the diameters of the ileum and esophagus are similar. The ileocecal valve functionally inhibits regurgitation of digestive juices. Finally, the use of an ileocolon grafts allows alternative grafts, including ascending-transverse colon or left-colon grafts, to be used in case of the first graft failure. None of the patients in the current series demonstrated a failure of the first right hemicolon graft according to the procedures.

The choice of the route of reconstruction also varies among institutes. Mine *et al*. reported that the exclusive use of a retrosternal route led to a favorable surgical outcome.[8] Motoyama *et al*. reported that

Table 4 Previously reported data of colon interposition

Author, year	No. of cases	Microvascular surgery, %	Anastomotic leakage, %	Colon necrosis, %
Shirakawa *et al*., 2006[6]	51	80	7.8	0
Fujita *et al*., 1997[7]	53	55	28	5.7
Mine *et al*., 2009[8]	95	3.1	13	0
Cerfolio *et al*., 1995[9]	32	6.3	3.3	9.4
Kolh *et al*., 2000[10]	38	N.D.	0	0
Hagen *et al*., 2001[11]	72	N.D.	13	5.6
Fürst *et al*., 2001[12]	53	N.D.	12	3.8
Davis *et al*., 2003[13]	42	N.D.	14	2.4
Popovici, 2003[14]	347	N.D.	6.9	1.4
Knezević *et al*., 2007[15]	336	N.D.	9.2	2.4
Doki *et al*., 2008[16]	28	100	46	0
Motoyama *et al*., 2007[17]	34	N.D.	9	0
Fürst *et al*., 2000[18]	15	N.D.	6.7	0
Thomas *et al*., 1997[19]	60	N.D.	10	5
Klink *et al*., 2010[24]	43	N.D.	30	9
Historical data	17	0	41.2	11.8
Current study	21	100	23.8	0

N.D., not described.

colon interposition by the posterior mediastinal route also provided a good outcome and recommended it as the route of first choice.[17] Finally, the subcutaneous route is another popular approach. Although this has cosmetic disadvantages, it is relatively safer than the other approaches, particularly in elderly patients and poor surgical candidates. Moreover, various vessels can be selected for supercharge in all cases treated via this route. However, to the best of our knowledge, no randomized studies have identified the optimal route for esophageal replacement by colon interposition with respect to surgical outcomes, morbidity, and quality of life.

Esophageal replacement by colon interposition is an uncommonly performed procedure. As microsurgical training is required to perform the microvascular anastomoses, plastic surgeons are frequently consulted to assist with the procedure. The need for additional consultants makes it impractical to conduct randomized controlled trials examining the usefulness of microvascular surgery during colon interposition. Therefore, much of what is known regarding present techniques has been obtained through retrospective studies. Therefore, the present study provides valuable insight into the efficacy of superdrainage and supercharge.

We describe a technique that represents one option for colon interposition when using the right hemicolon. In conclusion, the right hemicolon interposition with the routine use of superdrainage by microvascular surgery is associated with satisfactory postoperative outcomes.

Acknowledgments

We thank Brian Quinn and Akio Nagaoka for assisting with the preparation of the manuscript.

References

1 Wu P C, Posner M. The role of surgery in the management of oesophageal cancer. Lancet Oncol 2003; 4: 481–8.
2 Jamieson G G, Mathew G, Ludemann R, Wayman J, Myers J C, Devitt P G. Postoperative mortality following oesophagectomy and problem in reporting its rate. Br J Surg 2004; 9: 943–7.
3 Morita M, Yoshida R, Ikeda K *et al*. Advances in esophageal cancer surgery in Japan: an analysis of 1000 consecutive patients treated at a single institute. Surgery 2008; 143: 499–508.
4 Saeki H, Masuda T, Okada S *et al*. Impact of perioperative peripheral blood values on postoperative complications after esophageal surgery. Surg Today 2010; 40: 626–31.
5 Saeki H, Ishimura H, Higashi H *et al*. Postoperative management using intensive patient-controlled epidural analgesia and early rehabilitation after an esophagectomy. Surg Today 2009; 39: 476–80.
6 Shirakawa Y, Naomoto Y, Noma K *et al*. Colonic interposition and supercharge for esophageal reconstruction. Langenbecks Arch Surg 2006; 391: 19–23.
7 Fujita H, Yamana H, Sueyoshi S *et al*. Impact on outcome of additional microvascular anastomosis – supercharge – on colon interposition for esophageal replacement: comparative and multivariate analysis. World J Surg 1997; 21: 998–1003.
8 Mine S, Udagawa H, Tsutsumi K *et al*. Colon interposition after esophagectomy with extended lymphadenectomy for esophageal cancer. Ann Thorac Surg 2009; 88: 1647–54.
9 Cerfolio R J, Allen M S, Deschamps C, Trastek V F, Pairolero P C. Esophageal replacement by colon interposition. Ann Thorac Surg 1995; 59: 1382–4.
10 Kolh P, Honore P, Degauque C, Gielen J, Gerard P, Jacquet N. Early stage results after oesophageal resection for malignancy – colon interposition vs. gastric pull-up. Eur J Cardiothorac Surg 2000; 18: 293–300.
11 Hagen J A, DeMeester S R, Peters J H, Chandrasoma P, DeMeester T R. Curative resection for esophageal adenocarcinoma: analysis of 100 en bloc esophagectomies. Ann Surg 2001; 234: 520–30.
12 Fürst H, Hüttl T P, Löhe F, Schildberg F W. German experience with colon interposition grafting as an esophageal substitute. Dis Esophagus 2001; 14: 131–4.
13 Davis P A, Law S, Wong J. Colonic interposition after esophagectomy for cancer. Arch Surg 2003; 138: 303–8.
14 Popovici Z. A new philosophy in esophageal reconstruction with colon. Thirty-years experience. Dis Esophagus 2003; 16: 323–7.

15 Knezević J D, Radovanović N S, Simić A P *et al*. Colon interposition in the treatment of esophageal caustic strictures: 40 years of experience. Dis Esophagus 2007; 20: 530–34.
16 Doki Y, Okada K, Miyata H *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.
17 Motoyama S, Kitamura M, Saito R *et al*. Surgical outcome of colon interposition by the posterior mediastinal route for thoracic esophageal cancer. Ann Thorac Surg 2007; 83: 1273–8.
18 Fürst H, Hartl W H, Löhe F, Schildberg F W. Colon interposition for esophageal replacement an alternative technique based on the use of the right colon. Ann Surg 2000; 231: 173–8.
19 Thomas P, Fuentes P, Giudicelli R, Reboud E. Colon interposition for esophageal replacement: current indications and long-term function. Ann Thorac Surg 1997; 64: 757–64.
20 Gorman J H III, Low D W, Guy T S IV, Gorman R C, Rosato E F. Extended left colon interposition for esophageal replacement using arterial augmentation. Ann Thorac Surg 2003; 76: 933–5.
21 Nguyen N T, Hinojosa M, Fayad C, Gray J, Murrell Z, Stamos M. Laparoscopic and thoracoscopic Ivor Lewis esophagectomy with colonic interposition. Ann Thorac Surg 2007; 84: 2120–24.
22 Cheng B C, Xia J, Shao K, Mao Z F, Huang J, Wang T S. Surgical treatment for upper or middle esophageal carcinoma occurring after gastrectomy: a study of 52 cases. Dis Esophagus 2005; 18: 239–45.
23 Cense H A, Visser M R, van Sandick J W *et al*. Quality of life after colon interposition by necessity for esophageal cancer replacement. J Surg Oncol 2004; 88: 32–8.
24 Klink C D, Binnebösel M, Schneider M, Ophoff K, Schumpelick V, Jansen M. Operative outcome of colon interposition in the treatment of esophageal cancer: a 20-year experience. Surgery 2010; 147: 491–6.
25 Uchiyama H, Morita M, Toh Y *et al*. Superdrainage of the ileocolic vein to the internal jugular vein interposed by an inferior mesenteric vein graft in replacing the esophagus with the right hemicolon. Surg Today 2010; 40: 578–82.
26 Morita M, Nakanoko T, Kubo N *et al*. Two-stage operation for high-risk patients with thoracic esophageal cancer: an old operation revisited. Ann Surg Oncol 2011; 18: 2613–21.
27 UICC International Union Against Cancer. TNM Classification of Malignant Tumors, 7th edn. New York: Wiley, 2009.
28 Schemper M, Smith T L. A note on quantifying follow-up in studies of failure time. Control Clin Trials 1996; 17: 343–6.
29 Morita M, Ikeda K, Sugiyama M *et al*. Repair using the pectoralis major muscle flap for anastomotic leakage after esophageal reconstruction via the subcutaneous route. Surgery 2010; 147: 212–18.
30 Nagawa H, Seto Y, Nakatsuka T, Kaizaki S, Muto T. Microvascular anastomosis for additional blood flow in reconstruction after intrathoracic esophageal carcinoma surgery. Am J Surg 1997; 173: 131–3.
31 Kono K, Sugai H, Omata H, Fujii H. Transient bloodletting of the short gastric vein in the reconstructed gastric tube improves gastric microcirculation during esophagectomy. World J Surg 2007; 31: 780–84.
32 Morita M, Yoshida R, Ikeda K *et al*. Acute lung injury following an esophagectomy for esophageal cancer, with special reference to the clinical factors and cytokine levels of peripheral blood and pleural drainage fluid. Dis Esophagus 2008; 21: 30–36.
33 Morita M, Masuda T, Okada S *et al*. Preoperative chemoradiotherapy for esophageal cancer: factors associated with clinical response and postoperative complications. Anticancer Res 2009; 29: 2555–62.