

# Relationship between the Incidence of Postoperative Fistula or Dysphagia and Resection Style, Gastric Tube Formation, and Irradiation following Free Jejunal Flap Transfer

Satoshi Onoda, PhD\*  
Masahito Kinoshita, MD\*  
Yukino Ariyoshi, MD†

**Background:** The purpose of this study was to examine the relationship between the incidence of dysphagia or fistula formation in an anastomotic region and factors such as extent of resection, gastric tube formation, and irradiation among patients who underwent free jejunal flap transfer.

**Methods:** We retrospectively examined 100 cases (88 men and 12 women; average age, 65.8 years; range, 46–88 years) in whom the evaluation of postoperative oral intake was possible after undergoing total pharyngo-laryngo-esophagectomy (TPLE) and free jejunal flap transfer. Chi-square test (with Fisher transformation, if necessary) was performed to analyze the relationship among resection styles (the resection margin extended to the oropharynx or to the cervical esophagus and gastric tube elevation), radiation therapy history, and incidence of dysphagia or fistula formation.

**Results:** One hundred patients were analyzed, and complications such as postoperative fistula and dysphagia occurred in 8 (8.0%) and 20 patients (20.0%), respectively. However, no significant correlation was found between various resection factors and fistula formation or adverse events. At the reconstruction site, other complications such as postoperative lymphorrhea (7%), postoperative hematoma (4%), trachea necrosis (4%), cervical flap necrosis (1%), and thyroid necrosis (1%) occurred. These complications were managed by a cervical open wound and additional minor operation as needed.

**Conclusion:** Thus, free jejunal transfer for TPLE is a good reconstruction technique with few complications and postoperative adverse events, regardless of the extent of resection and preoperative radiation therapy. (*Plast Reconstr Surg Glob Open* 2020;8:e2663; doi: [10.1097/GOX.0000000000002663](https://doi.org/10.1097/GOX.0000000000002663); Published online 26 February 2020.)

## INTRODUCTION

Total pharyngo-laryngo-esophagectomy (TPLE) and free jejunal flap transfer is one of the optional operative procedures for advanced hypopharyngeal, laryngeal, and

cervical esophageal cancers.<sup>1–5</sup> Regarding the free jejunal flap, vascular pedicles are relatively large, allowing for easy tubular reconstruction using the gastrointestinal tract. Moreover, the incidence of complications, such as fistula formation, is low, and the free jejunal flap is considered an excellent tissue for reconstruction. Therefore, many studies reported on the use of a free jejunal flap in postoperative monitoring,<sup>6–8</sup> vascular pedicles,<sup>9,10</sup> and salvage operation.<sup>11–16</sup> Moreover, free jejunal flap transfer is often used for patch-type reconstruction after hypopharyngeal segmental resection.<sup>17–19</sup> There are some large-scale studies on free jejunal flap transfer.<sup>4,5</sup> Major postoperative complications or adverse events after TPLE and free jejunal flap transfer include fistula formation in an anastomotic region and dysphagia.<sup>20</sup> Meanwhile, the resection area of TPLE extends to the deep part of the cervical esophagus or the oropharynx direction in some cases. In

From the \*Department of Plastic and Reconstructive Surgery, Kagawa Rosai Hospital, Kagawa, Japan; and †Department of Surgery, Takahashi Central Hospital, Okayama, Japan.

This work was supported by a grant from the Grants-in-Aid for Scientific Research (KAKENHI) program (grant no. 17K17016).

Received for publication November 6, 2019; accepted January 6, 2020.

Copyright © 2020 The Authors. Published by Wolters Kluwer Health, Inc. on behalf of The American Society of Plastic Surgeons. This is an open-access article distributed under the terms of the [Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 \(CCBY-NC-ND\)](https://creativecommons.org/licenses/by-nc-nd/4.0/), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

DOI: [10.1097/GOX.0000000000002663](https://doi.org/10.1097/GOX.0000000000002663)

**Disclosure:** The authors have no financial interest to declare in relation to the content of this article.

patients with the cephalad resection margin extended to the oropharynx or gastric tube formation, a food passage may be obstructed due to traction for jejunum. However, the relationship between postoperative function and the extent of resection is unknown.<sup>21–23</sup>

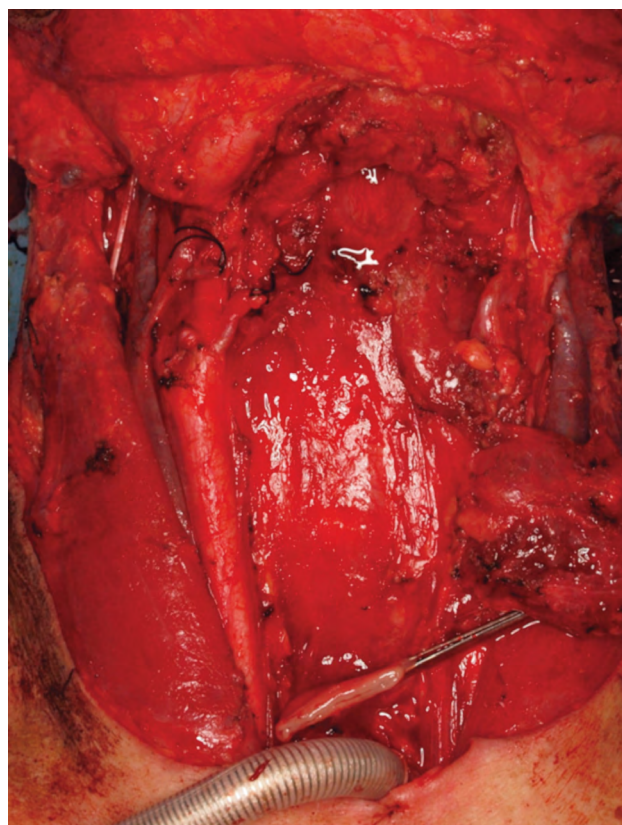
There is no report on the relationship between incidence of postoperative fistula formation or dysphagia and extent of resection and irradiation when the range of resection is extended to the oral region and/or to the deep part of the cervical esophagus. Because transferred flaps such as the free jejunal flap or the fasciocutaneous flap do not have normal perception, passage disorder and food reflux to the nasal cavity are concerns when free flap is transferred broadly to the oral cavity and/or deep part of the cervical esophagus.<sup>24</sup> The purpose of this study was to examine the relationship between the incidence of dysphagia or fistula formation in an anastomotic region and factors, such as extent of resection, gastric tube formation, and irradiation, among patients who underwent free jejunal flap transfer.

### PATIENTS AND METHODS

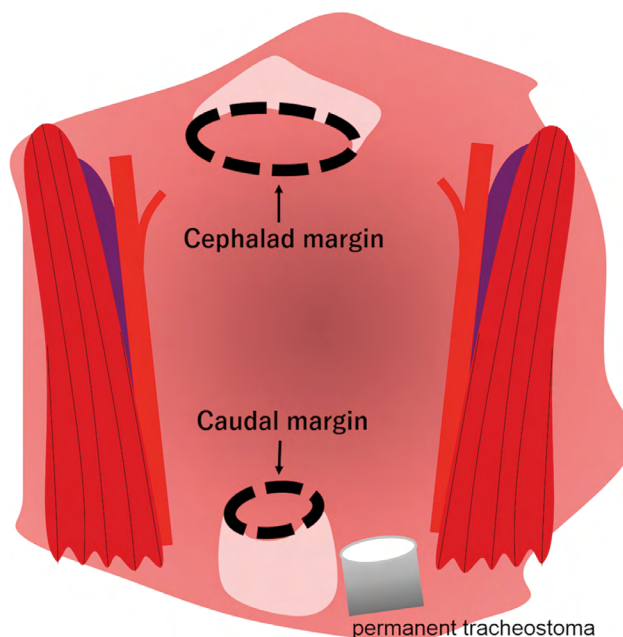
After 2005, we retrospectively examined 100 cases (88 men and 12 women; average age, 65.8 years; range, 46–88 years) in whom the evaluation of postoperative oral intake was possible after undergoing TPLE and free jejunal flap transfer. The primary diseases were hypopharyngeal cancer (n = 57), cervical esophageal cancer (n = 25), laryngeal cancer (n = 5), oropharyngeal cancer (n = 4), thyroid cancer (n = 2), and others (n = 7). With respect to the tumor stage of all 74 cases except the recurrence cases and nontumor cases, stage I was noted in 3 cases, stage II in 8 cases, stage III in 24 cases, stage IVa in 35 cases, stage IVb in 2 cases, and stage IVc in 2 cases. We conducted the pipe-formed gastrointestinal reconstruction from the pharynx to the cervical esophagus by free jejunal flap transfer.

#### Surgical Technique

After tumor resection, we confirmed the margin of the cephalad and caudal sides (Figs. 1, 2). We examined the state of the recipient vessels and determined which blood vessels to use. The superior thyroid artery, transverse cervical artery, internal jugular vein, and external jugular vein were primarily used. We harvested about 20 cm of the jejunum with the second jejunum artery and vein as vascular pedicle and determined the cephalad anastomotic point to ensure that a vascular pedicle of the jejunum is located near the recipient vessels. We resected the mesentery to an anastomotic region and resected surplus intestinal tract. Initially, we performed cephalad gastrointestinal anastomosis. The length of the transferred jejunum was 50%–60% of the deficiency length from the cephalad to the caudal margins. We made the monitoring jejunum (Fig. 3). Next, we conducted microvascular anastomosis. After blood flow restoration, the jejunal length was increased to match the deficiency length. Finally, we coated the anastomosed portion using mesentery, which remained and formed a permanent tracheal stoma before wound closure (Fig. 4). A jejunum harvest was

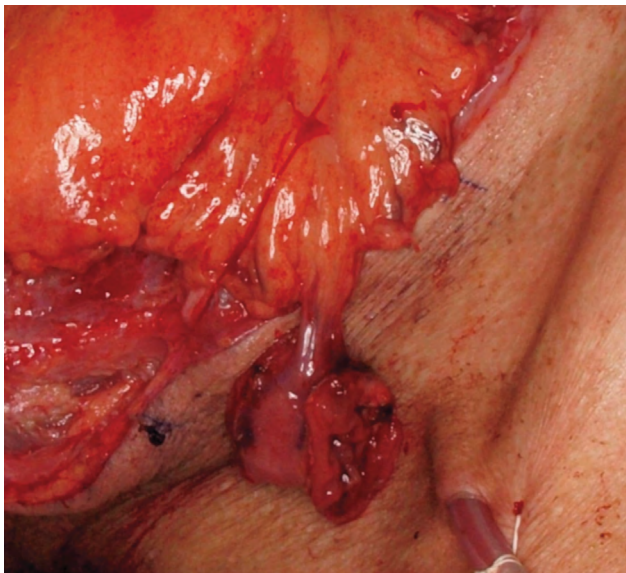


**Fig. 1.** Intraoperative photograph after tumor resection. The resection margin of the cephalad caudal side was the usual area of TPLE. The superficial thyroid artery and internal jugular vein were used as recipient vessels.

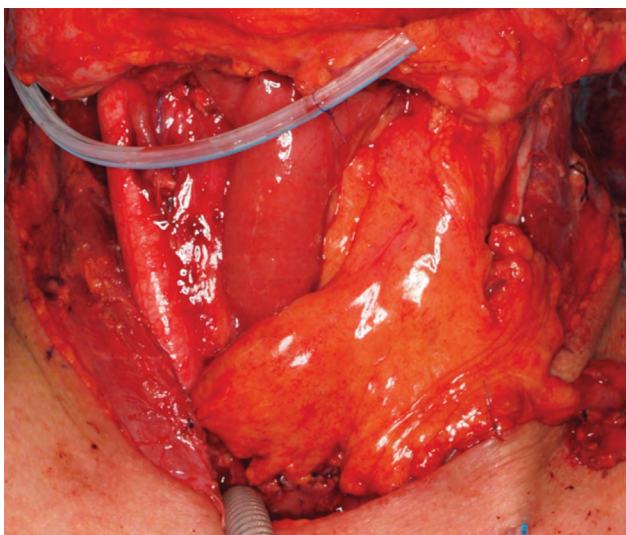


**Fig. 2.** The diagram of TPLE.

performed by general surgeons. The ischemic interval was approximately 2 hours. It takes approximately 2 hours 30 minutes to 3 hours from the intestinal anastomosis to



**Fig. 3.** Monitoring flap. After confirming jejunum circulation, we resected it about 1 week later.



**Fig. 4.** Intraoperative photograph after intestinal and microvascular anastomoses. The transferred jejunum had almost the same length as that of the deficient part, and it was good. And distal anastomosis department was coated using the mesentery which remained.

wound area closure. We performed an esophagram in all cases and confirmed the presence or absence of fistula formation and dysphagia. Patients started ingesting food after the esophagram.

We defined the following factors in relation to tumor resection: the cephalad resection margin extended to the oropharynx—cases in which resection was extended beyond the lower pole of the tonsil due to tumor invasion; the caudal resection margin extended to the cervical esophagus—cases in which resection was extended below the upper end of the episternum due to tumor invasion; gastric tube in patients—patients who underwent gastric tube elevation because of esophageal cancer in previous or

the current surgery; and radiation therapy—patients with a history of radiation therapy. Moreover, we defined dysphagia as stagnation of food despite multiple attempts of swallowing from the time of hospitalization to follow-up in the outpatient department. Fistula formation was defined as formation of a fistula between the oropharynx and the skin in the cephalad or caudal anastomotic region.

#### Statistical Analysis

Chi-square test (with Fisher transformation, if necessary) was performed to analyze the relationship among resection styles (the resection margin extended to the oropharynx or to the cervical esophagus and gastric tube elevation), radiation therapy history, and incidence of dysphagia or fistula formation. A *P* value of <0.05 was considered to indicate statistical significance.

### RESULTS

Out of the 100 patients analyzed, 18 (18%) had the cephalad resection margin extended to the oropharynx. Eleven patients (11%) had the caudal resection margin extended to the cervical esophagus [of these, 3 patients (3%) underwent mechanical anastomosis]. Sixteen patients (16%) had gastric tube elevation. Twenty-eight patients (28%) had a history of radiation therapy. One patient presented with necrosis of the jejunum due to postoperative thrombosis of the anastomotic area. This case underwent repeated jejunum transfer, and the flap survived. In contrast, complications such as postoperative fistula and dysphagia occurred in 8 (8%) and 20 patients (20%), respectively. In one patient who developed a fistula, we removed the transferred jejunum and performed a secondary free jejunum transfer. At the reconstruction site, other complications such as postoperative lymphorrhea (7%), postoperative hematoma (4%), trachea necrosis (4%), cervical flap necrosis (1%), and thyroid necrosis (1%) occurred. These complications were managed by a cervical open wound and additional minor operation as needed. At the donor site, no major complication associated with jejunum harvesting occurred in any of the cases. The jejunum harvesting was performed simultaneously with the resection of tumor, and the procedural time was 1 hour; the total operative time was usually in the range of 6–8 hours. The follow-up period was from 8 months to 12 years.

Among the cephalad resection margin extended cases, incidence of fistula formation was 0 out of 18 cases (0%) and incidence of dysphagia was 4 out of 18 cases (22%). Among the caudal resection margin extended cases, incidence of fistula formation was 1 out of 11 cases (9%) and incidence of dysphagia was 5 out of 11 cases (45%). Among the gastric tube formation cases, incidence of fistula formation was 1 out of 16 cases (6%) and incidence of dysphagia was 7 out of 16 cases (44%). Among the radiation therapy cases, incidence of fistula formation was 1 out of 28 cases (4%) and incidence of dysphagia was 4 out of 28 cases (14%).

The *P* values for the association between cephalad resection margin extending to the oropharynx and fistula

formation, 0.22; cephalad resection margin extending to the oropharynx and dysphagia, 0.55; caudal resection margin extending to the cervical esophagus and fistula formation, 0.62; caudal resection margin extending to the cervical esophagus and dysphagia, 0.48; gastric tube formation and fistula formation, 0.63; gastric tube formation and dysphagia, 0.17; radiation therapy and fistula formation, 0.31; radiation therapy and dysphagia, 0.55. (Table 1). No significant correlation was found between various resection factors and fistula formation or adverse events.

### DISCUSSION

When TPLE is performed, breathing is carried out using the external tracheal stoma made in the upper sternum. On the contrary, gastrointestinal cephalad margin is resected at the level of the vallecula, and the caudal margin is usually above the sternum. For reconstruction materials after TPLE, the anterolateral thigh flap may be used instead of free jejunal flap. However, few articles have reported its postoperative outcomes. In this study, free jejunal flap transfer provided excellent reconstruction material with good postoperative outcomes in patients with extensive resection owing to tumor invasion. However, the free jejunal flap is more vulnerable to ischemia than the rectus abdominis myocutaneous flap or anterolateral thigh flap. Therefore, it is necessary to maintain a short ischemic interval as much as possible. Regarding the defect after TPLE, the diameter of gastrointestinal cephalad anastomotic side is wide and the caudal anastomotic side is narrow. As compared with the diameter of the transferred jejunum, the jejunum should be vertically cut to increase its diameter. The jejunal diameter is similar to that of the cervical esophagus and can be easily anastomosed circumferentially.<sup>25</sup> Regarding anastomosis style, after regulating the difference in diameter, end-to-end anastomosis is the first method of choice. Meanwhile, end-to-side anastomosis allows food to remain inside the transferred jejunum. Regarding the tension of the transferred jejunum, intestinal meandering is prevented by using higher tension and aiming at good food passage.

Regarding the anastomotic region of the caudal side, passage disorder was considered. In cases in whom the

cephalad resection margin was extended to the oropharynx, nasal reflux of food was expected not only because the cephalad anastomotic side was wider but also because the transferred jejunum did not have normal perception. However, no significant correlation was found in this study between the incidence rate of nasal reflux of food and cases of extension of the cephalad resection margin to the oropharynx.

The fistula develops owing to problems in suturing or with increase in gastrointestinal pressure. When the resection margin is in a lower part, a stenosis secondary to the downward pull of the anastomotic region, and increase in gastrointestinal is considered. However, no significant difference was found between anastomosis position and dysphagia or fistula formation in this study.

In most cases of hypopharyngeal and cervical esophageal cancers, the usual primary histopathology was squamous cell carcinoma, which was treated with radiotherapy or chemotherapy. Additionally, this region is common in multiple primary cancers of the esophagus comprising the gastric tube. The incidence rate of adverse events and postoperative complications was not significant in radiation therapy or in gastric tube cases.<sup>26</sup> The elevation of the gastric tube was roughly classified into three routes: (1) the posterior mediastinal course, which was physiologic but difficult to deal with in case of complications; (2) the retrosternal route; and (3) the subcutaneous course, which had the longest distance. For free jejunal flap transfer in high-risk cases, the subcutaneous course is often chosen because it is easy to deal with in case of complications, such as fistula in an anastomotic region of the gastrointestinal tract. In this series, most cases underwent gastric tube elevation through the subcutaneous course. When gastric tube elevation of the subcutaneous course was performed, the course of gastric tube was steep and it was bent on the part where the subcutaneous gastric tube shifts to the abdominal cavity near the hypochondrium, making it susceptible to external pressure.<sup>27</sup> It results in high pressure of the gastric tube and the upper part of the transferred jejunum, predisposing to easy fistula formation in the gastrointestinal anastomotic region and dysphagia. In three patients who developed fistula in this series, we used surplus mesenterium to coat an anastomotic region on the

**Table 1. Relationship between Resection Styles and Dysphagia or Fistula Formation**

<b>Cephalad Margin</b>			
<b>Factors</b>	<b>Cephalad Margin Cases (n = 18), n (%)</b>	<b>Non-Cephalad Margin Cases (n = 82), n (%)</b>	<b>P</b>
Fistula	0/18 (0)	8/82 (9.8)	0.22
Dysphagia	4/18 (22.2)	16/82 (19.5)	0.55
<b>Anal Margin</b>			
<b>Factors</b>	<b>Anal Margin Cases (n = 11), n (%)</b>	<b>Non-Anal Margin Cases (n = 89), n (%)</b>	<b>P</b>
Fistula	1/11 (9.1)	7/89 (7.4)	0.62
Dysphagia	5/11 (45.5)	15/89 (16.9)	0.48
<b>Gastric Tube Formation</b>			
<b>Factors</b>	<b>Gastric Tube Formation Cases (n = 16), n (%)</b>	<b>Non-Gastric Tube Formation cases (n = 84), n (%)</b>	<b>P</b>
Fistula	1/16 (6.3)	7/84 (8.3)	0.63
Dysphagia	7/16 (43.8)	13/84 (15.5)	0.17
<b>Radiation Therapy</b>			
<b>Factors</b>	<b>Radiation Therapy Cases (n = 28), n (%)</b>	<b>Non-Radiation Therapy Cases (n = 72), n (%)</b>	<b>P</b>
Fistula	1/28 (3.6)	7/72 (9.7)	0.31
Dysphagia	4/28 (14.3)	16/72 (22.2)	0.55

Cephalad margin: the cephalad resection margin extended to the oropharynx. Anal margin: the anal resection margin extended to the cervical esophagus.

cephalad and caudal sides as much as possible. However, a fistula formed on the part that we were not able to coat due to mesenteric deficiency. For these high-risk cases, mesenteric coating of both the top and bottom anastomotic regions might be effective in the future by obtaining a jejunal length of about 30 cm.

The limitations of this study include its retrospective design and the difficulty of accurate evaluation of dysphagia owing to the shortage of data and test results. Moreover, the lack of a significant difference might be attributed to the small sample size. Future prospective studies of patients who underwent TPLE and free jejunal flap transfer, including a multivariate analysis of the risk factors, are needed.

### CONCLUSIONS

Our results suggested that the extent of the resection does not affect the postoperative complication and adverse event rates. Thus, the free jejunum is a good reconstruction technique for TPLE and demonstrates few complications and postoperative adverse events, regardless of the extent of resection and preoperative radiation therapy.

Satoshi Onoda, MD

Department of Plastic and Reconstructive Surgery  
Kagawa Rosai Hospital  
3-3-1 Joto-cho, Marugame  
Kagawa, Japan 763-8502  
E-mail: satoshiprs18@gmail.com

### ACKNOWLEDGMENT

The authors gratefully acknowledge the support of Yoshihiro Kimata (Okayama University), without which this study could not have been completed.

### REFERENCES

- Seidenberg B, Rosenak SS, Hurwitt ES, et al. Immediate reconstruction of the cervical esophagus by a revascularized isolated jejunal segment. *Ann Surg.* 1959;149:162–171.
- McKee DM, Peters CR. Reconstruction of the hypopharynx and cervical esophagus with microvascular jejunal transplant. *Clin Plast Surg.* 1978;5:305–312.
- Sarukawa S, Sakuraba M, Kimata Y, et al. Standardization of free jejunum transfer after total pharyngolaryngoesophagectomy. *Laryngoscope.* 2006;116:976–981.
- Sugiyama N, Takao S, Suzuki E, et al. Risk factors for wound complications in head and neck reconstruction: 773 free jejunal reconstruction procedures after total pharyngolaryngoesophagectomy. *Head Neck.* 2017;39:2057–2069.
- Sugiyama N, Takao S, Suzuki E, et al. Risk factors of thrombosis in a single method of microsurgical head and neck reconstruction: a multi-institutional study of 773 reconstructions with a free jejunal graft after total pharyngolaryngoesophagectomy for hypopharyngeal cancer. *Head Neck.* 2016;38:1688–1694.
- Sakurai H, Nozaki M, Takeuchi M, et al. Monitoring the changes in intraparenchymatous venous pressure to ascertain flap viability. *Plast Reconstr Surg.* 2007;119:2111–2117.
- Katsaros J, Banis JC, Acland RD, et al. Monitoring free vascularized jejunum grafts. *Br J Plast Surg.* 1985;38:220–222.
- Bafitis H, Stallings JO, Ban J. A reliable method for monitoring the microvascular patency of free jejunal transfers in reconstructing the pharynx and cervical esophagus. *Plast Reconstr Surg.* 1989;83:896–898.
- Kurita T, Kubo T, Tashima H, et al. Free jejunal flap transfer with multiple vascular pedicles for safe and reliable pharyngoesophageal reconstruction. *Head Neck.* 2018;40:2210–2218.
- Maier A, Pinter H, Tomaselli F, et al. Retrosternal pedicled jejunum interposition: an alternative for reconstruction after total esophago-gastrectomy. *Eur J Cardiothorac Surg.* 2002;22:661–665.
- Onoda S, Kimata Y, Yamada K, et al. The best salvage operation method after total necrosis of a free jejunal graft? Transfer of a second free jejunal graft. *J Plast Reconstr Aesthet Surg.* 2011;64:1030–1034.
- Onoda S, Kimata Y, Yamada K, et al. Non-occlusive mesenteric ischaemia of a free jejunal flap. *J Plast Reconstr Aesthet Surg.* 2013;66:e133–e136.
- Bertino G, Benazzo M, Occhini A, et al. Reconstruction of the hypopharynx after free jejunum flap failure: is a second free jejunum transfer feasible? *Oral Oncol.* 2008;44:61–64.
- Keereweer S, Sewnaik A, Kerrebijn J, et al. Salvage or what follows the failure of a free jejunum transfer for reconstruction of the hypopharynx? *J Plast Reconstr Aesthet Surg.* 2010;63:976–980.
- Oki M, Asato H, Suzuki Y, et al. Salvage reconstruction of the oesophagus: a retrospective study of 15 cases. *J Plast Reconstr Aesthet Surg.* 2010;63:589–597.
- Miyamoto S, Sakuraba M, Nagamatsu S, et al. Salvage total pharyngolaryngectomy and free jejunum transfer. *Laryngoscope.* 2011;121:947–951.
- Miyamoto S, Sakuraba M, Asano T, et al. Free jejunal patch graft for reconstruction after partial hypopharyngectomy with laryngeal preservation. *Arch Otolaryngol Head Neck Surg.* 2011;137:181–186.
- Kadota H, Sakuraba M, Kimata Y, et al. Larynx-preserving esophagectomy and jejunal transfer for cervical esophageal carcinoma. *Laryngoscope.* 2009;119:1274–1280.
- Nakatsuka T, Harii K, Ueda K, et al. Preservation of the larynx after resection of a carcinoma of the posterior wall of the hypopharynx: versatility of a free flap patch graft. *Head Neck.* 1997;19:137–142.
- Fujiki M, Miyamoto S, Hayashi R, et al. Evaluation of routine contrast swallow following total pharyngolaryngectomy and free jejunal transfer. *Laryngoscope.* 2015;125:2280–2283.
- Panhofer P, Springer C, Izay B, et al. Influence of resection extent on morbidity in surgery for squamous cell cancer at the pharyngoesophageal junction. *Langenbecks Arch Surg.* 2013;398:221–230.
- Bussi M, Ferrero V, Riontino E, et al. Problems in reconstructive surgery in the treatment of carcinoma of the hypopharyngoesophageal junction. *J Surg Oncol.* 2000;74:130–133.
- Suzuki S, Yasunaga H, Matsui H, et al. Postoperative mechanical bowel obstruction after pharyngolaryngectomy for hypopharyngeal cancer: retrospective analysis using a Japanese inpatient database. *Head Neck.* 2018;40:1548–1554.
- Yu P, Lewin JS, Reece GP, et al. Comparison of clinical and functional outcomes and hospital costs following pharyngoesophageal reconstruction with the anterolateral thigh free flap versus the jejunal flap. *Plast Reconstr Surg.* 2006;117:968–974.
- Chen HC, Rampazzo A, Gharb BB, et al. Motility differences in free colon and free jejunum flaps for reconstruction of the cervical esophagus. *Plast Reconstr Surg.* 2008;122:1410–1416.
- Onoda S, Kimata Y, Sugiyama N, et al. Effects of radiation therapy on postoperative complications and adverse events in patients with head and neck reconstruction with flaps. *Microsurgery.* 2014;34:516–521.
- Onoda S, Kimata Y, Koshimune S, et al. Salvage operation using free vascularized tissue transfer to treat esophageal conduit necrosis. *Plast Reconstr Surg.* 2013;131:460e–461e.