INTRODUCTION

Free jejunal transfer is widely accepted as a gold standard for cervical esophageal reconstruction because the conduit is physiologically reconstructed with well-vascularized mucosa, leading to a lower rate of fistula formation. However, despite the high success rate of initial free jejunal transfer, once vascular thrombosis occurs, the salvage of failing flap with reanastomosis is difficult. In such cases, normal gut flora may cause severe infection associated with a risk of potential life-threatening complications. When the jejunal flap is completely buried, the discovery of possible necrosis could be delayed significantly, especially in the case of arterial thrombosis. Moreover, this delay in the detection of vascular thrombosis and the susceptibility of ischemia cause irreversible damage to the jejunal flap. Onoda et al. reported that secondary free jejunal flap after failed initial transfer is ideal as long as locoregional infection is controlled. However, in the case of delayed reexploration after necrosis,
the jejunal transfer technique carries a huge risk because of the lack of adequate recipient vessels, severe neck infection, and compromised general condition.10 Previously, the authors successfully performed secondary free jejunal transfer in a case of vascular thrombosis developed after free-jejunal-flap transfer. However, in that patient, because of the early detection of thrombosis at the anastomotic site, secondary free jejunal flap was performed before the infection of surrounding tissues and onset of severe necrosis. Although the literature historically and extensively describes locoregional flaps for the reconstruction of the cervical esophagus, no reports regarding pedicled flaps similar to that in this study in salvage situations after free jejunum flap necrosis were found.10–12 This study described

**Fig. 1.** Schematic illustration of the combined pedicled flap technique. Pink ellipses indicate the external fistula on the pharyngeal side, yellow ellipses indicate the external fistula on the esophageal side, and white indicates the tracheal stoma.
a combined deltopectoral (DP) and pectoralis major musculocutaneous (PMMC) flap 2-step technique for the reconstruction of the cervical esophagus after free-jejunal-flap necrosis with illustrations and clinical cases.

**OPERATIVE PROCEDURE**

Clinical signs of jejunal necrosis such as oral bleeding, salivary gland fistulae, and the inflammation of the cervical skin alerted surgeons to evaluate them as soon as possible. Free-jejunal-flap necrosis coexisting with arterial or venous thrombosis required the debridement of necrotic and infected tissue, a hole was made for the external fistula in the cervical skin, and a DP flap was fashioned (Fig. 1A). Next, an external fistula was made on the pharyngeal side through the hole in the cervical skin. Single or double DP flaps were harvested for constructing an esophageal external fistula and a tracheal stoma, and the respective donor sites were grafted with autologous skin or artificial dermis (Fig. 1B). Choice of using either a single or double DP flap was made by patient’s body shape, especially chest width, and the presence of scars from other surgeries. In addition, for managing DP flap donor sites, either a skin graft or artificial dermis was selected by the thickness of skin. Considering the age and nutritional statuses of patient, the flap donor sites with thick skin are treated with 1-step skin grafting, and the sites with thin skin were treated by 2-step surgery with an initial artificial dermis grafting and secondary skin grafting.

Subsequently, after the complete primary healing of all suture wounds, a hinge flap was designed and elevated for the posterior pharyngeal wall. If the region of the DP flap graft including the pharyngeal and esophageal fistulae had no ulceration or contracture, the wide hinge flap was elevated and used to make a rolled flap, which was used to reconstruct the full circumferential defect of the neck of the esophagus (Fig. 1C). Finally, PMMC flap was harvested from either the left or right anterior chest wall and used to reconstruct the cervical surface defect or anterior pharyngeal wall (Fig. 1D).

**CLINICAL CASES**

The present technique was applied to cervical esophageal reconstruction after free-jejunal-flap necrosis in 5 patients (all males; mean age, 73.4 years; age range, 62–84 years), and tumor sites were the hypopharynx in 4 patients and the larynx in 1 patient, who were admitted in Tokyo Women’s Medical University Hospital and related facilities (Table 1). At the authors’ institution, cervical esophageal reconstruction with free jejunal flaps is mainly performed by the departments of head and neck surgery, and gastrointestinal surgery, and both departments also undertake postoperative management including dietary requirements and blood flow monitoring by their own protocols. The authors’ plastic and reconstructive surgery department performs 2-step surgery for reconstruction of the cervical esophagus, as shown in this study, upon the request of salvage surgery for patients suspected of having jejunal necrosis. Step 1 surgery was performed at an average of 10 days after primary free-jejunal-flap transfer. Oral intake was resumed in all cases at an average of 117 days after final reconstructive step 2 surgery, and the average duration of hospital stay was 163 days. No complications such as esophageal stricture were found during a follow-up period of 6 months postoperatively.

**Case 1**

An 84-year-old man underwent total laryngectomy for laryngeal cancer, and at 1.5 years after the primary surgery, esophageal stenosis was repaired with a free jejunal flap. Eleven days after the transfer procedure, necrosis due to vascular thrombosis was observed (Fig. 2A). External fistula on the pharyngeal side was constructed with the hole in the cervical skin (Fig. 2B), and double DP flaps were harvested and used for the esophageal fistula and tracheal stoma (Fig. 2C). Two months after the step 1 surgery, the pharyngeal fistula was able to facilitate saliva flow from the oral cavity, and the esophageal fistula was able to prevent the spillage of mucus from the esophagus into the tracheal stoma (Fig. 2D). The inflammation of cervical skin improved, and the condition of skin allowed adequate skin-mucosal apposition to be performed for the safety of the next step. A wide hinge flap was elevated and used to construct a rolled flap (Fig. 2E). PMMC fashioned from the right chest region was used to reconstruct the cervical surface defect (Fig. 2F, G). One year after the 2-step surgery (Fig. 2H), there were no complications, and a good swallowing function was confirmed by videofluorography (see video, Supplemental Digital Content 1, which displays a videofluorography of the patient in case 1 at 1 year after 2-step surgery, [http://links.lww.com/PRSGO/A502](http://links.lww.com/PRSGO/A502)). In terms of aesthetics, disfiguring scars appeared on the chest due to the harvesting of DP and PMMC flaps.

**Case 2**

A 78-year-old man underwent total pharyngolaryngo-esophagectomy with free jejunal flap for hypopharyngeal cancer. Jejunal necrosis was observed due to abscess formation 23 days later (Fig. 3A). Because of the small dimensions of the damaged cervical area, a single DP flap was harvested, and used to construct an esophageal fistula

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**Table 1. Clinical Data of 5 Patients Who Were Treated by the Present Technique**

| Age (y) | Tumor Location | Stage | Onset of Failure after Surgery (d) | Clinical Signs of Failure | Interval between Reoperation and Oral Intake (d) | Total Hospital Stay (d) |
|---------|----------------|-------|----------------------------------|--------------------------|-----------------------------------------------|------------------------|
| 84      | Larynx         | T2N0M0| 11                               | Septic shock             | 106                                           | 133                    |
| 66      | Hypopharynx    | T3N2aM0| 4                                | Oral bleeding            | 87                                            | 144                    |
| 71      | Hypopharynx    | T3N2bM0| 23                               | Abscess                  | 181                                           | 210                    |
| 62      | Hypopharynx    | T2N2cM0| 11                               | Abscess                  | 100                                           | 180                    |
| 84      | Hypopharynx    | T4aN2aM0| 2                                | Putrid smell             | 114                                           | 146                    |
and a tracheal stoma (Fig. 3B). One month after the step 1 surgery, a hinge flap was elevated for the posterior pharyngeal wall, PMMC was used to reconstruct the anterior pharyngeal wall (Fig. 3C), and the autologous skin graft was applied to all raw surfaces (Fig. 3D). There were no complications after the step 2 surgery, and the patient was transferred to another hospital for postoperative adjuvant therapy and dysphagia rehabilitation.

**DISCUSSION**

External fistula formation and pedicled skin-flap combination salvage after free jejunal-flap necrosis have been described by several authors. Okazaki et al. recommend that if general conditions do not permit further free flap transfer, a pedicled flap should be considered. Bertino et al. stated that in the presence of infection, secondary reconstruction with a PMMC flap is a good choice for reducing the risk of repeated failure. Although the present technique resulted in a good outcome by the 2-step surgery, this study identified 2 major areas of focus for improvement, safety, and reliability. For achieving safety, the primary healing of the pharyngeal and esophageal fistulae was needed within the skin-mucosa junction as soon as possible without ulceration because the healing was crucial (1) for managing saliva and mucus, (2) for safe wound closure and the prevention of wound infection, and (3) for regulating the condition of the recipient skin for the next surgery. Regarding the reliability, with considering the spatial relationship between donor sites, the pedicled flaps were used primarily as DP flaps and secondarily as PMMC flaps for easily achieving an efficient reconstruction.

In addition, the present technique had the following 3 major advantages over other procedures: (1) no abdominal surgery is required for harvesting the second free jejunal flap, (2) the loss of the second free jejunal flap by arterial and venous thromboses in microvascular anastomoses is very unlikely, and (3) the surgery probably could still be performed despite inflammation due to the severe infection of the site or lack of suitable recipient vessels for free tissue transfer. When patients develop inflammation in the surgical site of the neck region, as a complication of free-jejunal-flap necrosis, due to infection by normal gut flora in mucosal fluid leaked through (1) an opening at the mucosal anastomotic site or (2) a fistula formed in the intestinal wall, surgeons should decide to perform 2-step surgery for safety reasons because reconstruction with 1 stage secondary jejunal flap including free radial forearm or free ALT flap is associated with a risk of developing infection accompanied by postoperative fistula formation. In contrast, the technique had some disadvantages such as (1) delayed adjuvant treatments, including

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**Fig. 2.** Case 1: an 84-year-old man who underwent total laryngectomy for laryngeal cancer. His esophageal stenosis was repaired with free jejunal flap. Jejunal necrosis was detected at 11 days after transfer (A). External fistula on the pharyngeal side was constructed with the hole in the cervical skin (B), and double DP flaps were harvested and used for the esophageal external fistula and tracheal stoma (C). Two months after the step 1 surgery (D), wide hinge flap was elevated and used for a rolled flap (E). PMMC flap was used to reconstruct cervical surface defect (F and G). No complications were found at 1 year after the 2-step surgery (H).

**Video Graphic 1.** See video, Supplemental Digital Content 1, which displays a videofluorography of the patient in case 1 at 1 year after 2-step surgery. A good swallowing function was confirmed by videofluorography, [http://links.lww.com/PRSGO/A502](http://links.lww.com/PRSGO/A502).
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chemo- and radiation therapy, by secondary closure after external fistula formation, (2) delayed postoperative recovery of eating function often requiring prolonged hospitalization, and (3) reconstruction requires 2- or 3-step surgeries. These are the huge drawbacks of secondary jejunal flap and other free flaps constructed by 1-step surgery. Moreover, implantable Doppler monitors that have high sensitivity and specificity for buried free flap such as free jejunal flap and are routinely used in countries other than Japan are unapproved for clinical use in Japan, and this reason contributes to long delays in detecting jejunal necrosis.

In view of these disadvantages, (1) establishing a more effective monitoring method, such as an intraparenchymatous venous-pressure monitoring system, to avoid free jejunal-flap necrosis, (2) a clinical environment that allows the patient to be taken back to the operating room quickly, and (3) coordination and communication among members of the microsurgical team are essential to ensure optimal outcome in the reconstructed head and neck patient.

**CONCLUSIONS**

The combined DP and PMMC flap technique was useful for reconstructing the cervical esophagus after free-jejunum-flap necrosis. The present technique will be employed in treating patients who have late detection of jejunal necrosis with surgical-site infection.

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