



Salvage Surgery for Jejunal Necrosis After a Free Jejunal Transfer

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ABSTRACT

Introduction. Given the few reports regarding the salvage methods for managing jejunal necrosis, finding candidates for a meta-analysis or systematic review is difficult. Thus, this study aimed to describe the interventions for jejunal necrosis and investigate important points relating to this condition.

Methods. The interventions used to treat free jejunal necrosis are external fistula formation with jejunal debridement, secondary reconstruction of the local site, and overall status improvement, and re-free jejunal transfer with removal of the necrotic jejunum. Selecting the optimal procedure for each patient depends on the following factors. First, patients must have a good overall status to be able to endure re-free jejunal transfer, and next, the procedure is also dependent on local factors, including the intensity of the infections of the postoperative wound.

Results. One of the most common factors of jejunal necrosis is necrosis due to blood flow deficiency of the transferred tissue. However, among jejunal necrotic cases, some patients had no blood circulation disorder. We inferred that a non-occlusive mesenteric ischemia like occurred in the transferred jejunum, and also considered patients' overall status and necrotic association. Thus, patients who underwent re-free jejunal transfer are at an increased risk of experiencing re-necrosis. Based on these findings, we designed a jejunal necrosis algorithm.

Conclusions. Early debridement and re-free jejunal transfer are optimal treatment options for patients with early-stage jejunal necrosis. Because re-jejunum transfer is a possible state after necrosis, it was thought that coping

was the most important aspect of detection at an early stage.

The free jejunum, used in gastrointestinal reconstruction, is a very excellent reconstruction tool^{1–3} that is used in many reconstruction types, such as reconstruction after resection of total pharyngo-laryngo-esophagectomy, salvage surgery for gastric conduit necrosis after esophageal reconstruction, and defect of the cervical and thoracic gastrointestinal tract, among others. These reconstruction techniques are difficult to perform by using only a pedicle graft or pedicle intestine. In addition, the free jejunal transfer is also applied in various forms and sites, such as patch-formed reconstruction for partial deficiency of the pharynx.^{4–8} The free jejunal transfer has various advantages: (1) few postoperative complications, such as fistula formation of the anastomosis site that acts as a physiological reconstruction of the digestive tract to avoid postoperative wound infection; (2) the omentum, with a rich blood flow, is used for filling dead space; and (3) a jejunum diameter similar to that of the cervical or thoracic intestine, allowing ease of anastomosis during reconstruction of the neck or chest. On the other hand, the free jejunal transfer also has the following disadvantages: (1) it requires a laparotomy; and (2) may lead to severe infections caused by the resident flora in cases wherein there is jejunal necrosis due to a blood circulation disorder. Of these, jejunal necrosis is the most severe complication of free jejunal transfer, and, in case of onset, an immediate intervention is necessary.

Given the few reports available regarding salvage methods for managing jejunal necrosis, finding candidates for a meta-analysis or systematic review is difficult.^{8–12} Moreover, the spread of infection to the neck or chest region due to jejunal necrosis is life-threatening as this may lead to rupture of the carotid artery and development of refractory complications, such as fistula formation between

the trachea and the esophagus.¹³ Thus, this study aimed to describe the interventions for jejunal necrosis and investigate important points relating to this condition.

INTERVENTION FOR JEJUNAL NECROSIS

The interventions used to treat free jejunal necrosis are (1) external fistula formation with jejunal debridement, secondary reconstruction of the local site, and overall status improvement; and (2) re-free jejunal transfer with removal of the necrotic jejunum.

We reported 600 free jejunal transfer cases after hypopharyngeal cancer or esophagus cancer resection and reconstruction for esophageal conduit necrosis in the past, and examined the salvage procedure for free jejunal necrosis. Five immediate re-jejunal transfer cases and six external fistula formation cases were compared in terms of time of first oral intake and duration of in-hospitalization days.¹⁴ Oral intake initiation was possible in all cases in the re-jejunum transfer group, with an average time of first oral intake of 20.4 days (range 14–26).

On the other hand, oral intake initiation was possible in only three cases in the fistula formation group, and the time of first oral intake was at least 2 months after the salvage operation. The other three patients died due to tumor recurrence before complete postoperative wound healing. The average days of in-hospital stay was 210 days. Bertino et al.¹⁵ reported on reconstruction of the hypopharynx after free jejunal flap failure. For three cases with possible necrotic tissues, which were detected early, patients underwent re-free jejunal transfer to secure the recipient's blood vessel and avoid infection of the wounded area; these patients obtained a good postoperative course, whereas two cases salvaged using the pectoralis major myocutaneous flap had fistula postoperatively.

Generally, in cases with jejunal necrosis managed with external fistula formation, which becomes the secondary reconstructive operation, patients' overall status was improved. Patients were unable to ingest anything during this period, hence ptyalism in the oral side of the intestinal defect is necessary. During this period, some cases experience tumor recurrence at the local site, or distant metastasis without complete healing of the postoperative wound. In addition, delayed wound healing of the postoperative area also delays the initiation of additional treatment, such as postoperative radiotherapy or chemotherapy. Therefore, it is thought the optimal salvage method for free jejunal necrosis is debridement of the necrotic jejunum with re-free jejunal transfer to achieve good prognosis, shorten the duration of wound healing, and improve patients' quality of life.

SELECTION OF THE OPERATION PROCEDURE

There are several treatments for free jejunal necrosis, including free jejunal transfer, free flap reconstruction (anterolateral thigh flap), pedicled flap reconstruction (pectoralis major myocutaneous flap), fistula formation, and negative-pressure wound therapy. Of these, re-free jejunal transfer is thought to be the optimal therapy, as previously reported,¹⁴ because of its advantages of early initiation of oral feeding and shorter length of hospital stay after surgery. Selecting the optimal procedure for each patient depends on the following factors. First, patients must have a good overall status to be able to endure re-free jejunal transfer. Given that initial tumor resection and free jejunal transfer are major invasive operations, some patients may not be able to endure reconstructive operations over a long period of time, especially elderly patients or those with cardiovascular and respiratory problems preoperatively. For these cases, external fistula formation or negative-pressure wound therapy, which has a short operative time compared with re-free jejunal transfer, is performed.

Next, the procedure is also dependent on local factors, including the intensity of the postoperative wound infections. Necrotic tissues around the postoperative wound after free jejunal transfer are often associated with severe infection caused by the presence of resident flora, which easily spreads the infection to the neck and chest through an anastomotic region from the gut lumen. In cases with severe wound infections, complications such as blood flow deficiency of the transferred tissue due to recipient blood vessel or fistula of the suture area may easily occur during re-free jejunal transfer. Hence, external fistula formation or negative-pressure wound therapy is more suitable for these cases. In addition, cases with a history of abdominal surgery and those wherein the re-harvest of free jejunum is difficult, reconstruction using a free anterolateral thigh flap is considered. Moreover, in patients who cannot secure a stable recipient vessel during reoperation, reconstruction using a pedicled pectoralis major myocutaneous flap is considered.

JEJUNAL NECROSIS FACTORS

One of the most common factors relating to jejunal necrosis is necrosis due to blood flow deficiency of the transferred tissue. The causes of vascular complications after free flap transfer are classified into two groups: surgical factors, including surgical technique, vascular position, tissue edema, and vascular pedicle kinking; and patient factors, including arteriosclerosis, venous inflammation after chemotherapy, neck dissection, and infection.

With regard to surgical factors, the vascular pedicle of the free jejunum is short compared with other free flaps, such as the anterolateral thigh flap or radial forearm flap, and has an arcade structure. Therefore, vascular position, tissue edema, and vascular pedicle kinking rarely occur when using a normal flap. Next, with regard to patient factors, the vascular pedicle of the free jejunum in patients with arterial hypertension is prone to developing arteriosclerosis. Moreover, the patient's vessel wall is very soft and fragile because the pedicle of the free jejunum is intra-abdominal blood vessels, such as the second jejunum. Therefore, the Backwall and Dropdown techniques are useful for microvascular anastomosis.^{16–20} Bilateral cervical dissection is still performed in several free jejunal transfer cases and there are many choices of recipient vessels; therefore, it is necessary to choose good recipient vessels with the best artery blood flow and venous return. Many surgeons have performed one pair of artery and venous anastomoses, but only a few studies have performed two pairs of anastomoses.²¹ We only performed one pair of anastomoses, but the incidence of jejunal necrosis was only approximately 2% and we kept the results stable. Moreover, we did not perform super charge and super drainage, and did not use postoperative vasodilators.

Among the jejunal necrotic cases, some patients had no blood circulation disorder. In the past, we have reported two jejunal necrotic cases without vascular pedicle thrombus. For these cases, a thrombus was not detected in the anastomotic region and recipient vessels, and patients developed delayed jejunal necrosis at 1 week postoperatively. One patient immediately underwent re-free jejunal transfer at the site of jejunal necrosis, but necrosis ensued in this case. The other patient underwent an external fistula formation procedure, but eventually died due to the early recurrence of tumor.²² We inferred that a non-occlusive mesenteric ischemia (NOMI) occurred in the transferred jejunum. And we also inferred that the patients' overall status is related to jejunum necrosis, but we're not sure of the real reason.^{23–27} Moreover, with regard to the recipient vessels, the artery with good flow and the vein with good blood circulation should be used at reoperation, but the effect of the blood circulation disorder on the recipient vessels should be taken into account. Therefore, it is better to use the other recipient vessels if there are many recipient vessels near the operative region. Moreover, another option is the use of peripheral blood vessels, such as the thoracoacromial or intra-thoracic blood vessels, when it is difficult to find a good recipient vessel in the operative site.^{28–32}

MONITORING OF THE TRANSFERRED JEJUNUM

The optimal intervention for free jejunal necrosis is re-free jejunal transfer, as described above. However, re-free jejunal transfer is avoided in cases with severe local infections or those with a poor overall health status; thus, external fistula formation is preferred. Early detection and early debridement of jejunal necrotic tissues are important for a successful re-free jejunum transfer before the infection with necrosis spreads to the surrounding tissue. Examination of wound infections in the postoperative area is performed through blood tests and computed tomography of the buried flaps, such as the free jejunum of the cervical esophageal reconstruction or reconstruction after total laryngo-pharyngo-esophagectomy. Therefore, necrotic discovery is apt to be behind than common flap with an observable flap from the body surface.

In our institution, we routinely perform jejunal monitoring (Fig. 1) and postoperative blood flow evaluation.^{33–36} Given that we only had one pair of jejunal arcade blood vessels for blood flow, blood circulation disorders may result from traction and torsion of the heavy jejunum, leading to false negative findings during routine monitoring of jejunum abnormalities.³⁷ Moreover, there are only a few reported cases wherein salvage of the jejunum is possible through re-anastomosis of a blood vessel with abnormal findings compared with a normal flap.^{37,38} However, we think that this is effective in preventing the worsening of wound infections due to delayed discovery of necrotic jejunal tissues.³⁹ Sakurai et al.⁴⁰ evaluated postoperative blood circulation of the free flap transfer by monitoring venous pressure, which is



FIG. 1 Monitoring of the jejunum. Jejunal blood flow is confirmed from the body surface through routine monitoring of the jejunum, which was performed 1 week after surgery

considered a useful method in buried flaps such as the free jejunum. Moreover, Keereweer et al.⁹ reported that bleeding from the oral cavity is an important sign of blood circulation disorders of free jejunal transfer congestion. When a flap has a venous return disorder, the phenomenon of blood flow from the oral cavity is thought to be an important sign of congestion.

JEJUNUM NECROSIS ALGORITHM

Based on these findings, we designed a jejunal necrosis algorithm (Fig. 2). When transferred jejunal necrosis becomes apparent, a reoperation is necessary, and when a jejunal necrosis risk factor is apparent, a re-free jejunal transfer is immediately performed. However, in cases with unidentified necrotic factors, such as NOMI or poor overall status, external fistula formation is preferred over re-free jejunal transfer, which makes removal of necrotic tissues difficult.

Next, a good pair of recipient vessels should be found, whether an infection state of the operation field can endure re-jejunal transfer or whether mucosa tissue of the intestinal tract anastomotic region can endure intestinal tract anastomosis. Finally, we confirm the general condition for long-time operation of possible cases. Moreover, in cases with postoperative sites suitable for a re-reconstructive operation, but not for a secondary jejunum sampling, the radial forearm flap and anterolateral thigh flap, in a roll shape, is considered a salvage operation.^{41–48} Last, there is potentially high publication bias that might have referred report. In the future, it will be important to review the results, in relation to salvage methods of free jejunum transfer, in a clinical setting.

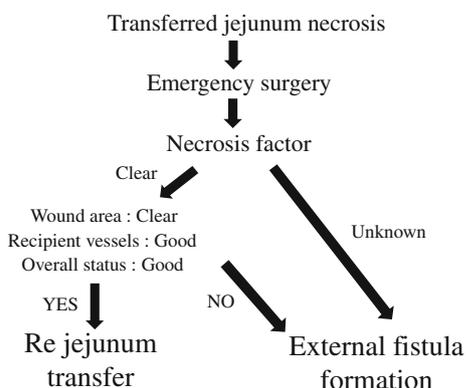


FIG. 2 Jejunal necrosis algorithm

CONCLUSION

We reviewed a past report on jejunal necrosis after a free jejunal transfer. Early debridement and re-free jejunal transfer are optimal treatment options for patients with early-stage jejunal necrosis. Because re-jejunal transfer is a possible state after necrosis, it was thought that coping was the most important aspect of detection at an early stage.

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