Clinical Study

Factors Predicting Total Free Flap Loss after Microsurgical Reconstruction Following the Radical Ablation of Head and Neck Cancers

Masaki Fujioka^{1,2}

¹ Division of Functional Reconstructive Surgery, Department of Surgical Therapeutics, National Hospital Organization Nagasaki Medical Center, Nagasaki 856-8562, Japan

² Department of Plastic and Reconstructive Surgery, National Hospital Organization Nagasaki Medical Center, Nagasaki 856-8562, Japan

Correspondence should be addressed to Masaki Fujioka; mfujioka@nmc.hosp.go.jp

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Background. With greater experience in microsurgical reconstruction, free tissue transfer has become common and reliable. However, total flap necrosis after microsurgical reconstruction is sometimes seen in patients who have undergone radical ablation of head and neck malignancies. We investigated factors predicting free flap loss in head and neck reconstruction. **Methods.** We reviewed the records of 111 free flap reconstructions carried out among 107 patients with head and neck cancer who required radical resection and microsurgical reconstruction in our unit from 2004 through 2010. Among these patients, 6 showed total flap necrosis postoperatively. We investigated the associations between primary or recurrent tumor, type of flaps, chemotherapy, and radiotherapy and flap loss. **Results.** Five of 20 (25.0%) patients who underwent radiotherapy developed flap necrosis; among the 91 patient who did not undergo radiotherapy, only one (1.1%) developed. Preoperative radiotherapy was statistically identified as the most important risk factor for postoperative flap failure. **Conclusions.** Patients receiving radiation treatment are more likely to develop total flap failure when they undergo reconstructive surgery with free flaps after tumor ablation, because the combination of endarteritis and chronic ischemia caused by radiation damaged endothelial membrane in the recipient vessels, consequently, thrombosis tends to develop.

1. Introduction

As the familiarity and reliability of microsurgical reconstruction has increased, microvascular free tissue transfer has become the primary surgical method for head and neck reconstruction (Figure 1) [1–4]. Despite the benefits associated with microvascular free tissue transfer, a small chance of complication remains such as wound dehiscence, infection, hematoma, seroma, flap failure, and fistula. Among the complications, postoperative total flap failure after microsurgical reconstruction requires another salvage surgery, causes long-term distress for the patient, delays initiation of oral intake, increases hospitalization time, and, consequently, decreases patient quality of life (Figure 2).

In this paper, 6 cases of total flap loss after free flap reconstruction for the head and neck abrasion were investigated

to determine the factors responsible for the occurrence of postoperative total free flap necrosis.

2. Patients and Methods

We examined the records of 111 free flap reconstructions carried out among 107 patients with head and neck cancers who underwent radical resection in our unit from 2004 through 2010. Ages ranged from 26 to 82 years (mean age, 54.0 years). Among these patients, 6 developed postoperative total flap necrosis. They ranged in age from 26 to 76 years (mean age, 51.0 ± 18.0 years); patients without cervical fistulae ranged in age from 26 to 82 years (mean age, 54.0 ± 11.0 years) (no significant difference, Wilcoxon signed rank test). Their original diseases are shown in Table 1.

FIGURE 1: (a) Flap survival case. MRI showed that the squamous cell carcinoma of the nasal cavity had destroyed the skull base and maxillary bone and invaded brain, orbital cavity, and maxillary sinus. (b) Flap survival case. Intraoperative view of case 1. The tumor in the ethmoidal and maxillary sinus, orbital cavity, and intracranial space was exposed through a defect of the orbital roof after orbitotomy and resected. (c) Flap survival case. Skull base closure and facial reconstruction were performed using free rectus abdominal musculocutaneous flap. (d) Flap survival case. The picture shows a favorable appearance 1 year after the surgery.

FIGURE 2: (a) Flap necrosis case. MRI showed that the mass of olfactory neuroblastoma had destroyed the skull base and invaded brain. (b) Flap necrosis case. Figure 1(b): Flap survival case. Intraoperative view of case 2. The tumor in the ethmoidal and maxillary sinus, orbital cavity and intracranial space were resected. (c) Flap survival case. Skull base closure and facial reconstruction were performed using free rectus abdominal musculocutaneous flap. (d) Flap survival case. The picture shows total necrosis of transferred muscle due to venous embolism 1 day after the surgery. Necrotic-free flap was resected and re-reconstruction was performed using free anterolateral thigh flap.

We investigated several aspects of postoperative total free flap loss due to necrosis in head and neck reconstruction including (1) differences in kind of flaps (2) differences in primary and recurrent cancer (3) influence of preoperative chemotherapy (4) influence of preoperative radiotherapy. Statistical analysis was performed using chi-square test.

3. Results

Postsurgical vessel thrombosis occurred in 10 free flaps which required thrombectomy and reanastomosis of vessels. Among them, 4 flaps survived but 6 could not be salvaged and, consequently, developed total flap failure. Their profiles and clinical parameters including sex, age, original disease, staging and pathological diagnosis, primary and salvage surgery, and presurgical radiation and chemotherapy are shown in Table 2.

- (1) The association between kind of flap and the flap loss is shown in Figure 3. Flap necrosis occurred in 2 of 42 patients (4.8%) after free musculocutaneous flap transfer, in 1 of 40 cases (2.5%) after free jejunum flap transfer, in 1 of 17 (5.9%) after free fasciocutaneous flap transfer, in 1 of 7 (9.1%) after free skin flap transfer, and in 1 of 5 (20.0%) after free bone flap transfer. The difference was not significant.
- (2) The influence of primary and recurrent cancer in occurrence of flap necrosis is shown in Figure 4. A total of 4 of 89 (4.5%) patients who were treated to the primary cancer developed flap loss. Among the 22 recurrent cancer patients, 2 (9.1%) patients developed flap loss and none developed flap loss among the 48 patients who did not undergo radiotherapy. There was no significant difference between these subgroups ($P > 0.10$, chi-square test).

TABLE 1: Original diseases of patients who underwent free flap transfer.

Original disease	Hypopharyngeal cancer	Oral and tongue cancer	Mesopharyngeal cancer	Epipharyngeal cancer	Laryngeal cancer	Maxillary cancer	Esophageal cancer	Parotid gland cancer	Neuroblastoma	Palatal cancer
Number of cases	33	27	17	7	7	6	5	4	3	2

TABLE 2: Characteristics of patients who developed total free flap failure.

Sex	Age	Original disease	Primary surgery	Presurgical radiation (Gy)	Presurgical chemotherapy	Salvage surgery	
1	F	68	Hypopharyngeal cancer (SCC) pT2N1M0	Partial hypopharyngectomy Neck resection Free forearm flap transfer	100	TXT 360 mg	Free jejunum flap transfer
2	M	76	Recurrent laryngeal cancer (SCC) pT4N2M0	Partial oral base resection, Neck resection Free RAMC flap transfer	65	—	PMMC flap
3	F	68	Recurrent hypopharyngeal cancer (SCC) pT2N1M0	Hypopharyngectomy Neck resection Free jejunum flap transfer	66	TXT 360 mg	Free jejunum flap transfer
4	M	57	Nesopharyngeal cancer (SCC) pT3N2bM0	TPLE, Neck resection Free ALT flap transfer	65	CDDP 100 mg, 5Fu 500 mg	PMMC flap
5	F	26	Maxillary sarcoma pT3N2bM0	Radical maxillary resection, Free scapular and LD MC flap transfer	65	CDDP 500 mg, TXT 300 mg	Free ALT flap
6	F	50	Olfactory neuroblastoma pT3N2bM0	Radical maxillary and skull base resection, Orbitotomy Free RAMC flap transfer	—	—	Free ALT flap

SCC: squamous cell carcinoma. LD MC flap: latissimus dorsi musculocutaneous flap. PMMC flap: pectoralis major musculocutaneous flap.

TLPE: total laryngopharyngoesophagectomy. NR: neck resection. RAMC flap: rectus abdominal musculocutaneous flap. ALT flap: anterolateral thigh flap. CDDP: Cisplatin. TXT: docetaxel.

FIGURE 3: Flap choice in patients with and without flap loss.

- (3) The association between chemotherapy and the development of flap loss is shown in Figure 5. Flap necrosis occurred in 4 of 80 (5.0%) of patients, who underwent chemotherapy and in 2 of 31 (6.5%) patients, who did

not. There was no significant difference between these subgroups ($P > 0.10$, chi-square test).

- (4) The association between radiotherapy and the development of flap necrosis is shown in Figure 6. A total of 5 of 20 (25.0%) patients who underwent radiotherapy developed flap necrosis: among the 91 patient who did not undergo radiotherapy, only one (1.1%) developed. There was a significant difference between these subgroups ($P < 0.01$, chi-square test).

4. Discussion

Reconstruction of defects in the head and neck region has remained a challenging problem for craniofacial, plastic, and head and neck surgeons [5]. Cervical skin flaps have been utilized in head and neck reconstruction from the time they were originally described, more than 100 years ago; later, axial pattern flaps were developed [6–8]. However, the use of these flaps has declined because pedicle flaps do not provide sufficient tissue volume and proper texture. The pectoralis major myocutaneous pedicled flap is the most commonly indicated procedure; however, 60% of head and neck reconstructions using this flap result in postoperative complications such as

wound dehiscence, infection, hematoma, seroma, partial flap failure, total flap failure, and fistula [7].

Application of microvascular free tissue transfer allows the surgeon to select the tissue that is most suitable for the size and shape of defect. Consequently, the incidence of flap complications is reduced to 33.5% of that of free flaps [4]. Free flaps can be utilized for the reconstruction of mid-upper facial defects, including the skull base, scalp, orbit, maxilla, and palate, all of which are hard to restore using conventional pedicle flaps [9, 10]. With greater experience in microsurgical reconstruction and the availability of a larger number of flaps, free tissue transfer has become common and reliable. Indeed, it is now a standard technique for the head and neck reconstruction after tumor ablation [1–3, 11].

However, total flap necrosis after microsurgical reconstruction is sometimes seen in patients who have undergone radical ablation of head and neck malignancies. Nakatsuka et al. [11] described that total flap necrosis accounted for 4.2 percent of 2372 free flaps in head and neck reconstruction after cancer ablation. Bozikov and Arnez [4] also performed 105 free flaps for head and neck reconstruction after tumor resection in 101 patients and flap failure rate accounted 5.7 percent. Serletti et al. [1] performed a total of 104 free flap transfers in 100 patients and described that 6 reconstructive failures occurred related to flap loss. O'Brien et al. [12] reviewed 250 cases of head and neck reconstruction using free flap and concluded that a 96% success rate was achieved.

It is commonly believed that the development of postoperative free flap failure is influenced by several underlying factors, including the presence of systemic diseases, previous radiotherapy, chemotherapy, positive surgical margins, and lymph node metastases [4, 13]. There are many conflicting reports concerning the predisposing factors for postoperative free flap failure, but our data show that radiotherapy is the most important [12–14]. Chronic endotheliangiitis in the recipient vessels caused by radiation may be one of the factors to develop thrombosis [14, 15].

Once free flap develops necrosis completely after head and neck reconstruction, some flaps are required to resurface the tissue defect at a minimum. Surgeons are recommended immediate coverage with a well-vascularized axial-pattern musculocutaneous flap or revascularized free flap [13]. When wound defect increases in size, wound coverage requires a well-vascularized distant flap [16, 17]. Usage of a pectoralis major musculocutaneous (PMMC) flap remains an important reconstructive technique in head and neck cancer surgery, because it is a low-risk procedure with acceptable morbidity [18]. Thus, this flap can be still used in a salvage procedure after free flap failure, when the facility of microsurgery is limited [7]. This safe and reliable flap is our first choice for salvage surgery after unfavorable outcomes for free flap reconstruction in the neck and mandibular area, including development of cervical fistulae. When free flap transferred to the maxilla or head fails, we chose free flap again to reconstruction, because no pedicled axial-pattern flaps can reach to this distal area safely. When free jejunum flap transferred to the esophageal defect fails, we chose free jejunum flap again, because esophageal reconstruction using skin flap tends to develop fistulae or stenosis on the

FIGURE 4: Free flap failure in patients with primary and recurrent cancer.

FIGURE 5: Chemotherapy in patients with and without flap loss.

mucosa-skin anastomosis site. Besides, reharvesting jejunum will be the least morbidity for the patient. In these reasons, we performed restoration after total free flap failure using pedicled PMMC flap for 2 pharyngeal re-reconstructions, free jejunum flap for 2 esophageal reconstructions, and free anterolateral thigh flap for 2 skull base and maxillary re-reconstructions.

5. Conclusion

With increased experience in microsurgical reconstruction, free tissue transfer has become a standard technique in head and neck reconstruction after tumor ablation. However, patients receiving radiation treatment are more likely to develop total flap failure when they undergo reconstructive surgery with free flaps after tumor ablation, because the combination of endarteritis and chronic ischemia caused by

FIGURE 6: Radiotherapy in patients with and without flap loss.

radiation damaged endothelial membrane in the recipient vessels, consequently, thrombosis tends to develop.

Ethical Considerations

The procedures followed were in accordance with the ethical standards of our institutional committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 1983.

Conflict of Interests

This paper has not benefited from any source of funding support, and the author certifies that there are no conflicting financial interests associated with this paper.

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