

soft tissue has not yet adhered to the peripheral structures and ocular movement is less likely to be restricted after surgery. However, in the late stage of trauma, fibrosis, scarring, and atrophy of soft tissues may cause diplopia, although tissue adhesion is mechanically separated during surgery.

The study was designed as a prospective study, which assured totality and accuracy in the data collection. Besides, measurement of orbital volume quantitatively confirmed the precision and effectiveness of the surgery. The weaknesses of this study included the small sample, which was limited by the strict inclusion criteria, and the follow-up period, which was not long enough to identify all possible complications.

In conclusion, the composite material of HDPP and titanium mesh combined their advantages to facilitate safe and effective repair of orbital blowout fractures. Studies of larger sample and longer follow-up period should be conducted in the future.

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OPEN

Modified Free Latissimus Dorsi Musculocutaneous Flap in the Reconstruction of Extensive Postoncologic Defects in the Head and Neck Region

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Abstract: Oncological resection of advanced carcinoma in the head and neck region results in vast defects. The free latissimus dorsi musculocutaneous flap (FLDMF) is one of the most commonly used flaps for the repair of complex head and neck defects. We tried to modify FLDMF to multiple segments or combine it with acellular dermis to fit through-and-through defects in the oral-facial region during the last decade. A retrospective review of patients with FLDMF reconstruction between 2004 and 2012 was undertaken. Demographics, histology, surgical management, disease control and overall survival, complications, radiotherapy, aesthetic outcome, as well as economic results were analyzed. The majority of the patients (66.7%) had recurrent tumors, and the rest of the patients had primary tumor with stage IV. Fourteen patients (38.9%) had a history of prior radiation therapy, whereas 27.8% of the patients had postoperative radiation therapy. The areas of the defects vary from 52 cm² to 180 cm² (mean, 86.4 cm²). The flap failed in 1 of the 37 patients. The complications at the recipient site include hematoma (n = 6, 16.7%), venous insufficiency (n = 4, 11.1%), infection (n = 3, 8.3%), and partial flap necrosis (n = 2, 5.5%). The donor-site complications include delayed healing, necrosis of skin graft, and limited shoulder function. The 5-year overall survival rate was 39.1%, and the 5-year disease-free survival rate was 22.1%. In conclusion, the FLDMF could be modified to fit vast defects where voluminous tissue is needed to be transferred in the head and neck region.

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Key Words: Modified free latissimus dorsi musculocutaneous flap, head and neck defects, reconstruction, oncologic surgery

Surgical defects on the head and neck region after tumor resection result in functional impairment such as swallowing and speech deficits.^{1,2} The reconstruction for postoperative defects on the head and neck region needs timely and adequate wound healing to optimize cosmetic appearance and function, to facilitate postoperative radiation, and to restore sensation if possible.² Skin graft, regional pedicled flaps, and distant free vascularized free flaps are the most frequently used methods in the reconstruction of postoperative defects of the head and neck.

The application of vascularized skin flaps on the head and neck reconstruction was first described in 1959.³ However, despite encouraging reports, it did not achieve popularity until the 1970s.⁴ Nowadays, microvascular surgery is a highly successful and relatively safe method for the reconstruction of head and neck defects and has largely become globally accepted means of repairing complex head and neck defects with an overall success rate of 94% to 96%.⁵⁻⁸

The free latissimus dorsi musculocutaneous flap (FLDMF) is one of the most commonly used flaps for the repair of complex head and neck defects.⁹⁻¹² It contains the necessary muscular, cutaneous, and osseous elements that provide adequate tissue volume to fill the defects on a single common pedicle. Therefore, the FLDMF was used in the patients of our series with vast postoncologic surgical defects in the head and neck region.

In this article, we present a series of patients who had postoncologic surgical defects in the head and neck region and underwent reconstruction using the FLDMF. The objective of this study was to review these reconstructive cases regarding the oncological outcomes, complications, as well as the functional and aesthetic status of these patients.

MATERIALS AND METHODS

Patients

After the institutional review board approval by Sichuan Cancer Hospital, records of patients who underwent FLDMF procedures of reconstruction of defects in the head and neck region were reviewed retrospectively. In this study, the patients who presented to the department of head and neck surgery between 2004 and 2012 for free FLDMF reconstruction were included. The characteristics of the patients are summarized in Table 1. The medical records as well as the details of age, sex, follow-up, histology, primary or secondary nature of the tumor, tumor site, flap type, tumor stage, neoadjuvant and adjuvant radiation therapy, locoregional disease control, cosmetic outcome, and complications were analyzed. Surgical procedures were performed by the same surgeon team. Microvascular complications were attributed to either venous congestion (evident through pinprick examination, changes in flap color/consistency, and decreased venous Doppler signal) or arterial insufficiency (decreased arterial Doppler signal). Partial failure, acute total failure, and late total failure are considered as free flap complications.

Statistical Analysis

Descriptive variables were summarized as means for continuous variables and number (percentage) for categorical variables. Disease-free interval and disease-specific survival curves were illustrated using the Kaplan-Meier method. The Student's *t*-test was applied to compare means between the groups. The κ statistic was carried out to analyze the interrater reliability. The Pearson Chi-squared test was used to

analyze the correlation between radiotherapy and postoperative complications. $P < 0.05$ was considered statistically significant. Statistical analysis was performed using SPSS 13.0 for Windows (SPSS Inc, Chicago, IL).

RESULTS

Patient Characteristics

The characteristics of the patients are summarized in Table 1. The median age of the patients was 58 years (range, 42–80 y), with 16 women and 20 men. The most common site of tumor was the parotid gland ($n = 6$), followed by adenoid cystic carcinoma of the acoustic duct ($n = 4$), eyeball involvement of maxillary sinus carcinoma ($n = 4$, Fig. 1), neck recurrence of nasopharyngeal carcinoma after radiation therapy ($n = 4$), recurrence of buccal squamous cell carcinoma ($n = 4$, Fig. 2), as well as recurrence and mandible involvement of squamous cell carcinoma in the tongue ($n = 4$). The majority of the patients ($n = 24$, 66.7%) had recurrent tumors, whereas the rest of the patients (33.3%) had primary tumor with stage IV. Fourteen patients (38.9%) had a history of prior

TABLE 1. Patient Characteristics

Variables	No. Patients
Age (range), y	58 (42–80)
Sex	
Male	20
Female	16
Tumor site	
Recurrence of parotid gland malignancies	6
Adenoid cystic carcinoma of acoustic duct	4
Eyeball involvement of maxillary sinus carcinoma	4
Neck recurrence and skin involvement of nasopharyngeal carcinoma after radiotherapy	4
Recurrence of buccal squamous cell carcinoma	4
Recurrence and mandible involvement of squamous cell carcinoma in the tongue	4
Eyeball involvement of basal cell carcinoma around angulus oculi medialis	2
Malignancy in neurofibromatosis type 1 on the nape	2
Recurrence of adenocarcinoma of lacrimal gland	2
Recurrence of basal cell carcinoma on the face after radiotherapy	2
Recurrence and skin involvement of thyroid cancer	2
T stage	
T1	0
T2	0
T3	4
T4	32
N stage	
N0	6
N1	6
N2	20
N3	4
Tumor	
Primary tumor	12
Recurrent tumor	24
Radiotherapy	
Prior radiotherapy	14
Postoperative radiotherapy	10

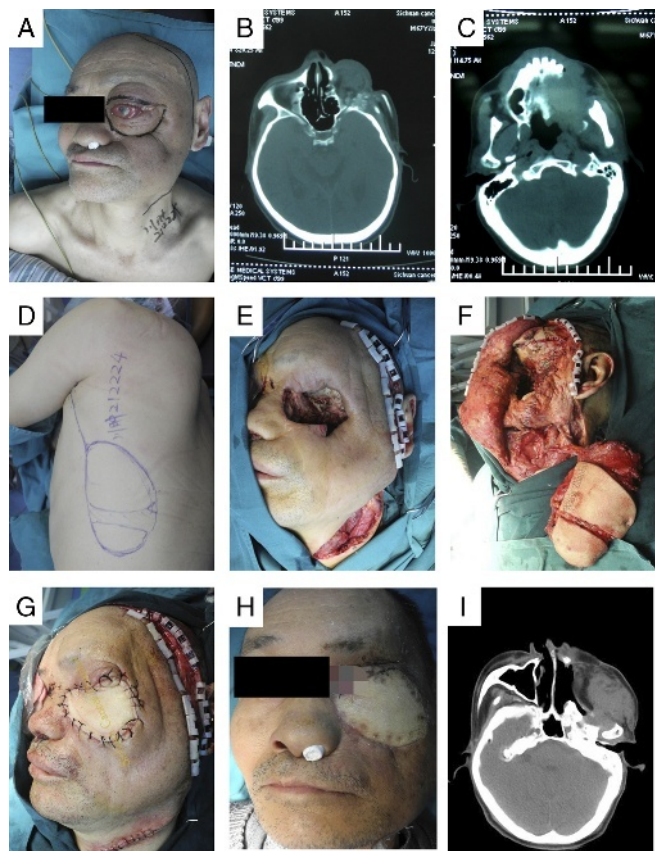


FIGURE 1. A 65-year-old man presented with recurrent, poorly differentiated squamous cell carcinoma of the maxillary sinus after surgery and radiation therapy. A, Preoperative image. B and C, The computed tomographic appearance of the lesions. D, The design of 2 segmental latissimus dorsi flaps. E, Defect after removal of the tumor. F, The flap was anastomosis end to end with superior thyroid artery and vein. G, Immediate photograph after the reconstruction. H, Postoperative image after stitches removal. I, The computed tomographic image 2 weeks after the reconstruction.

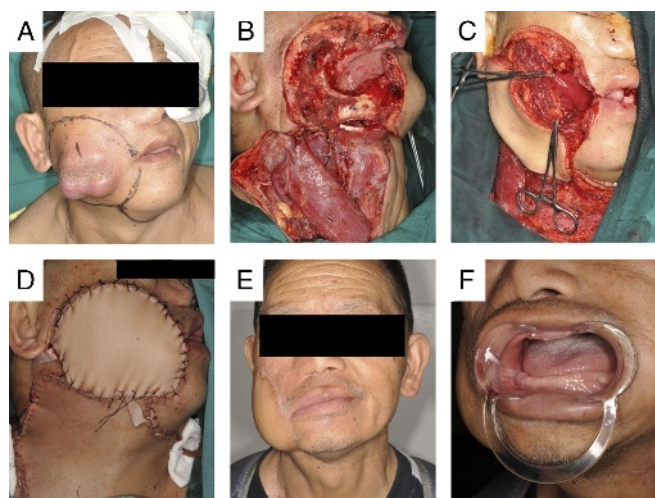


FIGURE 2. A 58-year-old man presented with poorly differentiated squamous cell carcinoma of buccal mucous. A, Preoperative image. B, Defect after tumor removal and neck dissection. C, The FLDMF was used to repair the defect of skin and muscle, and the acellular dermis was applied to repair the defect of buccal mucous. D, The appearance after stitch. E, Six months after the radiation therapy. F, The acellular dermis was well mucosalized.

radiation therapy, whereas 10 patients (27.8%) had postoperative radiation therapy.

Defects and Reconstruction

The areas of the defects vary from 52 cm² to 180 cm² (mean, 86.4 cm²). Thirty-seven FLDMFs were applied for 36 patients because 1 patient had another FLDMF transfer because of the necrosis of flap. The types of flap transferred included skin paddle overlying latissimus dorsi muscle (n = 28), 2 segmental latissimus dorsi flaps (n = 8), and latissimus dorsi perforator-based flap (n = 4). Of the 8 patients who underwent 2 segmental latissimus dorsi flaps transfer, 4 patients had through-and-through cheek defect because of buccal squamous cell carcinoma and the remaining 4 had large orbital-maxillary defects.

Complications

Sixteen of the 37 patients had complications at the recipient site (Table 2). The most common complication at the recipient site was hematoma (n = 6), followed by venous insufficiency (n = 4), infection (n = 3), partial flap necrosis (n = 2), and total flap necrosis (n = 1). One patient had total flap necrosis that happened 10 hours after the operation. The reoperation was carried out to replace the necrotic one with the heterolateral FLDMF. The rest of the 15 patients with complications at the recipient site healed finally. There were 8 patients who had complications at the donor site, in which 3 had delayed wound healing and 2 had necrosis of skin graft and had another skin grafting. There were 2 patients who had limited shoulder function after 7 months of follow-up. The limitations on the shoulder function moderately affected the daily activities. Systemic medical complications developed in 3 patients. Two patients had postoperative pneumonia, and the other one had both pneumonia and supraventricular tachyarrhythmia. The patients who had systemic complications are older than 80 years and had a history of hypertension.

Radiotherapy

There were 14 patients who received radiotherapy before the reconstructive surgery (55–73 Gy; median, 65 Gy). The patients who received radiotherapy before the surgery tend to have a higher risk for postoperative complications. There was a significant correlation between radiotherapy and postoperative radiotherapy analyzed by the Pearson Chi-squared test (P = 0.006, Table 3). Moreover, the only 1 flap failure happened in the patient who received curative intent radiotherapy (73 Gy). Ten patients received postoperative radiotherapy with median intent of 55 Gy

TABLE 2. Postoperative Complications

Type of Complication	No. Patients
Recipient Site	16
Hematoma	6
Venous insufficiency	4
Infection	3
Partial flap necrosis	2
Total flap necrosis	1
Donor site	8
Delayed healing	3
Necrosis of skin graft	3
Limited shoulder function	2
General medical complication	3
Pneumonia	2
Supraventricular tachyarrhythmia	1

TABLE 3. Correlation Between Radiotherapy and Postoperative Complications

Complication	Radiotherapy	
	With	Without
With	10	6
Without	4	16

Pearson Chi-squared $P = 0.009$ (2-sided).

(50–60 Gy). No flap failure was observed in the patients who received postoperative radiotherapy.

Disease Control and Survival

The median follow-up period was 32 months (range, 10–60 mo). Eighteen patients died during the follow-up period. The 5-year overall survival rate was 39.1%, and the median overall survival time was 53 months (Fig. 3A). Twenty patients developed a recurrence during the follow-up period. The 5-year disease-free survival rate was 22.1%. The median disease-free survival time was 37 months (Fig. 3B).

Aesthetic Outcome

Skin color, texture matches, and appearance of a surgical scar were evaluated by all patients and the operating surgeons. Aesthetic outcome was graded on the following 4-point scale: 1, poor; 2, moderate; 3, good; and 4, excellent. The self-assessed aesthetic results were excellent for 4 patients, good for 16 patients, moderate for 12 patients, and poor for 4 patients. However, the aesthetic outcomes evaluated by the surgeons were excellent for 6 patients, good for 18 patients, moderate for 8 patients, and poor for 4 patients. We considered good and excellent as satisfied; poor and moderate, as unsatisfied. Thus, 20 patients were satisfied with the aesthetic outcome, whereas the surgeons were satisfied with the aesthetic outcome of 24 patients. The κ statistic was carried out to analyze the interrater reliability. The value of κ was 0.538 ($P = 0.001$), suggesting that the ratings between the patients and the surgeons are largely similar.

Economic Results

The mean operative time was 8.2 hours, ranging from 6.5 to 9.5 hours. Postoperative intensive care recovery was used in 10 patients. The mean duration of hospitalization for the patients who had postoperative complications (23.5 d) was significantly longer than that for those who had no complication (15.5 d) ($P = 0.014$). The mean cost per patient was 62550 RMB (range, 51200–78430 RMB). Expenses for the patients who had postoperative complications were significantly higher than that for those had no complication ($P = 0.007$).

DISCUSSION

Head and neck surgical defects after oncological resection of advanced carcinoma often involve different structures, with different functions and characteristics. The use of free flaps for the reconstruction of large defects in head and neck surgery is considered the first choice in the repair of defects after resection of head and neck cancer. Free flap transfer is a highly successful and reliable strategy for the repair of large defects in the head and neck region, associated with a low incidence of flap failure, promoting primary wound healing, preserving residual function, and ensuring effective deglutition and intelligible speech.

In recent years, fasciocutaneous (eg, anterolateral thigh and radial forearm flaps) and myocutaneous free flaps (eg, latissimus dorsi and

rectus abdominis) have represented popular options for head and neck reconstruction. The FLDMF was used for the patients in this cohort because the defects were large (>7 cm in width), preventing the use of radial forearm flap. The anterolateral thigh flap was not used because no obvious perforator was detected using computed tomographic angiography.

The reported failure rate of FLDMF reconstruction in the head and neck region ranged from 0% to 8.4%.^{6,10,12} In our patients, the flap failed in 2.78% (1/36) of the cases. The total flap necrosis happened in the patient who had a history of radical radiation therapy (73 Gy). However, the flap failure happened in 10 hours after the surgery because of venous thrombosis. We therefore consider that the flap failure may not be attributed to the radiation therapy but to the surgical operation or improper postoperative anticoagulant therapy. This specific patient was 80 years old with hyperlipemia (4.35 mmol/L), which may be another 1 candidate reason for the flap loss. However, there was no epidemiological or experimental evidence to suggest the correlation between hyperlipemia and flap failure. We will analyze this correlation in a larger sample in our further study.

Sixteen of the 37 patients (44.4%) had complications at the recipient site. The most common complication at the recipient site was hematoma (n = 6, 16.7%), followed by venous insufficiency (n = 4, 11.1%), infection (n = 3, 8.3), partial flap necrosis (n = 2, 5.5%), and total flap necrosis (n = 1, 2.8%). Pohlenz et al⁶ analyzed the surgical outcome and complications of 1000 microvascular free flaps performed at the authors' institution. They reported that the hematoma and partial flap failure happened in 5.7% and 6.8% of patients, respectively, which is lower than our results. However, the total flap loss of latissimus in our study (2.8%) was lower than that in their report (8.4%). Considering the high rate of hematoma and partial flap failure rate in the early period of practice, we changed our operative procedure with ultrasonic scalpel energy and modified the method of drainage. Most of the patients in our cohort had recurrent disease or radiation therapy, which may be the potential reason why our patients had a higher rate of hematoma and partial flap loss. It has been reported that an increased risk for free flap failure in patients with previous surgery exist because of scarring and fibrosis secondary to previous surgery.¹³

Whether previous radiation therapy would increase the complication rate of free tissue transfer in the head and neck region remains controversial. Tabah et al¹⁴ suggested that previously irradiated patients had more incidence of local complication. On the contrary, no correlation between complication and preoperative radiation therapy was also reported.^{15–17} In our study, however, the previous radiation therapy (including radical and preoperative radiation therapy) was significantly correlated with an increased risk for recipient complications. However, owing to the limited number of samples, this correlation might be a false positive. Therefore, a larger sample size is needed to further analyze this question.

The donor-site complications include delayed healing, necrosis of skin graft, and limited shoulder function. There are 2 patients who complained of limited shoulder function after 7 months of

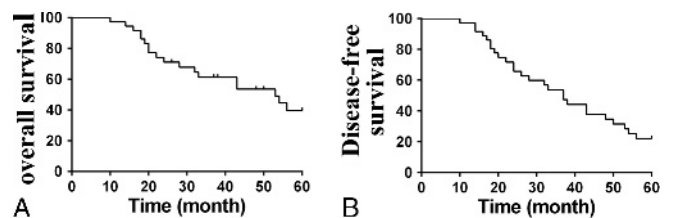


FIGURE 3. The survival curves of the patients: overall survival (A) and disease-free survival (B).

follow-up in our study. The limitations on the shoulder function mildly affected the daily activities. Giordano et al¹¹ studied the long-term shoulder function of a patient who underwent FLDMF harvesting using objective measurements. They found a significant reduction in the range of motion in intrarotation and forward elevation in the long term after FLDMF procedure. However, insignificant loss of shoulder functionality has been reported by several studies.^{18,19} The contraries between the studies may be attributed to the small sample sizes, uneven follow-up time, and different methods in evaluating the function. Therefore, a larger sample size, a longer follow-up period, and objective measurements are needed to further clarify long-term shoulder dysfunction after FLDMF harvesting.

The 5-year overall survival and disease-free survival rates in our patients were 39.1% and 22.1%, respectively. All patients in this study had local advanced or recurrent diseases, which contributed to the low survival rate for our patients. Moreover, these patients had different types of cancer, including squamous cell carcinoma, adenocarcinoma, and basal cell carcinoma. These malignancies happened in almost all the anatomic region of the head and neck. Therefore, the survival data in our cohort do not reflect the general survival rate for patients with head and neck malignancies.

In general, the FLDMF is a useful strategy for the reconstruction of vast defects where voluminous tissue is needed to be transferred. However, a larger sample size and a longer follow-up time are needed to further analyze the risk factor for flap failure and long-term complication.

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Reconstruction of Full-Thickness Lower Eyelid Defect Using Superficial Temporal Artery Island Flap Combined With Auricular Cartilage Graft

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Abstract: Full-thickness lower eyelid defect is one of common surgical diseases, which may lead to exposure keratopathy, corneal ulceration, and blindness. The aim of this study was to investigate the effect of superficial temporal artery island flap combined with auricular cartilage graft on the repair of full-thickness lower eyelid defect.

In this study, the reconstructions in 6 patients who had unilateral full-thickness lower eyelid defects due to ocular traumas or surgical resections of malignant tumors were carried out. The island flap of the frontal branch of superficial temporal artery reconstructed the outer layer and the total lower lid was supported with the plane of an auricular cartilage strip, offering a proper contour and physical strength to maintain a normal eyelid height. The follow-up time

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