Reconstruction of Through-and-through Oromandibular Defect: Comparison of Four Different Techniques

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**Background:** Through-and-through oromandibular defects originate from surgical intervention of tumors of the oral cavity involving external skin, soft tissue, bone, and oral lining. Reconstruction of such composite defects is primarily achieved by 4 methods using distinct flaps in Chang Gung Memorial Hospital, including a single anterolateral thigh (ALT) flap, a single fibula flap, an osteomyocutaneous peroneal artery-based combined flap, and a combination of a fibular flap and an ALT flap, also known as a double flap.

**Methods:** In this retrospective study, 41 patients with through-and-through oromandibular defects reconstructed in Chang Gung Memorial Hospital Linkou branch from July 2007 to June 2009 using either of the 4 flaps were evaluated. Patients were divided into 4 groups according to the choice of flap, and their surgical outcomes, immediate and late complications, and their general condition were studied. Group 1 included 12 patients reconstructed with a single ALT flap, whereas group 2 included 15 patients using fibular flaps. Group 3 included 8 patients with osteomyocutaneous peroneal artery-based combined flaps, and group 4 included 6 patients who underwent reconstruction with double flaps.

**Results:** Among all statistical results, we found that none of the differences regarding either patient demography or surgical outcomes between groups were statistically significant, except for squamous cell carcinoma staging.

**Conclusions:** Although the results were insignificant, trends within the data could be seen that support previous notions regarding each reconstruction method. For future studies, we strongly recommend a larger sample size. (Plast Reconstr Surg Glob Open 2017;5:e1212; doi: 10.1097/GOX.0000000000001212; Published online 24 February 2017.)

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### Background

The reconstruction of extensive composite oromandibular defects usually involves the external skin, soft tissue, bone, and oral lining. To convey its severity and complexity, these deformities are often described among head and neck surgeons using the term “through-and-through” defects. Reconstructing such defects continues to challenge surgeons, as inadequate reconstruction may lead to functional problems with speaking, eating, respiration, saliva retention, and undesired cosmetic results.¹

Through-and-through oromandibular defects result from the surgical treatment of T3 and T4 tumors originating from the oral cavity. Primary malignancies of the oral cavity are the main culprits that lead to such defects, with more than 90% of the cases classified as squamous cell carcinoma.² According to the World Health Organization International Agency for Research on Cancer, oral cavity cancer is the fifth most common malignancy in Southeast Asia and had the second highest incidence rate among men in Taiwan, primarily due to tobacco- and betel nut-chewing customs.³

### Flap Characteristics

Reconstruction of through-and-through oromandibular defect is primarily accomplished by 4 different methods.
using 2 types of flaps, a single anterolateral thigh (ALT) flap, a single fibular flap, an osteomyoarterial pedicle (OPAC) flap, and a combination of a fibula flap and an ALT flap, known commonly as a double flap. Each type of flap and method has its distinct advantages and disadvantages that must be considered when surgeons attempt to determine the optimum choice for reconstruction.

The fibula osteocutaneous (OSC) flap has gained increased popularity for mandibular reconstruction over the last decade, as it provides excellent bone stock with a dependable and versatile skin island. The fibular OSC flap’s excellent bone quality allows osseointegrated implants for dental restoration while sufficient length is obtainable to replace the entire mandible if necessary. In addition, the donor-site morbidity is limited and well tolerated. The fibular flap, however, also has distinct disadvantages, as its most glaring shortcoming is its lack of soft-tissue volume. Although the skin paddle of the fibular flap is adequate enough to provide an inner and outer lining, its lack of soft tissue prevents it from filling up the dead space that results from the extirpated masticator muscles, buccal fat, and parotid gland. This dead space may lead to fluid accumulation that could cause secondary infection and an unfavorable cosmetic appearance along with further functional difficulties in swallowing, chewing, and speech. In addition, the fibular flaps require longer operation hours due to difficulties in harvesting and inset.

Song et al. first described the ALT flap in 1984. The main advantage of the ALT flap is that it provides a large cutaneous surface area and can be combined with either the tensor fasciae latae or the vastus lateralis muscle to provide a chimeric flap. It can then be trimmed intraoperatively and thinned to the desired thickness to provide good contouring of the face. The adequate soft-tissue bulk of the ALT flap is also required to prevent subsequent bone and plate exposure. Although ALT flaps provide greater soft-tissue volumes and are easier to harvest and inset when compared with the fibular osteocutaneous flap, their lack of a bone component that leads to the necessity of reconstruction plates should also be taken into consideration.

Because of the above-mentioned drawbacks for each type of flap, the preferred method of treatment over the past several years is reconstruction with an OPAC flap or with 2 free flaps, also known as double flaps. The OPAC flap, first described by Cheng et al. in 2009, is a refinement of the fibula OSC flap, with the inclusion of partial soleus muscle based on an independent myocutaneous perforator. For the double-flap method, the 2 free flaps of choice commonly used at the Chang Gung Memorial Hospital are the fibular osteocutaneous flap and the ALT flap. The vascularized fibula osteocutaneous flap is used for the bone and inner-lining defect, whereas the ALT flap is used for the outer face, neck, and submandibular region reconstructions. Two flaps provide adequate tissue volume, which prevents a sunken appearance on the neck and trismus because of fibrosis, especially after radiotherapy. Meanwhile, a double-flap procedure maintains tongue mobility and oral sulcus and a watertight intraoral closure to prevent failure from salivary contamination. Reconstruction of through-and-through oromandibular defects of the head and neck, especially using the double-flap technique, is probably the most challenging procedure to the reconstructive surgeon, as it is both technically demanding and time consuming.

In this article, we hold a discussion on patients who have undergone either 1 of the 4 reconstruction methods using the 2 types of flaps described and compared their surgical outcomes. We evaluated each reconstruction method based on their operation details, hospital stay, subsequent radiotherapy, short-term and long-term complications of donor and recipient site, flap conditions, and their recurrence rate. In addition, we attempted to determine correlations between the type of flap used and its subgroup of patients as well as the reasoning behind the surgeons’ choice of reconstruction method.

**PATIENTS AND METHODS**

This retrospective study evaluated 41 patients with extensive composite oromandibular defects reconstructed by surgeons at the division of reconstruction microsurgery of Chang Gung Memorial Hospital from July 2007 to June 2009. Patients were included in this study if the surgical defects resulting from cancer excision involved the external skin, soft tissue, mandible, and oral mucosa. The oral cavity cancer had to be a primary tumor, and the patients had to be followed up for at least 1 year after the surgery. Of the 41 patients, 38 were male, and in all the cases, the tumor type was squamous cell carcinoma with a tumor stage of stage 2 to stage 4. The complete inclusion criteria for this study are listed below (Table 1).

These patients received oromandibular reconstruction by using either a single ALT flap, a single fibular OSC flap, an OPAC flap, or a combination of both flaps. Their surgical outcomes, immediate and late complications, and their general condition were traced for at least 12 months after the surgery (Table 1).

**RESULTS**

Forty-one patients were included in the study (Table 2), and they were divided into 4 groups based on the choice of flap(s) and method used in the reconstruction surgery. Group 1 included 12 patients, who underwent reconstruction with a single ALT flap. Group 2 included 15 patients, who underwent reconstruction with a single

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**Table 1. Patient Inclusion Criteria**

| Inclusion Criteria |
|--------------------|
| Through-and-through oromandibular defects |
| Primary tumor (recurrence tumors not included) |
| Squamous cell carcinoma of the oral cavity |
| Follow-up for at least 1 y after the surgery |
| Reconstruction method using a single or a combination of the 2 flaps |
Table 2. Patient Basic Demographic Data

| Group     | Number | Age (±SD) | BMI (±SD) | DM (±SD) | CV (±SD) | Operation Time (min) | ICU Stay (d) | Total Hospital Stay (d) | Subsequent Radiotherapy |
|-----------|--------|-----------|-----------|----------|----------|----------------------|-------------|------------------------|------------------------|
| Group 1   | 12     | 52.1 (±8.2) | 22.5 (±3.5) | 1 (8.3%) | 1 (8.3%) | 600.8 (±218.9)       | 7.5 (±2.3)  | 25.9 (±8.7)            | 11 (91.7%)             |
| Group 2   | 15     | 56.1 (±11.0) | 24.7 (±5.1) | 2 (13.3%) | 7 (46.7%) | 715.7 (±149.5)       | 11.5 (±5.0) | 30.7 (±8.3)            | 13 (86.7%)             |
| Group 3   | 8      | 54.1 (±14.0) | 23.9 (±2.9) | 1 (12.5%) | 2 (25%)  | 599.0 (±89.8)        | 11.6 (±9.8) | 29.4 (±8.0)            | 8 (100%)               |
| Group 4   | 6      | 54.5 (±15.8) | 22.0 (±3.8) | 1 (16.7%) | 0 (0.0%)  | 762.3 (±339.1)       | 11.5 (±9.6) | 35.8 (±9.6)            | 5 (83.3%)              |
| Total     | 41     | 54.3 (±11.4) | 23.6 (±4.1) | 5 (12.2%) | 10 (24.4%) | 666.1 (±203.1)       | 10.3 (±6.5) | 29.8 (±13.1)           | 37 (90.2%)             |

DM, diabetes mellitus; CV, cardiovascular disease; BMI, body mass index; ICU, intensive care unit.

DISCUSSION

In this study, we set out to determine the advantages and disadvantages of the 4 different reconstruction methods. We compared their basic patient demographic details, hospital and ICU stays, recurrence rate, and their short-term and long-term complications. The results were insignificant, most likely limited by a small sample size due to strict inclusion criteria, but trends that are compatible with previous beliefs could be seen within the data.

From Table 2, we can see that patients' basic demographic condition did not affect surgeons' preference in flap selection for reconstruction, except in those with
Table 3. Patient SCC Stage, Comorbidity, and Short-term Complication Data

| Group | Stage | General Short-Term Complication (Within 30 d) | Short-term Complication—Donor Site | Short-term Complication—Recipient Site (Head and Neck) |
|-------|-------|-----------------------------------------------|-----------------------------------|--------------------------------------------------------|
|       | II    | III | IVa | IVb |                    | Wound Infection | Hematoma or Bleeding Exploring | Flap Circulation | Partial Flap Loss | Flap Failure | Wound Dehiscence |
| Group 1 | 0 (0%) | 0 (0%) | 8 (66.6%) | 4 (33.3%) | 2 (16.7%) | 1 (8.3%) | 5 (41.7%) | 0 (0%) | 1 (8.3%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Group 2 | 0 (0%) | 0 (0%) | 15 (100%) | 0 (0%) | 3 (20.0%) | 0 (0%) | 6 (40.0%) | 1 (6.7%) | 2 (13.3%) | 2 (13.3%) | 2 (13.3%) | 0 (0%) |
| Group 3 | 1 (12.5%) | 0 (0%) | 7 (87.5%) | 0 (0%) | 1 (12.5%) | 0 (0%) | 3 (37.5%) | 3 (37.5%) | 1 (12.5%) | 1 (12.5%) | 1 (12.5%) | 0 (0%) |
| Group 4 | 4 (16.7%) | 1 (16.7%) | 4 (66.7%) | 0 (0%) | 0 (0%) | 1 (66.7%) | 2 (33.3%) | 6 (40.0%) | 1 (6.7%) | 2 (13.3%) | 2 (13.3%) | 1 (6.7%) |
| Total  | 4 (4.9%) | 2 (2.4%) | 34 (82.9%) | 4 (9.8%) | 3 (7.5%) | 0.074 | 0.896 | 0.024 | 0.806 | 0.074 | 0.896 | 0.024 |

Table 4. Patient Long-term Complication (Donor and Recipient Sites) Data

| Group | Recurrence | Detection Time of Recurrence | Orocutaneous Fistula | Plate Exposure | Poor Bone Healing | Severe Scar/Flap Contracture (Mostly Presented as Trismus) | Others | Long-term Complication—Donor Site | Long-term Complication—Recipient Site |
|-------|------------|------------------------------|----------------------|----------------|-------------------|-----------------------------------------------------------|--------|-----------------------------|---------------------------------------|
| 1     | 3 (25.0%)  | 9.7 (±4.5)                  | 1 (8.3%)             | 2 (16.7%)      | 0 (0.0%)         | 8 (66.7%)                                                 | 3 (25.0%) | 1 (8.3%) | 0.618 |
| 2     | 7 (40.7%)  | 13.3 (±10.7)                | 1 (6.7%)             | 1 (6.7%)       | 0 (0.0%)         | 5 (33.3%)                                                 | 3 (20.0%) | 3 (20.0%) | 0.737 |
| 3     | 2 (25.0%)  | 21.0 (±21.2)                | 1 (12.5%)            | 0 (0.0%)       | 0 (0.0%)         | 6 (75.0%)                                                 | 0 (0.0%) | 0 (0.0%) | 0.752 |
| 4     | 2 (33.3%)  | 26 (±25.4)                  | 0 (0.0%)             | 0 (0.0%)       | 1 (16.7%)        | 2 (33.3%)                                                 | 2 (33.3%) | 1 (16.7%) | 0.347 |
| Total | 14 (34.1%) | 13.4 (±13.1%)               | 3 (7.3%)             | 3 (7.3%)       | 1 (2.4%)         | 21 (51.2%)                                                | 8 (19.5%) | 6 (14.6%) | 0.262 |

P 0.618 0.737 0.347 0.262 0.121 0.228 0.848 0.984
cardiovascular disease. Surgeons prefer single flap and OPAC flap for reconstruction in patients with cardiovascular disease, which takes less operation time and hospital stay in comparison with double flaps but without statistical significance. From Tables 2 and 3, it is known that patients with stage IVb head and neck cancer underwent reconstruction with the single ALT flap method. This suggests that in cases with a worse prognosis, surgeons prefer the single ALT method because the flap is less time-consuming, easier to harvest, more reliable, and more surgeon friendly. This notion is supported by a 0% in partial flap loss and flap failure for group 1 patients.

In addition to the topic of flap failure, we can also see from our results that both group 1 and group 4 patients had 0% flap failure rate, whereas group 2 and group 3 patients had 2 cases and 1 case of partial flap loss and flap failure, respectively. This suggests that the fibular flap and OPAC flap are more likely to break down and lead to flap failure, and thus surgeons must be particularly cautious when harvesting and insetting these 2 types of flaps. Of a total of 47 flaps (12 flaps total in group 4; double-flap group), 44 flaps were successful, which is a 93.6% success rate. This success rate is low compared with the annual success rate (96.8%) obtained by the same team at Chang Gung Memorial Hospital, with the results from this study suggesting that a simple ALT or a double-flap method is the safer reconstruction technique.

With regard to wound infection rates, we can see from Table 3 that group 4 has a 0% wound infection rate. This result advocates our belief that with more volume from the double-flap method, less dead space results, thus lowering the risk of infection at the recipient site. From Table 4, we can see that plate exposure rates are higher in groups 1 and 2, whereas both group 3 and group 4 had zero plate exposure cases. This suggests that reconstruction methods using larger volume flaps tend to yield a lower chance of plate exposure, especially when we consider that the flaps will shrink in size after the surgery and subsequent radiotherapy. Thus, to lower the risk of wound infection and future plate exposure, a larger initial flap volume is recommended.

In regard to the long-term complication of trismus, postoperative radiotherapy appears to be the main contributing factor. In our study, the percentage of patients with long-term severe scar formation was higher in groups that had more patients receiving postoperative radiotherapy. The complication rate is the highest in group 3 (75%) and then followed by group 1 (66.7%). All (100%) of the patients in group 3 and 11 patients in group 1 (91.7%) received postoperative radiotherapy, which has positive correlation to the complication rate.

The treatment of oral cavity cancers often requires extensive surgical resections, resulting in large, through-and-through defects of the lateral face. Reconstruction of such defects presents a tremendous challenge because not only must the mandibular continuity be restored but both intraoral and external skin coverage are required to achieve the reconstructive goals: creation of a stable oral cavity, bony restoration, resumption of an oral diet, dental restoration, and cosmetics. Microsurgical free tissue transfer allows reconstruction of the oromandibular area with aesthetic and functional results that generally are far superior to those of other techniques.

The fibular osteocutaneous free flap provides excellent bone stock with a dependable and versatile skin island. The donor-site morbidity is limited and well tolerated. Sufficient tissue may be unavailable with the fibula flap, however, as the dead space left by the extirpated masticator muscles, buccal fat, and the parotid gland must be obliterated to prevent fluid accumulation that may cause secondary infection and to prevent further soft-tissue contraction. This lack of volume may lead to a subsequent hollowed, sunken appearance and an increased risk of plate exposure.

In comparison, the ALT flap has a large cutaneous area with a modifiable thickness after harvesting. One of the main advantages of the ALT flap is that it provides a good contour in the face. Although it has a bulky appearance after the reconstruction, it shrinks with time, especially after treatment with radiotherapy. In addition, if the patient needs correction of the mouth angle, this flap still has enough tissue for this purpose, thus reducing the risk of scar contracture and the development of trismus.

To compensate for the deficits of each flap type, the OPAC flap and double-flap methods were introduced. The advantages of the OPAC flap include a single donor site, 1 pair of recipient vessels, versatile 3-dimensional inset, adequate soft-tissue augmentation, and better aesthetic and functional outcomes. Two free flaps are increasingly advocated for reconstruction of large composite mandibular defects. Double free flaps now commonly include a free osteocutaneous fibula flap combined with an ALT flap or free radial forearm flap for provision of additional skin coverage. Double free flaps provide maximal flexibility in insetting and excellent reproduction of 3-dimensional defects, but require longer operative time and 2 pairs of recipient vessels, and may result in increased donor-site morbidity.

There are 2 major limitations in this study. First, the small sample size due to strict inclusion criteria may have led to statistically insignificant results. Second, there is inherent bias to the surgeon-dependent flap decision. In some cases, the surgeon, may have their own flap preference in mind, instead of choosing a flap that is more suitable to the patients’ clinical condition.

CONCLUSIONS

In this retrospective study of 41 patients with through-and-through oromandibular defects, we found that none of the differences regarding either patient demography or surgical outcomes among 4 groups was statistically significant except for SCC staging and cardiovascular function. The insignificance was most likely owing to a limited sample size of the study due to strict inclusion criteria. However, trends could still be observed and discussed within data that are compatible with current notions and beliefs. It is notable that postoperative radiotherapy contributes to subsequent long-term complications among 4 groups.
For future studies, we suggest including more patients or adopting more lenient inclusion criteria.

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