Comparison of the reconstruction of through-and-through cheek defects involving the labial commissure following tumor resection using four types of local and pedicle flaps

Wei-liang Chen†, Yan Wang†, Bin Zhou, Juan-kun Liao and Rui Chen

Abstract

Background: The reconstruction of through-and-through cheek defects involving the labial commissure following cancer ablation is a surgical challenge.

Methods: This study evaluated 35 patients with buccal squamous cell carcinoma (SCC) involving the labial commissure who underwent Abbe–Estlander (A-EF), folded extended supraclavicular fasciocutaneous island (SFIF), folded pectoralis major muscle (PMMF), or folded extended vertical lower trapezius island myocutaneous (TIMF) flap reconstruction of through-and-through cheek defects involving the labial commissure following radical resection.

Results: The A-EF and SFIF groups differed significantly (P < 0.05) from the PMMF and TIMF groups in terms of tumor clinical stage and type of treatment. The inner PMMF (median 6.3 × 4.5) and TIMF (median 9.8 × 6.7) skin paddle dimensions were larger than those of the A-EF (median 1.8 × 2.2) and SFIF (median 5.5 × 4.3) groups (P < 0.05). The outer PMMF (median 6.3 × 6.6) and TIMF (median 9.8 × 13.2) dimensions were larger than those of the A-EF (median 1.8 × 3.8) and SFIF (median 5.5 × 4.6) groups (P < 0.05). The esthetic results, orbicularis oris function, and speech function were significantly (P < 0.05) better in the A-EF group than in the SFIF, PMMF, and TIMF groups. The patients were followed for 6–38 months (median 26.8, 25.0, 22.1, and 20.8 months in the A-EF, SFIF, PMMF, and TIMF groups, respectively). At the final follow-up, 4 (80.0%) patients in the A-EF, 7 (87.5%) in the SFIF, 5 (55.6%) in the PMMF, and 5 (38.4%) in the TIMF groups were alive with no disease; 1 (20.0%), 1 (22.2%), 2 (22.2%), and 4 (30.8%) patients, respectively, were alive with disease; and 2 (22.2%) patients in the PMMF and 4 (30.8%) in the TIMF group had died of local recurrence or distant metastases at between 9 and 38 months. There was a significant survival difference in the A-EF and SFIF groups compared with the PMMF and TIMF groups (P < 0.05).

Conclusions: The A-EF is suitable for reconstructing defects of clinical stage II disease; the SFIF for clinical stage II or III disease; the PMMF for clinical stage III or IV; and the TIMF for clinical stage rCS III or rCS IV disease.

Keywords: Buccal squamous cell carcinoma, Cheek defect, Pedicle flaps, Abbe–Estlander flap, Supraclavicular flap, Pectoralis major muscle flap, Trapezius myocutaneous flap

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Table 1 Demographics, clinical characteristics, and outcomes of the A-EF, SFIF, PMMF, and TIMF for reconstructing through-and-through cheek defects involving the labial commissure following cheek cancer ablation in 35 patients with buccal squamous cell carcinoma

|                      | A-EF (n = 5) No. of patients (%) | SFIF (n = 8) No. of patients (%) | PMMF (n = 9) No. of patients (%) | TIMF (n = 13) No. of patients (%) | P-value |
|----------------------|---------------------------------|---------------------------------|---------------------------------|-----------------------------------|--------|
| **Sex**              |                                 |                                 |                                 |                                   |        |
| Male                 | 3 (80.0)                        | 5 (62.6)                        | 6 (66.7)                        | 7 (53.8)                          | 0.887a |
| Female               | 2 (20.0)                        | 3 (37.4)                        | 3 (33.3)                        | 6 (46.2)                          |        |
| **Age, years (mean ± SD)** | 52.0 ± 8.5                     | 64.3 ± 9.2                      | 59.6 ± 8.2                      | 59.8 ± 12.7                       | 0.863a |
| **Clinical stage**   |                                 |                                 |                                 |                                   |        |
| I                    | 0 (0.0)                         | 0 (0.0)                         | 0 (0.0)                         | 0 (0.0)                           | 0.026b |
| II                   | 5 (100.0)                       | 3 (22.5)                        | 0 (0.0)                         | 0 (0.0)                           |        |
| III + rCS III        | 0 (0.0)                         | 5 (42.5)                        | 5 + 1 (66.7)                    | 1 + 6 (53.8)                      |        |
| IV + rCS IV          | 0 (0.0)                         | 0 (0.0)                         | 2 + 1 (33.3)                    | 4 + 2 (46.2)                      |        |
| **Treatment**        |                                 |                                 |                                 |                                   |        |
| TR                   | 5 (100.0)                       | 7 (87.5)                        | 3 (33.3)                        | 0 (0.0)                           | 0.036b |
| TR + PM + MM         | 0 (0.0)                         | 1 (12.5)                        | 5 (55.6)                        | 8 (61.5)                          |        |
| TR + Man + Max       | 0 (0.0)                         | 0 (0.0)                         | 1 (11.1)                        | 5 (38.5)                          |        |
| **Flap (cm)**        |                                 |                                 |                                 |                                   |        |
| Inner dimensions     |                                 |                                 |                                 |                                   |        |
| Range, median        | 1 × 2 to 2 × 3, 1.8 × 2.2        | 5 × 3 to 7 × 5, 5.5 × 4.3       | 6 × 4 to 7 × 5, 6.3 × 4.5       | 6 × 6 to 15 × 8, 9.8 × 6.7        | 0.041b |
| Outer dimensions     |                                 |                                 |                                 |                                   |        |
| Range, median        | 2 × 2 to 3 × 5, 1.8 × 3.8        | 5 × 4 to 7 × 8, 5.5 × 6.8       | 6 × 6 to 8 × 7, 6.3 × 6.6       | 6 × 8 to 15 × 20, 9.8 × 13.2      | 0.033b |
| Successful (no.)     | 5 (100.0)                       | 7 (87.5)                        | 9 (100.0)                       | 13 (100.0)                        | 0.967a |
| **Local complications** |                                 |                                 |                                 |                                   |        |
| Hemorrhage           | 1 (20.0)                        | 1 (12.5)                        | 0 (0.0)                         | 1 (7.7)                           | 0.554c |
| Orocutaneous fistula | 0 (0.0)                         | 1 (12.5)                        | 0 (0.0)                         | 0 (0.0)                           |        |
| **Dehiscence in donor-site** | 0 (0.0)             | 0 (0.0)                         | 1 (11.1)                        | 2 (15.4)                          |        |
| **Esthetic results** |                                 |                                 |                                 |                                   |        |
| 1                    | 0 (0.0)                         | 1 (12.5)                        | 1 (11.1)                        | 4 (30.8)                          | 0.039c |
| 2                    | 1 (20.0)                        | 2 (25.0)                        | 6 (66.7)                        | 7 (53.8)                          |        |
| 3                    | 4 (80.0)                        | 5 (62.5)                        | 2 (22.2)                        | 2 (15.4)                          |        |
| **Orbicularis oris function** | 0 (0.0)                  | 1 (12.5)                        | 2 (22.2)                        | 4 (30.8)                          | 0.042c |
| 2                    | 0 (0.0)                         | 1 (12.5)                        | 4 (44.5)                        | 6 (46.2)                          |        |
| 3                    | 5 (100.0)                       | 6 (75.0)                        | 3 (33.3)                        | 3 (23.0)                          |        |
| **Speech function**  |                                 |                                 |                                 |                                   |        |
| 1                    | 0 (0.0)                         | 0 (0.0)                         | 2 (22.2)                        | 5 (38.4)                          | 0.046c |
| 2                    | 0 (0.0)                         | 2 (25.0)                        | 3 (33.3)                        | 6 (46.2)                          |        |
| 3                    | 5 (100.0)                       | 6 (75.0)                        | 4 (44.5)                        | 2 (15.4)                          |        |
| **Follow-up range, median (months)** | 6–38, 26.8                        | 6–36, 25.0                        | 6–32, 22.1                        | 6–33, 20.8                        | 0.829a |
| **Status (months)**  |                                 |                                 |                                 |                                   |        |
| AND                  | 4 (80.0)                        | 7 (87.5)                        | 5 (55.6)                        | 5 (38.4)                          | 0.039d |
Table 1 Demographics, clinical characteristics, and outcomes of the A-EF, SFIF, PMMF, and TIMF for reconstructing through-and-through cheek defects involving the labial commissure following cheek cancer ablation in 35 patients with buccal squamous cell carcinoma (Continued)

|                | A-EF (n = 5) No. of patients (%) | SFIF (n = 8) No. of patients (%) | PMMF (n = 9) No. of patients (%) | TIMF (n = 13) No. of patients (%) | P-value |
|----------------|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|---------|
| AWD            | 1 (20.0)                         | 1 (12.5)                         | 2 (22.2)                         | 4 (30.8)                          |         |
| DOD            | 0 (0.0)                          | 0 (0.0)                          | 2 (22.2)                         | 4 (30.8)                          |         |

Abbreviations: A-EF Abbe–Estlander flap, SFIF folded extended supraclavicular fasciocutaneous island flap, PMMF pectoralis major muscle flap, TIMF folded extended vertical lower trapezius island myocutaneous flap, rCS clinical staging of recurrence, TR tumor resection, Man mandibulotomy, Max maxillotomy, PM + MM partial maxillotomy plus marginal mandibulotomy, AND alive with no disease, AWD alive with disease, DOD died of disease

Introduction

Reconstruction of through-and-through cheek defects involving the labial commissure following cancer ablation is a surgical challenge. Several methods for reconstructing small- to medium-sized defects and labial commissure defects have been reported, such as the Karapandzic [1], Estlander [2], Abbe–Estlander flap (A-EF) [3], double full-thickness cheek rhomboidal [4], and facial artery musculocutaneous flaps [5]. For the reconstruction of large through-and-through cheek defects involving the oral commissure, several free flaps have been reported, including chimeric flaps from the thigh lower trapezius island myocutaneous flap, rCS clinical staging of recurrence (rCS) [10], and folded extended vertical lower trapezius island myocutaneous flap (TIMF) based on the transverse cervical vessels can also be used [11, 12]. This study compares the outcomes of A-EF, SFIF, PMMF, and TIMF pedicle flaps for reconstructing through-and-through cheek defects involving the labial commissure following cheek cancer ablation.

Patients and methods

The study evaluated 35 patients with buccal squamous cell carcinoma (SCC) involving the labial commissure who underwent a A-EF, SFIF, PMMF, or TIMF for reconstructing through-and-through cheek defects involving the labial commissure following radical resection, between January 2012 and June 2017 at Sun Yat-sen Memorial Hospital, Sun Yat-sen University. The Institutional Review Board of Sun Yat-sen University approved this study. The patients included 20 men and 15 women ranging in age from 44 to 81 (median 59.1) years. According to the 2010 American Joint Committee on Cancer staging guidelines [13], the clinical stages of the disease or recurrence (rCS) were I, II, III + rCS III, and IV + rCS IV in 0, 8 (22.9%), 11 + 7 (51.4%), and 4 + 5 (25.7%) patients, respectively. The recurrences were classified as rCS III in 7 patients and rCS IV in 5. Eight patients were treated with surgery, including ipsilateral radical neck dissection (6 cases) and reconstruction with a pectoralis major myocutaneous flap (4 cases), forearm free flap (4 cases) or Abbe–Estlander flap (1 case), three patients underwent radiotherapy and chemotherapy and one patient underwent radiotherapy alone.

All cases of buccal SCC involving the labial commissure SCC underwent tumor resection and a partial maxillotomy plus marginal mandibulotomy was performed in 14 cases and a total maxillotomy plus total mandibulotomy in six cases; ipsilateral radical neck dissection was performed in 21 cases. The inner dimensions (in cm) of the A-EF, SFIF, PMMF and TIMF skin paddle were 1 × 2 to 2 × 3 (median 1.8 × 2.2), 5 × 3 to 7 × 5 (median 5.5 × 4.3), 6 × 4 to 7 × 5 (median 6.3 × 4.5), and 6 × 6 to 15 × 8 (median 9.8 × 6.7), respectively. The outer dimensions (in cm) were 2 × 2–3 × 5 (median 1.8 × 3.8), 5 × 4–7 × 8 (median 5.5 × 4.6), 6 × 6–7 × 6 (median 6.3 × 6.6), and 6 × 8–15 × 20 (median 9.8 × 13.2), respectively. The mean flap harvesting times in the A-EF, SFIF, PMMF and TIMF groups were 20, 55, 56 and 65 min, respectively. All patients were followed for at least 3 months postoperatively by a panel of three surgeons to assess the esthetic results, orbicularis oris function, and speech function. The esthetic result for the cheek and lip was rated as 1 = unsatisfactory, 2 = satisfactory, and 3 = excellent [14]. The orbicularis oris function was rated as 1 = unable to suction water with a straw, 2 = can suction some water with a straw, and 3 = can suction water with a straw [15]. The speech function was rated as 1 = slurred speech, 2 = intelligible speech, and 3 = normal speech. Table 1 summarizes the data for the A-EF, SFIF, PMMF, and TIMF groups.

The statistical analyses were performed using SPSS 20 (IBM, Armonk, NY, USA). The chi-squared test, independent samples t-test, and Mann–Whitney U-test were used to analyze the data, and the level of significance was set at P < 0.05.
Case reports
Case 1
A 45-year-old man presented with stage II buccal squamous cell carcinoma involving the labial commissure (Fig. 1). Under general anesthesia, the A-EF was drawn along the nasolabial fold, creating a triangular total thickness flap; the flap was used to reconstruct the defect in the commissure following tumor resection and radical neck dissection (Fig. 2). The inner and outer dimensions of the A-EF skin paddle were 1.8 × 3.0 and 1.8 × 2.5 cm, respectively. At the 3-month follow-up, the esthetic result for the cheek and lip was excellent, the orbicularis oris function was rated 3 (can suction water with a straw), and the speech function was rated 3 (normal speech) (Fig. 3). At 23 months, the patient had local recurrence and underwent salvage surgery.

Case 2
A 43-year-old man presented with stage III buccal SCC involving the labial commissure. Under general anesthesia, he was placed on his side at an angle of approximately 45° with the head and neck extended moderately. Tumor resection and neck dissection were performed in this position. The folded extended SFIF
based on the transverse cervical vessels and incisions for the tumor resection are shown in Fig. 4. A foldable flap with a skin paddle including inner (7 × 5 cm) and outer (7 × 8 cm) linings for reconstructing the full cheek defect and labial commissure were created by dissecting the skin in the flap bilaterally (Fig. 5). The flap was pulled through a tunnel to reach distant cheek defects; the medial portion of the flap was used for the buccal mucosa and the distal portion was used for the skin of the cheek following tumor resection and neck dissection (Fig. 6). The donor site was closed directly. At the 6-month follow-up, the esthetic result for the cheek and lip was satisfactory; the orbicularis oris function was rated 2 (can suction some water with a straw), and the speech function was rated 2 (intelligible speech) (Fig. 7). The patient was alive with no evidence of disease at 26 months.
Case 3
A 63-year-old man presented with stage IV buccal SCC involving the labial commissure (Fig. 8). Under general anesthesia, a folded PMMF was used to reconstruct the defect in the commissure (Fig. 9). The flap was based on the thoracoacromial vessels and pulled through a tunnel to reach the distant cheek defect following tumor resection, with a partial maxillotomy plus marginal mandibulectomy and radical neck dissection. At the 4-month follow-up, the esthetic result for the cheek and lip was satisfactory; the orbicularis oris function was rated 2 (can suction some water with a straw) and the speech function was rated 2 (intelligible speech) (Fig. 10). The patient was alive with no evidence of disease at 22 months.

Case 4
An 81-year-old woman presented with stage IV recurrent buccal SCC involving the labial commissure (Fig. 11). Under general anesthesia, a folded extended vertical lower TIMF based on the transverse cervical vessels was raised with the patient in the lateral prone position. The flap was designed to follow the course of the transverse cervical vessels, ensuring that the center of the long axis of the flap was between the vertebral column and the medial border of the scapula (Fig. 12). The flap was raised from its midpoint and proceeded in...
a medial to lateral direction, preserving the upper part of the trapezius muscle; a tunnel was made in the upper part of the trapezius muscle. A foldable flap with a skin paddle including inner (7 × 5 cm) and outer (7 × 10 cm) linings for reconstructing the full cheek defect and labial commissure was created by dissecting the skin in the flap bilaterally (Fig. 13). The donor area was closed primarily. After tumor resection, a partial maxillotomy plus marginal mandibulotomy and radical neck dissection were performed (Fig. 14). The distal portion of the flap was turned to serve as the inner lining or oral mucosa, and the medial portion for the outer lining or skin (Fig. 15). At the 3-month follow-up, the esthetic result for the cheek and lip was satisfactory; the orbicularis oris function was rated 2 (can suction some water with a straw), and the speech function was rated 2 (intelligible speech) (Fig. 16). The patient was alive with no evidence of disease at 27 months.

**Results**

The study included 35 patients (21 men and 14 women). There were no significant differences among the A-EF, SFIF, PMMF, and TIMF groups in terms of age and sex. However, the A-EF and SFIF groups differed significantly (\(P < 0.05\)) from the PMMF and TIMF groups in terms of tumor clinical stage and type of treatment. The inner dimensions of the PMMF (median 6.3 × 4.5) and TIMF (median 9.8 × 6.7) skin paddles were larger than those of the A-EF (median 1.8 × 2.2) and SFIF (median 5.5 × 4.3) groups (\(P < 0.05\)). The outer dimensions of the PMMF (median 6.3 × 6.6) and TIMF (median 9.8 × 13.2) were also larger than those of the A-EF (median 1.8 × 3.8) and SFIF (median 5.5 × 4.6) groups (\(P < 0.05\)). The mean flap harvesting times in the SFIF, PMMF, and TIMF groups were longer than in the A-EF groups. No major complications developed in any patient. One flap failure occurred and no significant difference was observed in the rate of flap among the A-EF, SFIF, PMMF, and TIMF groups. Hemorrhage, orocutaneous fistulas and dehiscence in donor-site occurred in one (20%), two (21.5%), one (11.1%), and three (23.1%) cases in the A-EF, SFIF, PMMF, and TIMF groups, respectively. An urgent exploratory operation was performed to stop the bleeding when a hemorrhage occurred. The flap failures, orocutaneous fistulas and dehiscence in donor-site were treated successfully with debridement. The esthetic results, orbicularis oris function, and speech function were significantly (\(P < 0.05\)) better in the A-EF group than in the SFIF, PMMF, and TIMF groups. The patients were followed for 6–38 months (median 26.8, 25.0, 22.1, and 20.8 months in the A-EF, SFIF, PMMF, and TIMF groups, respectively). At the final follow-up, 4 (80.0%) patients in the A-EF, 7 (87.5%) in the SFIF, 5 (55.6%) in the PMMF, and 5 (38.4%) in the TIMF groups were alive with no disease, while 1 (20.0%), 1 (22.2%), 2 (22.2%),
and 4 (30.8%), respectively, were alive with disease. Two
(22.2%) patients in the PMMF and 4 (30.8%) in the
TIMF group had died of local recurrence or distant me-
tastases at between 9 and 38 months. There was a sig-
nificant ($P < 0.05$) survival difference in the A-EF and
SFIF groups compared with the PMMF and TIMF
groups. Table 1 summarizes the data for the four groups.

**Discussion**

Pedicle flaps play an important role in head-and-neck
reconstruction, even in the era of microvascular surgery
[9–12, 16, 17], not only as an alternative to a free flap
but also because they involve less risk to the patient. In
this study, we compared the outcomes of four types of
pedicle flap for reconstructing through-and-through
cheek defects involving the labial commissure following
cheek cancer ablation: the A-EF based on the superior
labial vessels; the SFIF based on the transverse cervical
vessels; the PMMF based on the thoracoacromial vessels;
and the TIMF based on the transverse cervical vessels.
The four groups were similar in terms of patient age and
sex, and the success rates of the four types of pedicle
flap were very high and there were no significant differ-
ences in the rate of flap failure among the four groups.
The four types of pedicle flap were reliable and safe. Our
results showed that the patients in the PMMF and TIMF
groups were at more advanced tumor stages compared
with the A-EF and SFIF groups, the dissections were
wider. Consequently, the dimensions of the inner and
outer linings of the PMMF and TIMF skin paddles were
larger than for the A-EF and SFIF groups. We believe
that four types of flap have major roles in surgery for
different clinical stages: the A-EF is suitable for recon-
structing defects of clinical stage II disease; the SFIF for
clinical stage II or III disease; the PMMF for clinical stage III or IV; and the
TIMF for clinical stage rCS III or rCS IV disease.

**Conclusions**

The A-EF is suitable for reconstructing defects of clinical
stage II disease; the SFIF for clinical stage II or III
disease; the PMMF for clinical stage III or IV; and the
TIMF for clinical stage rCS III or rCS IV disease.

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**Availability of data and materials**

Data sharing is not applicable to this article as no datasets were generated
or analysed during the current study.

**Authors’ contributions**

W-IC conceived the study, oversaw the design of the study, oversaw all
clinical and technical aspects of the study, helped analyze the data, provided
guidance in the initial draft of the manuscript, and edited and approved the
final version of the manuscript in its current form. YW helped design the
study, collected patient data, analyzed the results, wrote the initial draft of
the manuscript, and edited and approved the final version of the manuscript
in its current form. BZ assisted in study design, collected patient data, and
edited and approved the final version of the manuscript in its current form.
J-KL and RC assisted in study design, collected patient data, and edited and
approved the final version of the manuscript in its current form. All authors
read and approved the final manuscript.

**Ethics approval and consent to participate**

This study was approved by the university’s Institutional Review Board
(Authorization No. 3–528).

**Consent for publication**

Informed written consent was obtained from each participant involved in
the study.
Competing interests
The authors declare that they have no competing interests.

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