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RECONSTRUCTION

COMBINED FREE FLAP RECONSTRUCTION FOLLOWING HEAD AND NECK CANCER RESECTION: CHIMERIC AND DOUBLE FREE FLAP RECONSTRUCTION

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ABSTRACT

Background: Head and neck reconstruction following cancer resection remains a challenge for surgeons. Microsurgical free tissue transfer is the technique of choice to close the defect. Extensive complex defects resulted from radical excision often require two free flaps to provide adequate bony structure and soft tissue coverage.
Method: Three cases following head and neck cancer resection that require reconstruction with two combined free flaps were reported. The combination of two free flaps between vastus lateral free flap, radial forearm free flap, and free fibular flap was reviewed in this study. The patients were then followed up for 1-2 months.
Result: Two of the patients had a flow through chimeric free flap between radial forearm free flap and free fibular flap to reconstruct the maxillary, palatal and mandibular defect. One patient had a combination of free fibular flap and vastus lateral free flap to reconstruct the mandibular defect. No complications were observed in all patients. All the flaps were vital without donor site morbidity. However, two patients needed secondary procedures for further reconstructions.
Conclusion: Combined free flaps are reliable for closing the complex defect after wide resection of head and neck cancer. They can provide adequate tissues, reduce recipient site morbidity, permit simultaneous reconstruction with two-team approach. Therefore, provide a practical method of defect coverage for these patients.
Keywords: *Combined free flap, Chimeric free flap, Free fibular flap, Radial forearm free flap, Vastus lateral free flap, and Head and Neck Cancer*

Latar Belakang: Rekonstruksi kepala dan leher pasca reseksi kanker merupakan tantangan bagi ahli bedah. Operasi mikro transfer jaringan bebas biasanya digunakan untuk menutup defek. Cacat kompleks luas yang terjadi pasca eksisi radikal terkadang membutuhkan dua flap bebas untuk memberikan struktur tulang dan jaringan lunak yang cukup. Kombinasi dua flap bebas dari flap bebas *vastus lateralis*, flap bebas *radial forearm*, dan flap bebas fibula digunakan dalam penelitian ini.
Metodologi: Tiga kasus defek kepala dan leher pasca reseksi yang membutuhkan rekonstruksi dengan dua flap bebas gabungan dilaporkan. Dua pasien dilakukan pembuatan aliran melalui flap bebas *chimeric* antara flap bebas *radial forearm* dan flap bebas fibula untuk ,merekonstruksi defek maksila, palatum dan mandibula. Satu orang pasien mendapat rekonstruksi defek mandibula dengan mengombinasikan flap bebas fibula dan flap bebas vastus lateralis. Pemantauan lanjutan dilakukan hingga 1-2 bulan pasca operasi.
Hasil: Tidak ditemukan komplikasi pada semua pasien. Semua flap vital tanpa adanya morbiditas pada lokasi donor. Rekonstruksi sekunder diantisipasi pada dua pasien.
Kesimpulan: Kombinasi flap bebas sangat ideal untuk menutup defek yang kompleks setelah reseksi luas pada kanker kepala dan leher. Hal tersebut dapat menggantikan komposit yang cocok pada jaringan yang hilang, meminimalisir morbiditas penerima, memungkinkan dilakukannya rekonstruksi secara bersamaan dengan pendekatan dua tim, sehingga menawarkan metode penutupan defek yang aplikatif dilakukan bagi pasien seperti ini.
***Keywords**: Combined free flap, Chimeric free flap, Free fibular flap, Radial forearm free flap, Vastus lateral free flap, and Head and Neck Cancer*

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BACKGROUND

Head and neck reconstruction following cancer resection possess a challenge for surgeons. This region contributes a significant role in appearance, therefore the high reconstructive skills are needed to provide a good aesthetic result. The large complex defects resulted after the radical tumor excisions need three-dimensional reconstruction: the bone that provides load and structure, inner mucosa lining, and external cover that provides a barrier. [1]

The ideal reconstruction should replace the removed tissues in the similar form of shape, geometry, and quality of injured stuctures.[2] Micro-surgical free tissue reconstruction enables reconstruction of massive defect on head and neck. A single free flap, usually in the form of a composite flap, can be harvested to close the entire defect. However, a composite flap may provide a sufficient quantity of tissue, but the spatial configuration of the flap is not always ideal.[3] A combination of two flaps is an ideal alternative to close a complex mixed defect. The combined flap can overcome the need for both bone and soft tissue reconstruction for total reconstruction.[4]

This study provides three cases with extensive composite defect post wide excision of the head and neck cancer. The combined free flap was done between two flaps in chimeric and double flaps fashion. Surgical technique and consideration in choosing such flaps were also discussed.

PATIENT AND METHOD

Case 1.

A 13-year-old girl diagnosed with ossifying fibroma of the left maxilla (Fig. 1A). The Oncologic Surgeon team performed left subtotal maxillectomy. Hard palate was removed with preservation of soft palate. The outer skin was intact. The defect of the palate (outer mucosal lining) was 4x4 cm, and the maxillary defect was 4.5 cm (Fig. 1B). A fibular osteocutaneous flap was harvested during tumor excision with skin paddle of 10x6 cm. When the flap was harvested, no bleeding was found on the vitality test of the skin paddle. The author decided to harvest only the vascularized fibular bone flap (FFF). A 20 cm of fibular bone was harvested, and the osteotomy was done to yield 2 bone segments that connected through 1 pedicle: 2 cm and 4.5 cm length of the fibular bone.

The author decided to harvest a radial forearm free flap (RFFF) to resurface the oral lining of the hard palate. A 6.5x5.5 cm skin flap of RFFF harvested. Anastomosis between the radial artery and peroneal artery (FFF) was done first (Fig. 1C). Next, the other end of the peroneal artery of FFF was anastomosed with the recipient vessel of facial artery, which made a flow-through chimeric flap (Fig. 1D). RFFF's skin paddle was inset to close the hard palate defect; while the vascularized fibular bone flap was used to replace the left maxillary bone (Fig. 1D and E). The non-vital skin paddle of FFF was thinned to obtain a full thickness skin graft (FTSG) to close the donor defect of the fibular flap and radial forearm flap. Six months following the surgery, a vital thin tissue has replaced the excised hard palate with a good contour of maxilla region (Fig. 1F).

Case 2

A 32-year-old woman was diagnosed with osteosarcoma of the right mandible. Patient was consulted from oncologic surgery division with wound dehiscence following subtotal mandibulectomy and plate removal (Fig. 3A). the patient was performed a subtotal mandibulectomy of the left mandible and placement of a reconstruction plate to replace the left mandible. The defect was closed primarily. A week after, there was wound dehiscence with exposed plate. They performed debridement and plate removal and decided to consult to plastic surgery division.

Tissue biopsy from the first surgery showed there was still atypical cells from the incision border of the remaining mandible bone. Therefore, the oncologic surgery team performed a total mandibulectomy. After the resection, there was an extensive composite defect of the whole mandible, left buccal mucosa, outer skin lining of left buccal, and inferior left commissure of the lips (Fig. 3B). Reconstruction was conducted with, initially, a 7x7 cm of radial forearm free flap (RFFF). Anastomosis end-to-end was done between the radial artery and cephalic vein of RFFF and the recipient vessels of superior thyroid artery and jugular vein.

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Skin paddle of RFFF was inset to close the defect of the outer buccal skin and also folded-in to provide the left inner buccal mucosal lining and to become left commissure of the lips (Fig. 3D). Next, a free fibular flap was harvested with a skin paddle sized 11x6 cm. An osteotomy was done to the fibular bone that resulted in two bone segments, 4-cm long each. The fibular bone was placed on the reconstruction plate to form a mandible arch. Molded reconstruction plate along with fibular bone was inset to replace the whole mandibular bone. Skin paddle of FFF was used to close the exposed reconstruction plate and bone (Fig. 3D).

Anastomoses were conducted between the peroneal vessels of FFF to another end of radial and cephalic vessels of RFFF, which made a flow-through chimeric flap (Fig 3C). The RFFF donor was closed with FTSG from the left inguinal, whereas the FFF donor was closed primarily.

An 11-month follow up period showed a vital tissue of intraoral and buccal region. Though she still experiencing drooling because of an inadequate lips mucosa, secondary reconstruction will overcome this problem.

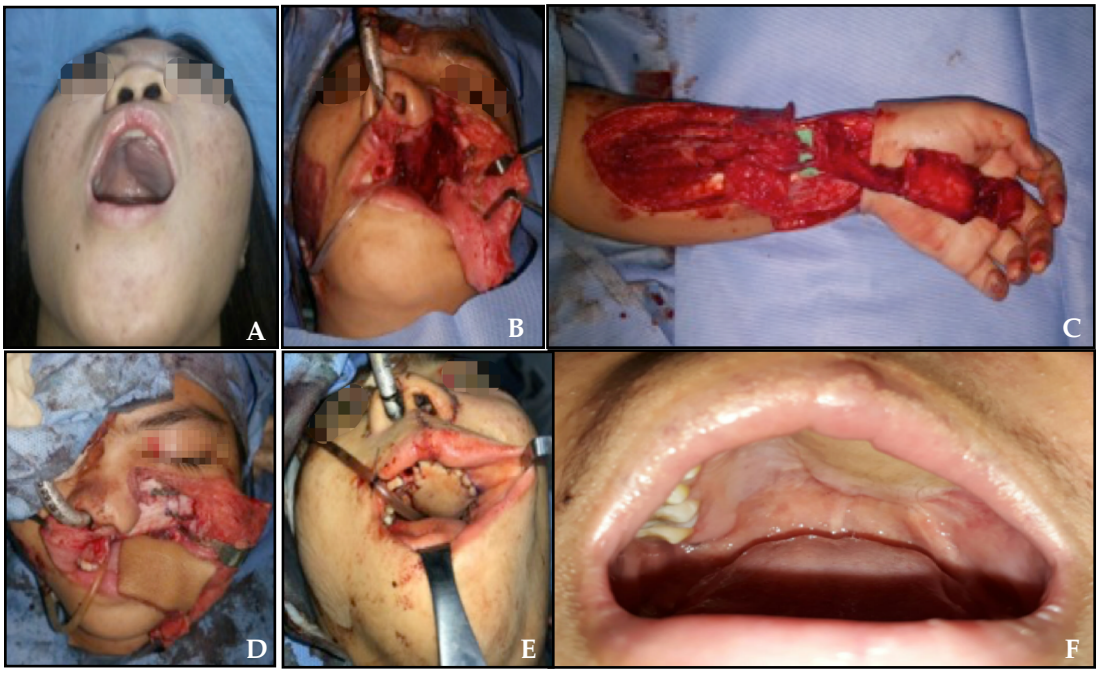

Figure **1. (A).** Preoperative view showed a bulging mass into a hard palate. **(B).** A defect resulted after excision, including half of the hard palate until alveolus and right maxilla bone. The outer skin was intact. **(C).** The first anastomosis was done between the radial forearm free flap (radial artery) and the vascularized fibular bone flap (peroneal artery). **(D).** The now combined FFF and RFFF was then connected into the recipient vessels of the facial artery via another end of the peroneal artery (flow-through chimeric free flap). **(E).** Immediate post operation showed RFFF skin paddle was used to replace the excised hard palate. **(F)** 6 months following the operation showed a vital and thin tissue replacing the hard palate. F: free fibular flap; rf: radial forearm free flap.

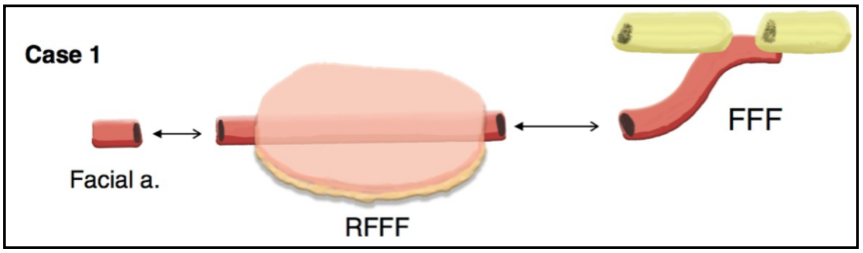

Figure 2. Schematic diagram of flow through chimeric free flap between tha facial artery as a recipient, radial forearm free flap, and free fibular flap

Figure 3. (A). The pre-operative picture showed wound dehiscence and defect in the left mandibular and buccal area. **(B).** Composite defect after re-excision: the whole mandible, left buccal mucosa, outer skin lining of left buccal, and inferior left commissure of the lips. **(C)** A Flow-through chimeric free flap between RFFF and FFF was insetting to close the defect. **(D)** Immediate after operation **(E)** 11 months follow up showed a vital tissue replacing intraoral and buccal region, though subsequent reconstruction is anticipated. F: free fibular flap; rf: radial forearm free flap

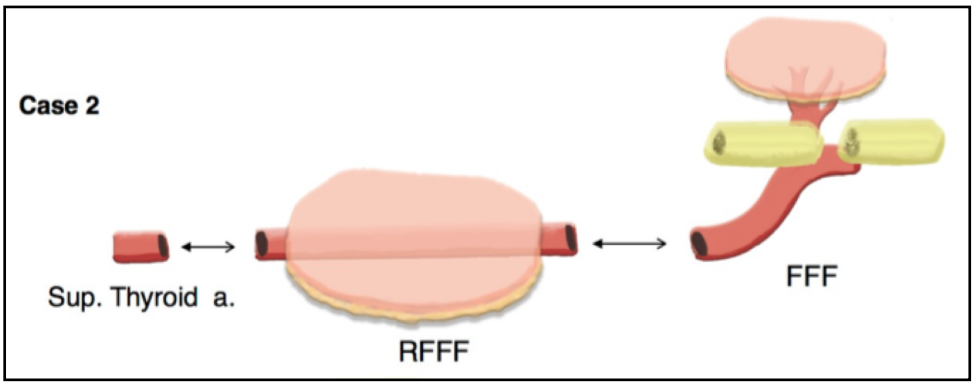

Figure 4. Schematic diagram of flow through chimeric free flap between the facial artery as a recipient, radial forearm free flap, and free osteocutaneous fibular flap

Case 3

An 11-year-old boy presented with ameloblastoma of the right mandible. There was a large mass sized 15x10x10cm protruding from the intraoral region (Fig. 5A). The mass almost occluded the airway. Consequently, a tracheostomy was performed by the oncologic surgeon to secure the airway. The oncologic surgery team performed a right hemimandibulectomy and left sub total hemimandibulectomy. The mandible was excised from right condyle until left angle. Following the tumor excision, soft tissue deficiency was observed on the right inner buccal area and floor of the mouth; meanwhile, the outer skin was still intact (Fig. 5B). Reconstruction was conducted by harvesting a free fibular flap with skin paddle first. Reconstruction plate along with fibular bone was inset to replace the excised mandible. Anastomoses were performed between the peroneal artery of FFF and a branch of internal carotid artery as the recipient's vessels. After anastomoses, the skin paddle of FFF was found non-vital (no bleeding from the scratch test). The author decided to harvest another flap to fill the soft tissue deficiency and preserved the bone from the free fibular flap as a vascularized bone flap (Fig. 5C).

Anterolateral thigh flap (ALT) was then harvested and lateral circumflex femoral artery (from the ALT) was anastomosed to another branch of the internal carotid artery. After anastomoses, the ALT skin paddle found compromised (from the scratch and Doppler test). The author decided to include only the muscle of the ALT (as a vastus lateral free flap) to fill the defect of the right buccal area tissue deficiency (Fig. 5C).

The outer skin of buccal, lower lips, and mental area can be placed back and sutured primarily (Fig. 5D). Both of the donor sites were primarily sutured.

A one-year follow up showed a vital intraoral tissue, but there was still a soft tissue deficiency visible from the right buccal region (Fig. 5E). Secondary reconstruction was anticipated.

Figure 5. (A). The pre-operative picture showed a large mass protruding from the intraoral region. **(B).** Wide defect after re-excision: parts of the mandible (right condyle until the left angle of mandible), right buccal mucosa, and floor of the mouth. **(C)** A double free flap between free vascularized fibular bone flap (f) and vastus lateral free flap (vl) was anastomosed to the two terminating branches of the internal carotid artery **(D)** Immediate after the operation. **(E)** 1 year follow up showed a vital intraoral tissue. There was still a soft tissue deficiency visible from the right buccal region. F: free fibular flap; rf: radial forearm free flap

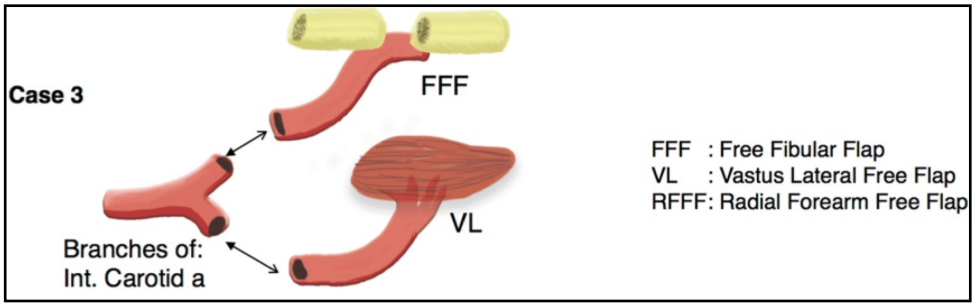

Figure 6. Schematic diagram of flow through chimeric free flap between tha facial artery as a recipient, radial forearm free flap, and free osteocutaneous fibular flap

BACKGROUND

Case 1

Follow-up of 6 months after the operation showed a vital thin tissue replacing an excised hard palate with a good contour of maxilla region (Fig. 1F).

Case 2

The 11-month follow-up period showed a vital intraoral tissue and buccal region. Though she still experiences drooling because of an inadequate lips mucosa, secondary reconstruction will overcome this problem.

Case 3

The 1-year follow-up period showed a vital intraoral tissue, but there was still a soft tissue deficiency visible from the right buccal region (Fig. 5E). Subsequent reconstruction was anticipated.

DISCUSSION

An ideal free flap for head and neck reconstruction should meet the following criteria: versatility in design, adequate tissue volume, proper texture, availability of diverse tissue types on one pedicle with consistent anatomy, easy and safe flap dissection, feasibility of a two-team approach, and minimal donor site morbidity.[5,6] When one free flap cannot meet those following criteria, the use of combined two flaps is needed to be considered. The combined flap has been used in extraordinary circumstances where usually the simultaneous restoration of multiple missing tissue components is mandatory.[1] In this series, we used the combination of two free flaps in chimeric and double flaps fashion.

In this study, all patients used the free fibular flap to reconstruct the bony defects. Two patients used only the vascularized free fibular bone, while one patient used fibular flap as an osteocutaneous flap. The location of the peroneal artery perforator was identified pre-operatively using handheld a Doppler device. The fibular flap is a superior flap that could provide the bony structures rather than the other sources of bone flap (Iliac crest, scapular, bone graft). It has an outstanding length of pedicle for harvest, a reliable blood supply, minimal donor site morbidity and allows the use of the osseointegrated implant for later reconstruction.[1]

All of the patients had extensive soft tissue defect, and the author decided to add another flap to cover the defect. In the first two patients, another flap was attached in a chimeric fashion. The flaps used were radial forearm free flap and vascularized fibula bone flap. Both of the chimeric flaps used RFFF as the proximal flap to be anastomosed with recipient's vessels.

The consideration in choosing the RFFF as proximal flap is because the vessel's caliber is wider than those on the FFF. According to Poiseuille's equation (1846): [9]

$$F = \frac{\Delta P.\ \Pi.r^4}{8.\ \xi.L}$$

In which
F = flow
P = pressure difference between the ends of the tube
r = radius of the tube
ξ= coefficient of viscosity
L = length of the system

According to the equation above, if viscosity and pressure remain constant, the flow within vessels of equal length would be proportional to the fourth power of the radius of each vessel.[9] Therefore, in the chimeric flap, flap with bigger caliber vessels is preferred to be anastomosed with recipient's vessels, because a bigger caliber vessel will make a more significant flow and volume of blood. In which the distal vessels of the flap will receive equally the same flow and volume of blood with the proximal anastomosed vessels.

Both of chimeric flaps had inserted a skin flap to cover the outer defect. Evaluation was done to the farthest skin paddle to the main anastomoses of the recipient site. If the distal skin flap was vital, it indicated a vitality of the whole chimeric flap.

The chimeric flap, as described by *Hallock*, consists of multiple flaps, each with its individual blood supply, but all pedicles are linked to a common vessel.[7] *Huang et al.* further subdivided chimeric flaps into three subtypes based on their specific blood supply: perforator based, branch based and fabricated (sequential and internal) (Fig 4).[8] The branch-based chimeric flaps are nourished by direct branches from the arterial pedicle (e.g. latissimus dorsi and serratus anterior muscle flap, scapular, parascapular, and ascending scapular fascial flaps). Perforator-based chimeric flaps are nourished from 1 mother vessel, and the cutaneous component of this flap can be separated into two skin paddles with at least one cutaneous perforator for each. [8]

In the pre-fabricated chimeric flap, another flap component is added to a simple flap by microvascular anastomosis to a branch of axial vessels.[8]

CONCLUSION

Combined free flaps are an ideal procedure to close the complex defect after wide resection of head and neck cancer. They replace suitable composite loss tissues, minimalized recipient site morbidity, permit simultaneous reconstruction with a two-team approach, and also offer the best possible treatment to the cancer patients.

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