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Finesse in Damage Control Reconstruction for Trauma in Plastic Surgery

Shihheng Chen, Hung-Chi Chen and Yueh-Bih Tang

Abstract

Reconstructions of body, extremity and facial resurfacing facial defects are common encounters in plastic surgery. It may be owing to trauma, burn injury, tumor, congenital anomalies, miscellaneous kinds of malignancies. The face has its specific landmarks: the forehead, eyebrows, eyes with upper and lower eyelids, orbit, midface (nose, maxilla, zygoma), upper lip, cheeks, nasolabial folds, lower face (lower lip, mandible with angle), oral mucosa (buccal mucosa, upper lip sulcus, lower lip sulcus), mentum, and neck. Anatomical landmarks include forehead, eyebrow, and eyelids: upper/lower, orbit, midface: nose, maxilla, upper lip, nasolabial folds, and zygoma. Lower face: lower lip, mandible, oral mucosa, buccal mucosa, upper lip sulcus, lower lip sulcus. Strategic approaches include the following: tissue expansion, resection of tumor, and repair with resurfacing, repair of multilayer defect repair for functional purpose. Reconstruction for trauma is commonly encountered in the daily practice in plastic surgery. The trauma may be caused by miscellaneous causes, including traffic accident, fall, cutting, avulsion, contusion, electrical injuries, irradiation injuries, chemical injuries, etc., resulting in disfigurement, deformity and functional disabilities. The strategic approach is to achieve anatomical restoration, functional rehabilitation and aesthetic refinements for the afflicted individuals. Pursuing excellence in plastic surgery, bringing excellence to life is always the ultimate goal for plastic surgeons.

Keywords: reconstruction, anatomical restoration, functional rehabilitation, strategic approaches, aesthetic refinements

1. Introduction (Plastic surgery)

1.1 Anatomical restoration functional rehabilitation, aesthetic refinement are main goals in plastic surgery

The aim of plastic surgery is to achieve anatomical restoration, functional rehabilitation, aesthetic refinements.

1.1.1 Functional reconstruction for trauma

Post-trauma functional reconstruction involves solving scar contractures, restoration of nerve function, tendon or muscle function or body integrity.

1.1.2 Extremity reconstruction for trauma

Trauma to the extremities include partial or complete severance of body parts, injuries to major artery, vein, or nerve or tendon, all may cause different degree of functional disabilities and possible disfigurement.

1.1.3 Aesthetic facial reconstruction for trauma

Trauma at face with tissue defects are common encounters [1]. It may be caused by laceration, avulsion, contusion, burn injury, electrical injury, tumor, congenital anomalies [2–4], infections [5], miscellaneous kinds of malignancies and related treatments [6–9], radiation necrosis [10–11], etc.

1.1.4 Demarcation

The face has its specific landmarks [8]: the forehead, eyebrows, eyes with upper and lower eyelids, nose, upper and lower lips, cheeks, nasolabial folds, mandible with angles and mentum, and neck. Dynamic facial expressions and chewing, mastication are specific functions of face.

2. Strategic approaches

Strategic approaches should follow the demarcation of anatomical landmarks as the following:

- Forehead
- Eyebrow
- Eyelids: upper/lower
- Orbit
- Midface: nose, maxilla, upper lip, nasolabial folds, zygoma
- Lower face: lower lip, mandible, oral mucosa (buccal mucosa, upper lip sulcus, lower lip sulcus)

2.1 Methods of facial reconstruction

Methods commonly applied for facial resurfacing can be categorized as the followings:

- Tissue expansion
- Resection of tumor
- Repair with resurfacing
- Repair of multilayer defect
- Repair for functional purpose
- Recontouring with tissue restoration

Selection of method for facial resurfacing depends on location, etiology, functional and aesthetic considerations on each specific individual demands.

In this chapter, many kinds of situations for facial resurfacing are to be presented, with discussions explicitly depicted for each strategic approach.

3. Case presentations

1. Resurfacing with tissue expansion

The patient sustained avulsion injury of right side forehead, resulting in a palm sized uneven unsightly scar. The right side temple and mid-forehead skin was then expanded by using 2 tissue expanders. Thereafter, the grafted area was removed with sufficient expansion of the forehead skin, which brought about much improved esthetic result (**Figure 1**).

2. Tissue expansion at grafted skin for auricular reconstruction.

This 18 y/o boy had a big AVM at left ear and temple, which was excised and the ear was 3/5 amputated and then skin grafted during his childhood.

To reconstruct his left ear, a 70 ml tissue expander was placed underneath the grafted skin. With gradual expansion at grafted skin, implantation of a carved rib cartilage graft for recontouring of his left ear was accomplished (**Figure 2**).

3. Facial resurfacing with resection of underlying AVM (arteriovenous malformation) at parotid gland, where skin had been expanded with the growth of the AVM.

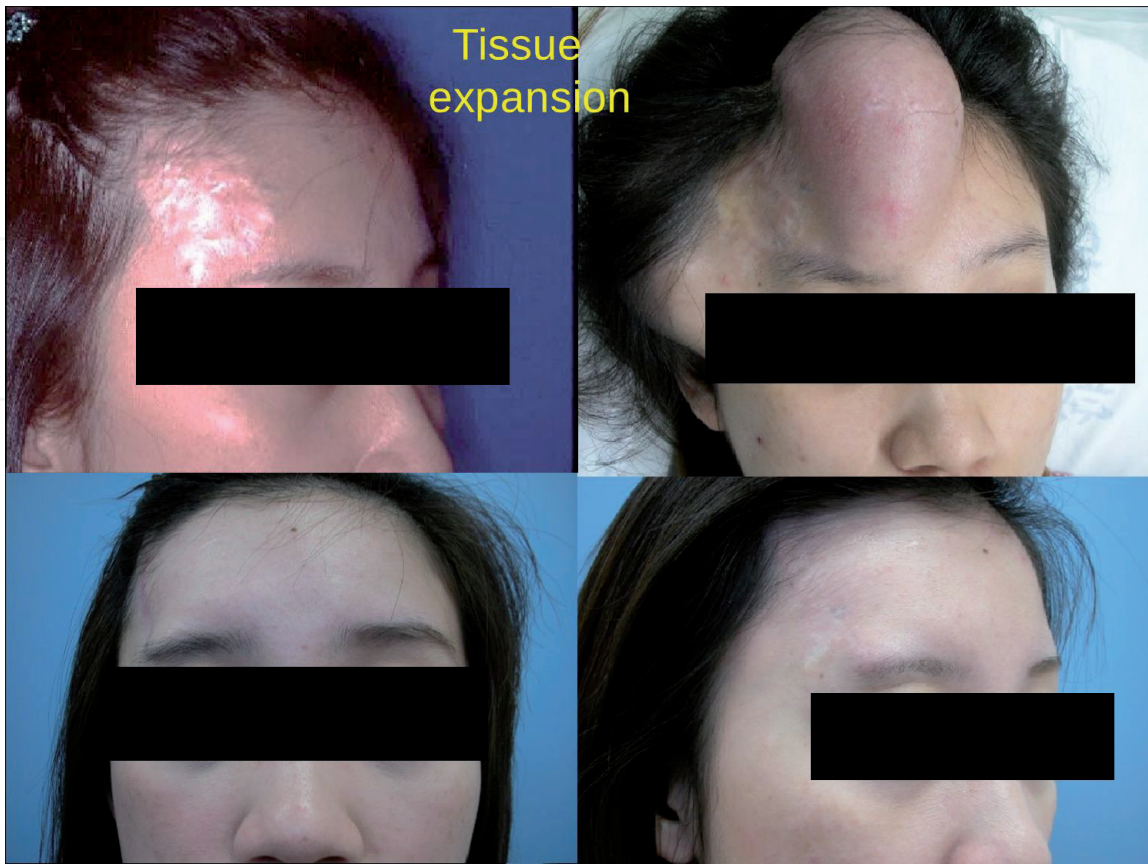


Figure 1.
Right forehead scar, treated with tissue expansion of neighboring flaps, excision of scar with primary closure. The remaining scar can be inconspicuous.

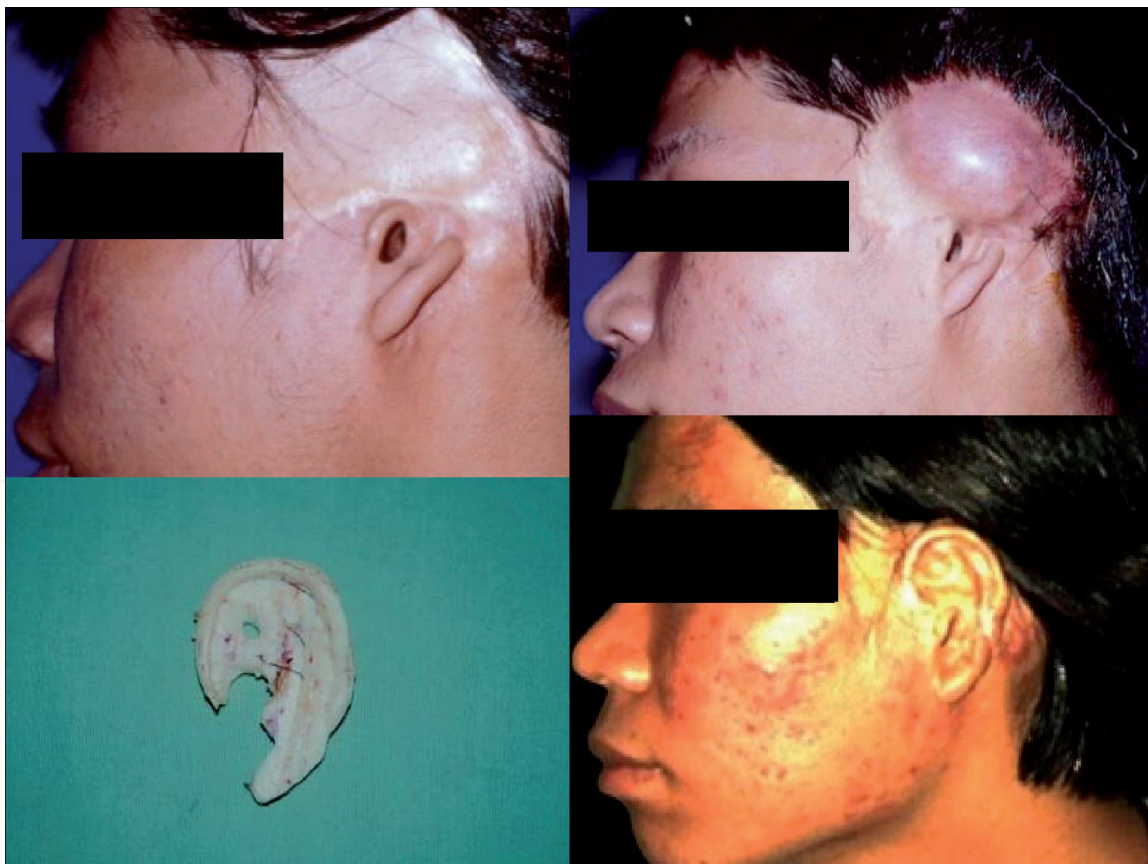


Figure 2.
Tissue expansion at grafted skin to accommodate a three dimensional carved auricular framework taken from costal cartilage block.

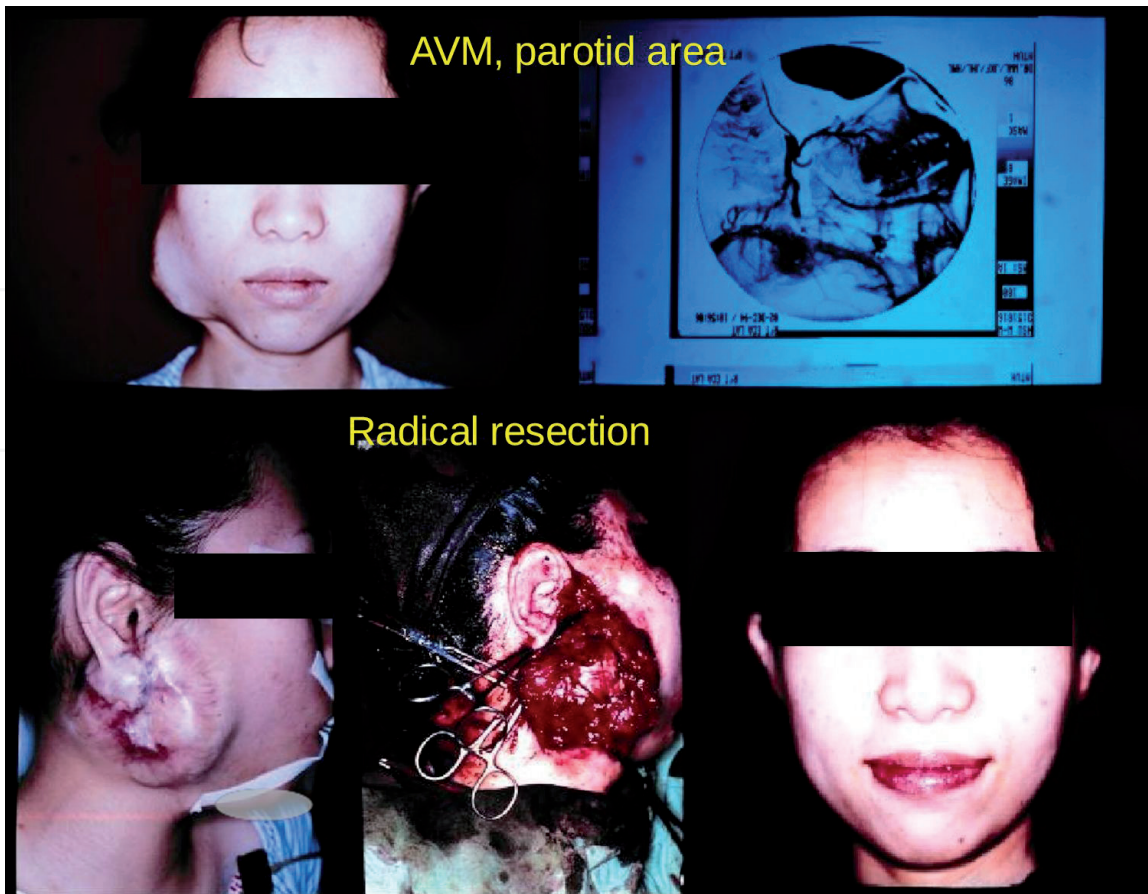


Figure 3.
With complete resection of the underlying AVM, the wound can be closed with pre-expanded skin flaps. The sunken right parotid area was filled with fat graft injection after 2 years. The patient regain satisfactory facial contour without facial asymmetry.



Figure 4.
Chemical burn facial contracture treated with: (1) resurfacing of nose with thick STSG; (2) releasing upper and lower eyelid scar contracture with FTSG; (3) resurfacing upper lip scar with FTSG; and (4) releasing forehead scar contracture to lower down the eyebrow and reconstruct left side forehead hairline with axial pattern scalp flap; followed by Kenacort A injection at remaining scars. Restoration of facial contour and symmetry was obtained.



Figure 5.
This girl got assaulted with H₂SO₄, resulting in facial skin necrosis. Early tangential excision with early grafting following functional esthetic unit principle gave the girl a smooth, symmetric face.

4. The AVM was totally resected after arterial embolization, with complete preservation of the underlying facial nerve. After 2 years, fat grafting [9–11] was performed to fill the slightly sunken right parotid area. The patient regained satisfactory facial contour without facial asymmetry nor dynamic facial nerve dysfunction (**Figure 3**).
5. Facial scar contracture with ectropion, eyebrow asymmetry, nasal deformity and hypertrophic scarring. Anterior hairline reconstruction with hair-bearing scalp island flap, FTSG of bilateral upper and lower eyelids after release of scar contracture, thick STSG at nose and FTSG at upper lip after excision of hypertrophic scar were performed. The patient regained a smooth and symmetric face (**Figure 4**).
6. Major facial resurfacing with functional aesthetic unit concept and eyebrow scalp grafting (**Figure 5**) as primary treatment of a severe chemical burn patient (**Figure 5**).
7. Orbital reconstruction with free dorsalis pedis flap, conchal chondrocutaneous grafts, fat grafting, eyelash grafting with composite scalp graft (**Figure 6**).
Expansion of orbital socket dimension with chondrocutaneous composite graft. Correction of enophthalmos with fat grafting and accommodation of an appropriate size of eye prosthesis, lateral canthopexy, creation of supratarsal fold, strip hair composite graft for eyelash followed.
8. The patient suffers from radiation necrosis of palate, resulting in a sizable palatal defect and scar contracture of soft palate and uvula.



Figure 6.
Reconstruction of left orbital socket lining with dorsalis pedis free flap.

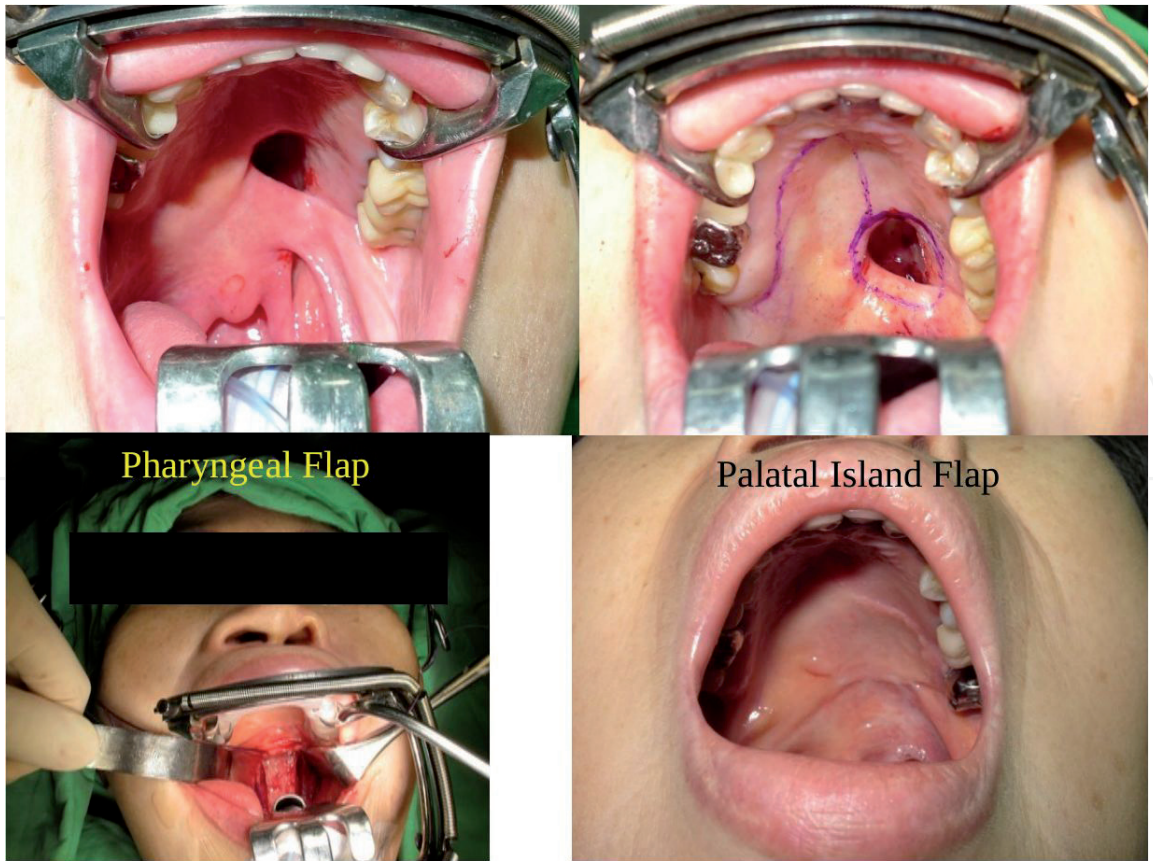


Figure 7.
(a) Radiation necrosis of hard palate and soft palate. (b) Right palatal flap was employed to repair the big oronasal fistula. (c) Pharyngeal flap was employed to hold the shortened uvula in order to ameliorate nasopharyngeal insufficiency.

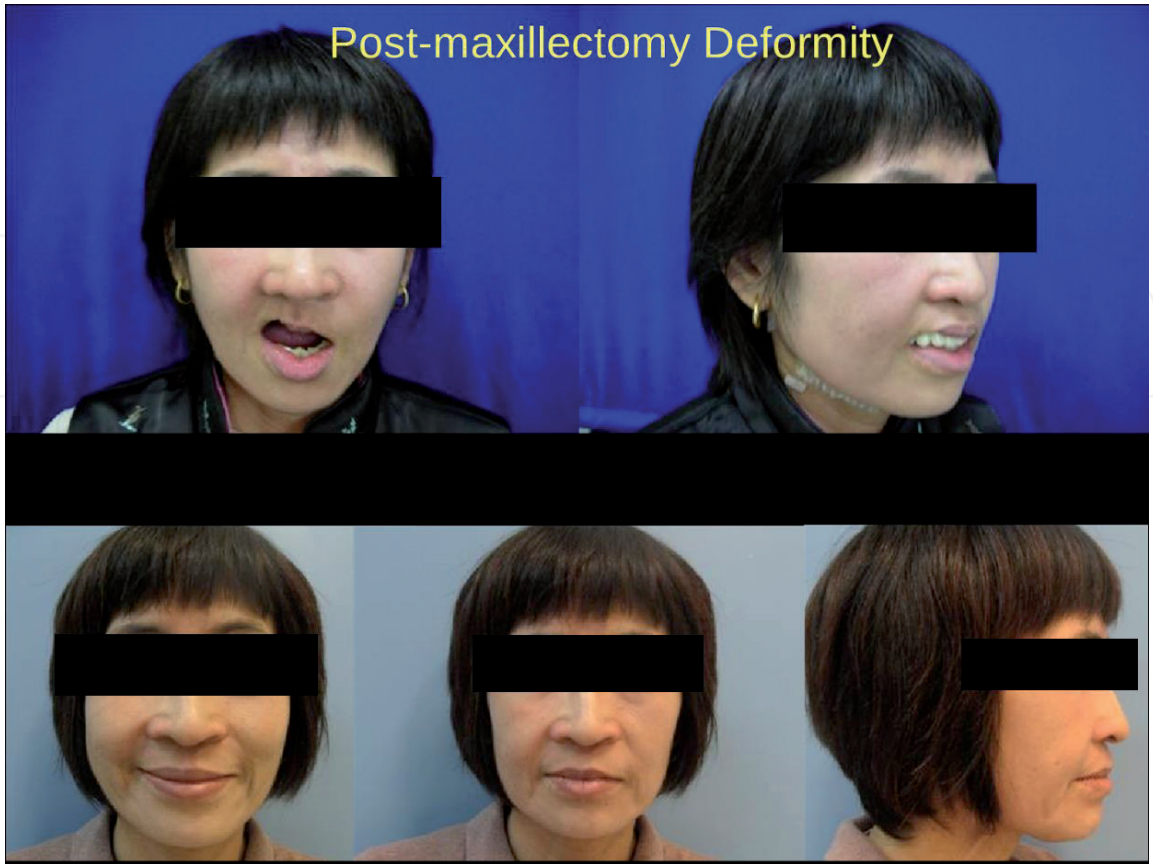


Figure 8.
Significant deformity after right maxillectomy for cancer.

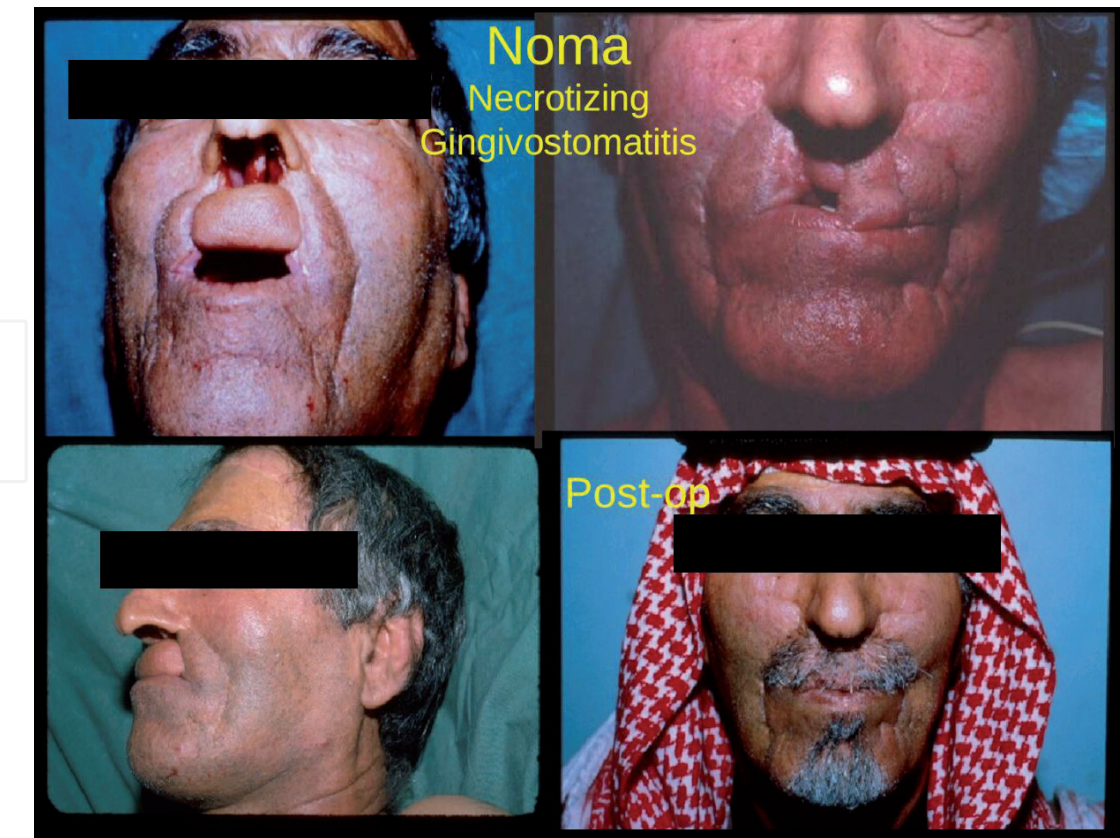


Figure 9.
This 57 y/o patient lost his upper lip, nasal base, and columella due to necrotizing gingivostomatitis. He had ever received upper lip reconstruction with forehead flap; however, the result was disappointing.

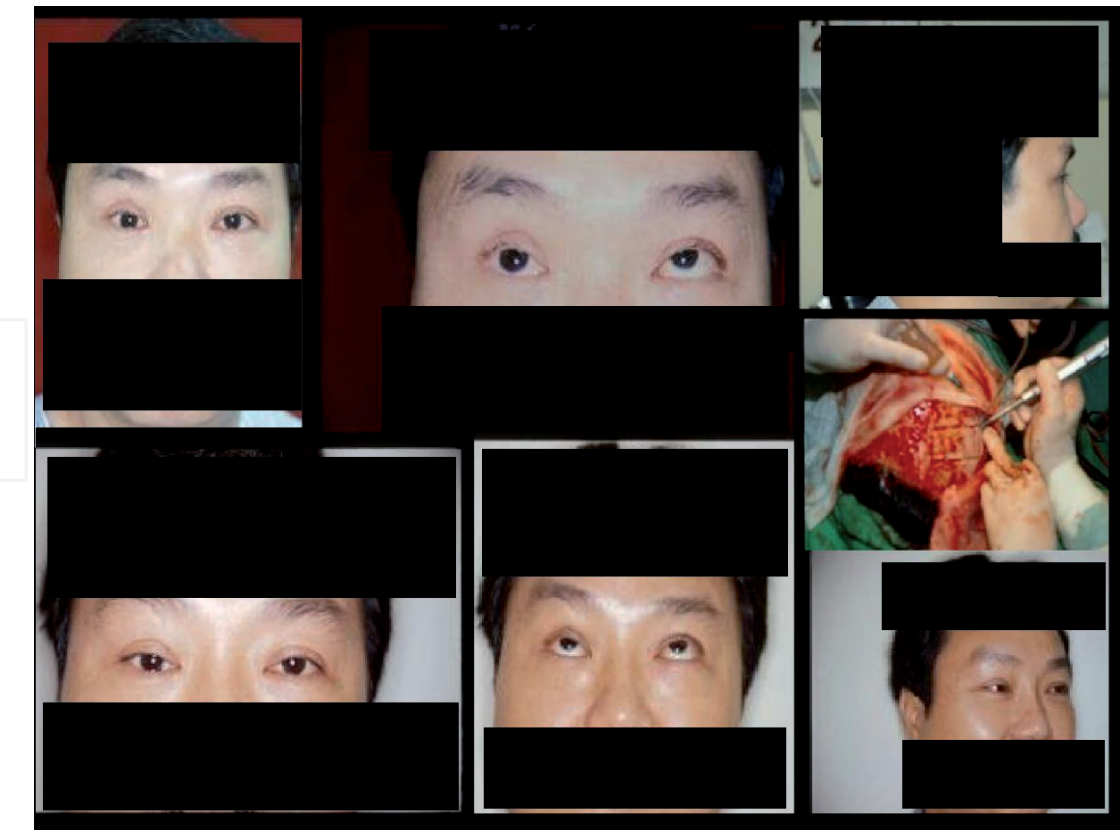


Figure 10.
Upper row: This patient got a panfacial fracture after a bad trauma. Diplopia owing to right orbital floor blow out fracture with enophthalmos and ptosis, flattening of nose due to untreated LeFort I, II, III maxillary fracture and displacement bothered him. Right middle: Calvarial bone grafting taken from the outer table of parietal bone was used to correct flat nose and right orbital floor bone defect, diplopia and enophthalmos (lower row). The patient was happy with the result.

Palatal arterial island flap of the right side was employed to cover the big palatal defect, and nasopharyngeal insufficiency was corrected with the use of pharyngeal flap to hold the uvula [2]. After the reconstruction, the patient was able to regain an intelligible speech (**Figure 7a–c**).

9. Significant deformity after right maxillectomy for cancer.

Full thickness skin graft for maxillary contracture after complete release of the intraoral contracture was employed for reconstruction, followed by fitting a proper right maxillary obturator and upper denture (**Figure 8**).

Full thickness skin graft for maxillary contracture after complete release of the intraoral contracture was employed for reconstruction, botox injection to lessen the activity of levator labii superioris, add volume to right side upper lip with hyaluronic acid, followed by fitting a proper right maxillary obturator and upper denture. The patient was happy to resume to a near normal appearance.

10. Reconstruction of complex upper lip, nasal floor and columella defect.

The upper lip (**Figure 9**) flap was turned up to reconstruct the columella and nasal base, then Abbe flap from mid-lower lip was employed to reconstruct the

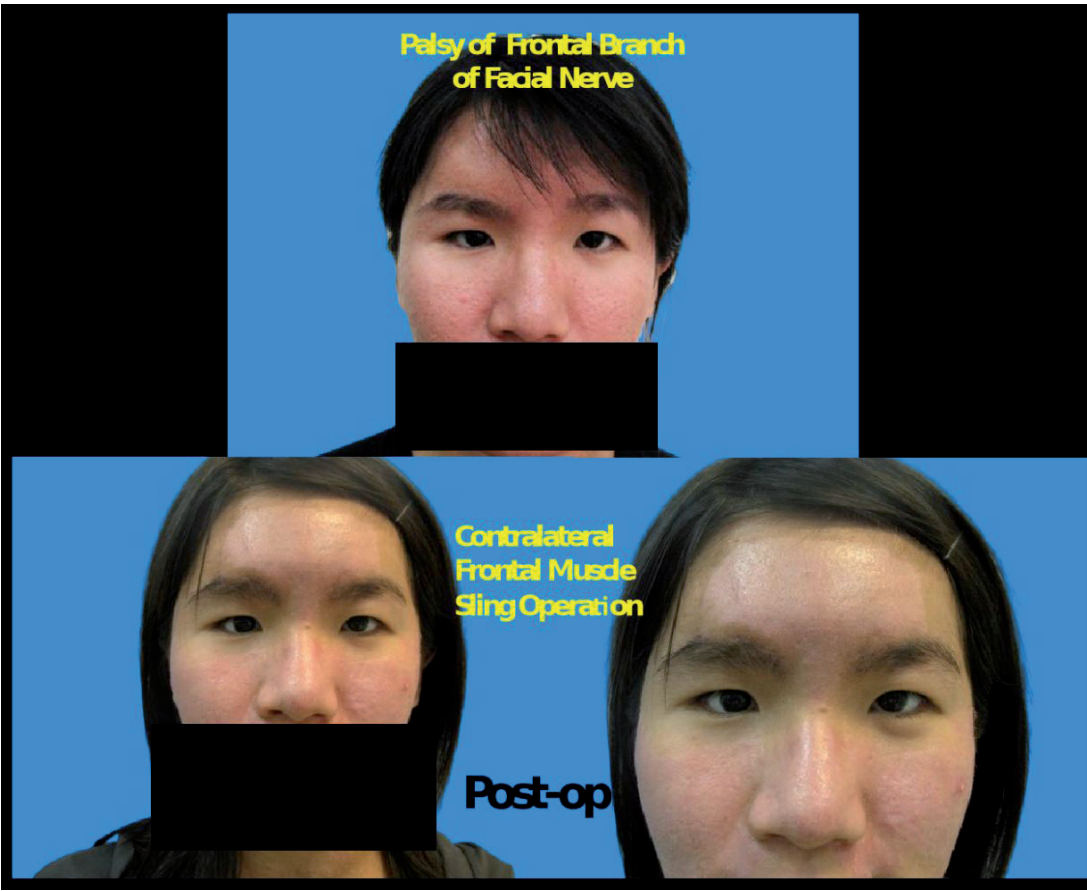
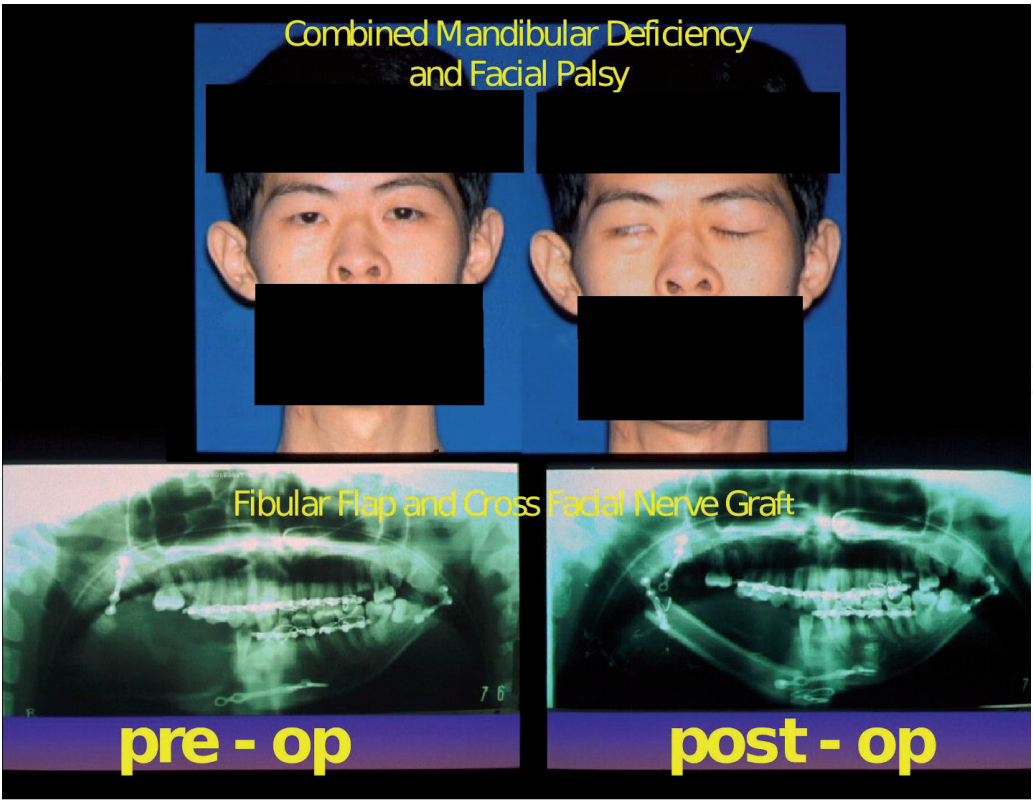
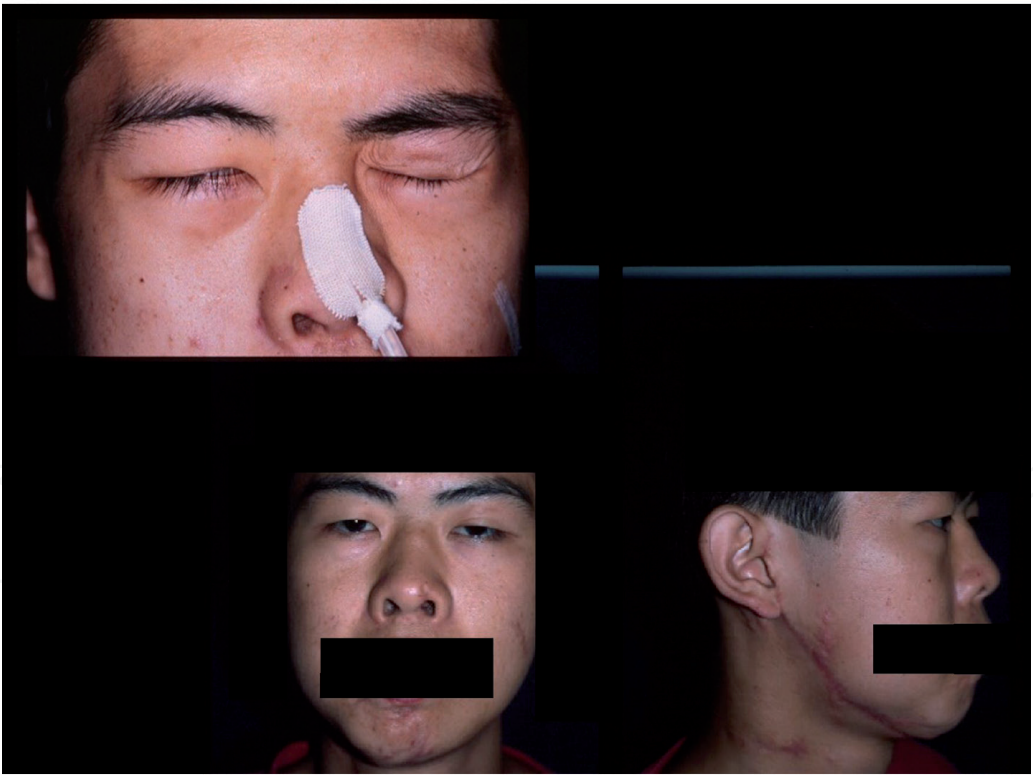


Figure 11.
This girl was a victim of train crash, resulting in avulsion laceration of right frontal area with frontal branch of facial nerve avulsion as well as zygomatic-orbital fracture displacement. She sustained palsy of right frontal branch facial nerve 8 months after operation, with asymmetry of right upper eyelid and eyebrow. Sling operation was employed with medial strip of frontal myoperiosteal flap to bring right eyebrow up to the right position. Upper row: pre-op; lower row: post-op.



(a)



(b)

Figure 12.
(a) This 18 y/o boy was hit by a fallen wall during work, which resulted in compound comminuted fracture of right mandibular body, as well as right facial palsy and glossopharyngeal nerve palsy. Plating of right mandible was not successful, he was left with right mandibular defect and right facial palsy. He was referred to us 3 months later; then, we did free vascularized fibula mandibular reconstruction with concomitant cross facial nerve grafting at the same operation. After 3 months, the patient regained facial nerve function with good right mandibular contour. (b) Three months after free vascularized fibula mandibular reconstruction with concomitant cross facial nerve grafting at the same operation, the patient regained facial nerve function with good right mandibular contour.

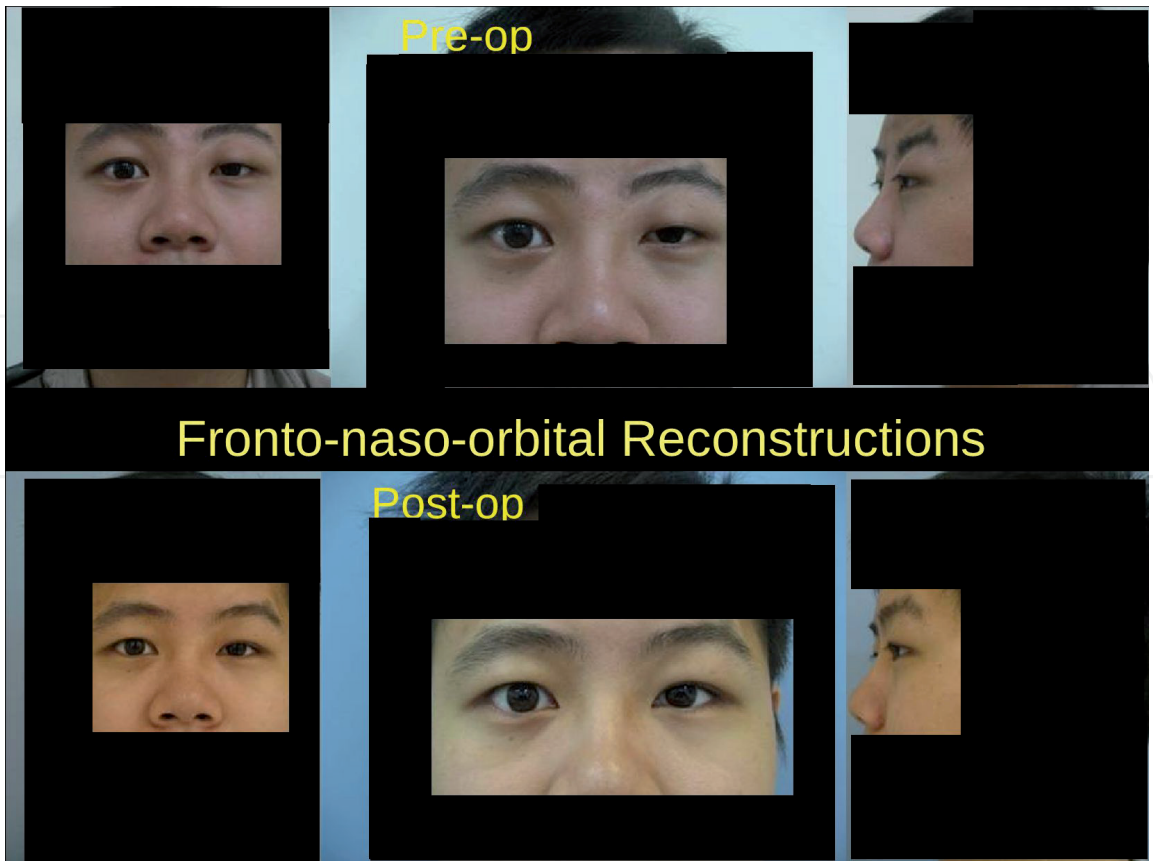


Figure 13.
This young man had a bad traffic accident, resulted in a frontonasal bone defect and left blepharoptosis (upper row). Reconstruction was accomplished with 3D CT reformation of the implant that is exactly the bony defect and contour of the defect, followed by correction of blepharoptosis (lower row).



Figure 14.
This 30 y/o patient had his left forearm completely severed, and his right hand thumb and 4 fingers entirely cut by a machine. The amputated parts were completely replanted without any loss at all. The photo was taken 17 years later.

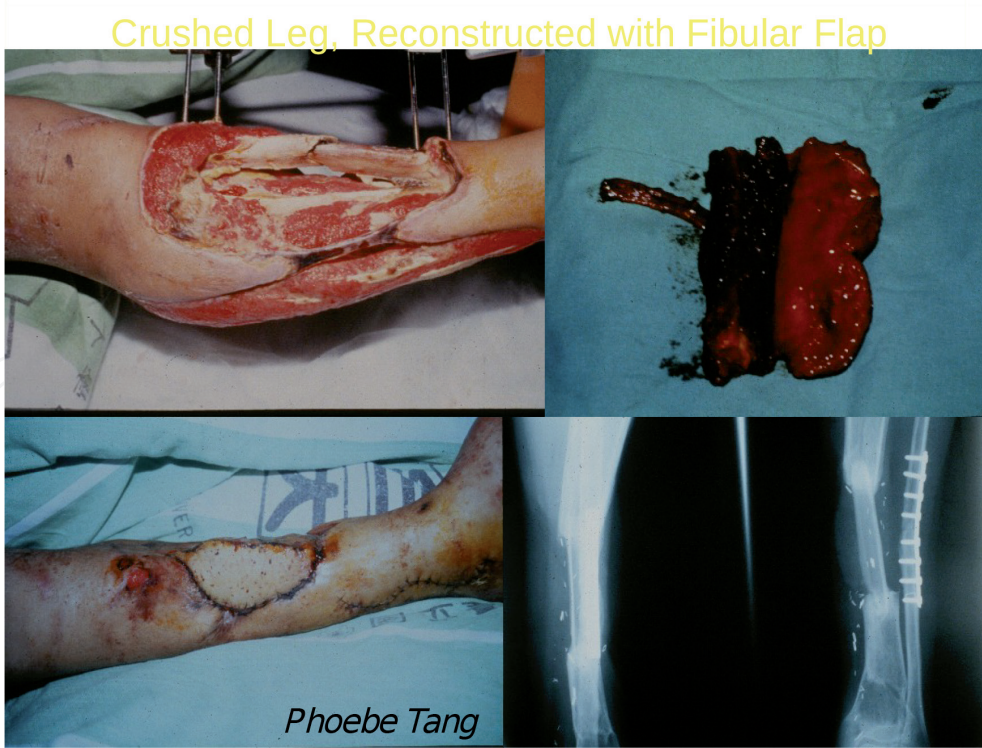


Figure 15.
This 26 y/o young man had his left leg run over by a high speed car at the superhighway. After serial debridement, the compound comminuted wound showed exposure of a long segment of tibia with denuded, devitalized bone with osteomyelitis. He was announced to receive above knee amputation, then he visited our service and was transferred for limb preserving surgery. The reconstruction was accomplished with plating of fractured fibula for stabilization, and concomitant debridement, resection of dried, infected bone, followed by harvesting contralateral fibula osteoseptocutaneous free flap to re-established the left tibia segmental continuity with artery and veins anastomosed at left posterior tibial artery and veins. The patient resumed walking 3 months after the operation, the vascularized fibula hypertrophied after weight bearing.



Figure 16.
This 18 y/o young man got a bad electrical injury, resulted in bilateral below elbow amputation and loss of penis, painful hypertrophic scars at entire abdomen. A jumping flap was performed by another surgeon, however cannot get a satisfactory result. He was referred to our service, where resurfacing of the abdomen was performed first to completely release the scar contracture (courtesy of plastic and reconstructive surgery).

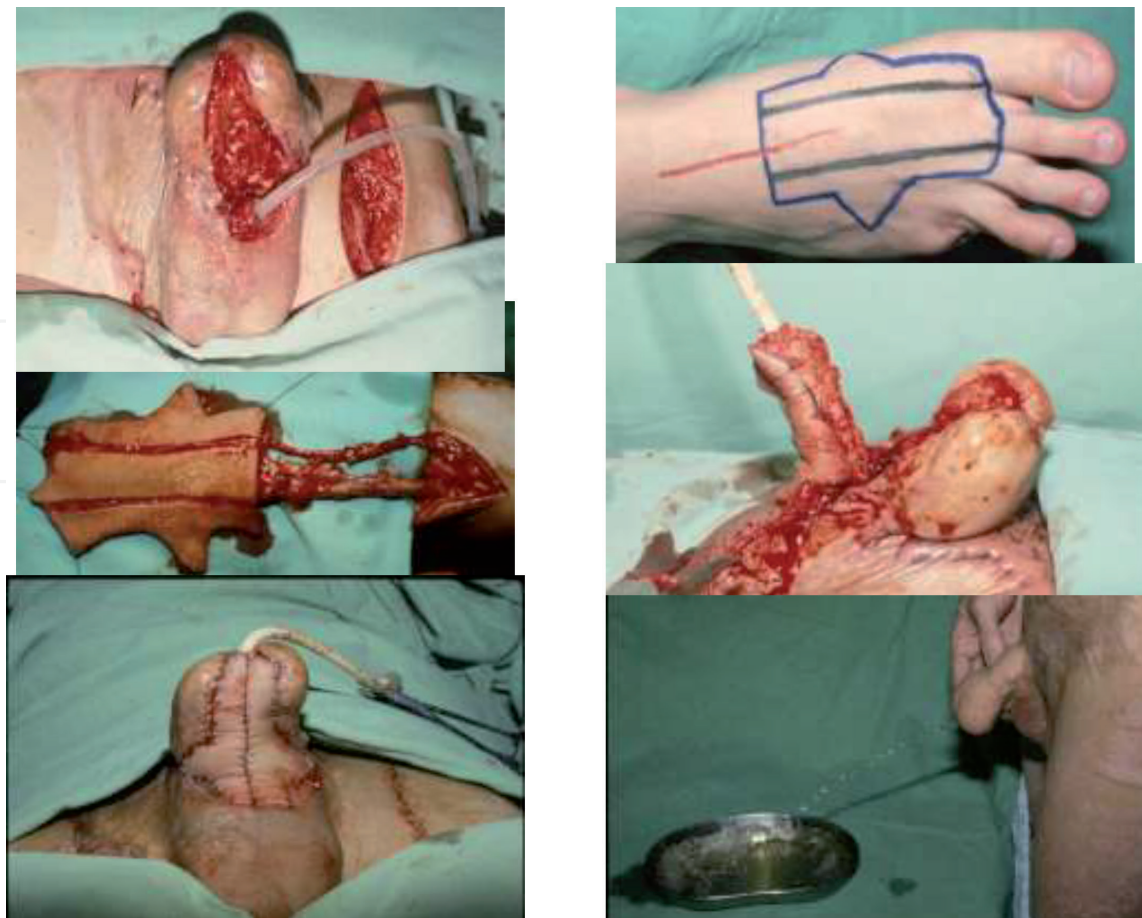


Figure 17.

Then reconstruction of the penile urethra was accomplished with a well-designed dorsalis pedis free flap, with simultaneous release of scar contracture in one operation. The wound healed uneventfully. This young man had been able to perform stand peeing. Two years later, a costal cartilage graft was employed to increase the rigidity of the reconstructed penis (courtesy of plastic and reconstructive surgery).

whole layer upper lip defect. The patient then regained a satisfactory facial appearance without noticeable disfigurement.

11. This patient got a panfacial fracture after a bad trauma (**Figure 10**). Diplopia owing to right orbital floor blow out fracture with enophthalmos and ptosis, flattening of nose due to untreated LeFort I, II, III maxillary fracture and displacement bothered him. Calvarial bone grafting taken from the outer table of parietal bone was used to correct flat nose and right orbital floor bone defect, diplopia and enophthalmos. The patient was happy with the result.

12. Palsy of the frontal branch of facial nerve (**Figure 11**).

13. Combined mandibular deficiency and facial palsy (**Figure 12a and b**).

14. Traffic accident, resulted in a frontonasal bone defect and left blepharoptosis (**Figure 13**).

15. Complete severance of left forearm; right thumb and four fingers (**Figure 14**).

He had been able to take care of himself with good function and sensibility at both hands. He got a stable job, got married and raised children with a good family.

- 16. Crushed leg, reconstructed with fibula osteoseptocutaneous free flap (**Figure 15**).
- 17. Reconstruction of penile loss due to electrical injury (**Figures 16a and 17**).

4. Discussion

Body and facial defect, injury, congenital deformities, status post-tumor excisions, secondary contractures are common encounters in daily practice of plastic surgeons.

In this chapter, we present miscellaneous kinds of measures employed for resurfacing, contour restoration and functional rehabilitation of the face, extremity, and body parts. Tissue expansion, tumor excision, skin grafting (split thickness/ full thickness), composite graft, cartilage graft, hair composite graft are commonly used measures. Flap surgery should be elaborated in proper situations. Selection of proper tissue for reconstruction is of utmost importance.

The ailments that were cited and treated are as the followings:

Problems	Solutions
1. Forehead trauma, with facial disfigurement	Tissue expansion
2. s/p right auricle amputation with skin graft	Tissue expansion at grafted skin with implantation of carved rib cartilage graft for ear reconstruction
3. AVM at parotid area	Complete excision
4. Scar contracture at face with secondary	FTSG, thick STSG, scalp deformities, arterial skin island flap
5. Chemical burn facial defects	Early FTSG at functional esthetic units
6. Orbital reconstruction	Free dorsalis pedis flap, conchal chondrocutaneous grafts, fat graft, free dorsalis pedis flap, conchal chondrocutaneous grafts, fat graft, eyelash composite graft
7. Radiation necrosis of palate	Palatal island flap, pharyngeal flap
8. Maxillary defect, contracture	FTSG, upper denture with stent
9. Reconstruction of complex upper lip	Abbe flap nasal floor and columella defect
10. Panfacial fracture	Calvarial bone graft
11. Palsy of the frontal branch of facial nerve	Frontalis sling operation
12. Combined mandibular deficiency, facial palsy	Fibular flap; cross facial nerve graft
13. Frontonasal bone defect, left blepharoptosis	3D CT bone reformation
14. Complete severance of left forearm	Replantation right thumb and 4 fingers
15. Crushed leg with tibial defect	Fibula osteocutaneous free flap
16, 17. Penile loss due to electrical injury	Dorsalis pedis free flap

The flaps that we described and introduced in this chapter were as the followings: forehead flap, Abbe flap for upper lip reconstruction, cheek flap, nasolabial flap for nasal defects, greater palatine artery flap and pharyngeal flap for complex palatal defect, dorsalis pedis free flap for penile and urethral reconstruction, free

fibular osteoseptocutaneous flap for reconstruction of composite bone and skin defect of the lower extremity.

5. Conclusion

Difficult reconstructions are not only challenging, but also formidable tasks in terms of anatomical restoration, functional rehabilitation and esthetic refinements. With deliberate planning, selection of proper measure and tissue for reconstruction, optimal results can always be achieved. Pursuing excellence in plastic surgery, bringing excellence to life has always been our ultimate goals.

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