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Primary Free Flaps for Coverage and Reconstruction in Acute Facial Trauma

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Abstract

Background Acute facial trauma in motor vehicle accident defects may be associated with skeletal, neuromuscular, or mucosal losses. Simultaneous repair of the critical structures in these defects mandates the use of flap cover; paucity of local tissues necessitates the use of free skin flaps.

Materials and Methods Six free flap reconstructions for acute facial trauma defects over a 10-year period were reviewed. The defect location, associated injuries, flap choice, additional reconstructive procedures, and flap outcomes were analyzed.

Results There were four males and two females with ages between 18 and 63 years. Four defects were located in the lateral face and scalp, and two in the lower central face. Defect size ranged between 96 and 346 cm^2. There were fractures in three, facial nerve injuries in two, and loss of facial muscles in one. Five free flaps were anterolateral thigh flap; simple and composite, one was a radial artery forearm flap. Recipient pedicles were the superficial temporal vessels in two and facial vessels in four cases. There were no re-explorations but one flap necrosed on 7th postoperative day on account of invasive aspergillosis.

Discussion Use of free flaps for ballistic wounds is common. In uncommon non-ballistic traumatic facial defects, the location, nature of the defect, and type of associated injuries and need for simultaneous reconstructions may dictate the use of free flaps and permit a one stage debridement, flap coverage, and a simultaneous reconstruction of lost functional units.

Conclusion Free flap coverage in high velocity acute facial trauma defects offers a better possibility for primary reconstruction of associated facial injuries and helps in achieving better functional outcomes.

Keywords
- acute facial trauma defects
- free flaps in facial trauma
- primary reconstruction

Introduction

Motor vehicle accidents are high velocity impacts and can lead to significant loss of skin and soft tissues in the face and scalp; the victim may have been dragged after the initial impact leading to friction burns and deep abrasions that can cause a larger area of tissue loss. They can be accompanied by facial bone fractures, loss of the facial muscles, and injury to facial nerve branches[1] (►**Fig. 1**).

The rich vascular supply of the facial skin does imply the need for a high degree of conservation; this may lead one to consider that there is very little role for free flaps in facial

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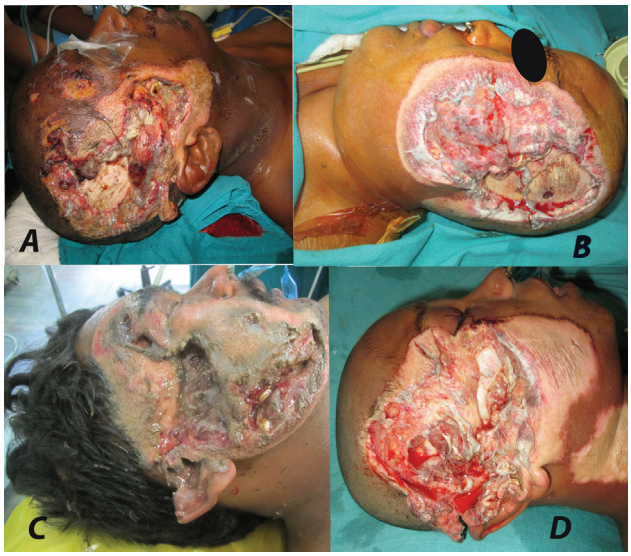

Fig. 1 Cases A, B, C, and D are showing the predebridement images of lateral facial trauma; the depth of injury implies loss of muscles and avulsion of facial nerve branches.

trauma. The zone of trauma in high velocity accidents dictates a more radical approach to debridement precluding either direct closure or the use of local tissues for wound coverage.[2]

In the face, free skin flaps have been described more commonly in correction of burn contracture deformities with loss of facial subunits, electrical burn sequelae, and defects following excision of advanced skin cancers. In burn deformities and reconstruction for elective non-neoplastic indications, the use of the technique of pre-expansion and flap prefabrication permits a reconstruction oriented with esthetics of the facial units and can mitigate donor site concerns.[3,4] Such an option is not available in acute trauma.

The presence of unstable fractures and loss of functional neuromuscular units need fixation and replacement primarily. The use of free flaps permits a one stage debridement, flap coverage, and a simultaneous reconstruction of lost functional units.

Materials and Methods

All free flaps done for acute facial trauma over a 10-year period were reviewed; the collection of data included the specific indication, region of tissue loss, reconstructive details, flap outcome, and secondary procedures. A total of 222 free flaps were done in the face and the scalp during the 10-year period; 11 of these were done as an emergency. There were five flaps for loss of scalp tissue secondary to nonreplantable avulsions and six for defects in the lateral facial region and the lip. Free flaps done for facial defects due to infection were excluded.

All these patients had isolated facial trauma and no head injury with a normal Glasgow coma score prior to surgery. The defect following debridement involved three facial subunits in part or whole.

A two-team approach was used in all the cases; the procedure began with a meticulous debridement of all avulsed nonviable skin; where possible, deeply abraded skin was conserved. Injured facial nerve branches were identified for either nerve approximation or as donors for functional muscle transfer. Facial bone fractures were fixed with miniplates. Recipient pedicles were dissected in the preauricular region or the neck. Anterolateral thigh (ALT) flaps were harvested after assessment of the defect size and on the need for a functional muscle reconstruction. One of the six cases needed an exploration of the second thigh, as suitable perforators could not be found.

Results

Four patients had extensive skin loss on the lateral face (cheek, preauricular, temporal regions; ►**Fig. 1**). One patient had loss of hemi-upper lip with adjoining nasolabial area and commissure; one had loss of parts of the upper lip, lower lip, commissure, and nasolabial skin. Four of the patients were male and two were female. The ages ranged from 18 to 63 years. The defect size was from 96 to 364 cm^2 with a mean of 203 cm^2. One patient had mandibular body fracture and two had minimally displaced zygomatic body, arch fractures.

Three patients had a partial loss of the facial nerve branches to the upper eyelid and two also had a loss of the facial muscles of the upper lip and the commissure (►**Table 1**).

Four patients underwent reconstruction within 72 hours after the injury and two beyond that period. The debridement, skeletal fixation, nerve reconstruction, and free flap cover were done in a single stage after ensuring a hemodynamically and neurologically stable patient fit for major surgery. The mean operating time was 7 hours.

The flaps included one radial forearm flap, three ALT skin, and two composite ALT/vastus lateralis muscle functioning units. The recipient vessels were the superficial temporal in two cases and the facial vessels in four cases. Only one of the five patients needed an additional elective vein graft (for superficial temporal vein) to ensure safe venous drainage. All donor sites needed split skin grafting after reduction of donor area.

Additional procedures done at the time of primary surgery included the following: internal fixation of mandible fracture in one case, coaptation of the zygomatic-frontal branch of facial nerve in three cases (direct repair in two and a 2 cm sural nerve graft (►**Figs. 2** and **3**) in the other, and use of vascularized fascia turnover from ALT flap to cover retro-auricular exposed cartilage in one case (►**Figs. 4** and **5**). The lip reconstruction using radial forearm flap needed a palmaris longus sling.

In both the functional transfers, the nerve to the vastus lateralis was coapted to transected facial nerve branches.

There were no re-explorations and five of the six flaps had an uneventful postoperative course with complete flap success. The only flap that failed completely did so after the 7th postoperative day; there was a progressive discoloration toward the center of the flap over a period of 72 hours, starting the 4th day. A tissue fungal culture was sent from the flap edges due to a nonuniform mottled flap appearance, even though parts of the flap had arterial blood on dermal

Table 1

		Defect location	Additional injuries	Flap	Recipient	Reconstruction
Case 1	24 hours after injury	Cheek, preauricular 17×14 cm	Mandibular fracture, cut branches facial nerve to eyelids and loss of cheek muscles	Vastus lateralis and ALT composite flap	Temporal artery and venae comitantes Second vein to EJV with vein graft	Plate fixation mandible fracture, repair of facial nerve branch to eyelid, reinnervated vastus lateralis muscle with fascia lata graft for right modiolus
Case 2	24 hours after injury	Cheek, temporal and preauricular—26×14 cm	Complete ear avulsion left ear, partial avulsion right ear with skin bridge, outer cortex fracture temporal bone; facial nerve branches to left eyelid and modiolus	ALT flap	Facial artery and 2 veins to common facial vein and EJV	2 cm sural nerve graft to cut facial nerve branches
Case 3	2 days after injury	Cheek, temporal and preauricular—18×12 cm	Loss of upper third right ear, facial nerve branches to upper eyelid	ALT flap	Facial artery and 2 veins to common facial vein and EJV	Closure of ear defect
Case 4	7 days after injury	Right half of upper lip, commissure, and adjacent nasolabial part of cheek 12×8 cm	None	Radial forearm flap	Facial artery and 1 vein to common facial vein	Free palmaris tendon graft as sling
Case 5	3 days after injury	Cheek, temporal and preauricular—18×12 cm	Loss of upper third right ear	ALT flap	Facial artery and 2 veins to common facial vein and EJV	Closure of ear defect
Case 6	17 days after injury	1/3 lower lip, ½ upper lip, commissure and nasolabial skin 15×12 cm	Scalp wound, eyelid injury and closed head trauma	Vastus lateralis and ALT composite flap	Facial artery and 2 veins to common facial vein and EJV	Neurotization of vastus lateralis using facial nerve motor branch

Abbreviations: ALT, anterolateral thigh; EJV, external jugular vein.

Fig. 2 Case B: (a, b) After debridement and coaptation of facial nerve branch with nerve graft; (c) planned anterolateral thigh flap from the right thigh; (d) after complete flap inset with a hole for auditory meatus.

Fig. 3 Case B: Images after flap thinning; 4 years follow-up with good contour and eye closure.

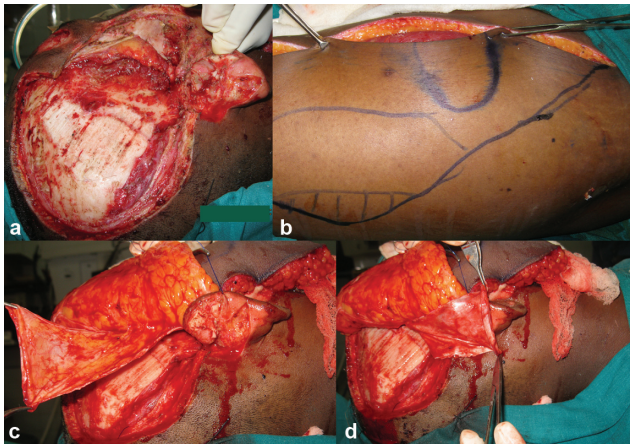

Fig. 4 Case A: (a) Extensive lateral defect involving face and scalp with exposed skeleton and ear cartilage, (b) flap marking, (c) vascularized fascia from anerolateral thigh, and (d) draped over the exposed cartilage.

Fig. 5 (**A**) Before flap thinning, (**B**) ongoing expansion, and (**C**, **D**) appearance 8 weeks after completion of expansion.

scratch test. This confirmed an Aspergillus infection that was treated by systemic antifungal therapy, but the entire flap was lost; debridement was followed by secondary split skin grafting.

Donor site graft loss in one of the five successful cases needed secondary split skin grafting. Secondary procedures were done in five of the six successful reconstructions and a mean of 2.4 procedures was done in each case: these included flap thinning, commissure creation, and tissue expansion for scalp hair (►**Fig. 5**). Further thinning is planned in one patient. The mean follow-up period was 2 years.

Discussion

Futran[5] et al reported 49 cases of complex facial trauma needing 54 free flaps; 9 were nonballistic injuries, of which 7 were due to motor vehicle accidents 21 needed soft tissue flaps only, the radial forearm being the preferred donor tissue. There were six re-explorations but no complete flap losses; four partial flap losses were not critical to the reconstruction. The article does not state any of the details for nongunshot injuries.

Motor vehicle accidents lead to skin losses in the lateral immobile regions of the face and scalp where both avulsive loss of skin and deep grazed abrasions are seen. Lateral defects are associated with exposed or fractured zygoma, maxilla or mandible, and one must anticipate the possibility of loss of facial nerve and/or muscle units. Primary reconstruction may imply the need for nerve repairs or grafts, or a loss of muscle unit may need composite functioning muscle flap like ALT with vastus lateralis functioning muscle flap.

It is true that on account of good blood supply facial injuries are managed with the principle of "conservation." This cannot deny the role of adequate debridement in high

Fig. 6 Outcome of a similar defect managed conservatively elsewhere, with split skin grafting and not a primary free flap. The facial nerve branch neurorrhaphy done in two cases was successful, as the eye closure in the follow up images show.

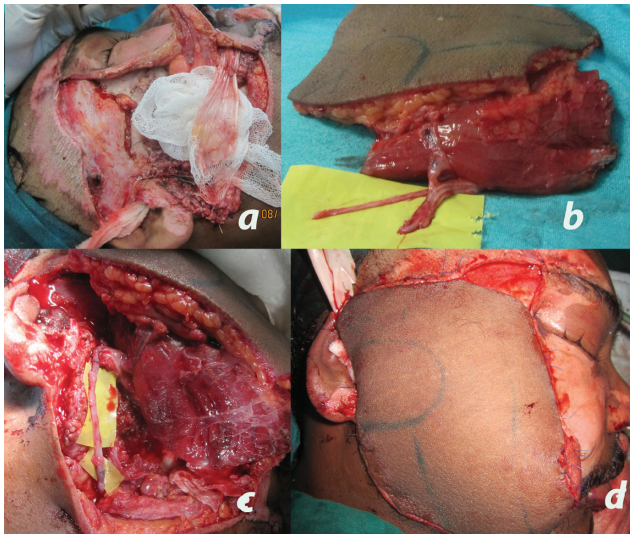

Fig. 7 Case C: After debridement and fixation of mandibular fracture; (a) fascia lata graft to the modiolus; (b) composite anterolateral thigh and innervated vastus lateralis flap; (c) vein graft to the EJV for second venous anastomosis; (d) after complete flap inset.

velocity road traffic accidents leading to tissue defects not amenable to primary closure. Split skin grafts and the use of local flaps may lead to a less than optimal outcome and could prove difficult for a secondary reconstruction (►**Fig. 6**).

The location of the defects was such that the superficial temporal vessels could be used as recipient vessels in only two cases; in the rest the facial vessels were chosen as the nearest safest recipient pedicle.

The composite ALT vastus lateralis flap for cheek went on to a successful innervation of the transferred vastus lateralis muscle (extended with a fascia lata graft to the opposite commissure) (►**Fig. 7**), the purpose of which was to produce animation of the angle of the mouth (►**Fig. 8**). The facial nerve branch neurorrhaphy done in two cases was successful as the eye closure in follow-up images show.

Reconstruction of lip losses is akin to defects following resection of malignant lesions, and in the event of a lack of local tissue the radial forearm flap or the ALT has been the flap of choice.[6]

The second lip commissure defect was reconstructed using ALT with vastus lateralis (VL) muscle for loss of muscle units involving the upper lip, commissure, and the lower lip. This patient achieved good mouth opening but needed palmaris longus sling at a subsequent flap thinning procedure for improving oral continence. He needs a further flap adjustment to reposition the commissure.

Among the five successful outcomes, at follow-up, four patients have completed their reconstruction needs, one did not opt for any further reconstruction (63-year-old lady), and one is awaiting flap thinning.

Since the possibility of fungal infection is real in acute trauma, it would be prudent to get a potassium hydroxide (KOH) staining of margins for ensuring a safe flap transfer.

Jaiswal and Pu[7] report a single case of free ALT flap for cheek and temporal area skin loss in combination with implants for reconstruction of contour defect; secondary surgery with tissue expansion for eliminating scalp alopecia was needed.

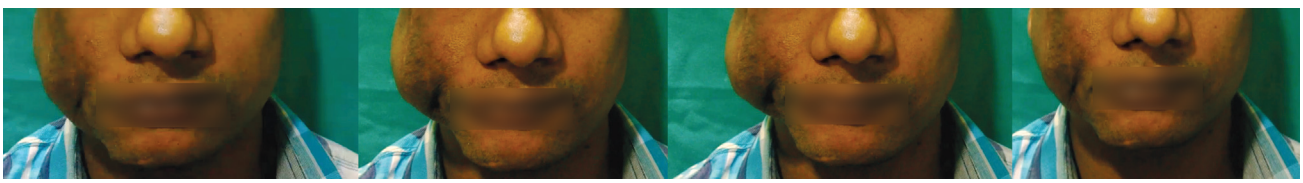

Fig. 8 Sequential images to show animation of the transferred vastus lateralis, prior to debulking of thicker flap.

Zeiderman and Pu[8] published a series of three cases, one of which was similar to the three successful reconstructions in the present series; Medpor implants were used for bone defect; the patient needed multiple secondary procedures and had an acceptable outcome at 25 months follow-up. Since our series did not have any skeletal losses, there was no need for any implant reconstruction.

Multicomponent losses in the face need the use of free flaps. A plan for a primary vein graft for second venous drainage in large or composite flaps while using superficial temporal vessels as a recipient pedicle may avoid critical flap losses. Debridement and primary flap cover allow primary definitive reconstruction of critical structures for a better functional outcome. Secondary procedures are unavoidable to ensure better aesthetic outcomes.

Conclusion

If more than three facial subunits are lost in whole or part, there is a need to plan for a free skin flap. Though free flaps are not the ideal match and secondary procedures cannot be avoided, they offer a better possibility of an easier, primary reconstruction of other injured nerves and muscles in lateral skin losses.

Conflict of Interest
None declared.

References

1 Kim RY, Sokoya M, Williams FC, Shokri T, Ducic Y. Role of free tissue transfer in facial trauma. Facial Plast Surg 2019;35(06): 584–589
2 Collins JB, Mahabir RC, Potter JK. Facial soft tissue trauma. In: Janies JE, ed. Essentials of Plastic Surgery. Boca Raton, FL: Taylor & Francis Group; 2014:315–322
3 Topalan M, Guven E, Demirtas Y. Hemifacial resurfacing with prefabricated induced expanded supraclavicular skin flap. Plast Reconstr Surg 2010;125(05):1429–1438
4 Yang DP, Zhang P. Facial resurfacing with prefabricated induced expanded skin flap. J Craniofac Surg 2019;30(04): 1131–1134
5 Futran ND, Farwell DG, Smith RB, Johnson PE, Funk GF. Definitive management of severe facial trauma utilizing free tissue transfer. Otolaryngol Head Neck Surg 2005;132(01):75–85
6 Daya M, Nair V. Free radial forearm flap lip reconstruction: a clinical series and case reports of technical refinements. Ann Plast Surg 2009;62(04):361–367
7 Jaiswal R, Pu LL. Reconstruction after complex facial trauma: achieving optimal outcome through multiple contemporary surgeries. Ann Plast Surg 2013;70(04):406–409
8 Zeiderman MR, Pu LLQ. Contemporary reconstruction after complex facial trauma. Burns Trauma 2020;8:tkaa003

