

The Complicated Facial War Injury: Pitfalls and Mismanagement

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Objective: The aim of this paper is to share the authors' experience in the management of complicated facial war injuries using free tissue transfer. A discussion on the most commonly encountered pitfalls in management during the acute and complicated settings is presented in an effort to raise insight on facial war wound complications.

Methodology: Two patients of complicated facial war injuries are presented to exemplify the pitfalls in acute and chronic management of the mandibular region in the first patient and the orbito-maxillary region in the second. The examples demonstrate free tissue transfer for early as well as late definitive reconstructions.

Results and Discussion: A reconstruction algorithm or consensus regarding the optimal management plan of complicated facial war injuries is not attainable. The main principles of treatment, however, remain to decrease bacterial burden by adequate aggressive debridement followed by revisit sessions, remove of all infected hardware followed by replacement with external bony fixation if necessary and reviving the affected area by coverage with well-vascularized tissues and bone. The later is feasible via local, regional, or distant tissue transfer depending on the extent of injury, surgeon's experience, and time and personnel available.

Conclusion: Free tissue transfer has revolutionized the management of complicated facial war injuries associated with soft tissue or bone loss as it has allowed the introduction of well-vascularized tissues into a hostile wound environment. The end result is a reduced infection rate, faster recovery time, and better functional outcome compared with when loco-regional soft tissue coverage or bone grafting is used. When soft tissue or bone loss is present, free tissue transfer should be the first management plan if time and personnel are available. The ultimate treatment of a complicated war wound remains prevention by accurate initial management.

Key Words: Free tissue transfer, mandibular blast injuries, mandibular reconstruction, maxillary blast injuries, maxillary reconstruction, war-related injuries

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Received July 20, 2016.

Accepted for publication September 5, 2016.

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The authors report no conflicts of interest.
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ISSN: 1049-2275

DOI: 10.1097/SCS.0000000000003254

(*J Craniofac Surg* 2017;28: 118–121)

Although the head and neck region constitutes only 12% of the body's surface area, it is the second most commonly injured site in the war setting following extremity trauma.¹ Facial war injuries can range from simple lacerations or abrasions to massive tissue loss and fractures of all parts of the facial skeleton. When analyzing these injuries, it is obvious that all parts of the facial skeleton are at equal risk of involvement and more than 1 facial zone is commonly affected.² The extent of injury strongly correlates to the assaulting weapon itself where improvised and complex explosive devices cause more significant injuries than mortars, rocket-propelled grenades, or gunshots, probably due to the proximity of the victim to the insult.³

The aim of this paper is to share the experience gained at the American University of Beirut Medical Center (AUBMC) in the management of complicated facial war injuries using free tissue transfer. A discussion on the most commonly encountered pitfalls in management during the acute and complicated settings is presented in an effort to raise insight and decrease the rate of facial war wound complications.

DISCUSSION

Acute Wound Mismanagement Wound Preparation

Early initial debridement and empiric antibiotic treatment should be implemented as soon as possible. Antibiotic coverage should account for *Acinetobacter* and other contaminants in moist soil as well as multidrug-resistant organisms in patients transferred from other hospitals or previously treated with antibiotics.⁴

Thorough serial debridement is necessary to remove foreign bodies, decrease bacterial load, eliminate necrotic tissue, and prevent dirt tattooing.^{4–6} It is important to be aware that healthy appearing tissues following debridement may have suboptimal blood supply and undergo further necrosis and infection.^{4,6} Revisit sessions are, therefore, essential, and should be performed within 24 to 72 hours to assess tissue viability. This is especially important in the maxillary region, which is more prone to infections and reconstructive failure.⁷

After adequate debridement, if cleanliness and vascularity of the injury site is still questionable, it is always recommended to observe the wound for more time than less.⁶ Attaining a clean and well-vascularized injury site before definitive reconstruction helps avoid complications allows faster recovery time and prevents the need of additional operative interventions.⁵

Tissue Coverage

A clean wound alone is not sufficient to ensure a complication-free reconstruction. It is as important to maintain underlying skeletal structure in the acute phase to avoid future tissue shrinkage

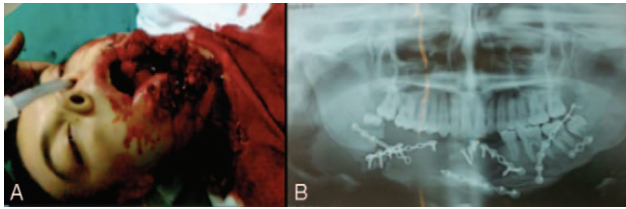


FIGURE 1. (A) Initial injury. (B) Excessive plate and screw fixation in the acute setting; disregarding bone gap rigid fixation or bony replacement.

and distortion of normal anatomy. In the past, facial trauma used to be managed by soft tissue closure despite underlying bone loss.⁵ The healing process and resultant facial scar contraction rendered it impossible to perform optimal bone and soft tissue reconstruction.⁵

Restoring the underlying bony skeleton can be achieved in the initial phases of reconstruction in various methods depending on the degree of soft tissue loss and contamination. With satisfactory soft tissue coverage, immediate bone grafting or temporary rigid plate and screw fixation of bone gaps awaiting future reconstruction are both viable options. With unsatisfactory soft tissue coverage or bone loss with severe tissue contamination, vascularized composite tissue transfer is ideal.^{5,8}

The introduction of well-vascularized bone and soft tissues into a hostile wound environment maintains excellent survival of the free flaps and permits an early definitive reconstruction and shorter recovery period.⁵ Although bone grafting is used with high success rates in high turnover scenarios, vascularized bone transfer has superior short and long-term results and should be the first choice when time and personnel are available.^{9–12}

Mandibular Fractures

Mandibular fractures are managed by reestablishing adequate occlusion by intermaxillary fixation prior to definitive fixation. This prevents jaw mal-occlusion, which can progress into temporomandibular joint ankylosis on the long term. Simple mandibular fractures can be managed using external fixation in the form of intermaxillary fixation alone. When severe comminution is present, external fixation devices are advised in conjunction with intermaxillary fixation. This decreases the risk of infection by limiting instrumentation and maintaining good tissue viability.¹³ Internal fixation in severe comminutions, on the other hand, requires periosteal stripping and devascularization of bony fragments, which in turn, increase the risk of nonunion, osteomyelitis, and hardware infection.

Maxillary and Frontal Sinus Fractures

Plate and screw fixation should be used with caution when fixating upper and middle third facial fractures because of a higher risk of infection in this area of the face.¹⁴ In frontal sinus stripping care should be taken to burr the bony crypts that harbor mucosal cells. Incomplete mucosal stripping may lead to mucocele formation up to 10 years from injury.

Treatment of crushed maxillary sinus walls should start by irrigation through the same wound opening or using a Caldwell–Luc approach. Any free fragments of bone should be washed and removed, and by gentle manipulation, the remaining fragments can be pushed back into position and the maxillary sinus packed with iodoform paste or Vaseline gauze to preserve the bone fragments in their anatomic location. The sinus packs should be removed after 2 weeks and help avoid unnecessary hardware fixation.⁵



FIGURE 2. (A) Wound bed after hardware removal and debridement. (B) Mouth opening at 1-year follow-up.

Complicated Wound Mismanagement

Although management of the complicated facial war wound remains well described, some practitioners fail to implement optimal treatment. The principles are as follows:^{1,5,13,15}

- Initiating broad-spectrum antibiotics as soon as possible when infection is suspected
- Aggressive debridement of all avascular fragments of bone and infected tissue
- Removal of all hardware in zones of infection or bony malunion/nonunion
- Replacement of plate and screw fixation with external fixation devices if healing is not complete
- Immediate free tissue transfer to large composite defects resulting from debridement
- Definitive reestablishment of skeletal support and avoiding temporary rigid fixation
- Vascularized tissue coverage to exposed bone with priority given to local tissues if available
- Protection of bone grafts with well-vascularized local or free soft tissue transfer
- Avoiding definitive reconstruction during the inflammatory phase between 72 hours and 3 weeks from injury
- Providing tissue cover to wounds that are unlikely to heal, or may heal with residual deformities.

Patient 1 (Mandibular Injury)

A young female sustained a shrapnel injury to the mandible (Fig. 1A) and underwent open reduction and internal fixation of a severe pan-mandibular comminution using miniplates and screws (Fig. 1B). She presented 5 months later with a draining cheek sinus that showed mandibular osteomyelitis on computed tomography scan.

Early broad-spectrum antibiotics were administered intravenously 24 hours prior to removal of hardware, aggressive surgical debridement, and immediate mandibular reconstruction using an iliac crest osseous-free flap (Fig. 2A).

Her postoperative course was complicated by a self-resolving cheek seroma. She successfully underwent dental implantation 1 year after surgery and at 4-year follow-up still maintains a good functional outcome (Fig. 2B).

Pitfalls Reviewed

1. Internal fixation in mandibular comminutions
In mandibular comminutions with adequate soft tissue coverage, external fixation using intermaxillary fixation, external fixator devices, or both is advised. This prevents surgical



FIGURE 3. Initial presentation and computed tomography scan.

devascularization of bone fragments while attempting internal fixation and limits instrumentation to avoid complications.¹³

2. Failure to replace or rigidly stabilize bone gaps
 Realigning comminuted bony fragments using miniplate fixation provides suboptimal bony support and instability, which pose a high risk of complications. A better management plan in this scenario would have been a more aggressive debridement of bony fragments with temporary rigid fixation, or immediate bone grafting. Bony or composite free tissue transfer should be the primary option if local soft tissues are inadequate for closure and time and personnel are available.¹⁶⁻¹⁹

Patient 2 (Maxillary Injury)

A young female sustained a shrapnel injury to the upper and mid-face (Fig. 3A). She presented 3 days after injury with a significantly contaminated orbital and periorbital wound, a shattered maxillary sinus, frontal sinus fracture, intracranial aneurysm, and cerebrospinal fluid leak.

Initial operations consisted of cerebral aneurysm coiling and dural patching. Broad-spectrum antibiotics had been initiated since admission and a thorough debridement session was scheduled as soon as possible. The frontal sinus was obliterated using a pericranial flap and calvarial bone grafts were harvested and fixed to the superior and inferior orbital rims using miniplates and covered by the available local tissues.

Three weeks postinjury, after C-reactive protein levels dropped to 3 mg/L, a radial forearm facio-cutaneous flap was used to cover the orbital soft tissue defect (Fig. 4A and B).

Two months later, a globe socket was created through the radial forearm flap using a full-thickness skin graft. Medial canthal suspension was performed using trans-nasal wiring.



FIGURE 4. (A) Radial forearm flap anastomosed to the facial artery outside the zone of injury. (B) Orbital soft tissue coverage using the radial forearm flap.



FIGURE 5. Cheek sinus residual scar.

At 4 months follow-up, the patient presented with a draining cheek sinus (Fig. 5) that was successfully managed by the removal of the infra-orbital bone graft hardware with no further stabilization requirement. After 4 weeks of combined intravenous and oral antibiotics, the patient recovered with no further complications.

Pitfalls Reviewed

1. Inadequate initial debridement
 In conflict zones with high patient turnover, debridement value is significantly neglected and soft tissue closure or definitive reconstruction attempted prematurely. We have found this especially important in the maxillary region since their reconstruction has been challenging and prone to infections and failure.²⁰
2. Improper reconstruction timing
 In all war wounds, the intermediate phase of injury, between 3 days and 3 weeks, has the highest reconstructive complication rates. During this phase, inflammation and catabolism increase the risk of wound breakdown, bone graft failure, and free flap anastomotic thrombosis. This necessitates delaying definitive reconstruction to later than 3 weeks as long as skeletal integrity has been secured.²¹ C-reactive protein levels below 2.5 mg/L are adequate for attempting definitive reconstruction; however, this value is only an adjunct to good clinical reasoning proper wound preparation prior to reconstruction.
3. Bone grafts versus vascularized bone
 The incorporation of a bony component to composite flaps such as radial forearm, iliac crest, and scapular flaps, although more technically demanding and time consuming, provides better support of the orbit and cheek than when soft-tissue free flaps and separate bone grafts are used.¹² Vascularized bone is also more resistant to infection and does not undergo resorption when compared with bone grafts. This in turn reduces the need for future surgeries.

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CONCLUSION

The severe tissue devascularization and contamination in facial war wounds increases the risk of reconstructive complications when compared with civilian facial trauma. The need of reoperation sessions and prolonged antibiotic therapy lengthens of the duration of treatment of the complicated facial war injury.

Common pitfalls encountered in management of these injuries lie in the most basic principles of acute and complicated wound management. The key is to decrease contamination by minimizing instrumentation and maximizing debridement, replacing bone loss, and providing well-vascularized tissue coverage. The intermediate phase of injury is marked by inflammation and reconstruction should not be attempted during this period.²² When soft tissue or bone loss is present, free tissue transfer should be the first management plan if time and personnel are available. The increased cost and burden on both patient and surgeon validate that prevention is the best management strategy in complicated facial war wound treatment.

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