Chapter 47

HEAD AND NECK LESSONS LEARNED IN IRAQ AND AFGHANISTAN

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INTRODUCTION

During the past 10 years in Iraq and Afghanistan, more than 7,000 head and neck trauma patients have been treated at American hospitals in both war zones.[1–3] The high incidence of maxillofacial injury (MFI) is due to the lack of head and neck protection provided by the body armor currently used by troops in the field.[4–7] The multispecialty head and neck surgical teams treating the MFI patients include neurosurgeons, otolaryngologists/head and neck surgeons, oral-maxillofacial surgeons, and ophthalmologists.[8] Valuable head and neck trauma lessons applicable to military and civilian practices were learned in Iraq and Afghanistan. These unique insights could be used in the civilian practice of trauma, especially in those situations where mass casualty events overwhelm the resources of local civilian medical facilities. Furthermore, these unique lessons learned can be used to tailor head and neck trauma education, and to prepare for acute maxillofacial trauma management for our residents and staff, both in military and civilian settings.[9,10]

ACUTE SURGERY FOR MAXILLOFACIAL INJURY

Lessons learned in Iraq and Afghanistan can be categorized according to the surgical procedures performed:

- soft-tissue repair of facial lacerations,
- mandibular open reduction and internal fixation (ORIF),
- midface ORIF,
- penetrating neck trauma exploration,
- laryngotracheal repair, and
- otological trauma repair.

Most Common Maxillofacial Injury Procedures

The most common MFI procedures performed in Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) are the following:

- repair of facial lacerations,
- placement of surgical airways,
- ORIF of facial fractures/intermaxillary fixation (IMF) with Erich arch bars,
- neck exploration for penetrating neck trauma, and
- aerodigestive endoscopy.[8,11]

Preoperative Planning

Multislice helical computed tomography angiography (MCTA) is essential in the preoperative evaluation of an MFI patient in OIF and OEF. MCTA will demonstrate the projectile tract with associated injuries to include bony fractures, vascular injury, and aerodigestive tract injury.[12] MCTA has a high sensitivity and a high specificity in identifying vascular and aerodigestive tract injuries in maxillofacial trauma and penetrating neck trauma.[12,13] However, because of the artifact from retained missile fragments, the MCTA may be nondiagnostic in 2.2% of trauma patients.[12] MFI patients presenting with zone I or zone II penetrating neck trauma need additional studies to rule out esophageal injury, which may result in a 19% mortality.[14] Panendoscopy, to include flexible and rigid esophagoscopy, is the most sensitive technique to rule out esophageal perforation. Swallow studies, which were not performed in OIF and OEF for penetrating neck trauma, may have up to a 10% false-negative rate.[15,16]

Additional preoperative lessons learned for facial fracture repair include the great value of three-dimensional computed tomography (3D-CT) scans in the planning of facial fracture repair. In Iraq in 2004, 3D-CT capability was not present.[8] However, in Afghanistan in 2009, the Role 3 facility did have 3D-CT capability, and this imaging was used in the preoperative planning for all facial fracture repairs. An example of such a planning diagram based on preoperative 3D-CT is shown in Figure 47-1.[11]

Surgical Procedures

Soft-Tissue Repair

Facial laceration repair with soft-tissue approximation was the most common head and neck operation performed in both Iraq and Afghanistan. The first lesson learned with traumatic soft-tissue repair, typically due to high-velocity missile trauma, is that the soft tissue can be closed immediately after extensive irrigation and conservative debridement. Only grossly contaminated and devitalized tissue should be removed from the head and neck. The goal of soft-tissue reconstruction is to reapproximate the wound edges with primary closure and to achieve soft-tissue coverage of the plates and exposed bone. Primary closure is typically performed with deep VICRYL sutures (Ethicon, Somerville, NJ) and permanent sutures (eg, PROLENE [Ethicon]) for the skin. The classic techniques of removing skin tension and everting the skin edges apply to

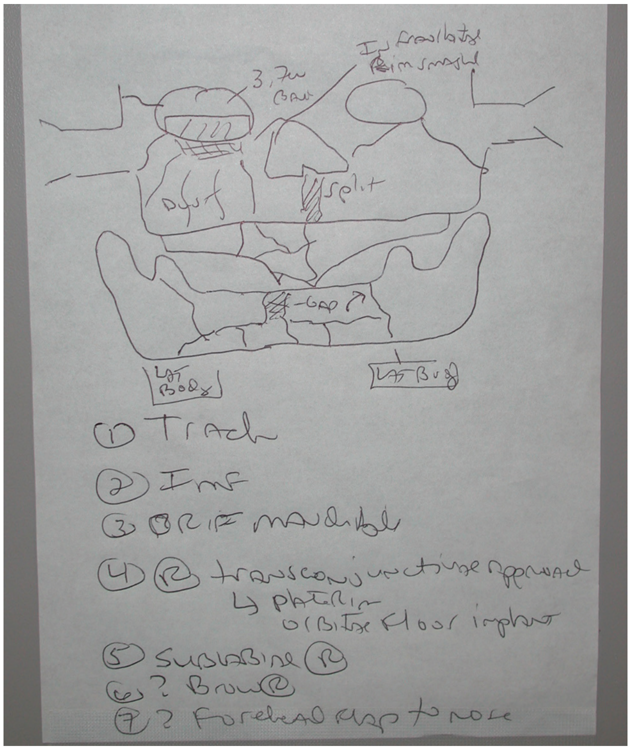

Figure 47-1. Three-dimensional computed tomography preoperative planning.

both high-velocity and low-velocity soft-tissue wound repair. Fast-absorbing gut sutures for skin closure were avoided since the high-velocity injuries often resulted in significant postoperative edema, and wound separation would occur with fast-absorbing gut sutures.

Figure 47-2. Gunshot wound to the face.

The most important lesson learned, primarily in Afghanistan with the massive soft-tissue injuries referred to Role 3 hospitals, is that "home-run" surgery should be avoided.[11] After high-velocity injury to the facial soft tissues, the temporary cavity that results from the high kinetic energy of the missile may partial devitalize a large area surrounding the wound. The concussive soft-tissue trauma caused by this temporary cavity may extend up to 30 times the missile cross-section.[17] Even with the great blood supply to the face, "doing too much too soon" with extensive soft-tissue undermining and flap rotation may result in dead tissue.[11] For example, a police chief was struck in the face by an AK-47 bullet with

- loss of most of his left zygomatic–maxillary complex,
- a shattered left zygomatic arch,
- a shattered orbital rim and orbital floor,
- loss of most of his nose (including all three layers), and
- a gaping wound of his left midface (Figure 47-2).

We elected to perform home-run surgery and repair this wound in one setting with

- a bicoronal flap,
- ORIF of the zygomatic arch,
- an orbital floor implant,
- cranial bone grafts to reconstruct the orbital rim and maxilla,
- a large cervicofacial advancement/rotation flap to cover the left cheek and nasal base defect,
- septal flaps for inner nasal lining,
- a conchal cartilage to replace the missing upper and lower lateral nasal cartilages, and
- a paramedian forehead flap to cover the nasal skin defect (Figures 47-3 and 47-4).

Within a few weeks of this surgery, the medial portion of the large cervicofacial flap died, and the patient has exposed midface plates and craniofacial bone grafts (Figure 47-5). Too much too soon was done with devitalized facial soft tissue, and it would have been better to stage this reconstruction with the first surgery reapproximating the remaining facial soft tissue that would have established the "nasal base" before later reconstruction efforts were performed. With massive soft-tissue injuries and a comminuted facial skeleton from high-velocity trauma, it is recommend that the goals of the initial surgery be limited to reconstruction with soft-tissue coverage of the exposed bone and plates with primary closure.

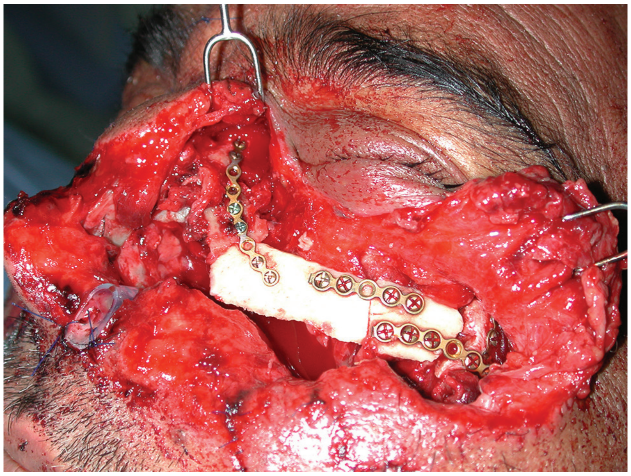

Figure 47-3. Cranial bone graft.

Traumatic injury of the facial nerve resulting in incomplete eye closure and paralysis of the facial muscles can be functionally disabling to the patient. Consequently, it is critically important that all MFI patients undergo careful examination of the facial nerve (cranial nerve 7) function as soon as possible after injury, and before they are paralyzed and intubated. Repair of facial nerve transections must be performed as soon as possible after injury because the severed ends of the facial nerve branches may be stimulated up to 72 hours after injury. The general rule for facial nerve repair is to "never let the sun rise and set on a facial nerve injury." If the MFI patient is noted to have facial nerve paralysis, then the wound needs to be explored and the severed ends of the transected nerve reapproximated using 9-0 nylon sutures through the epineurium (Figure 47-6). Facial nerve repair must be performed without tension and, if tension exists while reapproximating nerve ends, then an interposition graft using the greater auricular nerve or the sural nerve must be placed (Figures 47-7 to 47-10). Lastly, if the nerve is transected medial to a vertical line drawn down from the lateral canthus, then nerve repair is not indicated since the branches are small and these distal branches may regenerate with return of muscle movement.

Figure 47-4. Major reconstruction de-identified.

Figure 47-5. Loss of cervicofacial flap de-identified.

Figure 47-6. Facial nerve transection.

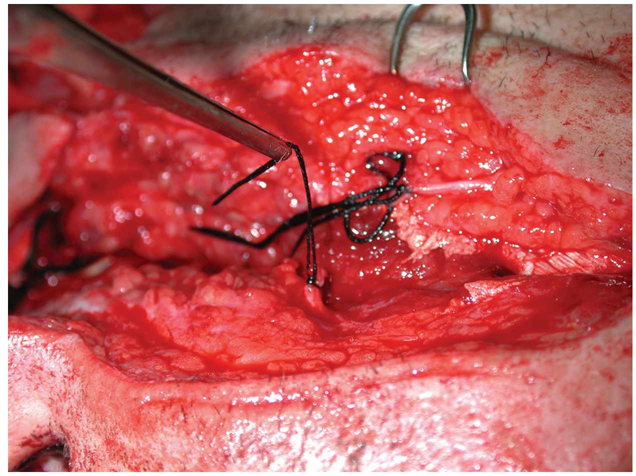

Figure 47-8. Facial nerve ends identified.

MFI patients with cheek lacerations near the course of the parotid duct or with saliva leakage should have exploration of the facial wound to rule out parotid duct injury. The parotid duct has three segments:

1. parotid segment within the parotid gland,
2. masseteric segment over the masseter muscle, and
3. buccal segment that penetrates the buccinator muscle into the oral cavity.[18]

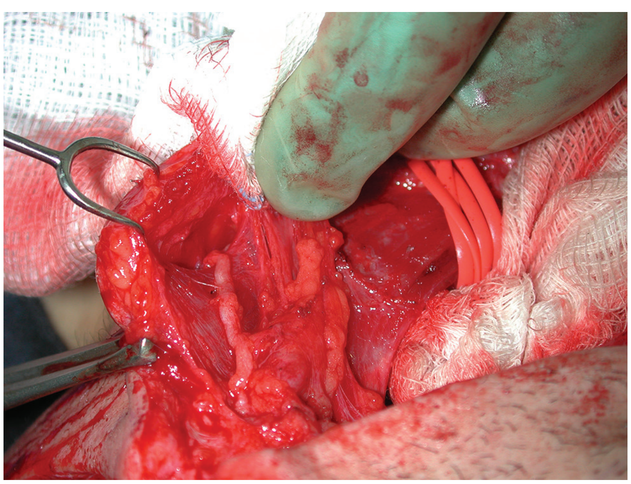

Figure 47-7. Greater auricular nerve harvest.

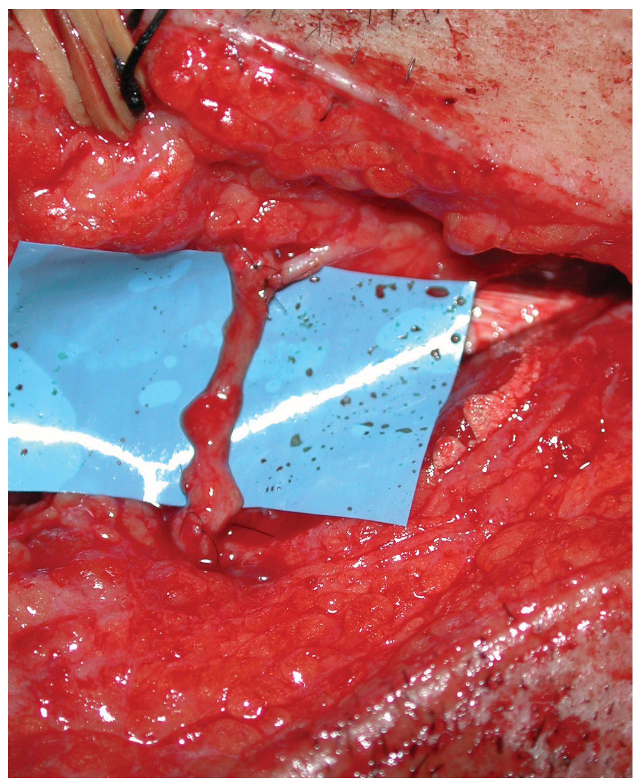

Figure 47-9. Greater auricular graft interposition graft.

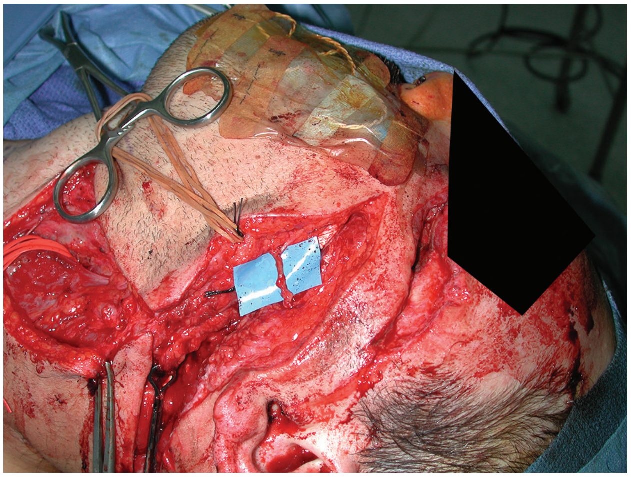

Figure 47-10. Greater auricular nerve graft.

Typically, the parotid duct is cannulated using a lacrimal probe, and then the duct is inspected within the wound to rule out transaction. If the parotid duct is transected, then repair is performed using 6-0 absorbable sutures with or without a stent (eg, an angiocatheter or lacrimal tube). If a parotid duct injury is missed, then treatment is similar to that for postparotidectomy salivary fistulas with pressure dressings and aspiration of trapped saliva as indicated.

Bony Repair

Mandible. The three most important goals of mandibular fracture repair are (1) occlusion, (2) occlusion, and (3) occlusion. That is why the proper application of IMF, typically with Erich arch bars or other techniques (eg, IMF screws), is critically important to achieving a satisfactory surgical outcome. Lessons learned during the application of Erich arch bars include the following:

- count 16 to 17 lugs and cut the Erich arch bar (additional lugs may need to be removed based on patient anatomy),
- place loose 24-gauge wires around the canine teeth,
- replace the arch bar with lugs in the correct position and tighten the canine wires,
- place all wires in a mesioocclusal fashion around each tooth from the canine to the second molar if possible,
- do not wire incisor teeth unless this is necessary to approximate a floating bony segment, and
- place in IMF with overlapping 26-gauge loops between teeth with at least two loops per side.

Wires are placed around each tooth in a mesioocclusal orientation with respect to the arch bar because this will better flatten out the arch bar against the teeth as wires are applied starting from medially to laterally. Also, before the wire loops are applied to the arch bars to achieve IMF, the patient's dentition is placed in a cross-bite and then the mandible is moved until the teeth lock into the wear facets and premorbid occlusion is achieved. It should be noted that the premorbid occlusion of the patient may not be the class I occlusion typically expected. Additionally, it is easier for a right-handed surgeon to apply arch bars from the patient's left side; to use automatic wire twisters to facilitate wire placement; and to place the first Erich arch bar on the maxillary dentition, which is generally more stable than the dentition on a comminuted mandible. All mandible fractures are considered open fractures and require perioperative antibiotic coverage, with clindamycin commonly used in the combat zone. The timing of mandibular ORIF should be within 48 hours, if possible, and no longer than 7 days after injury, depending on the medical status of the patient.

Lessons learned during mandibular ORIF occurred in OEF and OIF during the treatment for the severely comminuted and displaced mandible fractures caused by improvised explosive devices and close-range, high-velocity gunshot wounds. The establishment of premorbid occlusion with Erich arch bars or IMF screws is the single most important step in mandibular repair.[19] If ORIF is not indicated, such as for minimally displaced unilateral subcondylar fractures, then the patient will be treated with IMF alone with the appropriate airway protection. If ORIF of the mandible fracture is indicated, such as for comminuted and displaced fractures, all fracture sites should be exposed. The next step is to determine, based on examination and preoperative CT scans, whether the mandible fracture is severely comminuted and displaced, as is often seen with high-velocity combat injuries (Figure 47-11a,b).[20]

If there is not severe comminution and displacement, ORIF is performed in the standard fashion with mandibular plates (2 mm or less) applied as needed. If there is severe comminution and displacement, the surgeon should proceed with exploring the wound with special attention to preserving all bony mandibular fragments and preserving any soft-tissue attachments to these fragments (Figure 47-12). Then, a mandibular reconstruction plate, such as the 2.4-mm locking plate, was secured from the stable bone to the opposite stable bone on both sides of the intact mandible (Figure 47-13). Typically, these plates would span from one mandibular angle to the other angle, using the IMF obtained with the remaining dental contact points to estimate curvature of the plate. Reconstruction

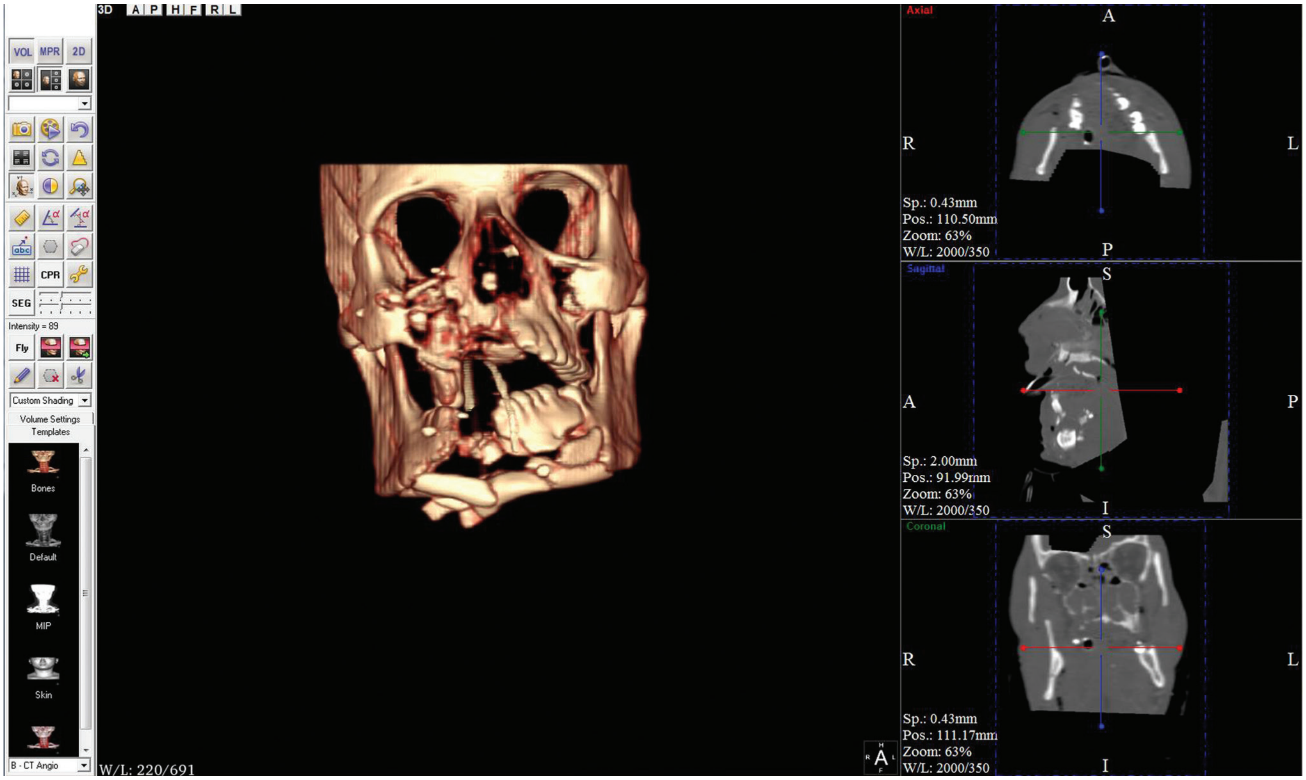

Figure 47-11 (**a**). Preoperative computed tomography scan.

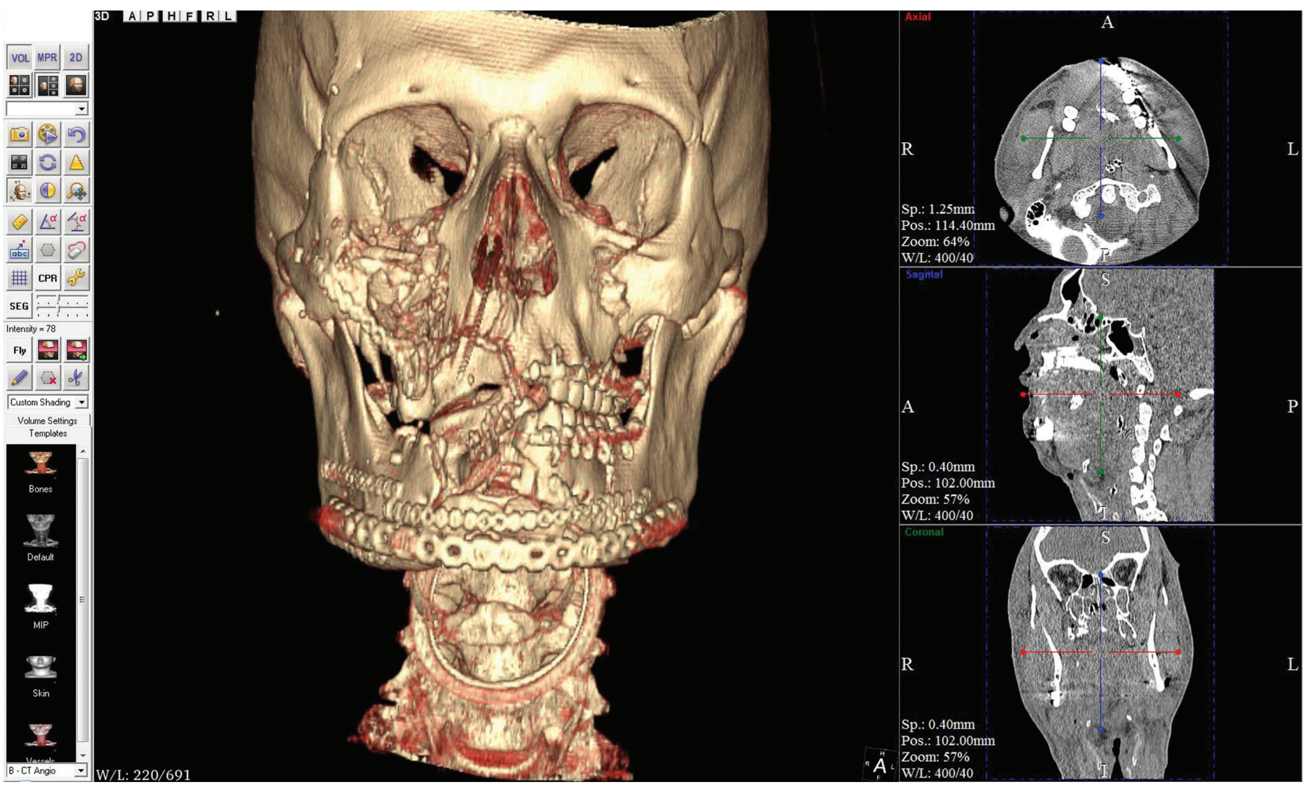

Figure 47-11 (**b**). Postoperative computed tomography scan.

Figure 47-12. Mandible exploration.

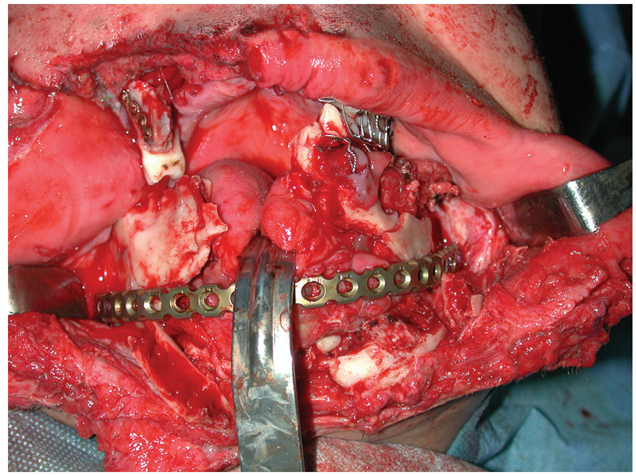

Figure 47-13. Reconstructive plate to stable bone.

plates can be slightly recessed to facilitate soft-tissue coverage at the end of the case. After placement of the reconstruction plate, the largest mandibular fragments, typically comprised of bone from the inferior border of the mandible with soft tissue still attached, were secured with screws into the reconstruction plate with every effort made to achieve bone-to-bone contact and to preserve soft-tissue attachments. Rarely a round

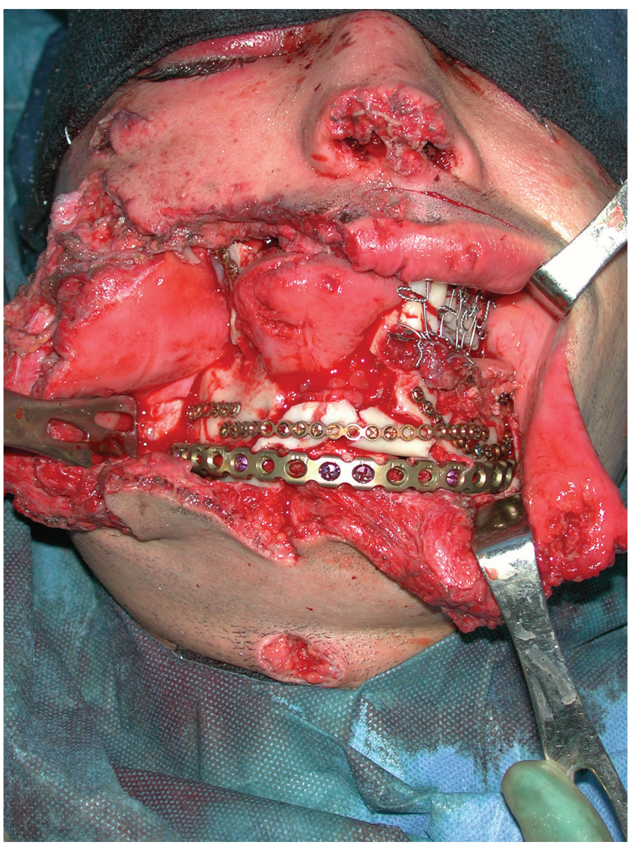

Figure 47-14. Craniofacial and mandible plates.

Figure 47-15. Soft-tissue closure de-identified.

cutting burr was used to shape the irregular edges of the larger bone fragments to facilitate bone-to-bone contact. After the mandibular body and symphysis were reconstructed, smaller mandibular fragments, typically from the occlusal surface of the mandible near the teeth, were replaced and fixed with smaller mandibular or craniofacial plates to the larger inferior bony segments (Figure 47-14). Finally, soft-tissue coverage was achieved following the principles previously discussed (Figure 47-15). Obviously, with such devastating injuries, many of these patients needed additional reconstructive surgery to further repair soft-tissue injuries.

Panfacial Fractures. Important lessons were learned during the repair of multiple midface fractures to include severely comminuted, high-velocity Le Fort III fractures. The first step in the management of panfacial fractures is airway and hemorrhage control. The next step is to "set the base" for the panfacial repair. Because the base is the mandible, IMF and ORIF of mandible fractures, if indicated, are performed first. IMF alone in patients without mandibular fractures may be needed to stabilize and set the base in patients with severely comminuted and displaced midface fractures with a mobile upper jaw. After the base is set with mandibular repair, all midface fracture sites are exposed. This exposure, especially with the massive, high-velocity craniofacial injuries extending from zygomatic arch to zygomatic arch, typically included a bicoronal flap for adequate exposure of both arches and the nasal bones for nasoethmoid repair, if indicated (Figure 47-16). The technique for bicoronal flaps and the precautions with the facial nerve are well described. Our technique involved transitioning through the temporoparietal and deep fascia 2 to 3 fingerbreadths above the zygomatic arch and following the temporalis muscle behind the zygomatic arch bony fragments that are typically displaced posteriorly and inferiorly because of the masseter pull. Then, we would dissect from known to unknown and expose the lateral orbital rim and zygomatic-frontal (Z-F) suture inferiorly in the subperiosteal plane toward the malar eminence. In a similar manner, we would dissect subperiosteally starting at the lateral zygomatic process medially toward the malar eminence that was identified previously, thus exposing the entire zygomatic arch. Other fracture sites are exposed using the following:

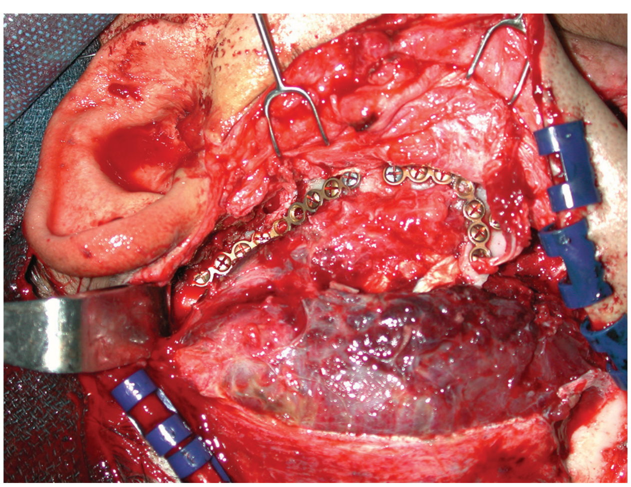

Figure 47-16. Bicoronal exposure.

- the *transconjunctival approach* with a lateral canthus release to expose the inferior orbital rim and orbital floor;
- the *sublabial approach* to expose the medial and lateral maxillary buttresses;
- (and, if the bicoronal approach was not used), the *brow approach* to expose the Z-F suture; and
- (rarely) the *lynch incision* to expose the medial orbital wall, ethmoid, and nasal bones.

After the appropriate surgical approaches are made and the bony fractures exposed, the bony segments should be reduced and positioned into their premorbid position ensuring that the midface height and projection are preserved (Figures 47-17 and 47-18). A trick to achieving proper projection is to manipulate the bony segments such that the fracture line interfaces appear "normal" and premorbid. After fracture reduction, the midface needs to be built from stable points to unstable points.[19] The primary point to which the midface is built is the malar eminence. The malar eminence is the most prominent projection in the midface, and the premorbid position of the malar eminence needs to be accurately restored. Consequently, one can start at the stable Z-F suture and proceed with fixation down the lateral orbital rim to the malar eminence using whatever number of plates are need to achieve stability. Then start from the stable laterally intact zygomatic arch segment and proceed with fixation medially along the fractured zygomatic arch to the malar eminence. It should be noted that the zygomatic arch is normally flat and that the malar eminence is the most prominent point of midface projection. Then, if indicated, one should plate from the stable frontal bone along the nasoethmoid complex to the inferior orbital rim and finally to the malar eminence. Finally, plates are placed from the now stable upper midface along the medial and lateral maxillary buttresses as indicated, and the soft-tissue incisions are closed.

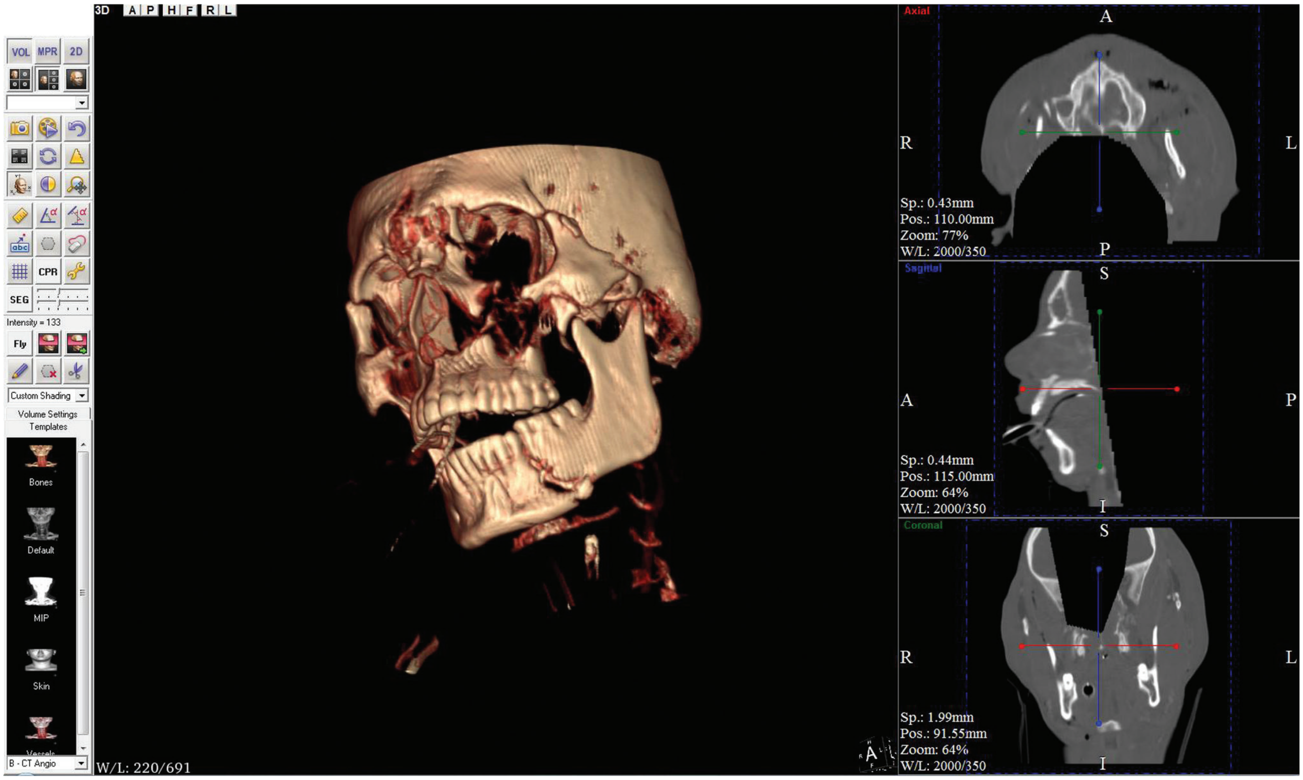

Figure 47-17. Preoperative computed tomography scan.

Figure 47-18. Postreduction computed tomography scan.

Neck/Skull Base Exploration

Wounded servicemen are surviving at higher rates because of significant advances in both medical treatment and protective equipment. For example, the survival rates for soldiers with penetrating neck trauma (PNT) were 86% in World War I, 93% in World War II, and ranged between 93% and 96% in the Vietnam War.[21–23] In Iraq and Afghanistan, the survival rate for PNT was 96.3%, despite the fact that 70% of these wounds were caused by devastating improvised explosive devices, mortars, and rockets.[24] The increased survival in PNT occurred because surgical teams, specializing in head and neck and vascular surgery, were able to perform definitive repair of these injuries typically within the first hour after the injury (see also reference 24 for more details).

Since World War II, high-velocity PNT has been treated with mandatory neck exploration by military surgeons.[21–23] However, in OIF and OEF, selective neck exploration is the current practice.[24] Two requirements are needed to follow a safe selective neck exploration algorithm.[25] The first requirement is the capability of accurate diagnostic testing, including MCTA and pandendoscopy, excluding significant injury.[25] The second requirement is the presence of appropriate personnel, including otolaryngologists and trauma surgeons, and providing active observation of the asymptomatic patient.[25] As opposed to previous US military conflicts, both requirements were present at Role 3 military hospitals in OIF and OEF, thus allowing coalition surgeons to safely follow the selective neck exploration algorithm.

MFI and PNT, most commonly zone III PNT, frequently coexist in patients injured by improvised explosive devices.[24] A key finding regarding PNT is that seemingly small and insignificant puncture wounds from improvised explosive devices may cause fatal injuries. Consequently, the phrase "small holes equal big pathology" was coined to refer to these potentially devastating injuries.[8] PNT patients who are symptomatic or who are asymptomatic, but found to have significant findings on diagnostic testing, will undergo neck exploration. Surgical approaches to the skull base for neck exploration with vascular/neural control in patients with zone III PNT can be difficult and associated with increased morbidity.[24] Zone III surgical approaches include the

- *transcervical approach*,
- *transparotid/transcervical approach* with identification of the facial nerve,
- *transfacial approach* with maxillary swing, and
- *mandibular split approach*.

Figure 47-19. Preoperative computed tomography scan.

Figure 47-19 shows the CT scan of a patient who was wounded by an improvised explosive device with a large metal fragment with multiple sharp edges lying immediately adjacent to the carotid sheath in zone III of the neck. The wound was explored using a parasagittal mandibular split approach with control of the common and internal carotid arteries; the internal jugular vein; and cranial nerves 7, 10, 11, and 12 (Figure 47-20). The

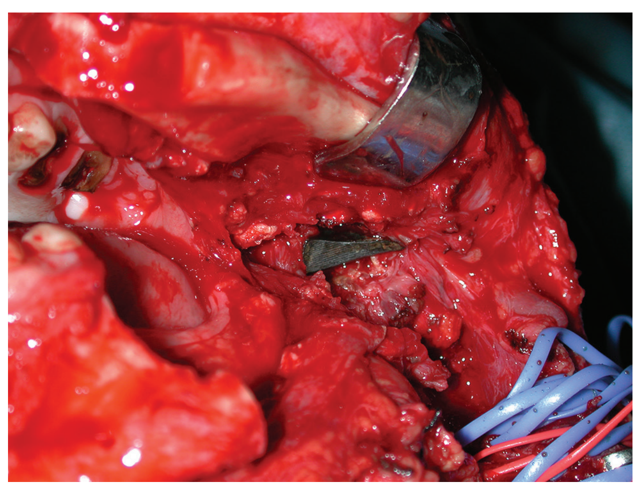

Figure 47-20. Mandible split.

Figure 47-21. Zone III fragment.

large, improvised explosive device fragment (Figure 47-21) was removed, and the mandible was repaired using a mandibular plate that had been previously placed and removed before the mandible was split using a sagittal saw (Figure 47-22).

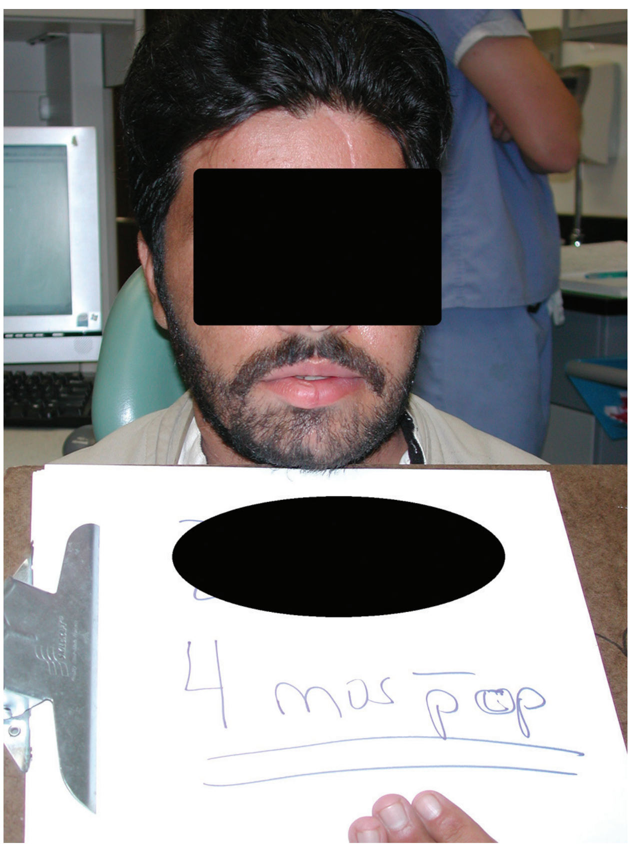

Figure 47-22. Zone III PNT 4 months postoperative de-identified.

The bottom line is that PNT patients who are symptomatic need to go to the operating room for neck exploration. If these symptomatic patients are stable, then CT angiography may be obtained en route to the operating room. PNT patients who are asymptomatic need to be evaluated with CT angiography. In addition, as indicated for zone I and zone II PNT, pandendoscopy with rigid/flexible esophagoscopy, bronchoscopy, and laryngoscopy may also need to be performed (swallow studies were not used in the war zone). If the workup shows significant neck pathology, then these PNT patients need to go to the operating room for neck exploration. If the workup is negative, then close observation is warranted.

Laryngotracheal Repair

Laryngotracheal trauma is the second most common cause of death in patients with head and neck trauma after intracranial injury.[26–28] Indications for laryngotracheal exploration and repair include large mucosal lacerations, exposed cartilage, displaced fractures, and vocal cord immobility.[29] All patients with high-velocity laryngotracheal trauma require direct laryngoscopy to assess the extent of laryngeal trauma and hypopharyngeal disruption.[30] During exploration, the principles of laryngotracheal repair include reduction and stabilization of fractures, mucosa-to-mucosa closure of respiratory tract defects, and use of endolaryngeal stents as indicated.[29,31] In a series of 25 laryngotracheal repairs in OIF, placement of 1.3-mm titanium plates was the most common technique used to stabilize laryngotracheal fractures (Figure 47-23).[32] In addition, only 1 of the 25 patients with laryngotracheal repair required an endolaryngeal stent.[32] Indications for endolaryngeal stenting may include anterior commissure disruption, comminuted laryngeal cartilage, and massive mucosal injuries.[29,32] However, the use of laryngeal stents is controversial because these stents may cause endolaryngeal infection and damage.[29,33] If a stent is used, then it should be soft with a length from the false vocal cords to the first tracheal ring that can be stabilized within the endolarynx.[29] The ideal length of time that the endolaryngeal stent should remain in place is also controversial, but most authors recommend between 10 days to 4 weeks.[29,33]

Otological/Vestibular Trauma

Since October 2001, nearly 2 million US troops have been deployed to the Central Command area of responsibility (OIF and OEF).[34] Hearing loss is the most common service-connected reason for disability, and the cost of hearing loss and tinnitus disability for all veterans exceeded 1 billion dollars in 2005.[35,36] In addition, traumatic hearing loss is the most common reason for outpatient visits to the otolaryngology clinics in the combat zone.[8] Traumatic hearing loss accounted for 20% of outpatient visits while traumatic tympanic membrane perforation accounted for 10% of visits.[8] Lastly, tympanic membrane perforation is the most common primary blast injury in OIF and OEF, and occurs in approximately 10% of patients wounded by combat explosions.[36,37]

Tympanic membrane perforations spontaneously heal in up to 90% of traumatic perforations.[38] The risk factors for nonhealing tympanic membrane perforations included a large or high-grade (>75%) perforation and a peripheral location of the perforation.[39,40] Consequently, the initial treatment of traumatic tympanic membrane perforation should include an audiogram to determine hearing loss and treatment with otological topical antibiotics for contaminated wounds. Hearing loss in patients with tympanic membrane perforation will occur in up to 77% of those patients.[36,41] Because acoustic injury with hearing loss degrades combat effectiveness, those troops with hearing loss should be removed from combat.[36] If the perforation does not spontaneously heal within 90 days, then consideration should be given to tympanoplasty to repair the hole.

Vestibular damage caused by explosions is common and will frequently be seen in patients with traumatic brain injury.[34] Within 72 hours of the blast, most patients have a common syndrome of dizziness, headache, and minor confusion.[34] Unfortunately, a significant percentage of blast patients will have persistent dizziness, hearing loss, headache, and posttraumatic stress disorder that persist in both the subacute (4–30 days postblast) and chronic (>30 days postblast) phases.[34] Ongoing research is being conducted to identify treatment modalities for these chronic vestibular and audiologic symptoms.

Hearing protection, including the use of combat ear plugs, is rarely used by infantry soldiers and marines. In 2004, during OIF, 113 patients were seen in the otolaryngology outpatient clinic complaining of traumatic hearing loss with or without tympanic membrane perforation.[8] Only one patient was wearing hearing protection (with combat ear plugs) when the blast occurred.[8] Five years later, in OEF, >100 patients were seen in the otolaryngology clinic with traumatic hearing loss with or without tympanic membrane perforation, and only one of those patients was wearing the new and improved combat ear plugs.[11] Consequently, at the beginning of basic combat training, soldiers should be fitted with combat ear plugs and should train with this hearing protection in place.[42] Unless the soldiers train with them and build confidence that the plugs will not degrade their combat effectiveness, then the plugs will never be used, which is happening today.[8] In addition, further research and the effort to fit all soldiers with active hearing protection that both enhances communication and provides protection from weapons fire need to continue.[42]

Airway Management

Airway compromise is the third leading cause of potentially survivable death on the battlefield behind compressible hemorrhage and tension pneumothorax.[7,43,44] Penetrating face and PNT account for >75% of the injuries necessitating traumatic airway control in OIF.[32] High-velocity trauma causes acute hemorrhage, tissue prolapse, and massive edema that may result in significant airway obstruction necessitating emergent airway control.[8,32]

Traumatic airways can be classified into three groups:

1. red airways,
2. yellow airways, and
3. green airways.[32]

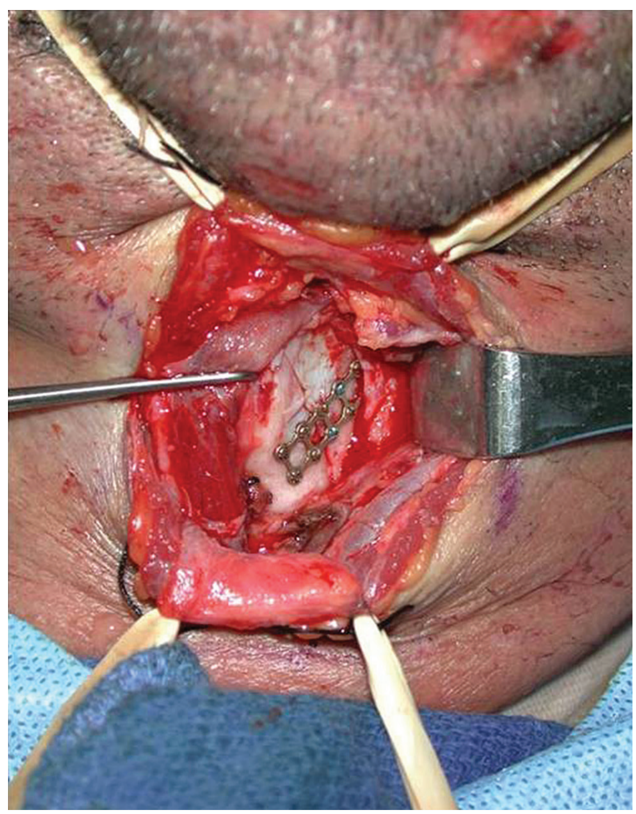

Figure 47-23. Open reduction and internal fixation.

Red airways are emergent airways requiring immediate airway control within 5 minutes.[32] Red airways occur in patients with acute airway compromise or with exsanguinating hemorrhage necessitating immediate airway control.[32] *Yellow or delayed airways* require urgent airway control within 12 hours.[32] Yellow airways occur in patients with progressive or impending airway compromise, active head and neck bleeding, urgent repair of MFI, and symptomatic PNT.[32] *Green airways* are elective airways requiring control >12 hours after consultation.[32] Green airways occur in those patients with respiratory failure on long-term ventilator support, closed-head trauma, and delayed MFI repair.[32]

The best method to assess airway patency during the primary trauma survey is to ask the patient to talk.[32] If the patient can give an intelligible and appropriate reply, then he or she has a patent airway, adequate ventilation to vibrate the true vocal cords and generate voice, and a Glasgow Coma Scale score of >8, indicating brain perfusion.[32] Surgeons should assess the direction of the missile track and the structures likely to be affected for clues on the risk of significant swelling. It is better to perform a definitive airway procedure semielectively rather than in an emergency. The key to airway management is to prevent a yellow or green airway from becoming more unstable and transitioning to a red airway.[32] Trauma patients with a yellow airway and abnormal anatomy distorting airway landmarks will typically be managed with awake tracheotomy under local anesthesia. Awake tracheotomy may be a safer approach than attempting a difficult oral or nasal intubation, causing additional airway edema and bleeding, and necessitating an emergent cricothyroidotomy for an airway that is now red.

Ten percent of OIF patients with high-velocity MFI necessitating traumatic airway intervention required immediate intubation or emergent cricothyroidotomy/tracheotomy by surgeons after initial airway management failed.[32] This high rate of emergent airway control for high-velocity MFI is three times higher than that seen for civilian low-velocity MFI.[45–47] Traumatic airway management in Iraq has yielded a survival rate of 94% in those wounded presenting with *red* or emergent airways requiring control of the airway generally within 5 minutes of presentation.[32] This high survival rate for wounded patients presenting with acute airway emergencies occurred because highly skilled surgical teams were stationed within the combat zone and could secure the airway immediately.[32] It is recommended that surgeons pre-position *emergency cricothyroidotomy kits* with the basic airway instruments in key locations of the combat hospital, the emergency room, and the intensive care unit for easy access should a red airway occur.

SUMMARY

The Mayo brothers stated that, "the only victor in war is medicine."[43] The surgical advances and lessons learned in the treatment of MFIs have been identified. The hope is that these costly lessons learned in the combat zone can be applied to the civilian practice of MFI and improve the current quality of care in civilian institutions.

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