

# Chapter 6

## DEMOGRAPHICS OF HEAD AND NECK INJURIES IN IRAQ AND AFGHANISTAN

JOSEPH A BRENNAN, MD, FACS\*

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*\*Colonel, Medical Corps, US Air Force; Chief, Department of Surgery, San Antonio Military Medical Center, 3551 Roger Brooke Drive, Joint Base San Antonio, Fort Sam Houston, Texas 78234; Professor of Surgery, Uniformed Services University of the Health Sciences*

## INTRODUCTION

Since January 2003, more than 7,200 US service members with head and neck trauma have been treated at American medical facilities in both war zones.<sup>1-3</sup> These service members suffered 37,523 discrete facial and penetrating neck injuries, with 25,834 soft tissue injuries and 11,689 facial fractures.<sup>3</sup> The most common mechanism of injury, the improvised explosive device (IED), typically occurs at close range and results in multisystem high-velocity inju-

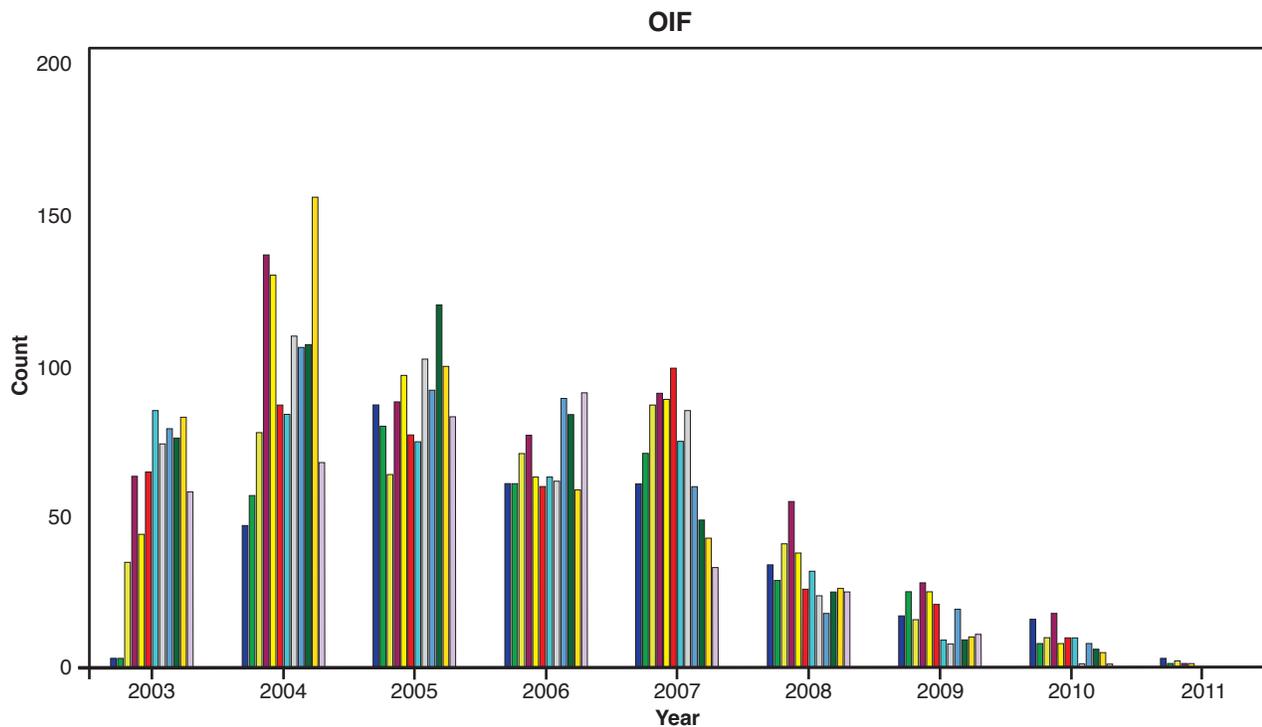
ries that can be devastating to the head and neck.<sup>4,5</sup> This chapter reviews demographic data obtained during the conflicts in Iraq and Afghanistan to obtain insights useful in future military conflicts and the civilian practice of trauma care. These unique lessons learned can be used to tailor head and neck trauma education and preparation for trauma management for residents and staff in both military and civilian settings.<sup>6,7</sup>

## GENERAL DEMOGRAPHICS

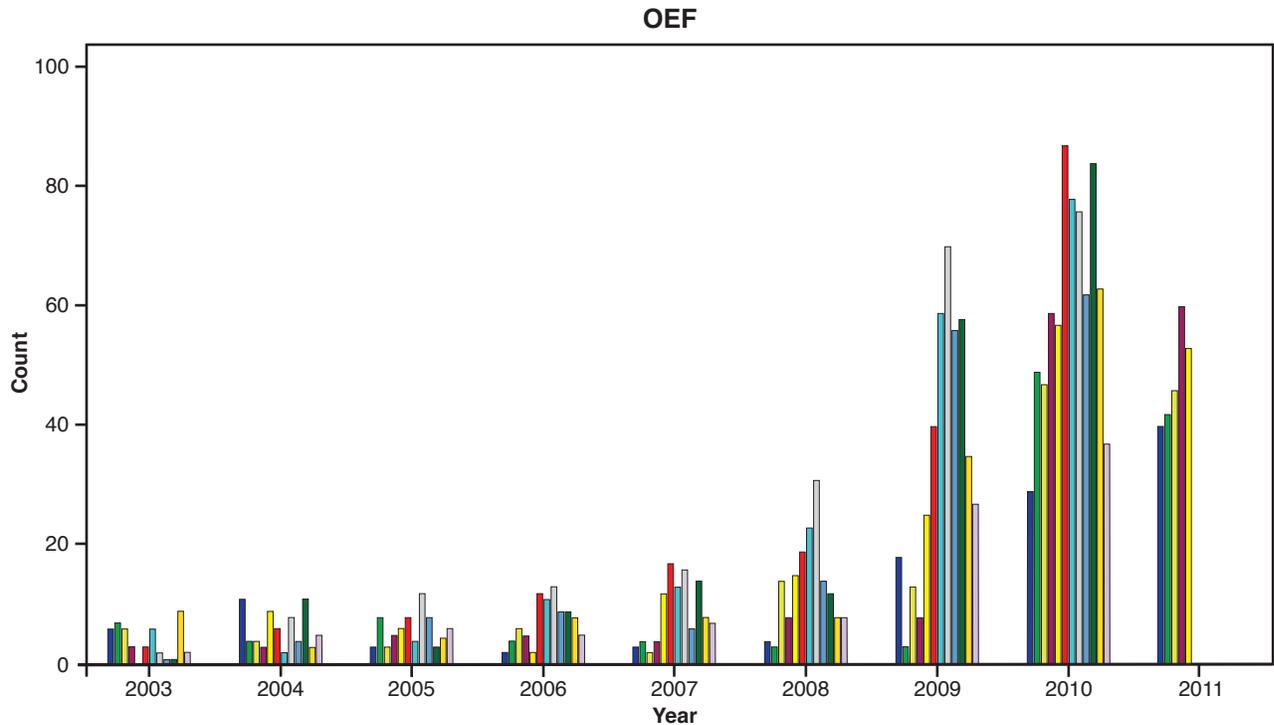
The preponderance of Americans and local national patients who present with head and neck wounds in the combat zone are male, with most series reporting 97% to 98% male populations.<sup>3,8</sup> The average age of Americans receiving head and neck wounds in Iraq and Afghanistan was 26 years old.<sup>3</sup> The percentage of American service members presenting with head and neck injuries to theater hospitals ranges between 30% and 43%, with a higher percentage of Americans wounded in Iraq early in the war.<sup>8,9</sup> The remaining

57% to 70% of wounded head and neck patients were local national soldiers, local national civilians, enemy prisoners of war, coalition soldiers, and contractors. Most of the wounded Americans served in the Army (75%), followed by the Marine Corps (20.5%), the Navy (2.5%), and the Air Force (2%).<sup>3</sup>

The incidence of head and neck injuries in Iraq, depicted in Figure 6-1a, shows a spike in injuries in 2004 and 2005, with the bloodiest month being November 2004 due to the Battle for Fallujah. The incidence of head



**Figure 6-1 (a).** Incidence of head and neck injuries in Operation Iraqi Freedom (OIF; no data was available for June 2013). Reproduced with permission from: Feldt BA, Salinas NL, Rasmussen TE, Brennan J. The Joint Facial and Invasive Neck Trauma (J-FAINT) Project, Iraq and Afghanistan 2003–2011. *Otolaryngol Head Neck Surg.* 2013;148(3):403–408.



**Figure 6-1 (b).** Incidence of head and neck injuries in Operation Enduring Freedom (OEF). Reproduced with permission from: Feldt BA, Salinas NL, Rasmussen TE, Brennan J. The Joint Facial and Invasive Neck Trauma (J-FAINT) Project, Iraq and Afghanistan 2003–2011. *Otolaryngol Head Neck Surg.* 2013;148(3):403–408.

and neck injuries in Afghanistan, depicted in Figure 6-1b, shows a spike in injuries in 2009 and 2010, which coincided with the surge in the number of combat forces. While almost 75% of American head and neck injuries have occurred in Iraq, it is difficult to compare the head and neck surgical volume per surgeon in each war zone.<sup>3</sup> A review of one surgeon's experience in both Iraq and Afghanistan demonstrated an equal number of head and neck procedures (60) performed each month.<sup>8</sup> However, a greater number of patients per month (35.5) were taken to the operating room in Iraq as compared with Afghanistan (26).<sup>8</sup> Nevertheless, fewer operative procedures per patient trip to the

operating room were performed in Iraq (1.7) than in Afghanistan (2.3).<sup>8</sup> The greater number of head and neck operations performed in the operating room in Afghanistan was mainly because there, this type of surgery was primarily a referral practice for complicated head and neck reconstruction, as opposed to the acute lifesaving practice for "bleeding" trauma done in Iraq (see further discussion of this topic below). Finally, the otolaryngologist/head and neck surgeon was shown to be the busiest surgeon among the head and neck team (otolaryngologist, neurosurgeon, oral maxillofacial surgeon, ophthalmologist) and served as the primary surgeon in 37% of all head, neck, and cranial cases.<sup>9</sup>

### PRETREATMENT

Role 1 treatment is immediate first aid delivered at the location of injury, generally by Army medics and Navy corpsmen.<sup>10</sup> Role 2 treatment provides increased medical capability with limited inpatient bed space.<sup>10</sup> Typically, most Role 2 facilities provide emergent and life-saving surgical capabilities ("damage control"). Role 2 facilities include the Army forward surgical team, the Air Force mobile field surgical team, and the

Navy/Marine surgical company.<sup>10</sup> Role 3 treatment provides the highest level of medical care in the combat zone. Role 3 facilities provide the most inpatient beds, including intensive care units, a comprehensive laboratory and blood bank, and advanced imaging, including computed tomography with angiography.<sup>10</sup> The US Air Force theater hospitals (AFTHs) and the Army combat support hospitals are fully equipped

hospitals that may be staffed with multispecialty head and neck teams (otolaryngology, neurosurgery, ophthalmology, and oral maxillofacial surgery).<sup>9</sup> Wounded Americans treated at Role 3 theater hospitals are aerovacuated to Role 4 facilities outside the combat zone when stabilized.<sup>10</sup> Finally, Role 4 facilities such as Landstuhl Regional Medical Center in Germany provide definitive medical and surgical care outside the combat zone.<sup>10</sup>

The most striking pretreatment difference between the two combat zones was the significantly lower percentage of wounded head and neck trauma patients in Iraq who were pretreated at Role 2 or 3 facilities with surgical capabilities.<sup>8</sup> The AFTH in Balad, Iraq, was located directly in the middle of the restive Sunni Triangle, where over 90% of the wartime trauma occurred. Consequently, the AFTH in Balad was within a 45-minute casualty evacuation helicopter ride from locations where the vast majority of soldiers and marines were wounded. For example, during the Fallujah mass casualty, helicopter crews were bringing wounded Americans and Iraqis directly to AFTH from the Fallujah battlefield, a 40-minute helicopter trip away. Since the wounded in Iraq received only basic wound care after being hit, the head and neck injuries were “bleeding” wounds and the head and neck surgeon was typically the first surgeon to treat these patients. Consequently, a recent review of head and neck wounds in Iraq demonstrated that only 10% of patients were pretreated by surgeons at Role 2 or 3 facilities before arriving at the AFTH.<sup>8</sup>

However, in Afghanistan, the most common areas where head and neck patients were wounded were

generally 1 to 3 hours away by helicopter, typically in the southern and eastern regions of the country. Consequently, Role 2 and 3 medical facilities were spread across these areas so that lifesaving surgery could be performed before they were sent to the AFTH in Bagram, Afghanistan. The vast majority of head and neck wounded in Afghanistan, 93%, were pretreated by surgeons at Role 2 and 3 facilities before being seen by the head and neck surgeon in Bagram.<sup>8</sup> Consequently, “bleeding” wounds in the head and neck, which were the norm in Iraq, were infrequently seen in Afghanistan.

Head and neck surgeons must be well-trained and prepared to treat both acute “bleeding” trauma and complex craniofacial reconstructive trauma. The belief that “by the time I get there” the patient will be stabilized by the trauma team may be false. Mass casualty events can and will occur both in civilian settings, such as during Hurricane Katrina and the Oklahoma City bombing, and in the combat zone.<sup>9,11</sup> Consequently, a rapid mass influx of trauma patients will challenge and perhaps overwhelm the medical resources in place, which may necessitate a triage process to prioritize care. During these mass casualty events, as witnessed during the 10-day Battle for Fallujah in November 2004, the head and neck surgeon will often be the primary surgeon managing airway emergencies and penetrating neck trauma. The head and neck surgeon will also manage devastating soft tissue and bony facial trauma requiring complex repair. Military and civilian head and neck surgeons have a duty and an obligation to maintain their surgical skill sets to deal with both scenarios.<sup>12</sup>

## SITES OF INJURY

The mechanisms of head and neck injuries seen in Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) included IEDs, gunshot, mortar/rocket, grenade (rocket-propelled and hand grenade), mine, closed head trauma, and noncombat injuries (assault and motor vehicle accident). The most devastating injuries are caused by IEDs, which have become the most commonly used weapon in these conflicts, causing over 70% of head and neck trauma (Figure 6-2).<sup>4,5</sup> IEDs include a plethora of weapons and can be divided into three categories: (1) roadside explosives or blast mines usually formed from conventional ordnance; (2) explosive-formed projectiles with penetrator devices designed to breach armored vehicles; and (3) suicide bombings, including human-borne and vehicular IEDs.<sup>4,5</sup> IEDs cause combined blunt, penetrating, and burn injuries resulting from a chain of events after the detonation that produce widespread damage.<sup>4,13,14</sup>

These weapons produce the “ultimate polytrauma,” resulting in potentially lethal high-velocity injuries to multiple anatomic locations.<sup>4</sup> An anatomical study of IED wound patterns demonstrated that IED survivors were wounded in 2.61 anatomic locations, while IED fatalities were wounded in 4.67 anatomic locations.<sup>15</sup>

The typical close-range, multisystem, high-velocity IED injuries can be devastating to the head and neck (see Figure 6-2).<sup>4,5</sup> Even though the head, face, and neck comprise only 12% of the total body surface area, the incidence of head, face, and neck injuries in Iraq and Afghanistan ranges between 25% and 40% of wounded.<sup>1,2,16-19</sup> This reported incidence is significantly higher than the 16% to 21% incidence of head, face, and neck injuries historically reported in previous 20th-century conflicts.<sup>1,2,17,18</sup> The higher incidence of head, face, and neck injuries has also been reported in civilian OIF and OEF casualties, including pediatric patients.



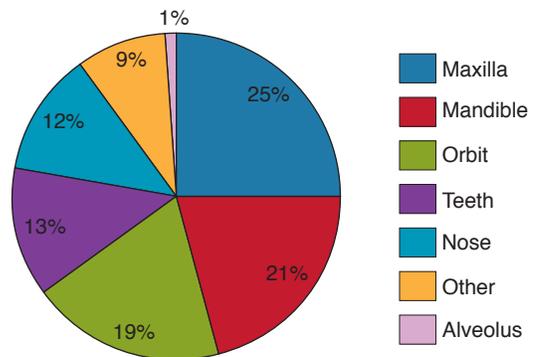
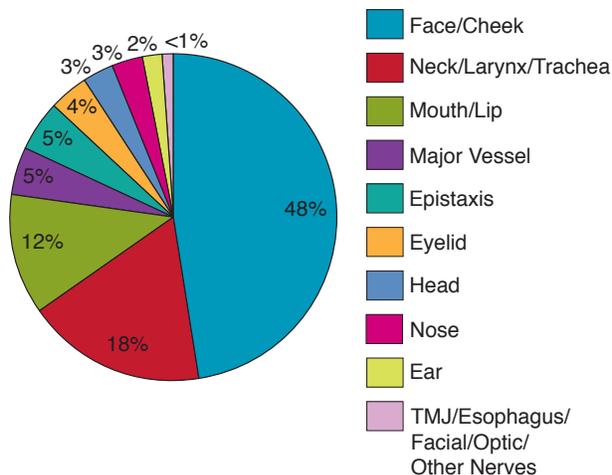
**Figure 6-2.** Improvised explosive device injury.

Creamer examined the medical records of 2,060 pediatric patients admitted to US military facilities in OIF and OEF and reported a head, face, and neck wound incidence of 23.5%.<sup>20</sup>

An extensive review by Feldt et al of the Joint Theater Trauma Registry (JTTR) between 2003 and 2011 showed that the most common mechanisms of head and neck injury in Iraq and Afghanistan were penetrating (49.1%), blunt (25.7%), blast (24.2%), and other/unknown/burn (1%).<sup>3</sup> IEDs cause all these mechanisms

of injury. The JTTR review also demonstrated that the face/cheek area was the most common site of soft tissue injury to the head and neck in 48% of wounded Americans (Figure 6-3a).<sup>3</sup> The second most commonly injured head and neck location was the neck/larynx/trachea, in 18% of patients, followed by the mouth/lip in 12%, the major vessels in 4%, the eyelid in 4%, the nose in 3%, and the ear in 2% of patients.<sup>3</sup> The most common location of facial fractures was the maxilla, in 25.5% of wounded Americans.<sup>3</sup> The second most common location of facial fractures was the mandible, in 21%, followed by the orbit in 19%, the teeth in 13%, and the nose in 12% of patients (Figure 6-3b).<sup>3</sup>

A retrospective review of 104 US service members who sustained traumatic facial injuries from IEDs in Iraq between 2004 and 2007 was performed by Salinas et al.<sup>21</sup> The face was divided into ten basic facial anatomic subunits: (1) forehead, (2, 3) right and left eye, (4, 5) right and left cheek, (6, 7) right and left ear, (8) nose, (9) lips/mouth, and (10) chin.<sup>21</sup> Facial trauma was divided into two categories: (1) massive facial trauma, defined as an injury to the face involving three or more facial subunits including soft tissue and/or facial skeleton, and (2) simple facial trauma, defined as an injury to the face involving fewer than three facial subunits.<sup>21</sup> Massive facial trauma in American service members was significantly associated with blood transfusion, eye injury, brain injury, and a higher injury severity score.<sup>21</sup>



**Figure 6-3 (a).** Distribution of head and neck soft tissue injuries in Iraq and Afghanistan, 2003–2011.

Reproduced with permission from: Feldt BA, Salinas NL, Rasmussen TE, Brennan J. The Joint Facial and Invasive Neck Trauma (J-FAINT) Project, Iraq and Afghanistan 2003–2011. *Otolaryngol Head Neck Surg.* 2013;148(3):403–408.

**Figure 6-3 (b).** Distribution of facial fractures in Iraq and Afghanistan, 2003–2011.

Reproduced with permission from: Feldt BA, Salinas NL, Rasmussen TE, Brennan J. The Joint Facial and Invasive Neck Trauma (J-FAINT) Project, Iraq and Afghanistan 2003–2011. *Otolaryngol Head Neck Surg.* 2013;148(3):403–408.

## SURGICAL PROCEDURES

The spectrum of head and neck surgical procedures in Iraq reflected the fact that 90% of head and neck injuries seen at the AFTH were not pretreated at Role 2 or 3 facilities with surgical capabilities.<sup>8</sup> The high preponderance of acute “bleeding” trauma in Iraq accounts for the ten most common head and neck procedures performed in this combat zone. The most common surgery performed in Iraq was complex facial laceration repair (2-layer closure), which accounted for about one-third of all surgery.<sup>8,9</sup> The second most common procedure was airway surgery, accounting for about one-quarter of procedures performed in Iraq.<sup>8,9</sup> The third most common surgery was neck exploration for high-velocity penetrating neck trauma, accounting for 13% of procedures.<sup>8,9</sup> Rounding out the top ten surgery list in Iraq were direct laryngoscopy (no. 4), intermaxillary fixation with Erich arch bars (no. 5), bronchoscopy (no. 6), esophagoscopy (no. 7), open reduction and internal fixation (ORIF) of facial fractures (no. 8), emergent intubation (no. 9), and lateral canthotomy (no. 10).<sup>8,9</sup>

The spectrum of head and neck surgical procedures in Afghanistan reflected the fact that only 7% of patients seen at the AFTH were not pretreated at Role 2 or 3 facilities with surgical capabilities.<sup>8</sup> Because 93% of head and neck patients were pretreated by surgeons, the head and neck practice in Afghanistan was a secondary referral practice. The low percentage of “bleeding” trauma and the high percentage of more complex craniofacial referrals are reflected in the Afghanistan caseload. As in Iraq, the two most common procedures performed in Afghanistan were complex facial laceration repair and airway surgery.<sup>8</sup> However, the third most common procedure performed in Afghanistan was open reduction and internal fixation of facial fractures.<sup>8</sup> Rounding out the top ten list of Afghanistan cases were intermaxillary fixation with Erich arch bars (no. 4), esophagoscopy (no. 5), direct laryngoscopy (no. 6), neck exploration for high-velocity penetrating neck trauma (no. 7), parotid duct exploration (no. 8), bronchoscopy (no. 9), and oral tongue laceration repair (no. 10).<sup>8</sup>

The difference in practice settings between Iraq and Afghanistan is evident when reviewing the incidence of the most common procedures performed in both combat zones (Table 6-1). Neck explorations for penetrating neck trauma comprised 13% of the surgical caseload in Iraq and only 4% in Afghanistan.<sup>8</sup> Furthermore, while the percentage of surgical airway cases was similar in both combat zones, a higher percentage of surgical airways were triaged as immediate in Iraq, and were “red” or emergent airways requiring

acute intervention within 5 minutes of patient contact.<sup>8</sup> This difference is reflected by the increased incidence of head and neck trauma patients triaged to the immediate category in Iraq (11%) compared with those in Afghanistan (5%).<sup>8</sup> Consequently, the perioperative mortality for head and neck trauma in Iraq (5.3%) was greater than the mortality in Afghanistan (1.3%).<sup>8</sup> Lastly, the referral or tertiary practice in Afghanistan is evident with the significantly increased number of facial fracture ORIF cases performed. Facial fracture repairs comprised 16.5% of the head and neck surgical volume in Afghanistan and only 3% of the surgical volume in Iraq.<sup>8</sup> Furthermore, 19 facial plates per month, including 3.5 mandibular reconstruction plates, were placed in Afghanistan, while only 4.5 facial plates per month, but no mandibular reconstruction plates, were placed in Iraq.<sup>8</sup>

**TABLE 6-1**

### COMPARISON OF HEAD AND NECK INJURIES BETWEEN IRAQ AND AFGHANISTAN

Theater	Iraq	Afghanistan
<b>Operations (%)*</b>		
Facial LAC repair	33	28
Surgical airways	23	19
Neck exploration	13.3	4
IMF (with Erich arch bars)	5.7	11
ORIF facial fractures	3.3	16.5
<b>Plates Per Month</b>		
Craniofacial	4.5	19
Reconstructive (2.4-mm)	0	3.5
<b>Triage (%)</b>		
Immediate	11	5
Delayed	66	69
Minimal	23	26
<b>Mortality (%)</b>	5.3	1.3

\*Each type of surgery as percentage of total surgeries (all types) performed in the war zone.

IMF: intermaxillary fixation

LAC: laceration

ORIF: open reduction and internal fixation

Data source: Brennan J. Head and neck trauma in Iraq and Afghanistan: different war, different surgery, lessons learned. *Laryngoscope*. 2013;123:2411–2417.

The implications for head and neck surgeons with respect to trauma training and maintenance of trauma skill sets are clearly defined by these study results. Head and neck surgeons must be well trained and prepared to treat both acute “bleeding” trauma and complex craniofacial reconstructive trauma. Consequently, a rapid mass influx of trauma patients may overwhelm the medical resources in place, resulting in

a mass casualty scenario. During these mass casualty events, the head and neck surgeon will often be the primary surgeon managing life-threatening head and neck injuries. Also, the head and neck surgeon will manage devastating facial trauma, requiring complex reconstruction of soft tissue and bony deformities. Head and neck surgeons need to maintain the surgical skill sets to deal with both scenarios.<sup>12</sup>

## SURVIVAL

Over the past 150 years, the overall survival rate for military personnel wounded in action was approximately 80%.<sup>22</sup> During the Vietnam War, American servicemen wounded in action had survival rates ranging between 76% and 86.5%.<sup>14,23</sup> During the current conflicts in Iraq and Afghanistan, American servicemen wounded in action have a 90.4% survival rate.<sup>14,23</sup> Americans wounded in Iraq and Afghanistan have the highest survival statistics seen in recent history despite the increasing lethality of weapons, most notably the IED. IEDs account for approximately three-fourths of all combat injuries in Iraq and Afghanistan<sup>24</sup>; whereas in previous conflicts, blast injuries accounted for less than 10% of the wounded.<sup>22</sup>

During the past 10 years in Iraq and Afghanistan, over 7,200 American head and neck trauma patients have been treated at US military medical facilities in both war zones.<sup>1-3</sup> The high incidence of head and neck injuries is due to the lack of head and neck protection provided by the body armor currently used by the troops in the field.<sup>24-27</sup> The multispecialty head and neck surgical teams treating these wounds include neurosurgeons, otolaryngologists/head and neck surgeons, oral maxillofacial surgeons, and ophthalmologists.<sup>9</sup> Feldt reviewed more than 37,000 facial and neck injuries from 2003 through 2011 and demonstrated a mortality of 3.5% for these maxillofacial/neck injuries.<sup>3</sup> The mortality of head and neck injuries was higher in Iraq, at 4.1%, as compared with the mortality in Afghanistan, at 2.3%.<sup>3</sup>

The highest risk factors for mortality were treatment at a Role 2 facility, prehospital intubation, blast injury, and female sex.<sup>3</sup> Often patients with life-threatening acute injuries are diverted to Role 2 facilities for “damage control” and then sent to larger Role 3 theater hospitals. This fact may account for the increased mortality for these patients. Pre-hospital intubation may correlate with more severe head and neck injuries with airway compromise and higher injury severity scores. Blast injuries, specifically from IEDs, are the most lethal mechanisms of injury seen in modern warfare and the associated higher mortality is expected. Lastly, it is unclear why female sex was correlated with higher mortality.

A review of one surgeon’s head and neck experience in Iraq and Afghanistan likewise demonstrated a significantly increased mortality in Iraq (5.3%), when compared with the mortality in Afghanistan (1.3%).<sup>8</sup> Why is the mortality of head and neck injuries higher in Iraq? First, 73% of head and neck wounds occurred in Iraq, and only 27% of head and neck wounds occurred in Afghanistan.<sup>3</sup> The highest number of facial and penetrating neck injuries occurred in November 2004 in Iraq,<sup>3,9</sup> which was the bloodiest month of the war in either Iraq or Afghanistan as a result of the Battle for Fallujah. After that November, the incidence of facial and penetrating neck injuries trended down for the remainder of OIF.<sup>3</sup>

Second, the three most common causes of potentially survivable death in Iraq and Afghanistan are compressible hemorrhage, tension pneumothorax, and airway compromise.<sup>22,26,27</sup> In previous reviews, airway compromise was shown to be either the second or the third leading cause of potentially survivable death in American service members.<sup>22,26,27</sup> Since approximately 75% of head and neck injuries occurred in Iraq, the higher frequency of airway compromise seen in OIF may account for this increased mortality.<sup>3</sup> A comprehensive review of traumatic airway management in Iraq between 2004 and 2007 showed that 196 patients presented with airway compromise requiring control of the airway.<sup>28</sup> Emergent airway control within 5 minutes of presentation was performed in 10% of patients, delayed airway control within 12 hours of presentation was performed in 58% of patients, and elective airway control more than 12 hours after presentation was performed in 32% of patients.<sup>28</sup> The most common injuries necessitating airway control, as expected, occurred in the head and neck and included penetrating face and neck trauma. The mortality of patients undergoing emergent airway control was 6%.<sup>28</sup>

Third, high-velocity penetrating neck trauma was more commonly seen in Iraq.<sup>29</sup> A review of 112 neck explorations performed by head and neck surgeons over a 30-month timeframe in Iraq showed a postoperative mortality of 3%.<sup>29</sup> Neck exploration for these

injuries comprised 13% of one head and neck surgeon's caseload in Iraq, with 27 neck explorations performed in about 4.5 months.<sup>8,9</sup> In contrast, neck explorations comprised only 4% of the same surgeon's caseload in Afghanistan, with only 13 neck explorations performed over 6 months.<sup>9</sup>

Despite the higher head and neck mortality seen in Iraq as compared with Afghanistan, the overall survival after head and neck injuries has increased due to significant advances in both medical treatment and protective equipment. For example, the survival rates for soldiers with penetrating neck trauma was 86% in World War I, 93% in World War II, and 93% to 96% in the Vietnam War.<sup>30-32</sup> In Iraq and Afghanistan, the survival rate for penetrating neck trauma was 97%, despite the fact that 70% of these wounds were caused by devastating IEDs, mortars, and rockets.<sup>29</sup> The increased survival in penetrating neck trauma 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 "golden hour" of trauma.<sup>29</sup>

Biffel et al<sup>33</sup> stated that the two requirements for the practice of safe selective neck exploration (standard practice in Iraq and Afghanistan) are (1) diagnostic testing to accurately exclude injury and (2) appropriate personnel to provide accurate observation. In Iraq and Afghanistan, diagnostic testing, including computed tomography angiography and panendoscopy, was available, and well-trained surgeons, including head and neck surgeons and vascular surgeons, staffed the theater hospitals. In previous conflicts, definitive repair of these devastating neck injuries may have been delayed until the patient was aerovacuated to facilities with advanced surgical capabilities and appropriate diagnostic testing. In addition, traumatic airway management in Iraq and Afghanistan 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.<sup>28</sup> This high survival rate for wounded patients presenting with acute airway emergencies occurred because highly skilled head and neck teams, trauma surgeons, anesthesiologists, and emergency medics were stationed within the combat zone and could immediately secure the airway.<sup>34</sup>

## SUMMARY

The head and neck trauma experience in Iraq differed from the experience in Afghanistan. The variability of this trauma experience supports the duty of head and neck surgeons to maintain skill sets that can effectively treat both acute "bleeding" trauma, such as traumatic airway compromise and penetrat-

ing neck trauma, and more complex craniofacial bony and soft tissue repair, which occurs during mass casualty events. In addition, the lessons learned in these combat zones may allow civilian providers to better treat patients if mass casualty events occur in their communities.

## CASE PRESENTATIONS

### Case Study 6-1

#### *Presentation*

A 32-year-old black male presents to the emergency room in Balad, Iraq, with penetrating neck trauma caused by fragments from an AK-47 assault rifle bullet during the Battle for Fallujah in November 2004. The young Army first sergeant walked into the emergency room under his own power after having been aerovacuated directly from Fallujah to Balad. He was alert and oriented times 3 (to person, place, time) and his initial vital signs were stable. However, he had bright red blood pouring from his mouth and intermittent vomiting of bright red blood. Physical exam showed multiple small 1- to 3-mm punctuate wounds in zone II of his left neck, with a moderate hoarseness, stable airway, midline trachea, and no obvious hematoma. Trauma resuscitation was begun in the emergency room.

#### *Preoperative Workup/Radiology*

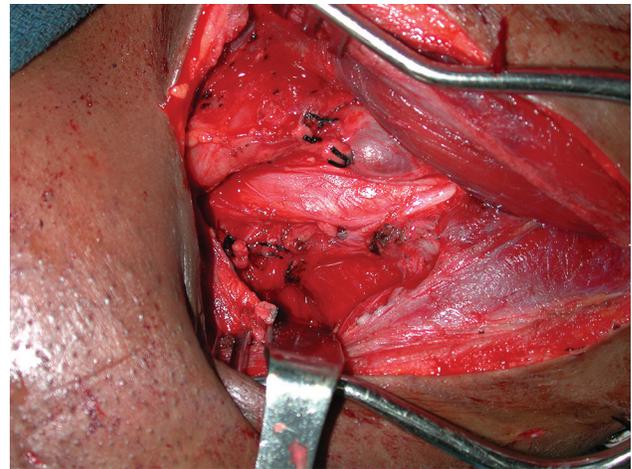
None. Because this patient with zone II penetrating neck trauma was symptomatic with active bleeding from his mouth, he was taken immediately to the operating room to secure his airway and control the bleeding.

#### *Operative Plan/Timing of Surgery*

Trauma patients with symptomatic penetrating neck trauma need neck exploration. If these patients are otherwise stable, then consideration should be given to obtaining appropriate imaging studies (such as computed tomography angiography) en route to the operating room. Since this high-velocity penetrating neck trauma patient had active and profuse bleeding, the decision was made to emergently go to the operating room for airway control and neck exploration.

### Operation

Rapid-sequence intubation was performed with the neck prepped for possible emergent cricothyroidotomy in case the anesthesiologist was unable to visualize the airway. After intubation, bright red blood continued to pour from the nose and mouth (Figure 6-4). A left neck exploration was rapidly performed, and the carotid sheath was noted to be completely normal, without bleeding or hematoma (Figure 6-5). A direct laryngoscopy was performed to pinpoint the bleeding, and bright red blood was found to be pouring out from a small hole in the left pyriform sinus. A rigid suction was placed at the site of bleeding and then palpated through the intact inferior constrictor muscle in the neck. The inferior constrictor muscle was opened over this area, a small, 3-mm metal fragment was seen, and an actively bleeding 2- to 3-mm pharyngeal artery was ligated. Bleeding immediately stopped. Penrose drains were placed into the wound, which was closed; a tracheotomy was performed due to significant laryngeal edema; and the patient was transferred to the intensive care unit (Figure 6-6).



**Figure 6-5.** Neck exploration with negative findings in carotid sheath.



**Figure 6-4.** Zone II symptomatic penetrating neck trauma from AK-47 bullet fragments.



**Figure 6-6.** Neck closure with small, punctate, potentially lethal high-velocity neck wounds.

### Complications

None.

### Lessons Learned

The Army first sergeant healed well without sequelae except for the “obvious scar” on his neck. When offered scar revision 5 years later by this author, he stated he was proud of his scar and refused. The lessons learned are that the head and neck surgeon must be prepared to treat acutely symptomatic penetrating neck trauma and control bleeding. The unique skill set of a head and neck surgeon, including endoscopy skills, were the key to saving this patient, who ultimately received 10 units of blood for his profuse bleeding. These small, seemingly innocuous punctate neck wounds from high-velocity missiles can be lethal. Head and neck surgeons in Iraq coined the phrase “small holes equal big pathology” to describe these punctate wounds that were frequently seen after IED explosions. Lastly, this acute trauma case directly referred from the battlefield to the Role 3 theater hospital in Balad is typical of the “bleeding” trauma typically seen in Iraq.

### Case Study 6-2

#### Presentation

A middle-aged Afghan police chief was referred from the outlying Role 2 US forward surgical base with a massive midface defect from an assassination



Figure 6-7. High-velocity midface defect from AK-47 bullet wound.

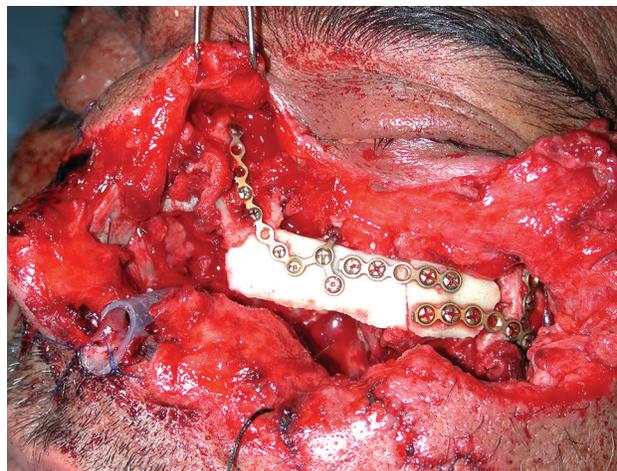


Figure 6-8. Cranial bone grafts in place.

attempt with a high-velocity AK-47 assault rifle (Figure 6-7). The patient was intubated, with stable vital signs and without active bleeding (bleeding was controlled by the referring American trauma surgeons),



Figure 6-9. Total nasal reconstruction.

and arrived at Bagram Air Base, Afghanistan, the day after his injury.

### *Preoperative Workup/Radiology*

Computed tomography (CT) showed a large mid-face defect with near-total loss of nose (3 layers), left maxilla, and orbital floor. CT also demonstrated naso-orbital-ethmoid fracture, left Le Fort III fracture, orbital floor destruction, and loss of upper dentition.

### *Operative Plan/Timing of Surgery*

The patient was stable, and it was decided to take him to the operating room on day 2 after his injury for tracheotomy, minimal wound debridement, and irrigation. Then, 5 days later, on postinjury day 7, after the swelling improved and vision could be checked (it was normal), the patient was taken to the operating room for definitive surgery.



**Figure 6-10.** “Home run” (definitive) reconstruction completed.



**Figure 6-11.** Loss of cervicofacial flap with exposed graft/plates.

### *Operation*

The patient underwent bicoronal flap for arch exposure with ORIF of naso-orbital-ethmoid and Le Fort III fractures, left orbital rim/nasal wall/orbital floor reconstruction with cranial bone grafts, 3-layer reconstruction of total nasal defect with turnover septal inner lining/conchal cartilage graft/paramedian forehead flap, and large cervicofacial rotation/advancement flap to close left maxillary defect (Figures 6-8 through 6-10).

### *Complications*

Loss of medial portion of cervicofacial rotation/advancement flap with exposure of midface craniofacial plates requiring removal of one plate 4 weeks postoperatively and a second plate about 9 months postoperatively (Figure 6-11).

### *Lessons Learned*

Too much surgery too soon was done on this patient. The temporary cavity formed by a high-velocity missile can devitalize a surrounding area of tissue up to

30 times the bullet cross-section.<sup>34</sup> The initial goals of surgery for these devastating high-velocity wounds, after the airway and bleeding are controlled, are to reconstruct the bony deformities and fractures and then to cover the bone with soft tissue. Ideally this soft tissue coverage should be completed with primary closure and minimal tissue advancement/rotation. Instead of performing the “home-run” or definitive surgery on this patient with total nasal/midface reconstruction with rotation/advancement flaps, the initial reconstructive surgery should have repaired and reconstructed the bony defects and closed the soft tissue over the exposed bone, with primary closure if possible. This limited repair would have set the nasal

base and allowed the definitive reconstruction to be staged at a later date, with total nasal and midface reconstruction with rotation/advancement flaps. The expectation is that the large cervicofacial rotation/advancement flap would not have partially died and dehisced because the acutely devitalized tissue would have had weeks to months to recover, with an improved blood supply. After several revision operations, the patient ultimately healed well, with complete closure of his left maxillary soft tissue defect. Lastly, this delayed bony and soft tissue reconstructive case for high-velocity trauma is typical of the complex “non-bleeding” referral cases seen at the Role 3 theater hospital in Afghanistan.

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