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The Joint Facial and Invasive Neck Trauma (J-FAINT) Project, Iraq and Afghanistan 2003-2011

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Abstract

Objective. Define the number and type of facial and penetrating neck trauma injuries sustained in Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF).

Study Design. Retrospective database study.

Setting. Tertiary care level I trauma center.

Subjects and Methods. The Joint Theater Trauma Registry (JTTR) was queried for data from OIF and OEF from January 2003 to May 2011. Information on demographics; type and severity of facial, neck, and associated trauma injures; and impact on overall mortality was recorded.

Results. There were 37,523 discrete facial and penetrating neck injuries that occurred in 7177 service members. There were 25,834 soft tissue injuries and 11,689 facial fractures. The most common soft injury sites were the face/cheek (48%), neck/larynx/trachea (17%), and mouth/lip (12%). The maxilla (25%), mandible (21%), and orbit (19%) were the most common facial fracture sites. The most common mechanism of injury was penetrating (49.1%), followed by blunt (25.7%), blast (24.2%), and other/unknown/burn (1%). Injuries were associated with an overall mortality rate of 3.5%. The highest risks for mortality were treatment at a level IIa facility, female sex, prehospital intubation, and blast injury. Most injuries were mild to moderate.

Conclusion. Facial and penetrating neck trauma are common in modern warfare. Most injuries are minor to moderate and survivable. Training and potential body armor updates can be made. Medical personnel deploying to support OIF and OEF could benefit from specific training in the management of facial and penetrating neck injuries. A surgeon skilled in managing these injuries would likely be beneficial in a deployed setting.

Keywords

facial fracture, Iraq, Afghanistan, neck trauma

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More than 43,000 US military personnel have been injured during Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF). Approximately one-third of battlefield wounds have been in the head and neck.[1-4] This higher incidence of facial and penetrating neck trauma is believed to be the result of improvements in body armor and the widespread use of improvised explosive devices (IEDs) by insurgent forces.[3] The wounds produced by blasts and projectiles from IEDs and the high-velocity gunshot wounds (GSWs) seen among the injured in OIF/OEF are unique and are difficult to compare with the typical low-velocity and blunt trauma seen among civilian trauma facilities in the United States.[1-8] The surgical management of multisystem trauma patients treated in OIF and OEF presents a myriad of challenges. The increased use and effectiveness of IEDs in the OIF and OEF theaters has introduced new wounds, which frequently combine both blunt and penetrating injuries.[1] The epidemiological and long-term clinical course of these devastating injuries has not been documented, and potential exists to improve the care of these soldiers through investigation of the natural history of their injuries.

The evaluation and management of facial and penetrating neck trauma is well described and generally agreed upon. However, areas of controversy still exist. One of the controversies is the need for immediate vs delayed open reduction and internal fixation (ORIF) due to contaminated wounds[9] and the need for immediate vs delayed exploration of neck wounds.[5,10] Prior to 2005, most US service members with

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facial fractures were not treated in theater but were stabilized and sent to higher echelons of care for definitive ORIF. However, beginning in 2005, the definitive treatment of facial fractures in theater in US troops was demonstrated to be safe.[9] An algorithm for determining immediate vs delayed exploration of penetrating neck wounds was also developed through experience in OIF.[10] These practices are now the standard treatment for otherwise stable patients with facial fractures and penetrating neck trauma in OIF and OEF.

Multiple studies have reported on the incidence and management of facial and penetrating neck trauma during parts of the OIF/OEF conflict.[2,4,6,11,12] Although these publications offer timely and helpful glimpses of the surgical treatment of personnel with facial and penetrating neck trauma, none have systematically described all the patients in OIF/OEF over the first 8 years of the conflict. Nor have any of the previously published studies examined the severity of the wounds using injury severity score (ISS) and/or abbreviated injury scale (AIS). The purpose of the Joint Facial and Invasive Neck Trauma (J-FAINT) Study is to describe the incidence, etiology, injury severity, and risk factors for mortality of US service members who sustained facial and/or neck trauma during OIF and OEF from January 2003 through May 2011.

Methods

The institutional review board of the US Army Medical Research and Materiel Command approved the J-FAINT Study. The study used the Joint Theater Trauma Registry (JTTR) database. This is a database that includes demographics and trauma-related information on all US service members injured while deployed during OIF and OEF. The JTTR was queried to identify facial and penetrating neck trauma patients. The JTTR began in 2003, so the first 16 months of the conflicts are unavailable for study. The JTTR collects data on each service member injured, including demographics, injury type, injury pattern, injury location, AIS, ISS, vital signs, transfusion history, intubations, surgical procedures, and discharge status. These data elements are cataloged and stored electronically from the initial evaluation of the trauma patient through transport to level V treatment facilities in the United States or discharge from the treating facility. The repository for the JTTR is at the Institute for Surgical Research at Fort Sam Houston, Texas.

A characterization of the population who incurred a face or neck injury during OIF and OEF included sex, age, incidence month and year, type of injuries, and mortality rate (overall and by injury type). The ISS and AIS were analyzed to determine severity of injuries and predictive value for mortality. The AIS was used to calculate the ISS.[13] The ISS is a trauma scoring system that provides an overall assessment score for patients with multiple traumatic injuries. It includes 6 regions of the body: head and neck, face, chest, abdomen, extremity, and external. Each of these regions is assigned an AIS score from 1 to 6 (**Table 1**). The 3 most severely injured body region AIS scores are each squared and added together. The maximum ISS is 75, and any patient with an AIS score of 6 (unsurvivable) is automatically assigned an ISS of 75. The ISS correlates linearly with mortality, morbidity, and hospital stay.[13]

Table 1. Abbreviated Injury Scale

Abbreviated Injury Scale	Severity
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Unsurvivable

A descriptive comparison of the mean for ISS and each of the 6 AIS was conducted and the results were stratified by OIF/OEF, year, injury type, sex, and branch of service. Using logistic regression, we further assessed the predictive value of the ISS and the AIS for mortality. For the AIS analysis, each of the 6 AIS scores was analyzed for their respective prediction of mortality with results expressed as the odds ratio and included a 95% confidence interval. All odds ratios with 95% confidence intervals that did not include 1 were considered statistically significant. Among the confounding variables included in the risk assessment of ISS and each of the 6 AIS were injury type, initial vital signs, the need for airway intervention, age, sex, and the need for vascular resuscitation (eg, use of whole blood, colloids, platelets, etc). All analyses were conducted using STATA 11.0 (StataCorp, College Station, Texas).

Results

Overall, there were 37,523 discrete facial and penetrating neck injuries that occurred in 7177 service members. This gives an average injury rate of 5.2 injuries per service member. The injuries included 25,834 soft tissue and 11,689 facial fractures (**Tables 2** and **3**). The most common soft injury sites identified were the face/cheek (48%), neck/larynx/trachea (17%), mouth/lip (12%), and vessels (5%). The maxilla (25%), mandible (21%), and orbit (19%) were the most common facial fracture sites. **Figures 1** and **2** illustrate these injury incidence findings.

The most common mechanism of injury was penetrating (49.1%), followed by blunt (25.7%), blast (24.2%), and other/unknown/burn (1%).

The majority of service members injured in the face and neck were male (97.5%). The average age was 25.9 ± 6.4 years. Most of the injured service members were in the Army (75%), followed by the Marine Corps (20.5%), Navy (2.5%), and Air Force (2.0%). Most injuries occurred in OIF (73.3%) as compared with OEF (26.7%).

The OIF and OEF conflicts were associated with a respective mortality rate of 4.1% and 2.3% and an overall mortality rate of 3.5% for service members with facial and

Table 2. Soft Tissue Injuries

Soft Tissue	Total No.	%
Face/cheek	12,357	47.83
Neck/larynx/trachea	4541	17.58
Mouth/lip	3134	12.13
Major vessel	1124	4.35
Epistaxis	1306	5.06
Eyelid	1116	4.32
Head	860	3.33
Nose	799	3.09
Ear	447	1.73
TMJ	39	0.15
Esophagus	35	0.14
Facial nerve	35	0.14
Optic nerve	27	0.10
Nerve	14	0.05
Total	25,834	

Abbreviation: TMJ, temporomandibular joint.

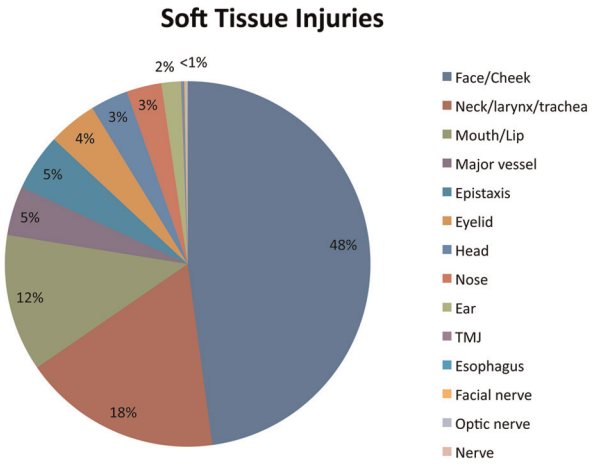

Figure 1. Soft tissue injuries. TMJ, temporomandibular joint.

Table 3. Facial Fractures

Fracture	Total No.	%
Maxilla	2859	24.46
Mandible	2437	20.85
Orbit	2241	19.17
Teeth	1560	13.35
Nose	1434	12.27
Other	1012	8.66
Alveolus	124	1.06
Panfacial	22	0.19
Total	11,689	

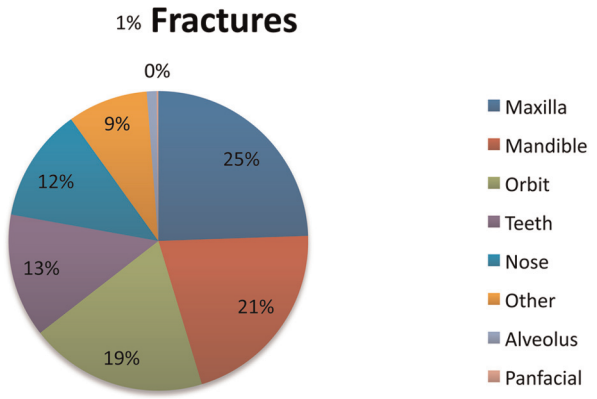

Figure 2. Facial fractures.

penetrating neck trauma (**Table 4**). The mortality rates for sex, branch of service, and mechanism of injury are also illustrated in **Table 3** along with the odds ratio for the risk of death and associated confidence interval. Odds ratio and confidence interval for transfusion, facility level, and airway interventions are shown in **Table 5**. The odds ratios for these variables compare patients treated with the interventions vs those who did not receive the intervention and their likelihood of mortality. For example, the patients with prehospital intubation were 8% more likely to die of their head and neck trauma than patients who did not undergo this procedure.

The highest casualty month for patients with facial and penetrating neck trauma was April 2008. The highest number of facial and penetrating neck injuries occurred in November 2004 in OIF (136), coinciding with a major US offensive in Fallujah. From that point, the incidence of facial and penetrating neck injuries declined on the whole throughout the study period in OIF (**Figure 3**). Interestingly, the incidence of injuries in OEF was relatively low until 2009, with the maximum injuries occurring in June 2010 (87), and has remained relatively steady between 30 and 40 per month during the remainder of the study period (**Figure 4**).

Most service members were characterized as AIS 1 to 2. The AIS is divided into different body regions, with the facial region demonstrating 97.7% minor to moderate injuries and the neck 60.7% minor to moderate injuries. The body regions demonstrating the highest AIS were the thorax (mean 2.79) and extremity (mean 2.52). The overall average ISS was 12.2.

Discussion

Facial trauma and penetrating neck trauma are common in modern warfare. The most common mechanisms of injury included penetrating, blast, and blunt trauma, which are consistent with prior studies showing that IEDs are common weapons in OIF and OEF.[4,11,12,14] On average, the individuals identified in this study sustained more than 5 separate facial and penetrating neck injuries. Although most of these injuries involved superficial soft tissue regions with low injury severity as suggested by a low AIS of 1 to 2, a

Table 4. Mortality Rates, Odds Ratio, and 95% Confidence Interval of Service Members with Facial and Penetrating Neck Trauma Characterized by Conflict, Sex, Branch of Service, and Mechanism of Injury

	Mortality Rate, %	Odds Ratio for Risk of Death Compared with the Variable Not Being Present	95% CI
Military operation			
Overall	3.5		
OIF	4.1	1.06	1.05-1.07
OEF	2.3	1.07	1.05-1.09
Sex			
Male	3.7	1.06	1.05-1.07
Female	2.1	1.16	1.01-1.33
Service			
Army	4.0		
Navy	2.6		
Marines	2.2		
Air Force	1.3		
Mechanism of injury			
Blast	4.6	1.08	1.06-1.10
Blunt	1.3	1.06	1.04-1.09
Penetrating	4.3	1.05	1.04-1.06

Abbreviations: CI, confidence interval; OEF, Operation Enduring Freedom; OIF, Operation Iraqi Freedom.

Table 5. Predictive Variables for Mortality

Data Element	Odds Ratio for the Risk of Death Compared with the Event Not Occurring	95% CI
Prehospital intubation	1.08	1.05-1.11
Whole-blood transfusion	1.06	1.05-1.07
Platelets	1.06	1.05-1.07
Cryoprecipitate	1.06	1.05-1.07
Level IIa	1.21	1.00-1.47
Level IIb	1.06	1.03-1.09
Level III	1.06	1.05-1.07

Abbreviation: CI, confidence interval.

significant number of the injuries identified included facial fractures (31%) and damage to vessels (5%) with the potential for significant morbidity.

The highest risk factors for mortality included treatment at a level IIa facility, female sex, prehospital intubation, and blast injury. Level IIa facilities are the initial site in military medical treatment facilities that have surgical capabilities. Most surgeries here are ''damage control,'' used to stabilize patients before moving to a higher echelon of care. Many patients treated at these facilities have life-threatening polytrauma injuries. It is unclear why females had a higher mortality rate in this study. Another interesting finding is that prehospital intubation led to a higher mortality risk. This could again be due to higher acuity injuries with higher ISS. Blast injuries led to more risk for mortality, possibly because of the diffuse injury patterns this mechanism of injury causes.[8]

This study represents the most comprehensive examination of injury data from facial and penetrating neck injures in OIF and OEF during the study period. Lew et al[6] examined facial trauma data from 2001 to 2007 in OIF and OEF and found only 2014 facial soft tissue and facial fractures. However, their data only included *International Classification of Diseases* codes and likely underestimated the true number of injuries. Many more of their injuries were the result of blast (84%), as compared with 24% in our study. They also did not comment on mortality as an outcome in their patient population.

Massive facial trauma has been described as injury to 3 or more facial aesthetic subunits with a statistically higher rate for brain injury, ocular injury, transfusion rate, and ISS.[4] Although it is not possible to separate facial and penetrating neck injuries from other types of injuries for individual patients in this study, the service members with

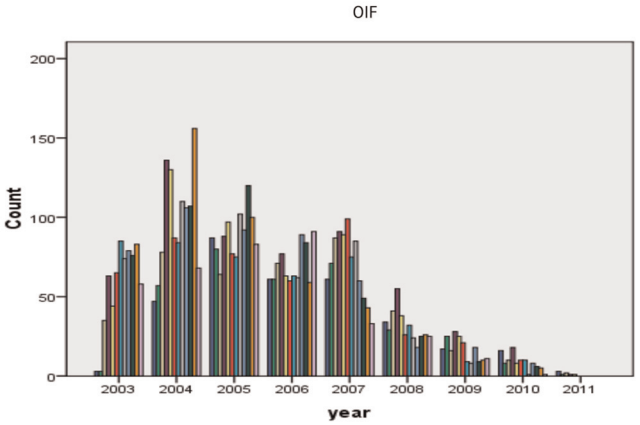

Figure 3. Month-by-month number of facial and penetrating neck injuries in Operation Iraqi Freedom.

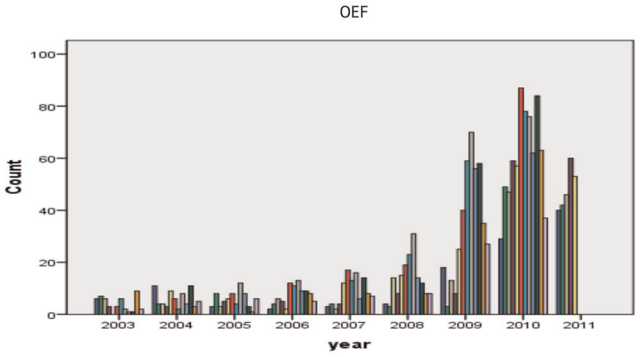

Figure 4. Month-by-month number of facial and penetrating neck injuries in Operation Enduring Freedom.

polytrauma from multiple injuries of the face, neck, trunk, and extremities represent an important type of patient seen during modern operational warfare.

Many of our patients had associated trauma injuries, with the most severe in the thorax and extremity. These polytrauma patients require a thorough workup by a highly trained team of emergency physicians, surgeons, anesthesiologists, and radiologists. The management of these patients begins with a thorough trauma survey as described by the American College of Surgeons primary survey in the Advanced Trauma and Life Support (ATLS) course. Identifying significant airway and life-threatening penetrating neck injuries is an important part of this initial survey. An algorithm for management of penetrating neck injuries was described by Brennan et al[10] in 2011. They divided patients with penetrating neck injury or injuries into symptomatic vs asymptomatic. Symptomatic patients undergo mandatory neck exploration, whereas asymptomatic patients receive further evaluation with computed tomographic angiography with or without panendoscopy followed by exploration only if the workup is positive or equivocal.[10] This approach was used extensively in the evaluation of penetrating neck injuries in the OIF and OEF theaters.

Management of facial fractures in theater has also undergone evolution during the OIF and OEF conflicts. Initially, a head and neck surgeon was not included in the facial trauma team. It was not until 2004 that a head and neck surgeon was deployed in support of the modern conflict.[2] In 2005, successful in-theater internal fixation was reported with follow-up demonstrating minimal postoperative infectious complications.[9] Prior to this experience, most definitive facial fracture fixation was delayed until the individual was transferred to higher echelons of care.[9] Further study validated immediate open reduction and internal fixation (ORIF) for management of injured personnel stable enough to undergo surgery.[12]

The current conflicts have changed the way military surgeons approach facial and penetrating neck trauma. This study highlights the need for a trained head and neck surgeon in the deployed environment to address these changes and manage the high number of injuries.[2] There are a few reasons for this change in management. Primarily, this is the first conflict where IEDs have caused the majority of facial and penetrating neck trauma. Clouse et al[14] reviewed vascular injuries in service members injured in Iraq, noting that IEDs are more damaging than earlier weapons because of the close-range blast, blunt, and burn injury along with multiple projectiles. Exposed body areas not covered by modern body armor are especially susceptible to multiple injuries from IEDs. Despite the technological advancements in body armor, a lightweight, comfortable yet effective face and neck shield has not yet been developed.

Another factor that has increased the ability of in-theater and US-based surgeons to care for facial and penetrating neck trauma patients is the ability to pass voluminous amounts of data from one place to another instantaneously. The JTTR has proven to be an invaluable asset to efficient and safe medical evacuation. It allows accepting surgeons in Germany or the United States to prepare, sometimes days in advance, for the arrival of a polytrauma patient. In some instances, surgeons and other physicians are able to discuss cases with their deployed colleagues. This type of telemedicine has allowed many service members to remain in theater to receive treatment, rather than being medically evacuated.

The limitation of our study is that it is a database study, providing statistics about the type, etiology, and mortality of facial and penetrating neck trauma patients. Deriving clinical and management decisions from this type of study is not possible. However, there are a number of important potential applications. First, the amount and type of training deployed surgeons receive before they deploy can be tailored to fit the types of injuries most commonly seen. For instance, since there was a high percentage of midface fractures, a surgeon training for deployment would be wise to attend a course or training session that specifically addresses the surgical management of these patients. Also, there were a number of great vessel injuries and airway injuries. Ensuring deploying surgeons are comfortable with control of vascular injuries and emergent airway control is important. Another potential application is to help design body

armor that more adequately protects the face and neck. The current body armor is lightweight, but a fully outfitted infantry soldier can still carry close to 80 to 100 pounds of equipment while on patrol. Being able to effectively communicate, scan their surroundings, and stay as comfortable as possible are as important to their survival as adequate body armor.

Conclusion

Facial and penetrating neck injuries are common in modern warfare. Most injuries sustained in the OIF and OEF conflicts have been minor to moderate, and most patients with these injuries survive. About one-third of the injuries identified included facial fractures. The factors contributing most to mortality were treatment at a level IIa facility, female sex, prehospital intubation, and blast injury. It is hoped that this study can help guide predeployment training for US medical personnel who contribute to the management of patients with facial and penetrating neck trauma.

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Author Contributions

Brent A. Feldt, substantial contributions to conception and design, acquisition of data, analysis and interpretation of data, drafting the article and revising it critically for important intellectual content, and final approval of the version to be published; **Nathan L. Salinas**, substantial contributions to conception and design, acquisition of data, analysis and interpretation of data, drafting the article and revising it critically for important intellectual content, and final approval of the version to be published; **Todd E. Rasmussen**, substantial contributions to conception and design, acquisition of data, analysis and interpretation of data, revising the article critically for important intellectual content, and final approval of the version to be published; **Joseph Brennan**, substantial contributions to conception and design, acquisition of data, analysis and interpretation of data, revising the article critically for important intellectual content, and final approval of the version to be published.

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