Combat orthopedic trauma

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Summary
Introduction. Throughout history, military conflicts have provided an opportunity for worldwide medical lessons learned in a way that no peacetime situations can parallel. Operation Iraqi Freedom and Operation Enduring Freedom are no exceptions. This study aims to report the combat casualties seen at FOB Ghazni, a Role 2 facility in Afghanistan, during Operation Enduring Freedom from 1 January 2012 to 28 February 2013.
Methods. The data was collected in an independent registry created here at FOB Ghazni. The database included operating room records, anesthesia records, and patient transfer data. Our patient population included all personnel (military and civilian) who sustained injuries during combat operations and were brought to our institution for evaluation and treatment. These patients all underwent operative intervention and transfer (with the exception of one intraoperative death) to a Role 3 facility for further care.
Results. We identified 198 people with an average age of 27 years old. The mechanism of injury for 76 (38.4%) patients was high velocity gunshot wounds whereas 122 (61.6%) sustained blast injuries. 7 of the 76 gunshot-swounded patients also sustained injuries secondary to blast effects. 101 (50.1%) of our patients sustained musculoskeletal injuries and 69 (68.3%) of these patients required an operation. The mean NISS for orthopaedic patients was 33.2 (range 4-66). Lower extremity injuries occurred in 55 patients, upper extremity injuries in 29 patients, and pelvis injuries were identified in 8 patients. There was an average of 1.53 body regions involved (range 1-5). Orthopaedic procedures included three vascular reconstructions, four leg fasciotomies, 15 external fixator stabilizations, six K wire fixations, and one open reduction internal fixation. 44 patients underwent wound revision with debridement and irrigation. 24 of the 69 (33.8%) orthopaedic patients required other (nonorthopaedic) damage control operations.
Conclusions. This study contributes FOB Ghazni's experience to the building body of data that we can use at all levels of medical care to learn from and apply to improve combat casualty care. We emphasize the importance on the initial exam and appropriate prioritization of care based on solid ATLS principles as this no doubt saves lives. We continue to learn from past wars and we continue to evolve our care to improve survival rates.
Key words: Combat injury, GSW, Blast Injuries, Damage Control

INTRODUCTION

Throughout history, military conflicts have provided an opportunity for worldwide medical lessons learned in a way that no peacetime situations can parallel. Operation Iraqi Freedom and Operation Enduring Freedom are no exceptions. The United States' Joint Theater Trauma Registry (US JTTR) and the UK Joint Theatre Trauma Registry (UK JTTR) are examples of large databases that are populated with prospective data collected in theater. These are independent registries, but both have been developed to track and record data on combat casualties for the purpose of improving patient care and outcomes. The data collected from these conflicts has given way to lifesaving advances as well as reinforcement of basic principles.

Medical care at the far forward level has markedly evolved from the large, fixed field hospitals in the World War II era. Mobile Army Surgical Hospital (MASH) units were widely utilized in the 1950s in the Korean War. As wars and conflicts have continued, the capabilities have met the needs for surgical care with flexibility and mobility at forward locations. These units are called Forward Surgical Teams (FST) [1]. FOB Ghazni has two medical treatment facilities, one run by the United States military, the other by the Polish military. Both facilities are considered Role 2. This denotes their capabilities and resources as defined by NATO regulations [2]. The facilities and staffing are considered FSTs.

FOB Ghazni FSTs received casualties both from the point of injury as well as transfers from civilian medical facilities. These civilian facilities are often ill-equipped local hospitals where care is minimal, and combat injuries often are more severe than can be addressed by those facilities and personnel. Our facility at the Ghazni Polish Field Hospital included a four bed trauma bay/ER, 2 bed operating room, four bed ICU and 6 bed hospital ward. Transfer to the nearest Role 3 facility took 45 minutes by helicopter at the very minimum. This transfer time was constantly changing in real time for reasons including but not limited to weather, enemy threat level, and helicopter availability.

The purpose of this paper is to present our experience at FOB Ghazni in the Polish Field Hospital over a 14 month period.

MATERIALS AND METHODS

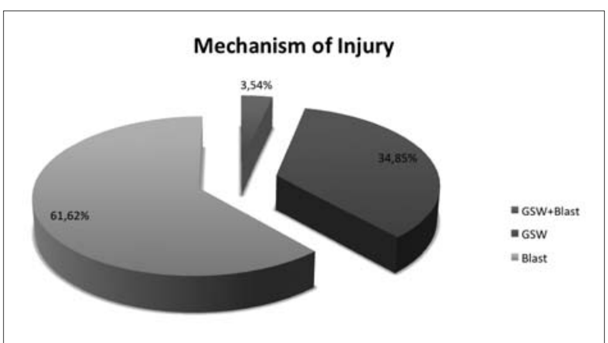
The FOB Ghazni Polish Field Hospital retrospectively reviewed data on all patients who sustained combat injuries from 1 January 2012 to 28 February 2013. The data was collected in an independent registry created here at FOB Ghazni. The database included operating room records, anesthesia records, and patient transfer data. Our patient population included all personnel (military and civilian) who sustained injuries during combat operations and were brought to our institution for evaluation and treatment. All of these patients were evacuated to one of several Role III facilities in the region, depending on the patient's nationality and continued medical needs. Those patients with minor wounds who did not require evacuation were not included in this database.

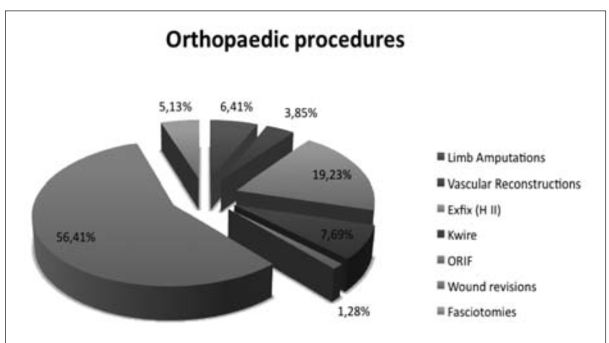
The database included demographic information such as age, gender, and civilian vs military affiliation. The mechanism of injury was recorded in addition to all of the injuries sustained by each patient. Our study design limited statistical analysis to simple statistics. There was no separation of local nationals versus coalition forces within the calculations. Because we included Afghanistan local nationals in our statistics, we are unable to have an accurate estimate of how many persons are at risk; therefore, it is not possible to express our incidence per population. Our records allowed us to calculate each patient's Revised Trauma Score (RTS) and New Injury Severity Score (NISS).

RESULTS

The cohort identified 198 people who suffered from combat injuries. Male to female ratio was 195:3. The average patient age was 27 years, with a range from 5-50 years old. Military members (including all coalition forces and local nationals) comprised 162 (82%) of our patients in contrast to 36 civilians (18%).

Mechanism of injury was divided into gunshot wounds (GSW) and blast injuries. GSWs accounted for 76 (38.4%) of injured patients. Seven of these patients (9.6% of the GSW patients) also sustained concomitant blast injuries. The 122 patients with blast injuries (61.6%) were further stratified by specific weaponry used. 103 patients (84.4%) of the blast injury patients were harmed by an IED. 7 patients (5.7%) were wounded by landmines. Six





patients (4.9%) were involved with a rocket propelled grenade (RPG), mortar or rocket. The final six patients (4.9%) were injured by multiple mechanisms and did not fall into one of the more specific categories. Patient records were reviewed for data to calculate injury scales. The mean RTS for our patients was 11.18. The mean NISS overall was 16.9.

We further stratified our data to isolate those patients who sustained injuries to the musculoskeletal system. This was defined as the upper and lower extremities, pelvis/sacrum. There were no recorded axial spine injuries. Musculoskeletal injuries were sustained by 101 (50.1%) of our patients. 69 (68.3%) of these patients required an operation. Mechanism of injury was recorded for the operative patients and was notable for 35 (50.7%) patients with GSW and 3 of these had secondary blast injuries. 34 (49.3%) patients were injured by blast mechanism only. The mean NISS for orthopaedic patients was 33.2 (range 4-66). Lower extremity injuries occurred in 55 patients, upper extremity injuries in 29 patients, and pelvis injuries were identified in 8 patients. There was an average of 1.53 body regions involved (range 1-5) which accounts for the distribution of injuries within the total number of casualties.

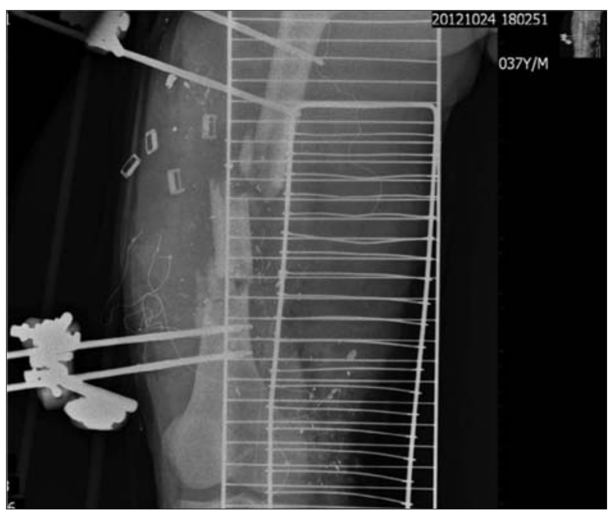
Orthopaedic procedures varied across our data set. There were six limbs amputated on five patients. Three patients required vascular reconstructions for limb threatening arterial injuries. Four patients underwent four compartment leg fasciotomies. 15 external fixator devices (Hoffman II, Stryker) were placed for axial stability and alignment. Six patients had Kirschner wire fixation while one patient underwent a fracture open reduction and internal fixation procedure. 44 patients had debridement & irrigation (D&I) and revision of traumatic wounds and these were generally in multiple locations on most patients. During the D&I, hemostasis was achieved and adequate evaluation of involved neurovascular bundles was performed. If there was an accessible foreign body, this was removed; however, deep foreign bodies were not retrieved if they neither threatened life or limb nor were encountered during the D&I. Four lower extremities required fasciotomies.

24 of the 69 (33.8%) orthopaedic patients required other damage control operations. One patient underwent a craniectomy. Four required thoracotomies, five required laparotomies, and two required both thoracotomy and laparotomy. Six patients had less severe thoracic trauma and only required chest tubes. Perineal wounds and wounds in various other regions required revision in three and five patients respectively. Further resuscitation of our orthopaedic patients included blood transfusions. Twelve patients received an average of 3.5 units of packed red blood cells (range 2-7), and 2.3 units of fresh frozen plasma (range 2-9). There was one intraoperative death. This patient was a 12 year old boy who was severely injured by a landmine explosion with head, chest, upper extremity injuries and a femur fracture. All patients besides this young boy were transferred to Role 3 by medevac as soon as possible after operative intervention and resuscitation.

Phot. 1. Shrapnels in inguinal and pelvic area

DISCUSSION

We compared our data with reports from US JTTR and the UK JTTR. There are differences as US JTTR only includes only data pertaining to injured service members throughout all levels of care from the point of injury to discharge from Role 5 facilities [3]. In contrast, the UK



Phot. 2. GSW of the femur

JTTR includes all-comers including civilian, coalition and non-coalition patients. These differences are notable as we do not have a parallel data set, but we can still gain insight and knowledge by comparing our experience to these sources.

Epidemiologically, our patient population was similar to other reports. Average ages of combat injured persons is 24.4-29.4 years [3-6] compared to our mean of 27years. Cross et al. found women to comprise 1.9% of all casualties and 2.4% of all deaths documented from 2001-2009 in OIF and OEF [7]. Our casualty rate for women was similar at 1.5% of our cohort.

It has been repeatedly established that there is an evolution of combat mechanisms of injury since the beginning of the 20th century to now. While explosive or blast injuries made up 35% of combat casualties in WWI and 65% in Vietnam, we now see over 70% of casualties resulting from blast injuries [5]. Lin and collegues reported data from the early years of OEF (2001-2003) as seen at Walter Reed Army Medical Center showing GSW contributed up 27% of the injury patterns while blasts injured 65% of soldiers [6]. More recent reports from 2005-2009 again show 75% of patients sustained blast injuries [3,5], and 20% GSW [3]. Afghanistan alone showed a sharp increase of 59.5%-73.6% of blast injuries from 2007 -2008 [5]. When musculoskeletal injuries are stratified out, 82% are the result of a blast, while only 14% are due to GSW[3]. Up to 77% of casualties are reported to sustain musculoskeletal injuries, and 6% of all wounds are amputations [3,5,8].

Combat trauma causes multisystem involvement with distracting injuries as a norm rather than the exception. Even in the setting of a thoracic injury which generally has a dismal mortality rate in civilian and military settings, Poon et al. found that this was not an independent predictor of mortality [4]. Overall injury burden is a greater predictor of mortality [4].

The leading cause of prehospital, potentially survivable deaths is hemorrhage (90.9%) [9]. The distribution of hemorrhage is 67.3% truncal, 19.2% junctional, and 13.5% extremity [9]. Because of the consistency in trending of these statistics, tourniquet and hemostatic dressings were aggressively pushed to the prehospital care. Even as recently as Operation Iraqi Freedom, not every soldier had a his/her own tourniquet [10]. This shortfall was identified and by August 2005, over 275,000 tourniquets (CAT-1) had been sent to Iraq for individual soldiers to carry on their person. Similarly, Brodie et al reported 70/1375 (5.1%) patients treated with one or more tourniquets with an 87% survival rate between Feb 2003 and April 2006 [11]. This is in contrast to the data they cite from April 2006-September 2007 where 64/70 (91%) of patients were treated with a tourniquet in the field. This abrupt change in numbers corresponds with the introduction of tourniquets were issued in the UK as a standard first aid item [11].

The cooperation between the Polish and United States' facilities demonstrated the consistency of lessons learned and ATLS practice with the exception of an otoscopic exam and a digital rectal exam. These are mandatory components of the US secondary survey, but are optional in the Polish system. The FAST exam is, of note, consistent between the systems as a mandatory adjunct to the physical exam within the secondary survey. The evaluation of the casualty in the systematic way as outlined by ATLS saves lives. Combat casualties frequently have multisystem involvement of their injuries.

Orthopaedic care at the Role II facility continues to focus on wound irrigation, debridement, and revision, with longitudinal stabilization of fractures. Adequate initial debridement and delayed wound closure was found to positively impact survival throughout the Korean War when compared to WWII practices [1]. Infection rates have been repeatedly shown to be reduced by 2/3 for open fractures when D&I was performed in theatre from more recent conflicts [12]. This continues to be the standard of care for combat casualties [13]. While there is no absolute ideal timing for definitive coverage of traumatic extremity wounds, the current recommendation is for coverage as soon as the patient's wound and physiology will allow [13]. This guidance reinforces our musculoskeletal work at the Role 2 level to stop ongoing blood loss, resuscitate the patient, thoroughly debride wounds, and reduce and stabilize fractures/dislocations for not only patients' immediate needs, but for expediting recovery through the higher echelons of care.

Our treatment of the small foreign bodies resulting from "peppering" type fragmentary blasts was consistent and supported by previous literature [8]. As long as there was only soft tissue involvement without neurovascular injury, large cavitary wounds, intraarticular fragments, or impediment of future bony healing, these small fragments are routinely left alone in order to not create further injury [8]. The only concern retained fragmentation presents is if there is indication for later MRI studies at Role 3 or 4 facilities. This dilemma is patient-specific and addressed on an individual patient basis.

Medical education is continually evolving and is necessary to bridge the variance between was is seen and taught in civilian surgical education versus what military combat surgeons are expected to do in theatre. Prehospital care has greatly evolved to focus on immediate life saving measures (tourniquet use or needle decompression of the chest) through the US Tactical Combat Casualty Care (TC3) program. This program has trained many medics outside of the US as well. Poland, for instance has no formal TC3 education for their paramedics who deploy with combat units; however, the principles of TC3 have appropriately infiltrated the predeployment training for these men. There are some medics and paramedics who have come to the US for formal TC3 training. Centers such as the Army Trauma Training Center in Miami, FL and the Navy Trauma Training Center in Los Angeles, CA are just two examples of additional training opportunities (outside of the TC3 centers) for medics to improve prehospital care [10].

Surgical education has taken a similar focus for adjunct training. In the UK, general surgeons see limited thoracic trauma; therefore, courses such as Definitive Surgical Trauma Skills (DSTS), Definite Surgical Trauma Care (DSTC), and Military Operational Surgical Training (MOST) have been developed [4]. In the US, similar adjuncts have been developed for not only the surgeon in training, but for the staff surgeon who has completed residency training. Opportunities include the Emergency Surgery War Course in San Antonio, TX, and the newly implemented Disaster Response Course developed by the Society of Military Orthopaedic Surgeons and taught at the annual American Academy of Orthopaedic Surgeons meeting in the US.

Further research needs have been established by those who continue to review the large US and UK databases. The Extremity War Injury Symposium consisting of military and civilian orthopaedic surgeons in the United States convened most recently in 2012 and reported their priorities for further research at the acute care level [14], FOB Ghazni, as a Role 2 facility, is poised to assist with the six priorities as defined by the panel: hemorrhage control (emphasis on the difficult junctional large vessels of the groin and axilla), early perioperative high dose oxygen, local antibiotic use, comparing negative-pressure wound therapy versus antibiotic bead pouch, pelvic binders in the prehospital time and during early transport, and surgical debridement techniques [14]. Aside from the six outlined priorities, the symposium also reported interest into late outcomes of prolonged tourniquet use, urogenital protection with specialized undergarments and the desire for more aggressive point of injury documentation [14].

This study has several strengths. First, the 14 consecutive month timeframe of the records review is advantageous because it allowed for a very reasonable idea of the insurgent activity in this area and volume for analysis of mechanisms and injuries. Documentation was standardized and thorough for review by our team. Lastly, the validity of our experience is proven through comparison with the larger databases.

Inherent to the retrospective nature of this study, there was no power analysis. Occasionally, there were difficulties in consolidating mechanisms of injury due to differences between surgical teams' verbiage and documentation. Our database does not input into the larger databases such as the US JTTR or UK JTTR. There are no doubt many civilians who are not in our data due to obtaining care from local hospitals, or who never receive any medical attention for combat wounds. These persons are not accounted for in our data; therefore, we cannot calculate incidence of injury per person, as there is no tracking of the true numbers of persons injured in this region. Followup can be very difficult in theatre because patient identification numbers change for various reasons, patients are transferred to local facilities where communication is dismal, and names can be challenges and age is often unknown in Afghan patients.

CONCLUSION

This study contributes FOB Ghazni's experience to the building body of data that we can use at all levels of medical care to learn from and apply to improve combat casualty care. We emphasize the importance on the initial exam and appropriate prioritization of care based on solid ATLS principles as this no doubt saves lives. Life, limb and eyesight saving interventions and procedures are the emphasis at the Role 2 and our data follows the same trends as the larger reports from both the US and the UK.

We continue to learn from past wars and we continue to evolve our care to improve survival rates. While the enemy constantly revises techniques to harm, maim, and kill, we must continue to aggressively learn from our past to preserve life, limb, eyesight, and function of innocent civilians and of our brave men and women who sacrifice through their service.

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