A GUEST EDITORIAL

Desert Storm 1991: Orthopaedic Related Surgical Injuries

I have been asked by the editorial staff of the *Journal of Rehabilitation Research and Development* to provide some personal observations in my capacity as an orthopaedic surgeon assigned for five months to the 2nd General Hospital, Landstuhl Army Regional Medical Center (LARMC), Landstuhl, Germany during Desert Storm 1991. Prior to providing more factual information, my reflections include the honor of having the opportunity to serve the U.S. Army and the U.S. government as a member of the Armed Forces (Army). I am also appreciative that, as a member of the medical corps, our mission was to provide the highest caliber of medical/surgical care possible for our wounded or injured. A constant thought in my mind was the concern that those individuals who would ultimately enter the VA system of care would have received maximum care resulting in no impediment in their ultimate rehabilitation. My expectations were high that this goal could be accomplished—and was strived for constantly. I can honestly say that all the military medical colleagues with whom I had the good fortune to serve had the same motive, and were equally successful.

For the United States and its coalition forces, Desert Storm began during the nighttime hours of 17 January 1991. The initial thrust, until the initiation of the ground offensive on 24 February, was conducted by the air arms of the Army, the Air Force, and the Navy. Orthopaedic injuries prior to the initiation of the combined air/land operation consequently were primarily the result of military activities associated with the influx of a large number of troops stationed throughout Southwest Asia, in preparation for, or participation in, war activities. The primary causes of the initial casualties were accidental and enemy-related missile and mine injuries, along with a wide variety of other orthopaedic injuries resulting from living, driving, and participating in recreational activities within a desert environment.

Preparations for the potential orthopaedic aspects of war for both the active and reserve military medical officer begins long before the onset of any conflict. Actually, an orthopaedic surgeon trains for the management of war-incurred wounds during the performance of orthopaedic surgery in the course of daily surgical practice. Furthermore, the military surgeon maintains familiarization training for the potential of operating under conditions or settings foreign to his customary environment.

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Beginning in early August of 1991, with the initiation of Operation Desert Shield, came the mobilization of large numbers of ground forces, along with medical personnel. First, they were assigned to units within the continental United States, then others were assigned to units within the European and Southwest Asia commands. This officer was assigned to the European theater.

Sixty-three U.S. Armed Services medical/surgical hospital units participated in Desert Storm. Of those, 44 were U.S. Army hospitals. The primary military general hospitals within Germany

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(Landstuhl, Frankfurt, Nuremberg) served as the principal evacuation receipt centers for injuries and war wounds exiting in Southwest Asia. The majority were evacuated to LARMC, Landstuhl, Germany, the site from which the following data are derived.

Between 17 January until 29 March, 7,500 evacuations from Southwest Asia occurred. Thirty-five percent (35%), or 2,679, were evacuated to LARMC. Of those, approximately 35% were orthopaedic-related injuries. Of the Desert Storm orthopaedic data collected, the most interesting observations have been the unbelievably small number of high velocity (rifle–17) weapon injuries and the sparsity of lower extremity amputations (13) resulting from exploding land mines. The low incidence of these two modes of injury were directly related to, and proportional to, the shortness of the ground war and the essential absence of hand-to-hand combat between adversarial forces.

As noted earlier, the majority of war-related causes of injury, following "soldiering activity" related to living and surviving within the semi-hostile desert environment. Examples included a large number of highway accidents resulting in both injury and/or deaths. The cause for this high incidence lies in the occurrence of traffic carrying both arms and personnel into the desert on either existing roadways or unimproved terrain. Other "soldiering-types" of injuries (52) resulted from working within the environment of heavy equipment, the occurrence of sports and after-dark injuries (i.e., falls into foxholes), or falls from structures being erected within the desert environment (14). Of war wounds incurred, the majority were of the crush injury type (34), gunshot wounds (17), land mine injuries (17), wounding secondary to SCUD missiles (15), etc. The remaining 95 of the 210 orthopaedic war-related injuries resulted from activities such as: anti-tank warfare, grenades, helicopter accidents, cluster bombs, mortar injuries, or "friendly fire."

War surgery, particularly orthopaedic war surgery, is an area of surgical medicine which has received careful scrutiny by military physicians since war surgery records were initiated. The first careful chronicling of war wound statistics was recorded in the War of the Crimea in the early 1800s, followed by a very accurate analysis by the Army Medical Department during and following the War of the Great Rebellion (Civil War), 1861-65. The mechanism of injury in most war wounds is the receipt of some form of high velocity injury to soft and/or hard tissue, leading to a loss of skin, muscle, or bone, resulting in a loss of all tissue vascularity, each within a highly contaminated environment. Thus, the most important surgical procedure that can be performed in all war wounds, including those that occurred in Desert Storm, is thorough and careful wound debridement, redebridement, and wound stabilization.

What may be looked upon as philosophically one of the more significant deviations in Desert Storm war wound management, from wound management techniques utilized during World War II, Korea, and Vietnam was the early use of hardware, both external and internal, in the management of open injuries. Noted with interest, reluctance, and suspicion (due to prior orthopaedic and military medical education) while serving in El Salvador (1985), was the early use of internal fracture stabilization in open war wounds. Now, with enhanced medical care and immediate patient evacuation to tertiary care facilities within hours of injury, followed by early wound debridement, stabilization, and appropriate antibiotics, these same management techniques were being utilized in the management of Desert Storm wounds. This method of management proved to be efficacious regardless of the magnitude of injury. The safe use of internal hardware following meticulous wound debridement and redebridement, along with the occasional abbreviated use of an external fixator, appropriate antibiotics, and early closure within 1-2 weeks (using vascularized muscle pedicle or free pedicle flaps and split thickness skin grafts), was demonstrated to be a most successful management scheme. Utilizing these techniques uniformly resulted in early soft tissue wound healing and provided for fracture stabilization which preserved heretofore unsalvageable extremity injuries.

Of the injured cared for at LARMC (444), there were 194 open fractures, 49 meniscal injuries, 47 closed fractures, 36 joint dislocations, 31 ligament ruptures, and a variety of other orthopaedic injuries. The most frequently performed orthopaedic surgical procedures included the following: wound debridement, application of external fixators, skin grafts, and delayed primary wound closures followed by the internal stabilization of long bone fractures.

Of those patients who sustained war-related traumatic extremity amputations (13), residual limb prosthetic concerns were always a consideration. To this end, there was careful adherence to the principle of maintaining optimal residual limb length and good tissue coverage. Open wound management with repeated debridement, the use of stockinette–Benzoin skin traction and the maintenance of maximum possible bone length continues to be the most successful means of managing this type of wound. It was generally noted that the amputation wound could be closed within 3 weeks, regardless of the mechanism of injury (land mine, crush, burn, etc.). Postoperatively, and prior to evacuation from the European theater, amputee wound management included the frequent reapplication of compressive extremity elastic dressings.

When asked, "What were the primary orthopaedic surgical lessons learned in this war (Desert Storm)?" the following might be said . . . that the United States provides an unexcelled opportunity for its wounded to receive the highest caliber of medical care available anywhere, within hours of the injury or wounding; that well-trained orthopaedic surgeons were mobilized and available at every level of the care process, including the desert, in Europe, and in the continental United States; that early patient resuscitation and initial wound debridement was immediately followed by evacuation to the European tertiary hospital for further medical or surgical tertiary care (within 6 to 32 hours of wounding). Such care resulted in an exceedingly high survival and recovery rate. The use of the external fixator in the stabilization of massive soft tissue injuries and long bone fractures provided an environment which allowed ease of patient transport, relief of pain, and enhanced wound care and recovery. Heretofore, the insertion of hardware in long bone injuries, incurred under wartime conditions, was a mechanism of wound management looked upon with a high degree of suspicion. What has been noted, however, was that good wound management, plus early skin coverage (to include muscle pedicle flaps) greatly enhanced soft tissue healing and vascular resupply to long bones, allowing for early and successful implantation of internal fracture fixation hardware. Each of the above provided an opportunity for rapid mobilization of the patients, a significant improvement in patient comfort throughout the care process, a more expeditious entry into the rehabilitation process of the Department of Veterans Affairs, and reentry into the mainstream of life.

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