Summary: War produces an abundance of musculoskeletal injury and often spurs advances in surgical practice. This phenomenon is currently taking place in Afghanistan and Iraq, where local surgeons have recently adopted intramedullary nail fixation to treat long bone fractures. The Afghan National Military Hospital and several Afghan public hospitals perform intramedullary nail fixation, using the Surgical Implant Generation Network (SIGN) system. The SIGN system is also used at US military hospitals in Iraq, as well as Iraqi public hospitals. SIGN has provided the means by which surgeons in these countries have improved patient care and advanced their practice during a period of war.

Key Words: IM nail—musculoskeletal injury—intramedullary nail—SIGN.

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“He who would become a surgeon should find an army and follow it.”

—Hippocrates

Human injury during war produces a virtual epidemic in orthopaedic trauma. In periods of wartime, the need to treat large numbers of injured patients with complex trauma often serves as a catalyst for major advances in surgical practice. The military medical experience during World War II is a classic example. This period spawned major orthopaedic surgery advancements in fracture care, wound management, amputation, rehabilitation, antibiotics, and leadership. These advancements provided the framework from which modern orthopaedic trauma practice arose in the US and other western nations.

Intramedullary (IM) nail fixation, although not used by American surgeons during World War II, had its beginnings during this period. Dr. Gerhard Kuntscher, a German surgeon, developed his method for IM nail fixation during this period and used it to treat war-injured patients. This method was eventually observed by American surgeons in captured Allied airmen who had received IM nailing for femoral fractures while they were prisoners of war. American surgeons began using the method during the Korean War, and the method has since developed to become the standard of care for treatment of diaphyseal femoral and tibial fractures. Surgical protocols for IM fixation continue to evolve as surgeons expand the indications for the technique to include fractures complicated by complex soft tissue injuries, which are common in war injuries produced by gunshot and blasts.

The current century is marked with multiple wars and conflicts spread throughout the globe, most of which are occurring in developing nations. Although the American military orthopaedic experience in Iraq and Afghanistan continues to be well documented, the experience of the local surgeons in these countries is virtually unreported. Coalition military hospitals in Iraq and Afghanistan treat a significant number of local national soldiers and civilians; however the majority of injured patients present to host nation military and civilian hospitals for treatment. Thus, the wartime epidemic in orthopaedic trauma is a present-day phenomenon in Afghanistan and Iraq. Faced with large volumes of injured patients, Afghan and Iraqi surgeons now seek to advance their own orthopaedic practice, particularly in the area of IM fixation. The arrival of the Surgical Implant Generation Network (SIGN) IM nailing system to these countries has made this possible.

SIGN at Developing Nation Hospitals

Host nation military hospitals in Afghanistan and Iraq face the same budgetary, logistical, and facilities challenges as their civilian counterparts. The major obstacles these hospitals face in adopting IM fixation are the prohibitive cost of modern commercially available implants and the technical dependence on fluoroscopy with cannulated, titanium nail systems. Many developing nation hospitals have barely enough funding to keep gauze, drapes, and gloves in constant supply, let alone titanium nails which cost $1700 to $2500 each. Furthermore, developing nation hospitals also often lack fluoroscopy, or a steady supply of electricity to use fluoroscopy where units do exist. SIGN provides a solution to these obstacles. The open, solid nail SIGN technique eliminates the technical need for intraoperative fluoroscopy, whereas the donation programs provide hospitals with a no- or low-cost re-supply mechanism for implants.

Afghanistan

For the past three decades, the nation of Afghanistan has been locked in a state of conflict. This period began with the Soviet invasion and occupation in 1979, followed by the mujahedeen insurgency and defeat of Soviet forces in 1989. A civil war between mujahedeen factions then followed in the early 1990’s, which culminated in Taliban victory. The late 1990’s was a dark period of cultural and social strife under Taliban rule, which finally ended in the fall of 2001 with the US military invasion. The conflict continues today as the Afghan national government struggles to stand against a pervasive insurgency.

The orthopaedic surgeons at the Afghan National Military Hospital (NMH) live on the front lines of this conflict. Located...
in downtown Kabul, the NMH is known locally as the “The Four Hundred Bed Hospital.” Built with Soviet assistance in late 1969, the hospital is by far the largest in Afghanistan and is also regarded as the best center for patient care in the country. From their office windows on the NMH orthopaedic ward, the NMH orthopaedic surgeons watched in 1989 when warring mujahedeen factions took up a small arms battle on the hospital grounds, using the reflecting pool at the hospital’s front entrance for cover. In subsequent months, the hospital staff were forced to move all patients to rooms on the north side of the building, as the south side of the hospital was hit by tank rounds during battles that put the building in the crossfire between forces seeking to control the mountain ridges overlooking Kabul (M. I. Wardak, personal communication, July 2009).

Today, the orthopaedic ward on the sixth floor still provides a grand view of Kabul, as both doctors and patients witnesses to the tall plumes of smoke and dirt caused by the sporadic explosions of car bombs, the insurgents’ weapon of choice in Afghanistan’s largest city.

Over the long recent history of conflict in Afghanistan, the NMH orthopaedic surgeons have treated a large volume of extremity war injuries, and their practice continues today as both Afghan soldiers and civilians fall victim in the counter-insurgency war. Afghanistan is also no exception to the global rise in orthopaedic trauma caused by road traffic accidents, as automobile travel continues to gain favor in developing nations. These factors combine to present Afghan surgeons with an unrelenting stream of patients in need of orthopaedic trauma care. The daily census on the orthopaedic inpatient ward at NMH averages sixty patients. In addition, hundreds of outpatients are referred to the facility every week. Approximately half of the orthopaedic patients treated at NMH are soldiers of the Afghan National Army or policemen of the Afghan National Police, whereas the other half are civilians, including both military relatives and non-military-associated individuals.

The NMH surgeons have significant clinical expertise in the use of external fixation methods for treatment of open and closed extremity trauma, for both primary fracture treatment and secondary deformity correction. They are particularly skilled in the methods of Ilizarov, which reflects the influence of Russian surgeons who worked in the hospital during the 1970’s and 1980’s. Interestingly, the storerooms on the orthopaedic ward still house Soviet military crates full of metal alloy rings, threaded bars, and other such material used in circular external fixation. In recent years, the orthopaedic storerooms have started filling with modern, US-manufactured external fixation parts, collected from patients initially treated at US military hospitals in Afghanistan and subsequently transferred to NMH. The Afghan surgeons have been quick to adopt the practice of recycling western-manufactured unilateral fixators for use on patients in their own operating theater, since the carbon fiber bars and universal clamps are more surgeon-friendly than the less forgiving, first generation AO-type fixators they have used for decades.

These methods of external fixation have been used extensively at NMH, especially in cases of complicated soft tissue trauma, which so often accompany fractures in wartime trauma. Recently, however, the NMH surgeons have learned through the orthopaedic literature, along with the rest of the global orthopaedic community, the utility of IM nailing for treatment of long bone fractures, and have sought to change their practice accordingly. Through western donations, US-manufactured cannulated titanium nails were obtained and trialed several years ago. Although quick to learn the basic techniques of IM fixation, the NMH surgeons also discovered that they could not continue treating patients with commercial western IM nail systems because of the high cost of implants and the technical dependence on fluoroscopy. The arrival of SIGN to Afghanistan provided a solution. The NMH surgeons immediately recognized the practicality of the technique and the principle of participating in a global network of orthopaedic surgeons. SIGN has allowed IM fixation to flourish as a treatment method at NMH and many other hospitals around the country.

SIGN first arrived in Kabul when Dr. Lewis G. Zirkle visited the Wazir-Akbar-Khan (WAK) district hospital, the largest and busiest public hospital in Afghanistan, in January 2009.
2007. Located directly across “Hospital Road” from WAK hospital is the Afghan NMH described above. Therefore, the Afghan military surgeons were able to observe and learn the SIGN technique immediately after it was introduced to their public hospital colleagues. Surgeons such as Dr. Ismail Wardak and Dr. Nazir Shirzai, orthopaedic department chiefs at NMH, were delighted with the utility of the SIGN technique, with its simple, surgeon-friendly system mechanics, its independence of fluoroscopy, and the mechanism for implant re-supply through the SIGN database. Through the leadership of Dr. Wardak and Dr. Shirzai, IM nailing using the SIGN system quickly grew to be a mainstay in the treatment of trauma patients at the NMH. Since January 2008, over 200 SIGN cases have been performed at the NMH. The SIGN system has recently been distributed to the four regional hospitals in the Afghan National Army health system.

SIGN at Afghan Civilian Hospitals

The Afghan Ministry of Public Health (MoPH) administers the public hospital network in Afghanistan. Surgeons at MoPH hospitals also face a high volume of orthopaedic trauma, as they too treat war-injured patients, along with an increasing incidence of patients injured in road traffic accidents. Several MoPH hospitals have recently started IM nailing with SIGN, as the technique is rapidly gaining acceptance among surgeons previously unfamiliar with it. The public hospitals at WAK, Mazar-e-Sharif, Herat, Shebergan, and Kandahar have recently obtained the SIGN system and are demonstrating excellent technique as shown by their postoperative reports on the SIGN database. In addition to the MoPH hospitals, there are several foreign non-governmental organization (NGO)-sponsored hospitals treating civilian trauma patients in Afghanistan. One example is the Emergency Hospital in Kabul, which is administered by an Italian NGO. At this hospital, surgeons from Italy, the US, and Afghanistan perform SIGN nail procedures on long bone fractures caused by both war and traffic.

Afghan SIGN Conference

Orthopedic surgeons from public, private, NGO and military hospitals all traveled to Kabul in November 2008 for the first annual Afghan-SIGN Orthopedics and Traumatology Conference. This meeting was organized and sponsored by Dr. Wardak and the Orthopedic staff at NMH. Initially intended to be a SIGN workshop, it quickly became a national Orthopedic conference as attendance increased. Surgeons from all regions of Afghanistan traveled over dangerous roads and through active war zones to attend the conference. Presentations were given by representatives from all regions attending and included several spontaneous speeches.

There was a great feeling of orthopaedic camaraderie by the participants, and this momentum translated into the formation of the first Afghan Orthopaedic Association. The conference workshops provided a forum for surgeons gathered to discuss and learn the SIGN technique. At this event, an academic conference held inside an active war zone, SIGN provided a rallying point for surgeons to learn about IM nailing and improve the care they provide to their patients. The
meeting turned out to be a significant stepping stone for orthopaedics in Afghanistan.

**Iraq**

As IM nailing has spread to Afghanistan during the current period of war, so also it has arrived in Iraq. In contrast to Afghanistan, the SIGN system was first used in Iraq at US military hospitals to treat injured civilians. Colonel James Ficke brought the SIGN system to the US Army hospital in Mosul in March of 2005, and standardized its use to treat war-injured Iraqi civilians. These injured civilians could not be treated by the same protocols as used for American soldiers, because military protocols call for injured soldiers at forward surgical hospitals with long bone fractures to be treated with rapid external fixation and subsequent evacuation of the war zone. Definitive fracture fixation for these patients is performed after patients are transported to medical centers in Germany and the US. On the other hand, American military surgeons treating Iraqi civilians strive for as much initial definitive fixation as possible, since bed shortages force US medical personnel to discharge civilian patients as soon as they are adequately stabilized. Moreover, civilian patients often have little opportunity for surgical follow-up care after discharge, making definitive treatment critical. American military surgeons in Iraq reported good initial results with the SIGN surgical technique, although follow-up evaluations have proven extremely difficult to achieve.

SIGN first arrived to civilian hospitals in Iraq in 2006, when Dr. Zirkle traveled to Erbil to participate in a regional orthopaedic conference. A predecessor to the conference in Afghanistan, this meeting also provided an academic forum inside a war zone at which surgeons from many different parts of Iraq came together to learn about IM nailing and advance their surgical practice. Surgeons from civilian hospitals in Sulamaynia, Mosul, Tikrit, and Baghdad all participated. Just as in Afghanistan, these civilian hospitals treat a large volume of war-injured patients. These Iraqi surgeons, faced with treating scores of injured patients during a period of war, were spurned to adopt IM nailing because they recognized the effectiveness of the technique and its advantages over traction, plating, and external fixation for treatment of long bone fractures. SIGN programs were started at each of these hospitals soon after the conference. In some instances, the SIGN system is now the only complete surgical set with which these surgeons have to work. As such, the advance in practice has been tremendous. As in many other developing nations, Iraqi surgeons also face a growing burden of injury from road traffic accidents in addition to the war-related injuries they already treat. SIGN has provided these surgeons with the technique and implants with which to treat these patients by modern, reliable surgical methods. Through the online SIGN surgical database, Iraqi surgeons have reported their procedures and demonstrated fast learning, as well as excellent technique.

**Surgical Protocols**

The war-injured with soft tissue wounds, Afghan and Iraqi surgeons typically use a staged technique of fracture care. Open fractures are initially stabilized with external fixation to allow for treatment of soft tissue injury. Once soft tissue wounds have been treated appropriately, the external fixator is removed and the patient is placed in traction or a splint for a week to allow for pin sites to heal. Finally, often 4 to 6 weeks after the initial injury, previously open fractures are stabilized with SIGN nails. Closed fractures of the tibia and femur are now treated routinely with SIGN IM fixation using protocols similar to those in western practice.

Similar to many other developing nation hospitals, the Afghan and Iraqi surgeons also treat a large volume of tibial and femoral nonunions. These nonunions often develop after nonoperative treatment of fractures by bonesetters in the community, especially in the civilian patient population. Afghan and Iraqi surgeons have observed great success in treating such nonunions with SIGN nails, with and without bone grafting. Nonunions without evidence of infection are typically treated by open debridement of the fracture site, resection of nonviable bone, shortening of the limb, and IM fixation. Mild limb shortening is an understood compromise made to achieve fracture healing. Infected nonunions, on the other hand, usually require more radical bone debridement, and therefore are treated regularly with an Ilizarov-type external fixator, using bone transport techniques to re-establish limb length.

**Medical Reconstruction**

Since 2007, US Navy and Air Force medical advisor teams have been working inside Afghan military hospitals to rebuild the Afghan military health system. Within the scope of counterinsurgency, the task of medical reconstruction is a part of the overall coalition military strategy in Afghanistan. Revitalizing Afghan military hospitals strengthens the Afghan government, fostering civilian confidence and reducing support for insurgent elements.
For any military or medical reconstruction effort to be successful, it must be sustainable. This reality presents a considerable challenge for orthopaedics, a medical field uniquely dependent on technology and implants, which are often too expensive and difficult to re-supply in developing countries to be considered sustainable. With this challenge in mind, the US military has turned to SIGN and purchased the system for use at all Afghan regional military hospitals. SIGN is a sustainable investment for several reasons. First, the technique is relatively easy to master for surgeons previously untrained in IM fixation and therefore does not require western training. Second, the system is independent of fluoroscopy. Third, the cost of SIGN instruments and implants is a fraction of western commercially available IM nail systems. Moreover, SIGN nail treatment of femoral fractures has been shown to be more cost effective than conservative treatment in a developing nation hospital. Finally, surgeons benefit from continuing education via feedback provided on postoperative radiographs uploaded to the SIGN online database.

CONCLUSION

The SIGN system has caused a paradigm shift in the treatment of both closed and open long bone fractures at hospitals in Afghanistan and Iraq. Like at so many other hospitals around the world, patients once treated solely by external fixation or traction are now treated by IM fixation. As a high volume center for both civilian and military patients, and as the only referral center in the Afghan military hospital system, the arrival of SIGN to the Afghan NMH has quickly changed the lives of hundreds of patients in a short period of time. Similarly, patients in Iraq are also benefitting as SIGN provides the only modern, reliable surgical system for long bone treatment at many hospitals.

REFERENCES