SPECIAL REPORT

Prehospital Care of Orthopedic Injuries

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IV = intravenous
PHTLS = Prehospital Trauma Life Support

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Abstract

Orthopedic injuries are predominant among combat casualties, and carry the potential for significant morbidity. An expert consensus process (Prehospital care of military orthopedic trauma: A consensus meeting, Israel Defense Forces Medical Corps, May 2003) was used to create guidelines for the treatment of these injuries by military prehospital providers. The consensus treatment guidelines developed by experienced orthopedic trauma personnel from leading trauma centers in Israel are presented in this paper.

For victims with open fractures, the first priority is hemorrhage control. Splinting, irrigation, and wound care should be performed while waiting for transport, or, in any scenario, in the case of an isolated limb injury. The use of traction splints was advocated for both the rapid transport scenario (up to one hour from the time of injury to arrival at the hospital) and the delayed transport scenario. In the urban setting, traction splints may not be necessary. Any victim experiencing pelvic pain following a high-energy mechanism of injury should be presumed to have an unstable pelvic fracture, and a sheet should be tied around the pelvis. The panel agreed that field-reduction of dislocations should be avoided by the medical officer unless it is anticipated that the patient will need to go through a long evacuation chain and the medical officer is familiar with specific reduction techniques.

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Introduction

Orthopedic injuries are by far the most common injuries in the prehospital military setting, occurring with remarkable consistency throughout the past century.[1] However, compared to resuscitation issues, orthopedic injuries have gained little attention in the literature. Effective care requires a focus on the prevention of morbidity with an emphasis on the treatment of fractures and soft tissue injuries. Evidence-based clinical guidelines are not available for the major questions in prehospital orthopedic trauma.

Military medical doctrine in the Israel Defense Forces (IDF) Medical Corps is based on the assumption that in full-scale conflict, a soldier wounded in action will go through at least two echelons of care and arrive at the hospital within a few hours of being injured (the "golden six hours", as relevant in the military). In contrast, the last two decades of conflict are characterized by numerous operations with limited durations and small-unit engagements. Rapid evacuation within one hour of injury brings even severely wounded victims to hospitals. During prior wars, these patients would have expired on the battlefield. In exceptional situations, urban battles may be prolonged. Recently, this was seen in Jennin, where a running battle continued for >4 days, delaying evacuation and making treatment of casualties challenging. These observations have clear implications on the extent of care rendered by medics or medical officers in the rapid-evacuation urban warfare scenario. Fewer interventions are provid-

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Grade	Wound	Level of Contamination	Soft Tissue Injury	Bone Injury
I	<1cm long	Clean	Minimal	Simple, minimal comminution
II	>1cm long	Moderate	Moderate, some muscle damage	Moderate comminution
III*				
a	Usually >10cm long	High	Severe with crushing	Usually comminuted; soft tissue coverage of bone possible
b	Usually >10cm long	High	Very severe loss of coverage; usually requires soft tissue reconstructive surgery	Bone coverage poor; variable, may be moderate to severe comminution
c	Usually >10cm long	High	Very severe loss of coverage plus vascular injury requiring repair; may require soft tissue reconstruction	Bone coverage poor; variable, may be moderate to severe comminution

Table 1—Classification of open fractures
*Segmental fractures, farmyard injuries, fractures occurring in a highly contaminated environment, shotgun wounds, or high-velocity gunshot wounds automatically result in classification as Grade-III open fracture.

ed on the field, limiting on-scene time as much as possible.

The proposed guidelines provide a simple strategy for the treatment of orthopedic injuries in the prehospital setting in both rapid evacuation and delayed transport scenarios. The treatment of four main injuries is addressed: (1) open fractures; (2) traction splints; (3) immobilization of pelvic fractures; and (4) reduction of dislocations. The guidelines share common principles with Advanced Trauma Life Support and prehospital care.

The timing and emphasis of prehospital care differs when confronted with a life-threatening injury to the head or trunk, when management of limb injuries should be delayed.

Open Fractures

Open fractures occur in approximately 11%–17% of combat casualties.[2,3] While rarely life-threatening, these devastating injuries are among the most difficult to treat, may require multiple operative procedures, and often become infected. The disruption of skin and underlying tissue with visible bone is the most obvious of many exhibiting signs of an open fracture. In other cases, bone ends may not be visible, and even a small puncture wound near a deformity indicate the "tip of the iceberg" and must be regarded as an open fracture at presentation. The grades of open fractures are described in Table 1.

During military conflicts, most open fractures are caused by bullets and fragments of explosive munitions.[1] Gunshot fractures represent a unique type of open fracture. They are contaminated by definition. High velocity gunshot fractures closely parallel Grade-III open fractures due to the magnitude of soft tissue damage and the high incidence of complications. The associated soft tissue wounds might cause profuse hemorrhaging. Time is an important factor when treating open fractures. Although no "golden hour" exists in orthopedic trauma, any delay at the scene of injury might jeopardize limb survival and recovery.[4] Intravenous (IV) antibiotics should be introduced soon after the injury because a delay of >3 hours increases the risk of infection.[5] The rate of infection is related to the severity of the open fracture: Grade-I and Grade-II open fractures are associated with a low infection rate (2–10%), while Grade-III open fractures have a high overall infection rate (10%–50%).[6] However, there is great variability in these rates, depending on the level of damage to the soft tissue. For Grade-III fractures not requiring soft tissue reconstruction (IIIa), the infection rate is similar to that of Grade-I and Grade-II fractures. However, when soft tissue loss is extensive enough to require a soft tissue reconstruction (IIIb), or when the fracture includes a vascular injury requiring repair (IIIc), the infection rate rises to 52% and 42%, respectively. These are the rates of infection reported in civilian injuries; the rates of infection for combat casualties are likely to be higher due to delays before treatment, the predominance of penetrating trauma, and overall poor sanitation.[7]

The victim should receive immediate, formal wound exploration, irrigation, debridement, and fracture stabilization in the operating room. In view of these considerations, rapid transport to a definitive care facility should be urged. When this is not available, such as during wartime, wound irrigation and IV antibiotics are essential for infection prophylaxis. However, patients receiving irrigation do not always receive proper attention in civilian prehospital care. This is because in most situations, rapid transport is available. Irrigation is intended to dilute the contamination and decrease the bacterial load. This can be accomplished with crystalloids or even tap water.

Splinting, irrigation, and wound care should never delay the evacuation of a patient with an open fracture and a penetrating torso injury (suspected uncontrollable hemorrhage), even if stable. Splinting these patients in the field increases on-scene time and endangers their well-being.[8]

Consensus View

With an open fracture, the first priority is to control hemorrhaging by applying direct pressure, compressing firmly, and bandaging. The consensus panel agreed that on-scene time should not be prolonged by attempts to irrigate and splint open fractures for patients with suspected, ongoing, uncontrollable hemorrhaging, or unstable hemodynamics.

If time permits, copious irrigation should be performed before applying a dry, sterile, compression dressing. This can be performed during transport if there is not enough time on-scene. Dirt and bits of clothing should be kept away from the edges into the wound, and irrigations that are too deep also should be prevented.

In the prolonged transport scenario, when casualties must wait for transport, or when they have an isolated limb injury, the aforementioned interventions should occur.

Intravenous access should be gained and antibiotics should be administered to all victims with open fractures. As in the rapid transport military scenario and in civilian prehospital care, prophylactic antibiotic treatment is unnecessary when transport times are short (<60 minutes). Morphine should be administered intravenously to every casualty who expresses pain. Gross deformities should be corrected to relieve pain and to protect the neurovascular structures. Open fractures and severe soft tissue wounds should be splinted to relieve pain and to control hemorrhaging.

Traction Splints

The Thomas splint earned its reputation following its use in the treatment of femoral gunshot wounds during World War I.[9] The combination of the splint and evacuation to a higher echelon were reported to have a dramatic effect on morbidity and mortality of gunshot victims.[10] Since then, the Thomas splint commonly has been used in the prehospital setting for immobilizing femoral fractures. During the recent Gulf conflict, this splint was used by the British Army in seven cases of both closed and penetrating injuries with positive results.[11] The application of a traction splint is presumed to have the following advantages: (1) reduction of pain and hemorrhaging; (2) prevention of further soft tissue injury; and (3) reduction of the incidence of fat embolism. Traction reduces hemorrhaging by creating a smaller elliptical area surrounding the fracture, which holds less blood compared with the pretraction spherical area.[12] Although patients may lose 0.5–2.5 L of blood with a femoral fracture, hypotensive shock rarely results from an isolated femoral shaft fracture,[13] and another source of hemorrhaging must be considered. Recently, the efficacy and utility of the traction splint in the prehospital setting has been questioned, especially when compared to simple rigid splints or long backboard immobilization.[14,15] Furthermore, the application of a traction splint requires at least two caregivers, and in some situations, may take longer than the transport time to the nearest hospital. Another consideration is the risk of associated injuries, since the mechanism of injury often involves a high-energy transfer. In the case of uncontrolled hemorrhaging, time-consuming splinting may affect survival adversely. These considerations may limit the indication for traction splint application for patients with isolated femoral fractures and no other concomitant, life-threatening injury.

Consensus View

Traction splints still are essential for wartime extremity injuries. Traction splints should be used for isolated femoral fractures and gunshot wounds in victims without concomitant, life-threatening injuries. In an open or gunshot fracture, the indication for splinting is even greater, due to the possibility of neurovascular and extensive soft tissue injuries. In the case of pelvic injuries with leg or ankle injuries on the same side, the splint may be applied without traction. The splint was advocated for the rapid transport scenario and delayed transport scenario. In the urban setting, traction splints may not be necessary; simply tying one leg to another may suffice. Tourniquets should not be applied to control hemorrhaging from femoral fractures, since they will fail and may cause further injury.

When is it Appropriate to use a Tourniquet?

Indications for tourniquet application in the battlefield are tactical and medical. Tactical indications include care under fire for any severely bleeding extremity wound, since other treatments may place the casualty and the caregiver at an additional risk of injury. Medical indications include traumatic extremity amputations and the inability to control bleeding by other means.

If possible, the time a patient wears a tourniquet should be limited. This means either recognizing when a tourniquet is not necessary (when no medical or tactical indication exists) or switching to a less-damaging means of hemorrhage control as soon as possible.

Circumferential Sheet for Pelvic Fractures

In the prehospital setting, pelvic ring disruptions in polytraumatized patients are difficult to diagnose and manage. These mainly occur as a result of blunt injuries, as opposed to penetrating injuries in which pelvic ring instability is infrequent.[16] Stability and hemorrhaging always are concerns in the field. Although most pelvic fractures are stable, mechanical stability is difficult to assess in the field. Clinical signs include: (1) asymmetry of the legs; (2) pain in the pelvis; (3) pain on hip motion; and (4) with anterior pelvic fractures, swelling and local tenderness at the symphysis. The diagnosis is accomplished by x-ray. A simple method for stabilizing the fracture for transport and reducing pain is wrapping a sheet tightly around the pelvis. Use of this method, known as Circumferential Pelvic Antishock Sheeting (CPAS), has been reported to achieve rapid pelvic ring stability.[17] Temporary reduction of open-book fractures with a sheet was demonstrated both radiographically and in computerized tomography scans.[18] The Advanced Trauma Life Support (ATLS) course of The American College of Surgeons now includes a protocol for the emergent management of pelvic ring disruptions, advocating the circumferential application of a pelvic sheet.[19] Sheets can be applied readily on-scene, and may provide reduction and stabilization of open-book type fractures, or merely splinting painful but stable fractures.

Consensus View

Since pelvic ring stability is difficult to assess in the field, every victim experiencing pelvic pain following a high-

energy mechanism of injury should be treated for an unstable pelvic fracture, and a sheet should be tied tightly around the pelvis. The victim should be handled gently, with as little lifting or rolling as possible. This is important for providing comfort and avoiding disruption of the pelvic hematoma. The victim should be transported on a long spine board with a rigid cervical collar and lateral support. The lower extremities should be tied together to maintain an adducted position.

Prehospital Reduction of Dislocations

Dislocations and fracture-dislocations are difficult to assess and treat without an x-ray. While some dislocations are obvious and extremely painful with movement, others are subtle and may go unnoticed (e.g., posterior dislocation of the glenohumeral joint, midfoot dislocations). The main issue is whether to attempt a field reduction of dislocations. There is insufficient data to recommend or discourage such a practice in both the military and civilian prehospital settings. The *Prehospital Trauma Life Support (PHTLS) Manual*[20] recommends field reduction, but at the same time, quotes the National Association of EMS Physicians (NAEMSP) recommendations that advocate reduction only when transport time is prolonged. In case of impaired circulation, the PHTLS Manual advocates one or two attempts of "slight repositioning...towards a normal position".[20] The Battlefield Advanced Trauma Life Support (BATLS)[12] justifies reduction of all dislocations as early as possible, since they often are easier to reduce soon after injury. Early recognition and treatment of dislocations is important, since any delay in treatment can increase morbidity and loss of function markedly. This becomes especially important if there is compromised blood supply to the limb, (e.g., in posterior dislocation of the knee). A prompt diagnosis of vascular injury is essential because of the well-established, direct relationship between the time interval from injury to treatment, and the chance of limb loss. On the other hand, without an x-ray it is impossible to distinguish a dislocation from a fracture-dislocation. Thus, further damage may be done with blind manipulation. The relative inexperience and skill of the medical officer is another factor to be taken into account.

Consensus View

Suspected dislocations should be immobilized without repositioning. With no conclusive data at hand, the panelists believed that the risks of reduction attempts outweigh the benefits, due mainly to the potential for further damage. As a general rule, it is better for the medical officer to avoid reduction. In any case, the distal pulse should be palpated and marked on the skin for repeated assessments. Absent distal circulation makes the casualty a higher priority for evacuation. If the patient is anticipated to experience a long evacuation chain with >1 echelon (as in the delayed transport scenario), and the medical officer is familiar with reduction techniques, one or two attempts at reduction can be made using IV morphine to provide analgesia. Following reduction, the distal pulse should be rechecked and splinting should occur.

Conclusion

Orthopedic injuries predominate combat casualties, and have the potential for significant morbidity. Treating and avoiding further injuries begins with the prehospital care providers. Some conclusions can be drawn from existing literature, and when combined with the opinions of the panelists, the guidelines offered represent a good guide to limb injury management in the field for non-orthopedic primary care providers. As new information clarifies the issues discussed above, the recommendations can be changed accordingly.

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