JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Orthopaedic Trauma: Extremity Fractures (CPG ID: 56)

To describe the initial non-surgical and surgical management of extremity fractures and to define care guidelines for fractures of upper and lower extremities.

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GOALS

The purpose of this CPG is to describe the initial non-surgical and surgical management of extremity fractures; to demonstrate appropriate application of an external fixator with limited resources in order to stabilize for transport; and to define care guidelines for fractures of upper and lower extremities in the context of the host nation's environment and the options available to the different patient groups.

BACKGROUND

The majority of wounds sustained by soldiers in combat zone are to the extremities; largely due to the nature of modern body armor.[1] Surgeons caring for victims of war must be aware of management challenges of extremity fractures in the austere environment. Care follows many similar principles used in treating the same injuries at any U.S. civilian trauma center. Appropriate wound management followed by fracture stabilization is the mainstay of treatment.

EVALUATION AND TREATMENT

EARLY AND THOROUGH WOUND DEBRIDEMENT

- Far-forward medical facilities may not have the capability to administer surgical debridement, but early irrigation with removal of gross contaminants is possible at any level of care.
- During the primary examination, vascular status of the extremities should be determined and compartments checked for signs of acute Compartment Syndrome.
- A thorough irrigation and surgical debridement should be performed as early as possible [in accordance with JTS War Wounds CPG.]

    1. Debris and devitalized tissue should be removed.
    2. Bone fragments with any soft tissue attachment should be maintained; bone fragments that are devitalized should be debrided with exception of large articular fragments.
    3. All viable tissue should be preserved in order to permit receiving physicians the greatest number of definitive care options.
    4. To facilitate identification of structures during reconstruction, nerves and tendons should be tagged.
    5. Open fractures should receive prophylactic antibiotics, primarily 1st generation cephalosporin and tetanus toxoid as soon as possible.[2,3]

FRACTURE STABILIZATION

1. Fracture instability can compromise tenuous soft tissue viability; therefore, fracture stabilization is part of soft tissue wound management and is crucial in the setting of a vascular repair. Splinting may be the only far-forward option for fracture stabilization and affords the receiving surgeon the greatest number of surgical options. **Splinting** may be most appropriate for low energy and closed fractures, such as wrist, hand, humerus, elbow, ankle, and foot fractures.

2. **Open wounds** should be addressed first and the status of the underlying wound as well as the date and time of the most recent debridement and irrigation should be documented on the splint itself. If the patient is to be transported, splints must be suitable for the mode of transportation and acceptable

within limits of passenger space. Caution should be utilized so splints are not constrictive/circumferential or predispose to compartment syndrome, especially prior to long evacuations. Splints should immobilize the joint above and below the fracture and should have adequate padding at pressure points to prevent soft tissue injury. Splints are intended to limit further injury and are not meant to be definitive treatment. Complete reduction may not be possible or necessary for initial splinting of fractures. A neuro-vascular exam should be conducted post-splinting with or without reduction attempts, to confirm that perfusion remains intact after fracture manipulation.

3. **Finger and hand injuries** may be immobilized with standard splinting methods. Forearm and elbow injuries are best splinted with a long arm posterior splint or a double sugar-tong splint. Humerus and shoulder fractures are best immobilized using a sling and swathe or coaptation splint. Care must be taken to ensure there is enough padding at the axilla. Tibia and ankle fractures may be splinted and provide adequate stability for transport. Ensure the splint padding allows access for compartment checks if compartment releases have not been performed.

EXTERNAL FIXATION

1. **Internal fixation**, due to logistical constraints and concern for infection, is not ideal in the austere environment. Surgeons should be well versed on external fixator placement for both the long bones and joint-spanning constructs. In the setting of concurrent vascular injuries requiring repair, the orthopaedic surgeon and general surgeon should discuss the sequence of external fixation application (before or after vascular repair or shunting).

2. **External fixation** affords adequate fracture stabilization to minimize additional soft tissue trauma**.** Access for wound care and re-evaluation of compartments are maintained with external fixation. Constructs may be rapidly applied in the setting of poly-trauma and mass casualties; this also has physiological benefit, as early fracture stabilization is recommended to blunt inflammatory mediators associated with fractures in poly-trauma.[4] Stability afforded by external fixation is also beneficial for pain control and ease of transport, avoiding re-manipulation during transport and at each higher echelon of care.

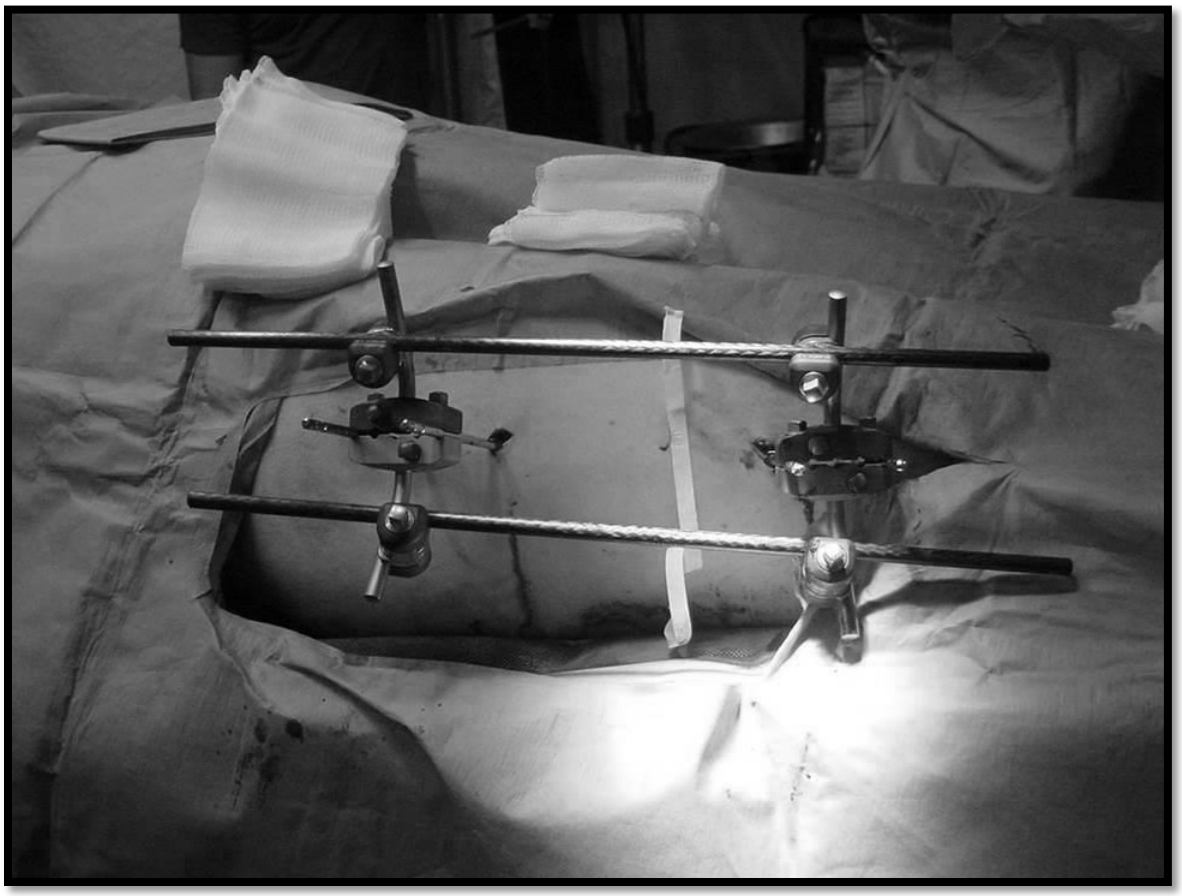
3. **External fixation** in the austere environment is performed within restrictions of equipment and the lack of available fluoroscopy. Specific portable external fixation kits designed for military use include the Hoffman II sterile field kit (Stryker Howmedica Osteonics, Rutherford, NJ). This kit contains carbon fiber rods, clamps, and self-drilling and taping pins that may be inserted without the need for electrical power drilling. (Figure 1)

4. **Frame stability** may be increased by optimizing reduction, minimizing bone-to-bar distance, maximizing space between pins, and using the largest diameter pin possible (bending strength is directly proportional to the pin radius to the fourth power). Using a minimum number of pins possible (2 pins per each end of the fracture) to maintain fracture stabilization will allow receiving surgeons the most options; consider future internal fixation plans when choosing pin placement. External fixation has been shown to be safe in the austere environment with no major complications (defined as neurovascular injury, mechanical failure, septic joint, and pin tract osteomyelitis) identified in a recent review of 55 tibial external fixators.[5]

5. **The following guidelines allow the safe and effective placement of fixation pins** in the austere environment without fluoroscopy.[6] Surgeons should make small longitudinal incision at the pin site and spread down to bone bluntly. Load the pin in either a drill or manual driver and place the pin into incision until pin meets bone (if power drill is available, pre-drilling the bone for pin placement will

improve long-term pin fixation). The pin tip can be "walked" anteriorly and posteriorly to feel edges of bone so that mid portion may be identified. Pin advancement should be stopped once purchasing the far cortex without over-penetration. Although advancing the pin through the far cortex is standard practice, lack of fluoroscopy puts neuro-vascular structures at risk with excessive pin advancement. Subsequent pin placement on the same bone should be performed in parallel and the clamp guide may be used as an aid. This will allow pin-to-bar clamps to engage both pin elements without difficulty. Pins should be placed both "near and far" from the fracture on both bone fragments. Avoid pin positioning too close to the fracture site (pins within the fracture itself will decrease external fixator's ability to maintain stability of fracture). External fixators may be placed to span joints if fractures extend into articular surface (knee, elbow).

Figure 1. Hoffman Femur Fracture



LOWER EXTREMITY

Half pins may be inserted at any point along the antero-lateral aspect of the femur with low risk to neurovascular structures; over-penetrating medial cortex may put the profunda femoris artery at risk. Lateral pins in distal femur and antero-medial pins in proximal tibia may be used to bridge the knee with additional bar-to-bar clamps. Tibial pins should be placed on the antero-medial surface of bone; this is easily palpable as it is subcutaneous the entire length of the bone. Proximal tibial pins should not be placed within 1 cm of the tibial plafond. Both half-pins and trans-calcaneal pins may be inserted into the calcaneus from medial to lateral position. Correct pin starting point is 2 cm above plantar skin and 2 cm anterior to posterior border of calcaneus. The medial cuneiform and the proximal shaft of first metatarsal will accept pins perpendicular to the long axis. Do not enter the base of the first metatarsal, as this may tether the tibialis anterior tendon.

UPPER EXTREMITY

In most situations splinting of the upper extremity is preferred over external fixation due to risk of nerve injury. If external fixation is necessary it is recommended that surgeons place pins in an open and not percutaneous technique in order to protect upper extremity nerves. Lateral or anterior half pins are used in the humerus. The deltoid tendon should be avoided as well as over-penetration of the medial cortex so as not to damage the neurovascular bundle. At the distal humerus pins can be placed at the lateral epicondyle in a posterior oblique manner. Either half-pins or trans-humeral pins may be placed laterally too medially in the lateral epicondyle. Surgeons should avoid anterior neurovascular structures and ulnar nerve by placing pins in plane with epicondyles, palpable on each side of elbow. The ulna is easily palpable and pins may generally be placed along any border. Lateral entry pins are typically used, keeping in mind the ulnar nerve proximally. Radial pins may be placed about the distal portion of the bone. Closed pin placement in the proximal portion of radius is not recommended because of risk to the posterior interosseous nerve. Until definitive internal fixation is done, twice daily wound care (50:50 hydrogen peroxide and normal saline) should be performed.

HOST NATION CASUALTIES

One particular challenge for medical providers in an under resourced host nation is the likelihood of treating individuals with unknown follow-up care. Low-energy, closed fractures may be treated definitively with a splint or cast. Plaster may be preferred to fiberglass for casting, if cast saws are not available locally. Certain low-energy fractures may warrant open reduction and internal fixation or closed reduction and percutaneous pinning. External fixation is also an option if transfer to a host nation facility is possible, or tempo of casualties allows for delayed internal stabilization. In the setting of high-energy wounds with extensive soft tissue loss, a staged amputation that may be definitively closed in a short period of time must be considered. Unavailability of prolonged and advanced surgical care make limb salvage challenging.

PERFORMANCE IMPROVEMENT (PI) MONITORING

INTENT (EXPECTED OUTCOMES)

All extremity fractures are appropriately reduced, dressed and splinted or ex-fixed in theater.

PERFORMANCE/ADHERENCE MEASURES

All extremity fractures are appropriately reduced, dressed and splinted or ex-fixed in theater.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed every five years; additional PI monitoring and system reporting maybe performed as needed.

The system review and data analysis will be performed by the JTS Director, Division Chiefs, and the Performance Improvement Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

REFERENCES

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2. Calhoun JH, Murray CK, Manring MM. Multidrug-Resistant Organisms in Military Wounds from Iraq and Afghanistan. Clin Orthop Rel Res 2008;466:1356-1362.
3. Murray CK, Hsu JR, Solomkin JS, Keeling JJ, Andersen RC, Ficke JR, Calhoun JH. Prevention and Management of Infections Associated With Combat-Related Extremity Injuries. J Trauma 2008;64:S239-S251.
4. Camuso MR. Far-forward fracture stabilization: external fixation versus splinting. J Am Acad Orthop Surg 2006;14:S118-S123.
5. Possley DR, Burns TC, Stinner DJ, et al. Temporary external fixation is safe in a combat environment. J Trauma 2010;69:S135-S139.
6. Hoppenfeld S. Surgical Exposures in Orthopaedics: The Anatomic Approach, 4th ed. Lippincott Williams and Wilkins: Philadelphia, 2009.

ADDITIONAL RESOURCES

1. Society of Military Orthopaedic Surgeons (SOMOS) Core Curriculum
2. Holcomb J. The 2004 Fitt lecture: Current perspectives on combat casualty care. J Trauma. 2005;59:990-1002.

APPENDIX A: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e., "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.