

Chapter 22

Extremity Fractures

Introduction

This chapter discusses two techniques for safe transportation of wounded service members with a long bone fracture: **splinting** and **temporary external fixation**. Both of these methods are acceptable for initial treatment of a casualty who will be evacuated out of theater.

Both splints and external fixators are acceptable methods for the initial management of long bone fractures. In the end, the choice of initial fracture stabilization must be made on a case-by-case basis by the treating surgeon.

External fixators are of benefit when soft tissue access is necessary, such as with a vascular injury; when other injuries make use of splinting impractical, such as with a femur fracture and abdominal injury; or with extensive burns. A splint and bulky dressing may be used to augment a limb that has been externally fixated for better soft-tissue support.

Although standard in civilian trauma centers, intramedullary nailing of major long bone fractures is contraindicated in combat zone hospitals because of a variety of logistical and physiological constraints. This method may be used once a patient reaches a Role 4 or other site where more definitive care can be provided. Intramedullary nailing has been performed successfully at Role 3 facilities on local nationals after appropriate initial damage control surgeries, however these should be placed with caution. Local national surgeons must be able to care for patients with orthopaedic implants, particularly in the event they become infected. Historically, infected intramedullary devices have posed a significant management problem in developing countries.

General Considerations of Wound Management

- Initial management.
 - Treat by debridement and irrigation as soon as feasible to help prevent infection.
 - Biplanar radiographs should be obtained when possible.
 - Neurovascular status of the extremity should be documented and checked repeatedly.
 - Internal fixation is contraindicated in the face of gross contamination.
 - Begin IV antibiotics as soon as possible and maintain throughout the evacuation chain. Use a broad-spectrum cephalosporin (Cefazolin 1-2 grams q8h).
- Wound incision/excision.
 - Guidelines as per Chapter 9, Soft-Tissue and Open Joint Injuries.
 - Use longitudinal incisions to obtain exposure.
 - The fascia is incised longitudinally to expose underlying structures and facilitate **compartment release**.
 - All foreign material in the operative field must be removed, along with devitalized bone and nonviable muscle (Fig. 22-1).
 - Bone fragments should be retained only if they have a viable soft-tissue attachment or constitute a large portion of the joint.
 - Detached bone fragments are discarded.
 - Copious irrigation is essential (Fig. 22-1d).
 - Pulsatile lavage is not necessary.
- Closure of wounds.
 - Primary closure is **NOT** indicated in these contaminated wounds. Loose approximation of tissues with one or two retention sutures **MAY BE** appropriate to cover nerves, vessels, and tendons; but, there must be a provision for substantial free drainage.
 - Skin grafts, local flaps, and relaxing incisions are contraindicated in the initial management.
 - Delayed primary closure may be attempted, as described in Chapter 9, Soft-Tissue and Open Joint Injuries. This should be accomplished in a stable wound environment following acceptable serial debridement.
 - Negative pressure wound therapy is a useful adjunct in soft-tissue wound management.

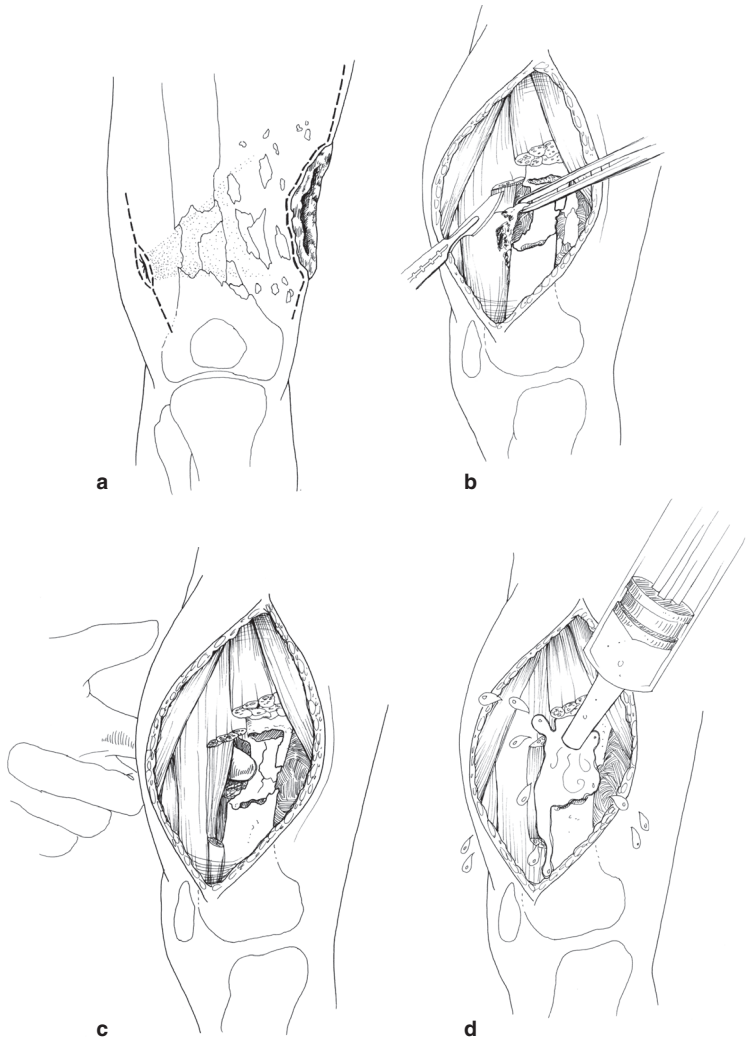


Fig. 22-1. Wound incision/excision.

External Fixation

- General technique: the surgeon should be familiar with four standard constructs of external fixation for use in the initial care of bone and joint injuries: femur, tibia, knee, and ankle.

External fixation can also be applied for humerus and ulna fractures, although these are seldom required.

- A thorough understanding of the anatomy of the extremities is essential for safe insertion of fixator pins.
- The external fixator for military purposes should be modular and allow for modification as healing progresses.
- Application of the external fixator may be done without the use of plain films or fluoroscopy.
- Pins can be inserted without power instruments.
- Enough pins should be placed to adequately stabilize the fracture for transport. This is usually two per multipin clamp, but three may occasionally be required.
- Most external fixation systems allow for the use of either single pin clamps or multipin clamps. Both clamps are acceptable to use in standard constructs.
- **Femur diaphyseal fracture technique.**
 - The entire limb is prepared for surgery, from the anterior superior iliac spine to the toes.
 - A standard OR table or portable fracture table may be used.
 - An assistant should apply counter pressure while pins are inserted.
 - Precise reduction is not necessary; however, one should reestablish appropriate length to optimize distal limb perfusion and to facilitate future reduction. A padded “bump” under the thigh will help reduce the fracture (Fig. 22-2).

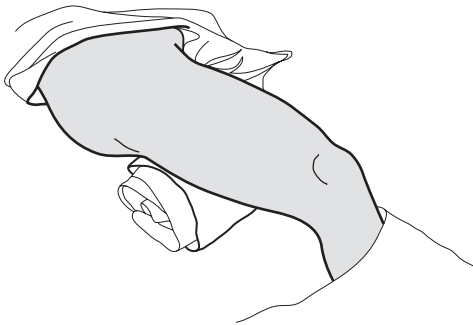


Fig. 22-2. Placing a towel underneath the thigh helps to reproduce the bow of the femur.

- The position of the proximal femur should be identified by palpation. A 1-cm longitudinal stab incision is made over the midaxis, or midlateral axis, of the femur (Fig. 22-3). Anteromedial pins place the neurovascular structures at risk and should be avoided. The pin closest to the fracture should be outside of the fracture hematoma and at least 3 fingerbreadths from the fracture (Fig. 22-4).

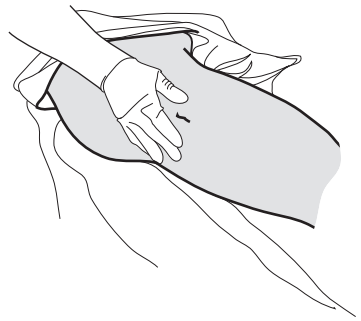


Fig. 22-3. Place a 1-cm longitudinal incision in line with the midlateral axis of the femur.

- Spread soft tissue bluntly down to the bone. Insert a pin through this opening and when reaching the bone, assess its midpoint by sweeping the pin anteriorly and posteriorly (Fig. 22-5). Your assistant should provide stability and counter pressure. Pins are placed by hand or power. Use 5 or 6-mm half-pins for the femur. Insert the pin in the midportion of the bone and advance through both the near and far cortices. (Fig. 22-6). The pin will move easier as it enters the intramedullary canal and become more difficult to drive as it enters the far cortex.

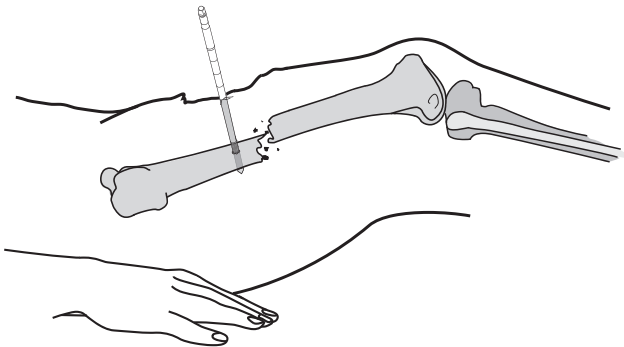


Fig. 22-4. Pins should be placed outside of the fracture hematoma and at least 3 fingerbreadths from the fracture.

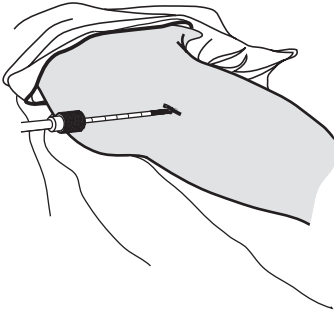


Fig. 22-5. Femoral pin placement.

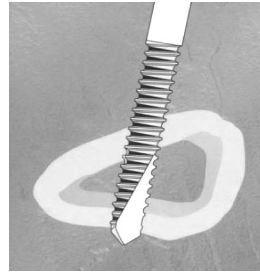


Fig. 22-6. Bicortical placement of 5-mm half-pin.

- Place a multipin clamp over the inserted pin. Ideally, the pin should occupy one of the end positions (Fig. 22-7).
- Using the clamp as a guide, insert a second pin through the clamp. An assistant should hold the clamp. Ensure that the clamp is aligned with the bone and that bicortical purchase is obtained. The second pin must be parallel to the first pin. To ensure they are parallel, it can be helpful to use the clamp as a guide for placing the second pin. Use the pin sites that are the farthest apart on the clamp as possible for biomechanical stability (see Fig. 22-7). A third pin may be inserted if needed for additional clamp stability.

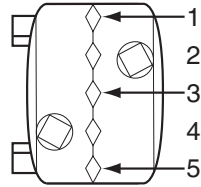


Fig. 22-7. Multipin clamp showing positions 1–5.

- Repeat this technique when inserting pins and applying the multipin clamp to the distal femoral fracture fragment.
- Connect the two clamps with elbows, bar-to-bar clamps, and two longitudinal bars placed parallel to each other (Fig. 22-8).
- Reduce the fracture with longitudinal traction. Manipulating the fracture fragments using the clamps may be helpful. Once adequate reduction is achieved, tighten all of the connections. Precise reduction is not necessary.
- Tibia shaft fracture technique.
 - Place a 1-cm longitudinal incision over the anteromedial face of the tibia (Fig. 22-9). The pin closest to the fracture

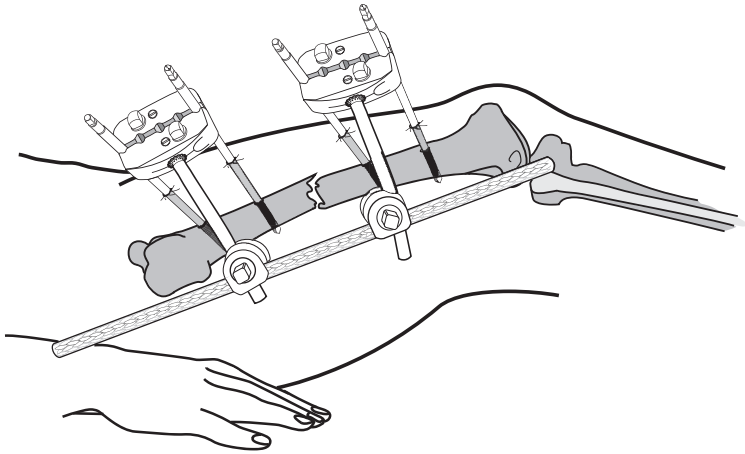


Fig. 22-8. Frame applied and fracture grossly reduced. Anterolateral or anterior placement of stabilizing rod is preferred. Consider use of multiple rods for increased stability.

site should be outside the hematoma and at least 2–3 fingerbreadths away from the fracture site (Fig. 22-10).

- Insert the first pin into either the proximal or distal fragment. Place the pin perpendicular to the subcutaneous border of the tibia and centered across the width of the tibia. Ensure that pins engage both cortices (Fig. 22-11).

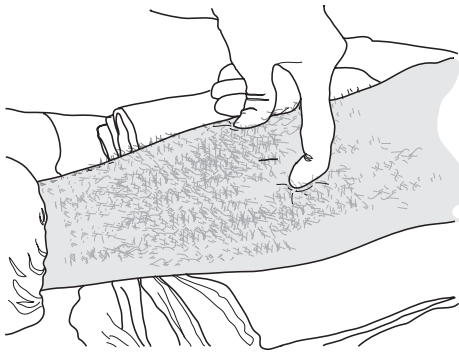


Fig. 22-9. Palpation of the anterior and posterior margins of the medial face of the tibia where a 1-cm incision has been made midway between these two points.

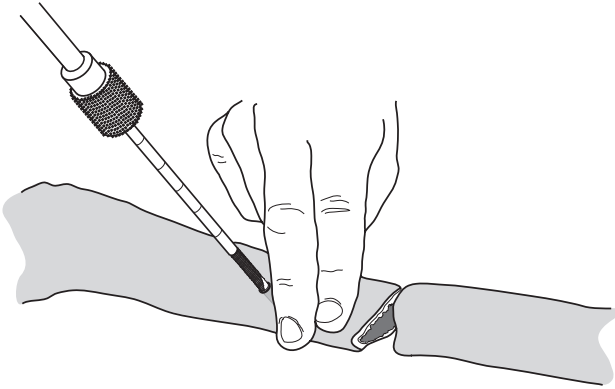


Fig. 22-10. The anteromedial surface is the safest location for tibial pins. Pins should be a minimum of 2 or 3 fingerbreadths from the fracture site.

- Using the clamp as a guide, insert a second pin through the clamp. An assistant should hold the clamp. Align the clamp with the bone and advance the pin through both cortices. The second pin **must** be parallel to the first. Use the pin sites as far apart on the clamp as possible for biomechanical stability (see Fig. 22-7).
- Apply a second multipin clamp and two pins in the same manner to the other main fracture fragment (Fig. 22-12). Connect the two clamps via two elbows, bar-to-bar clamps, and a single bar (Fig. 22-13).
- Most combat-related fractures are comminuted. Therefore, a second bar may be added for increased fracture stabilization (Fig. 22-14).

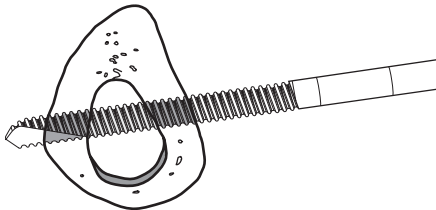


Fig. 22-11. Bicortical placement of tibial pins.

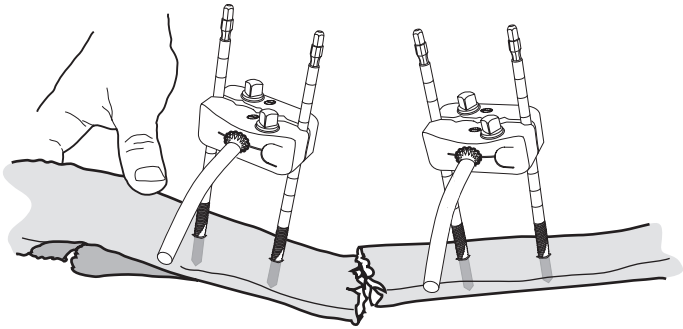


Fig. 22-12. Application of the second multipin clamp and two pins. Add 30-degree elbows to the two sets of multipin clamps. Point the elbows in a direction that will position the bar(s) away from open wounds and allow for the best access.

- Technique to span knee.
 - Indications are proximal tibia fractures, distal femur fractures or extensive knee injuries, or vascular repairs in the popliteal fossa.
 - Check the distal vascular status of the limb prior to and after the procedure. If there is a vascular injury, refer to Chapter 25, Vascular Injuries.

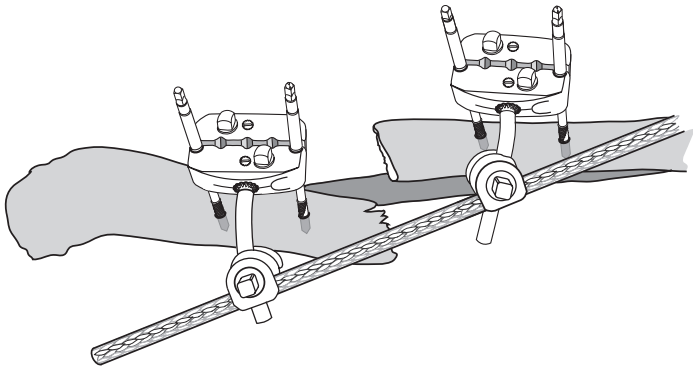


Fig. 22-13. Addition of the cross-bar and two bar-to-bar clamps. Apply longitudinal traction to reduce the fracture and then tighten the frame in alignment.

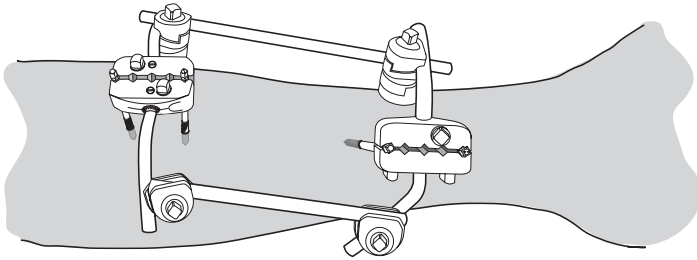


Fig. 22-14. The two-bar apparatus is a more stable construct for typical, unstable tibial fractures.

- General reduction maneuver should be longitudinal traction with slight (10° – 15°) flexion at the knee.
- Pins are placed anteromedial on the proximal tibia and anterolateral on the distal femur. Pin placement should be outside the zone of injury, at least 3 fingerbreadths from a fracture site and outside the knee joint. A longitudinal stab incision is made over the mid-anterolateral aspect of the femur and the pin inserted at a 45-degree angle to the long axis of the bone. Depending on the fracture configuration, it may also be placed directly anteriorly, although it is generally better to avoid pin placement through the quadriceps tendon.
- Blunt dissection is used to create a corridor to the bone.
- A single pin is inserted by hand or power through both cortices of the bone.
- A multipin clamp is used as a guide for a second pin. The second pin **must** be parallel to the first pin and also be bicortical—care should be taken to maintain pin alignment. The proximal tibia should be palpated on the anteromedial surface, and pins should be placed in a similar fashion as described above for the placement in tibial fractures.
- The two pin clusters (femur and tibia) should be connected via 2 elbows, 2 bar-to-bar clamps, and 1 bar. The knee should be aligned.
- A second bar may be added in the manner described previously.

- Technique to span ankle.
 - An assistant will be required to help apply the frame and reduce the ankle.
 - General indications are for open distal tibia fractures and open ankle wounds.
 - Pins should be inserted on the anteromedial surface of the tibia and on the medial aspect of the calcaneus.
 - Check the distal vascular status prior to and after the procedure. Mark where the posterior tibial and dorsalis pedis artery pulses can be felt.
 - Palpate the anteromedial border of the tibia. Make a 1-cm longitudinal incision midway between the anterior-posterior border of the tibia. Insert the most distal pin on the tibia outside the zone of injury, at least 3 fingerbreadths from the fracture site.
 - Using a multipin clamp as a guide, insert a second pin in the tibia proximal to the first pin. The pin **must** be parallel and aligned with the longitudinal axis of the first pin.
 - Palpate the medial border of the calcaneus. Make a longitudinal incision over the calcaneus **avoiding the posterior neurovascular structures**: dissect to the bone with a blunt instrument and insert the pin. When available, insert a centrally threaded pin from medial to lateral. The pin insertion point should be the junction of posterior and middle one-third distance between medial malleolus and posterior calcaneus tuberosity. If using two half pins, then apply in the posterior half of this line.
 - Using a multipin clamp as a guide, insert a second pin in the calcaneus.
 - Connect the 2 clamps via 2 elbows, 2 bar-to-bar clamps, and 1 bar.
- Skeletal traction.

As skeletal traction is incompatible with the evacuation of patients on most standard military aircraft, its use in theater is generally discouraged.

- Care in the evacuation chain.
 - When planning procedures, consider the potential for complications during air evacuation.
 - Consider medication supply for transport (see Chapter 4, Aeromedical Evacuation).
 - Skeletal traction should **not** be used for transportation.
 - Casts should not be used. **Casts may act as tourniquets due to tissue swelling.** Even a bivalved cast can create the same effect if the ace wrap is applied too tightly.
 - All documentation, including radiographs, should accompany the patient.
 - Well-padded splints can be used with and without external fixation with large open wounds, such as blast injuries.

For Clinical Practice Guidelines, go to
http://jts.amedd.army.mil/index.cfm/PI_CPGs/cpgs