CHAPTER 27

EXTERNAL FIXATION IN LOWER EXTREMITY SURGERY

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External fixators now play an important role in the treatment of foot ankle and leg deformities. With an understanding of the various categories of fixators and their prospective uses, the podiatric physician can broaden his treatment choices.

GENERAL PRINCIPLES

There are four current forms of external fixators: circular, unilateral, hybrid and spatial. Each fixator, when used properly, will provide adequate osseous stability to aid in potential bone healing. The purpose of external fixation is to anchor osseous fragments together through the use of wires and rods.[1] External fixators posses an advantage over other forms of immobilization. Immobilization of multiple areas of the affected limb can be accomplished while applying compression or distraction at varying sites.[2] In the case of large soft tissue loss, the external fixator can be applied to avoid potential areas of vascular supply. The fixator may also be applied in such a fashion as to allow the placement of skin grafts if necessary. When stability is achieved with external fixation, patients may begin early range of motion and ambulation.

BIOMECHANICS

The use of external fixation devices to stabilize osseous segments is governed by the biomechanical characteristics each fixator contains. These characteristics can easily be altered through the use of tension, distraction, transosseous wires, half-pins and the alignment of the fixator on the limb. Each fixator applies static stresses on the bone structure through the use of compression and tensioned wires. Dynamic stress is applied when the patient is weightbearing. The combination of these stresses must be controlled by the stability and rigidity characteristics of the fixator in order for osseous union to occur.[3]

UNILATERAL FIXATORS

Unilateral fixators provide stability through the use of half-pins in a linear configuration. Oni et al. found that half-pins concentrated in small areas provide less stability then those in larger areas.[3] Behrens et al. found that an increase in stability occurred with unilateral fixators using half-pins in a biplane configuration.[4] In both cases, the fixator rigidity and stiffness characteristics are determined by the half-pin bone interface. The primary weakness found in unilateral fixators is the lack of stability in the sagittal plane.[3,4] Due to the sagittal plane motion, immediate postoperative weightbearing is not indicated. Weightbearing may begin at six to eight weeks later in the osseous healing phase. Therefore when osseous union fails to occur the physician must consider a lack of sagittal plane stability.

CIRCULAR FIXATORS

Circular fixators differ from unilateral fixators through the use of transosseous-tensioned wires, the use of olive wires, and the position of the wires Stability and rigidity characteristics also differ from those of unilateral fixators. The ring structure, the tensioned wires and the position of wires and half-pins control stability characteristics while half-pins and threaded rods aid in rigidity.[5] When transosseous wires are placed under tension, they undergo a self-stiffening effect, which increases stability between the bone fixator interface. Circular fixators provide sagittal plane stability while allowing axial rotation. It is thought that small amounts of axial rotation increase the potential for osseous union. The optimal stabilizing position for transosseous wires and half-pins occur when they are applied at 90 degree angles to each other and the bone.[6] When transosseous wires and half-pins are used in combination, an increase in stiffness and rigidity occurs while a decrease in axial motion is noted.[7,8] Often a true 90 degree angle is not possible secondary to anatomical considerations. When this occurs, smaller angles must be used with an increase in the amount of wires or half-pins in an effort to maintain stability and rigidity. In addition to smooth wires, the use of olive wires allows for greater control of fusion sites or fracture fragments.

DISCUSSION

Circular fixators are technically more difficult to apply than are unilateral and hybrid fixators. Due to the flexibility of the ring systems and wire/half-pin combinations, stability can be built in to each fixator. However not all deformities require stability greater than that allowed with a unilateral fixator. If full-weightbearing status is necessary, unilateral and hybrid fixators must be traded for circular fixation. In cases where weightbearing may be delayed 6 to 8 weeks, unilateral and hybrid fixators may be applied. The construction of circular fixators is time consuming when compared with unilateral and hybrid fixators. Therefore if speed of application is a factor, as may be found in poly-trauma cases, unilateral fixators may be applied with greater speed even in the emergency room.

External fixation devices each have characteristics that make them ideal for application in many situations. The surgeon should select the type of fixator based on the osseous stability requirements in each individual case.

UNILATERAL FIXATOR CASE

Figure 1A. A fifty-eight-year-old male presented with significant arthrosis of the ankle resulting from a pilon fracture, 6 years previous.

Figure 1B. Lateral view radiograph.

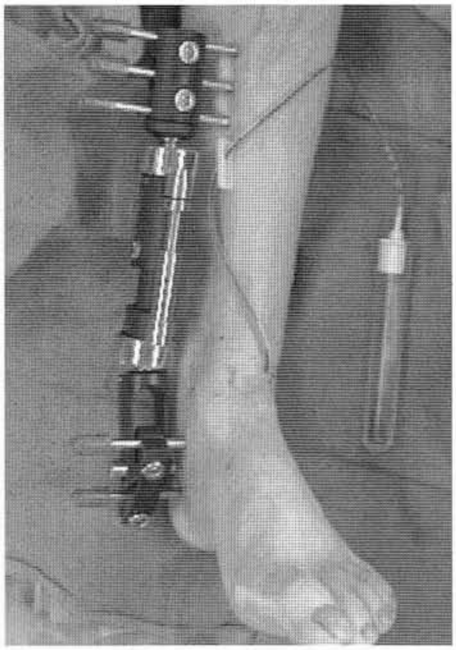

Figure 2. Intraoperative view of the unilateral fixator. Note the size of the 5mm half-pins. Three were placed in the tibia, one in the talus, and one in the calcaneus.

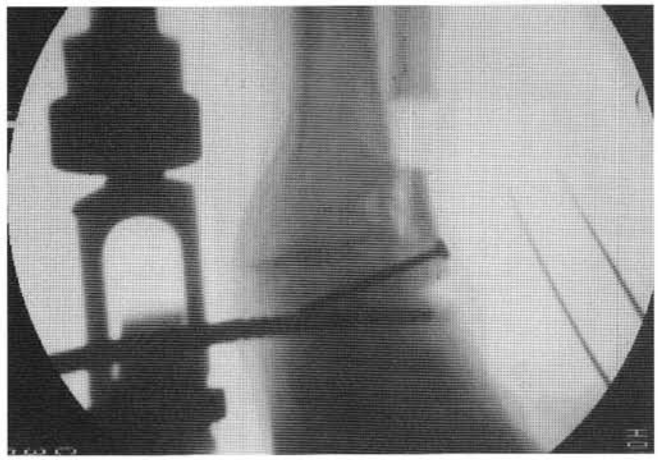

Figure 3. Radiographic intraoperative view with use of a large unilateral fixator achieving fusion at the ankle site.

Figure 4A. Postoperative anteroposterior view of the ankle.

Figure 4B. Postoperative view. Note the lateral fibular strut with the use of a cancellous screw inserted into the talus, not the tibia. This functions as an onlay sliding graft.

CIRCULAR FIXATOR CASE

Figure 5A. Anteroposterior radiograph of a thirty-four-year-old female who suffered extensive ankle trauma resulting from an automobile accident.

Figure 5B. Lateral view.

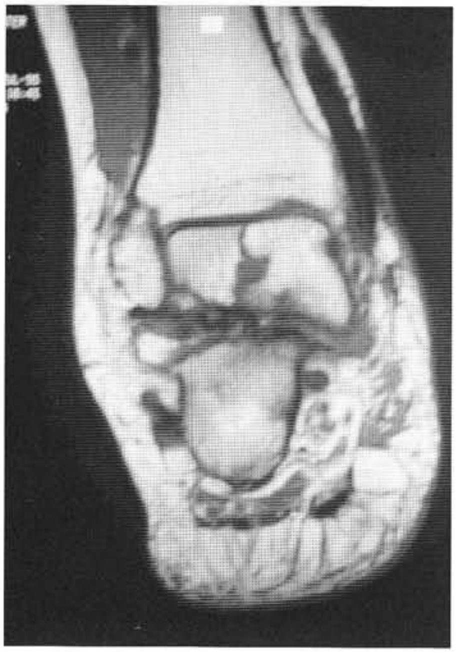

Figure 6. MRI reveals multiple fractures of the talus. An Ilizarov frame uses small wires through the talus, providing better stability and compression at the fusion site.

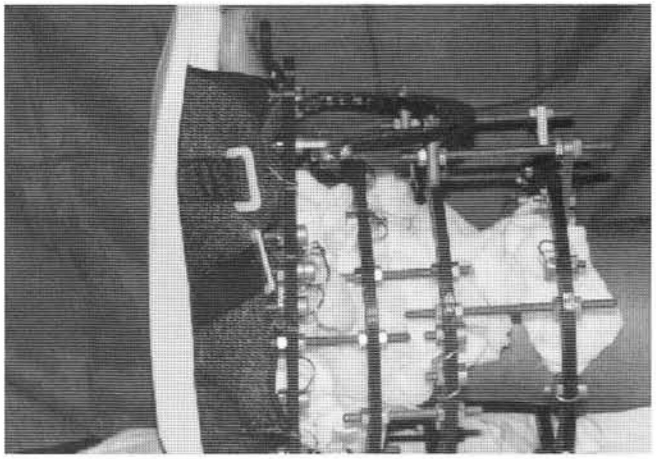

Figure 7A. View of the circular Ilizarov frame in place. The patient was allowed full weightbearing on the first postoperative day.

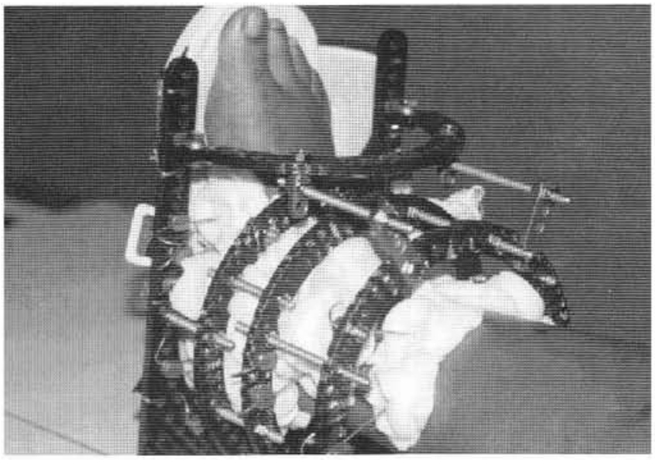

Figure 7B. This frame can provide up to 5 times greater compression through the fusion site when compared to conventional screw fixation.

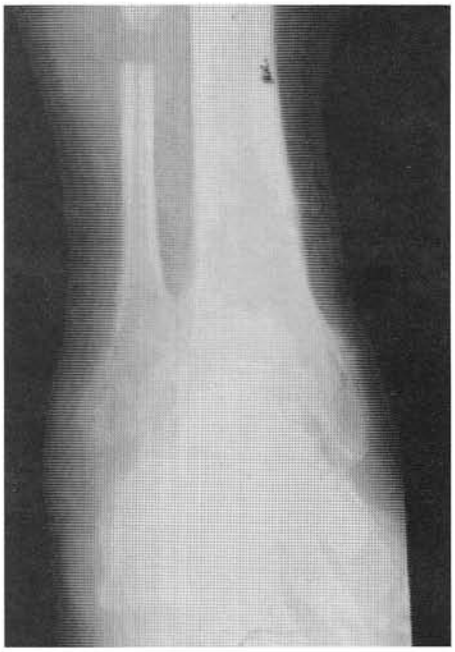

Figure 8A. Postoperative radiograph. Fusion was achieved after a period of only 6 weeks of compression.

Figure 8B. Lateral postoperative view.

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