The Foot and Ankle Online Journal
Official Publication of the International Foot & Ankle Foundation
faoj.com / ISSN 1941-6806

Ilizarov method of fixation for the management of pilon and distal tibial fractures in the compromised diabetic patient: A technique guide.

by Edgardo Rodriguez, DPM[1], Michael Bowen, DPM[2], Alexander Cherkashin, MD[3], Mikhail Samchukov, MD[4], Stephen Frania, DPM FACFAS[5], Paul Dayton, DPM FACFAS[6], Patrick Nelson, DPM[7]

The Foot and Ankle Online Journal 7 (2): 6

The purpose of this technique guide is to provide the foot and ankle surgeon with a comprehensive guide for reducing pilon and distal tibial fractures when dealing with the co-morbid patient and/or a soft tissue envelope that does not lend itself to ORIF. The senior author presents a relatively low complication rate (13% in the pilon group and 23% in the distal tibial group), with a low number of amputations (five out of 59 patients).

Key words: Pilon fracture, distal tibial fracture, diabetes, Ilizarov external fixation.

The principles of external fixation have gone far beyond the mere use of stabilizing an injury. External fixation allows for the stabilization of a traumatic injury to further stage the procedure, as with an open fracture, and allows the surgeon anatomical correction along with careful observation of the soft tissue envelope. External fixation has afforded greater surgical options when dealing with the ever increasing diabetic population which has significant manifestations in the lower extremity.

Address correspondence to: Edgardo Rodriguez, DPM
875 North Dearborn Street Suite 400N, Chicago, Illinois USA 60610. Telephone: 312.335.3939, Facsimile: 312.335.5469. Email: egodpm@gmail.com

1. Director, Chicago Foot and Ankle Deformity Correction Center: 875 North Dearborn Street Suite 400N, Chicago, Illinois USA 60610.
- Director, Reconstructive Foot & Ankle Fellowship Program Saint Anthony Hospital: 2875 W. 19th St, Chicago, IL 60623.
- Center for Excellence in Limb Lengthening and Reconstruction, Department of Pediatrics.
2. PGY-2, Foot and Ankle Residency Program, St. Vincent Charity Medical Center: 2351 E. 22nd St., Cleveland, OH 44115. mbowen@alumni.ocpm.edu
3,4. Orthopedics, Texas Scottish Rite Children Hospital: 2222 Welborn Street Dallas, Texas USA 75219.
5. Foot and Ankle Specialists of Ohio: 7062 Wayside Dr., Mentor, OH USA 44060.
6. Director, Podiatric Surgical Residency, Trinity Regional Medical Center, Trimark Physicians Group, Fort Dodge IA 50501
7. PGY-3, PGY-2, Foot and Ankle Residency Program, St. Vincent Charity Medical Center: 2351 E. 22nd St., Cleveland, OH 44115.
ISSN 1941-6806 doi: 10.3827/faoj.2014.0702.0006

High complication rates related to open reduction and internal fixation in co-morbid patients have been well documented. Blotter et al in 1990 did a retrospective review of 21 patients who had diabetes and 46 randomly selected patients who did not have diabetes. The complication rate of patients with diabetes was 43% undergoing ORIF ankle fracture versus 16% complication rate without diabetes. Complications were more severe in diabetic population, including below knee amputation [1]. Also, McCormack and Leith's 1998 review of 26 diabetic patients with displaced malleolar fractures and a cohort group, overall complication rate of 42% in the diabetic patients compared with no complications in the cohort group treated non-invasively. Six of the 19 patients treated surgically developed a deep infection, and 2 patients eventually required an amputation at an unspecified level [2]. Wukich and Kline in 2008 did a current concept review for the management of ankle fractures in patients with diabetes and they showed that there is currently insufficient literature (grade-I recommendation) to support the use of supplemental fixation including multiple syndesmotic screws, transarticular fixation and external fixation [3].

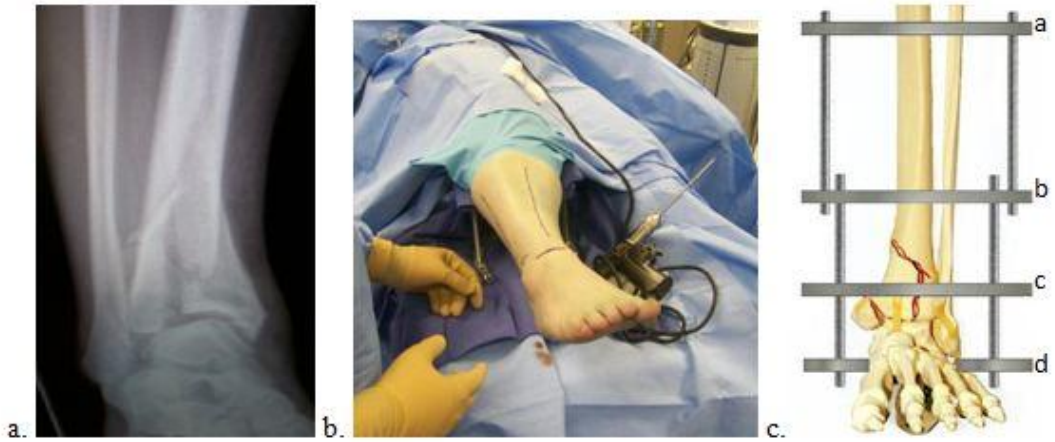

Figure 1 a. Pre-op AP radiographs (OTA 43-C2.2), b. Proper positioning of the patient with anatomical landmarks marked with skin marker. c. Distal third ring (c: floating ring) at the level of the fracture (a: proximal tibial ring, b: distal tibial ring, c: floating ring, d: foot support).

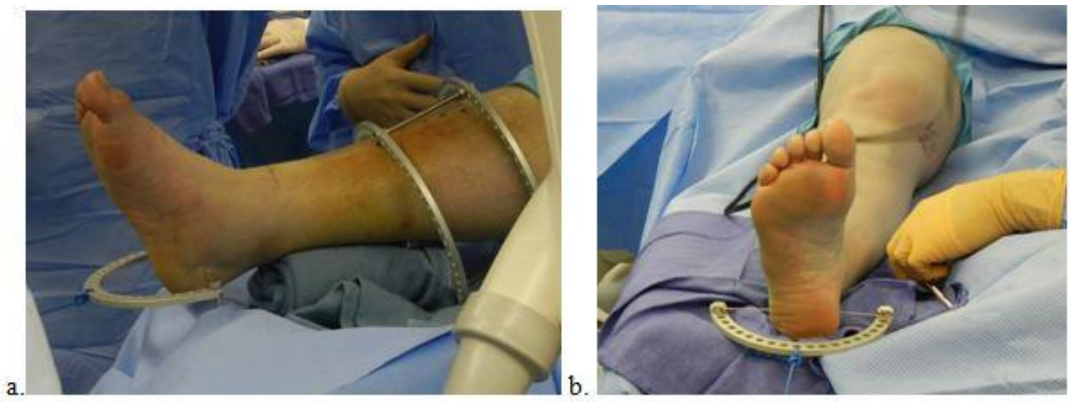

Figure 2 a, b Placement of smooth wire with 20-25lbs hung to allow the fracture to distract.

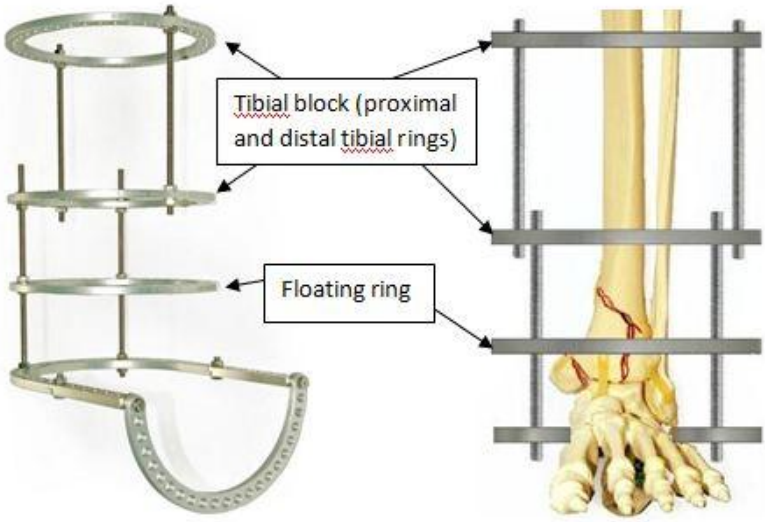

Figure 3 Completion of the External Fixation device (tibial block, floating ring, and foot plate).

One could make the argument that any incisions made on these already fragile soft tissue envelopes puts the patient at greater risk from the start of the surgery. This technique presents a no incisional approach and only if absolutely necessary the placement of percutaneous k-wires for additional support. The advantage of external fixation affords the patient earlier weight bearing which decreases the complications associated with the patient being bed bound and non-weight bearing.

SURGICAL TECHNIQUE

Patient preparation: Three standard x-ray views, which include the tibia and foot, should be available for planning prior to the procedure. CT scans with 3D reconstructions are very helpful to orient the surgical team to the positions of the fracture fragments. The patient is prepared for general or spinal anesthesia. Generally a tourniquet is not needed during the procedure.

Patient positioning: The patient is placed on the operating table in the supine position with the affected extremity elevated above the contralateral limb using radiolucent materials (blankets will suffice) and the foot hanging about 2 – 3 inches over edge of table (Figure 1). The extremity is then scrubbed and draped up to the level of the knee. Using fluoroscopy the fracture, the ankle, and the tibia are mapped for proper frame placement and for planning of ring size and rod lengths. The bottom ring of the tibial block should be placed just above the most proximal extent of the fracture.

Axial traction: Axial traction is an important component of this treatment method. Sustained gentle axial traction provides relaxation of contracted soft tissues and aids in reduction through ligamentotaxis. A smooth pin is driven lateral to medial through tuber of calcaneus parallel to that of the foot (Figure 2a,b). The pin should enter inferior to the peroneal tendons and exit inferior to the tarsal tunnel in a safe zone and a weight consisting of approximately 20-25lbs is then hung from the smooth wire to aid in reducing the fracture.

Frame construction: While the ankle is being distracted by the traction construct, the static circular external fixator should be built. The fixator will consist of a long double ring proximal tibial block, a floating ring at the level of the ankle joint (All nuts securing the floating ring to the threaded rods are loosened so the ring can be pushed up or down), and a foot plate (Figure 3). The frame is then checked in the frontal and sagittal planes (Figure 4).

Figure 4 Proper position and alignment of the frame on the leg in both the sagittal and frontal planes.

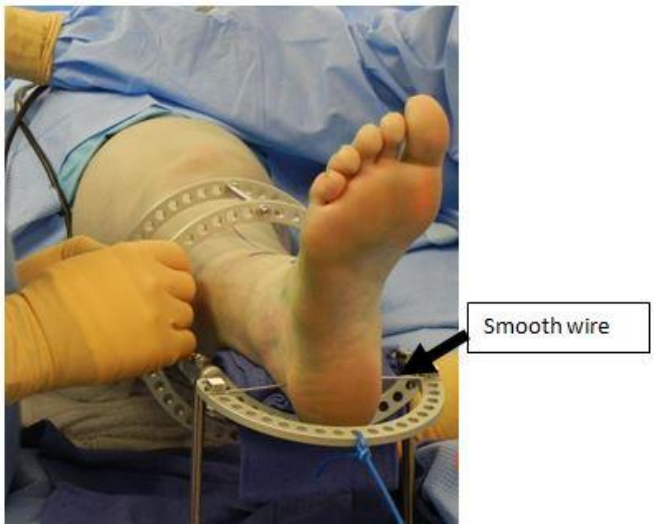

Figure 5 Placement of tibial block during axial traction by means of a smooth wire.

Figure 6 Reduction of fracture fragments via axial traction and ligamentotaxis and stabilized with temporary k-wire fixation.

Recommended wire placement technique: At least two wires per ring with wire angle between 30 and 60 degrees to augment anterior-posterior stability. One wire should be above the ring and one wire below and the wires twin tensioned. This step is then repeated at 60 degree angles from the first wires on each respective ring. The tibial block wires should be tightened and tensioned at this time. Wires exiting posteriorly should be tightened with the supplied wrench and anterior wires should be finger tightened and dual tension to 130kg.

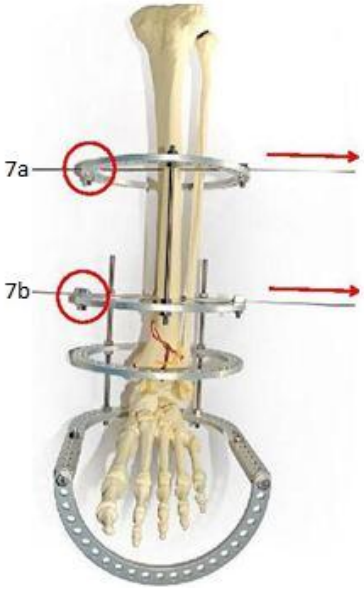

Figure 7 a: A smooth wire is inserted from lateral to medial on the proximal tibial ring. b: The next wire is then inserted in the same fashion, parallel to the first wire on the distal tibial ring.

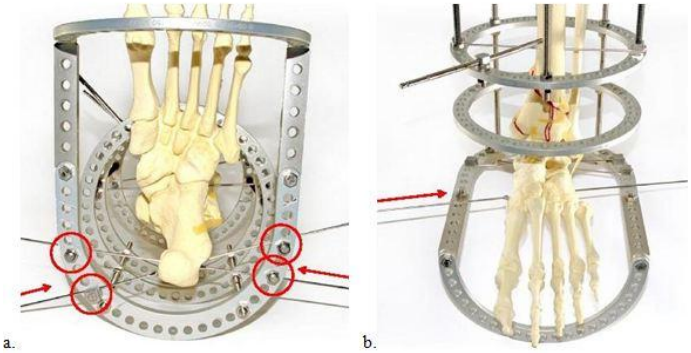

Figure 8 a: Placement of calcaneal smooth wires, b: Placement of midfoot olive wires.

The calcaneal wires will be dual tensioned to 90kg and then the forefoot wires will be dual tensioned to 90kg if smooth wires are used. If an olive wire across the midfoot is used, tension the opposite end of the wire (lateral) to 110kg. The foot plate is then connected to the tibial ring, bypassing the floating ring and is connected with two threaded rods (Figure 9).

Note that no wires will be attached to the floating ring at the ankle joint at this time.

Next, two smooth wires will then be placed through the posterior tuber of the calcaneus from medial to lateral at approximately 60 degrees from one another (Figure 8a). It is important not to compromise the tarsal tunnel or the peroneal tendons with these wires. Two smooth wires will then be placed across the forefoot, one from medial to lateral and the other from lateral to medial trying to grab the 1st and 5th rays with these wires. This can also be accomplished using an olive wire from medial to lateral with the olive being placed medial or across the midfoot (Figure 8b).

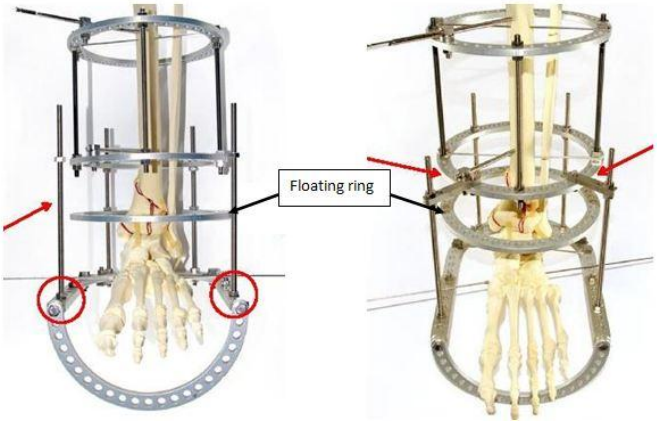

Figure 9 Attachment of the foot plate to the tibial ring. Note that the floating ring is bypassed.

Once the static circular external fixator is securely applied the weights and smooth wire can be removed from the calcaneus. The ankle is then distracted and the fracture reduction is held in place via ligamentotaxis. To maintain distraction, the nuts are tightened to secure tibial block to the foot plate (Figure 10).

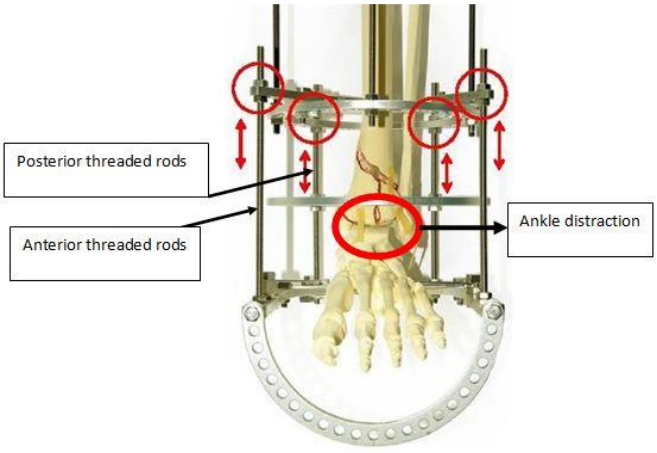

Figure 10 Distraction of the ankle joint is held into position by tightening of the anterior and posterior threaded rods.

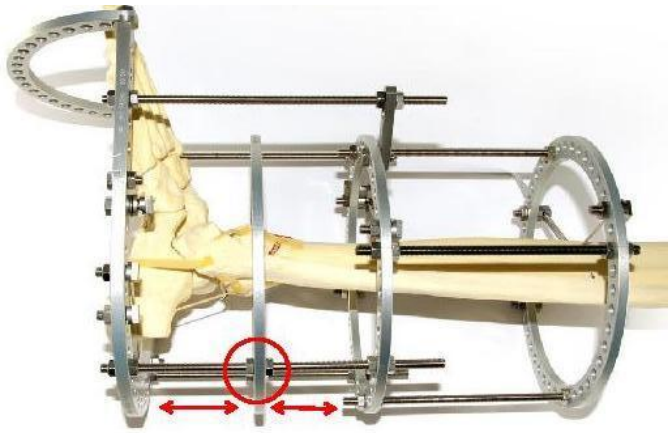

Figure 11 Adjustment of the floating ring. Position approximately 10mm above the ankle joint.

Next the medial tibial pilon reduction wire is inserted. Drive an olive wire from medial to lateral on the floating ring (the olive on the medial side of the tibia) approximately 1-2 cm superior to the ankle joint. Connection posts will be needed for the lateral side. This will allow stabilization of the largest tibial pilon fragment (Figure 12a). Tension the opposite end of the wire to 110kg.

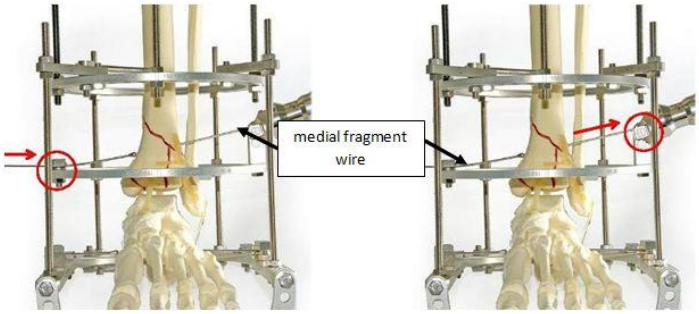

Figure 12 a Reduction of medial tibial pilon fragment with olive wire placement.

Next the medial malleolar fragment is reduced. An olive wire is driven from distal medial at the tip of the medial malleolus to proximal lateral through the tibia. The wire is cut flush at the olive/wire interface and buried under the skin as to reduce the fragment (Figure 12b). This wire is then attached to the distal tibia ring (normally requiring post to reach the wire) and tensioned from the lateral side to 90kg.

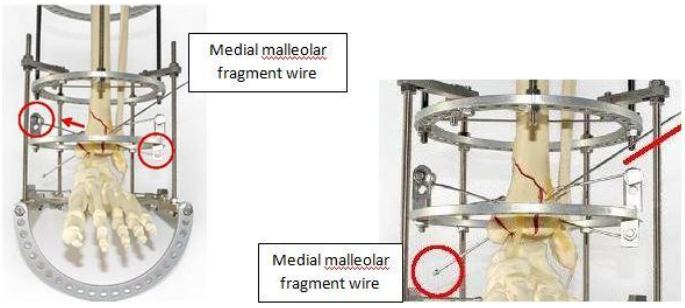

Figure 12b Reduction olive wire for medial malleolar fracture fragment.

Next the lateral tibial pilon fragment is reduced. An olive wire is driven from distal lateral to proximal medial through the fibula and tibia (again the olive remains on the lateral side) approximately 1-2 cm superior to the ankle joint. The distal end of the wire is then connected to the floating ring and tensioned to 110kg (Figure 12c).

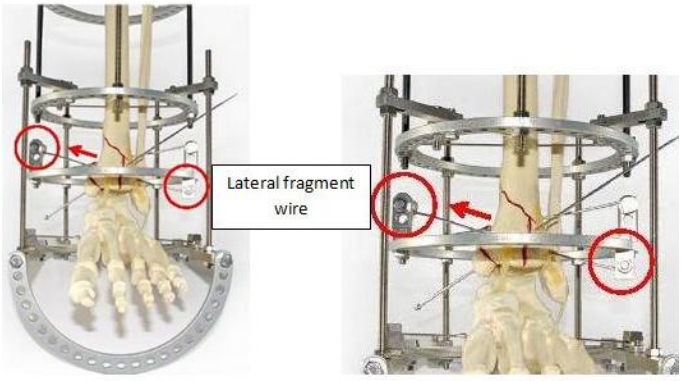

Figure 12c Reduction of the lateral tibial fragment.

The final reduction is then checked under fluoroscopy. The ankle joint distraction is then released, by loosening the proximal nuts on the anterior connection rods and the distal nuts on the two posterior threaded rods (Figure 13).

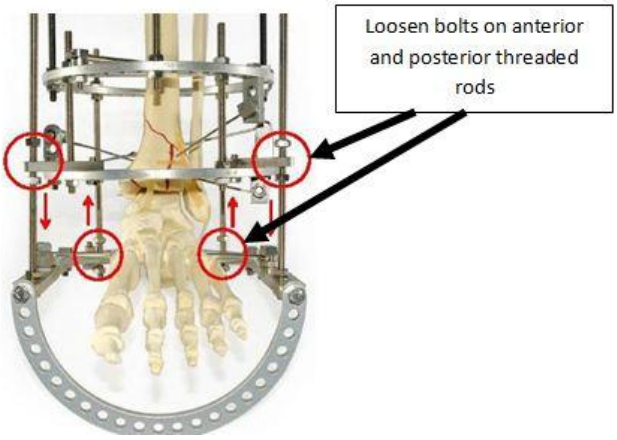

Figure 13 Decreasing the ankle joint distraction.

The distal floating ring is then attached to the double-ring block with two anterior 115mm threaded rods. The foot support can then be re-inverted to allow immediate weight bearing post operatively. We choose to use smooth wires instead of threaded half pins on the tibial block (Figure 14).

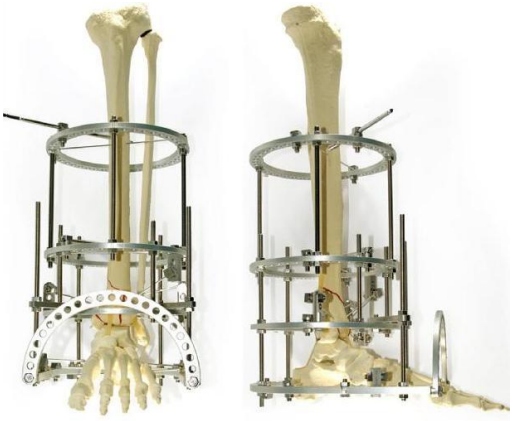

Figure 14 Final frame construct. Half pins in the tibial block are substituted for smooth wires as indicated in the initial steps.

The leg/foot and fixator are then cleansed with hydrogen peroxide. If need be, negative pressure wound therapy can be applied or any other wound products as you deem appropriate. If there no open wounds in the skin then all wires are dressed with gauze sponges soaked in 70% isopropyl alcohol. Kerlix fluffs are packed around the fixator. The fixator is then wrapped in three 6-inch ace wraps.

Adjunct procedure: To help aid in post-op analgesia a popliteal block can be performed either before

induction of general anesthesia or immediately post-op while the patient is still on the operating table.

Tips and Pearls: It is imperative to release the ankle joint distraction at the end of the case as to not cause tibial nerve neuropraxia. Avoid the use of half pins in metaphyseal or cancellous bone.

To prevent burning of the skin, the wires should always be moist before entry into the skin (wet gauze with isopropyl alcohol can be used for this) and the drill should be pulsed during insertion of the wire.

POST-OP PROTOCOL

Weight-Bearing Status:

- Patients are normally allowed to WB 20-30% on the limb with the external fixation device. This is actually encouraged as this promotes callus formation and bone healing.
- Patients are normally discharged with either crutches or a walker for assistance with ambulation. Walkers are preferred.
- Patient needs to be seen by physical therapy prior or discharge for gait training and use of assistances devices. Patients should not be discharged prior to completing all physical therapy requirements.

Dressing:

- Original dressing not to be changed for 12-14 days
- Ex-Fix to be sprayed with alcohol, pins cleaned, and sterile 4x4's placed around each wire at initial bandage change by resident/doctor.
- After initial bandage change then patient can start daily cleaning of frame themselves. This will consist of spraying frame/wires daily with alcohol. Patients are instructed to not touch wires or remove scabs/crust. 4x4's no longer need to be placed around wires unless the patient is diabetic, the wire has discharge, or if an animal is present in home.
- Once all wires are dry and stable the patient can start cleaning frame at about every 3 days.
- Once all wires are dry and stable the patient is allowed to shower/bath, whirlpool, swimming pool with spray application of alcohol immediately after.
- Frame needs to be covered at all times (except when in water) with ACE wraps or cloth bag that can be tied at the top.
- Roll of Kerlix to be placed between frame and leg in areas of swelling or when the frame is nearing the skin.
- Foot pad can be made with blue towels or ABD pads and incorporated into dressing for WB assistance
- Entire frame to be wrapped in ACE Bandage (Normally takes three rolls of 6 inch ACE)

Warning Signs:

- If the patient is concerned about pin tract infection (redness, swelling, pain, discharge) give them a prescription for oral antibiotics and see them in the office within 24 hours. Also, it is okay to give a patient a prescription for an antibiotic ahead of time and tell them to begin taking the medication if the above signs/symptoms occur and to contact office within 24 hours to make appointment.
- Superficial erythema and drainage around a wire is normally due to a loose or unstable wire (not due to infection) this can be resolved by tightening the wire with the "Russian Technique". This technique involves applying a wrench to the top part of the bolt (the one in which the wire is passing through) and applying a wrench to the nut below this bolt. Next, tighten the bottom nut. While holding the bottom wrench in place, tighten the top bolt between a quarter and half a turn, depending on how lose the wire is.
- Painful wires are normally a sign of loose unstable wire or because of high tension on the skin. This can be resolved by tightening the wire and by releasing the skin around the wire with a # 11 blade. This is performed quickly and normally does not require anesthesia
- Granulomas are common around wires and after the ex-fix are removed. These can be resolved with a silver nitrate stick.
- Superficial infections are normally cared for with oral antibiotics; however, deep or un-resolving infections should be admitted for IV antibiotics to prevent osteomyelitis.

Antibiotics:

- Augmentin 875 mg 1 tab PO BID x 14 days (broad spectrum, commonly used)
- Cipro 500 mg 1 tab PO BID/Clindamycin 300 mg 1 tab PO QID Combo (for PNC allergy)
- Zyvox 600 mg 1 tab PO q12h

Post-Op Pain:

- Outpatients and patients at discharge should be placed on Tylenol # 3 1-2 tabs PO q4-6h
- While in the hospital it is okay to use whatever is needed for post-op pain relief however upon discharge they should be switched to Tylenol # 3. Normally post-ops that get admitted will be placed on PCA per anesthesia with either Norco 10/325 or Vicodin ES. Titrated off PCA then titrated down to Tylenol #3 then discharged. Post-ops are normally discharged on post-op day # 2.
- Never use Toradol, this inhibits bone healing. Ask the anesthesiologist to not use Toradol at the end of cases, if orthopedic work was performed.

Removal of Ex-Fix:

- Removal of circular external fixator is determined by a CT scan to confirm fusion or bone regeneration.

Cleaning Solution:

- Daily/Home/Clinic cleaning – 70% Isopropyl alcohol.
- O.R. Scrub Spray – Mixture of the following:
    - 50% Hibiclens 4% (Chlorhexidine)
    - 45% Isopropyl Alcohol 70%
    - 5% Hydrogen Peroxide

CASE PRESENTATION

This is a case of a 55-year-old female with a past medical history of non-insulin diabetes, peripheral arterial disease and asthma presented one hour after being involved in an MVA. Radiographs were obtained of the left ankle (Figure 15). There was an intra-articular fracture of the tibial plafond with impaction of the articular cartilage as well as comminution of the tibial dia-metaphyseal region (OTA classification 43-C1).

Treatment Stage 1: Patient underwent closed reduction with application of posterior splint (Figure 15).

Figure 15 Closed, displaced, intra-articular tibial plafond fracture left ankle.

Physical examination revealed isolated trauma to the left lower extremity. Brisk CFT to digits, with significant edema and ecchymosis to left ankle. No open fracture visualized, no tenting of the skin.

Treatment Stage 2: Patient underwent the previous discussed surgical technique with application of external fixator (Figures 16, 17).

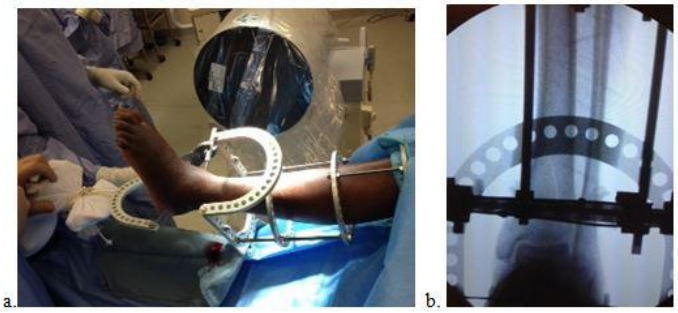

Figure 16 a. Application of smooth wire and half ring about the calcaneus. b. Intra-op fluroscopy pictures of the reduction via ligamentotaxis, revealing anatomic alignment of the tibial plafond.

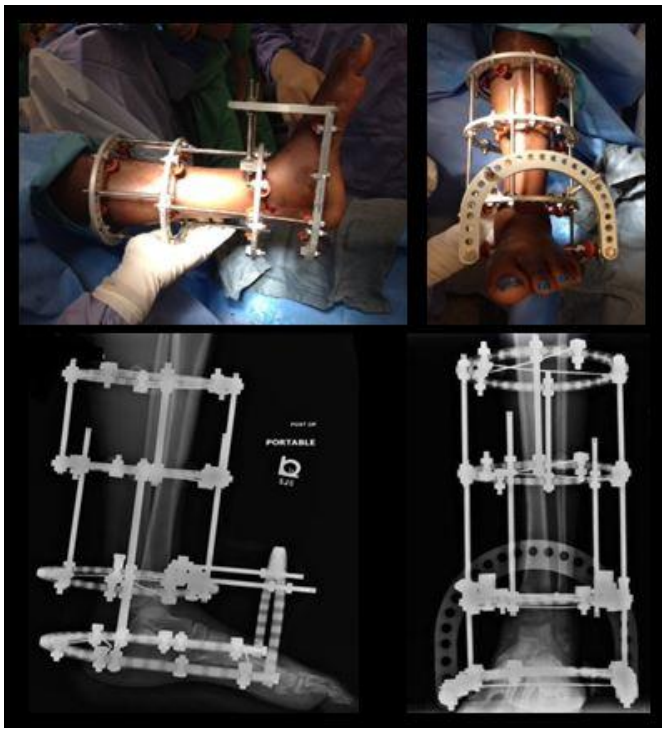

Figure 17 Final frame construct.

The external fixator was kept in place for 12 weeks. There were no severe complications during the post-op course, only a minor pin site redness which resolved with localized wound care. Patient was non-weight bearing for 8 weeks following fixator removal and has been in an AFO since that time. Final weight bearing films were taken at 10 months post-operatively (Figure 18).

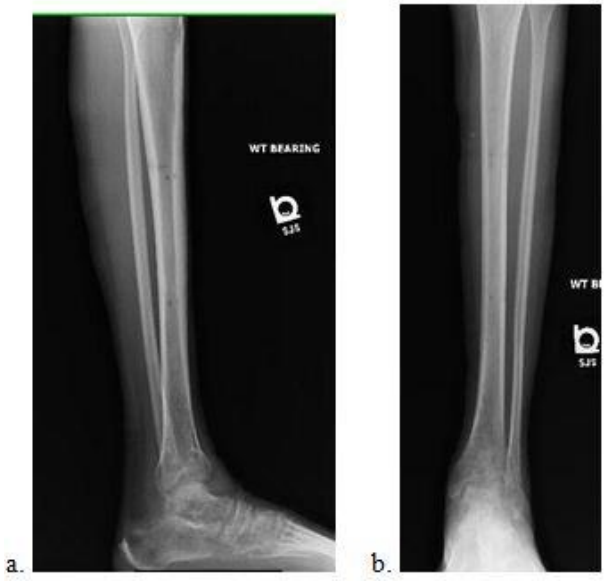

Figure 18 Final lateral (a) and AP (b), weight bearing radiographs at 10 months post-operatively.

Results

Traditional approaches to fixation for pilon and distal tibial involve large ancillary incisions putting the already fragile soft tissue envelope at even more risk of complications. According the senior author (ER), the following data has been compiled retrospectively for both pilon fractures as well as distal tibial fractures using this surgical technique. In the pilon fracture series (n= 37, mean age 57, m= 17; f= 40), mean follow-up was 42 months and an average AOFAS score of 85.04. Combined complication rate was 13% (infection, metal breakage, wound dehiscence) and two patients requiring below the knee amputations. In the Distal tibial fracture series (n= 22, mean age 62, m= 22;f= 40), with mean follow-up of 28 months and an average AOFAS score of 92.13. Combined complication rate of 23% (Infection, metal breakage, wound dehiscence) and three patients requiring below the knee amputation.

Discussion

The use of circular external fixation alone in a single staged procedure might help to decrease the risk of morbidity and even mortality for these patients as shown in the data presented by the senior author. Single stage approach using external fixation allows the patient to have more mobility by allowing partial weight bearing starting on post-operative day one. As with any surgical technique, the individual patient must be fully evaluated and this technique is not proposing that it be used on every pilon fracture.

References

1. Blotter RH, Connolly E, Wasan A et-al. Acute complications in the operative treatment of isolated ankle fractures in patients with diabetes mellitus. Foot Ankle Int. 1999;20 (11): 687-94. - Pubmed
2. McCormack RG, Leith JM. Ankle fractures in diabetics. Complications of surgical management. J Bone Joint Surg Br. 1998;80 (4): 689-92. - Pubmed
3. Wukich DK, Kline AJ. The management of ankle fractures in patients with diabetes. J Bone Joint Surg Am. 2008;90 (7): 1570-8. - Pubmed

Disclaimers

Drs. Rodriguez, Cherkashin, and Samchukov are consultants for Orthofix.