

## REVIEW

# Practical Management of the Orthofix Truelok External Circular Fixator in Deformity Correction and Lower Limb Salvage

Edgardo Rodriguez-Collazo\*, Matthew Cummins†, Bruce Bever‡, and Mikhael Samchukov§

Circular external fixation offers an important option for reconstructive surgeons. When the soft tissue envelope is compromised, either by disease or trauma, external fixation offers a chance to address limb abnormalities that may otherwise be delayed. The application of the Ilizarov apparatus requires skills and experience to address unique scenarios, starting prior to surgery and extending months following application. This article will offer practical management concepts based on the authors' experience using the Orthofix Truelok system. It is our hope that the information provided will lend to improved management strategies and outcomes for the practitioner and patient.

**Keywords:** Orthofix; Truelok; External fixator; external fixation; frame; Ilizarov; circular fixator; circular fixation

## Introduction

The application of circular external fixation has been an effective treatment method in orthopedic trauma, limb preservation, complex deformity correction and limb reconstruction of the lower limb [1–3]. The choice to use circular fixation must be considered carefully, based on the level of skill and experience of the surgeon. Even then, unforeseen complications are to be expected. Compliance from the patient and an open line of communication are vital to increase the probability of a successful outcome. It is our goal in this article to aid the surgeon in treating and preventing many of the clinical complexities that arise by offering practical advice. Common questions and concerns throughout the preoperative period, patient/physician expectations, frame management and post-operative protocols will be discussed.

## Patient Communication

Effective communication regarding challenges that may be encountered is paramount. Any discussion should include:

- 1) Discussion of outcomes and possible complications.
- 2) Pain management options.
- 3) A realistic timeline of frame wear.

Orthopedic fractures	12–16 weeks
Orthopedic fracture with compromised host (DM, PVD)	20–24 weeks
Charcot Reconstruction	24 weeks minimum
Smoker or Tobacco use	double the time in fixator

- 4) Psychological considerations
- 5) Photos or models of representative external fixators, setting patient expectations prior to emerging from the OR.

## Frame Size Selection

The circular external fixator is constructed with no less than 2.0 cm of distance between the skin and the inside diameter of the ring, ensuring adequate stability of the bone segments. If additional clearance to the skin edges is needed, coning or funneling of the fixator rings is needed without compromising bone stability.

## Ring and Pin Placement

While there are myriad application techniques and constructs possible, several pearls warrant mention regardless of the apparatus chosen.

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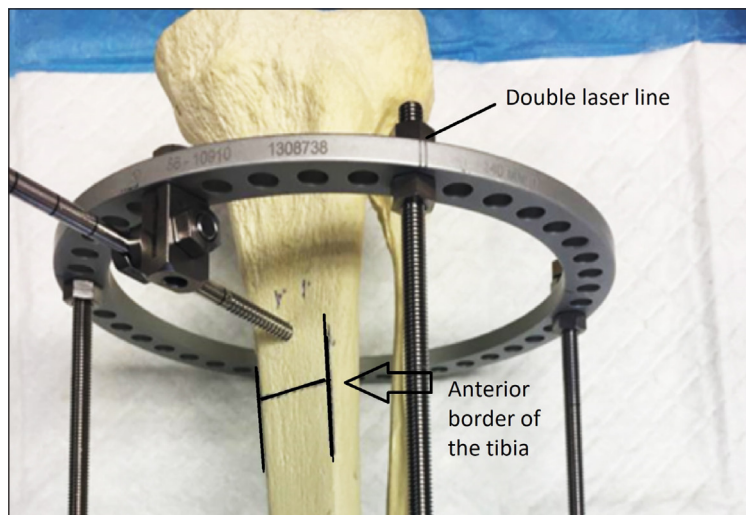
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*Note: Proper soft tissue management throughout the procedure is a primary concern. Soft tissues should be released and retracted during insertion of transosseous wires and half pins, preventing soft tissue irritation [2, 6].*

- 1) **Proximal ring:** The double laser line on the proximal ring should be aligned parallel with the tibial crest, 4 cm distal to the tibial tuberosity (**Figure 1**).
- 2) **Proximal half-pin:** Placed 10–15° oblique to the medial surface of the tibia, in the direction of the diaphysis of the bone (**Figure 1**).
- 3) **Transosseous wires:** Mounted above and below the same ring at a 60° angle, relative to the opposing wire or half pin, laterally (**Figure 2**) [4].
- 4) **Simultaneous wire tensioning:** Allows uniform tension across the length of the wire and ring, preventing instability (**Figure 3**) [5].
- 5) **Leg fully extended, ankle dorsiflexed to 90°:** Limb positioning minimizes post-operative stress on soft tissues caused by transosseous wire and half pin placement.
- 6) **Avoid thermal trauma to the tissues:** Wires and pins are placed in cold sterile water prior to use



**Figure 1:** Position of the half pin on the anterior surface of the tibia. Note: the double laser line of the proximal ring is parallel to the tibial crest. Laser lines are helpful to align the axogonal rings to the tibial anterior axis.



**Figure 2:** Half pin on the medial anterior aspect of the tibia, with a transosseous wire 60 degrees relative to opposing wire or half-pin. Note: half-pins are always inserted medially and transosseous wires laterally.

(**Figure 4**). K-wires are pulsed, rather than drilled on the “constant” setting while grasping the wire with a wet sponge (**Figure 5**) [6].

- 7) **Dressing:** Transosseous wires and half-pins are dressed in the OR with 4 × 4 gauze, cut in the center, and saturated in isopropyl alcohol. the entire construct is dressed with Kerlix and an ACE bandage, with a modified surgical shoe secured to the bottom of the fixator by bandage or Zip tie.



**Figure 3:** Simultaneous manual tensioning of transosseous wires.



**Figure 4:** Transosseous wires are placed in cold sterile saline prior to implantation.

## Postoperative Period

### *Pain management*

Patients are discharged on a multimodal pain management protocol [7–9].

**Tramadol 50 mg, TID**

**Gabapentin 100 mg, TID**

**Acetaminophen 500 mg, TID**

The combination of Tramadol, Acetaminophen, and Gabapentin work synergistically together to reduce/eliminate the need for schedule 2 opiates post-operatively. Patients gradually reduce the dosages over the course of 2–4 weeks.

### *Weight Bearing*

The ability to bear weight immediately offers a practical advantage over other modalities [10]. Patients are advised 20% weight-bearing, best explained as gentle touchdown, stabilizing the limb while ambulating with a walker or crutches. Once initial incisions have healed, our protocol increases weight bearing on the limb as tolerated.

It is important to remember that consistent weight bearing increases the forces around the wire, ring and limb. Therefore, the practitioner must ensure the tightness and the tension of the wires to construct at every clinical visit.

### *Pin Care*

Pin site complications range from 0% to 100% [2, 11, 12], with the majority of complications noted as “infection”. This broad range is problematic, due in part to the lack of a universal classification and optimal pin care protocols [2, 6, 11–14].

Our classification is based on the algorithm devised by Checketts (2000) [15] and modified with subtle procedural guidelines:



**Figure 5:** Wet sponge (Raytec gauze) allows wire to be held securely during insertion, minimizing thermal bone necrosis.

**Grade 1: Pin Tract Irritation**

- a) *If wire is loose, re-tension*
- b) *Soft tissue involvement receives local treatment and/or soft tissue release*

**Grade 2: Pin tract irritation with drainage**

- a) *Grade 1 interventions*
- b) *Oral antibiotics*

**Grade 3: Erythema > 2 cm radius from pin with drainage and low grade constitutional symptoms**

- a) *Grade 1 interventions*
- b) *IV antibiotics*

**Grade 4: Erythema > 2 cm radius, with drainage and radiographic evidence of localized osteolysis**

- a) *Pin removal*

**Grade 5: radiographic osteolysis with soft tissue infection**

- a) *Pin removal with surgical debridement*

**Grade 6: Suspected osteomyelitis**

- a) *Radiologic and imaging confirmation with possible bone resection*

Overall, pin-tract irritation is expected and should not initially be considered a complication [6, 10, 13]. Infection is emergent when erythema, edema and induration exceed 2.0 cm around the perimeter of a given pin site. In these instances, patients begin a 3-to-4-day course of oral antibiotics and should undergo fluoroscopy. If lucency is noted around the osseous portion of the wire or pin, the wire is removed and a bone resection in the operating theatre is scheduled. If osseous structures are normal, the local pin site is adequately treated and the surgeon re-tensions the loose wire.

**Dressing Changes**

We assess the cleanliness and condition of the pin sites using the "peek technique", visualizing pin sites directly only if the patient reports pain or drainage. Crusts or eschar around pins are not removed [16, 17]. In our experience, frequent and overzealous dressing changes can lead to skin irritation. First dressing changes occur at 10–12 days. In the case of flap reconstruction, dressing changes are done in 5–7 days. Transosseous wires and half pins are dressed with 4 gauze, cut in the center, saturated with isopropyl alcohol.

**Soft Tissue release:** Problems can be minimized by avoiding tension on soft tissues during initial wire or half-pin placement. Proximal tibial wires should be assessed with the knee flexed and extended. Distal tibial and foot wires are assessed with the ankle flexed and extended. If impingement is noted between the skin and wire, the skin is released under local anesthesia. A soft tissue release consists of 1 cm incision through the skin and dermis superior, inferior, lateral and medial to the pin depending on the pull of the tissue. *Remember: Proximal wires should always be inserted with the knee fully extended.*

**Loose Fixation:** Progressive mechanical deterioration of the bone-pin interface can lead to instability and infection [18]. As pins move within the soft tissue envelope, they

compromise a biologically sealed insertion point, allowing microbes a portal to irritate and infect progressively deeper tissues. Wires that are found to be loose are tightened manually in a clinical setting.

**Manual Wire Tensioning:** Two 10 mm wrenches are used for manual wire tensioning. First, the corresponding nut is gently loosened. Using both wrenches, force is applied on both the nut and tension bolt, wrapping the wire in the direction that will apply tension. If clinical suspicion of a loose transosseous wire is noted, patients will stand and, if pain is noted at the wire, manual wire tensioning is performed. The patient is then asked to stand again. In these instances, pain reduction is a good clinical marker of a properly tensioned wire.

**Edema** is expected and should be managed actively. The mismanagement of post-operative edema can lead to dehiscence, lagging wound control, and infection [19]. The Primary author recommends 10 minutes of ambulation per hour with subsequent limb elevation, usually with 3–4 pillows underneath the extremity.

**Neuritic pain** can be the result of improperly placed wires that have directly penetrated, transected or implanted in close proximity to native nerve tissue [20]. Any insult may show symptoms of intractable pain, palsy or numbness [21]. Early recognition is critical. If intractable neuritic pain is noted, the transosseous wire should be removed immediately.

**Psychological Impact:** The course of treatment utilizing circular external fixator is arduous and patients are often not prepared for the several months wearing an unwieldy construct [22]. In some instances, counseling and pharmacotherapy should be discussed and implemented for patients with stress-related anxiety/depression associated with long term external fixator use.

**Discussion**

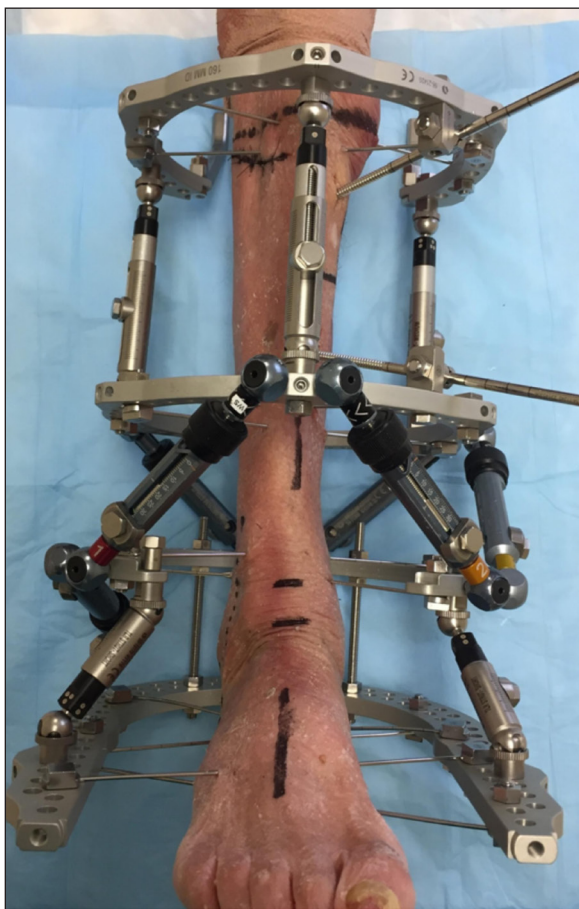
The day a patient is freed from the construct after a successful outcome marks a milestone. It is not the end of the patient's care, however, and challenges still remain. It is important that patients remain faithful to their clinical appointments so progress may be monitored and, if necessary, the clinical course altered.

Our patients are discharged only after physical benchmarks are completed. Information on longterm goals is provided and, if warranted, follow up appointments are scheduled for 6 months and 1 year after initial discharge.

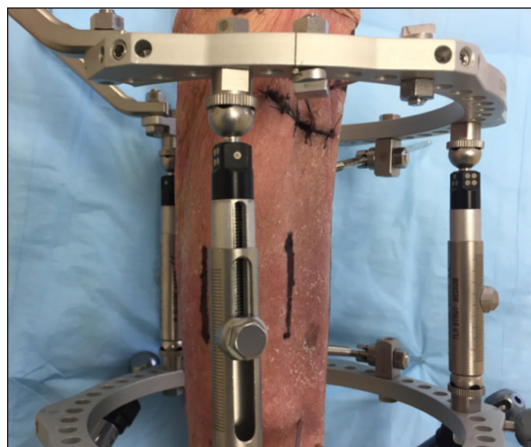
**Conclusion**

Although the purpose of this article is to share our current management applications, we continue to develop new protocols as our experience grows and new literature emerges. As a result, we have found the Orthofix Truelok circular ring fixation system to be an effective tool for deformity correction and limb salvage in the complex patient population.

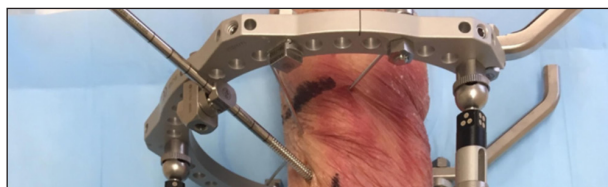
### Anatomical Landmarks Demonstrated on Orthofix TrueLok Hexapod Ring Fixation



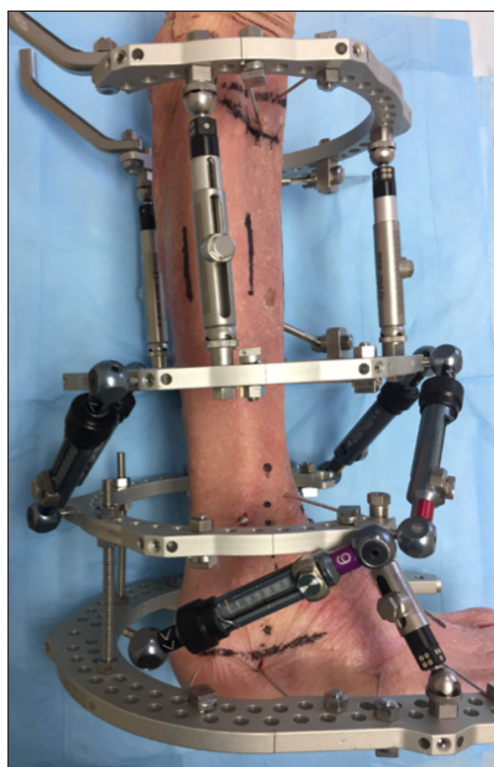
Center of ring is oriented parallel with tibial crest.



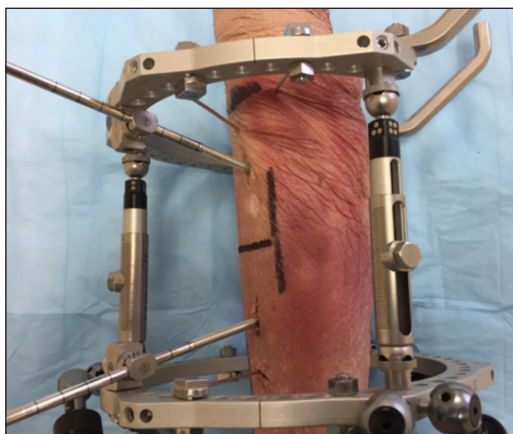
Anterior and posterior tibial borders noted in black skin marker.



Two wires in proximal ring and "drop" half pin [23] in 10–15° of angulation.



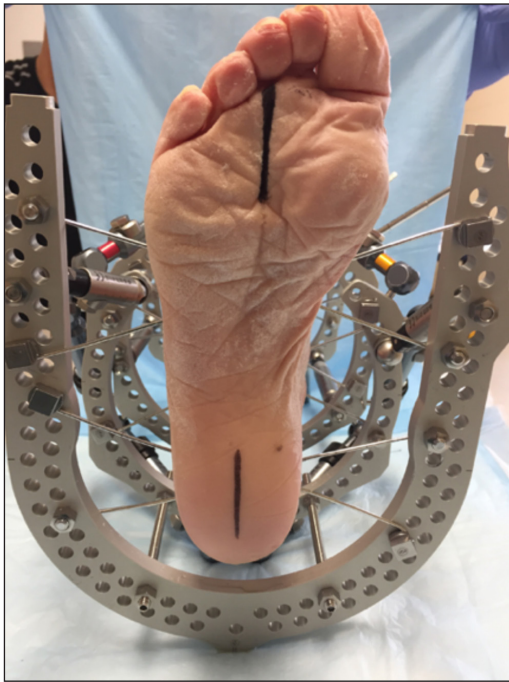
The addition of a foot plate and posterior support on the proximal ring.



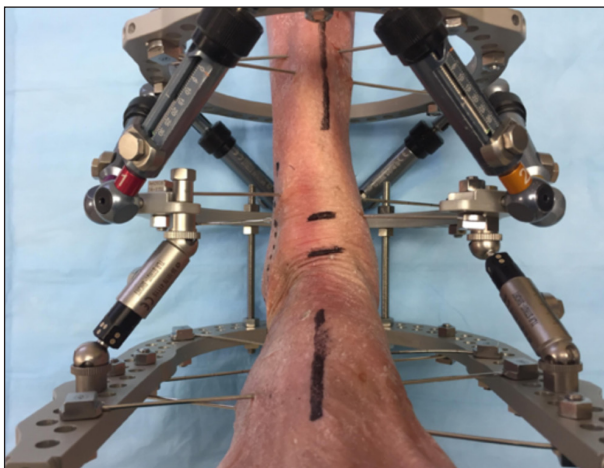
Half-pin and transosseous wires oriented at 60° to each other.



Anterior and distal fibula marked. Calcaneal wires inserted at 60° relative to each other.



Midfoot and calcaneal transosseous wires oriented at 60°. Center of foot plate aligned with center of calcaneus and 2<sup>nd</sup> interspace.



Tibial crest is aligned with second interspace.

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Mikhail Samchekov: Royalties, Orthofix.

#### Author Contributions

- Edgardo Rodriguez-Collazo
- Bruce Bever
- Matthew Cummins
- Mikhail Samchukov

#### Special Contributor

Allesandro Thione, MD.

#### Guarantor

Edgardo Rodriguez-Collazo.

#### Peer Review

This is a non-commissioned paper that has undergone external peer review according to journal policy.

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