

EXTERNAL FIXATION FOR DUMMIES: Practical Uses in Foot Surgery.

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In recent years, external fixation techniques have become more prevalent in the podiatric surgeon's practice. External fixation is not a new method, but traditionally it has not been a commonly utilized technique by the podiatrist. External fixation has some benefits over internal fixation. For instance, one can attain more compression and stability for arthrodesis procedures. In some instances, patients can ambulate immediately following fracture repair. Another advantage is that the surgeon can adjust the fixation during the postoperative period. And finally, in some cases, less dissection or no incision may be necessary when treating certain pathologies of the foot.

This manuscript will explore the different applications for using external fixation on the foot. It is not meant to be an all-inclusive primer, but rather an introduction to the common foot disorders that may be amenable to external fixation. These applications are not meant to replace the "traditional" methods that have stood the test of time, but to give the surgeon and the patient other options that should produce similar outcomes.

ARTHRODESIS

Mini-rail fixators (Figure 1) can be used for fusion of joints in the medial column. The first metatarsophalangeal (MTPJ) joint, first metatarsocuneiform joint (MCJ), naviculocuneiform joint (NCJ), and even the talonavicular

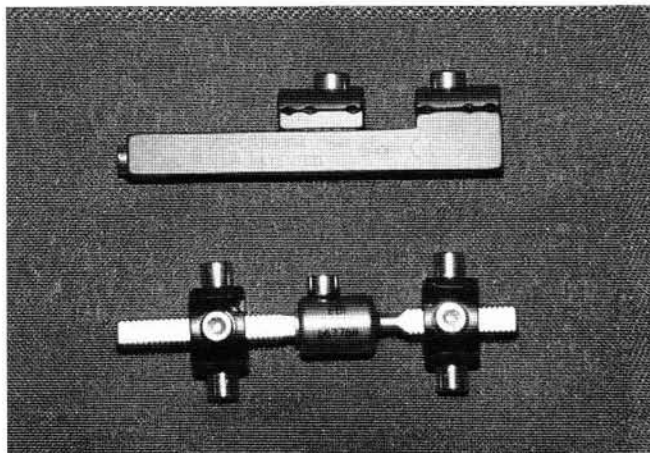


Figure 1. Examples of two types of mini-rail external fixators. On top is Orthofix and on bottom is EBI. Note the EBI device has a hinge.

joint (TNJ). Fusion of other flat or saddle joints such as the Lisfranc's joints and the calcaneocuboid joint (CCJ) are ideal for using external fixation. When using external fixation on the medial column, the device can be applied medially or dorsally. If the device is placed dorsally, then the rail (leaving cortical pins intact) may need to be removed when taking x-rays to visualize bone healing on the dorsoplantar view. The author has no preference as far as device placement, but prefers to insert pins percutaneously away from the incision versus inserting pins through the incision site.

A technique that the author performs using mini-rail external fixation for an arthrodesis involves applying the external fixation prior to the joint dissection. The first step is to use intraoperative fluoroscopy to identify the fusion site and mark the foot with a skin scribe. Two 0.062 Kirschner wires, one proximal and one distal to the fusion site are inserted. Fluoroscopy is used to confirm position and if adequate, cortical half-pins (supplied in your mini-rail fixation tray) are inserted replacing both Kirschner wires. Next, the mini-rail is attached to the two cortical half pins. At this time, the soft tissue dissection is performed. The external fixation device can act as a joint distracter to facilitate cartilage resection. Additionally, while the joint is held open, one can better visualize your joint preparation, add bone graft, and/or fenestrate if needed. After the arthrodesis site is prepared to your satisfaction, then the external fixator is compressed minimally. Finally, the two remaining half pins are inserted by using the collar on the mini-rail as a "jig" so that the pins can be inserted at the appropriate distance and parallel to each existing pin. Final confirmation of pin placement is performed, and then compression is applied. Soft tissues are closed in usual manner. Antibiotic ointment is added to pin-skin interface. Appropriate dressings are then applied.

ARTHRODIASTASIS

Arthrodiastasis is a technique to stretch soft tissues. Disorders of the first MTPJ are commonly associated with contracted soft tissues. For example, hallux limitus can be approached with a soft tissue correction. Certainly if there is a long first metatarsal with functional or structural

elevatus, then arthrodiastasis would be a poor choice for primary reconstruction. However, a relatively short first metatarsal without a dorsal exostosis can be a challenging pathology. A traditional osteotomy approach would shorten the metatarsal, which could lead to other pathologies. The effect of shortening the metatarsal is a functional lengthening of soft tissues. Arthrodiastasis can achieve the lengthening of soft tissues without unnecessary shortening of the bone segment.

Reconstruction of a failed first MTPJ arthroplasty can be difficult. It may be a failed Keller or a failed implant that has been removed. If your reconstruction goal is to perform an arthrodesis, then you will most likely need a bone graft to regain length for optimum stability and function. Generally speaking, there is retraction of the tissues, which clinically appears to be a short and cocked-up toe. One method for reconstruction that the author has performed includes a two-staged procedure. First, an external fixation device is applied to perform arthrodiastasis. After three to four weeks, at the same time, an iliac crest bone graft is harvested while the dissection of the great toe joint is performed. The mini-rail is left intact medially, then the joint surfaces are prepared and the bone graft is inserted. Compression is then applied and the wound is closed in usual fashion.

CALLUS DISTRACTION

One of the more common uses for external fixation is to perform callus distraction. Congenitally short metatarsals and iatrogenic causes are frequently seen in practice. Callus distraction can attain length in a metatarsal with less dissection and fewer bone healing complications than traditional approaches. These traditional methods include bone grafting or elongating osteotomies. One is limited to the amount of length that can be achieved with an elongating osteotomy. Furthermore, time to incorporate a bone graft with non-weight bearing cast immobilization can be lengthy.

More complicated applications include performing an Evans or a Cotton osteotomy without bone graft, but callus distraction.

FRACTURES

Fractures of the metatarsals can often times be addressed percutaneously. Applications of percutaneous Kirschner wire pinning still have its role in fracture repair. The technique of closed reduction can be enhanced with

external fixation. Mini-rail devices that have hinges and can allow for rotational and translational correction. Under intraoperative fluoroscopy, one can stabilize the metatarsal fracture by inserting a pin into the distal portion and then in the proximal portion. The mini-rail is attached to its pins, then distraction can be applied if necessary and manipulation is performed to reduce the deformity, and finally compression applied. The remaining two pins can then be inserted to have two points of fixation proximal and distal to the fracture.

In cases of comminuted fractures, one may choose to use both internal and external fixation. The external fixation device will give you additional strength, maintain length, and resist bending and/or rotational forces. Moreover, if internal fixation is compromised (implant bending, breaking, loss of compression, etc.), then additional stability will be maintained.

Proximal fifth metatarsal fractures can be easily repaired with external fixation, and in fact, is the author's preferred method of treatment. It is uncommon for an avulsion fracture to go on to a painful non-union. In most cases, these fractures can be treated conservatively with a walking removable cast. In a case of a painful non-union (Figures 2, 3) external fixation was applied and went on to successful union in 8 weeks (Figure 4). The patient was weight bearing immediately following surgery. No dissection was necessary, as the device was applied percutaneously (Figure 5).

A more troublesome fifth metatarsal fracture is the Jones fracture. With cast immobilization, these fractures usually heal. It is more common to see a symptomatic non-union with these fractures. The traditional approach to repair a non-union involves stripping the periosteum to "freshen" up the fracture site, then inserting a screw into the medullary canal. With a fresh fracture, less dissection is needed, but a screw is inserted into the medullary canal of the metatarsal with questionable amounts of compression. The author chooses not to open these fractures, but to use external fixation. For fresh Jones fractures, the mini-rail is applied percutaneously and the patient is allowed to ambulate immediately (Figures 6-8). Normally, depending on radiographic union, patients are usually wearing the device for eight weeks. For a non-union, depending on the age of the fracture and if there is any doubt whether the fracture is "hot", a Technetium 99 bone scan may be necessary. If you are dealing with a cold fracture, then external fixation without dissecting out the non-union would most likely fail.



Figure 2. AP radiograph depicting a non-union of a fifth metatarsal avulsion fracture.



Figure 3. Lateral radiograph depicting a non-union of a fifth metatarsal avulsion fracture.



Figure 4. AP radiograph at eight weeks following external fixation. The patient was asymptomatic after the external fixation device was removed.

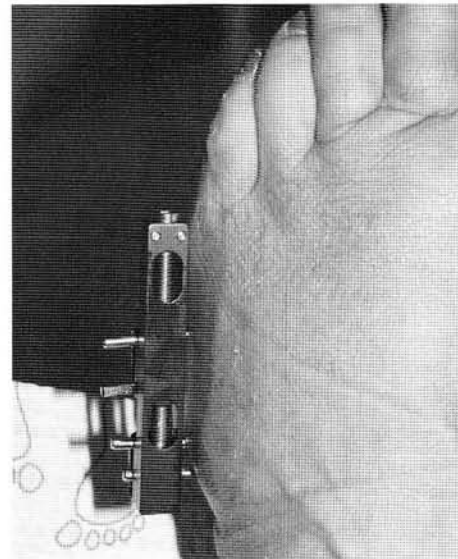


Figure 5. A clinical photograph of an external fixation device applied to a Jones fracture.



Figure 6. AP radiograph of a Jones fracture.



Figure 7. AP radiograph 4 weeks postoperative.

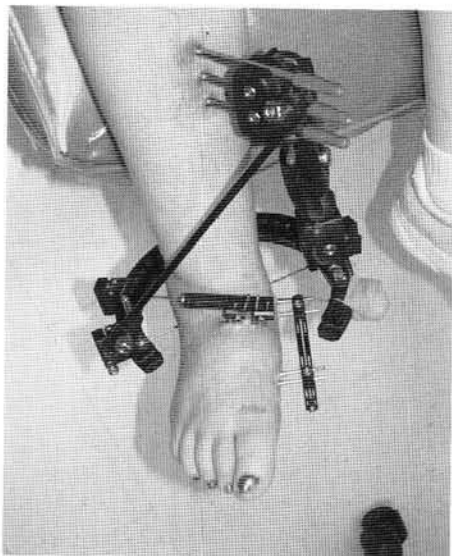


Figure 9. A clinical photograph of a Charcot foot with a hybrid fixation

NON UNION (PSUEDOARTHROSIS) REPAIR

External fixation plays an important role in failed fusions (non-union). In some instances where internal fixation has failed and the position of the fusion is acceptable, then one option is to remove the implant(s) and use external fixation for compression. It is best to apply the external fixator first under fluoroscopy, then remove any implants. Compression is then obtained. Fluoroscopy can then verify alignment, compression, and stability. Certainly, if there is malalignment, significant fibrous



Figure 8. AP radiograph 3 months postoperative showing a healed fracture.

tissue that needs to be debrided, or inactive bone healing, then this technique is of limited benefit. A technesium 99 bone scan may be necessary to ascertain viability in a long-standing non-union.

CHARCOT'S JOINT

Most foot surgeons would like to avoid extensive dissection in a Charcot foot if possible. In some instances when fractures are present without significant deformity of the foot, external fixation can be used to consolidate fractures. More often than not, a posterior release will need to be performed. Mini-rail external fixators can be applied in any fashion to achieve compression. Every case is different, and in these applications, one needs to be creative. In certain circumstances, if there is significant rearfoot breakdown with flattening of the calcaneal pitch and plantarflexion of the talar head, then a more complex reconstruction may need to be performed. Exostectomies, osteotomies, arthrodeses may need to be utilized in cases of profound deformity. Transfixion wires with a hybrid fixator or a ring fixator may be incorporated to help reverse the rearfoot deformity (Figure 9).

TECHNICAL CONSIDERATIONS

When inserting pins for mini-rail fixation, it is important that all four pins are in the same spatial plane and parallel to one another. This is paramount especially when performing callus distraction. Secondly, if there is excessive motion or tension around a pin site, the skin will get irritated and a pin tract infection is likely. Therefore, avoid tension on the skin by making a small incision on both sides of the pin. Pin maintenance is extremely important to reduce pin tract infections. The patient should not get the

foot wet until the skin has sealed around all pins. Cleansing pin sites with liquid soap using a cotton applicator stick and then applying antibiotic ointment is necessary. A short course of oral antibiotic may be necessary from time to time. Upon each postoperative check up, appropriate adjustments are made. Make sure all hardware is tight and increase compression or distraction as necessary. Removal of the device is simple; it is uncommon to need local anesthesia to remove the pins. Therefore, this is done in the office.

Mini-rail fixators come in a solid one-piece bar or a hinged apparatus. Generally speaking, if stability is important, such as an application allowing the patient to be ambulatory, then single piece unit is a better choice. However, if the application is for stabilizing fractures that need to be reduced and the patient will be in a cast, then a hinged device is preferred.

CONCLUSION

External fixation is a technique that offers the foot surgeon a wide range of reconstruction possibilities. Technically, applying external fixation is no more difficult than inserting Kirschner wires. Advantages include less surgical dissection and time in the operating room, ability to adjust fixation postoperatively, attain more compression than internal fixation, less immobilization, and finally it can be used for callus distraction and arthrodiastasis.