# Tibial non-union treated with the TL-Hex: a case report

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## Abstract

Tibial non-unions are difficult to treat, even for the experienced orthopaedic trauma surgeon. Despite being relatively common problems, controversy exists regarding their ideal management. We report a case of a stiff oligotrophic tibial non-union successfully treated with the new TL-Hex (Orthofix, Verona, Italy) circular external fixator. Closed gradual distraction was effective to correct all deformities and stimulate bone formation without the need for a tibial osteotomy or bone graft.

**Key words**: tibia, non-union, oligotrophic, hexapod, TL-Hex

## Background

The tibia in the most commonly injured long bone.[1] Due to its anatomical site and subcutaneous location the tibia is often exposed to high-energy trauma, and it is prone to a number of complications including non-union formation.[1-4] Along with the severity of injury, many other factors have been implicated in non-union development, including systemic compromise of the host and iatrogenic factors relating to the management of the initial injury.[3,5-10]

Once established, non-unions are difficult to treat.[5,7,11] For the patient, non-unions harbour significant morbidity in terms of financial and emotional compromise.[9,12-14] For the healthcare system and treating physician, non-unions demand increased resources, expensive treatment strategies and a meticulous understanding of the underlying disease process.[14,15] The optimal management strategy promotes rapid consolidation of the non-union while simultaneously allowing functional rehabilitation of the affected limb.

We report a case of a stiff oligotrophic non-union of the distal tibia that was successfully treated with monofocal distraction with the new TL-Hex (Orthofix, Verona, Italy) circular external fixator.

## Case report

A 26-year-old woman was referred to our limb reconstruction unit after failed conservative management of a closed distal third tibia fracture. The fracture was sustained after a fall, six months prior to our consultation. Her initial management consisted of a patella-tendon bearing plaster cast and regular follow-up at her base hospital. At presentation to our unit a stiff tibial non-union with a partially correctable deformity was evident.

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Local and systemic staging confirmed the diagnosis of metabolic syndrome X. She was a type 1 diabetic, hypertensive and hypothyroid on treatment. A bone density scan done at the base hospital revealed the patient to be osteopaenic. Radiographs confirmed an oligotrophic non-union of an oblique distal third right tibia fracture with an 11° varus, 9° recurvatum and 22 mm shortening deformity (*Figure 1*). Full knee and ankle motion was possible and no vascular or neurological compromise was present. No other abnormalities were identified.

***Figure 1. AP and lateral radiographs showing an oligotrophic non-union of the distal third tibia***

***Figure 2. Day 6 after TL-Hex frame application***

Surgical management consisted of a fibula osteotomy followed by application of a TL-Hex circular external fixator. Proximal and distal fixation consisted of two hydroxyapatite-coated half pins and one 1.8 mm tensioned transverse wire secured to a single ring for each bone segment (*Figure 2*). The non-union site was left undisturbed and in the deformed position. No bone graft was added.

After a latency period of seven days, gradual correction was achieved over 23 days at a distraction rate of 1 mm per day. During the correction and the consolidation phase functional rehabilitation was encouraged with the assistance of a physiotherapist. Full weight bearing was allowed from the first post-operative day. Pin tract care followed our standard protocol and included twice daily cleaning with an alcoholic solution of chlorhexidine.[16,17]

No complications were encountered during the treatment period, and no pin site infections developed. After 22 weeks, radiographic evaluation confirmed solid union with exuberant callus formation. Union was confirmed by the lack of tenderness at the non-union site and the ability to weight bear on a fully dynamised external fixator without pain. After clinical and radiographic confirmation of union, the external fixator was removed (*Figure 3*). Radiographic follow-up confirmed a solid union with no displacement of deformity, ten months after fixator removal.

***Figure 3. AP and lateral radiographs after frame removal showing solid union with exuberant callus formation***

## Discussion

Circular external fixators are increasingly being used for orthopaedic trauma and post-traumatic reconstruction.[18-20] These fixators exhibit a unique ability to eliminate bending and translational shear while maintaining a degree of axial micromotion.[19,21-25] This three-dimensional stability translates into a biomechanical environment that is conducive to bone healing and regenerate formation and is often exploited for limb salvage and reconstruction.[18,24,26-28]

The hexapod fixator has been a recent modification of the traditional Ilizarov-type fine wire circular external fixator.[29,30] It consists of two rings connected with six oblique struts in an octahedral configuration. Complex mathematical algorithms calculate strut length adjustments in order to manipulate the orientations of the two rings to each other.[31,32] By attaching each of these rings to a bone segment, their position and orientation can be altered, thereby facilitating the reduction of complex multiplanar deformities.

Partial fibula resection is an important step in the management of tibial non-unions.[33] Not only does the fibula osteotomy increase compressive forces across the ununited tibia, correction of tibial deformities relies on a mobile fibula.[33-37] For both these reasons a partial fibula resection was performed in our patient as it allowed correction of the tibial deformity and force transmission across the tibial non-union site.

The Orthofix TL-Hex is the latest hexapod circular external fixator that is commercially available. The first case was performed in South Africa on 12 November 2012 and since then its use has steadily increased in South Africa, Great Britain, France and Italy. The key design features of the TL-Hex include struts with both acute and gradual excursions that increase their working lengths *(Figure 4)*, struts that attach via stable ball joints on the outside of rings to open more fixation holes in the rings *(Figure 5)*, and the adjustment of struts through a user-friendly click mechanism that prevents accidental adjustments.

In stiff non-unions, the ability of the hexapod circular external fixator to provide controlled gradual distraction allows not only the correction of existing deformities, but also the stimulation of new bone formation. This 'tension-stress effect' was initially described by Ilizarov and is the biological basis of distraction histogenesis used in limb lengthening and bone transport.[38-40] It is thus possible, in low biologically active scenarios, to stimulate natural bone healing without the addition of bone graft or orthobiologics. This was demonstrated in our case, where an oligotrophic non-union healed with exuberant callus formation through gradual distraction without the addition of bone graft.

## Conclusion

Circular external fixators are extremely useful in the management of tibial non-unions. Hexapod fixators in particular provide additional management options where non-unions are associated with deformities that are not acutely correctable.

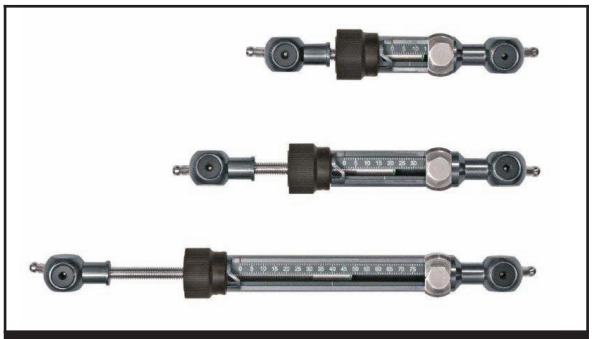

*Figure 4. TL-Hex telescopic struts that allow acute and gradual adjustments*

*Figure 5. TL-Hex strut attachment to the outer surface of the ring*

The TL-Hex fixator is the latest hexapod circular external fixator that is commercially available, and this case is the first report of its use in clinical practice. Its use allowed gradual reduction of a stiff non-union while also facilitating functional rehabilitation and eventual union in an acceptable position.

## Consent

Written consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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