

# Treatment of Nonunion and Malunion of Trauma of the Foot and Ankle Using External Fixation

Andrew Peter Molloy, MR, FRCS (Tr & Orth)<sup>a,\*</sup>, Andy Roche, MR, MRCS<sup>a</sup>,  
Badri Narayan, MR, FRCS (Tr & Orth)<sup>b</sup>

## KEYWORDS

• External • Fixation • Nonunion • Malunion • Foot • Ankle

External fixation is a valuable clinical tool, because it allows the surgeon to promote healing of bone and correct deformities by static and dynamic means. External fixators are often quick and easy to apply and frequently suitable for damage control procedures in trauma scenarios. They have significant biologic advantages over internal fixation with preservation of tissue envelopes and blood supply. Therefore external fixators can be used in areas and occasions where internal fixation would pose a threat to wound healing and bone union. External fixation has its advantages over internal fixation, particularly where there is active infection in the foot or ankle, where methods of internal fixation almost certainly would succumb to infection.

Internal fixation can be problematic when utilized in areas with poor skin coverage, for example the distal tibia. This can predispose to either wound breakdown or symptoms secondary to prominence of the hardware through thin subcutaneous tissue. Incisions made for wide exposure for placement of internal fixation through poorly vascularized or edematous skin, often seen in diabetic patients, can predispose to wound breakdown and are therefore more amenable to percutaneous external fixation methods. Bone loss and paucity of bone quality are often problems in nonunion revision surgery, especially in the presence of infection or in patients who have Charcot joints. In these clinical scenarios, internal fixation becomes difficult, and the advantages of minimally invasive techniques in external fixation become apparent. The construction and versatility of fixators also afford the surgeon the ability to place the

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<sup>a</sup> Department of Trauma and Orthopaedics, University Hospital Aintree, Lower Lane, Liverpool, L9 7AL, United Kingdom

<sup>b</sup> Department of Trauma and Orthopaedics, Royal Liverpool University Hospital, Prescot Street, Liverpool, L7 8XP, United Kingdom

\* Corresponding author.

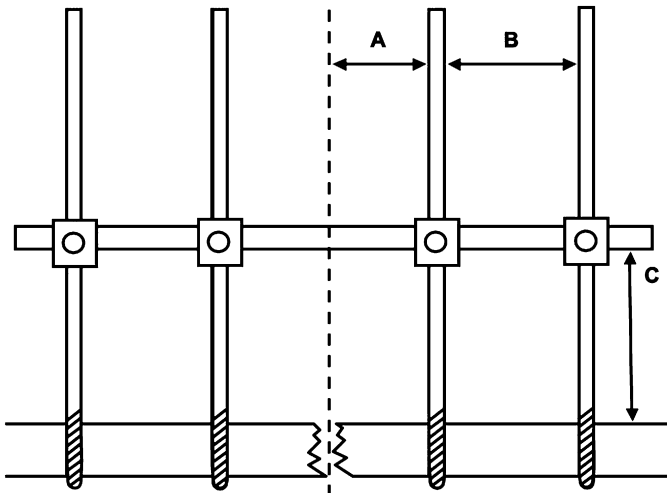
E-mail address: [andy.molloy@aintree.nhs.uk](mailto:andy.molloy@aintree.nhs.uk) (A.P. Molloy).

percutaneous pins outside the zones of injury or arthrodesis, thus reducing the risk of vascular compromise and infection of the affected site. Although obviously safe corridors of passage of wires and pins have to be used, the ability to place them away from sites of previous surgery can prevent iatrogenic damage where scarring may have altered the normal course of the nerves. The construct of, especially circular, external fixators render sufficient inherent stability to allow early weight bearing and joint mobilization (in nonspanning fixators). This achieves early restoration of limb and joint function, one of the primary goals in any orthopedic intervention.

### EXTERNAL FIXATOR CONSTRUCTS

External fixators used in modern orthopedics and trauma surgery encompass various constructs. The most basic are the mono-lateral fixators. The basic design is using threaded half pins connected by a rod (**Fig. 1**).

Stability depends on various factors. The bone–pin interface is the crux of stability, starting with a good hold and keeping a good hold of bone. Two important parameters that influence interface stresses and bone hold are pin diameter and interference. Larger diameter pins have a higher resistance to bending forces. This in turn can reduce the stresses at the bone–pin interface.<sup>1</sup> The limit to increasing pin size is set by the diameter of the bone in which the pin is inserted. A hole exceeding 20% of the diameter of the bone will reduce torsional strength by 34%, and if the hole size is greater than 50%, the reduction is 62%.<sup>2</sup> In practice, it is advisable to keep pin sizes to within a third of the diameter of the bone to reduce the risk of fracture on removal of the half pin. Interference is a measure of the grip the pin has of bone; traditionally it is at its maximum at the time of pin insertion and may decrease gradually as the fixator is loaded. Manufacturers have sought to maintain the grip on bone by altering the material properties or surface coatings of the pin. One technology that has shown promise in comparative studies and proven itself in clinical use is hydroxyapatite (HA) coating of the threaded portion of the pin. This causes bone hold to increase with time with increased extraction torques.



**Fig. 1.** Factors influencing stability of a simple monolateral external fixator. (A) Pin to fracture distance. (B) Pin to pin distance. (C) Bar to bone distance.

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