Acta Orthop. Belg., 2012, **78**, 543-547

TECHNICAL NOTE

Reduction of treatment time in external ring fixation using the Monofix device

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One of the disadvantages of the Ilizarov method is the long treatment time needed for extensive lengthening or complex deformity correction. To minimize the discomfort of the circular frame the authors have introduced a 'frame reduction' technique in which the ring frame is converted towards a unilateral fixator, the 'Monofix'.
Both its efficacy and patient satisfaction encouraged the authors to apply this method on a routine basis since 1998 for lower and upper limb corrections. The technique is demonstrated, its indications and potential problems are discussed.

Keywords : Ilizarov ; ring fixator ; monolateral fixator ; monofix ; frame reduction.

INTRODUCTION

For several decades the use of ring frames has been an essential tool in the correction of limb length discrepancies or severe axial and rotational deformities, and has also proven its efficacy in various treatments for non-union. The circular fixator is superior to other external fixation systems as it allows gradual adaptations in all directions, including compression, distraction, translation, axial and rotational alignment (*3*). However, once the correction has been achieved and the bone healing is progressing, the advantages of ring fixation are less clear. In our experience the removal of Kirschner-wires, and the reduction of the ring fixator to a less bulky monolateral fixator with half pins increases patient comfort and improves function : to this purpose a technique for transformation from a ring to a unilateral fixation system was developed and included as a standard in our strategy of treating patients with ring frames.

TECHNIQUE

All operations are performed as day clinic procedures. Unless contraindicated, all patients are operated under general anaesthesia. The operation starts by disconnecting the half pins (Apex screws – Stryker, Selzach, Switzerland) that are incorporated in the ring frame at the time of initial operation with a minimum of one screw per segment (Fig. 1a). The small cubes in which those half pins are fixed are detached from the ring and replaced by larger four- or five-hole cubes over the existing half pins which are interconnected with a threaded rod. This construction is placed at a two centimetres distance from the skin, just below the level of the rings

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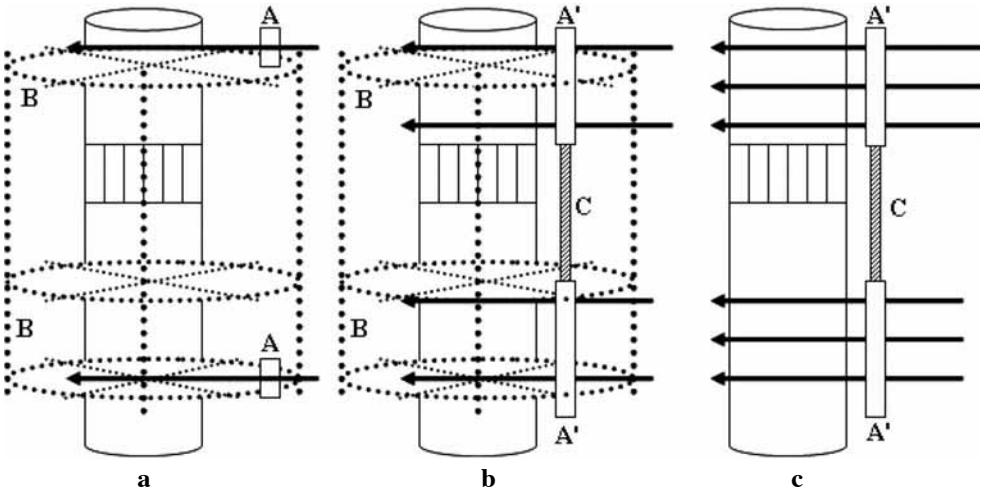
No benefits or funds were received in support of this study



Schematic representation of progressive reduction starting from the circular frame with incorporated half pins (a). With the ring fixator still in situ the unilateral fixator is mounted on the half pins (b). After completing the Monofix, the rings and wires are removed completely (c).

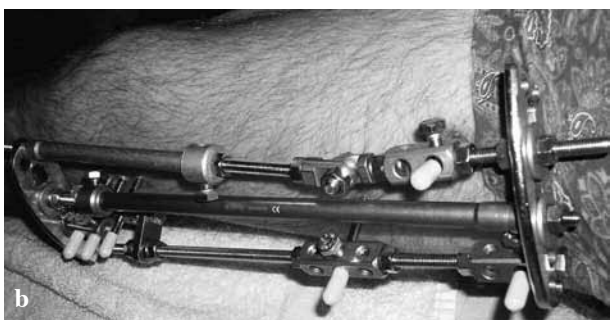
Fig. 1. — a : Small cubes and half pins (A) detached from original ring frame (B).
b : Larger cubes and additional half pins (A') interconnected with rod (C) creating unilateral fixator with rings still in place holding the reduction.
c : Final Monofix with only cubes and half pins (A').

which are still in place with the attached Kirschner-wires tightly holding the reduction (Fig. 1b). Additional half pins are then introduced into the cubes and firmly secured making sure that enough distance is kept to the osteotomy or distraction site. At this stage the Kirschner-wires and rings are removed and the depth of the half pins checked under image intensifier (Fig. 1c). Finally the cubes are interconnected with two additional rods that are reinforced with aluminium telescopes, thus creating a monolateral fixation system, which throughout the years has been named the Monofix (Fig. 2).

In cases where additional stability is needed, the cubes can be placed in a divergent direction and fixed on small arches (5, 7 or 9 hole ring fragments) creating a more extensive Monofix but with increased stability due to multi-plane pin position (*4*). The different parts of the Ilizarov equipment allow for sheer endless possibilities in connecting cubes under different angles and planes, offering unlimited combinations for the fixation of bony segments.

DISCUSSION

Although the original Ilizarov technique is based on rings with tensioned wires, many modifications combining the use of wires and half pins have been designed throughout the world. In the most extreme modification, the tensioned Kirschner wires were completely replaced by half pins, as e.g. in Stuart Green's Rancho mounting technique (*2*). Nowadays most surgeons use a combination of wires and pins in their frames, both for anatomical and functional reasons, thereby offering their patients a minimum of discomfort. Nevertheless, ring frames remain quite bulky and due to the transfixation of Kirschner-wires, even if restricted to a minimum, function is often limited. Moreover, during lengthenings and corrections, the tension of the skin over the wires may lead to infection (*5*). Despite these inconveniences such frames are often mandatory for complex corrections, non-union treatments and lengthening, and have widespread use. To minimize patient discomfort the authors therefore reduce



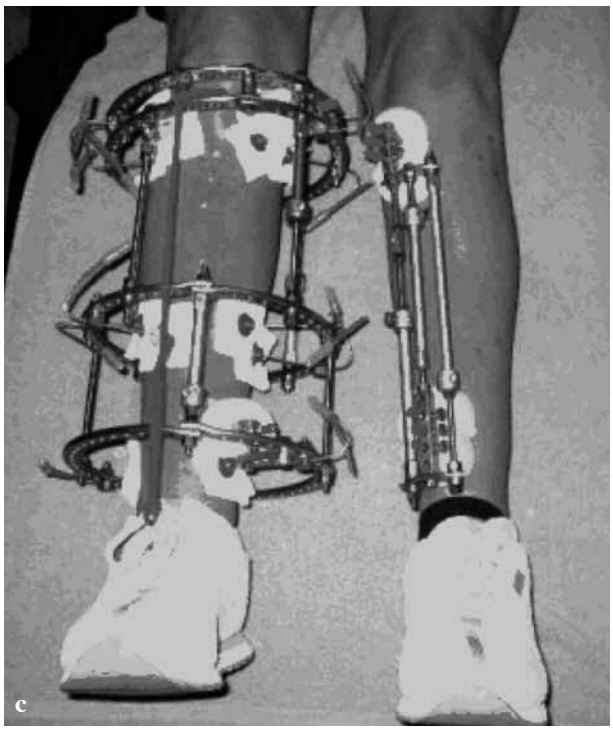


Fig. 2. — Clinical pictures of Monofix on humerus (a), femur (b), tibia (c) the latter representing a case of bilateral correction, the right leg at initial correction with ring frame, the left at time of exchange to Monofix.

patients' time spent in a ring frame. It should be noted that it is often not possible to exchange the frame immediately after achieving the correction. Especially after obtaining a distraction, the immature bone is subjected to bending forces and will undergo axial deviation if the ring frame is reduced too soon. As a general rule we always wait for exchange until at least corticalisation is visible on one side. Furthermore, we always keep the fixation with the ring frame stable during the procedure until it is substituted by the monolateral fixation.

One benefit of the Monofix is the opportunity to avoid a synchronous ring frame or subsequent treatment of each limb in bilateral corrections, either axial or rotational. The procedure on the first limb is performed with the circular system while the other side can be started with the ring fixator at the time of frame reduction of the first limb (Fig. 2a). The limb with the Monofix can bear weight fully. Double level corrections in one bone can also easily be fixated with the Monofix due to its extensive connection possibilities.

An additional advantage of a reduction to a Monofix is the positive effect on callus formation which was observed in most cases (Fig. 3). Compression stiffness of a ring frame is relatively low compared to other systems, but with increasing callus formation this may rapidly increase and slow down the final maturation and remodelling unless dynamised (*6*). This observation was already made decades ago by Terjesen who demonstrated that bone can regain its normal stiffness long before it

obtains its normal strength (*8*). Therefore, decreasing the fixation can stimulate bone healing and in ring frames this can be done by decreasing wire tension, removing wires and/or rods or reducing the entire frame as in the authors' application, but the fixation should retain enough axial and shear stiffness to allow further healing (*1-9*). This principle of complete exchange has been sporadically published as e.g. by the group of Sakkers who describe their 'Utrecht concept' in 9 patients and use a specially designed connector that fits on an Orthofix® fixator (*7*). With the technique presented here, only the original Ilizarov equipment is necessary. The reduction is a simple procedure, provided it is done in a well-equipped operating room with the complete Ilizarov instrumentation and an image intensifier available for pin check. It is a minimal invasive and quick intervention, improving patients' satisfaction without compromising bone healing while even stimulating it to some extent.

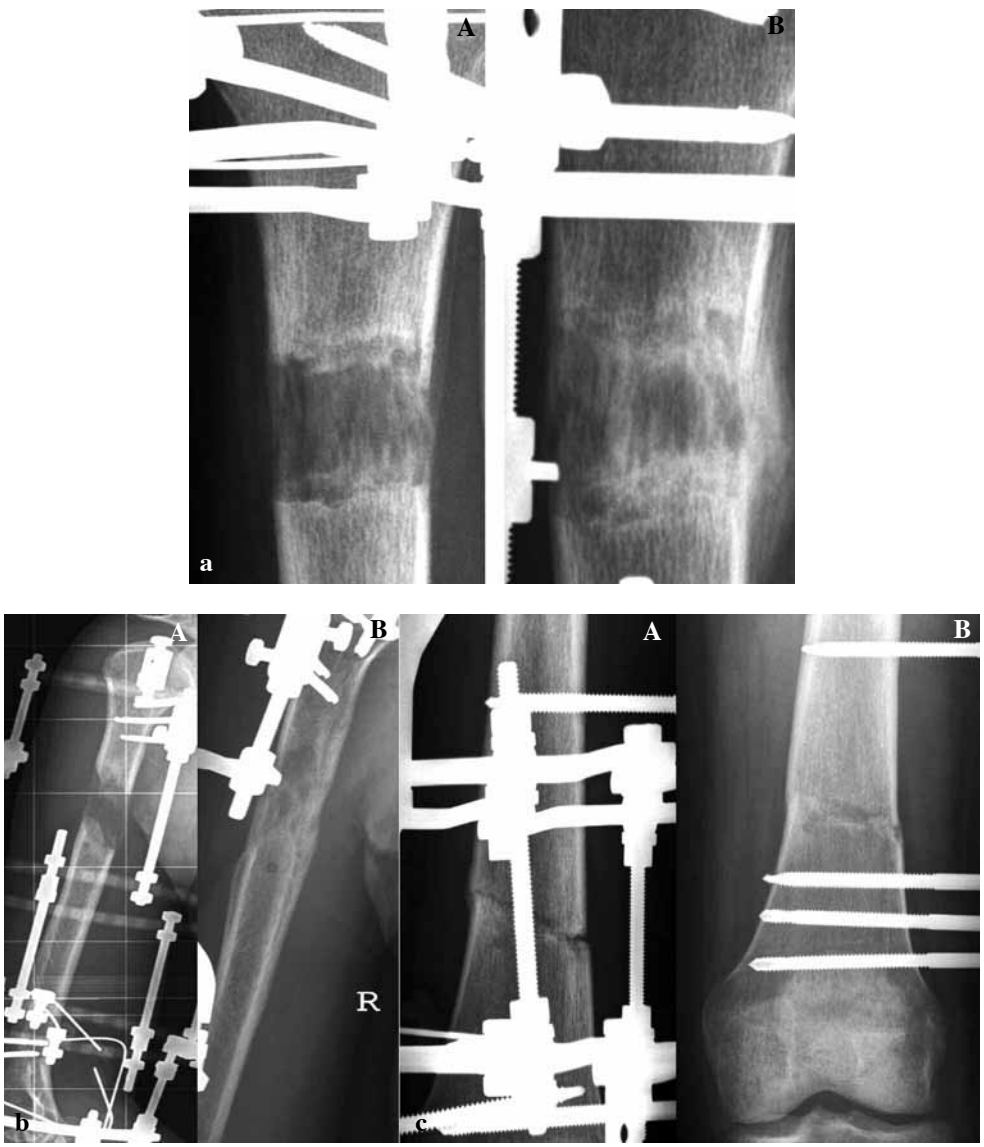


Fig. 3. — Radiograph of ring frame (A) versus monofix (B) in tibial (a) and humeral (b) lengthening and femoral osteotomy (c)

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