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Reduction of an Angled Displacement Using the Ilizarov Apparatus

Alexander S. Zolotov, MD


Different types of bone displacement can be reduced using the Ilizarov apparatus. Assembling the Ilizarov frame is not a simple procedure, especially for reduction of an angled displacement. In most cases, the rings of the Ilizarov frame should be positioned perpendicular to the bone. However, on an angularly deformed bone, the rings above and below the deformation will not be parallel and require hinged rods for their connection.

The angle of the hinges should correspond to the degree of bone deformity. However, it is difficult to hold the flexible hinge in the correct position during initial assembly. It is even more difficult if the bone deformation is in the frontal and sagittal planes. Positioning can only be approximate, as a rule. The reduction of the fracture can be monitored by frequent examinations and radiographs.

This article presents a method for assembling the Ilizarov apparatus to reduce angled bone displacement correctly with the minimum number of radiographic exposures.

SURGICAL TECHNIQUE

A preoperative radiograph of the injured bone segment was taken, and the angle between bone fragments was measured. The necessary rods were chosen to connect the rings at the fracture site. Rods must be bent in accordance with the angle of deformation. They have a thread that can be damaged during bending, therefore, bending was achieved with the aid of the telescopic tubes from the standard Ilizarov set (Figure 1). These tubes protect the rod's thread.

At the start of surgery, an outline of the bone segment, fracture pattern, and proposed position of the rings are drawn on the patient's skin. The prebent rod serves as a template to sketch the bone deformation. Two pins are insert-

Figure 1: Equipment for bending the rod and hinged rods. Telescopic tubes, protractor, bent rod (A), and hinged rods (B).
ankylosis with equine deformation (no open surgery) (n=1). One patient had arthritis of the knee and 11° varus deformation.

After the Ilizarov apparatus had been assembled with the prebent rods, the high tibia dome osteotomy was performed, deformation was reduced manually in one step, and the prebent rods were replaced by straight rods. In all other cases, slow correction of the deformation was used with the nuts (approximately 1° of deformation per day).

Four of 12 patients developed pin track infections. Local injections with antibiotics or pin replacement were effective. Bone reduction and bone healing were achieved in 11 patients. One patient with congenital tibia pseudarthrosis suffered a recurrence of the deformation. He is continuing treatment after a second operation: resection of the pseudarthrotic zone, manual reduction, bone graft, and Ilizarov fixation. This patient refused simultaneous leg lengthening.

The displacement was corrected by 2 weeks postoperatively and the hinged rods had straightened (Figure 2C). Fixation continued for 4 months after reduction, and bone healing was achieved.

**Case 2**

A 60-year-old man presented with an infected pseudarthrosis of the distal tibia with a rigid angled deformation after an open fracture, having had a bone defect treated by bone transport (8 cm) 2 years previously.

Radiographs revealed a 30° valgus deformation and a 24° posterior deviation (Figure 3A). The real angle of the deformation was 40° and was located 42° to the frontal plane. Preoperatively, the angled rods were contoured to 40° and fixed in the plane of the deformation during surgery (Figure 3B). Two days postoperatively, the angled rods were replaced by hinged rods and reduction commenced.

The displacement had been corrected by 5 weeks postoperatively, at which time the hinged rods had straightened (Figures 3C and 3D). Fixation continued for 4.5 months after reduction, then the limb was immobilized in a cast for 2 months, after which bone healing was achieved (Figure 3E).

**Case 3**

An 18-year-old woman presented with an infected nonunion of the femur with a rigid angled deformation following an open fracture 1 year previously. The leg was shortened by 5 cm.

Radiographs revealed a 26° varus deformation and 20° posterior deviation (Figure 4). The real angle of the deformation was 33° and was 38° to the frontal plane. The angled rods...
ed in the proximal and distal metaphyses perpendicular to the bone shaft in the frontal plane. The Ilizarov apparatus is mounted temporarily on these two pins only, starting from the upper rings. The middle rings are connected by the angled rods, whereby the bend is located at the malunion or nonunion. When the entire apparatus has been assembled, the remaining pins are inserted in the same plane as the rings.

Two to three days postoperatively, the angled rods are replaced by the hinged rods, and the slow realignment of the bone begins by exerting distraction forces on one side and compression forces on the opposite side of the apparatus with nuts (Figure 1). When reduction is completed, the hinged rods become straight. Rigid nonunion or pseudarthrosis does not require open surgery. In cases of malunion or nontraumatic bone deformation, osteotomy or corticotomy is performed after all of the pins have been inserted and the entire frame assembled.

This construction of the Ilizarov apparatus has been used since 1966 in the treatment of 12 patients aged 16-61 years with the following pathologies: rigid nonunion and pseudarthrosis (no open surgery) (n=6), malunion (corticotomy) (n=3), knee arthritis with varus deformation (n=2) (1 corticotomy and 1 dome osteotomy), and ankle fibrosis.

Figure 2: Case 1. Preoperative (A), postoperative (B), and postreduction (C) radiographs. Figure 3: Case 2. Preoperative (A), postoperative (B), postreduction of the frontal plane (C), postreduction of the sagittal plane (D), and 1 year after beginning treatment (E) radiographs.

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ORTHOPEDICS wants to hear from you. Send submissions to Steven F. Harwin, MD, % ORTHOPEDICS, 6900 Grove Rd, Thorofare, NJ 08086; or contact Robin J. Vadel, Managing Editor, at (856) 848-1000; fax (856) 848-6091; e-mail rvadel@slackinc.com; or www.orthobluejournal.com.
were contoured to 33° preoperatively and fixed in the plane of deformation during surgery.

Two days postoperatively, the angled rods were replaced by hinged rods and reduction commenced. After 1 month the displacement had been corrected and the hinged rods had straightened. The realignment of the femur lengthened the leg by 2 cm; the remaining 3 cm were regenerated by a distraction procedure carried out over 1.5 months. The apparatus was removed 8 months postoperatively once bone healing was achieved.

**CONCLUSION**

Assembling the Ilizarov apparatus using prebent rods for bone realignment is not precise because differences in pin tightening and eccentric pin placement in the rings or in the bone, for example, are not considered, although these factors may introduce noncritical errors. Nonetheless, this technique is considered useful in the treatment of rigid nonunion with angled displacement, malunion (with osteotomy), and for the different correction osteotomies.

**REFERENCES**


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