

Correction of leg-length discrepancies by ilizarov technique

Abstract

The management of leg-length discrepancies is one of the most challenging problems that the surgeon confronts in his daily practice. We are presenting here the use of Ilizarov apparatus-external ring device in a series of 86 patients for the limb lengthening. 66 patients are male & 20 female; the patients are 17 post polio shortening; 25 post-traumatic shortening; 5 gun shot shortening; 10 congenital pseudoarthrotic shortening, 24 congenital idiopathic shortening, shortening due to osteomyelitis-5. Among the complications 9 pin track infections were observed from which all responded positively to local care. Among the 86 patients, 3 admitted with the gun shot injury with 13 cm shortening, 39 admitted with the shortening of 7 cm, 18 with 5 cm & 26 with 3.5 cm. Lengthening & sound union was achieved according to Ilizarov's technique. The Ilizarov apparatus & technique represents a useful method for the successful lengthening of the limbs.

Keywords: leg-length, discrepancy, distraction osteogenesis, ilizarov apparatus

Volume 2 Issue 1 - 2015

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Received: December 05, 2014 | **Published:** January 09, 2015

Introduction

The Ilizarov methods basically consist of application of mechanical forces to induce new bone formation. This can be accomplished by two separate biological processes: distraction osteogenesis and osteogenesis by changing the mechanical environment at a pathological bony site.¹⁻⁴ Distraction osteogenesis is the method of lengthening a long bone without grafting. After a diaphyseal corticotomy, the early mesenchymal in growth (early callus), is elongated by gradual, progressive distraction using a dynamic external fixator.^{5,6} Corticotomy is a low energy osteotomy in which only the cortex is being cut. In this way the endosteum within the medullary canal, along with the medullary vessels, are preserved. Gradual distraction of the corticotomy site organizes the early callus into a cylinder of parallel fibers of collagen.⁴ Gradually as the distraction proceeds these fibers begin to ossify. As long as distraction is continuing a central region (the interzone), consisting histologically of undifferentiated cells, does not undergo ossification, allowing for the lengthening to continue. Ossification is carried out from both corticotomy surfaces towards the central interzone and extends through the entire cross section of the newly formed tissue. When the desired lengthening is obtained the distraction is stopped & the interzone ossifies. Later, under the compression forces, applied by muscle contraction & weight loading, the newly formed cylinder of solid bone remodels into cortex & medullary canal.⁴ The remodeling process may require years to produce mature, lamellar cortical bone. Osteogenesis may be achieved by changing the mechanical environment to stimulate a pathologic bony interface (e.g. non-union) & restore bony continuity. By this technique variations of compression & distraction forces across a non-union or a pseudoarthrotic site are applied to induce osteogenesis. The sequence of compression-distraction depends on the rigidity & compression of the pathologic bony interface.^{1,4,7} There are many critical factors related to osteogenesis. The local blood supply and the integrity of the periosteum are of great importance. Ilizarov emphasized the importance of careful corticotomy to prevent damage to the periosteum & to the medullary vessels. The integrity of the periosteum is the most important factor for new bone formation.

Another factor promoting the bone formation is the stable fixation of the bone fragments, so that the forces applied at the osteogenic zone are controlled both in their magnitude & their orientation. Another critical mechanical factor is the rate & the rhythm of distraction. Ilizarov found experimentally, that distraction at a rate of 0.25 mm every 6 hours (1 mm/day) is ideal. Distraction at a faster rate causes local ischaemia & subsequently retardation of osteogenesis or poor quality of the newly formed bone. Distraction at a slower rate will cause premature consolidation of the interzone, preventing further distraction. The last important factor is the level of the corticotomy.⁴ It seems that the ideal place for the corticotomy is at the Metaphyseal region. Metaphyseal corticotomy must be preferred whenever possible. Weight bearing is considered to be essential both for bone regeneration & consolidation. We used the above biological processes of distraction in our practice.

Materials and methods

For the last 23 years (1990-2013) 86 cases of femoral & tibial shortening where operated by the Ilizarov method. The follow up period was 2-20 years. Male predominated with an average age 24, as demonstrated in (Table 1). The age of patient ranges between 4-45 years (average- 34 yrs.) The main aetiological factors are presented in the (Table 2 & 3). Corticotomy of distal femur was done in 3 patients, 66 patients in the upper tibia (Monofocal). 17 patients in bifocal tibia 5 to 7 days after corticotomy the distraction were gradually started. Distraction at a rate of 0.25 mm every 6 hours (1 mm/day) is ideal. It was shown experimentally by Ilizarov, distraction at a faster rate causes local ischaemia or poor quality of the newly formed bone. Distraction at a slower rate will cause premature consolidation of the inter zone. So, we strictly followed the biological parameters of distraction osteogenesis.

Table 1 Shows sex incidence

Male (76.74%)	66
Female (23.26%)	20

Table 2 Shows aetiology

Post-polio complication (shortening)	17 cases
Post traumatic shortening	25 cases
Gun short shortening	5 cases
Congenital pseudoarthrotic shortening	10 cases
Idiopathic congenital shortening	24 cases
Shortening due to osteomyelitis	5 case
Total =	86 cases

Table 3 Shortening due to different diseases

3 patients	13 cm (Femur)
39 patients	7 cm (Tibia & femur)
18 patients	5 cm (Tibia)
26 patients	3.5 cm (Tibia)

Results

Osteogenesis and tissue genesis of the distraction gap was achieved in all the 86 patients. Gradual distraction formed early callus. This callus then forms parallel fibers of collagen,⁴ as the distraction proceeds. These collagen fibers begin to ossify & ultimately the solid bone remodels into cortex & medullary canal. The results are presented in Figure 1–9. The most common complication was pin track infection. Pin track infection required local treatment. There were no incidents of pin track osteomyelitis. Oedema of leg & foot was always present. Joint stiffness of knee & ankle occurred very often but after removal of fixator the rehabilitation of these joints resulted to full recovery. There were no incidents of neurovascular complications.



Figure 1 40 yrs old male, 19 yrs of Non-union left femur due to gunshot injury, 13 cm shortening; before surgery.



Figure 2 Radiograph of non-union of left femur with gunshot injury.

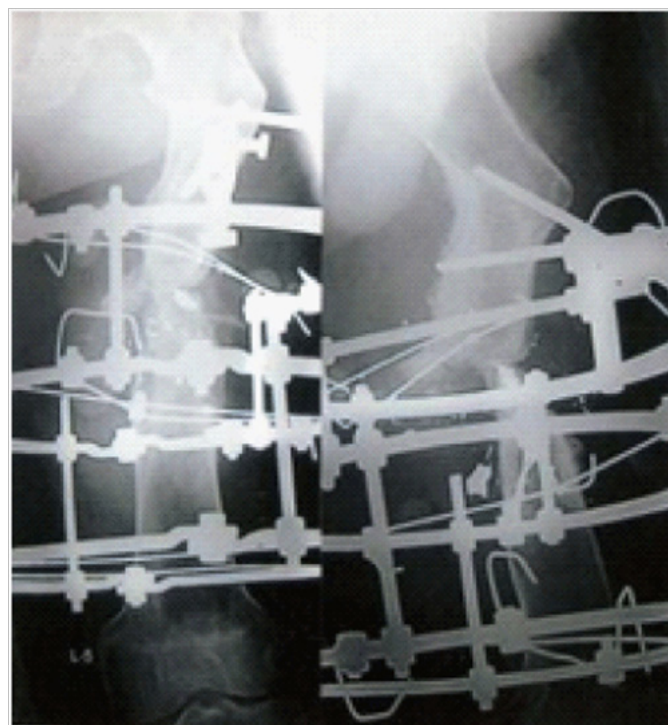


Figure 3 1st post op with Ilizarov in situ.

Discussion

The Ilizarov methods for the management of leg-length discrepancies have many advantages. However, several technical problems can arise if the details of the technique are not allowed precisely. The inexperienced surgeons usually fail to carry out the

whole technique. For successful tissue genesis one must have follow the rules & processes of Ilizarov technique. It is important to maintain the stability of the ring fixator. The Ilizarov's methods for limb lengthening are effective & offer many advantages. One of the greater advantages in that allows for the simultaneous treatment of bone loss, non union, shortening, deformity & problems of the soft tissues at same time.



Figure 4 Monofocal corticotomy of left tibia with fibular osteotomy.



Figure 5 Radiograph of left tibia with distraction osteogenesis.



Figure 6 No more LLD (Limb length discrepancy). Ilizarov in situ after 8 months follow up.

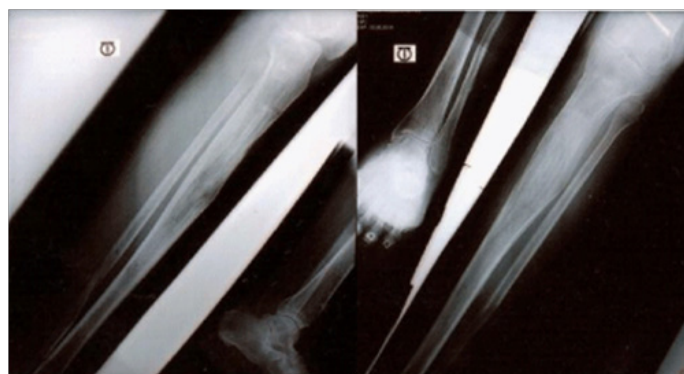


Figure 7 After removal of Ilizarov fixator 10 months follow up. Lengthening of tibia and fibula is visible.

Conclusion

With the current experimental and clinical experience it is evident that regeneration of bone at the site of distraction can be obtained safely. For successful bone transportation, it is also important to maintain the bone ends in good and stable position. In order to provide firm stability and to avoid axial deviation during distraction, the assembly of fixator in our cases usually required one or two rings proximally, 1 in the intercalate segment and 1 or 2 distally. Another important factor is to achieve good contract of the bones, when the transported fragment contacts the bone surface at the target zone (opposite the segmental defect). A partial contact in 1 of our cases was the cause of non-union. The importance of controlling precisely the movements of the transporting bone fragment has been emphasized by many authors.⁸⁻¹⁰

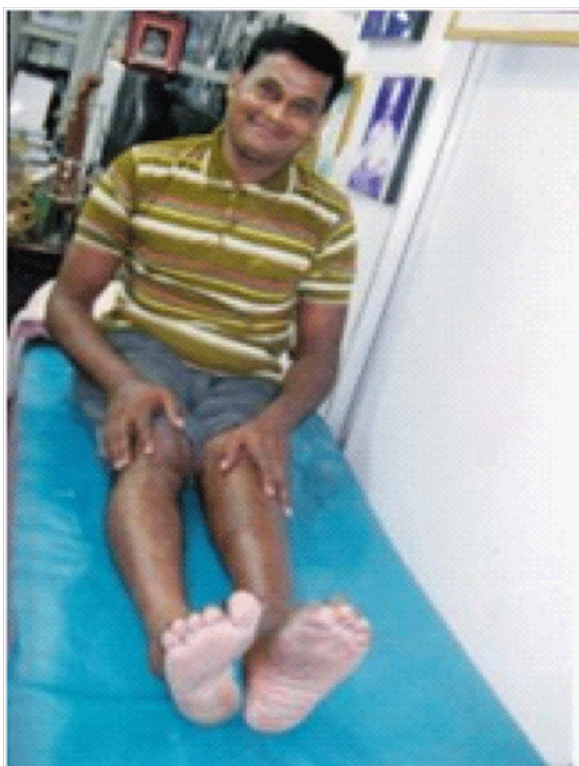


Figure 8 Limb length equalization is seen; patient is smiling.



Figure 9 Final follow up after 11 months (front and back view).

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