Egyptian Journal of Orthopaedic Research "*EJOR*"
An International peer-reviewed journal published bi-annually

Volume 1, Issue 1, May - 2020: pp: 11-16 www.ejor.sohag-univ.edu.eg

Original article

CORRECTION OF LOWER-LIMB DEFORMITIES USING ILIZAROV DEVICE

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Received 29/12/2019 Accepted 30/3/2020

Abstract

This retrospective study was done in department of orthopedic surgery, academic level 1 trauma center. During the period from August 2012 to August 2017 it included 23 patients (25 knees) with lower limb deformity whom had gradual correction of the lower limb deformity using Ilizarov device. The mean age of the patients was 26.5 years (10-45 years). Sixteen were males and nine females. Sixteen cases had genue varum and 9 cases had genue valgum deformity, the complication rate and the clinical outcome including the duration of treatment. The mean age at operation was 20.7 years; the mean follow-up was 21.1 months. All cases showed correction of deformity postoperatively. The mean preoperative "Hospital for Special Surgery" (HSS) scores was 60 and improved to a mean of 93 at follow-up. All limbs had excellent or good HSS scores. Disadvantages of this technique were mainly pin tract infection and poor patient acceptance and noncompliance. The Ilizarov device allows accurate results in correction of complex lower limb deformities with minimal morbidity.

Keyword: *Ilizarov, Varum, Valgum, Osteotomy, Correction*

1. Introduction

The management of post- traumatic deformities of the lower limb, either occurring immediately after failed primary fracture treatment leading to malunion, or developing gradually caused by injury of the growth mechanism, is a continuing challenge facing the orthopaedic surgeons. In particular, leg length discrepancy or soft-tissue compromise limits the options for acute correction and internal fixation. External fixation for the management of femoral and tibial post traumatic deformities have become a standard procedure over recent decades. Better understanding of the reaction of bone and soft tissue to gradual distraction has resulted in a reduc-tion of the historically high complication rate and improvement of functional outcome in correction of severe deformities with or without leg length discrepancy [1, 2]. The correction of deformities using the classic Ilizarov ring fixator has been reported in literature with good results even in the presence of soft-tissue compromise. However, residual malalignment after correction of multiplanar deformities is a common problem [3], as complex modifications of the Ilizarov frame would be necessary for those corrections. We have carried out a retrospective study of a consecutive case. Series

of patients treated with the Ilizarov device for deformities of the lower limb. The aim of the study was to analyze the accuracy of correction, the complication rate and the clinical outcome including the duration of treatment.

2. Patients and Methods

During the period from August 2012 to August 2017, 25 lower limbs of 23 patients (25 knees) had gradual correction of the lower limb deformity using Ilizarov device. The mean age of the patients was 26.5 years (10-45 years). Sixteen were males and nine females. Sixteen cases had genue varum and 9 cases had genue valgum deformity. We used the "Hospital for Special Surgery" (HSS) knee scoring system [4] for the clinical evaluation of our patients pre-and postoperatively. Preoperative planning was done using full length weight bearing radiographs. For the magnitude of correction, we planned to correct the deformity till the mechanical axis passed through the center of the knee joint (no over-correction). Patients were positioned supine on a standard radio translucent operating table. A tourniquet was applied to the thigh but was not inflated during assembly of the Ilizarov frame. Smooth Kirschnerwires1.8 mm in diameter were the only hardware used for frame application. In cases with genue varum, fig. (1) the first step was to drive a K-wire through the head of the fibula into the tibia parallel to the knee joint line. Rubber stoppers were put at each end of the wire. An Ilizarov ring of suitable diameter was then mounted to that K-wire and secured using two slotted bolts. The wire was tensioned to 110- 130 kg using a dynamometer. A second wire was then advanced on the same ring with an angle of about 90º to the first wire and was mounted to the ring and tensioned in the usual way. Using two hinges and a threaded motor rod, a second Ilizarov ring was attached to the first one and then secured to the boneusing two tensioned 1.8 mm K-wires. The angle between those two rings was equal to the magnitude of the planned correction. The hinges were adjusted to lie just opposite the lateral tibial border (one anterior and one posterior hinge) to allow for pure correction without lengthening. A third ring was attached to the second one using 4 threaded rods and was adjusted to be just proximal to the ankle joint and was secured to the bone using two tensioned 1.8 mm K-wires. In cases with genue valgum, fig. (2) the first step was to drive a K-wire through the distal femur parallel to the knee joint line. Rubber stoppers were put at each end of the wire. An Ilizarov ring of suitable diameter was then mounted to that K-wire and secured using two slotted bolts. The wire was tensioned to 110-130 kg using a dynam-ometer. A second wire was then advanced on the same ring with an angle of about 90º to the first wire and was mounted to the ring and tensioned in the usual way. Using two hinges and a threaded motor rod, a second Ilizarov ring was attached to the first one and then secured to the bone using two tensioned 1.8 mm K- wires. The angle between those tworings was equal to the magnitude of the planned correction. The hinges were adjusted to lie just opposite the medial femoral border (one anterior and one posterior hinge) to allow for pure correction without lengthening. Finally two drop-out wires were applied one for each ring. The tourniquet was then inflated. In cases of genue varum through a 1.5-2 cm skin incision, an oblique osteotomy was done in the mid shaft of the fibula and another small incision of 1.5-2 cm was made at the lower border of the tibial tuberosity. The periosteum of the tibia was incised and raised carefully. In cases of genue valgum through a 1.5-2 cm skin incision, an oblique osteotomy was done in the distal femur and periosteum was incised and raised carefully. Multiple drill holes were made with a 3.2 mm drill bit. Using a 10 mm osteotome, the medial and lateral cortices were osteotomised.

The threaded rods were then disassembled from the first and second rings. The posterior cortex was fractured indirectly by twisting the two rings. The two rings were attached to each other again and a compression was applied to the corticotomy site to increase its stability. The periosteum was carefully sutured again and subcutaneous tissue and skin were closed in layers. Starting from the first postoperative day, patients were allowed weight bearing as tolerated on crutches with full range of motion of the knee and ankle. Straight legraising and quadriceps strengthening and ankle dorsiflexors and plantar flexors strengthening exercises were encouraged. Patients were discharged on the second postoperative day after careful instruction about daily pin site care. Correction of the deformity was started gradually on the 7^{th} postoperative day at a rate of 0.25 mm / 6 hours. Follow-up radiographs were obtained weekly during the correction phase. Fine tuning of the correction was achieved by adjusting the positions of the hinges and the motor. Near the end of correction, another full length weight bearing radiograph was ordered to assess the corrected mechanical axis and fine tuning of the correction was again checked with another full length standing radiograph. The construct was then left in place and follow-up radiographs were obtained monthly to follow the consolidation of the new regenerate. With radiographic consolidation, the construct was removed gradually by removing one K-wire from each ring every week. The last K-wires (one on each ring) were removed at once. During this dynamization, the patients were fully weight bearing on the extremity. Another full length weight bearing radiograph was obtained following frame removal. Vigorous physiotherapy was not usually needed, because patients had already maintained a good range of knee and ankle motion. They were followed up every 6 months for a year, thenyearly.

Figure (1) Shows **a.** X-Ray of 12 years old boy with genue varum deformity of 15 degrees with limb discrepancy of 5 cm, **b.** after osteotomy and frame application, **c.** after end of correction awaiting consolidation, **d.** after consolidation and frame removal length

Figure (2) Shows **a**. &**b**. Photo and preoperative X-Ray of 13 years old boy with bilateral genue valgum of 30 degrees, **c**. after frame application, osteotomy and gradual correction of Rt knee, **d**. X-Ray after consolidation and frame removal of Rt knee, **e**. photo of the patient with frame application to the Lt knee, **f**. photo of the patient after correction of both limbs

3. Results

The follow-up period ranged from 10 to 36 months (mean 20 months). The Ilizarov frame was removed at mean of 16 weeks (11-30 weeks). The magnitude of overall achieved correction ranged from 11° to 25° (mean 16°). The mean preoperative HSS score of our patients was 60 (range 31-96). Postoperatively the average HSS knee score was 93 (67-100). The HSS score was excellent in 15 limbs, good in 8, fair in 1 limb and poor in 1 limb. Excellent or good results were present in 92 % of cases and fair orpoor results in 8 %. All patients in this study maintained near full range of motion of the knee and ankle joints during frame application. The range of motion of the knee was not decreased in any patient at the latest follow-up. Complications in this series were mainly grade 1 pin tract infection (13 limbs) and grade 2 infection (7 limbs). All of these pin site problems responded well to local pin site care and oral antibiotics. In no instance, did we have to remove or change a K-wire. There were no cases of deep infection or persistent discharge, or infection following frame removal. No cases had iatrogenic neuro-vascular injury or intraoperative compli-cation.

4. Discussion

Concerns regarding the conventional HTO techniques proximal to the tibial tuberosity fall mainly under one of three categories; complications related to HTO, the known fact that the results of HTO deteriorate with time, and difficulties encountered with revision of failed HTO into successful total knee replacement (TKR) [5-9]. The most frequent compli-cations with HTO are under-correction, loss of correction resulting in recurrence of varus deformity, and overcorrection [10-14]. Under-correction had been linked to the persistence (or early return) of symp-toms. Overcorrection can lead to a poor cosmetic result, persistent pain, tilting of the joint line, and considerable loss of bone, a situation which is difficult to treat with another osteotomy or arthroplasty [13, 15]. Accuracy of correction is therefore an important determinant for the postopera-tive results and the longevity of pain relief. The accuracy of correction is dependent mainly on the accuracy of preoperative planning and how we will implement that planning intra-operatively [16]. Manual methods for preoperative planning in lower limb deformity may have significant intra-observer variability [17-19]. On the other hand, intra-operative assessment of the lower limb mechanical axis is always the most difficult step in tibial osteotomies.

In the current technique, smooth 1.8 mm K-wires were the only hardware used for frame application. The gradual postoperative correction protocol, with assessment of the mechanical axis directly by standing full length radiographs results in high accuracy of correction. Regarding the patient with a fair result, under- correction was probably the cause of his fair HSS score. Reported disadvantages of this technique are mainly related to pin tract infection and pin loosening which may complicate later revision to total knee arthroplasty [20]. This is not a problem if only 1.8 mm tensioned wires are used with a good surgical technique. We do not use 5 mm half pins in the proximal ring. Tensioned 1.8 mm wires cause minor pin tract infection which resolve rapidly after removal of the construct. Other disadva-ntages are poor patient acceptance of the bulky external fixator and the need for surgeons experienced in the application of this fixator [20-22].

5. Conclusion

Ilizarov is an accurate and reliable technique for correction of lower limb deformity in adults. It is an important option in cases with severe deformities, where corrections of more than 15° are needed, in complex deformities in more than one plane and finally in cases with an associated severe lateral collateral ligament laxity.

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