Comparison between bone lengthening using Ilizarov and lengthening over intramedullary nail

Mahmoud Khairy[a], Gratien Nzayikorera[b]

[a]Department of Orthopedic Surgery and Traumatology, Faculty of Medicine, Alexandria University, Alexandria, [b]Department of Orthopedic Surgery and Traumatology, Faculty of Medicine, Port Said University, Fuad, Egypt

Correspondence to Mahmoud Khairy, MD, Department of Orthopedic Surgery and Traumatology, Faculty of Medicine, Alexandria University, Alexandria 21522, Egypt
Tel: +0114 410 6951;
e-mail: dr7odaa200988@gmail.com

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Background
Leg length discrepancy alters the biomechanics of the pelvis, hip, knee, and walking. It can occur due to congenital or acquired causes. Limb length discrepancy is always managed by lengthening the shortened limb by distraction osteogenesis. The osteotomized bone can be stabilized and distracted using external or internal fixation methods. External fixation using Ilizarov is a good method, but it has all the disadvantages of external fixators. Lengthening using an external fixator with bony internal fixation by an intramedullary nail (LON) emerged to allow early fixator removal and a more comfortable consolidation period without affecting the integrity of the regeneration. Our study aimed to conclude if Illizarov and LON are efficient methods for bone lengthening and which method has fewer complications with better compliance.

Patients and methods
This retrospective study included 25 patients with 33 limbs were lengthened. 10 patients with 10 short femurs were lengthened by Ilizarov (group I) and 15 patients with 23 short femurs were lengthened by LON (group II). The ages ranged from 3 to 37 years for group I and 18 to 42 years for group II.

Results
At the end of the follow-up period, all patients for both groups gained good regenerate consolidation after lengthening. The mean length gained for the Ilizarov group was 4.9 cm and 4.7 cm for the LON group. There was an insignificant difference in percentage increase in length and consolidation index between both groups. However, there was a significant difference in external fixation period, external fixation index, and complications between both groups.

Conclusion
It is concluded that this study supported the previous series in the literature, which proved that LON gives a lower complication rate with better patient compliance than lengthening using Ilizarov.

Keywords:
bone lengthening, distraction osteogenesis, ilizarov, intramedullary nail

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Introduction

Leg length discrepancy alters the biomechanics of the pelvis, hip, knee, and walking [1]. It can occur due to congenital or acquired causes. In patients with congenital leg length discrepancy, the affected leg is growing continuously slower than the normal leg. Shortening of a leg can also occur due to bone loss secondarily to traumatic insult, following tumour excision, or infectious epiphyseal plate injury in growing patients [2]. Rarely limb discrepancy occurs from leg elongation associated with hemihyperplasia or partial gigantism occurring in patients with syndromes or vascular conditions, such as Klippel-Trénaunay-Weber syndrome [2].

Limb length discrepancy is always managed by lengthening the shortened limb. This can done by distaction osteogenesis, which was first described by Codivilla in 1905 [3]. Distraction osteogenesis is done by bone osteotomy and gradual bone distraction to form a new bone regenerate. The osteotomized bone can be stabilized and distracted using external or internal fixation methods.

Internal fixation using magnetically controlled intramedullary lengthening nails is technically demanding and needs more facilities which is not allowed in most countries [4,5].

External fixation using Ilizarov is a good method, but it has all the disadvantages of external fixators such as pin tract infection, deep infection, joint stiffness, scarring, and poor tolerance by the patients as the Ilizarov cannot be removed except after

consolidation of the regenerate bone which can last for a long time. The consolidation phase for the lengthened column of bone is approximately twice as long as the distraction phase in children but is doubled in adults in whom periods of external fixation vary between 30 and 50 days per centimeter gain in length [6].

To avoid this long period of external fixation, lengthening using an external fixator with bony internal fixation by an intramedullary nail (LON) gives a better chance for early fixator removal after reaching the desired lengthening without affecting the stability of the regenerate which is supported by the nail till the occurrence of full consolidation [7].

However, some authors think that using two methods of fixation can lead to more hazardous complications when compared with using Ilizarov alone [8].

The purpose of this study is to compare bone lengthening using Ilizarov and lengthening over LON regarding percentage increase, external fixation index, consolidation index, efficacy, and rate of complications.

Patients and methods

This retrospective study was approved by the local ethical committee of our institution and has therefore been performed following the pertinent ethical guidelines (i.e. Declaration of Helsinki, as laid down in 1964 and revised in 2008). Written informed consent was obtained from all the patients. Between January 2019 and December 2020, 25 patients with 33 limbs were lengthened. 10 patients with 10 short femurs were lengthened by Ilizarov (group I) and 15 patients with 23 short femurs were lengthened by LON (group II). All patients had femoral shortening. The method of lengthening was chosen randomly regardless of any factor that can affect bone healing. Patients with limb length discrepancy (LLD) less than 3 cm and patients with severe deformity or angulation were excluded from our study. All the patients continued till the last follow-up of our study, all their data were available. The age ranged from 3 to 37 years for group I with a mean of 16.7 years and 18–42 years for group II with a mean of 22.5 years. There were three females and seven males in group I and 4 females and 11 males in group II.

Operative technique and postoperative protocol

The first group was managed by the application of an Ilizarov external fixator to the femur, then, complete femoral osteotomy was applied at the metaphyseal or diaphyseal region according to the bone condition and the amount needed to be lengthened.

The second group was managed by application of intramedullary nail with a diameter of 2 mm less than the reamed diameter to help for smooth bone distraction later on. The nail was locked by two transverse screws only at the insertion site, but, the application of the opposite locking screws was delayed, to be inserted in the second operation when the patient reached the desired length. Then, a complete femoral osteotomy was done, then, LRS external fixator was applied with the IM nail in place, with the assurance that all fixator pins were not coming in contact with the intramedullary nail. There was approximately one millimeter or more of space between the external fixation pin and the nail and this was ensured using the image intensifier.

All patients of both groups were allowed for full weight bearing with aids and all of them were asked to try to get a full ROM after surgery. Prophylactic intravenous antibiotics were administered for 48 h. Bone lengthening was started on 1 week postoperatively at a rate of 0.5 mm twice daily. The distraction rate was modified during follow-up according to the quality of regeneration.

After another week from the beginning of bone distraction, all wound sutures were removed. Then, patients were examined every 4 weeks, screened for local signs of infection, and radiography to assess the efficacy of distraction, regenerate formation, and the possibility of bone angulation or fracture. After the desired length was achieved in the Ilizarov group, distraction was stopped and the frame was left fixed till full consolidation of the regenerate. But, after the desired length was achieved in the LON group, the patients were taken to the operation room, the LRS fixator was removed and the opposite two interlocking screws are inserted; partial weight bearing was continued until full consolidation.

In the Ilizarov group, the fixators were removed when the individual was fully weight-bearing and after full consolidation which was confirmed by radiographic confirmation of 3 cortices in the regenerate column of both AP and lateral radiography images. Patients of the LON group were allowed for full weight bearing after full consolidation.

We used the percentage increase in length (PI), external fixation index (EFI), and consolidation index (CI). PI is defined as the length gained divided by the original length. EFI is defined as the duration of external fixation divided by the length gained. CI is defined as the time of consolidation (from the operation day to the confirmation of consolidation)

divided by the length gained. Consolidation was considered to be complete when anteroposterior and lateral radiographs confirmed at least three of four cortices were intact. We recorded the complication rate and the types of complications occurring within each group [9].

Statistical analysis

Data were analyzed by using SPSSR software (Statistical package for social science for personal computers, IBM, Armonk, New York) using the Pearson Chi-square χ^2 test and comparing means, Qualitative data were described using numbers and percentages. Quantitative data were expressed as mean±SD and P less than 0.05 was considered significant.

Results

The causes of femoral shortening for both groups are mentioned in Table 1.

At the end of the follow-up period, all patients for both groups gained good regenerate consolidation after lengthening (Figs. 1, 2). The mean duration of follow-up was 15 months (12–18 months). The mean length gained for the Ilizarov group was 4.9 cm (ranging from 3 to 7 cm), but the mean length gained for the LON group was 4.7 cm (ranging from 3 to 6 cm). The PI for the Ilizarov group was 12.2% and, 11.5% for the LON group. There was an insignificant difference in PI between both groups (0.35). The CI for the Ilizarov group was 35.5 days/cm (ranging from 32.8 to 40.3 days/cm) and, 40.4 days/cm for the LON group (ranging from 32.5 to 45.5 days/cm). There was an insignificant difference in CI between both groups (0.08) (Table 2).

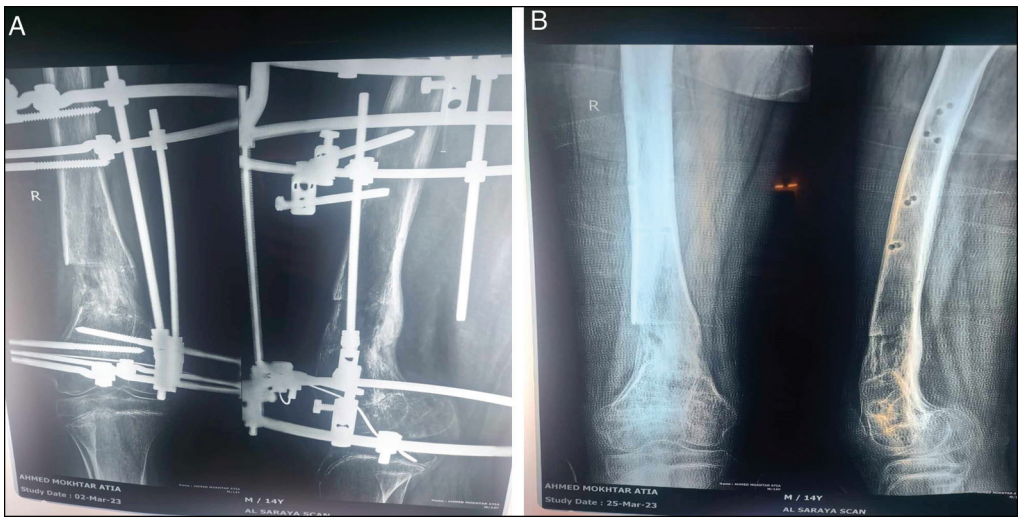
Table 1 Causes of femoral shortening for both groups

Cause	Group I Ilizarov	Group II LON
Congenital	2 patients	1 patient
Post-traumatic	6 patients	6 patients
Metabolic disorders	1 patient	7 patients
Physical arrest	1 patient	1 patient

The external fixation period (EFP) for the Ilizarov group was 183 days (ranging from 120 to 240 days) and, 62.1 days for the LON group (ranging from 45 to 75 days). There was a significant difference in EFP (<0.001). EFI for the Ilizarov group was 36.2 days/cm (ranging from 32.2 to 48.5 days/cm) and, 12.6 days/cm for the LON group (ranging from 10.4 to 16.1 days/cm). There was a highly significant difference in EFI between both groups (<0.001) (Table 2).

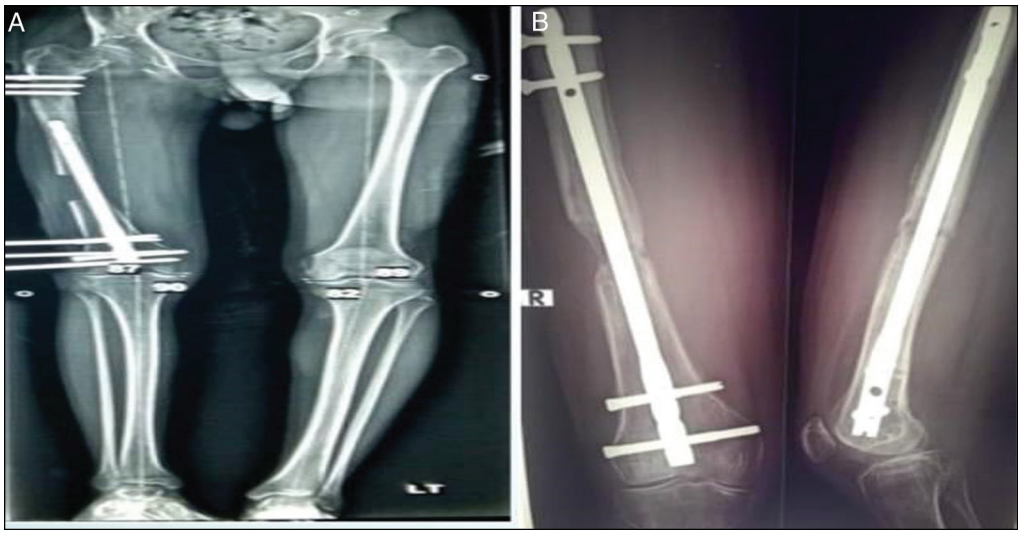
The mean number of complications was 2.8/limb in the Ilizarov group compared with a mean of 0.6/limb in the LON group. There was a significant difference in complication between both groups (<0.001). There were 7 cases of pin tract infection for the Ilizarov group compared with 1 case for the LON group. All cases were cured after the removal of the fixator. There were no cases of deep intramedullary infection for the Ilizarov group, but there was a single case for the LON group and it was completely cured after nail removal after full consolidation with reaming of the femoral medulla. There was no recurrence of infection for both groups. Axial deviation of the femur occurred in 2 cases managed by Ilizarov and was cured by frame modification. No deviation occurred with the LON group. No joint contracture occurred for the LON

Figure 1



A 37-year-old female patient with Ilizarov femoral lengthening (A) AP and Lat views during fixation (B) AP and Lat view after consolidation and frame removal.

Figure 2



A 28-year-old male with femoral lengthening using intramedullary nail: (A) AP views during lengthening (B) After fixator removal.

Table 2 Comparison between the results of both groups

	Ilizarov group	Intramedullary nail group
Length gained (cm)	4.9 (3–7)	4.7 (3–6)
Percentage increase (PI) (%)	12.2	11.5
External fixation period (days)	183 (120–240)	62.1 (45–75)
External fixation index (EFI) (days/cm)	36.2 (32.2–48.5)	12.6 (10.4–16.1)
Consolidation index (CI) (days/cm)	35.3 (32.8–40.3)	40.4 (32.5–45.5)

Table 3 Comparison of complications between the results of both groups

Complications	Ilizarov group	Intramedullary nail group
Pin tract infection	7	1
Intramedullary infection	0	1
Joint contracture	4	0
Axial deviation	2	0

group, but, 4 cases, managed by Ilizarov, and had knee joint contracture. 1 of them gained some improvement with physiotherapy, and 3 had quadricepsplasty. All of the four patients still have some degree of limited knee flexion (Table 3).

Discussion

Ilizarov was and still is used to correct limb shortening for the management of limb length discrepancy. Ilizarov fixator has all the disadvantages of external fixators such as pin tract infection, deep intramedullary infection, fractures due to bone weakness by the shanz of the Ilizarov, or axial deviation of the lengthened bones. Ilizarov cannot be removed except after complete consolidation occurs, which means a long time of external fixation with more possibility of occurrence of complications. LON uses an external fixator for a shorter time and is removed after reaching the desired amount of lengthening without waiting for complete consolidation to occur as the bone is stabilized by the intramedullary nail which means less possibility of external fixator complications [10,11].

In our study, we tried to discuss the results of managing limb length discrepancy using both Ilizarov and LON regardless of the factors that can affect the final results such as (cause of discrepancy, degree of discrepancy, age, smoking, associated comorbidities…). We tried to discover which gives better regenerate consolidation as a primary outcome and which method gives fewer complications as a secondary outcome.

As regards our primary outcome, we found that both Ilizarov and LON are good methods for bone lengthening as 100% of our cases get full consolidation at the end of the follow-up period. The same result was found by Paley and Sun [6,11].

In our study, There was a highly significant difference (<0.001) in EFP and EFI between the Ilizarov group and the LON group. Also, there was an insignificant difference in PI and CI between both groups. Sun, Park, and Geo found the same results [11-13]. The difference in EFP and EFI means that the duration of external fixation for Ilizarov is significantly longer than that of LON which means more possibility of external fixation complications. However, the insignificant difference in PI and CI means that both methods have nearly the same efficiency in bone lengthening.

The mean number of complications was 2.8/limb in the Ilizarov group compared with a mean of 0.6/limb in the LON group. There was a significant difference in complication between both groups (<0.001). The Ilizarov group got 7 cases with pin tract infection, 2 cases with axial deviation, and 4 cases with joint contracture. The rate of complication was much higher than that of the LON group. Paley and Kocaoglu found nearly the same results [7,8].

In the LON group, we were keen to keep any shanz away from the intramedullary nail by at least 1 mm and we ensured that by the C arm during surgery. Despite that, the only case of deep intramedullary infection, we encountered, occurred in the LON group. El-Husseini *et al.* encountered 3 cases [9]. We think that the infection began with a pin tract infection that extended to the intramedullary nail as we noticed, in the follow-up radiography, bone loosening around the single shanz that had pin tract infection. However, we did not remove the shanz except after completing the desired bone lengthening for the preservation of the stability of the fixator. Later on, the infection resolves after the removal of the intramedullary nail and reaming of the medulla.

In this study, we had some limitations. It is a nonrandomized retrospective study, the number of cases was small, and there was a bias in the implant choice by the surgeons as the implant was chosen regardless of the factors affecting the final results.

Conclusion

Ilizarov and LON, both, give excellent results for bone lengthening but LON gives less complication rate with better patient compliance and this supports the previous series in the literature.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Grill F, Chochole M, Schultz A. [Pelvic tilt and leg length discrepancy]. Orthopade 1990; 19:244–62.

2 Hasler CC. [Leg length inequality. Indications for treatment and importance of shortening procedures]. Orthopade 2000; 29:766–74.

3 Codivilla A. On the means of lengthening, in the lower limbs, the muscles and tissues which are shortened through deformity. Am J Orthop Surg 1905; 2:353–69.

4 Cole JD, Justin D, Kasparis T, DeVlught D, Knobloch C. The intramedullary skeletal kinetic distractor (ISKD): first clinical results of a new intramedullary nail for lengthening of the femur and tibia. Injury 2001; 32 (Suppl 4):SD129–39.

5 Baumgart R, Zeiler C, Kettler M, Weiss S, Schweiberer L. [Fully implantable intramedullary distraction nail in shortening deformity and bone defects. Spectrum of indications]. Orthopade 1999; 28:1058–65.

6 Paley D. Problems, obstacles, and complications of the limb lengthening by the Ilizarov technique. Clin Orthop 1990; 250:81–104.

7 Paley D, Herzenberg JE, Paremain G, Bhave A. Femoral lengthening over an intramedullary nail: a matched-case comparison with Ilizarov femoral lengthening. J Bone Joint Surg Am 1997; 79:1464–80.

8 Kocaoglu M, Eralp L, Kilicoglu O, Burc H, Cakmak M. Complications encountered during lengthening over an intramedullary nail. J Bone Joint Surg Am 2004; 86:2406–11.

9 El-Husseini TF, Ghaly NA, Mahran MA, Al Kersh MA, Emara KM. Comparison between lengthening over nail and conventional Ilizarov lengthening: a prospective randomized clinical study. Strategies Trauma Limb Reconstr 2013; 8:97–101.

10 Brady RJ, Dean JB, Skinner TM, Gross MT. Limb length inequality: clinical implications for assessment and intervention. J Orthop Sports Phys Ther 2003; 3:221–34.

11 Sun XT, Easwar TR, Manesh S, Ryu JH, Song SH, Kim SJ, Song HR. Complications and outcome of tibial lengthening using the Ilizarov method with or without a supplementary IM nail. J Bone Joint Surg Br 2012; 93b:782–7.

12 Park H, Yang K, Lee K, Joo S, Kwak Y, Kim H. Tibial lengthening over an intramedullary nail with use of the Ilizarov external fixator for idiopathic short stature. J Bone Joint Surg Am 2008; 90:1970–8.

13 Guo Q, Zhang T, Zheng Q, Feng S, Ma Aand X, Zhao F. Tibial lengthening over an intramedullary nail in patients with short stature or leg-length discrepancy: a comparative study. Int Orthop 2012; 36:179–84.