

Ilizarov Femoral Limb Lengthening in Lower Limb Discrepancy. Radio-Clinic Results. About 32 Cases

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How to cite this paper: Kasse, A.N., Ba, P.A., Diao, S., Sane, J.C., Diouf, J.D., Thiam, B., Diallo, M.B. and Sy, M.H. (2022) Ilizarov Femoral Limb Lengthening in Lower Limb Discrepancy. Radio-Clinic Results. About 32 Cases. *Open Journal of Orthopedics*, 12, 432-441.

<https://doi.org/10.4236/ojo.2022.1211044>

Received: October 10, 2022

Accepted: November 26, 2022

Published: November 29, 2022

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Abstract

Introduction: The progressive osseous lengthening on a single site corticotomy such as described by Ilizarov is a reliable but difficult method in the treatment of limb length discrepancies. The objective of this study was to appreciate the results of the recent application of this method in a low-income country such as Senegal. **Material and Method:** It was a retrospective study on 32 patients among whom 19 were men (people) and 13 were women over one continuous period of 7 years. The mean age was of 19 years with extremes of 10 and 36 years. Etiologies were dominated by osteoarthritis of the hip in 77.8%, traumatic sequela in 16.7% and the aseptic osteonecrosis of femoral head in 5.6%. The average duration of treatment was of 232 days with extremes of 110 and 363 days. **Results:** On the anatomical plan, the average lengthening was 55.89 mm that is 12.03% of the initial length with extremes of 35 and 110 mm. The equalization, in terms of length of the members, was obtained in 33.3% of the cases. The average index of cure was of 56.29 days, six patients, which are 18.75% of the cases, complained about pain at the end of treatment and walking without crutches was possible in 83.33%. The complications, in the phase of lengthening, were either mechanics, with 5 subluxations (3 at the level of the hip and 2 at the level of the knee), or biological with 7 infections (superficial 5 and 2 deep), 2 premature consolidations and 1 bleeding. The complications in the consolidation phase were also mechanical with 32 articular stiffness, 8 plastic deformations, 7 subluxations, a fracture and a collapse of the regenerate, or biological with 8 infections among which an osteitis and bleeding. **Conclusion:** Despite a strong rate of complications and sometimes not reached objectives, the results of this first series of lengthening are encouraging and rich in education and do not seem to be a limiting factor for the implementation of the method in devel-

oping countries.

Keywords

Limb Length Discrepancy, Lengthening, Ilizarov, Senegal

1. Introduction

Limb length discrepancy (LLD) is a common condition in orthopedic practice [1]. If it is usual to treat small LLD with footings, morphological and functional restitution during large anisomelia relies on surgery with a lot of techniques including progressive bone lengthening on a focal corticotomy as described by Ilizarov [1] [2] [3]. The lengthening program is a long and difficult challenge, especially in the femur, and complications are common with sometimes a real impact on the results [4].

Many techniques were described using internal or external fixation, but the challenge remains the same: long and exhausting postoperative commitment which can jeopardize early good results [5]. In the last two decades, many improvements were made, such as Computer-assisted correction with the Taylor Spatial Frame and many other methods to stimulate regeneration and reduce the period of treatment [6] [7].

However, the Ilizarov method still is the main method of bone lengthening by improving the results and reducing complications and allowing the production of bone with normal histological and mechanical properties [5] [8].

The objective of this work was to evaluate the clinical and radiological results of femur progressive lengthening by the Ilizarov method in order to specify its advantages, limitations and achievability in a difficult socio-economic context such as Senegal.

2. Material and Method

We report a retrospective study involving 32 patients treated by the Ilizarov method in the Orthopedic-Traumatology department of the Grand Yoff General Hospital over a continuous period of 7 years from January 2006 to December 2014.

Material

All patients with a lower limb shortening of at least 4 cm treated by the Ilizarov method of limb lengthening were included in the study.

The patient was in supine position on the regular table (72%) and under spinal anesthesia (72%). Fluoroscopy, desirable but not indispensable, had been used in 33% of our patients.

Corticotomy was done in a minimal invasive approach and made with scissors, especially in the metaphysical zone (72.22%). A slight distraction was made per operatively to ensure the effectivity of the corticotomy.

A percutaneous tenotomy of the adductors was performed to release a muscular retraction or a vicious attitude in adduction in 3 cases.

The lengthening was performed after corticotomy at the speed of 1 mm per day. It could be momentarily interrupted, reduced, accelerated or even reversed depending on the appearance of the callus and other factors related to the patient such as pain.

A variable period was left between the day the osteotomy was performed and the day the lengthening began. The average delay in our series was 6 days (3 and 18 days). A variable hospitalization period was required to rule out the risk of immediate postoperative complications (bleeding, compartment syndromes, infection...) and to familiarize the patient and his family with the device and the lengthening protocol. At home, lengthening was performed by the patient or a relative in 30 cases (93.75%).

The joints mobility was maintained by self-rehabilitation.

Device removal was based on the radiological aspect of a good quality regenerate (at least three cortices on four visible). It was performed either in the dressing room or in the operating room under general anesthesia with a reasonable mobilization of the stiffed joints.

Muscle strengthening and joint relaxation, in a specialized center after removal of the device, were necessary in 24 patients in our series (75%).

○ Results assessment

Anatomical results were evaluated according to 5 criteria: clinical measurement of the residual shortening (technique of the laths and the technique of the tape measure), radiological measurement (telemetric image) of the residual shortening (**Figure 1**), joint stability (knee and hip), percentage of elongated bone and appearance of the regenerate.

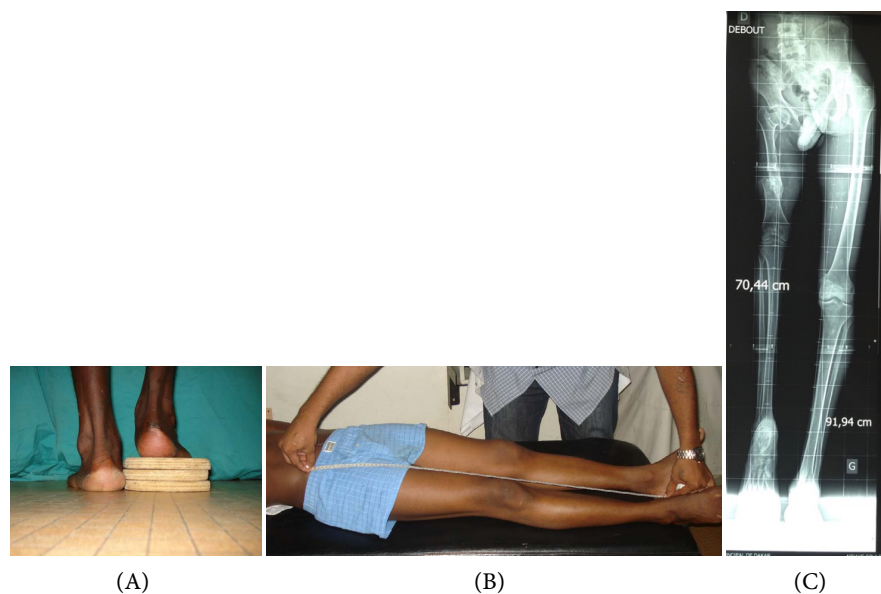


Figure 1. Limb length measurements. (A) Planchette technique; (B) Tape measurement technique; (C) Telemetry.

Functional outcomes were evaluated based on joint mobility (knee and hip), pain and walking.

Healing index represents the time in days needed to lengthen and consolidate one centimeter of bone segment ($HI = \text{Treatment time}/\text{number of centimeters elongated}$).

Complications were divided into mechanical complications (plastic deformation of the callus in the frontal and sagittal plane, stiffness of the joint, removal of the pins, subluxation of the joint, fracture of the regenerate, settlement of the regenerate) and biological (no regeneration or delayed consolidation, early consolidation, infection) at the elongation and consolidation phases.

○ Statistical analysis

Statistical analyses were performed based on Student's t-test with one observation per patient and with equal variances assumed (SPSS software version 21). Any p-values < 0.05 were considered statistically significant.

3. Results

- Sociodemographic and clinical results (Table 1)

The average age was 19 years with extremes of 10 and 36 years. Nineteen men and thirteen women benefited from a gradual lengthening of the lower limbs.

Etiologies were dominated by osteoarthritis of the hip in 77.8%, traumatic sequela in 16.7% and aseptic osteonecrosis of the femoral head in 5.6%.

The right side was most concerned in 20 cases.

The average shortening was 64.11 mm (47 and 140 mm) and the walking was autonomous without a pair of cane in 88% of cases.

Eight patients had hip instability before elongation while all knees were considered as stable.

The average duration of treatment was 232 days with extremes of 110 and 363 days.

- Anatomical results

The average lengthening was 55.89 mm or 12.03% of the starting length with extremes of 35 and 110 mm.

Equalization of limbs was achieved in 33.3% of cases (Figure 2).

The average healing index was 56.29 days per cm of lengthening with extremes of 19 and 153 days.

The regenerative aspect was rectilinear in 50% of cases (Figure 3).

- Functional results

Six patients or 18.75% of cases had persistent pain at the end of treatment.

Walking was autonomous in 83.33% of cases. All knees had lost mobility with varying degrees of stiffness at the end of treatment. However, 6 patients remained stiff at re-evaluation despite rehabilitation.

- Complications

Cortical bursting was the only per operative complication. It was observed in 6 patients (18.75%).

Table 1. Demographic and clinical data.

Age	19 years	(10 - 36 years)	
Sex	M = 19	F = 13	
Etiology	Hip arthritis n = 25	Traumatic n = 5	Femoral head necrosis n = 2
Side	Right n = 20	Left n = 12	
Shortening (mm)	64.11	(47 - 140)	
Treatment duration (day)	232	(110 - 363)	
Joint stability			



Figure 2. Device at the end of the lengthening program.

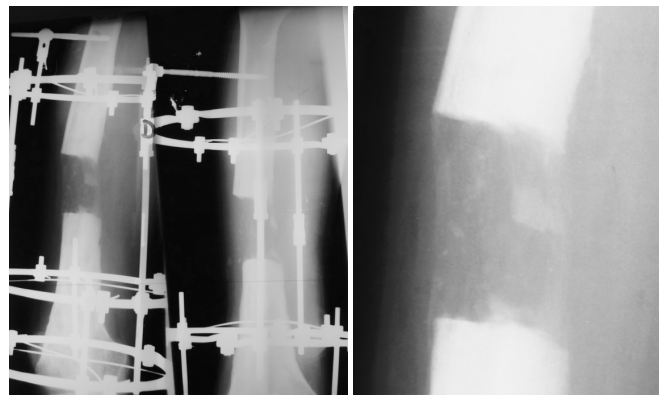


Figure 3. Rectilinear aspect of the regenerate during the lengthening phase.

No immediate post-operative complications were observed in our series.

In the long term, the complications were mechanical and biological observed during the elongation phase (**Table 2**) and the consolidation phase (**Table 3**).

Joint stiffness was the most common mechanical complication in both phases in severe form (n = 28 in the lengthening phase and n = 30 during the consolidation phase).

Table 2. Distribution of complications by severity during the lengthening phase.

COMPLICATION	BENIGN	SERIOUS	SEVERE	TOTAL
Plastic deformation	8	3	0	11
Pin lifting	0	2	0	2
Muscular contracture	7	0	0	7
Joint stiffness	4	0	28	32
Subluxation	0	1	4	5
Precocious fusion	0	2	0	2
Pressure ulcer	2	0	0	2
Pin tract infections	4	1	0	5
Bleeding	0	1	0	1
TOTAL	25	10	32	67

Table 3. Distribution of complications by severity during the consolidation phase.

COMPLICATION	BENIGN	SERIOUS	SEVERE	TOTAL
Plastic deformation	8	0	0	8
Joint stiffness	2	0	30	32
Subluxation	1	1	5	7
Pin tract infections	2	1	0	3
Osteitis	1	0	0	1
Pressure ulcer	4	0	0	4
Bleeding	0	1	0	1
Callus involvement	0	0	1	1
Callus fracture	0	1	0	1
TOTAL	18	4	36	58

It was 15 hips (46.8%) remained stiff at the end of treatment compared to 13 at the start and 16 knees remained stiff at the end of treatment compared to only 4 at the start

Ankylosis of the hip was noted in 9 patients or in 28.1% of cases against a single hip initially

Only one knee lost mobility after 115 mm extension in 248 days.

The other mechanical complications at the lengthening phase were plastic deformation of the callus (n = 11), muscular contracture (n = 7), subluxation (n = 5), precocious fusion (n = 2) among others.

Pin tract infection was the main biological complication and was noted in 5 patients at the lengthening phase (**Figure 4**).

Two cases of callus fracture were noted within 3 weeks after hardware removal and were treated conservatively. Fusion was obtained in 8 supplementary weeks.



Figure 4. Superficial pin tract infection.

4. Discussion

These preliminary results of the recent introduction of the Ilizarov method in Senegal in 2004 as well as the unfavorable socio-economical context mark out our series compared to other series in the literature despite the limited sample size. However, some comments may be made.

In fact, on the anatomical level, the healing index (56.29 days/cm) was higher than the index of other series as Merloz [8] series with 44 days/cm [6] [7] [8] [9] [10]. However, he specifies that this index grows up to 53 days/cm in the subgroup of adults. The same author reports a 25% over-regenerative fracture rate and recommends a longer treatment time in his recommendations. We attribute this difference to the long wearing time of the device linked to local specificities: organizational, socio-economic and structural problems.

Equalization was only achieved in 33% of patients. However, this finding is not an acceptance of failure. It was part of a therapeutic strategy of a two-step lengthening when the initial inequality is too great or as part of a secondary hip replacement. On the one hand, the risks associated with excessive lengthening are reduced and the hyper elongation due to a poor growth forecast is avoided, and on the other hand, equalization that must be obtained after hip replacement surgery. Moreover, a residual inequality is sometimes to the advantage of the function of the limb during walking [11].

Pouliquen [9] suggests making a hyper-elongation of 5mm in anticipation of the settling of the callus during the dynamization period.

Mechanical complications in the distraction and consolidation phase are due to the painful muscle tension resulting from stretching. Pain occurs when the muscle becomes relatively short for the femur [10] [11]. This muscular stretching will depend on other complications such as plastic deformation of the callus, subluxation, vicious attitude, epiphysiodesis and joint stiffness by compression [11] [12] [13] [14].

The occurrence of subluxation was correlated in our study with the loss of holding of a pin of the distal ring causing an imbalance of distraction forces in the sagittal plane. This imbalance created a couple of forces with the tension of the hamstrings back and the distractor thrust forward. Under these conditions, the passive stabilizing elements (condylar shells, cruciate ligaments) and, to a

lesser extent, the tension of the quadriceps will not prevent the forward movement of the femoral condyles [10] [11].

Jones [12] counted 7 posterior knee dislocations in a series of 21 Wagner Technique lengthening. In his study, he could not establish a link with age or the percentage of elongated bones. All authors agree to do preventive joint bypass surgery in case of unstable joint [3] [7] [9] [11] [12] [13]. In our series, only one dislocation is still persistent and leads to a complete painful knee ankylosis in 20° of flexion. No further treatment was done for this case.

Joint stiffness is also observed and mainly at the knee treated by physical therapy. The stresses are maximum on the joint around which osteotomy is performed [13] and in our series most osteotomies (83.3% of cases) were performed on the distal femur. The same authors suggest crossing the extended muscular planes in order to leave them a certain degree of mobility during the wearing of the device. This was not the case in 5 of our patients (15.6%) installed on orthopedic table.

Damsin [13], on a series of 20 lengthening, noted 20% knee stiffness with less than 60° mobility and other ten percent in which a release of the quadriceps was necessary to allow flexion beyond 90°. He proposes, for his part, a joint bypass or even a slight distraction at the knee to relieve the joint surfaces and facilitate the resumption of mobilization. Herzenberg [4] studying knee mobility during lengthening reports that knee mobility decreases to 37° during lengthening and 69° during consolidation. Merloz [8] reports a 25% stiffness rate and recognizes the need for release of quadriceps in some of them. In our series, all cases of stiffness was treated by physical therapy and in two cases, quadriceps tendon plasty was necessary.

Plastic deformation is the consequence of an imbalance between the antagonistic muscular forces or of an inextensible aponeurotic tension. The deviation appears from the side where the tension is the greatest [13]. It also depends on the site of the corticotomy and the stability of the device in relation to the stiffness of the fixator and the quality of the anchoring of plugs or pins in the bone [15]. Theoretically at the femur level the deviation is in varus and flexum when the osteotomy is proximal or diaphyseal and in valgus when it is low [8].

The callus fracture is a common complication occurring either during the period of fixation or after hardware removal.

Pin tract infections are the consequences of necrosis of the soft tissues around the path of the pins or plugs ranging from simple flow to osteitis [13] [14] [15] [16]. Their occurrence is linked to the technique of laying pins (burns) but also and especially to the mobility of the soft tissues crossed as well as the stress exerted on the skin [7] [12] [14]. Osteitis is the result of the infection of the holes in the pins or plugs and is in turn the source of osteolysis at the fixation site, which is responsible for the loss of stability [12]. In our series, their incidence has dropped significantly with the provision of a nurse specialized in the care of pin tracts.

5. Conclusion

Despite a high rate of complications and objectives sometimes not achieved, the results of this first series of femoral lengthening are encouraging and educational. The difficult economic context does not seem to be a limiting factor for the implementation of the method in developing countries, most complications can be avoided by a careful selection of patients, the improvement of our surgical technique, a rigorous protocol for monitoring patients and the information and education of patients and their families.

What Is Known about This Subject

- Lower limb length discrepancy is a common reason for orthopedic consultation.
- Several techniques are used in these limb lengthening.
- The Ilizarov method has proven its reliability in these indications but is little known in sub-Saharan Africa.

What's New about Your Study

- Applicability of this method in Senegal for limb lengthening
- Frequent but preventable complications due to good technique.

Conflicts of Interest

The authors do not declare any conflict of interest.

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