International Orthopaedics (SICOT) (2007) 31:587–591
DOI 10.1007/S00264-006-0236-2

ORIGINAL PAPER

Complications of Ilizarov leg lengthening: a comparative study between patients with leg length discrepancy and short stature

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Received: 20 June 2006 / Revised: 29 June 2006 / Accepted: 4 July 2006 / Published online: 12 October 2006

Abstract The Ilizarov technique has been used to treat severe limb length discrepancy and short stature. However, complications of this treatment are frequent. Between 1984 and 2001, 57 patients (94 tibias) had an Ilizarov procedure for limb lengthening. Twenty patients had limb discrepancy and 37 had short stature. Their mean age was 20.2 years (range 15–34). The average limb lengthening was 8.37 cm (range 3.2–14.7), which was equivalent to 26% (range 9.2–60%) average tibial lengthening. A total of 90 complications were observed. Thirty-three unplanned procedures were required during the lengthening programme. Two patients stopped the lengthening programme. There was no difference in the complications in leg lengthening using Ilizarov technique between the group of patients with leg length discrepancy and the group with short stature. A good knowledge of the Ilizarov technique is necessary to perform a lengthening programme with a low rate of complications.

Résumé La technique d'Ilizarov a été utilisée pour traiter d'importantes inégalités de longueur et pour allonger des sujets de petites tailles. Les complications de ce traitement sont fréquentes. De 1984 à 2001, 57 patients (94 tibias) ont bénéficié d'un allongement des membres inférieurs au niveau de la jambe par la technique d'Ilizarov. Vingt patients avaient une inégalité de longueur et 37 une petite taille. L'âge moyen était de 20.2 ans (de 15 à 34). L'allongement moyen a été de 8.37 cm (3.2 à 14.7), c'est-à-dire de 26% de la longueur de l'os (9.2 à 60%). Quatre-vingts dix complications ont été observées. Trente-trois interventions non prévues dans le plan de traitement ont dû être réalisées, pendant le programme d'allongement. Deux patients ont arrêté leur programme d'allongement. Les auteurs n'ont pas observé de différence dans le taux de complication entre le groupe des patients qui ont bénéficié d'un allongement selon la technique d'Ilizarov pour inégalités de longueur ou pour petites tailles. Il est nécessaire, pour tous les auteurs, de bien connaître la technique d'Ilizarov si l'on veut réaliser un programme d'allongement avec un taux de complications relativement bas.

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Introduction

Limb-lengthening techniques were introduced by Codivilla [7] and popularized by Wagner [15]. This technique has been associated with high rates of complications [9, 11, 12, 14]. Current techniques of lengthening the tibia include two phases of bone distraction with the use of an external fixator. During the first phase the bone is progressively distracted and during the second phase the distracted bone completes the consolidation. Bone lengthening has been performed with lateral or circular devices. In tibial lengthening, circular devices seem to produce better results with fewer complications in comparison to the lateral

fixator [4–14]. These techniques have been used for patients with a limb length discrepancy or short stature. The aim of this study was to compare and evaluate the complications in patients who had lengthening for short stature with those in patients who had lengthening for limb discrepancy at the same institution by the same surgeon. As the lengthening is performed in a potentially normal limb in the case of a discrepancy, we expected to find more complications during procedures in patients with short stature.

Materials and methods

Between 1984 and 2001, 57 patients with leg length discrepancy or short stature underwent an Ilizarov procedure by the senior author (J.C.). The procedure included proximal tibial osteotomy in all cases. All patients were operated on when their growth was completed. After a short stay in our hospital the patients were transferred to a highly specialized rehabilitation unit, where the lengthening was performed under medical and physiotherapeutic supervision. Lengthening was started between 7 and 10 days after the initial procedure. The patients were allowed to bear weight on the affected side and received physical therapy during the lengthening Fig. 1. Patients were discharged during the consolidation phase. The complications were studied according to the classification proposed by one of the authors (J.C.) [6]. With this classification, we suggested three categories of patients and three categories of complications. Category I patients had no complications or minor complications, and healed at the end of the lengthening programme. Category II patients required an additional surgical intervention that was not envisaged in the initial strategy. These complications did not leave sequelae and the lengthening programme was completed. Category III patients had major complications that left sequelae and/or the lengthening program was not carried out as expected. Patients with two or more complications were classified into the more severe category of patients, but the number of complications they had were counted as separate events for the analysis. Table 1 includes two major groups analysed by their respective aetiologies. Group A included patients with leg length discrepancy and Group B included short stature patients. All the patients with leg length discrepancy had a discrepancy of at least 4 cm. We consider that an adult has a short stature when their height is at least inferior to two standard deviations. All the patients with short stature had a psychological analysis before the procedure in order to find out their personal motivation and their capacity to tolerate this procedure. Many group B patients also had a simultaneous lengthening program of the opposite femur and tibia. The analysis of this series did not take into account femoral lengthening complications, because our aim was only the analysis of tibial lengthening complications. Removal of the Ilizarov device was performed after a consolidation of at least three cortices observed on X-rays and ultrasound images. Ultrasound images were obtained with a 10- and 13-mHz linear probe. The index of consolidation was obtained by the ratio between the number of days with the fixator (including time with cast after the removal of the device) and the total lengthening in centimetres (index of consolidation = X days/cm of total lengthening). Statistical significance was evaluated with use of a Pearson's χ^2 test.

Fig. 1 Full weight bearing is recommended during lengthening of the tibia

Results

Two patients stopped the program of lengthening. The first was a 16-year old girl who presented with a severe congenital tibial hemimelia of her right side. After 18 months she

Table 1 Aetiology

Aetiology	Total of patients
Group A—patients with limb length discrepancy	
Fibular hemimelia	3
Pseudarthrosis of the tibia	3
Traumatic	3
Septic growth arrest	4
Clubfoot	1
Cerebral palsy	1
Tibial hypoplasia	1
Polio	4
Total	21
Group B—short stature patients	
Achondroplasia or hypochondroplasia	22
Turner Syndrome	4
Noonan Syndrome	1
Constitutional short stature (familial)	10
Total	37

underwent a fibular transfer with triple arthrodesis of her foot. Lengthening was stopped due to subluxation of the knee, explained by the absence of cruciate ligaments. The second was an 18-year old woman who was unable to tolerate the fixator psychologically, which justified her being excluded from the lengthening programme. One patient had a delayed union of the callus and needed secondary autologous grafting Fig. 2. In one patient a fibular osteotomy was performed for early consolidation. Only one fracture was observed in this study. It was not displaced and occurred at the end of the consolidation phase. Thus, the fixator ensured osseous stability and the patient's fracture healed without any additional procedure. One lengthening of the Achilles' tendon was carried out in this series.

Group A

Twenty patients were treated for leg length discrepancy of different aetiologies (Table 1). There were 6 males and 14 females with a mean age of 19 years (range 13–41). Mean lengthening was 5.5 cm (range 3.2–11). Mean tibial lengthening was 20% (range 9.2–50%). Mean of index of consolidation was 63.5 days per centimetre of lengthening (range 36.2 to 104). The mean speed of lengthening was 0.63 mm per day occurring during a mean of 95 days (range 39–186). Thirty-six complications were observed in this group (Table 2).

Group B

Thirty-seven patients with short stature of different causes were treated (Table 2). There were 15 males and 22 females with a mean age of 21 years (range 15–37). Mean lengthening was 9.1 cm (range 5.3–14.7). Mean tibial

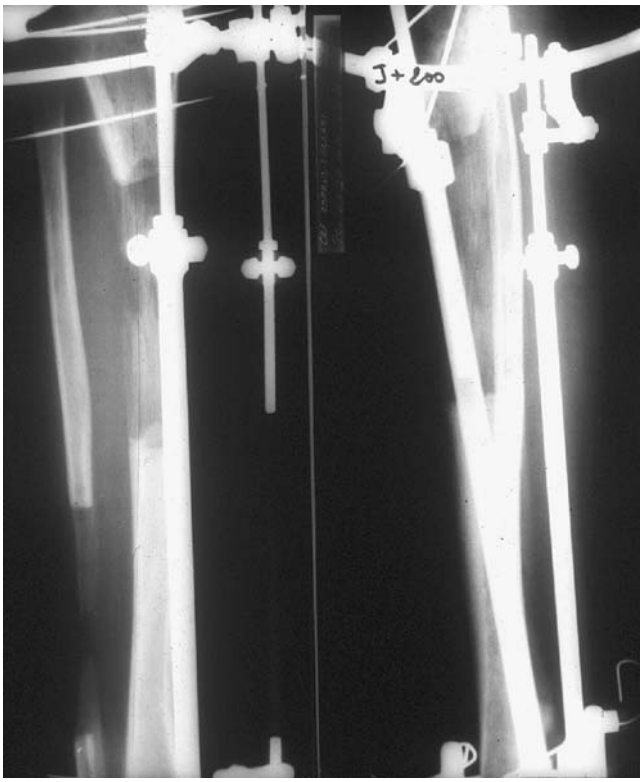

Fig. 2 X-ray result showing the evolution of the callus 200 days after the initial procedure

lengthening was 31.2% (range 16.1–60.8%). Mean of index of consolidation was 54.2 days per centimetre of lengthening (range 28.7–97.88). Mean speed of lengthening was 0.64 mm per day (0.3–0.92) occurring during a mean of 152 days. There were 54 complications in this group (Table 2).

Total series

We performed 94 tibial lengthening procedures in 57 patients (37 females) (Fig. 2). The mean age of the patients at the time of the operation was 20.2 years (range 15–41). Average lengthening was 8.37 cm (range 3.2–14.7). Mean tibial lengthening was 26% (range 9.2–60.8%). The mean of the index of consolidation was 56 days per centimetre of lengthening (range 28.7–97,8). The average speed of lengthening was 0.64 mm per day (range 0.3–0.92) and

Table 2 Complications

	Group A[a]	Group B[b]	Total of complications
Category I	19	36	55
Category II	15	18	33
Category III	2	0	2
Total	36	54	90

[a] Group A: patients with limb length discrepancy
[b] Group B: short stature patients

the average duration of lengthening was 125 days (range 39–186). Ninety complications were observed. There were 66 complications in category I (61%), 33 in category II (36%) and 2 complications in category III (0.04%). These 90 complications were observed in 29 category I patients (50%), 27 category II patients (46%) and 2 category III patients (4%; Table 2). A Pearson's χ^2 test was performed to compare groups A and B. No significant difference was observed between each category of complication and patients (p>0.182).

Discussion

The technique of lengthening with the Ilizarov device is particularly interesting for tibial lengthening because patients continue ambulation. In this series, a significant lengthening of the leg was carried out with acceptable morbidity.

The final outcome of our patients was very satisfactory with only 4% included in category III. Our results showed a relatively low complication rate compared with other reported series [1, 16]. The rate of complications was higher in patients with short stature than in the patients treated for a limb length discrepancy in Aldegheri's series [1], but those results are not comparable to our series because the author's used a lateral frame (Orthofix).

The complications are the major risk of lengthening. The Ilizarov technique has been associated with a high rate of complications. The classification of the complications proposed by Caton [6] may be applied to all techniques of lengthening. It makes it possible to analyse and compare the results of lengthening with different techniques in an objective way. Paley [12] proposed a classification using problems (grade 1), obstacles (grade 2), and complications including minor or major sequelae (grade 3). These two classification systems are very similar, except that Paley's does not include classification of the patient.

Failures in lengthening programmes are rare, as they were in our series. Psychological intolerance to the Ilizarov frame is a very rare case of failure of the method. We arranged a psychological analysis before the procedure, but this precaution was not useful in one case in our series. Treatment with the Ilizarov method is not associated with long-term psychological disturbances [10].

Fractures seem to be more frequent with the Ilizarov method in femur lengthening in comparison to tibial lengthening. Danziger [9] reported 8 femoral fractures after 18 femoral lengthening procedures using the Ilizarov method and no tibial fractures following 8 tibial lengthening procedures. The incidence of complications of our series is similar to that of other studies published [5, 14]. In Stanitski [14], the authors reported an incidence of 28 additional interventions in 62 lengthening programmes (45% of category II complications). Catagni [5] recently described the same risk of a further surgical procedure during what he called "cosmetic leg lengthening". Shevtsov [13] reported only 19% of category II complications, but their percentage of tibial lengthening was much lower than that of our series. The complications during lengthening are more frequent as the tibia is increased by more than 20% of its initial size [16]. In our series, all patients had lengthening of more than 15% of their tibia, which explains the highest number of category II patients (almost 50% of the total series). Therefore, in our opinion, during lengthening of the tibia with the Ilizarov device, approximately one in two patients requires a secondary surgical procedure not planned in the initial lengthening programme.

One of the most common complications of tibial lengthening with an Ilizarov device is the decreased range of motion in the Achilles' tendon [4]. Even though we performed one Achilles' lengthening in our series, we believe that physiotherapy focussed on the stiffness seems more appropriate than surgery, which can weaken the Achilles' tendon.

The index of consolidation with the Ilizarov device in our series was an average of 59 days/cm, which is almost double than that in Shevtsov's series [13]. The reason for this difference can be explained by the amount of limb lengthening, which was higher in our series in comparison to Shevtsov's report.

Analysis of the osseous consolidation by ultrasound was evaluated in our study. This assessment may be used for the evaluation of lengthening and to enable radiographic exposure to be reduced. Research [2] shows that ultrasound seems to be a reliable method in the early stages.

A higher frequency of complications seems to be found in patients with Turner's syndrome [3]. In our series, four patients with Turner's syndrome underwent a lengthening programme. We found that all the patients with Turner's syndrome had at least one complication from category II, but the group is too small to conclude that lengthening procedures should not be recommended in Turner's syndrome.

In summary, we did not find a significant difference between the complications of leg lengthening using the Ilizarov technique in patients with leg length discrepancy and those with short stature. The Ilizarov technique can be recommended as a good technique for tibial lengthening in patients with short stature or severe leg length discrepancies. We did not find more complications in patients with short stature, particularly in those with hypochondroplasia. An accurate knowledge of the different complications that may appear during this long treatment is necessary before planning a limb lengthening programme. The complications can be reduced with a greater understanding of lengthening and considerable experience of the technique.

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