Complications of Femoral Lengthening using the Ilizarov Fixator

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Citation

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Abstract

Objective: To report and evaluate the complications of femoral lengthening using the Ilizarov fixator.Method: Retrospective study of 10 patients who underwent femoral lengthening between 2001 and 2008. Demographics were collected by reviewing the medical records of each patient.Results: Of 10 patients, seven (70%) were females. Average age was 20 years (range 11 – 48 years). Equal limb lengths were achieved in six patients. Three patients had significant residual leg length discrepancies. Lengthening was discontinued in two patients due to marked restriction in knee flexion. In the other patient lengthening was discontinued due to subluxation of the hip. One patient developed mild subluxation of the knee. One patient sustained a fracture following fixator removal. The fracture healed with a mild leg length discrepancy. All patients developed knee stiffness following lengthening. Nine patients achieved full knee extension and flexion greater than 90˚.Conclusion: Generally, the number of complications and failures of lengthening increase in proportion to the length of distraction and the severity of the preoperative problems.

INTRODUCTION

Limb-length discrepancy is not an uncommon problem. Discrepancies of less than 5 centimetre (cm) are conventionally treated by a shoe lift, epiphysiodesis or femoral shortening. Most patients are reluctant to wear a lift greater than 2cm. Discrepancies in excess of 5cm may warrant limb lengthening. With the introduction of more physiologic methods of lengthening pioneered by Ilizarov and based on the biology of bone and soft tissue regeneration under the conditions of tension stress, the bone healing problems have become less common (1, 2). However, the soft tissue problems of decreased joint motion, prolonged or permanent stiffness, joint subluxation, refracture, nerve palsy and infection after lengthening have remained (3 – 8).

The author reports his complications following femoral lengthening using the Ilizarov Circular Fixator.

SUBJECTS AND METHODS

This is a retrospective study of 10 patients who underwent femoral lengthening utilizing the Ilizarov fixator between 2001 and 2008. Demographics were collected by reviewing the medical records of each patient. The principles for optimization of the regenerate bone were as follows: low energy osteotomy utilizing osteotomes, stable external fixation, latency period of 7 – 10 days, distraction rate of 0.25mm four times per day and a period of consolidation.

Physical therapy was started immediately and continued throughout the lengthening period to maintain ranges of motion of the hip and knee. Upon discharge from hospital, patients were given prescriptions for oral antibiotics which were to be taken only if a pin site infection developed. The signs and symptoms of a pin site infection were explained to the patient and relatives. Daily cleaning of pin sites with cotton swabs soaked in normal saline to remove crusts was recommended. Weekly follow-up with plain radiographs to ensure good quality of the regenerate bone was maintained for the first month and then at three-weekly intervals until distraction was complete. Once the distraction phase was complete, patients were usually seen monthly to assess bony consolidation. Rate of distraction was decreased in patients who had poor regenerate bone during the distraction periods. Normal rates of distraction were resumed when radiographs demonstrated good regenerate bone.

Two patients (cases 3 and 9) had simultaneous lengthening with correction of angular deformities of the distal femora. Hinges were used to correct the angular deformities and the hinges were replaced by telescopic rods for the lengthening

process. The Ilizarov frame was extended across the knee in four patients in whom lengthening greater than 7cm was contemplated. This was performed to prevent knee subluxation and reduce the compression of the articular cartilages.

Apparatus removal was performed under general anaesthesia. Routine immobilization after frame removal was not generally used. Physical therapy was continued until no further improvement in range of motion, and muscle strength were noted.

RESULTS

There were 7 female and 3 male patients with a mean age of 20 years at surgery (range 11 years – 48 years). Table 1 lists each patient's demographics, diagnosis and treatment

Figure 2

Table 2. Patient Data

Case	Lengthening (cm)	Lengthening index (mths/cm)	Time in Fixator (mths)	Complications	Further Treatment
1	10	1.1	11	Knee subluxation Knee extension contracture	Tibial fixator Quadricepsplasty
2	4	1.0	4	Temporary knee stiffness	-
3	13	1.3	18	Permanent knee stiffness Delayed union	-
4	6	2.3	14	Hip subluxation Residual 9cm LLD Malunion of regenerate bone Prolonged knee stiffness	Compression of regenerate bone Coverage of dysplastic acetabulum and further lengthening planned
5	3	2.0	6	Temporary knee stiffness Delayed union	-
6	7	2.0	14	Delayed union Knee stiffness Residual 7cm LLD	PEMF Further lengthening planned
7	6	1.1	7	Femoral fracture Prolonged knee stiffness Angular deformity with 1cm LLD	Cast
8	6	2.3	14	Prolonged knee stiffness Residual 6cm LLD Delayed union	Further lengthening planned
9	4	1.2	5	Temporary knee stiffness	-
10	3	3	9	Delayed union	-

LLD (Limb length discrepancy), mths (months), PEMF (Pulsed electromagnetic field therapy)

Table 2 summarizes the results.

{image:2}

The average lengthening was 6.2cm (range 3cm – 13cm). Treatment time (time in fixator) ranged from 4 months – 14 months (mean 10 months). The lengthening index, or total treatment time per centimetre of length gained, was 1.73 months/cm (range 1.0 – 3 months/cm).

Complications were divided into those related to the pin tracts, bones, joints, neurovascular structures and mental status. There were many cases of superficial (minor complications) pin-site infections, and these resolved promptly with oral antibiotics. There were no cases of osteomyelitis or ring sequestrum formation. One patient (Case 1) developed mild subluxation of the knee joint. The subluxation was corrected by extension of the frame across the joint. Case 1 was the first femoral lengthening performed by the author. Following removal of the frame, there was an extension contracture of 0 degrees. Intensive physical therapy failed to improve the range of motion of the knee. A Judet Quadricepsplasty was performed. At nine months follow-up, there was 90˚ of active flexion and no extension lag.

Hip subluxation was noted in one patient (Case 4). This patient had a 15.5cm femoral shortening with congenital coxa vara of the right hip. Prior to application of the Ilizarov frame, plain radiographs of the right hip in abduction and adduction were taken to assess the amount of coverage of the femoral head and the stability of the hip joint.

After 8cm of femoral lengthening, the hip subluxed. Distraction was immediately discontinued and the distraction gap compressed sufficiently to allow reduction of the hip joint. The final length of the regenerate bone was 6cm and this was allowed to consolidate, after which the frame was removed. An osteotomy to provide better coverage for the right hip will be undertaken before performing another lengthening procedure.

One patient (Case 7) developed a fracture through the regenerate bone as a result of a fall two months following removal of the fixator. Plain radiographs revealed an undisplaced transverse fracture with 5˚ of anterior angulation. The fracture was reduced and immobilized in a long leg cast. Following removal of the cast, there was an anterior angulation of 7˚ and a 1cm leg length discrepancy (LLD).

Three patients had significant residual leg length discrepancies (Case 4, 6, 8). Case 4 has already been discussed. In Cases 6 and 8, further lengthening was discontinued after 7cm and 6cm of distraction respectively, due to marked stiffness of the knee joints. Following consolidation, the frames were removed. Further lengthening is planned.

The consolidation periods were prolonged in Cases 3, 4, 5, 6, 8, and 10 due to delayed union of the regenerate bones. The average lengthening indices of the above patients was 1.73 months/cm (range 1.0 – 3 months/cm). Pulsed electromagnetic field stimulation (PEMF) was used on one patient (Case 6) for a period of two months and there was improvement in the quality of the regenerate bone.

Soft tissue complications were present in all patients. Maintaining knee range of motion was very difficult, particularly once lengthening exceeded 5cm. Two patients (Cases 7 and 8) were admitted for daily supervised physical therapy. One patient (Case 1) required a quadricepsplasty, and one patient (Case 3) had permanent knee stiffness (range 0˚ - 45˚). This patient had restriction in range of motion pre-operatively, due to degenerative changes in the knee. The other patients required months of physical therapy following removal of the frame to achieve flexions greater than 90˚.

DISCUSSION

Most complications of femoral lengthening develope during the distraction phase. Muscle contracture and joint stiffness are significant problems during femoral lengthening and they have proved to be the most difficult to treat. Despite active range of motion exercises and passive and dynamic stretching, all 10 patients developed knee stiffness. One patient (Case 1) developed a mild knee subluxation which was treated by extension of the frame across the knee. Lengthening was continued. Following removal of the frame, there was an extension contracture of the knee which was treated with a Judet Quadricepsplasty. To prevent extension contractures of the knee, it is recommended that lengthening be stopped if knee flexion is less than 40˚ (8). Antero-posterior and especially lateral radiographs should be taken of the patient's knee at each follow-up evaluation during distraction. At the first sign of subluxation, the frame should be extended across the knee. The author extended the frame across the knees in four patients in whom lengthening greater than 7cm was contemplated. Hinges were used to allow active ranges of motion. No knee subluxation occurred in these patients.

Following removal of the fixator, all patients had some degree of knee stiffness. Many months of intensive physical therapy was required to restore flexion greater than 90˚. One patient (Case 3) had pre-operative knee stiffness and this was not improved with physical therapy. Not all patients had the same degree of compliance with physical therapy.

Hip dislocation or subluxation can be a serious complication of limb lengthening procedures (5, 6, 9, 10). Suzuki et al (5) showed that hip deterioration during femoral lengthening occurred in the hips that had poor acetabular coverage due to hip disease or disease related to the hip joint. The deterioration was closely related to the pre-operative angle of Wiberg (CE). When the CE angle was greater than 20˚, the hip showed no deterioration. In contrast, when the CE angle was less that 20˚, hip displacement was likely. The CE angle of the right hip of Case 4 was 15˚, but this was not measured prior to lengthening. An osteotomy to provide coverage for the dysplastic acetabulum is required prior to resuming femoral lengthening. This patient has a residual leg length discrepancy of 9cm. It is recommended that, if the CE angle is less than 20˚, bony procedures such as an innominate osteotomy should precede the lengthening procedure to prevent femoral head displacement (5).

Poor regenerate bone may lead to a prolonged time in the frame and creates a high risk of regenerate bone fracture. The lengthening indices in all 10 patients were greater than one. Poor regenerate bone may result from too short a latency period, too rapid distraction or poor local blood supply (11). The latency periods for the 10 patients were between 10 – 14 days. The rate of distraction was reduced once poor regenerate bone was present on radiographs. At the end of distraction, the author did not dynamize the regenerate bones by loosening the nuts at the side of the connecting rods. This procedure would have stimulated osteogenesis of the regenerate bone thereby shortening the period in the frame. All ten patients were allowed to weight bear as tolerated. Some authors recommend that the regenerate bone be overlengthened 7mm to 10mm and then be compressed back before removing the frame (8, 12).

Fractures can occur through regenerate bone or remote from the lengthening site during or after lengthening. Simpson and Kenwright (13) published a series of 180 lengthening segments in 173 patients and reported an overall fracture rate of 9.4% per lengthening segment. O'Carrigan et al (14) presented a series of 986 lengthening segments in 650 patients and reported an overall fracture rate of 8% per lengthening segment. The vast majority of fractures (81% occur after frame removal and 69% of those within six weeks (14). The presentation of the fracture can be the typical signs and symptoms of a fracture or a gradual deformity progression with weight bearing. Treatment options include the following: casting, external fixation, intramedullary nail and plating. Cast treatment is simple but is associated with the highest rate of deformity. External

fixation is often the least popular treatment choice for the patient and the family. Flexible nails control angulation but not length. Locked intramedullary nails control length and alignment well, but there is a significant risk of infection, and in the pediatric population, there is the risk of avascular necrosis. Open reduction and internal fixation is a possible solution. In our series, the patient who developed a fracture and was treated with a cast healed with a 7˚ angular deformity.

Three patients had significant residual leg length discrepancies. The patient with the hip subluxation was previously discussed. A decision was made to discontinue lengthening in the other two patients due to the marked reduction in knee flexion. Progressive lengthening is associated with extension contracture of the knee (6).

The Ilizarov technique affords the ability to eliminate deformity and equalize limb length in a single treatment. Generally, the number of complications and failures of lengthening increase in proportion to the length of distraction and the severity of the pre-operative problems (4). This technique is challenging for patients, their families and the surgeon. The surgeon should be fairly versed in this treatment method as well as the prevention and management of the complications.

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