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Original Article

Femur lengthening with monoplanar external fixator associated with locked intramedullary nail☆

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ABSTRACT

Objective: This study aimed to demonstrate that the lengthening technique of an external fixator associated with locked intramedullary nail is an efficient method that decreases the duration of the external fixation and improves the rehabilitation period.
Methods: From January of 2005 to May of 2014, 31 patients with mean lower limb discrepancy of 5.31 cm were treated. The etiologies of the deformity were femur fracture sequelae, infection, hip development dysplasia, polio, and congenital short femur.
Results: The mean duration of external fixation was 2.47 months (external fixation index of 16.15 days per cm). The mean time for bone healing was 6.66 months (consolidation index 43 days per cm). Initial mean knee range of motion was −1° to 100°, progressing to 0°–115° at the end of treatment. The complications observed were incomplete osteotomies, hip subluxation, broken fixator, decreased knee range of motion, and need for locking screw removal.
Conclusion: Femur lengthening with a monoplanar external fixator associated with locked intramedullary nail allowed for a shorter period of external fixation use, better protection for the regenerated bone tissue, and early rehabilitation with possible complications.

☆ Study conducted at the Faculdade de Medicina do ABC, Hospital Estadual Mario Covas, Santo André, SP, Brazil.

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Alongamento ósseo femoral com fixador externo monoplanar associado a haste intramedular bloqueada

Palavras-chave:
Alongamento ósseo
Fixadores externos
Fixação intramedular de fraturas

RESUMO

Objetivo: Demonstrar que a técnica de alongamento do fixador externo associado a haste intramedular bloqueada é eficaz e traz benefícios quanto ao tempo de uso do fixador e a melhoria na reabilitação.

Método: Entre janeiro de 2005 e maio de 2014 foram tratados 31 pacientes com discrepância de membros inferiores com média de encurtamento de 5,31 cm. As etiologias da deformidade foram sequelas de fratura de fêmur, infecção, displasia de desenvolvimento do quadril, paralisia infantil e fêmur curto congênito.

Resultados: O tempo médio de fixação externa foi de 2,47 meses (índice de fixação externa de 16,15 dias por centímetro). O tempo médio necessário para consolidação óssea foi 6,66 meses (índice de consolidação 43 dias por centímetro). A amplitude de movimento do joelho média inicial era de -1 a 100 graus e no término do tratamento de 0 a 115 graus. As complicações observadas foram osteotomias incompletas, subluxação de quadril, quebra do fixador, limitação da amplitude do joelho e necessidade de retirada de material.

Conclusão: A técnica de alongamento femoral com fixador externo monolateral sobre haste intramedular propicia um tempo menor de uso do fixador externo, melhor proteção do regenerado ósseo e reabilitação precoce, não isenta de complicações.

Introduction

Lower limb shortening due to fracture sequelae or congenital defects leads, in the short term, to pelvic tilt and secondary scoliosis; in the long term, it leads to early osteoarthritis of the knee, hip, and spine.[1] Another problem is patient discomfort due to the time spent with a external fixator.

Traditionally, the most used surgical technique for bone shortening is that recommended by Ilizarov. It uses a system of rings anchored by transfixing Kirschner wires in tensions ranging from 50 to 130 N, followed by osteotomy and subsequent gradual bone distraction. The lengthening speed is 1 mm per day, but the fixator should remain in place until complete fracture consolidation. Bone regenerate fracture has been described in cases of premature fixator removal.[2–6]

Moreover, patients tolerate the lengthening period well, which is shorter, but the long wait until consolidation may present complications, such as pin site infection and limited joint mobility. The need to use the external fixator until consolidation is not well tolerated by most patients.[7,8]

Femoral lengthening with a monolateral external fixator associated with locked intramedullary nail is an alternative technique that brings benefits such as shorter duration of treatment and improved knee range of motion without compromising the bone regenerate.[9–12]

This study aimed to demonstrate whether the lengthening technique with an external fixator associated with locked intramedullary nail is effective and beneficial regarding duration of external fixator use and improved rehabilitation.

Material and methods

Between January 2005 and May 2014, 31 patients with femoral shortening who underwent lengthening technique with external fixator were retrospectively studied. Regarding the cause of shortening, 23 patients had fracture sequelae, three had congenital short femur, two had polio, two had previously resolved infection, and one had developmental dysplasia of the hip. Age ranged from 15 to 62 years; 26 patients were male and five female. Initial shortening ranged from 2.5 cm to 8 cm, assessed at a scanogram of the lower limbs, with a mean of 5.31 cm. The mean initial knee range of motion was 1°–100°. All patients were treated with a monolateral external fixator and locked intramedullary nails, with 23 anterograde and eight retrograde nails. The nail diameter was 9 mm for solid nails and 10 mm for milled nails.

Surgical technique

Patient is positioned in lateral decubitus for the anterograde nails and in dorsal decubitus for the retrograde nails, on a radiolucent operating table. Femoral osteotomy is made by a small longitudinal lateral incision in the middle third of the thigh. Subsequently, a semi-circumferential bone drilling is made with a 3.5-mm drill in the lateral, medial, and anterior cortices, and a complete linear osteotomy is finalized with the osteotome in the posterior cortex. After the nail is introduced, the locking screws are positioned closest to the entrance of the guide. A Schanz screw is then placed in the fragment proximal to the osteotomy, perpendicularly to the lateral cortex, from lateral to medial, in order to avoid an impact on the previously inserted intramedullary nail. Then, the screw head is

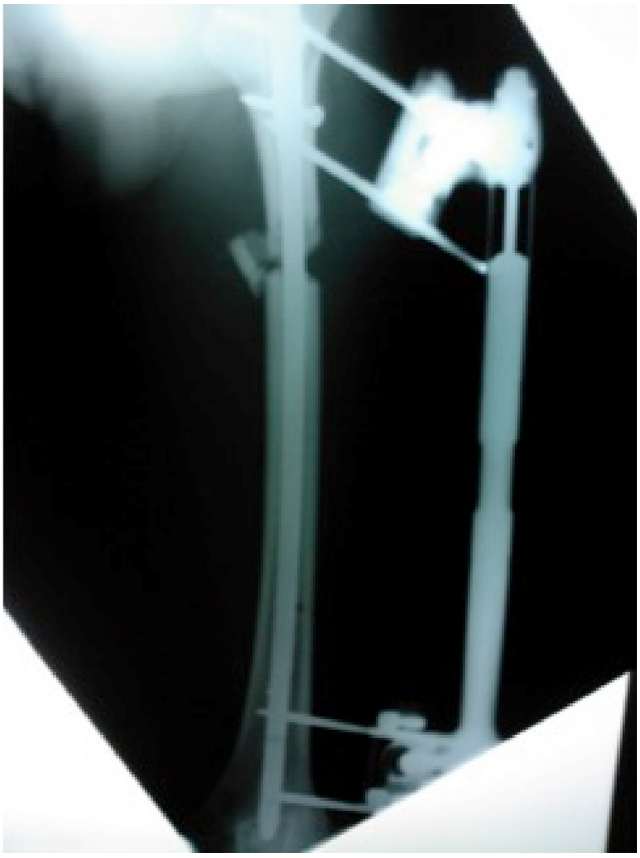

Fig. 1 – Radiographic image of a femur in the lengthening phase after osteotomy, undergoing lengthening.

positioned on the screw and the lengthening device is installed in the same direction of the mechanical axis of the femur. The distal head is coupled onto the device and, guided by its orifices, a Schanz screw of same dimension is inserted in the same orientation. After bone alignment, positioning of the screws, and structure of the external device are assessed and confirmed, device assembly is completed with two or three screws in the proximal and distal fragments (Fig. 1).

In the present study, antibiotic therapy was performed with 1 g intravenous cephalothin every 6 h during hospitalizations, followed by 500 mg oral cephalexin every 6 h for seven days after discharge.

Patients were instructed to initiate distraction on the seventh day, with a frequency of one-quarter of a turn every 6 h, or 1 mm per day. All patients were followed-up every two weeks until the end of the lengthening phase. One week after the programmed bone lengthening was reached, distal locking screws of the nails were made; the external fixator was removed and the knee was manipulated. Then, active and passive movements of the hip, knee, and ankle were initiated. Partially-loaded gait with the aid of crutches was stimulated as tolerated; patients were followed-up monthly thereafter (Fig. 2).

A bone regenerate was considered consolidated when frontal and profile radiographs presented visible bone callus in three cortices.

Fig. 2 – Radiographic image of the femur after the final lengthening, in which bone healing can be observed.

The external fixation duration, time interval until consolidation, knee range of motion, and complications were assessed.

Results

Bone consolidation was observed in all patients. The mean lengthening was 4.65 cm per patient. The mean duration of external fixation use was 2.47 months (external fixation index of 16.15 days per centimeter). The mean time to bone healing was 6.665 months (consolidation index of 43 days ratio per centimeter). The mean knee range of motion was 0°–115°.

No fractures or residual deformities were observed in the bone regenerate. Regarding complications, four patients were re-approached due to osteotomies that were considered incomplete; the patient with dysplasia sequela had hip subluxation. The fixator of one patient broke, and was replaced on an outpatient basis; a locking screw was removed in one patient. Two patients evolved with knee limitation, and were treated with arthroscopic release, which improved range of motion.

Discussion

The lengthening method over intramedullary nails was developed by Paley et al.[9] to accelerate the healing and onset of rehabilitation. The present study was not comparative. However, the external fixation technique with intramedullary nails showed satisfactory results in relation to consolidation time, duration of external fixator use, and mobility of the knee joint.

The bone lengthening method introduced by Ilizarov is currently the treatment of choice for limb length discrepancy, regardless of the etiology. The major disadvantage described is the prolonged use of external fixation, especially during the regenerated bone healing time. This imposes psychological complications to both the patients and their families.[7,8]

The use of locked intramedullary nails associated with external fixator allows the removal of the external fixator after

the lengthening phase. The consolidation period, which is at least twice as long as the lengthening, can be completed using only a locked intramedullary nail. This technique allows for early joint mobility and protects the bone regenerate.[9–12]

In 1992, García-Cimbrelo et al.[7] reported that, of 100 patients treated with the traditional technique using the circular external fixator, in which 47 patients were subjected to lengthening, complications such as intolerance to the device occurred in 6%, muscle contracture in 22%, and two patients presented fractures in the bone regenerate. They concluded that the prolonged duration of external fixation use contributed to complications. In the present study, as the fixator was removed after the lengthening period, these complications did not occur.

Several authors have described the advantages of bone lengthening through the association of external fixator and locked intramedullary nails.[9,13]

In 2011, Sun et al.[14] conducted a retrospective comparative study in tibial bone lengthening in which they compared 176 patients (289 tibias) that were elongated with (143) and without (146) the association of intramedullary nails. They concluded that the group of external fixation associated with intramedullary nails presented better results regarding bone healing time.

In 2012, in a systematic review comparing the traditional Ilizarov method with the technique of external fixator associated with intramedullary nails in tibial lengthening, Jain and Harwood[15] assessed whether the healing time and the duration of external fixator use decreased. They concluded that there was no change in the time of consolidation, and that the duration of external fixation in the combined technique was lower. Complications were similar in both methods. These results are in agreement with those obtained in the present study.

Mahboubian et al.,[16] in 2011, compared the use of external fixator over nails with telescopic intramedullary nail in femoral lengthening. They reported that patients who used external fixator over nails had fewer complications and better control of the lengthening speed.

El-Husseini et al.,[17] in a randomized prospective clinical study, compared lower limb lengthening (femur and tibia) through the Ilizarov technique with the technique of external fixator associated with intramedullary nails They concluded that the healing time was shorter in the group that used the fixator over nails. In addition, more complications observed in the group in which only an external fixator was used. The present study was not comparative; therefore, it was not possible to conclude whether the consolidation time was shorter.

The technique of lengthening over nails is not free of complications. Some studies on femur lengthening reported that, when lengthening reached 20% of total limb length, patients evolved with posterior subluxation of the knee or patellar subluxation. Although lengthening over nails reduces the duration of external fixation use, caution is required to prevent the main complications reported.[18]

In the present study, some complications (28.7%) related to the osteotomy technique were observed. In four patients, a new osteotomy was necessary. Intraoperative maneuvers with fragment translation, confirmed by fluoroscopy, facilitated the confirmation that the osteotomy was complete.

Surgical manipulation of the knee was performed in all patients; in two cases, arthroscopy was used. These maneuvers allow the improvement of the knee range of motion.

Conclusion

Femoral lengthening technique with monolateral external fixator over intramedullary nail is an effective method, allows a shorter duration of external fixator use, better protection of the bone regenerate, and early joint rehabilitation; however, it is not free of complications.

Conflicts of interest

The authors declare no conflicts of interest.

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