

Fixator-assisted tibial lengthening over a plate in a patient with sequelae of poliomyelitis

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Abstract

There are many techniques for limb lengthening. Lengthening over a plate is an alternative choice of fixation in children or when nailing is difficult. We present a new technique for tibial lengthening with using a monolateral external fixator over a lengthening plate.

Lengthening over an intramedullary nail is a commonly used method in patients with short stature or limb-length discrepancy. However, in patients with a narrow and excessively sclerotic intramedullary cavity in the pediatric age group where the skeletal system has not yet fully developed, difficulties have been observed in lengthening methods with nailing.

Therefore, in these cases, the use of lengthening techniques over a plate is an alternative treatment option. Nevertheless, in lengthening techniques over a plate, if one side of the osteotomy area cannot be fixed, associated mechanical axis problems have been reported.

We applied tibia lengthening with external fixator assistance over a custom-made lengthening plate in a patient with sequelae of poliomyelitis. This new lengthening technique applied over a plate could be the solution to the problems observed in other lengthening techniques over a plate.

Abbreviation: MIPO = minimally invasive plate osteosynthesis.

Keywords: external fixator, lengthening plate, malalignment, tibial lengthening

1. Introduction

Distraction osteogenesis is an effective method which is widely used in the treatment of bone defects, nonunion, extremity deformities, and limb-length inequalities.^[1–3] For many years, in the treatment of problems such as these, a circular external fixator has often been used. However, complications such as pin tract infection, deep infection, malalignment, regenerate collapse,

and joint stiffness are frequently observed. Patient dissatisfaction is also associated with the long-term application of an external fixator frame. With early removal of the external fixator frame, secondary axial deformities, shortening, nonunion, and fractures in the area of osteomyelitis may be observed.^[1,4–7]

In the past few decades, lengthening techniques over intramedullary nails have become an alternative to the traditional lengthening method with an external fixator.^[5,8,9] However, the use of these techniques is limited in pediatric patients in whom skeletal development has not been completed and in those with a narrow and overly sclerotic intramedullary canal, such as in achondroplasia or sequelae of poliomyelitis.^[13,14] In recent years, the technique of lengthening over a locking plate has been applied in patients with narrow or sclerotic intramedullary cavity, who are not suitable for lengthening over an intramedullary nail.^[10,11,15] As the new lengthening technique presented here is different from other plate-lengthening techniques, it can be considered a solution to the problems of malalignment, angulation, and rotational defects.

In this paper, we presented a new technique. We applied tibial lengthening using external fixator assistance over a custom-made lengthening plate in a patient with sequelae of poliomyelitis.

2. Surgical technique

A 31-year-old female presented at our clinic with lower limb-length inequality due to the sequelae of poliomyelitis. In the physical examination, right lower extremity was determined to be 5.5 cm shorter than the right side extremity. The patient was informed in detail about the planned lengthening surgery, and written informed consent was given.

Following the preoperative preparations, the patient underwent spinal anesthesia. We performed tibial lengthening over a custom-made anatomic lateral proximal tibial lengthening plate (Tipmed, Izmir, Turkey) with the assistance of a monolateral

Editor: Johannes Mayr.

Patient consent: We informed both the patient and patient's parents about this study and obtained written informed consent.

Authors' contributions: HBT performed the technique and wrote the manuscript. HBT, SS, and AU contributed to the discussion and reviewed/edited the manuscript and researched data. SS, AU, and SC helped to draft the manuscript. SAG and AU researched data and contributed to discussion. All authors read and approved the final manuscript.

Funding: The authors received no financial support for the research and/or authorship of this article.

The authors have no conflicts of interest to disclose.

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Medicine (2016) 95:44(e5252)

Received: 27 June 2016 / Received in final form: 30 September 2016 /

Accepted: 3 October 2016

<http://dx.doi.org/10.1097/MD.0000000000005252>



Figure 1. Lateral (A) and anteroposterior (B) images of the custom-made anatomic lateral proximal tibia lengthening plate. Screw fixation in the "Lengthening Hole" from the distal of the osteotomy area allows lengthening by sliding over the plate during lengthening.

external fixator (Orthofix LRS, Orthofix, Berkshire, UK) (Fig. 1). The patient was positioned supine on a fracture table to enable fluoroscopic imaging during surgery. Under a tourniquet, an oblique entry incision approximately 3 to 4 cm in length was made in the tibia proximal lateral, appropriate for the minimally invasive plate osteosynthesis (MIPO) technique. The skin, subcutaneous tissue, and fascia were passed, then a subcutaneous tunnel was created using a periosteal elevator. The custom-made anatomic lateral proximal tibial lengthening plate was placed subcutaneously on the

lateral surface using a guide of the appropriate length for the planned lengthening (Fig. 2). The placement of the plate was checked under fluoroscopy with anterior–posterior and lateral images. The area where the osteotomy was to be applied was identified, and $4 \times 4.5 \text{ mm}^2$ locking screws were fixed with using a tissue-protecting sleeve to screw holes proximal of the planned osteotomy region.

Subsequently, with the guidance of the lengthening hole, $2 \times 4.5 \text{ mm}^2$ cortical screws were advanced with a tissue-protecting sleeve, from 2 cm distal of the planned osteotomy and fixed. The plate placement was checked with fluoroscopy AP and lateral images (Fig. 3). Then, the line of the osteotomy was drilled with the aid of a K-wire from distal of the proximal incision, and transvers osteotomy was created with an osteotome. The completion of the osteotomy was monitored under fluoroscopy (Fig. 4). To place, opened layers of the wound were closed properly in sequence. Then, to place a monolateral external fixator on the medial surface of the tibia, $2 \times 5 \text{ mm}^2$ Schanz screws were advanced medially obliquely to the proximal and distal of the osteotomy area (Fig. 5). After the monolateral external fixator was applied, the operation of the lengthening system was checked. To prevent obstruction by the fibula during lengthening, an osteotomy was applied to the mid and distal diaphyseal junction of the fibula.

On the seventh day postoperatively, lengthening was started at 1 mm/d ($4 \times 0.25 \text{ mm/d}$). How the lengthening could be applied at home was explained and demonstrated to the patient, and follow-up visits were scheduled at 10-day intervals. At the follow-up examinations, physical and radiological evaluations were made and recorded (Fig. 6). After the planned amount of lengthening was confirmed by radiological examination, the external fixator was removed (Fig. 7). Under spinal anesthesia, $3 \times 4.5 \text{ mm}^2$ locking screws were fixed with a tissue-protecting sleeve over the guide to the most distal screw holes of the lengthening plate. Subsequently, the external fixator was removed (Fig. 8). On postoperative day 1, active–passive knee and ankle exercises were started, and mobilization was made with crutches, with only toe pressure permitted on the affected



Figure 2. The anatomic lateral proximal tibial lengthening plate designed to be compatible with the minimally invasive plate osteosynthesis technique was placed subcutaneously. Anterior (A) and lateral (B) view of the lengthening plate and insertion guide. Using a small incision and the guide, the lengthening plate was placed subcutaneously on the tibial lateral surface (C).

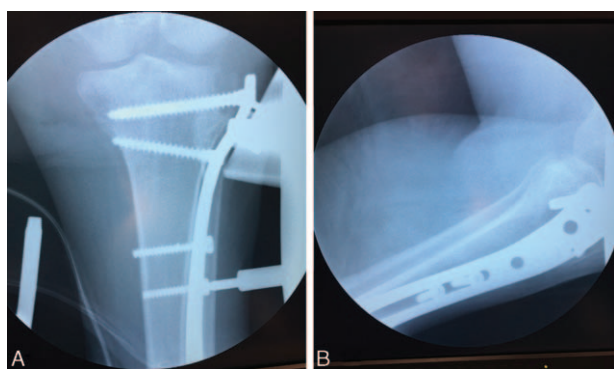


Figure 3. Anteroposterior (A) and lateral (B) fluoroscopy images after fixation of the lengthening plate.

side. Full weight-bearing was permitted when fracture healing in the osteotomy area was obtained (Fig. 9).

Throughout the lengthening procedure and afterward, no complications were encountered such as axial or rotational deviations, infection, implant failure, or distraction defect. A total of 4.3-cm tibial lengthening was achieved. The external fixator was removed on the 55th day after the start of the lengthening procedure. Stable consolidation was noted at 4 months postoperatively, so full weight-bearing was then permitted. At the final follow-up examination, completed bony union was observed in the lengthening area, and excellent patient satisfaction was achieved.

3. Discussion

In patients with angular deformity and very narrow and sclerotic medullary cavity, the application of lengthening techniques with intramedullary nailing is extremely difficult. Therefore, the lengthening method over a plate has become an alternative treatment option in these patients.^[12,16] In this study, tibial lengthening was applied to a patient with sequelae of poliomyelitis, using the MIPO technique with a monolateral, external fixator-assisted, and custom-made lengthening plate. The MIPO technique was preferred as it is a fixation method which, by protecting the perforating and feeding arteries, does not disrupt the periosteal and endosteal circulation.^[11,16]

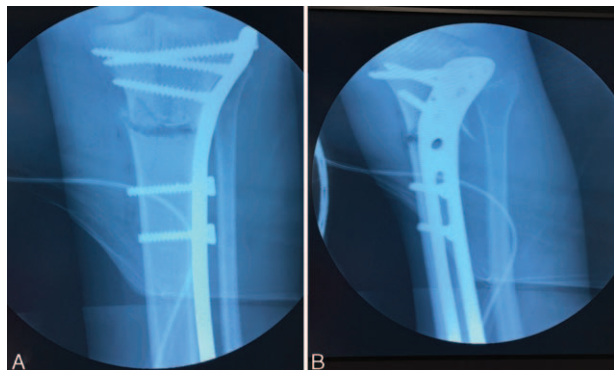


Figure 4. Anteroposterior (A) and lateral (B) fluoroscopy images after osteotomy.

External fixator-assisted lengthening techniques over a plate have several advantages compared to other intramedullary lengthening techniques, such as the applicability in pediatric patients where the epiphysis has not completely closed and in patients with excessive bone deformity, joint contracture, or very narrow and sclerotic medullary cavity. In addition, compared to intramedullary lengthening techniques, method reduces the risk of infection and fat embolism.^[10,12,17]

Endo et al^[11] reported that in patients with a complicated deformity such as achondroplasia, osteosynthesis made with the MIPO technique following lengthening with an external fixator shortened the period of application of the external fixator. Iobst and Dahl^[10] reported that in respect of shortening the duration of application of the external fixator, regaining movement, maintaining patient satisfaction, and achieving the other targets of lengthening, the technique of lengthening over a plate was just as effective as the lengthening technique with nailing. Apivatthakul and Arpornchayanon^[15] described the MIPO technique combined with the distraction osteogenesis technique as an alternative method to other techniques in bone transport. Uysal et al^[7] applied a narrow locking compression plate (LCP) with the MIPO technique after lengthening with an Ilizarov fixator in patients with lower limb-length inequality. They emphasized that plating after lengthening was a simple, reliable, and effective method, and as it decreased the duration of application of the external fixator, patient comfort was increased and complication rates were reduced.

The technique used in the present study is different from lengthening over plating and plating techniques after lengthening. Uysal et al,^[7] Endo et al,^[11] Oh et al,^[12] and Harbacheuski et al^[18] applied bone lengthening with an external fixator, then after lengthening, internal fixation was made with an LCP with the MIPO technique, and the fixator was removed. However, in some of these studies, mechanical axis problems were encountered. Harbacheuski et al^[18] reported a high rate of varus deformity in patients with plating made after tibial lengthening. In a study by Iobst and Dahl,^[10] although the external fixator and plate were applied at the same time, as in the present study, there was a significant difference. In the lengthening technique used in the present study, fixation of the lengthening plate in the osteotomy area was made with screws in the superior and inferior parts, whereas in the study by Iobst et al, only the section above the osteotomy area was fixed with screws. Although the lengthening holes in the custom-made lengthening plate of the present study were fixed with screws on both sides of the osteotomy area, the possibility for lengthening was provided. In the study by Iobst and Dahl,^[10] it was reported that severe residual procurvatum deformity developed in 2 patients. In the present study, as the lengthening plate was fixed from both the proximal and distal of the osteotomy area, there was no possibility of mechanical axis problems developing during lengthening, such as malalignment, angular, or rotational deformity.

To avoid deep infection which may develop in the pin tract, the external fixator was applied from the medial and the lengthening plate from the lateral in the technique of the present study. Great care was taken that the screws with which the lengthening plate was fixed and the Schanz screws of the fixator were not in contact with each other. This was important in respect of preventing cross-contamination, which can be observed especially in fixator-assisted lengthening with intramedullary nailing. Furthermore, because there could be problems associated with insufficient space left by the application of intramedullary nails for the

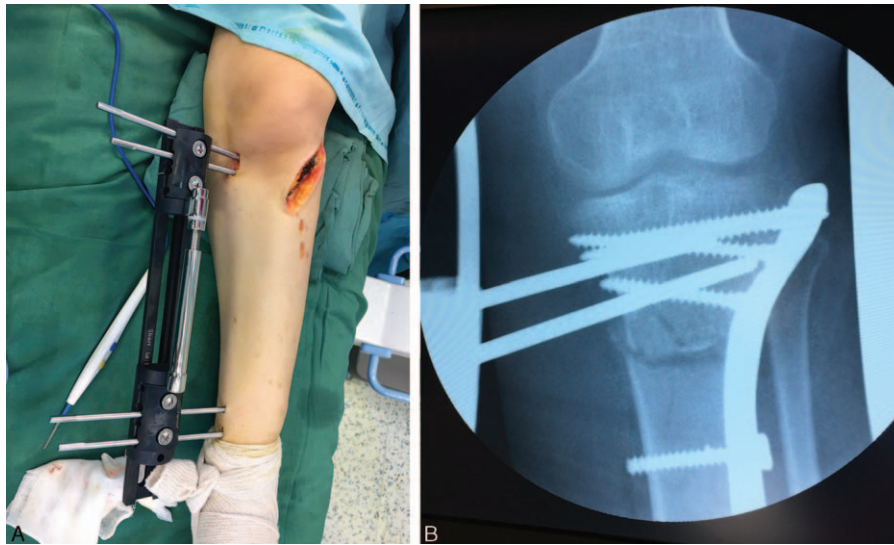


Figure 5. Visual image (A) and fluoroscopic image (B) of the monolateral external fixator placement on the tibial medial surface.

passage of the K-wires or Schanz screw used in the fixation of the external fixator in fixator-assisted tibial lengthening, the lengthening technique over a plate used in the present study could be more advantageous.

There are 2 elements of this technique which can be criticized. The first is that there can be a problem of plate failure associated with the length of the lengthening hole of the designed plate. In order to avoid problems such as breaking, bending, and fatigue of the lengthening plate and screw failure, we recommend full weight-bearing only after sufficient union is achieved. The other element is the risk of infection related to contact of the fixator and plate fixation screws. However, this contact risk can be minimized if care is taken during surgery regarding the directions that the screws are advanced and the fixation locations.

Due to the fixation with screws on both sides of the osteotomy area, the lengthening plate used in this study during fixator-assisted lengthening provided a very important advantage in respect of resolving mechanical axis defects observed in other lengthening techniques over a plate. In addition, as it allowed for early removal of the external fixator after the completion of the lengthening procedure, it was considered to reduce the risk of joint contracture and pin tract infection by shortening the duration of application and thereby increase patient satisfaction.

In conclusion, the method described in this study of a tibial lengthening technique made over a custom-made lengthening plate is an advantageous method compared to other lengthening techniques for pediatric patients where the skeletal system has not yet fully developed, patients with very narrow and sclerotic medullary cavity, and patients with bone deformities for whom lengthening techniques with intramedullary nails would not be appropriate. This lengthening technique is a simple and reliable

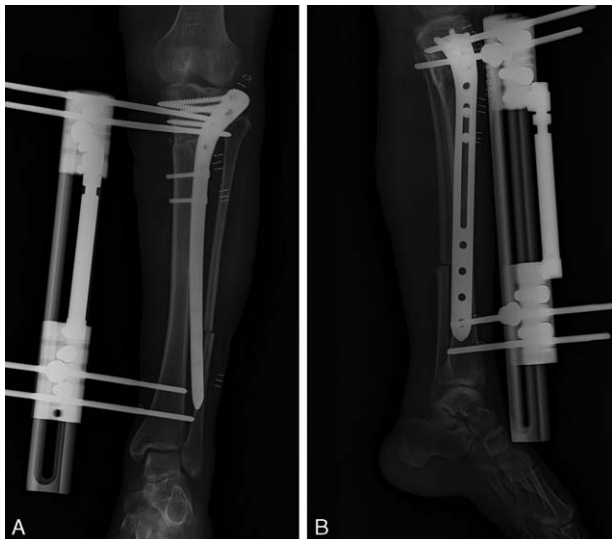


Figure 6. Postoperative anteroposterior (A) and lateral (B) radiographic images before lengthening.

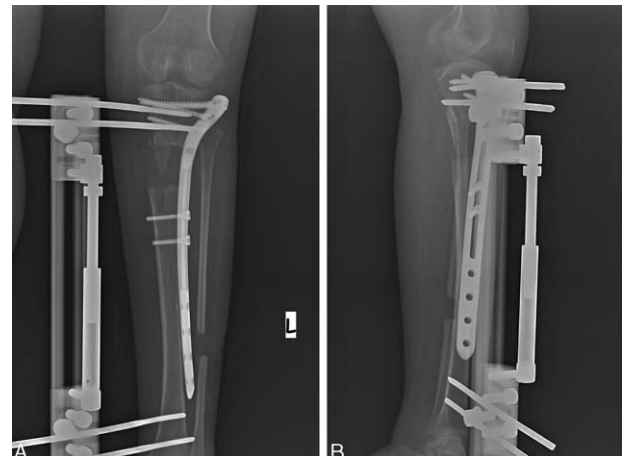


Figure 7. Anteroposterior (A) and lateral (B) radiographic images after lengthening.



Figure 8. Anteroposterior (A) and lateral (B) radiographic images after fixation of the most distal screws of the lengthening plate after removal of the external fixator.



Figure 9. Anteroposterior (A) and lateral (B) radiographic images document healing of the lengthening area and well consolidated osteotomy site.

method which can be applied with similar plate designs for other extremity problems for which lengthening is planned.

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