Tibial Lengthening Using A Magnetic Lengthening Intramedullary Nail in an HIV-Positive Patient: A Case Report and Review of Literature

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ABSTRACT

Limb lengthening can be affected by poor bone healing in patients with human immunodeficiency virus. This is a case report of a 56-year-old man with 6.1 cm leg length discrepancy and end-stage arthritis in the hip. The patient had total hip arthroplasty prior to his lengthening procedure. The patient was human immunodeficiency virus positive. This case report describes the experiences of using a motorized intramedullary magnetic lengthening nail in equalization of limb length discrepancy. Treatment for the patient included tibial lengthening with a motorized nail to correct the limb length discrepancy, with adequate bone healing in a patient with an human immunodeficiency virus infection.

Keywords: Leg Lengthening, HIV-Positive Patient, Motorized Tibial Nail, Leg Length Discrepancy, Limb inequality

INTRODUCTION

Leg length discrepancy (LLD) can result in considerable disabilities such as limping, back pain, and joint arthritis.[1] Gradual limb lengthening using distraction osteogenesis is a well-established technique that equalizes LLD. Reasonable operative options include external fixation, lengthening over the nail, lengthening and then nailing, or lengthening with a fully implantable motorized nail such as the PRECICE Nail (NuVasive, San Diego, CA).[2-4] Each surgical technique has its advantages and limitations.

In recent years, motorized nailing has become the more popular method of treating LLD for several reasons, including transcutaneous activation, short consolidation time, high-quality bone regeneration during lengthening, and early functional rehabilitation.[3, 5-11] The advantages of using motorized nails compared to external fixation include earlier weight bearing, reduced refracture or regenerate bending after external fixators removal, less pain during lengthening, lack of pin-site infection, and rapid restoration of joint range of motion.[12] Disadvantages to using motorized nails include increased risk of blood loss, fat emboli, mechanical failures, and intramedullary infection.[5-7]

Human immunodeficiency virus (HIV) disrupts the normal inflammatory process, leading to delayed wound healing, osteopenia, and osteoporosis.[13,14] For patients with HIV, the incidence of contracting infection is higher during external fixation for open fractures.[15,16] Poor bone mineral density compromises the post-surgical healing process of fractures in patients with HIV.[17]

This case describes a complex case of a 6.1 cm LLD of the right femur in an HIV-positive patient treated with tibial lengthening with a motorized nail.

CASE REPORT

A 56-year-old man was referred to clinic for management of an LLD owing to shortening of the right femur. The patient reported remote history of a right femur shaft fracture that was treated nonoperatively during childhood. He had concerns of pain and limping. The pain was aggravated by exercise and walking. Preoperative images confirmed end-stage osteoarthritis of the hip and LLD. The patient underwent arthroplasty of the right hip for the end-stage right-hip osteoarthritis. The surgery was performed by a different surgeon. Total hip arthroplasty (THA) was uneventful; however, the patient continued to have pain and limping after THA due to LLD. The patient was referred to our center for further evaluation and treatment of LLD.

The patient was evaluated clinically and radiologically for the amount and source of LLD, ankle and knee

Figure 1. *Preoperative radiograph showing leg length discrepancy with shortening of the right lower extremity.*

range of motion, and limb alignment. The LLD was 6.1 cm in the right femur (Figure 1). The femoral stem of the ipsilateral THA extended down to the mid-shaft. The plan was to lengthen the right tibia 6 cm to compensate for the 6.1 cm shortening of the right femur. The patient was counseled about other treatment options and their complications (ie, left femur shortening and external fixators), and he consented for implantation of a PRECICE Nail in the right tibia to correct the LLD.

SURGICAL TECHNIQUE

The procedure began with a fibular osteotomy and prophylactic stabilization of distal tibia-fibular joints with 3.5 mm screws to allow lengthening of both the tibia and fibula. Before reaming, a single venting hole at the presumed osteotomy site was made to minimize the risk of fat embolism during reaming. This single hole was purposefully located in the medial border of the tibia and opened into the subcutaneous tissue to be an exit for excess reaming material, and avoid the extravasation into the closed anterolateral leg compartment. This technique was used to reduce the risk of the acute postoperative compartment syndrome. The tibia was then progressively reamed to 13 mm and implanted with a 305 x 10.75 mm PRECICE Nail. Additional drill holes were made at the presumed osteotomy site using a 4.8 mm drill bit. The nail was then advanced just short of the osteotomy. Completion of osteotomy was then performed using a sharp osteotome (DeBastiani technique). The completion of osteotomy was verified using two orthogonal fluoroscopic images. The nail was then carefully advanced through the tibia. Advancing of the nail was monitored using fluoroscopy.

The fixation of the superior tibiofibular joint was achieved with one of the proximal locking screws of the nail (Figure 2). The screws passed from medial to lateral through the nail and through the proximal tibiofibular

Figure 2. *A,B) Anteroposterior and lateral radiographs of implantation of PRECICE nail at 1 week postoperatively.*

Figure 3. *A,B,C) Images at 12 months follow-up showing correct leg length discrepancy of right lower extremity and range of motion of the affected extremity.*

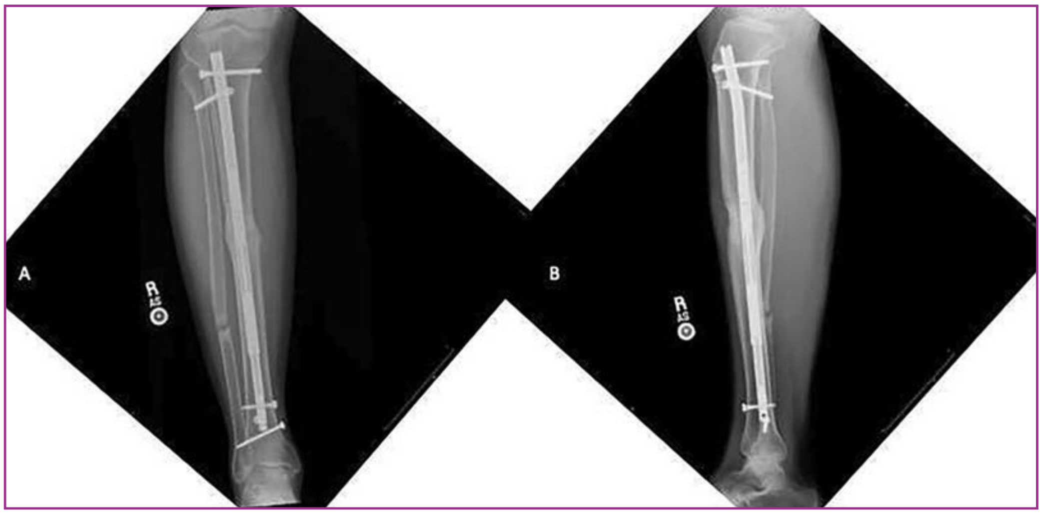

Figure 4. *A,B Anteroposterior and lateral radiographs of PRECICE nail implantation at 12 months follow-up showing union of the tibial osteotomy site and nonunion of the fibula.*

joint. The distal locking screws were inserted using a perfect circle technique. Intraoperative lengthening of 1 mm was applied by the PRECICE nail to verify its mechanical properties using the external remote controller, while the patient was still under general anesthesia.

Postoperative Course

The patient was admitted for pain control and received intravenous antibiotics for 24 hours. The patient wore a controlled ankle motion boot during the night to protect against ankle equinus contracture. He was referred to physical therapy immediately after surgery.

After a latency period of 2 weeks, tibia lengthening began at a rate of 0.75 mm per day for three increments per day. Partial weight bearing of 40 lb was allowed during the distraction phase. Follow-up appointments were scheduled regularly every 1 to 2 weeks. The patient reported trouble scheduling physical therapy appointments due to his insurance. At 3 months postoperatively, gastrocnemius recession (Strayer procedure) was performed for ankle equinus contracture. Ankle range of motion was fully restored postoperatively.

Radiographs showed poor-quality bone regeneration. The rate of distraction was slowed to induce normotrophic regeneration. The slower rate (ie, 0.25 mm per day) improved bone regeneration quality, and the patient consolidated without further interventions. Before stopping the distraction, a final LLD evaluation was performed clinically and radiographically. Clinical evaluation was performed using wooden blocks, and radiographic evaluation was performed using a weight bearing, full-length scanogram. A total of 6.1 cm of lengthening was achieved over 9 months for a lengthening index of 0.68 cm per month. At the final follow-up at 28 months postoperatively, the patient reported ambulation without assisted devices or pain. The patient maintained a full range of motion in the knee and ankle (Figure 3). The radiographs confirmed the full healing of the regenerate and equalization of

Figure 5. *Radiograph at 12 months follow-up showing corrected leg length discrepancy of right lower extremity*

LLD (Figures 4 and 5). Removal of screws across the superior and inferior tibiofibular joints were performed owing to pain and screw loosening (Figure 6).

DISCUSSION

LLD with associated end stage arthritis is a challenging clinical scenario and adds to the complexity of primary THA. Dysplastic hip joints associated with femoral shortening were well-known examples. There is no consensus in the literature about the proper timing of limb lengthening whether before or after THA. In this report, the patient had THA before the limb lengthening procedure. The lack of the co-ordination with arthroplasty surgeon limited the options for the limb lengthening procedure.

The patient's factors and surgeon's skillset should be considered when deciding on appropriate treatment. In this case report, the patient's factors included the poor bone quality, increased risk of infection secondary to HIV and the presence of femoral stem in the femur. The treating surgeon discussed all operative options with the patient. Additionally, the treating surgeon thoroughly discussed that equalization of LLD can be achieved through shortening of long limb (left femur) or lengthening of the short leg. The patient declined shortening of left femur due to height reduction, loss of muscle strength and risk of vascular compromise.

The various limb lengthening techniques were discussed as well, including whether to lengthen the femur or tibia and the best device to be used for bone lengthening. In this case, the treating surgeon always preferred to lengthen the short bone (femur), which has a better bone regenerate and short consolidation time after lengthening.[18] Despite these advantages of femoral lengthening, there were multiple concerns about femoral lengthening in this patient. The surgeon did the preoperative planning and radiographic measurements. The available lengths of the retrograde femoral nails would leave either a small area of the femur unprotected between the tips of the nail and

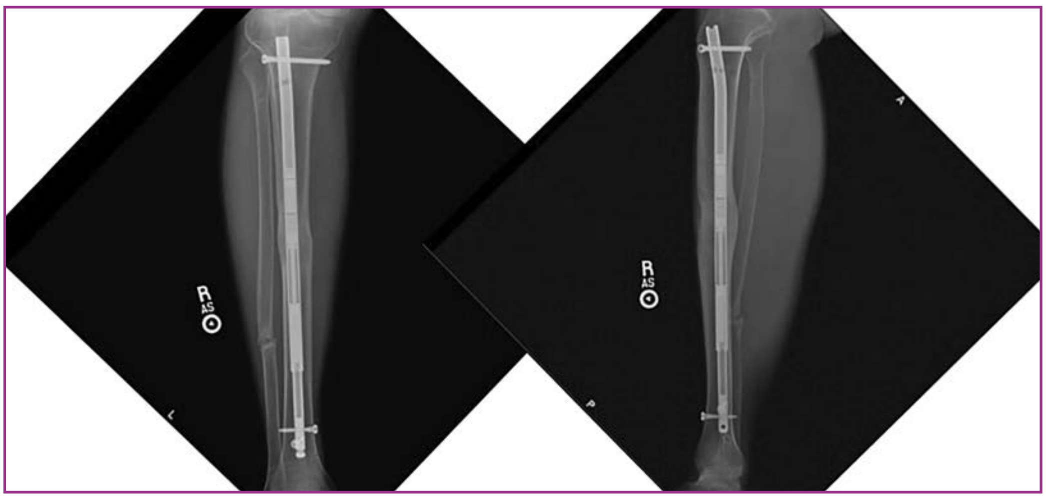

Figure 6. *Radiographic images after removing the loose proximal locking screw from the superior and inferior tibiofibular joints.*

femoral stem. The unprotected segment of the femur poses a significant risk of stress riser and increased risk of periprosthetic fracture, or the insertion of the nail will be stopped by the stem of the prosthesis becoming prominent in the knee. The risk of periprosthetic fracture is significant in this HIV patient with poor bone quality and impaired bone healing. Additionally, the amount of available nail stroke was another concern. The patient needed 6.1 cm of lengthening. The shorter nails allowed only 5 cm of lengthening. This might leave the patient with residual LLD. The external fixator was an option; however, it was not optimum in this HIV patient owing to increased risk of pin-site infection and knee joint stiffness due to muscle tethering.

The outcome of limb lengthening using motorized nails is well-documented in the literature. Hawi et al[19] showed that the intramedullary nailing lengthening (PRECICE system) had better results compared to an external fixator in controlling limb alignment during lengthening, less pain, and early weight bearing. However, the use of the intramedullary lengthening nail is contraindicated in different conditions such as infection, open physis, patients with small medullary canal, and patients who are not compliant to lengthening instructions.[19]

Leg lengthening can be complicated with soft tissue contractures. Knee flexion and iliotibial band contractures were well-reported during femoral lengthening in the literature. On the other hand, ankle equinus contracture was common in tibia lengthening.[20] Intensive physical therapy for muscle stretching and joint range of motion exercises helped to prevent soft-tissue contractures. Protective splints were very helpful to avoid soft-tissue contractures. Surgical soft-tissue release may be needed in fixed contractures that were not responding to nonoperative measurements.[21] In our case, the patient developed ankle equinus contracture owing to lack of access to physical therapy due to insurance issue. The equinus contracture was successfully treated with gastrocnemius recession.

To our knowledge, there is no clear published protocol in the literature to treat patients with end-stage hip arthritis and large LLD. Performing limb lengthening before or after THA, the amount of acute lengthening during THA, and whether to use external fixators or motorized nails for lengthening are questions remained to be answered. Harkin et al[22] reported a case series of three patients with THA who underwent ipsilateral femoral lengthening. The LLD in those patients were treated safely and accurately with intramedullary femoral lengthening. The treating surgeon used a motorized nail for tibial lengthening over an external fixator in this case for two reasons.

First, external fixators had higher risk of pin tract infection in HIV patients. The infection may spread to the femoral stem. This might cause a serious periprosthetic joint infection. Ferriera et al[23] examined 229 patients as well as the incidence of pin-site infection in HIV-positive patients versus their HIV-negative counterparts. Although HIV infection has been independently implicated in the development of pin-site infection, this study found no significant difference between the two groups in the incidence of the infection.[24-26] This is in contrast to the historical belief that HIV infection results in increased incidence and increased severity of the pin-site infection, as well as the general recommendation against their usage in these patients.[25,26] However, these studies were not limited to limb lengthening procedures and encompass all orthopaedic trauma. The second reason for lengthening using motorized nail was the reduced risk of secondary fracture or regenerate bending after external fixators removal.[27]

The asymmetry of the knee levels was an obvious limitation of using tibial lengthening for femoral shortening. However, our patient reported no functional limitation related to the asymmetry of knee height. The authors were not aware of any published report of the gait analysis study showing gait disturbance due to asymmetry of knee height. Despite this, the authors admitted the cosmetic concerns of the asymmetry of the knee height, the patient was extremely satisfied with the final outcome.

This is the first reported case of bone transport with a motorized nail in an HIV-positive patient. Although there have been studies examining the complications associated with HIV-positive patients and orthopaedic injuries, none have been conducted to measure the success of bone lengthening with a motorized nail. In this case, a decreased distraction rate was needed to accommodate the poor bone formation seen in this subset of patients. Implantation of a motorized nail controlled via external remote controller allowed rate and rhythm adjustments during lengthening and the achievement of a desirable outcome in our patient.

In conclusion, motorized nails can be used effectively to equalize LLD correction in HIV-positive patients. Slowing the rate and rhythm allows more time for bone healing and consolidation. Preoperative coordination between arthroplasty and limb lengthening surgeons is critical to increase the available treatment options in patients with combined LLD and hip osteoarthritis.

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