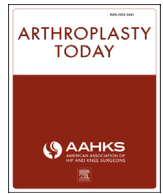




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Case report

Total hip arthroplasty and femoral nail lengthening for hip dysplasia and limb-length discrepancy

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ABSTRACT

The application of distraction osteogenesis through the use of magnet-operated, remote-controlled intramedullary lengthening continues to provide new opportunities for accurate limb equalization. While limb-length discrepancy and deformity can be addressed by total hip arthroplasty alone, the magnitude of correction is limited by the soft-tissue envelope and complications such as sciatic nerve palsy. This 3-patient case series presents the combination of staged ipsilateral total hip arthroplasty and retrograde intramedullary femoral nail lengthening for the correction of both deformity and limb-length discrepancy. Our results report leg-length equalization, independent ambulation without assistive devices, and excellent bone and functional outcomes without complications, demonstrating that this combined technique can be used to achieve targeted lengthening and deformity correction.

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Introduction

Distraction osteogenesis has been used to correct limb-length discrepancy (LLD) resulting from a wide range of etiologies including congenital shortening, growth plate arrest, open fractures with bone defects, nonunion, tumor, osteomyelitis, and achondroplasia. The application of a magnet-operated, remote-controlled intramedullary (IM) lengthening nail continues to provide new opportunities for accurate limb equalization with excellent functional outcomes and improved consolidation indices [1–6]. Bone lengthening with internal devices provides decreased complication rates compared with external fixation, including pin tract infections, soft-tissue tethering, and joint stiffness [1,4,5]. The PRECICE nail system (NuVasive Specialized Orthopedics, Aliso Viejo,

CA) is an IM, magnetic, telescopic rod that is activated through an external handheld controller. The rate and rhythm of distraction is programmed by the surgeon and transmitted to the device to allow for the desired daily distraction rate and rhythm. The advantages of the PRECICE nail system over previous models include the ability to either lengthen or shorten without the use of a cable or implanted subcutaneous antenna. Kirane et al [2] utilized the PRECICE system to perform a mean total lengthening of 35.0 mm with a range of 14.0–65.0 mm, while maintaining alignment and knee and ankle range of motion for 24 patients with femoral and tibial LLD.

While LLD and hip deformity can be addressed by total hip arthroplasty (THA) alone, the magnitude of achievable correction is limited by the soft-tissue envelope and concern over associated complications. Limb lengthening through THA is limited by the risk of sciatic, femoral, and peroneal nerve palsy, low back pain, and abnormal gait. There is no safe threshold for lengthening; however, it is agreed upon that progressively greater lengthening is associated with greater risk of injury [7]. Edwards et al [8] reviewed THA cases complicated by nerve palsy and found an average lengthening of 2.7 cm for peroneal nerve palsy and 4.4 cm for sciatic nerve palsy. Therefore, the general consensus on the amount of length that can be gained through THA at the time of surgery is 4.0 cm with careful monitoring and direct visualization of nerve tension with

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lengthening greater than 2.0 cm. It is important that the initial physical examination rules out other causes of deformity and LLD including flexion contracture and rigid scoliosis; the former is correctable with standing blocks on standing long-leg radiographs, whereas the latter is not [9]. Patients with an LLD undergoing THA are younger, tend not to use assist devices or shoe lifts, and are predominantly females. LLD can be addressed through THA by lowering the acetabulum toward an anatomic position or inserting a femoral component that is longer than the length of the femoral bone removed [10]. Although deformity correction through THA is possible, its limitations may prevent full correction of larger length discrepancies, and these individuals stand to benefit from a combined operative technique.

The use of IM limb lengthening in conjunction with THA has yet to be described. The present article presents a retrospective multicenter case review identifying 3 patients who underwent staged ipsilateral THA and retrograde IM femoral nail lengthening with the PRECICE nail for deformity and LLD. The mean age at surgery was 28.3 years (range, 17–40 years) and the minimum follow-up was 14 months from the index procedure (range, 14–40 months). The etiology of the original deformity was Perthes ($n = 1$) and neonatal septic arthritis ($n = 2$).

Assessment included preoperative and postoperative length and alignment radiographic measurements of LLD, mechanical axis deviation (MAD), medial proximal tibial angle (MPTA), and the medial lateral distal femoral angle (mLDFA) as defined by Paley [11] using long-standing radiographs of the entire lower extremity. The MAD was measured in the frontal plane from the center of the femoral head to the center of the ankle plafond; the normal mechanical axis line passes 8.0 ± 7.0 mm medial to the center of the knee joint line. The mLDFA was measured in the frontal plane as the lateral angle formed between the mechanical axis line of the femur and the knee joint line of the femur. The MPTA was measured in the frontal plane as the medial angle formed between the mechanical axis line of the tibia and the knee joint line of the tibia [11].

Outcomes were also evaluated according to the Association for the Study and Application of Methods of Ilizarov (ASAMI) bone and functional scores criteria [12,13]. An excellent functional outcome is defined as being active, no limp, $<15^\circ$ loss of knee extension, no reflex sympathetic dystrophy (RSD), and insignificant pain. Good and fair functional outcomes defined as when patients continued to have 1–2 or 3 of the following: limp, stiffness, RSD, or significant pain. A poor outcome being inactivity resulting in unemployment or inability to perform activities of daily living, whereas amputation is defined as a functional failure. Excellent bone outcomes were defined as union, no infection, final residual deformity $<7^\circ$, and a residual LLD <2.5 cm [13]. Good and fair bone outcomes were defined as union with any 2 or 3 of the following: absence of infection, deformity $<7^\circ$, and a limb-length inequality of <2.5 cm. A poor bone outcome being nonunion, refractures, or union with infection, deformity $>7^\circ$, or limb-length inequality >2.5 cm.

Case histories

Case 1

A 40-year-old female initially presented with left hip ankylosis. She had previously undergone left hip surgery at the age of 8 years in South America and was placed in a cast for 1 year for an unknown condition, presumed Legg-Calve Perthes disease, then subsequently developed avascular necrosis and fusion. Upon presentation, she had a 63.5-mm LLD, 40° hip flexion contracture, 15° of abduction, and 0° external rotation. She was able to ambulate with difficulty using a $1/2$ inch shoe lift (Fig. 1). She underwent an

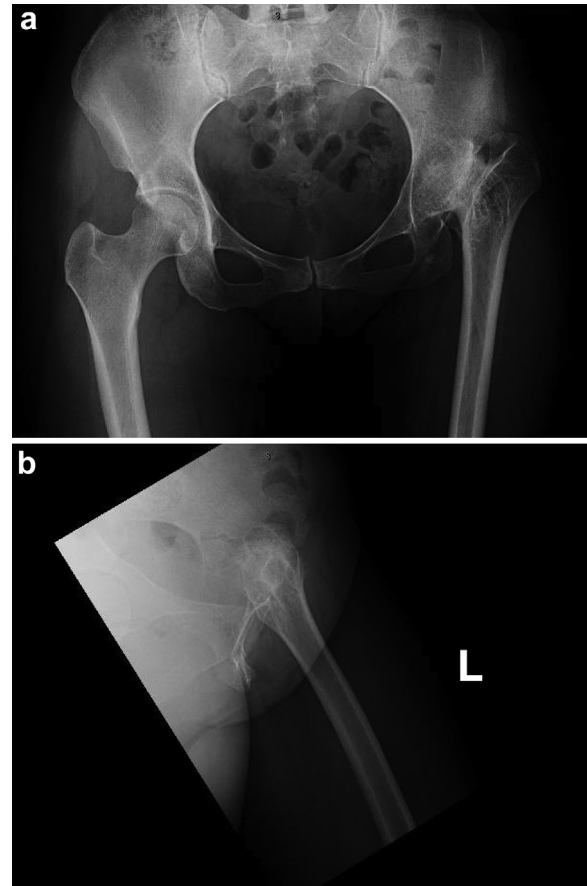


Figure 1. (a and b) Case 1: Preoperative anteroposterior (AP) pelvis and frog-leg lateral radiographs.

uncomplicated THA by a fellowship-trained arthroplasty surgeon using an S-range of motion (ROM) modular hip system (DePuy Synthes Joint Reconstruction, Warsaw, IN). An S-ROM modular hip system was specifically selected to achieve stability through a press-fit metaphyseal sleeve with a fluted diaphyseal stem with differing lengths and configurations, while simultaneously controlling version with independent neck and sleeve options that can be dialed in separately. An intraoperative alignment guide was used to place the acetabular components in 45° abduction and 20° anteversion. Postoperatively the abduction angle was measured to be 46° based on anteroposterior pelvis radiographs taken in post-anesthesia care unit. Lengthening through the THA was approximately 1.5 inches. The estimated blood loss (EBL) was 500 cc, operative time was 280 minutes, and the length of hospital stay was 5 days. Postoperatively the patient ambulated with a half inch shoe lift and had a residual internal rotation deformity and LLD of 24.0 mm originating from the femur. Approximately 21 months after THA, the patient underwent a femoral derotational osteotomy, iliotibial band release, and retrograde PRECICE IM nailing using a 215.0 mm by 10.7 mm diameter rod by a fellowship-trained trauma and limb deformity surgeon. For the lengthening procedure, the EBL was 20 cc, operative time was 225 minutes, and the length of hospital stay was 2 days. She underwent 26 days of lengthening at 1.0 mm per day resulting in a total of 24.0 mm of lengthening through the PRECICE IM system. She was maintained at 50 lbs weight bearing until distraction was completed, and 3 of 4 cortices were healed then advanced to weight bearing as tolerated at approximately 16 weeks. At 11 months postoperatively, the patient was ambulating without a lift or any assist device, reported

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