Bilateral Total Knee Arthroplasty in a 15 Year Old With Skeletal Dysplasia and Open Physes

JASON C. HO, MD; MARCELO B. P. SIQUEIRA, MD; PAUL JACOB, DO; RYAN C. GOODWIN, MD; WAEL K. BARSOUM, MD

abstract

There are limited reports of total knee arthroplasty (TKA) in the pediatric population. The use of constrained, stemmed components is particularly unusual in the setting of open physes due to concerns with growth arrest and implant survivorship. The current authors describe a 15-year-old boy with open growth plates and an epiphyseal dysplasia-like condition affecting the knees bilaterally. He had no other significant medical or orthopedic conditions and his genetic workup was negative. He had severe knee pain and a bilateral 40° valgus with severe lateral compartment arthritis. Conservative treatment provided no symptom relief, and the patient had been wheelchair bound for 18 months prior to presentation. Treatment with simultaneous bilateral TKA using cemented, stemmed, and constrained components was undertaken. There were no intraoperative complications, and his final follow-up was at 5.6 years postoperatively. Radiographic evaluation at follow-up showed that components were well placed with no loosening. The patient had pain-free motion and a perfect Knee injury and Osteoarthritis Outcome Score. Based on the review of the literature and the outcomes of this case, the authors believe simultaneous bilateral TKA using cemented, stemmed, and constrained components is a reasonable option for joint reconstruction in the pediatric patient with open physes who also has significant arthritis and deformity not of oncologic origin. [Orthopedics. 2016; 39(3):e549-e552.]

There are few reports of total knee arthroplasty (TKA) in pediatric patients, except in pediatric tumor1-5 and juvenile idiopathic arthritis literature.6-10 The current case report presents a pediatric patient with open physes who presented with significant bilateral knee deformities due to an epiphyseal dysplasia-like condition. This patient was treated with bilateral TKA using cemented, constrained, and stemmed components.

Case Report

A 15-year-old boy presented for an initial evaluation of bilateral knee pain of insidious onset 8 years prior that had worsened over the past 3 years. This pain was initially intermittent and only in the right knee. The patient had become wheelchair bound 1.5 years prior to evaluation secondary to intractable right knee pain. The patient was 5 feet, 6 inches tall and weighed 115 lb. He was evaluated by an orthopedic surgeon 2 years before presentation and underwent several bilateral knee surgeries, physical therapy, and bracing without improvement. The patient developed progressive valgus deformity over those 2 years and underwent
arthroscopic evaluation of both knees, revealing significant destruction of the articular surface without a specific underlying pathology. The patient denied other joint pain, and his spine evaluation was normal. In addition to his chronic knee problems, the patient had a history of marked flexibility, reporting the ability to excessively hyperextend his wrists and place his legs behind his head. His past medical history was otherwise unremarkable.

His physical examination demonstrated no flexion contracture of his hips bilaterally, with 0° to 100° of flexion, internal rotation to 20°, and external rotation to 45°. His abduction and adduction were 45° and 20° bilaterally. His knee examination showed a 40° valgus deformity bilaterally, with significant condylar enlargement in the coronal plane. There were no rotational abnormalities of the femoral neck or tibial rotation. No effusions were noted, but there was audible and palpable crepitance and tenderness to palpation over the medial and lateral femoral condyles bilaterally. He had full passive extension, 130° of passive flexion, 10° to 90° of active flexion, and laxity with varus and valgus stress tests bilaterally.

Radiographic evaluation of the knee showed bilateral severe genu valgus and evidence of bone loss involving both the lateral femoral condyles and lateral tibial condyles, consistent with severe osteoarthritic type changes secondary to previous avascular necrosis and/or epiphyseal dysplasia (Figure 1). Results of microarray and fluorescence in situ hybridization (FISH) showed a duplication of chromosome 11q23.3 of unknown clinical significance. Plasma amino acid analysis was inconclusive, skin biopsy for collagen screening failed to confirm Marfan and Ehlers-Danlos syndromes, and serum homocysteine levels were normal. Based on these findings, the patient and his family elected to undergo simultaneous bilateral TKA.

During the procedure, the patient was found to have bilateral anterior cruciate ligament deficiencies. It was also noted that the right knee had a remarkably small condylar profile in the lateral view. The lateral femoral condyle was clearly undersized in the medial-to-lateral plane. However, the lateral radiograph revealed a small femur, so a size 5 or 6 would have caused overstuffing the right knee in flexion. There was no hypoplastic lateral condyle, and a minimal medial release was used during the approach for both knees. Both tibias also had significant lateral bone loss, which required a 5-mm augment on the right knee but no augment on the left. In addition, soft tissue tension was adequate in each knee, and no lateral release was required on either side.

Cemented components were used for both knees. A varus-valgus constrained Total Stabilized (TS) knee (Stryker, Kalamazoo, Michigan) with a size 4 femur with a 150x12-mm stem, a size 5 tibia with a 50x12-mm stem, and a 13-mm TS polyethylene insert were implanted in the right knee with a 38-mm patella. The same varus-valgus constrained TS knee was used in the right knee with a size 5 femur with a 150x12-mm stem, a size 6 tibia with a 50x12-mm stem, an 11-mm TS polyethylene insert, and a 36-mm patella. Of note, the left medial collateral ligament was attenuated; therefore, a #2...
FiberWire (Arthrex, Naples, Florida) suture was used to place a modified Krakow stitch in an attempt to tighten the medial collateral ligament.

Postoperatively, a complete skeletal survey demonstrated no other physeal dysplasia. Subsequent office visits were unremarkable, and he progressed as expected. His most recent follow-up was 68 months postoperatively. His Knee Injury and Osteoarthritis Outcome Score was 100 for both knees, and he reported no knee pain. His range of motion was 0° to 135° bilaterally and was stable anteroposteriorly and in varus-valgus bilaterally. He was able to ambulate without pain and needed no ambulatory assistive devices. He was able to attend school and complete activities of daily living without restriction. Radiographs revealed components in good alignment with no signs of wear or loosening (Figure 2).

**DISCUSSION**

Pediatric patients requiring knee replacement in the setting of open physes has been a rare but difficult problem to address. Prior literature regarding this subject has primarily been described in the pediatric tumor1-5,11,12 and juvenile idiopathic arthritis literature,6,7 with most being Level IV case series or retrospective data due to the lack of cases. The juvenile idiopathic arthritis literature has been particularly useful in documenting long-term outcomes in pediatric patients who have undergone TKA. However, many of these studies have included patients of varying ages, including those in their 20s and older who have closed growth plates.

What makes the current case unique is the use of revision TKA components in a pediatric patient with open physes to provide deformity correction necessary for skeletal dysplasia while addressing significant arthritis. The juvenile idiopathic arthritis literature does not describe the use of revision-type knee components, or the description of such was limited. In the adult population, constrained implants have low failure rates in the setting of primary TKA, with approximately 3.5% failure with a mean follow-up of 5.3 years.13 Although no comparison is available in the pediatric population, tumor literature has described the use of stemmed and cemented components that cross open physes.1-5,11,12,14 Some studies have reported significant growth differences in the proximal tibia and distal femur between patients with and without stemmed and cemented reconstruction.3,14 Conversely, there are reports that endorse no difference in femoral and tibial growth among endoprosthetic knees and unreconstructed knees.2 In addition, long-term follow-up data (average, 105 months) showed Musculoskeletal Tumor Society scores similar to those of adult patients who have had endoprosthesis implantation.1

Although these data stem from the tumor literature, similarities can be drawn to the current case, particularly to the type of implant used. A stemmed and cemented prosthesis was used in this case and would present issues similar to those found in pediatric tumor reconstructions around the knee. The tumor literature provides support for the long-term survivability of these implants in the active pediatric population, similar to those implanted into the adult population. However, it should...
be noted that the tumor literature includes patients who underwent significant resections of bone and periarticular tissue due to their disease, which may not be applicable to the patient presented in the current case.

**Conclusion**

This case presents a unique knee reconstruction in a pediatric patient. Although he presented with open physes, this patient was near maturity and had a significant functional morbidity. The patient had significant joint destruction from his deformity; therefore, joint-sparing techniques would not have been successful in this instance. The juvenile idiopathic arthritis literature documents excellent functional improvements after juvenile TKA and long-term survivability of components, and stemmed components have been widely used in the pediatric tumor literature with good long-term results. In this case, the patient had significant functional morbidity to justify the risks associated with TKA, which both the parents and the patient understood. In addition, his skeletal dysplasia created significant deformity but did not require soft tissue reconstruction, which may be a contributor to his postoperative success. The authors believe that TKA is a reasonable option for joint reconstruction in the pediatric patient with open physes who has significant arthritis and deformity not of oncologic origin.

**References**