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Technical Tips

Posterior femoral hemiepiphysiodesis for genu recurvatum with equinus foot deformity: a novel surgical proposal

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Abstract

Genu recurvatum is characterized as an hyperextension deformity of the knee in the sagittal plane and can be associated to structured equinus deformity of the ankle and foot. Amongst its causes are conditions like arthrogryposis, cerebral palsy, tibial tuberosity arrest, poliomyelitis and syndromes with generalized ligamentous hyperlaxity. The treatment of this condition can be challenging, specially when associated with equinus of the foot and, to date, aggressive methods such as femur or tibia osteotomies are the most used for its correction. We describe here a safe and minimally invasive technique with posterior hemiepiphysiodesis of the distal femur performed with transphyseal screws for correction of the *genu recurvatum* with apex on the distal femur associated with rigid equinus of the foot due to tarsal coalition. This technique has great potential for correcting the recurvate knee in the immature skeleton and can be an excellent alternative to the more aggressive methods currently used for the treatment of this deformity.

Level of Evidence V; Therapeutic Studies; Expert Opinion.

Keywords: Child; Knee; Joint deformities, acquired; Orthopedic procedures/methods.

Introduction

Genu recurvatum is characterized as an hyperextension deformity of the knee in the sagittal plane. When untreated, it is associated with short and long-term complications, such as joint pain and early gonarthrosis, especially when associated with ipsilateral foot deformity. In extreme cases, there may even be anterior knee dislocation[1-3].

Recurvatum is an unusual deformity of the knee in children and amongst its causes are conditions such as arthrogryposis[4], cerebral palsy [5-7], poliomyelitis, sequelae of the tibial tuberosity fracture[8,9], and some syndromes with generalized joint hypermobility[1,10]. When there is a structured equinus deformity of the ankle and foot, the knee with joint hypermobility can deform into recurvatum due to the vector resulting from the relative posteriorization of the proximal tibia and anteriorization of the load axis to the knee.

It is important to highlight that the genu recurvatum's treatment is challenging, especially when associated with structured equinus of the foot. When the deformity is significant and surgical correction is indicated, soft tissue procedures can be used, such as quadricepsplasty[11] and hamstrings lengthening[6,12], as well as osteotomies of the distal femur and proximal tibia with internal[13] or external fixation[14,15] to correct bone alignment. The aforementioned surgical procedures are aggressive and require a long recovery time, and are subject to risks like neurovascular injury, compartment syndrome and infections.

Study performed at the Hospital Israelita Albert Einstein, São Paulo, SP, Brazil.

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Considering this scenario and searching for less aggressive methods with excellent potential for correcting this angular deformity, we have used the guided growth with posterior hemiepiphysiodesis of the distal femur to correct the genu recurvatum. In this study, we present a novel surgical technique performed on a patient with genu recurvatum resulting from joint hypermobility associated with structured equinus deformity of the ankle. The procedure has been performed with two cannulated transphyseal screws inserted in the posterior portion of the distal femoral physis. The clinical and radiographical results showed significant improvement in the deformity and in ankle and foot biomechanics.

Surgical Technique

The patient was positioned in horizontal dorsal decubitus. Two 1cm longitudinal incisions were made on the anterior face of the distal thigh, and blunt dissection was performed through the quadriceps muscle to the anterior face of the distal femur in an area proximal to the epiphyseal disc.

Percutaneously and using fluoroscopic images in the coronal and sagittal planes, two guide wires were inserted (one for each incision) in anterior to posterior and proximal to distal directions, crossing the distal femoral epiphyseal disc in its posterior third, close to the subchondral edge of the medial and lateral femoral condyles. Two 4.5mm cannulated fully threaded screws were inserted through the guide wires, with the tips of the screws placed completely in the distal femoral epiphysis (Figure 1). Subcutaneous and skin sutures were then performed.

Clinical Case

A nine-year-old patient with a unilateral 32° recurvatum knee deformity caused by joint hypermobility associated with fixed equinus deformity of the ankle due to tibiotarsal and subtalar ankylosis, calcaneocuboid and talonavicular coalition (Figures 2 and 3). Surgical treatment was performed and the patient was followed until achieving complete correction of the deformity. Immediate weight bearing was allowed after surgery. Every four months, the degree of the deformity was evaluated clinically and radiographically until its complete correction, and then the screws were removed. The time to correct the deformity was 15 months, with a follow-up of 23 months.

There were no perioperative complications, and there was no recurrence of the deformity measured by the femorotibial angle in the sagittal plane since the bone alignment of the lower limb in the sagittal plane was corrected.

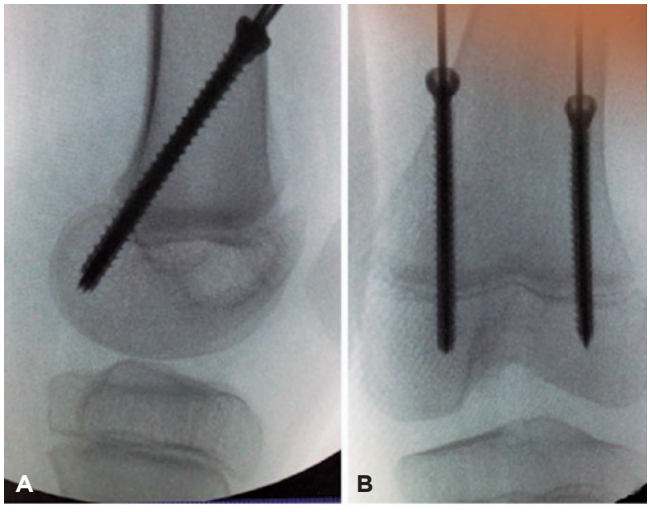

Figure 1. Intraoperative control of posterior hemiepiphysiodesis of the distal femur with two cannulated screws guided by metallic wires (A) lateral view; (B) anteroposterior view.

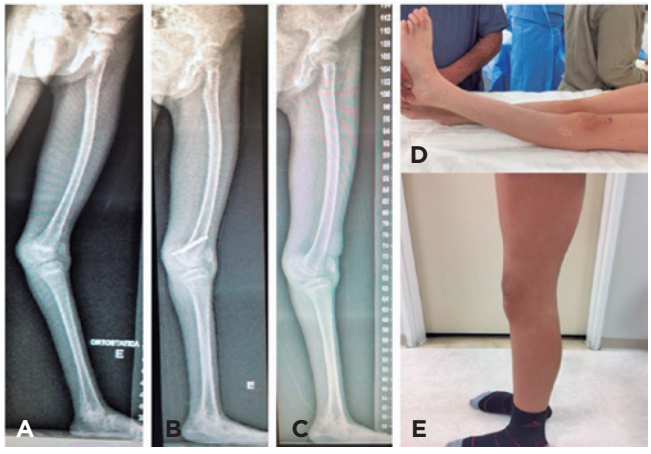

Figure 2. (A) Lateral panoramic radiograph of the left lower limb, demonstrating genu recurvatum deformity of 32o, due to joint hypermobility. (B) Lateral panoramic radiograph of the left lower limb, 13 months after posterior distal femoral hemiepiphysiodesis, correcting genu recurvatum deformity. (C) Lateral panoramic radiograph 14 months after screw removal, maintening the correction of genu recurvatum. (D) Preoperative lateral photograph of the left lower limb, demonstrating genu recurvatum deformity. (E) Photograph after 12 months of genu recurvatum correction.

Figure 3. Radiographs in the orthostatic profile of the right and left feet showing ankylosis of the left ankle and hindfoot.

Discussion

The knee recurvatum, or in hyperextension (genu recurvatum), may have its origin in bone deformities affecting the tibia or femur, neuro-orthopedic diseases[6], traumatic fracture or epiphysiodesis of the tibial tuberosity, infections, iatrogenic[9], capsule-ligament malformations by arthrogryposis and syndromes with joint hypermobility. The clinical characteristics are posterior knee angulation, unilateral or bilateral, depending on the etiology. During the patient's walk, there may be claudication, especially when unilateral or asymmetrical. The orthostatic radiographic analysis with the knees in maximum extension defines the origin of the deformity (bone, joint or mixed); it allows the angle calculation of the femorotibial deformity. The association with equinus deformity of the foot increases the deforming force at the knee level in the sagittal plane, resulting from the load axis anterior to this joint. The treatment of genu recurvatum depends on the clinical and functional repercussions and the degree of deformity.

Arthrogryposis, an important cause of genu recurvatum, is a condition that has existed since birth, with the rigidity of multiple joint deformities. The clinical presentation varies, which differentiates therapeutic options. In arthrogryposis, knee involvement is very common (38-90% of patients with amyoplasia), ranging from soft tissue contractions (in flexion or hyperextension) with instability, subluxation, or tibial femoral dislocation. Flexion contractures are more common and disabling, with significant resistance to treatment and a high recurrence rate[4]. Recurvatum deformities have a better prognosis for the ability to walk. According to the literature, the non-surgical treatment of genu recurvatum in arthrogryposis, with passive mobilization and orthoses, has failed in about one-third of cases. Therefore, surgical treatment is indicated when associated with the equinus deformity of the foot. According to Lampasi et al.[16], the most used methods to date are quadricepsplasty and femoral shortening-flexion osteotomies, which imply a higher complication rate than the percutaneous hemiepiphysiodesis with transphyseal screws described here.

The non-surgical treatment modalities of the genu recurvatum include physiotherapy, serial casting, and orthoses[16,17]. Surgery is for cases where the deformity is more resistant and part of the overall treatment plan, which may include correcting foot[18] and hip[6] deformities. Among the available surgical options, quadricepsplasty and other soft tissue procedures can be considered. In cases of bone deformities, supracondylar femur osteotomies with a posterior wedge removal, aiming at the angle normalization between the diaphysis and the intercondylar sulcus, is a surgical option described. Another treatment option is tibial osteotomy with anterior opening wedge, above the tibial tuberosity and with bone graft insertion[8]. Osteotomies can be combined with posterior capsular repair[19], mainly indicated in cases where premature closure of the anterior portion of the epiphyseal disc has occurred[9,15].

The most commonly used surgical treatment for genu recurvatum is performed with distal femur or proximal tibial osteotomies[13]. However, such procedures present high morbidity and risk of complications, demanding the search for less invasive, safer, and effective methods.

Guided growth is a treatment method for lower limb deformities in the sagittal plane. Jorneau[20] and Klatt et al.[21] described knee correction in flexion with guided growth by anterior distal femoral hemiepiphysiodesis with two plates (eight plates).

In 2021, Stevens et al.[22] described guided growth for tibial recurvatum by posterior proximal tibial epiphysiodesis using eight plates, obtaining excellent results. Kievit et al.[23] reported a case in which genu recurvatum was a complication of the treatment of lower limb length discrepancy through temporary epiphysiodesis of the distal femur and proximal tibia with eight plates. The hypothesis is that recurvatum was caused by the very anterior positioning of the plates. Then the recurvatum deformity was corrected with the surgical reapproach and posterior replacement of the plates on the distal femur.

To date, no surgical approach for treating genu recurvatum with posterior hemiepiphysiodesis of the distal femur with transphyseal screws has been described in the literature, as described here.

In this study, we report the surgical treatment of genu recurvatum with a novel technique performed through guided growth with the posterior hemiepiphysiodesis of the distal femur with two screws, indicated for deformities caused by capsule-ligament hyperextension associated with equinus deformity of the foot. However, this treatment is not indicated for situations with early closure of the anterior, femoral, or tibial epiphyseal plate by any etiology[15]. Eventually, in these situations, the posterior distal femur epiphysiodesis could only be indicated to reduce the deformity's progression during the residual growth.

Based on the study by Metaizeau et al.[24] on the techniques of guided growth, described for correction of deformities in the coronal plane (varus and valgus), we used two transphyseal cannulated screws positioned in the sagittal plane generating provisional posterior hemiepiphysiodesis of the distal femur to allow anterior distal femur growth, aiming to correct the deformity in genu recurvatum. In addition, a factor associated with genu recurvatum and equinus deformity of the foot can also be treated by the method described herein.

It is a minimally invasive, reversible method with a low complication rate, not requiring postoperative immobilization, and the patient can walk after the procedure and return to normal activities. However, it is important to emphasize the need for monitoring at short intervals to define the exact moment of screw removal, avoiding overcorrection with deformity inversion.

Patients with genu recurvatum due to ligament laxity have few options for physiotherapeutic or surgical treatment with soft tissue repair. Osteotomy treatment is reserved when there is great clinical involvement. The posterior hemiepiphysiodesis of the distal femur presented here is undoubtedly a less aggressive surgical alternative with lower risks, showing progressive and perennial correction after screw removal.

Conclusion

The posterior hemiepiphysiodesis of the distal femur with transphyseal screws proved to be a safe and very useful method for genu recurvatum deformities whose apex is present in the femur, associated with joint hypermobility and fixed equinus deformity of the foot. This technique has great potential for correcting the genu recurvatum in the immature skeleton, being an excellent alternative to the more aggressive methods currently used to treat this deformity.

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