Guided Growth for Tibial Recurvatum

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Abstract

Objective: Sagittal guided growth of the distal anterior femur has been shown to be effective for the correction of fixed knee flexion deformity that is encountered in clinical practice. The opposite deformity, namely genu recurvatum, is comparatively uncommon in children. The most common aetiology is post-traumatic. Acute correction by means of osteotomy has significant associated risks. Our objective was to determine whether a posterior 8-plate would suffice in correcting tibial recurvatum and obviate the need for an osteotomy.

Methods: We included a total of five deformities, three boys (one bilateral) and one girl, managed by means of tethering of the posterior proximal tibial physis with a tension band plate. Standard radiographs obtained preoperatively and at follow-up included a standing anteroposterior (AP) of the legs noting limb lengths and the mechanical axis. We also obtained standing lateral views of each knee in maximal extension to measure and compare the posterior proximal tibial angle (PPTA).

Results: The same-day surgery was well tolerated and there were no surgical or postoperative complications. The preoperative PPTA ranged from 106° to 117° and averaged 84° at follow-up. Correction occurred in an average of 20 months (range of 18–24 months). The patient with bilateral recurvatum due to Hurler's syndrome developed unilateral recurrent recurvatum culminating in percutaneous reinsertion of the metaphyseal screw. For each patient, knee hyperextension and associated pseudo-laxity resolved and limb lengths remained equal at follow-up.

Conclusion: Children with progressive genu recurvatum typically present with an insidious onset of symptoms. Guided growth of the posterior proximal tibia is a safe and effective means of correcting the deformity; osteotomy was avoided in this series.

Level of evidence: III – retrospective case series – no controls.

Keywords: Genu recurvatum, Guided growth, Tibial recurvatum.

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Introduction

The most common progressive and obvious knee deformities noted in the paediatric and adolescent population occur in the coronal plane. These include valgus, varus, and windswept deformities. Regardless of the underlying aetiology, guided growth employing extraperiosteal tension band plates has become the treatment of choice for safe and efficient management of these coronal deformities.[1–5] It is now recognised that guided growth is also applicable to correct sagittal and oblique plane deformities as well.[6,7] Anatomically, these may result from growth disturbance in the distal femur or the proximal tibia or both, or due to a chronic contracture. Historically, an osteotomy of the femur has been employed to correct fixed flexion deformity in patients with cerebral palsy, spina bifida, and arthrogryposis. As an alternative, sagittal plane guided growth of the distal anterior femur has been shown to be effective.[8,9]

Acquired genu recurvatum is comparatively uncommon in children. Acute correction by means of flexion osteotomy has significant inherent risks including neurovascular compromise, compartment syndrome, and possible recurrence. This report addresses the problem of tibial recurvatum that may result from trauma or from skeletal dysplasia. Rather than subjecting the child to osteotomy, we have managed this insidious and difficult problem by means of guided growth. We report the rationale, technique, and preliminary results of tethering the posterior proximal tibial physis with a single extraphyseal tension band plate.

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Materials and Methods

We undertook this retrospective review of four children presenting with symptomatic and progressive recurvatum of the tibia with approval from the Institutional Review Board (IRB). There were three boys (one bilateral) and one girl with a total of five recurvatum deformities that were managed by means of guided growth of the posterior proximal tibial physis. The aetiology of the tibial deformity was post-traumatic in three patients who were all 7 years old at the time of surgery. The fourth patient, with Hurler's disease, had bilateral dysplastic tibial recurvatum that was refractory to Metaizeau screw placement percutaneous epiphysiodesis with transphyseal screws (PETS) at another institution. He presented to us at the age of 11 years with persistent and disabling bilateral

genu recurvatum. The cancellous screws were removed and the guided growth with posterior 8-plates was undertaken. On a later occasion, genu valgum was corrected with guided growth of the distal femora.

Clinical Findings

The patients described discomfort with prolonged standing and progressive difficulty at walking. Each was unable to run due to a sense of mistrust of the knee that mimicked posterior cruciate ligament (PCL) deficiency, thus compromising sports participation. In unilateral cases, there was an obvious passive hyperextension of the involved knee compared to the normal side (Figs 1A to G). Apparent pseudo-posterior laxity was noted in 0° of extension but the Lachman test was negative when the knee was in maximal hyperextension. The indications for surgery were determined by the progression of deformity and the related symptoms. While surgical intervention was not needed urgently, once the diagnosis was confirmed the parents were typically anxious to proceed with minimally invasive guided growth as opposed to osteotomy of the tibia and fibula.

Imaging

Standard radiographs obtained preoperatively and at follow-up included a standing AP of the legs noting limb lengths and the mechanical axis (Figs 1A to G). Standing lateral views of each knee in maximal extension were obtained routinely to compare and measure the posterior proximal tibial angle (PPTA). The normal value for this is 81°.[10] Advanced imaging, such as MRI or CT scan, was unnecessary unless an anterior physeal bar was suspected. If this was encountered, a resection of the anterior bar would

have been done before placement of a posterior tension band plate on the tibia.

Technique

The direct posterior approach was adapted from a previously described procedure for PCL repair.[11] The patient is placed in the prone position with the image intensifier in the horizontal position in order to provide an orthogonal, sagittal view of the proximal tibial physis. Under tourniquet control, a longitudinal midline posterior incision is made extending 4 cm distally from the popliteal crease. The medial sural nerve to the calf is visualised and protected. A plane is developed between the medial and lateral heads of the gastrocnemius with avoiding and protecting the popliteal neurovascular structures. The popliteus muscle is mobilised and retracted sufficiently to visualize the posterior proximal tibia and allow palpation of the physeal prominence, with care taken to preserve the periosteum. Under fluoroscopic guidance, a 1.6-mm guide pin is placed in the proximal tibial epiphysis parallel to and between the articular surface and the physis. The tension band plate is placed over this and the metaphyseal pin placed. Having predrilled the cortex, the 4.5-mm cannulated screws are inserted over the guide pins and advanced, confirming their position fluoroscopically. The guide pins are removed and the screws further tightened to countersink within the plate. Following simple wound closure, an Ace bandage dressing is applied. The same-day surgery is followed by unrestricted weight bearing and progression to full activities as tolerated by the patient.

Follow-up

Routine follow-up at 3–6-month intervals with serial radiographic images is recommended. Upon correcting the PPTA to the
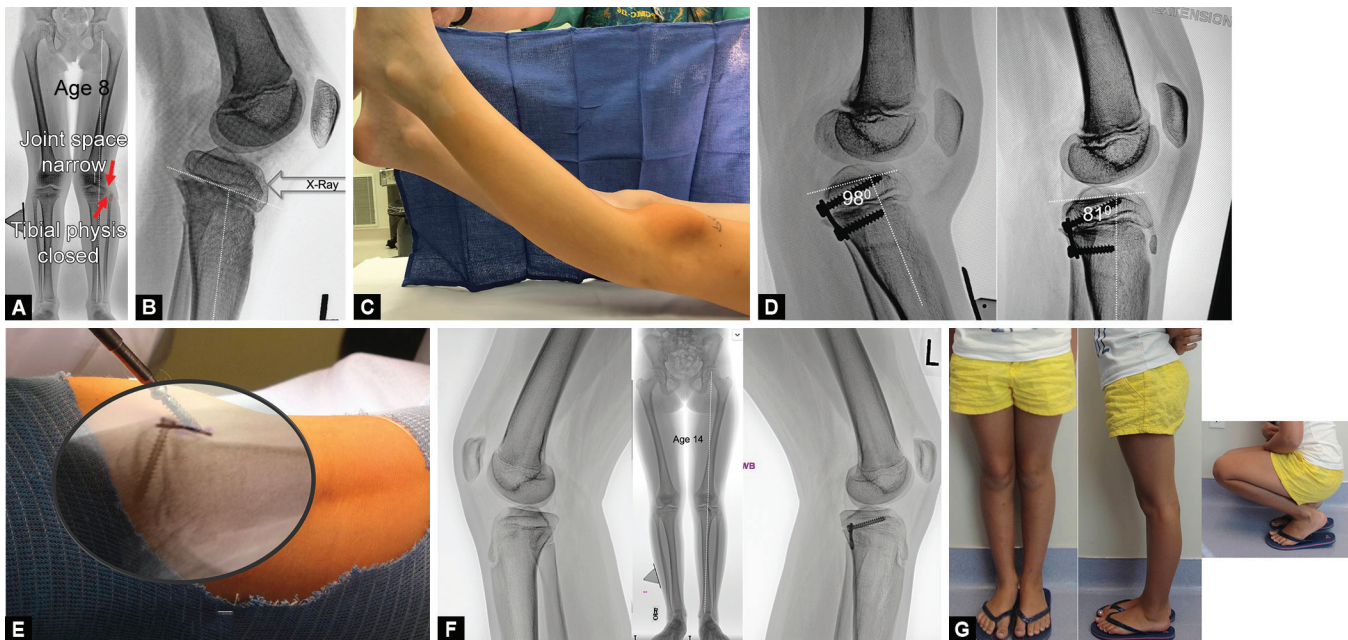
Figs 1A to G: (A) One year post-proximal tibial fracture (trampoline), this 8-year-old girl presented with recurvatum and instability. She was unable to run. The sagittal deformity distorts the AP view, as noted; (B) The lateral view demonstrates an open physis and 24° sagittal plane deformity; (C) Hyperextension of the involved knee is manifest as pseudo-laxity; (D) Gradual correction of recurvatum post-tethering (note screw divergence); (E) Percutaneous removal of metaphyseal screw. The plate and epiphyseal screw are left *in situ*. The metaphyseal screw may be reinserted p.r.n. if recurrent deformity ensues; (F) Normal radiographic alignment at maturity – 50 mos./p screw removal; (G) Fully recovered clinically – no functional limitations

normal range, a percutaneous removal of the metaphyseal screw is carried out in order to avoid overcorrection. This is accomplished through a 2-mm incision under general anaesthesia with fluoroscopic guidance. Alternatively, according to surgeon preference, the entire construct may be removed (one patient). At the time of percutaneous removal of the metaphyseal screw, medial or lateral physeal tethering of the femur or tibia may be accomplished, as deemed necessary, to address coincidental mechanical axis deviation (two patients). In the event of recurrent recurvatum, the metaphyseal screw or the plate may be reinserted (one patient).

RESULTS

The PPTA ranged from 106° to 117° preoperatively and averaged 84° at follow-up (Table 1). The posterior 8-plates were left *in situ* until the deformity was fully corrected (average time of 24 months), whereupon the metaphyseal screw was removed percutaneously (three patients). The rationale for leaving the plate and epiphyseal screw *in situ* was based on the possibility that rebound growth and recurrent deformity might occur over time. The patient with Hurler's syndrome experienced recurrent unilateral tibial recurvatum 21 months after screw removal with a PPTA measuring 88°. Therefore, he underwent percutaneous reinsertion of the metaphyseal screw and the deformity corrected. His opposite knee and those of the other patients did not show continued tethering nor rebound deformity following the percutaneous removal of the metaphyseal screw.

The patients' perception of knee instability improved accordingly as the recurvatum resolved. At follow-up, running was unimpaired and none has reported functional limitations. Now skeletally mature, all are assessed to have equal limb lengths and none has required further intervention.

Patients – Table 1

Patient 1

This 11-year-old boy with Hurler's syndrome developed complex deformities of both lower extremities and had previously undergone bilateral intertrochanteric osteotomies to correct coxa valga along with PETS (Metaizeau screws) of the proximal tibiae in an attempt to control tibial recurvatum that failed. These procedures were performed at another institution. At presentation to us (age 11), his PPTA measured 107° and 109° on the right and left sides, respectively. The Metaizeau screws were removed and he underwent bilateral placement of posterior proximal tibial plates. Upon correcting to 83° and 81°, the metaphyseal screws were removed percutaneously 7 months later. During the ensuing 21 months, the PPTA regressed to 88° on the left and so the metaphyseal screw was reinserted percutaneously.

Patient 2

This 7-year-old boy sustained a fracture of his proximal right tibia and gradually developed Cozen's deformity plus moderate tibial recurvatum. Initially treated with guided growth of the proximal medial tibia, he was lost to follow-up for 21 months during which time he developed iatrogenic genu varum and increased recurvatum (PPTA = 117°). The proximal medial tibial plate was removed and replaced with a posterolateral tension band plate. Over the ensuing 20 months, his recurvatum deformity corrected fully and the metaphyseal screw was removed. On separate occasions, he underwent tethering of the distal medial femoral physis for valgus and, recently, a reinsertion of a tension band plate on the proximal medial tibial physis for recurrence of Cozen's deformity. His sagittal correction has been maintained 36 months post-guided growth of the posterior tibia.

Patient 3

This 8-year-old girl developed recurvatum following a proximal tibial fracture with a PPTA of 109°. She was treated with a posterior 8-plate and the deformity corrected over a period of 24 months. The metaphyseal screw was removed and she has since reached skeletal maturity without recurrence (Figs 1A to G).

Patient 4

This 7-year-old boy presented with recurvatum of the tibia following a proximal tibial fracture. His PPTA measured 106° at presentation and 84° at the time of plate removal 21 months later.

DISCUSSION

A growth disturbance at the physis may be progressive, disabling, and difficult to manage. A corrective osteotomy of the proximal tibia and fibula, regardless of the direction, is challenging and fraught with potential complications including neurovascular compromise, compartment syndrome, over or under-correction or fixation problems.[12–14] One may resort to the use of external fixation to achieve gradual correction but this is both cumbersome and costly.[15,16]

Sagittal deformities of the knee may involve the distal femur or the proximal tibia or both. Fixed knee flexion deformity is commonly seen in neurogenic conditions including cerebral palsy, spina bifida, and arthrogryposis. The concept of guided growth using anterior Blount staples was introduced by Stevens et al. (2001).[2] However, occasional problems with staple migration required premature staple replacement or removal. Subsequent to the introduction of the 8-plate (Orthofix Inc.), the technique was modified to include the use of two tension band plates: one inserted medial and one lateral to the patellofemoral sulcus.[15] The success of this modification has since been corroborated by other investigators.[16] The most common applications for anterior guided growth are to correct crouch gait due

Table 1: Clinical and radiographic summary of our 4 patients (1 bilateral)

Patient	Age @GG	PPTA @surgery	Mos. correct	Hardware removal	PPTA @removal	Follow-up removal	PPTA @f-u	Mature	Comment
JS – right	11	107°	18	6/16	83°	44 mos	83°	Yes	
JS – left	11	108°	18	6/16	81°	44 mos	81°	Yes	Reinserted 6/18
LH	7	117°	20	9/17	86°	28 mos	85°	12 y.o.	
AP	8	106°	24	9/14	84°	50 mos	81°	Yes	
JW	7	106°	20	9/18	82°	21 mos	85°	10 y.o.	Plate d/c

to cerebral palsy, spina bifida, arthrogryposis, and other conditions. By and large, this has obviated the need for distal femoral extension osteotomies in the skeletally immature population.

Less common are sagittal plane deformities of the proximal tibia. The resultant recurvatum mimics a PCL-deficient knee, making it difficult for the child to walk and run. Bracing is ineffective and corrective osteotomy carries prohibitive risks. While gradual correction may be achieved using the Ilizarov technique, this is costly and not without untoward consequences. Guided growth offers a safe, low-cost, and minimally invasive solution to this perplexing problem.

The obvious limitation of this report is that it comprises a very small, retrospective series. Therefore, statistical analysis and validated outcomes scores were not feasible. Considering the sporadic and infrequent nature of this condition, we were not able to include additional subjects. However, it was felt important to report this as a preliminary "proof of concept", thereby preventing unnecessary osteotomies.

Conclusion

Guided growth of the posterior, proximal tibia offers a safe and effective means of correcting tibial recurvatum without requiring osteotomy. Further corroborative research is needed with a larger number of patients. As with any guided growth patients, recurrence is possible following extraction of the device and therefore patients should be followed until skeletal maturity.

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