Case Report

A Child with Severe Bilateral Tibia Vara: Treatment with Computer-Assisted Gradual Correction Utilizing Hexapod External Fixator

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Abstract

A 7-year-old obese boy presented to the Paediatric Orthopaedic clinic with a complaint of worsening bilateral knee bowing. He was initially seen for the same problem in another hospital at the age of 3. The bowing of the leg was associated with pain over the lateral aspect of both knees. He was able to walk but unable to run or participate in sports due to the deformity and knee pain. On examination, the child had a waddling gait and lateral thrust due to severe bilateral genu varus. The range of motion of bilateral knee joints was 0 to 110 degrees. The knee intercondylar distance was markedly increased and there was bilateral tibial torsion. No limb length discrepancy and neurovascular examination was normal. The radiograph revealed features of infantile tibia vara (Blount disease). Bilateral proximal tibia temporary hemiepiphysiodesis was attempted but no correction of the deformity was achieved due to implant failure. His parents were then counseled to let him undergo gradual deformity correction surgery using a ring external fixator (hexapod system). The bilateral varus deformity was corrected after 4 months, and the patient was able to walk normally.

Keywords: Blount's disease; deformity correction; hexapod; limb deformity; tibia vara

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Introduction

Blount disease or tibia vara is a developmental condition involving the medial part of the proximal tibial physis, which presents with knee bowing in a growing child. A disrupted ossification causing asymmetrical growth of the physis would lead to a coronal plane knee malalignment and in some cases multiplanar deformities (1). Early-onset tibia vara is associated with early walking age and obesity with a more severe growth inhibition as compared to the adolescent type (2).

Non-surgical management includes observation (3) or bracing (4) but has limited success. Operative options such as realignment osteotomy with or without medial plateau elevation, lateral hemiephysiodesis, and guided growth around the knees are among the accepted procedures for this condition (2). However, there is conflicting evidence regarding guided growth procedure for the treatment of Blount disease (5-7), especially in the more severe type. Meanwhile, valgus corrective osteotomy at the proximal tibia can effectively achieve normal alignment of the lower limbs, which can be performed in either an acute or a gradual manner.

Gradual correction of the proximal tibia alignment has the advantage of managing a severe, multiplanar deformity with fewer complications associated with acute correction such as compartment syndrome, neurologic injury, and limb length discrepancy (8). This can be done using Ilizarov apparatus (9), while recent advances have provided greater accuracy of correction with strut-based external fixators (hexapod) assisted by computer-generated correction schedules e.g., Taylor-Spatial Frame or Ortho-SUV (10). We described the management of a child with severe infantile tibia vara, which was successfully treated with valgus osteotomy, and gradual correction with Ortho-SUV hexapod system. The principle of this treatment method was also discussed.

Case Report

A 7-year-old boy presented with a progressive deformity of the lower limbs. It was first noticed by the mother that the child's knees were 'bowed' at the age of three. She sought medical attention at the time and was advised to continue observation of the condition. However, the knee bowing became worse and the child was subsequently referred to our center at 7 years old. At this juncture, the child had started to complain of knee pain upon walking.

Further history revealed that the child's prenatal and postnatal history were uneventful. The developmental milestones were up to age, although he was an early walker at 10 months old. The child's weight was also always on the higher side, above the 95th percentile. He is the third child of four siblings and there was no similar presentation of knee bowing in the family.

On presentation, it was noted that the child had a severe bilateral genu varus with increased intercondylar distance measuring 12 cm (Fig. 1a). Both lower limbs were internally rotated. The child walked with a lateral thrust gait. The lateral collateral ligaments of the knees were lax. The range of motion of the knees was normal. Blood investigation showed normal hematological and biochemistry results. Radiographs of the knees revealed bilateral genu varus with medial metaphyseal beaking, suggestive of infantile Blount disease (Langeskiold Stage III) (Fig. 1b & c). The scanogram indicated that the lower limb mechanical axis had deviated laterally around 11cm. The tibiofemoral angles were 45° on the right and 47° on the left, respectively.

The child was initially treated with a guided growth procedure using a plate. This however had failed, whereby the metaphyseal screw on the right tibia was broken, and the knee angular deformity correction was not achieved (Fig. 2). He was then planned for a gradual deformity correction utilising a hexapod external fixator system (Ortho-SUV). Preoperative planning included measurement of the centre of rotation of angulation (CORA) on the radiographs, which was translated to the child's knee intraoperatively. The Ortho-SUV was then fixed, followed by the osteotomy at the pre-determined CORA (Fig. 3a). Post-operatively, lower limbs radiographs were taken in a standard manner according to the system protocol. The images were then fed into the software for deformity measurements and analysis. A computed algorithm was generated to perform the gradual correction by manipulating the struts on the frame. Before being discharged home, the mother was trained to manipulate the struts according to the instructed algorithm.

FIGURE 1: (a) Clinical photo of the child with severe genu varus; (b & c): Anteroposterior radiographs showed features of tibia vara on both knees (Langeskiold Stage III)

The rest of the gradual correction procedure was then monitored as an outpatient in the clinic. The correction of the deformity took about one and half months. The child was initially allowed to partially weight bear on the frame and then fully weight bear once we changed the struts to fixed rods. After three months, the osteotomy site united, and the frame was subsequently removed. Clinically, the child's leg is now straight, and radiographs revealed restoration of the lower limb mechanical axis (Fig. 3b & c).

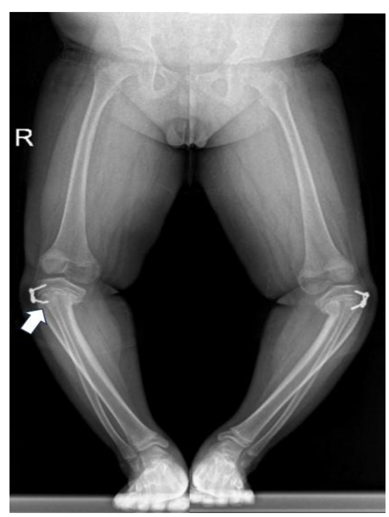

FIGURE 2: Long-leg radiographs showing the knee angular correction was not achieved and the implant failure- broken screw on the right tibia (arrowhead)

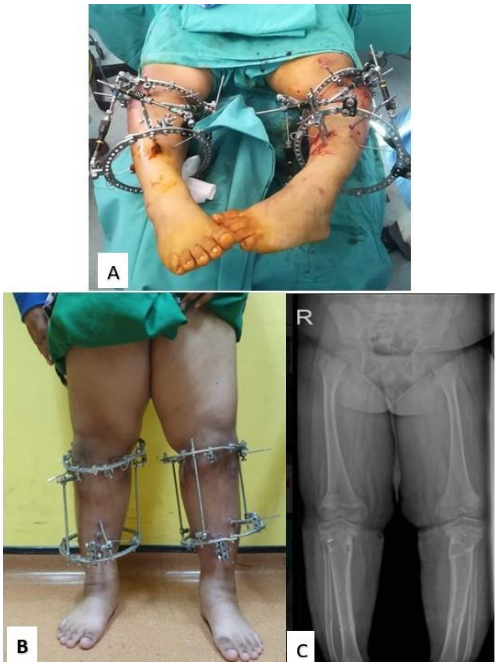

FIGURE 3a: Fixation of the Ortho-SUV frame; b: Clinical photo of the child's legs just before removal of frame; c: long-leg radiograph showed the improved alignment of the lower limbs

Discussion

Tibia vara in children is one of the common referrals to orthopaedic clinics. The indication for surgery is pain and worsening knee deformity. The aim is to restore the limb alignment to allow normal gait and avoid long-term consequences on the knee joint. Surgical treatment with guided growth utilising a plate was initially done for our patient. This procedure is minimally invasive and favourable as the effect on the physis is temporary and reversible. However, the efficacy of the treatment for tibia vara is still controversial. Some authors reported failure of correction of deformity as well as implant breakage (5,6). Increased body weight (which is common in Blount disease) was associated with a high risk of implant failure (6,11). In contrast, it was shown to be effective with minimal complications in other studies (7,12). This might be related to differences in patient selection.

Our own review of children with tibia vara treated with guided growth plates revealed that a more severe Langeskiold stage (stage III) was associated with failure of correction, in comparison to stage II (13). It is likely that a combination of factors e.g. severe deformity and body weight contributed to implant failure in our case. Following that, a repeat guided growth with a better and stronger construct was a viable option. Replacing the implant with two parallel plates or a single 4-hole plate and using solid screws instead of cannulating screws are among the options that could have improved the fixation (11). However, the risk of another failure cannot be truly eliminated.

We opted to perform valgus osteotomy rather than a repeat guided growth procedure. The valgus correction was performed gradually on a hexapod external fixator, guided by a schedule generated by computer software. This method has been shown to be more accurate than acute correction (14). However, full cooperation and compliance are needed from the patient for this method to succeed. In this case, we used the Ortho-SUV (Solomin-Utekhin-Vilensky) system (15). It comprised six telescopic struts connected to the rings, therefore able to correct multiple axes (angular, translational, rotational, and length) deformities simultaneously. The relationship between the struts and the rings forms triangles whose distance can be measured clinically and fed into the software. Additional parameters from radiographs taken post-operatively were also included. This information was analysed by the software which then generated a schedule to guide the gradual manipulation of the struts for deformity correction. Previous studies utilising various software-based hexapod systems have reported successful outcomes, including the Ortho-SUV (10).

The gradual correction of bony deformity follows the biological method of distraction osteogenesis, founded on the principle of 'tension-stress'. In our case, the software calculated the required distraction equivalent to the safe rate of 1 mm/day, performed by the Ortho-SUV. Once the distraction is completed, it will conclude the deformity correction and achieve the desired limb alignment. The last step is the consolidation phase whereby the regenerate bone is allowed to harden while on the external fixator. Some protected weight bearing is permitted to facilitate bone consolidation and once the bone has healed the external fixator is removed.

Conclusion

Tibia vara in children can be severe and progressive leading to pain and undesirable gait. With careful planning and correct patient selection, gradual deformity correction utilising software-based hexapod external fixator can produce a good outcome, as was shown in this case.

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