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Case Report

Acute "three-in-one" surgery for the treatment of severe Blount's disease: Surgical technique and report of two cases

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الملخص

تاريخيا، علاج داء بلونت مثير للجدل دائما. حيث لجميع التقنيات الموصوفة لعلاجه إيجابياتها وسلبياتها. لا يوجد إجماع على نهج جراحي واحد لعلاج هذا المرض. الهدف من هذا التقرير هو مشاركة النتائج المبكرة لتقنية الجمع حيث قمنا بتجميع ثلاث خطوات جراحية معروفة في إجراء واحد. ينصح بهذا الإجراء المشترك للحالات الشديدة والمتكررة. تجمع تقنية "ثلاثة في واحد" بين قطع عظمي داخل المشاشية لرفع الهضبة، وقطع العظم الظنبوبي الكردوسي وإيثاق جانبي المؤقت لمشاشة الظنبوب الدانية. وندكر في التقرير النتائج الأولية لثلاثة أطراف في مريضين عولجا بهذه التقنية. كانت الحالة الأولى لمراهق مصاب بداء بلونت الشديد في الجهة اليسرى (لانغنشيولد المرحلة الرابعة) مع الدفع الجانبي. بينما كانت الحالة الثانية مصابة بداء بلونت الطفولي الحاد على الجانبين (لانغنشيولد المرحلة الخامسة) والدفع الجانبي. تحسنت جميع القياسات بشكل ملحوظ في كليهما خلال تقييم ما بعد الجراحة. وكان التباين في طول الأطراف ٠.٦سم في الحالة الأولى و٠.٥ سم في الحالة الثانية. تم تصحيح الدوران الداخلي الظنبوبي والدفع الجانبي بشكل عفوي. كما لم يتم تسجيل أي مضاعفات في كلا المريضين. جراحة "الثلاثة في واحد" هي طريقة جراحية آمنة ومتعددة الاستخدامات يمكن استخدامها في الحالات الشديدة والمقاومة والمتكررة مع المشاشة المفتوحة. إلى جانب ذلك، يمكن أن تحل مشاكل الدفع الجانبي والدوران الظنبوبي الداخلي. يجب دراسة المزيد من الحالات قبل أن نتمكن من إقرار سلامة وفعالية هذه التقنية.

الكلمات المفتاحية: داء بلونت؛ وإيثاق جانبي المؤقت؛ قطع العظم داخل المشاشية؛ قطع العظم الكردوسي؛ الدوران الظنبوبي؛ الزاوية الظنبوبية الفخذية

Abstract

The treatment of Blount's disease has historically remained controversial. All the described techniques for its treatment have their own advantages and disadvantages, and no consensus has been reached on a single surgical approach. The aim of this report is to share the early results of a combination technique in which we have collated three well-known surgical steps in one procedure. This combined procedure is indicated for severe and recurrent cases. Our 'three-in-one' technique combines an intra-epiphyseal plateau elevating osteotomy with a tibial metaphyseal osteotomy and a lateral tibial temporary hemi-epiphysiodesis. We also report initial results of three limbs in two patients who were treated using this technique. The first case was that of an adolescent with severe left Blount's disease (Langenskiold stage IV) and a lateral thrust. The second case was that of bilateral severe infantile Blount's disease (Langenskiold stage V) and the infant had a lateral thrust. All measurements remarkably improved in both patients during the post-surgical assessment. The limb length discrepancy was 0.6 cm in the first case and 0.5 cm in the second. The preoperative internal tibial rotation and lateral thrust were corrected spontaneously. No complications were recorded in either patient. The three-in-one technique is a safe and versatile surgical approach that can be used in severe, refractory, and recurrent cases of open physis. Furthermore, it can potentially solve the problems of lateral thrust and internal tibial rotation. More cases should be studied before we can endorse the safety and effectiveness of this technique.

Keywords: Blount's disease; Hemi-epiphysiodesis; Intra-epiphyseal osteotomy; Metaphyseal osteotomy; Tibial rotation; Tibio-femoral angle

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Introduction

The surgical treatment of Blount's disease has remained controversial. The deformity of the proximal tibia is progressive and multiplanar. The treatment is tailored according to the age of the patient, stage of the disease, and the experience of the surgeon. Various techniques have been reported; however, none are conclusive. The general aim of the treatment is to correct the two major deformities of the proximal tibial varus and posteromedial slope of the medial tibial plateau to realign the limb into a normal shape and length. Many osteotomies were designed to address varus deformity (Oblique, V, Z, Inverted V, dome, closing and open wedge osteotomies).[1–4] Little attention has been paid to early correction of the medial plateau inclination, which is the other aspect of the deformity disturbing joint congruity. The posteromedial slope of the tibial plateau contributes to the varus instability and internal rotation of the limb. Ignoring this aspect of the deformity could result in persistence or recurrence after surgical correction.[5] Many double osteotomies were described to treat severe late and recurrent cases, creating an elevation of the medial plateau, either transepiphyseally or below the physis, in Langenskiold stages IV-VI. This is accomplished either acutely[6] or by gradual correction,[7] using external fixators. The hemi-epiphysiodesis gained popularity for its simplicity; however, it has its own limits. The current reports on hemi-epiphysiodesis recommend the careful selection of candidates, as the failure rate can be as high as 33% in type $\leq$2 (Langenskiold classification) and 100% failure in type $\geq$3.[8,9] The recurrence rate after proximal metaphyseal osteotomy mounts to 46% in patients younger than 4 years and 92% in older patients.[10] The first intra-epiphyseal osteotomy was performed by Storen H[11] and reported in 1969 with an 18-year follow-up; the same case was re-reported in 2018, with a 65-year follow-up.[12] It was an isolated intra-epiphyseal osteotomy without metaphyseal osteotomy, as the case had failed proximal tibial osteotomies twice. Another case report was presented in 1982 by Siffert R, combining intra-epiphyseal and inverted 'V' metaphyseal osteotomies.[4] This report details the early results in 2 patients (3 limbs) with severe Blount's disease treated with the 'three-in-one' combination technique—an intra-epiphyseal plateau elevating osteotomy combined with tibial metaphyseal osteotomy and lateral tibial temporary hemi-epiphysiodesis. The technique was developed following Siffert's combined approach (although the metaphyseal osteotomy was done differently) and an lateral hemi-epiphysiodesis was added as a guided growth control procedure, until the desired correction was achieved.[4] To our knowledge, no other reports in the available literature present the use of this approach.

Case report

Case 1

A 10-year-old boy (adolescent). He did not undergo prior surgical interventions. His follow-up was for 18 months (Table 1).

His pre- and post-operative clinical and radiological appearances (Langenskiold stage IV left tibia) are shown in Figures 10 and 11.

Case 2

(Two limbs) A 4-year and 6-month-old girl. She did not undergo prior surgical interventions. Her follow-up was for 18 months (Table 1). Her pre- and post-operative clinical and radiological appearances (Langenskiold stage V) are shown in Figures 12–14.

Pre- and post-operative radiographs and the patients' charts were reviewed. Assessment of the following parameters were recorded:

1. Tibio-femoral angle (TFA) [Figure 1].
2. Anatomical medial proximal tibial angle (aMPTA) [Figure 2].
3. Femoral condyle tibial shaft angle (FCTSA) [Figure 3].
4. Mean axis deviation (MAD) [Figure 4].

Table 1: Radiological measurements of the three limbs before and after correction.

Case	Timing	TFA	FCTSA	MAD	aMPTA	LLD
Case 1	Pre-operative	18 varus	66.3	>+2	35	Operated side shorter by 0.6 cm
	Post-operative	8 valgus	87.3	Central	85.8	
Case 2 Right knee	Pre-operative	40 varus	44.8	>+2	38	Operated side longer by 0.5 cm
	Post-operative	0.7 varus	93.6	0.5	76	
Case 2 Left knee	Pre-operative	26 varus	53.3	>+2	49	Operated side shorter by 0.5 cm
	Post-operative	15 valgus	100	−1	73	

TFA: Tibio-femoral angle.
FCTSA: Femoral condyle tibial shaft angle.
MAD: Mean axis deviation.
aMPTA: Anatomical medial proximal tibial angle.
LLD: Limb length discrepancy.

Figure 1: The tibio-femoral angle (TFA) is the angle between the anatomical axis of the femur and the anatomical axis of the tibia.

Figure 2: The anatomical medial proximal tibial angle (aMPTA) is the angle between the tibial mechanical axis and the articular surface of the proximal tibia.

Figure 3: The femoral condyle tibial shaft angle (FCTSA) is the angle between the articular surface of the distal femur and the tibial mechanical axis.

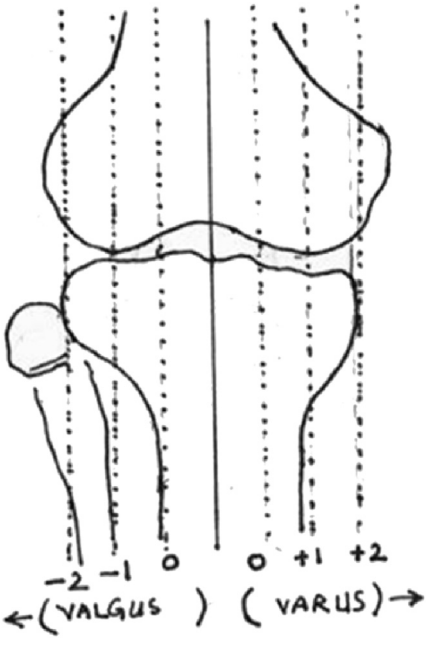

Figure 4: The mean axis deviation (MAD) is a measure of the medial or lateral malalignment. It is the distance between the centre of the knee and the mechanical axis.

Figure 5: Knee arthrogram showing the cartilaginous part of the proximal tibia with inclination of the medial tibial plateau.

5. Limb length discrepancy (LLD).

The charts were reviewed for complications, including compartment syndrome, nerve palsy, wound infection, pain, and effect on the range of motion.

Surgical technique of intra-epiphyseal osteotomy

The procedure was performed under tourniquet control and image intensifier, which is mandatory for this operation.

It started with a knee joint arthrogram, through the lateral side of the patellar tendon above the joint line with the knee flexed at 90°. Unlike the hip, the amount of the dye mix required was at least 10 ml to demonstrate medial joint inclination. The remnant of the dye is helpful for determining the size of the graft after osteotomy by equal levelling of the two plateaus [Figure 5].

A 10–15 cm long lazy 'S' shape incision was made (a straight incision can also be used), starting at the upper pole of the patella, medially, down to just below the insertion of the patellar tendon anteriorly. Then, the pes anserinus tendons were exposed and medially retracted. There was no need to open the joint. Under image intensifier guidance, two Kirschner (K) wires were inserted parallel to the epiphyseal medial inclination from the medial to the lateral direction. They ended in the bony part of the epiphysis at the centre of the joint, about the intercondylar notch. It is essential to start at a point mid-way between the physis and the joint line to avoid injuring either of them [Figure 6, a & b].

The cartilaginous part was easily cut using a blade. The cut was started posteromedially and the blade was then directed anterolaterally over the K-wires to the bony part of the epiphysis. The osteotomy was completed through the bony part using a saw and a wide straight osteotome.

Elevation of the medial hemi-plateau was attained through the insertion of a wide osteotome to the desired level. The remnant of the arthrography dye helped to determine the equal levelling of the plateaus [Figure 7, a & b].

A suitable graft size that maintained the desired elevation was subsequently inserted, making sure it was deeply seated

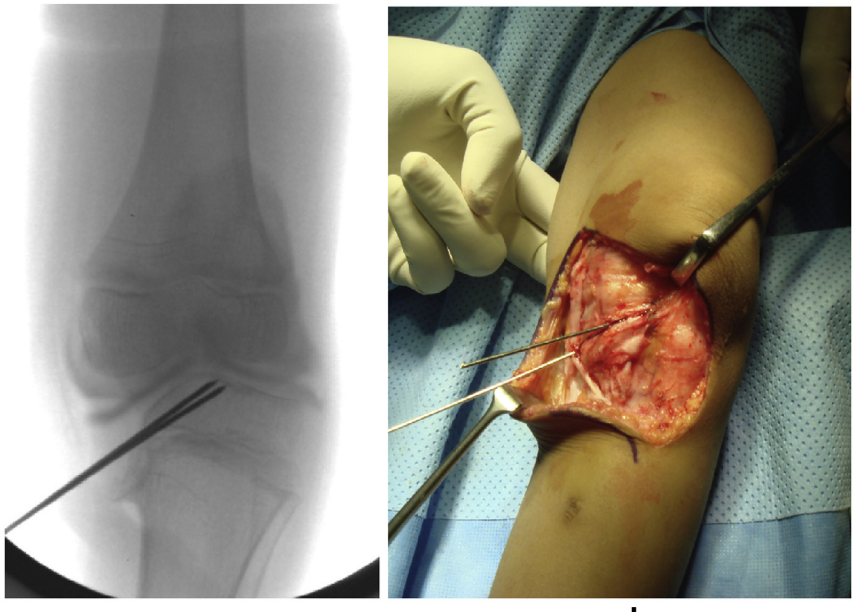

Figure 6: (a & b): Two K-wires passed parallel to the joint inclination, shown by the arthrogram, to the centre of the proximal tibia.

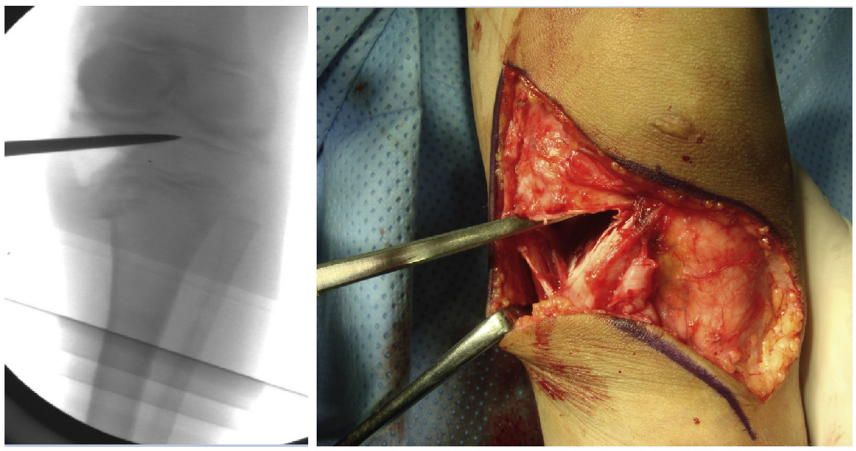

Figure 7: (a & b): Elevation of the medial hemi plateau, under image intensifier control, observed with the help of the dye in the joint showing correction of the proximal tibial joint line.

in the bony part of the epiphysis. This osteotomy was performed in combination with the metaphyseal osteotomy to correct the proximal varus, in which case the tibial closing wedge fragment (authors choice) or the fibular fragment can be used to obtain the graft; otherwise, an allograft can be used [Figure 8].

The graft was very stable in two of the three osteotomies and did not need fixation; however, if doubt exists, it can be fixed with a K-wire [Figure 8], which should be cut short and left under the skin and removed after healing is confirmed (usually 6–10 weeks).

After the intra-epiphyseal osteotomy, proximal tibial lateral closing wedge osteotomy and hemi-epiphysiodesis were performed using the same incision, with fibular osteotomy through a separate lateral and slightly distal incision. The tibial osteotomy was fixed with a plate and screws (it can be fixed with crossed K-wires in younger

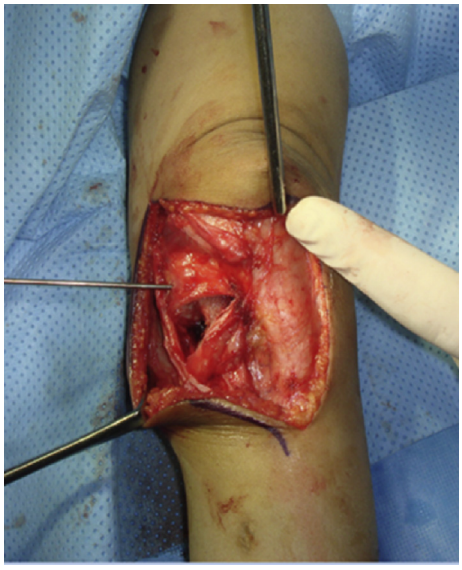

Figure 8: Graft deeply inserted, making sure that the desired correction was maintained, then fixed with a K-wire.

Figure 9: Final clinical alignment assessment showing correction of the deformity.

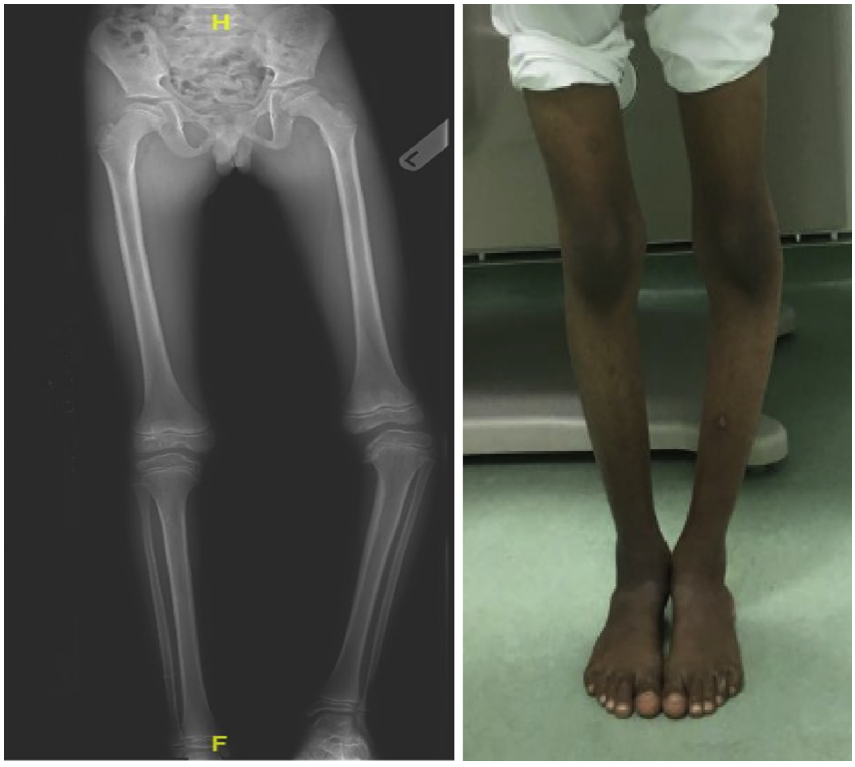

Figure 10: Pre-operative clinical and radiographic appearances showing left genu varus (Langenskiold stage IV).

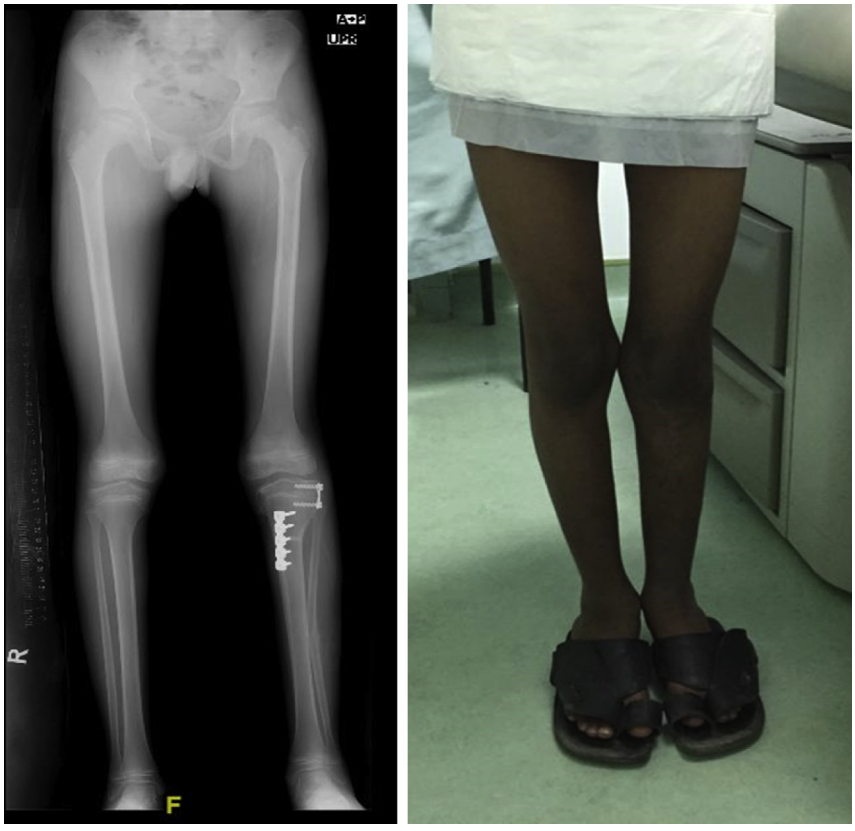

Figure 11: Post-operative clinical and radiographic appearances showing the correction of the left genu varus.

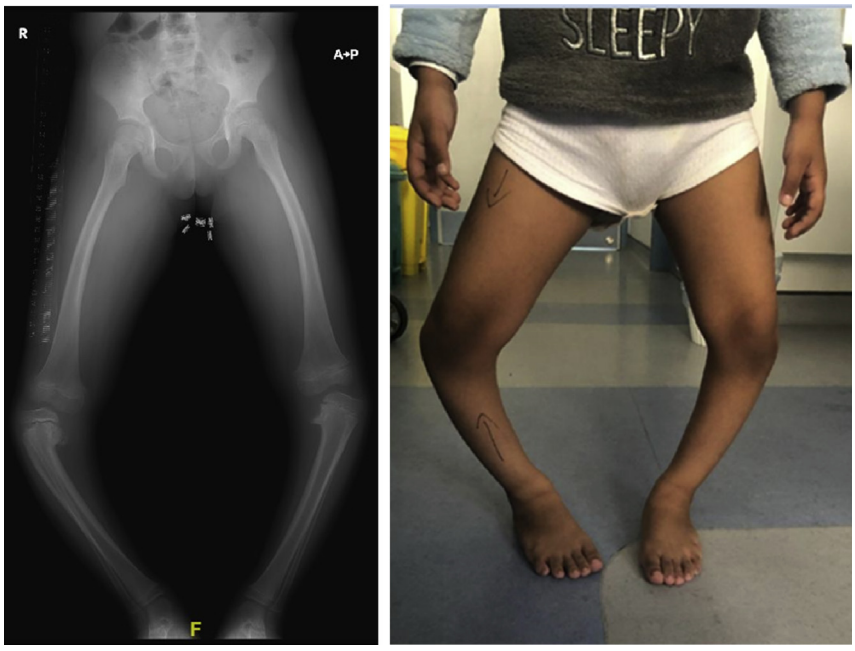

Figure 12: Pre-operative clinical and radiographic appearances showing bilateral genu varus (Langenskiold stage V).

patients), and the lateral hemi-epiphysiodesis with a tension band plate (TBP).

Assessment of the overall alignment was carried out clinically and radiologically at this stage [Figure 9]. The tourniquet was released and bleeders stopped, then the wound was closed over a drain that exited through the proximal part of the wound for easy removal from under a full-leg cast.

A full above-knee cast was worn by the patient for 3 months, followed by another 3-month-period of non-weight bearing without a cast.

The two patients did not have any peri- or postoperative complications and achieved complete knee range of motion.

Discussion

This is an early report of two patients who underwent the three-in-one procedure. Intra-epiphyseal osteotomy was performed following the Storen and Siffert technique.[4,11] The metaphyseal osteotomy comprised a lateral closing wedge osteotomy combined with fibular osteotomy. Lateral hemi-epiphysiodesis was performed

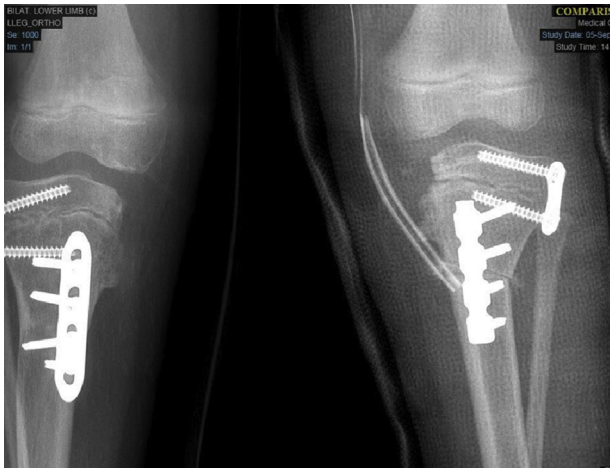

Figure 13: Immediate left knee post-operative radiograph showing the correction of the bilateral genu varus.

Figure 14: Post-operative clinical and radiographic appearances showing the correction of the bilateral genu varus.

with a TBP. This versatile approach could be used to treat both infantile and adolescent refractory cases of Blount's disease with an open physis, besides recurrent and failed surgeries. It addresses the two major problems in Blount's disease simultaneously, avoiding the lengthy duration and complications of the cumbersome external fixators. In this limited report, the limb length was not a major issue, with a maximum difference of 0.6 cm. The use of the TBP as an adjunct to the double-elevation osteotomies has the advantage of acting like a 'check rein' to confirm the achievement of the desired correction. This is well demonstrated in the second case, in which the left limb was overcorrected and the plate had to be removed, while the right limb remained in slight varus, and required longer retention of the plate. The hemi-epiphysiodesis following the osteotomies adds a few minutes to the operative time, as the incision created for intra-epiphyseal osteotomy is used for all the procedures.

The 6-month period of non-weight bearing is sufficient for the consolidation of the medial corner defect, which is created by the elevation of the plateau. During these 6 months, the growth from the medial physis is revived and freed by the de-tethering 'natural' rebound effect. The accelerated growth of the medial epiphysis adds to the support of the medial corner, which prevents recurrence. Early weight bearing should be strictly prohibited. The implants are removed (TBP) when the normal valgus is surpassed by at least 5°, anticipating reversed growth due to the rebound effect. The 5-degree excess is based on the 'be on the safe side' gut feeling, and not on specific, measured figures, as it is not precisely known how much reversed growth caused by the rebound effect is to be expected in a certain deformity at a particular age.

Another positive aspect of the plateau elevation is the spontaneous correction of varus instability (lateral thrust) and the excessive internal rotation of the leg.[13] Performing either of the two osteotomies alone is usually not enough to correct the severe deformity. The double osteotomies in the literature are reserved for Langenskiold types V and VI, for recurrent and severe neglected cases, and for older patients.[14] Acute or gradual correction double osteotomies are performed either transepiphyseally or below the physis.[15] Gradual correction using Ilizarov, Taylor Spatial Frame, and

hexapod external fixators have the benefit of multi-axial correction of the deformity and limb-length equalization.[5,16] However, these devices are more expensive, time-consuming, and fraught with many complications and poor patient compliance.[2] The approach described here is, to our knowledge, the only one combining acute intra-epiphyseal and metaphyseal osteotomies as well as lateral tibial temporary hemi-epiphysiodesis; thus being named 'three-in-one'. It is unwise to draw rigid conclusions regarding the efficacy of this approach, yet the results are very promising.

Conclusion

Although the reported cases are limited, the results of the 'three-in-one' technique are very promising, with high family and patient satisfactions. The surgical technique is easy for a trained paediatric orthopaedic surgeon to perform, practical, shorter, easier to monitor, does not require sophisticated apparatus or expertise, and does not have a steep learning curve. Residual over- or undercorrection can be handled either by removing the tension band plate or keeping it for longer.

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Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

Ethical consent regarding the protocol of the study was granted by the Ethical Research Committee of King Fahad Medical City, Riyadh, KSA. The parents of both patients gave consent for the publication of the data and pictures.

Authors contribution

AAA, and KIK conceived and designed the study, conducted research, provided research materials, and collected, organized data, and wrote the initial and final draft of the article. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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