Acute Correction of Severe Tibia Vara by (V) Shaped Osteotomy Using Ilizarov Fixator


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Abstract

Background: This study reports on the clinical experience and results of a new surgical technique for single-stage acute correction of the complex proximal tibial deformity in adolescent tibia vara using a minimally invasive surgical approach.

Methods: This prospective study included 30 limbs. The mean age was 12.5 years. A V-shaped proximal tibial osteotomy was performed such that the first osteotomy limb was used to elevate the depressed medial tibial plateau, while the second limb osteotomy corrected the metaphyseal varum and internal rotation deformity. This acute correction was stabilized by an Ilizarov frame construct.

Results: Follow-up averaged 16.8±4.4 months. Average time in the frame was 11.2±1.2 weeks. All cases reached maturity, maintained their correction, and ultimately achieved union. The angle of depression of the medial tibial plateau improved from a median of 34.8°±8.6° preoperatively to 7° postoperatively.

Conclusions: This technique seems to provide satisfactory basis for a dependable method of correction for severe adolescent tibia vara.

Key Words: Adolescent tibia vara – Osteotomy – Ilizarov external fixator.

Introduction

IN 1937, Blount published a classical article on what is now known as Blount's disease [1], and it has since then become a well-studied disorder. This disease has two distinct types: The infantile or early-onset form that appears before the age of 3 years and the adolescence or late-onset form that appears in children older than 11 years [2]. The deformity produced is not only a proximal tibia vara, as in the later stages of the disease, this varus might be accompanied by internal tibial torsion and depression of the medial tibial plateau [3-5].

Children with late-onset tibia vara present with a marked genu varum deformity that usually develops in middle childhood or early adolescence, and it is usually accompanied by obesity [6]. In these cases, the inhibition of growth may result in premature medial physeal arrest [7], which might explain the relative success of a single valgus osteotomy in the management of the earlier onset cases (60-75%) and the relative lack of its efficacy in cases with the later onset form. In these latter cases, complex and combined osteotomies might be required in the majority of the children (60-65%) [4,5].

Various management protocols of this complex deformity have been proposed. There have been descriptions of corrections performed acutely and fixed either internally [8,9] or externally [10]. In addition, there have been other reports on gradual corrections performed by utilizing Ilizarov fixators [11,12].

In 1964, Langenskiold and Riska suggested elevation of the medial plateau for later cases of infantile Blount disease [3]. Indication for this additional procedure is significant joint surface incongruity due to depression of the medial part of the tibial plateau [2]. This procedure has since then been reviewed, assessed, and modified [7-9].

There have been very few reports on the use of both the medial plateau elevation and tibial corrective osteotomies combined with application of Ilizarov fixators for the correction of adolescent severe tibia vara [13-16]. These reports have relied on gradually performed corrections. To our knowledge, the use of a medial plateau elevation, combined with tibial corrective osteotomy and circular ring Ilizarov fixation of the limb for acute single-stage correction of this complex deformity, has not been previously reported in literature.
The aim of this study was to report on our clinical experience and the short-term follow-up of a new surgical technique for single-stage acute correction of the complex proximal tibial deformity in adolescent tibia vara using a minimally invasive surgical approach, with the hypothesis that this technique would reduce the time in frame and ultimately maintain the correction in this older group of patients.

Patients and Methods

This prospective study included 30 limbs in 27 patients and was undertaken between the years 2010 and 2015. The included patients were (12/27) males and (15/27) females. There were twenty four (24/27) patient unilateral affection and three patient (3/27) bilateral affection. The mean age at initial procedure was 12.5 years. The included patients were three patients (3/27) over weight, seven patients (7/27) with obesity and seventeen patients (17/27) extreme obesity.

The lower extremities were evaluated preoperatively, immediately postoperatively, and at the time of the final follow-up with use of standard weight-bearing antero-posterior and lateral radiographs of both lower extremities in addition to CT scanographs of both limbs. Similar to other reports [3,9,13,14], the femoral-tibial shaft angle (F-T angle: Between the femoral and the tibial shafts), the femoral condyle-tibial shaft angle (FC-T angle: Between the femoral condyles and the tibial shaft), and the angle of the Medial Tibial Plateau Depression (MTPD) were assessed Fig. (1) and compared (preoperative angle values with those taken at the time of the last follow-up). A single-independent investigator performed all of the radiological evaluations.

Indications for surgery were adolescents with severe tibia vara of at least 13 years of age, significant deformity as defined by at least 20° of deformity in the coronal plane (i.e., a F-T angle of 20° varus), significant medial tibial plateau depression (15°) and pain or a functional disability as reported by the patient Fig. (2-A,B). Exclusion criteria included patients with Blount's disease without medial tibial plateau depression. In addition, patients who had other etiologies for their varus deformity, prior fracture (s) of the affected extremity, and other congenital, developmental, and or metabolic anomalies affecting growth of the involved extremity were also excluded. The same surgical technique was performed for all of the included 30 extremities.

Surgical technique: The concept behind this new technique was to use a single V-shaped osteotomy to correct simultaneously both the medial tibial plateau depression and the proximal tibial metaphyseal varus (± internal tibial torsion) within the same surgical session. In addition, fixation and maintenance of this correction were achieved by the use of a circular lizarov fixator. Under general anesthesia, the patient was placed supine on a radiolucent operating table. A tourniquet was applied to the mid-thigh, and standard sterile draping was done. A fibular osteotomy was performed in all patients between the junction of the middle and distal thirds of the fibula in standard manner using a 2-3cm lateral incision. Routinely, a lateral compartment fasciotomy was performed in all patients. Two epiphyseal self-drilling 5-mm screws were then inserted percutaneous under fluoroscopic control from medial to lateral stopping short of the intercondylar eminence and parallel to the joint line. The first of these screws was anterior in position, and the second was posterior and inferior in relation to the first screw (accounting for the posterior tibial slope). The V-shaped osteotomy is planned such that it comes to lie at the most proximal metaphysis above the tibial tuberosity and thus as near to the “CORA” of the deformity as possible. This osteotomy was performed through a 2-3cm medial skin incision placed approximately 2.5cm just distal to themedial physeal line. The subcutaneous tissue was separated carefully to avoid injury to the infra-patellar branch of the saphenous nerve, the periosteum incised, and then a 10-mm sharp curved osteotome was introduced to perform the first limb of the proposed osteotomy starting on the medial metaphysis and pointing towards the intercondylar eminence, taking care not to injure the joint cartilage Fig. (3A). In order to avoid loosening of the 5-mm screws, a broader osteotome was then introduced into the osteotomy plane and was used to elevate the medial tibial plateau. Now, the two 5-mm screws could be seen to lie on the same horizontal plane, indicating correction of the posterior sloping of the medial tibial plateau Fig. (3B). The 5-mm screws were thus advanced into the lateral tibial plateau also under fluoroscopic control Fig. (3C). The proximal lizarov ring was then assembled on these screws. Starting from the same point of the previous osteotomy, the second horizontal metaphyseal limb was then performed and directed from medial to lateral towards the lateral tibial surface. If internal tibial torsion is present, it is now corrected before attempting to correct the varus deformity. Correction of the varus occurs through compression of the lateral metaphysis, and there will be some
opening at the medial osteotomy site (neutral wedge). After which, an assistant held the limb in the corrected position while the surgeon fixed the distal tibia using two distal Ilizarov rings. The final external fixator frame is thus composed of a proximal ring fixed to the bone using two 5-mm screws and two K-wires. In addition, two distal rings are fixed to the bone using one K-wire and two 5-mm screws for each ring. The corrected position was controlled using the Bovie cord technique under fluoroscopic control. The skin was closed in normal fashion with care taken that it is not closed under excessive tension. Immediate postoperative radiographs are made to check for the attained correction. Physiotherapy was instituted for the patients, with special reference on knee and ankle range of motion. In addition, the families and children were taught the basics of physical care and cleanliness of the fixator and inserted pins.

Statistical analysis data were analyzed using Statistical Program for Social Science (SPSS) version 18.0. Quantitative data were expressed as mean ± Standard Deviation (SD). Qualitative data were expressed as frequency and percentage. Wilcoxon signed ranks test was used to compare two repeated measures. \( p \)-value <0.05 was considered significant.
Results

The patients were followed postoperatively for a mean of 16.8±4.4 months (range 12-23 months). The external fixator was removed after a mean of 10.233±1.851 weeks (range 8-16 weeks).

Radiographically, there was statistically significant improvement in the measured angles (Table 1).

Table (1): Radiological angles measured pre-and postoperatively in the whole studied groups.

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>p-value</th>
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<tbody>
<tr>
<td></td>
<td>Median</td>
<td>Range</td>
<td>Median</td>
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<tr>
<td>The angle of medial tibial plateau depression</td>
<td>34.867º±6.25º</td>
<td>20º to 50º</td>
<td>0º-22º</td>
</tr>
<tr>
<td>The femoral-tibial shaft angle</td>
<td>29º±7.497º</td>
<td>20º to 45º</td>
<td>3.3º±2.602º</td>
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<tr>
<td>The femoral condyle-tibial shaft angle</td>
<td>60.733º±7.575º</td>
<td>40º to 80º</td>
<td>85.933º±2.180º</td>
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Also, in the immediate postoperative period and by examination of the postoperative radiographs, two of the patients were found to have an under-correction of their deformity. A femoral condyle-tibial shaft varus angle of 74º and 78º was measured, respectively. The decision was consequently made to perform acute lengthening of the medial rods connecting the first and second rings and shortening of the lateral rods of the already applied circular fixator. This was performed as a bedside procedure on the third and fourth postoperative days, respectively. Both patients recorded satisfactory correction at the end of their follow-up (82º and 85º respectively).

Pin tract superficial infection was encountered in all patients, with a mean of 1.6 infections per patient. However, all superficial infections improved with oral antibiotics and local pin site care. There was a single self-drilling screw that became loose after 6 weeks and, consequently, required revision. We encountered no cases of septic arthritis of the knee or the development of a deep infection, osteomyelitis, or nonunion.

At final follow-up, all patients were satisfied with their procedure. All patients had regained full range of knee and ankle joint motion Figs. (4-A,B & 5). Limb Length Discrepancy (LLD) measurements were made, and no cases of significant LLD (>15mm) were recorded. There was a single patient who still complained of pain and instability of his knee. Upon examination, he was found to have grades II-III laxity of the lateral collateral ligament. A reconstruction of lateral collateral ligament was performed which managed to the pain and laxity.

Fig. (4): Postoperative photograph (A) and AP and lateral radiographs, (B,C) Of the previously depicted patient in Fig. (1) after removal of the fixator showing the attained correction.
Discussion

This study yielded satisfactory results after double osteotomy of the proximally deformed tibial segment in acute correction of late-presenting cases of adolescent tibia vara. The combination of acute percutaneous correction and stabilization by Ilizarov external fixation is a characteristic feature of this procedure.

Management of severe adolescent Blount’s disease is challenging. Patients are usually obese [6] and present with complex deformities of not only tibia vara but also procurvatum, internal torsion, and medial tibial plateau sloping [3,4]. The condition might progress to involve the femur [17] and cause instability of the knee and compensatory distal tibial valgus [18].

Early treatment of infantile Blount disease generally includes bracing, although the effectiveness of bracing continues to be controversial. Surgical management is recommended if the correction by bracing does not occur. Currently, the recommendation of progressive infantile Blount disease is avulsion of the proximal tibial osteotomy. Excessive valgus position of the osteotomy is primarily used. This position minimizes the compression force across the disorganized physis and provides time for normal growth to resume [19].

Generally, treatment is the same whatever the cause and comprises either acute or gradual correction of the deformity. The tibia is osteotomized, the mechanical axis corrected, and the osteotomy stabilized in the corrected position with some form of fixation. For acute corrections, the authors have employed internal plates [20], external mono-lateral fixation devices [10], or intra-medullary nails [21]. Meanwhile, Ilizarov circular fixators have been almost exclusively reserved for gradual corrections [11,12].

Circular external fixators have the advantage that they could be applied percutaneous, obviating the need for large surgical wounds, thus providing a more biologically suitable media for bone healing. In addition, there is no need for a second surgery for removal of the implants, and the patient might be allowed to bear weight prior to full consolidation of the bone. Perhaps, the most advantageous is the ability to use the circular fixators to “tweak” the attained correction during the postoperative period. With internal implants, if the attained fixation is suboptimal, then another surgery will have to be
considered. In the current series, there were two cases of under-correction that were managed by resorting to immediate “bedside” correction of the deformity by the use of the already applied fixator.

In cases of tibia vara presenting with significant incongruity of the joint surface due to depression of the medial part of the tibial plateau, surgical elevation of the depression has been described as early as 1964 [3], and since then, relatively few reports have been described for this procedure. Investigators have used internal methods of fixation for this deformity [7-9,18,22]. In comparison, metaphyseal osteotomies, while not addressing the medial tibial plateau pathology, and so are potentially unsuitable for correction of such deformities have been cited in literature much more frequently [22,23].

Recently, a few studies on the combined use of depression elevation and corrective osteotomies with the application of Ilizarov techniques for the correction of adolescent severe tibia vara have been described [13-16]. However, in all these previously described studies, the use of the Ilizarov frame has been only for gradual correction. In the current series, the Ilizarov fixator was used in stabilization of the acutely corrected deformity.

With acute correction, it has been reported that up to one third of patients can have transient or permanent neurologic injury, which typically presents as weakness of the extensor hallucis longus [4,10,24]. In the present work, no such complication was noted.

Investigators have reported on the successful combination of bone grafts with the osteotomy [8, 15,25]. Bone grafts were not used in the current study; the circular fixator was deemed sufficiently rigid to maintain the joint line elevation. The site of the correction is in the proximal metaphyseal part of the tibia above the tibial tubercle, and this possibly allows for adequate healing. In addition, this site is considered to be the site of the deformity (CORA), and thus, angular correction could be achieved without the need for translation. In this series, no cases of non-union were recorded. The drawback was the need to maintain the fixator for a mean of 10.233±1.851 weeks in our case series. However, due to the rigidity of the construct, the patients were allowed to bear weight after approximately 3 weeks, as tolerated. This time required for removal of the construct was significantly shorter in the current series when compared to other similar series that used external fixators for gradual correction of the deformity [13-16], where the documented duration until frame removal ranged from 22 [16] to 32 weeks [13].

Most investigators have deemed it necessary to perform a lateral proximal tibial and fibular epiphysiosis at the same time as the initial procedure to prevent recurrence of the deformity [13, 15,16,25]. However, in the current case series, epiphysiosis was not performed. The mean age of the involved patients in the current study was 14 years, and in comparison, the mean age of the included subjects in all of the abovementioned studies was roughly 9 years. Considering a proximal tibial growth of approximately 0.6cm/year, it was judged that there would not be a significant limb length discrepancy upon reaching the age of maturity. The measurements were made both clinically and by scanograms, and no cases of significant LLD (>15mm) were recorded. Additionally, the unilateral cases numbered seven cases with a mean age of 14 years also, and thus, most of these patients would have approached maturity during their current management and follow-up period. Similarly, the current study was aimed at investigating exclusively the tibial component of the genu varum deformity, and consequently, joint line angles as described by Paley were not used for evaluation of the results. In the current investigation, as in other similar reports [3,9,13,14], the femoral-tibial angle and the angle of medial tibial plateau depression were used.

Although the long-term results of this technique are not yet thoroughly documented, this procedure of acute correction allowed for restoration of normal lower extremity alignment, with a decreased time in frame that corresponded to the time required for bone healing in comparison to the previously described trials that relied on gradual correction or staged procedures.

In conclusion, the current study seems to provide satisfactory results with utilization of this newly described surgical technique for acute single-stage correction of the complex proximal tibial deformity in patients with severe adolescent tibia vara.

References
وصفت بلوانت مرضي الإعوجاج الأنسي الشديد أعلى عامة القصبة في عام 1974 واقتراح لانجيسكيرد وريسنا في تصنيف اشعاعي 1964. 

المرض يتكون من 3 مراحل تمثل تطور المرض دون علاج.

تهدف الدراسة إلى تقييم إجراء الشق العظمي الحاد على شكل حرف (V) من خلال الجلد والمعدن داخل مفصل الركبة ورفع الوضة الأنسية لعظمة الساق في حالات الإعوجاج الأنسي الشديد والثبت بواسطة جهاز اليداروف.

لا يوجد سبب واضح للمرض غير أن السمنة المفرطة للمرضي تزيد من نسبة حدوث المرض وتزيد من فصا الإعوجاج لعظمة القصبة. وقد تم وصف كثير من الطرق لعلاج المرض من أشهرها تثبيت الهرود التامي الخارجي أعلى عامة القصبة، الشد الخارجي للهرود الداخلي أعلى عامة القصبة، الشق العظمي أعلى عامة القصبة إذا لم تطرق إلى استعمال هبوط الوضة الأنسية أعلى عامة القصبة.

تقوم هذه الدراسة على استعمال التشوه أعلى عامة القصبة، في جميع الاتجاهات عن طريق الشق العظمي من خلال الجلد على شكل حرف (V) والرفع الحاد للوضة الأنسية مع استعمال التشوه الأنسية والانتقال الداخلي لعظمة القصبة في وقت واحد وعملية واحدة ثم التثبيت بواسطة جهاز اليداروف.

متوسط سن المرضى في هذه الدراسة 12.5 عام ومتوسط المتابعة 11 شهر ومتوسط وقت الجراحة 90 دقيقة ومتوسط的时间 جهاز اليداروف 10 أسابيع.

متوسط زاوية هبوط الوضة الأنسية قبل الجراحة 24 درجة وبعد الجراحة 7 درجات، متوسط زاوية بين ساق عظمي الساق والفخذ 29 درجة قبل الجراحة 62 درجة بعد الجراحة 85 درجة بعد الجراحة. وقد وجدت هذه النتائج مقارنة للدراسات الحديثة المماثلة.

رفع الحاد لعظمة القصبة عن طريق الشق العظمي على شكل حرف (V) المداخل لمفصل الركبة هو إستراتيجية تم تصليح الشد من حالة مرضي بلوانت. ومع ذلك يحتاج إلى الأنتظار لفترة طويلة من تطبيق تقنية فعالية التقنية على مدى البعيد والتأكد من تأخير أو غياب التغيرات التكنولوجية في حالات البالغين.