



## Evaluation of treatment of late-onset tibia vara using gradual angulation translation high tibial osteotomy

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Late-onset tibia vara or Blount's disease is the most common cause of pathologic genu varum in children and adolescents. Treatment remains controversial. Many studies in the past have shown that an osteotomy with acute correction is the most appropriate treatment. More recently however, there has been a growing interest, especially in severe cases, in using gradual correction with the Ilizarov technique after a single high tibial osteotomy.

A retrospective study in 20 children with late-onset tibia vara, who were treated by gradual angulation translation high tibial osteotomy using the Ilizarov technique, was performed. The mean follow-up period was 2.9 years (range : 2-4 years ; SD 0.75).

Recurrence of varus deformity to various degrees was noted in 10 of 22 cases (45.5%). Recurrence of deformity was found to be significantly related to both the degree of pre-operative deviation and the duration of follow-up. No statistically significant relationship was found between recurrence and the age of the patients at the time of the operation.

Angulation translation high tibial osteotomy using the Ilizarov technique is a unique method for realignment of the mechanical axis in late onset tibia vara. It also allows for correction of associated deformities.

The rate of recurrence of varus deformity is however relatively high.

**Keywords :** tibia vara ; Blount's disease ; osteotomy ; Ilizarov.

## INTRODUCTION

Blount's disease, or tibia vara, is the most common cause of pathologic genu varum in children and adolescents. Tibia vara has been classified as infantile, juvenile, and adolescent, the infantile form occurring before the age of 4, the juvenile form between 4 and 10 years of age and the adolescent form after 10 years. The term late-onset tibia vara includes both the juvenile and the adolescent forms (14). In late-onset tibia vara, the deformity is a combination of proximal tibial varus and procurvatum as well as internal tibial torsion resulting in a complex three-dimensional deformity. Leg length discrepancy may be present and adds to the complexity of treatment. Two other secondary deformities may be present, which are distal femoral varus

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and distal tibial valgus. The former is the result of excessive load on the medial half of the distal femoral epiphysis, while the latter is a compensatory deformity to the severe proximal tibial varus (10,14). The goals of surgery are to relieve pain, when present, and to correct limb alignment with a horizontal knee joint for weight-bearing. The long-term outcome of lower limb malalignment is not well understood. It is believed, however, that significant deviation from the normal mechanical axis may not only cause knee pain, but also predisposes the joint to osteoarthritis in the future (10,27). Treatment of late onset tibia vara remains controversial. Although several surgical options exist for its correction, a corrective osteotomy is still the gold standard (2,28). Many types of osteotomies have been described in literature, aiming at acute correction, including an opening wedge (23), a closing wedge, a spike (4) and an oblique osteotomy (21), elevation of the medial plateau (7,24,26), and finally a combination of different methods (7,8). Different modalities of internal fixation also have been described (1,5,16). Guided growth technique by hemiepiphysiodesis has been reported as an attractive alternative in the growing child to allow correction of an angular deformity in general. Using this technique, however, in patients with abnormal physes (eg, Blount's disease, skeletal dysplasias) has an unpredictable outcome. These cases showed a higher complication rate and were significantly more likely to require an osteotomy to correct a residual angular deformity due to failure of hemiepiphysiodesis (2,28). Medial plateau elevation procedures either alone or in combination with a high tibial osteotomy have been performed in patients with the severe forms of Blount's disease (Langenskiöld-IV, V, and VI) (9,17). More recently, there is a growing interest in using gradual correction by the Ilizarov technique in which, through a single high tibial osteotomy realignment of the mechanical axis is obtained, in combination with the correction of possible other associated deformities, including leg length discrepancy (6,25).

The aim of this study is to evaluate the results, after a follow-up period of at least 2 years, of a gradual angulation translation high tibial osteotomy in the treatment of late-onset tibia vara.

## PATIENTS AND METHODS

Twenty children (table I) from the Sporting Health Insurance Student Hospital – Alexandria, with a diagnosis of late onset tibia vara and older than 4 years of age at their first presentation, were evaluated after a minimum follow-up period of 2 years post-operatively. Two were bilateral. All cases were treated by the authors between December 2005 and January 2008. There were 9 males and 11 females. The two bilateral cases were males. Mean age of the patients at time of operation was 11 years (range : 8-14, SD 1.8). Ten cases were left sided, eight right sided and two bilateral. Fourteen legs were operated upon for the first time (63.6%) and eight cases were recurrences after prior treatment (36.4%). The mean follow-up period was 2.9 years (range : 2-4, SD 0.75)

The surgical procedure consisted of a single high tibial osteotomy, excision of part of the fibula, acute intra-operative correction of the tibial internal rotation and gradual angulation with translation with the Ilizarov apparatus, to correct the varus deformity using the so called "juxta-articular hinge assembly" (fig 1) (19,20). The aim was to obtain at the end an overcorrection of 10° valgus. Shortening, if present, was also corrected gradually.

Gradual correction of the varus deformity was started one week post-operatively and took 3-5 weeks depending on the degree of the pre-operative deformity. At the end the frame was locked and a further 10-12 weeks were allowed for consolidation, guided by regular radiological follow-up before frame removal. If a lengthening was performed, a further 4-6 weeks were needed for every additional centimetre.

Although limb length discrepancy was determined pre-operatively clinically and by a scanogram, the evaluation of limb length equalization was determined only clinically, as the presence of the Ilizarov apparatus prevented appropriate limb positioning during radiological limb length assessment. At least 2 years post-operatively, the charts and the initial radiographs of the 20 children (22 lower extremities) were studied. The patient age, gender and affected side were noted. The initial deformity angle (DA) of varus deformity was measured. The DA angle was formed between a line drawn from the center of the hip joint to the center of the knee joint and another line from the center of the knee joint to the center of the ankle joint. All measurements were read from standing anteroposterior radiographs or CT-scanograms. A negative DA represents a varus deformity. The degree of surgical correction (the sum of the initial degrees of the

Table I. — Data of the patients

Loss of correction	Follow up period (Y)	Degrees of correction	Pre-Op LLD (Cm)	Pre-Op Internal rotation	Pre-Op DA	Langenskiöld classification	Presentation	Side	Sex	Age (Y)	
20	3	40	-	-	-30	II	Recent	Rt.	Male	12	1
35	4	35	-	-	Lt. -25	VI	Recent	Bil	Male	9	2
25	3	30	-	-	Rt. -20	VI					
0	4	45	5	10	-35	II	Recurrent	Lt	Female	9	3
10	4	50	-	35	Rt. -40	II	Recent	Bil	Male	14	4
0	3	45	-	30	Lt. -25	II					
0	2	50	2	15	-40	I	Recent	Lt	Male	11	5
10	2	55	2	-	-45	VI	Recent	Rt.	Female	12	6
15	3	40	1	-	-30	IV	Recurrent	Rt.	Male	10	7
15	2	55	4	25	-45	VI	Recurrent	Lt	Female	9	8
0	3	45	3	-	-35	II	Recent	Lt	Female	12	9
20	3	50	2	20	-40	VI	Recurrent	Lt	Female	10	10
0	4	50	4	10	-40	IV	Recurrent	Rt.	Female	12	11
10	3	40	1	25	-30	III	Recent	Lt	Male	10	12
10	3	45	-	20	-35	I	Recurrent	Rt.	Female	8	13
15	2	50	1	25	-40	I	Recent	Lt	Male	11	14
0	3	35	-	-	-25	III	Recent	Rt.	Female	12	15
15	3	40	-	15	-30	VI	Recent	Lt	Female	9	16
20	2	55	2	-	-45	I	Recurrent	Rt.	Male	13	17
10	4	50	3	20	-40	III	Recent	Rt.	Female	10	18
0	2	40	2	-	-30	II	Recurrent	Lt	Female	14	19
20	2	45	1	-	-35	I	Recent	Lt	Male	12	20

varus deformity plus 10° valgus overcorrection) was noted after gradual correction was obtained. Loss of correction or the difference between the overcorrection achieved and the DA at the end of follow-up, was also evaluated. The mean preoperative deformity angle was -34.5° (range: -20° to -45°; SD 7.2°). The mean preoperative limb length discrepancy was 1.5 cm (range: 0.0-5; SD 1.5). The preoperative internal rotation of the tibia was 10.9° (range: 0.0°-35°; SD 12.2°).

Internal rotation of the tibia was measured using the thigh-foot axis test. In internal tibial torsion, the foot axis points inward and the angle is negative. The angle was measured with a goniometer.

According to the Langenskiöld classification, we divided the patients into two groups: grade I, II, III, and IV as the mild-to-moderate-group and grade V and VI as the severe group. The first group included 16 cases and had a mean pre-operative varus deformity of 34.7°

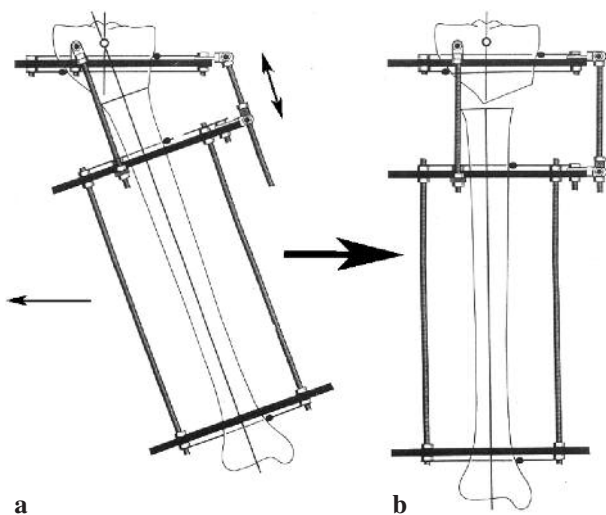
(range: 25°-45°). The second group included 6 cases with a mean pre-operative varus deformity of 34.2° (range: 20°-45°)

The mean angular correction was 45° (range: 30°-55°; SD 6.9°). Recurrence of deformity was defined as loss of correction of more than 10° at the end of follow-up.

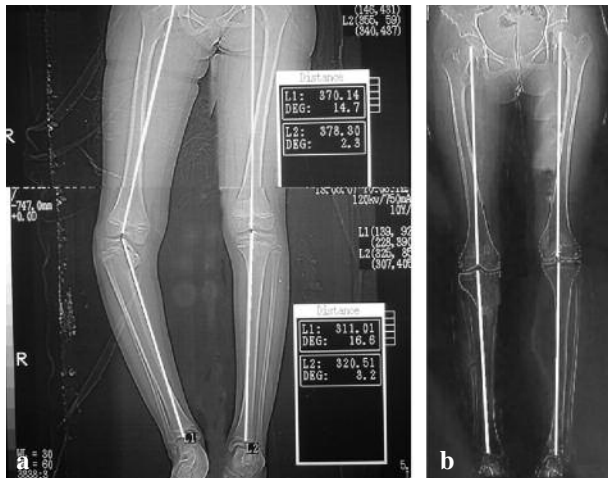
In data analysis, Student's t-test was used,  $p < 0.05$  being considered significant.

## RESULTS

New full-leg standing radiograms or CT-Scanograms of the lower limbs were evaluated after a mean follow-up period of 2.9 years (range: 2-4 years; SD 0.75) (fig 2). The mean loss of correction was 11.36° (range: 0.0° - 35°; SD 9.78°).

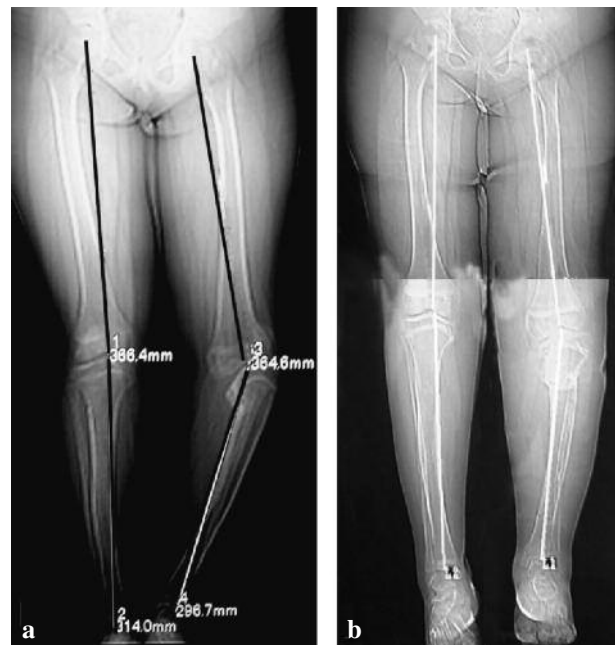


**Fig. 1.** — (a) juxta-articular hinge assembly mounted on a tibia vara in which the CORA lies near the joint line. To match the hinge of the fixator to the level of the CORA, the hinge must be above the ring. So, with correction of angulation, translation will result. (b) After correction, the mechanical axis is realigned.



**Fig. 2.** — (a) Preoperative CT-scanogram of a 12-year-old female with right-sided late onset tibia vara with a preoperative DA angle of  $-45^\circ$ . (b) follow-up scanogram after 2 years shows no recurrence.

Recurrence of varus deformity was noted in 10 of 22 cases (45.5%) (fig 3 & 4). The mean varus recurrence, in 5 out of 16 cases in the mild-to-moderate group, was  $18^\circ$  (range  $15^\circ$ - $20^\circ$ , SD  $2.7^\circ$ ) and  $22^\circ$  (range  $15^\circ$ - $35^\circ$ , SD  $4.8^\circ$ ) in 5 out of 6 cases in the



**Fig. 3.** — (a) Preoperative CT-scanogram of a 10-year-old female with left recurrent late onset tibia vara with a preoperative DA angle of  $-40^\circ$ . She had  $20^\circ$  of internal tibial torsion which was corrected acutely intraoperatively (b) follow up scanogram after 3 years shows a recurrence of  $25^\circ$ .

severe group. The difference in varus recurrence rates between the two groups was found to be statistically significant ( $p = 0.008$ ). There was also a statistically significant correlation between the rate of recurrence and the length of the follow-up period ( $p < 0.001$ ).

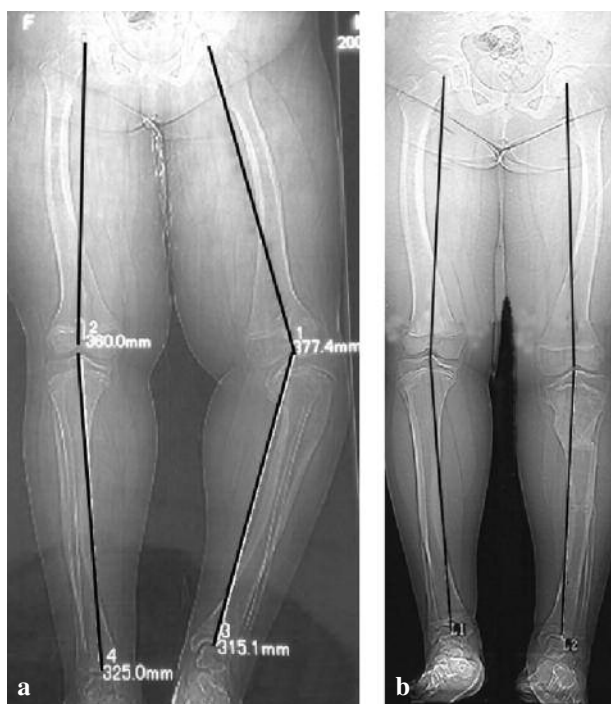
There was no statistically significant relation between the age of the patients at the time of operation and the recurrence ( $p = 0.87$ ).

No leg length discrepancy was recorded at the end of follow-up.

## DISCUSSION

Pain and knee arthrosis are the natural long-term result of untreated cases of Blount's disease (3,10-12).

Although a metaphyseal osteotomy with acute correction and internal or external fixation is the state of the art treatment of infantile tibia vara, this has been found to be less appropriate in treating late-onset tibia vara, where an extrafocal osteotomy



**Fig. 4.** — (a) Preoperative CT-scanogram of a 9 year old male with left recurrent late onset tibia vara with a preoperative DA angle of  $-45^\circ$ . He had  $25^\circ$  of tibial internal torsion which was corrected acutely intraoperatively ; (b) follow-up scanogram after 2 years shows a recurrence of  $15^\circ$ .

with gradual angulation translation using the Ilizarov technique is gaining popularity (6). Different reasons have been put forward.

Firstly, the center of rotation and angulation (CORA) is usually located juxta-articularly, which makes focal correction technically impossible. On the other hand, the upper tibial epiphyseal growth plate lies just distal to the CORA where osteotomies carry a high risk of potential injury of this growth plate, possibly adding more growth disturbance to the proximal tibia. So, the preferred location for the tibial osteotomy in this age is typically in the metadiaphysis, distal to both the tibial epiphysis and the insertion of the patellar tendon. The location of the osteotomy being away from the CORA (extra-focal correction), this necessitates appropriate lateral and often anterior translation of the distal fragment in order to realign the anatomic axis of the tibia. Disregarding this principle creates a secondary translational “dog-leg” deformity at

the metadiaphysis as well as valgus malorientation of the ankle (20). A “smiling face” dome osteotomy will have its center of rotation closer to the CORA and will induce appropriate translation and avoid injury to the proximal tibial epiphysis (18).

Secondly, most of these patient are morbidly obese, which makes the application of a well fitting above- knee cast difficult, if not impossible, and prevents adequate control of the position of the osteotomy site. In addition, the older age and size of the patient makes patient mobility highly desirable. The problems associated with non-weight bearing on the affected extremity makes walking extremely difficult for these patients. Furthermore, assessing limb alignment either intraoperatively or postoperatively is difficult with a cast and carries the risk of residual proximal tibial varus or undercorrection (6).

Thirdly, by using the Ilizarov technique the problem of limb length discrepancy is addressed comprehensively.

As regard the method of assessing the angular deformity around the knee, we chose the deformity angle (3), as discussed before, as the measure for both the pre-operative varus deformity as well as for the assessment of the results. This is because in these patients the upper tibial epiphysis is deformed with depression of its medial plateau, which makes measuring of the knee joint orientation angles such as lower lateral femoral angle and upper medial tibial angle less reproducible.

There is no consensus in the literature regarding the ideal alignment of the lower extremity following operative reconstruction in a patient with Blount’s disease (22). Most authors have advocated that some degree of overcorrection should be attempted (8,23,24,26,27). In this series  $10^\circ$  of overcorrection was aimed for at the end of treatment but still, recurrence occurred in 45.5% of cases. We still recommend overcorrection like other authors since overcorrection may decrease the incidence of the expected recurrence before the epiphyseal closure.

In this series, recurrence was evidently more frequent in Langenskiöld grades V and VI. It occurred in 5 out of 6 cases (83%) in the severe group, and only in 5 out of 16 cases (31.3%) in the mild-to-moderate group. This may support the need for an adjuvant procedure such as medial tibial plateau

elevation (9,17) or lateral tibial upper epiphyseal epiphyseodesis for Langenskiöld grades V and VI (2,28).

Limb length discrepancy in these patients is a result of two types of shortening, geometric (not a true shortening) and true shortening. Geometric shortening results from loss of co-linearity of the hip, knee, and ankle, which makes the overall limb length to be less than the summation of the individual lengths of both the tibia and the femur. True shortening results from compression of the medial physis due to the varus alignment with medial growth suppression in accordance with the Heuter-Volkman principle (13). Treatments that suppress lateral growth as lateral epiphyseal epiphyseodesis either by stapling or plating may also contribute to limb shortening (2,28).

Managing this shortening, Kessler *et al* (13) found in their work that a simple summation of femoral and tibial lengths predicts corrected limb length within a mean error of 0.7 cm, and that the corrected length is usually less than predicted, secondary to tibial shortening related to the osteotomy. However, shortening and recurrence of the deformity are expected as forthcoming problems when the osteotomy is performed prior to physeal closure. This was explained by Kessler *et al* to be due to imbalanced growth of the medial and lateral upper tibial epiphyseal plate, when this plate is still having a potential for growth (13). This conclusion correlates well with the result of this study, in that recurrence was found to be affected significantly by the length of follow-up period which gives the chance for the imbalanced growth of the upper tibial epiphysis to result in recurrence of the deformity. This was also noted by Chotigavanichaya *et al* (3).

As regard the relation of recurrence with the degree of the preoperative DA, this may be explained on the basis of the higher degree of pathological affection of the upper epiphyseal plate in higher DA value cases.

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