Relapsed infantile Blount's disease treated by hemiplateau elevation using the Ilizarov frame

S. Jones, H. S. Hosalkar, R. A. Hill, J. Hartley

From the Hospital for Sick Children, London, England

We have treated seven children with relapsed infantile Blount's disease by elevation of the hemiplateau using the Ilizarov frame.

Three boys and four girls with a mean age of 10.5 years were reviewed at a mean of 29 months after surgery. All had improved considerably and were pleased with the results. The improvements in radiological measurements were statistically significant ($p < 0.001$). Three-dimensional CT reconstruction was useful for planning surgery. There were no major complications. The advantages of this technique are that in addition to elevation of the hemiplateau, rotational deformities and limb-length discrepancies may be addressed.

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Blount, in 1937,¹ described infantile tibia vara as a developmental condition of the proximal tibia involving the epiphysis, physis and metaphysis. Mild early cases may resolve, but the deformity may progress with irreversible pathological changes and functional symptoms such as poor gait.^{2,3} Various techniques of osteotomy can restore alignment of the leg, thus facilitating normal development of the proximal tibia.^{4,5}

Recurrence of the deformity after surgical treatment is a recognised complication with reported rates of up to 55%.^{4,5} The recurrent deformity can be complex and is a combination of the deformity caused by the disease and postoperative changes.⁶ Repeat osteotomy is commonly advised.

Fig. 1

A long-leg standing radiograph taken before operation showing the deformity of the left knee.

We describe a staged technique of correction using the Ilizarov fixator which addresses all aspects of the deformity.

Patients and Methods

Between 1998 and 2000, seven children with severe relapsed infantile Blount's disease were treated using the Ilizarov fixator. The senior author (RAH) carried out all the operations.

S. Jones, FRCS Orth, Clinical Orthopaedic Fellow
H. S. Hosalkar, MS, Clinical Orthopaedic Fellow
R. A. Hill, FRCS, Senior Orthopaedic Consultant
J. Hartley, MCSP, Senior Physiotherapist
Division of Paediatric Orthopaedics, 5th floor, Southwood Building, Hospital for Sick Children, Great Ormond Street, London WC1N 3JH, UK.

Correspondence should be sent to Mr R. A. Hill.

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Fig. 2

Diagram showing the radiological parameters used to assess the outcome (see text).

There were four girls and three boys with a mean age of 10.5 years (7 years 10 months to 15 years) at the time of the initial operation (application of Ilizarov frame). Four patients were black (cases 1, 2, 3 and 7) and three white (cases 4, 5 and 6). In all seven the complex deformity was unilateral and had recurred despite previous tibial osteotomies. Two had had two previous osteotomies and the other five one.

The deformity was present to a less severe degree in the contralateral leg in three patients and two had previously undergone a successful proximal tibial osteotomy, while the third showed spontaneous correction.

Assessment. The clinical parameters which we assessed were: knee pain; range of knee movement; the stability of the knees; lateral thrust when walking; leg-length discrepancy using blocks; and rotational deformity.

For the radiological assessment we obtained standard long-leg standing radiographs with the patella pointing anteriorly and leg-length discrepancy corrected by standing on blocks (Fig. 1). We measured: (a) the angle formed by the anatomical axis of the femoral and tibial shafts (Fig. 2a); (b) the angle formed by the femoral condyle and the tibial shaft determined by a line drawn parallel to the inferior surface of the femoral condyle intersecting the anatomical axis of the tibia (Fig. 2b); and (c) the angle of depression of the medial tibial plateau formed by a line drawn parallel to the proximal margin of the medial plateau intersecting a line drawn parallel to the lateral tibial plateau (Fig. 2c).

These radiological measurements were chosen as they have been used by other authors in studies on Blount's disease.^{7,8} A single independent observer (SJ) undertook all the radiological measurements. To help to define the nature of the deformity three-dimensional CT was carried out before the operation (Fig. 3) using a Siemens Somatom plus 4 CT system (Siemens, Bracknell, UK). The slice thickness was 3 mm. The three-dimensional CT reconstructions were generated using computer software provided by the manufacturer. The scanning time for the distal femur and proximal tibia was less than five minutes and no sedation was required. In addition, clinical photographs were taken and a psychological assessment carried out by a trained psychologist.

The long-leg standing radiographs were repeated at regular intervals during the follow-up period.

Fig. 3a

Fig. 3b

Fig. 3c

Anterior (a), posterior (b) and oblique (c) CT reconstruction images showing a central depression and a medial and posterior slope.

Fig. 4

Intraoperative arthrogram using the image intensifier showing drill holes marking the proposed osteotomy site.

Fig. 5

Intraoperative arthrogram showing two half pins inserted into the fragment of the medial tibial plateau parallel to the true medial knee joint line.

We evaluated the results of treatment using these clinical and radiological parameters and graded them as good, fair or poor based on a modification of the criteria of Schoencker et al.³ A patient with a good result had no pain or instability of the knee. The knee was perpendicular to the mechanical axis of the leg and there was less than 5° of difference between the longitudinal axes of the lower limbs. A patient with a fair result had occasional pain in the knee which deviated by 5° to 10° from the perpendicular to the mechanical axis. A poor result implied pain in the knee which restricted normal activity and joint space incongruity with osteophytes at the femorotibial joint.

Statistical analysis was carried out using Student's *t*-test.

Operative technique

The operative correction was done in two stages.

Stage one. With the patient supine and under general anaesthesia we applied a tourniquet to the thigh. A preliminary arthrogram of the knee under aseptic conditions identified the true joint line. A J-shaped skin incision, made on the medial side of the knee, allowed subperiosteal exposure of the proximal tibia. A ring-handled retractor, carefully placed subperiosteally behind the knee, protected the neurovascular structures. After determining the level of the proposed osteotomy using an image intensifier, a Kirschner wire was inserted into the midline of the tibia anteriorly just below the tibial spine. A second Kirschner wire, inserted in the medial aspect of the proximal tibia (distal to the first wire), marked the distal extent of the osteotomy. This was usually at the metaphyseal-diaphyseal junction. We then pre-drilled

the osteotomy in line with the Kirschner wires, verifying the position of the drill holes using the image intensifier (Fig. 4). The skin incision was temporarily closed.

We then inserted three 4 or 5 mm half pins, depending on the size of the patient, into the fragment of the medial tibial plateau, parallel to the medial joint line as determined by the intraoperative arthrogram and three-dimensional CT (Fig. 5). If there was a posterior slope, pins were placed parallel to it from anterior to posterior. The skin wound was reopened and the osteotomy completed with Lambotte osteotomes leaving the articular cartilage intact proximally. The completed osteotomy was examined clinically and radiologically (Fig. 6).

A half ring of appropriate size was attached to the three half pins orientated parallel to the joint line in both the anteroposterior and mediolateral planes. A two-ring frame was applied distally perpendicular to the long axis of the tibia and attached to the half ring using anterior and posterior hinges. The hinges were placed opposite the intact articular cartilage at the proximal end of the osteotomy. In the presence of a posterior slope, based on CT, the posterior hinge acted as a distraction hinge to elevate the posterior slope while the anterior hinge was fixed. The anterior hinge was carefully positioned exactly in the midline over the tibial spine. Placement of the hinge is important because it has to lie over the cartilage-bone junction since the osteotomy hinges here. Two threaded rods, mounted medially, acted as motors. Distal ring fixation was by a 4 mm half pin and olive wire at each level.

Fig. 6

Radiographs showing the completed osteotomy with elevation of the hemiplateau underway using the Ilizarov frame.

Table I. The leg-length discrepancies before and after operation for the seven children with infantile Blount's disease

Case	Leg-length discrepancy (cm)		Comments
	Before operation	At latest review	
1	2.5	1.5	Ipsilateral tibial lengthening
2	2.5	2.0	Epiphysiodesis of opposite distal femur and proximal tibia
3	2.0	1.0	
4	5.0	<1.0	Ipsilateral tibial lengthening
5	2.0	2.0	Ipsilateral tibial lengthening
6	2.5	1.0	
7	2.0	1.0	

Stage two. Once we had achieved elevation of the medial plateau and the regenerate had consolidated, we undertook the second stage of the procedure. This involved removing or adjusting the Ilizarov frame for lengthening and, if necessary, any correction of rotational deformities. If there was any residual varus this was also corrected at the second stage. Patients with open epiphyseal plates underwent epiphysiodesis of the proximal fibular and lateral tibial physis to prevent recurrence of the deformity. This was by curettage under image-intensifier control. The amount of leg-length discrepancy expected following epiphysiodesis was predicted using Moseley's charts.⁹ The tibia was then lengthened by an amount equal to the anticipated shortening and the measured leg-length difference. The fibular osteotomy was performed at the level of the tibial osteotomy through a longitudinal skin incision using an oscillating saw.

Using the image intensifier we marked the site of the proposed tibial osteotomy and placed a Gigli saw subperiosteally with two mini skin incisions. Adding a half ring to the existing half ring over the medial plateau converted it into a full ring. An additional ring was attached to the proximal tibia using olive wires. This proximal ring block was then attached to the existing distal ring block by threaded rods for simple lengthening or derotation devices for correction of rotation, if necessary. We used the Gigli saw to complete the tibial osteotomy and sutured the skin incisions. After operation, the leg was kept elevated, a radiograph of the tibia was taken and distraction began between three and five days later under the supervision of a physiotherapist. Weight-bearing was allowed as tolerated.

Results

The mean duration of follow-up after the initial operation was 29 months (15 to 44). A clinical orthopaedic fellow (SJ) saw all the patients at the latest follow-up. No patient had pain in the knee or medial or lateral instability. The range of knee movement immediately after removal of the frame was 10° to 90° of flexion in two patients while in the other five it was from 0° to 110°. At the latest review, all had 0° to at least 110° of knee flexion. A lateral thrust was present, preoperatively, in three patients (cases 2, 5 and 7) but at the latest review none had a lateral thrust. Those patients who had a lateral thrust had a posterior slope on three-dimensional CT. The mean leg-length discrepancy was 2.6 cm (2 to 5) at the time of the initial operation. The deformed leg was the shorter in all patients (Table I).

In three patients (cases 1, 4 and 5) the frame was adjusted for ipsilateral tibial lengthening after elevation of

Table II. The radiological measurements and grading of Schoenecker et al³ for all seven children with infantile Blount's disease

Case	Gender	Age at surgery	Follow-up (mths)	Femoral shaft-tibial shaft angle (°)*		Femoral condyle-tibial shaft angle (°)		Depression of medial tibial plateau (°)		Grading of Schoenecker et al ³
				Preop	Postop	Preop	Postop	Preop	Postop	
1	M	8 yrs 3 mths	15	-36	-2	44	84	44	10	Fair
2	F	11 yrs 4 mths	21	-28	-3	50	82	46	20	Fair
3	F	12 yrs	20	-45	-4	40	86	50	8	Good
4	M	15 yrs	26	-24	+10	48	90	30	16	Good
5	F	7 yrs 10 mths	43	-26	-3	52	88	36	8	Good
6	F	8 yrs 4 mths	44	-36	-2	40	88	40	6	Good
7	M	10 yrs 9 mths	34	-40	-2	48	88	42	6	Good

*+, indicates valgus; -, indicates varus

the hemiplateau had been accomplished. The mean length gained was 4 cm.

In three of the remaining patients (cases 3, 6 and 7) the mean preoperative leg-length discrepancy was 2 cm. At latest follow-up, despite not having undergone lengthening, their mean limb-length discrepancy was 1 cm (Table I).

In the last patient (case 2), an epiphysiodesis of the contralateral distal femur and proximal tibia was undertaken at a bone age of 14 years to facilitate leg-length equalisation. This patient declined leg lengthening in view of her height.

One patient (case 1) required correction of an internal rotation deformity of his tibia. This was accomplished successfully using the Ilizarov frame.

The Ilizarov frame was removed at a mean of four months after the initial operation in those patients requiring elevation of the hemiplateau only. In those who also required tibial lengthening it was removed on average after eight months. As part of the second stage, three patients underwent epiphysiodesis of the lateral tibial physis.

The mean angle formed by the anatomical femoral and tibial axes had corrected from 33.6° of varus to neutral (Table II). The mean angle formed by the femoral condyle and the tibial shaft had increased from 46° to 87°. The mean depression of the medial tibial plateau had reduced from 41° before to 11° after operation. This last measurement was not very accurate because of difficulty in locating the true joint line on the plain radiograph.

Using Student's *t*-test the above improvements were all statistically significant ($p < 0.001$). On the grading scale of Schoenecker et al³ the results were good in five and fair in two patients (Table II). These latter two patients were pleased with the results because they had no pain, felt that their legs were much straighter and were able to partake in sporting activities in school.

There were no problems with nonunion at the site of the osteotomy. Premature consolidation of the osteotomy for elevation of the hemiplateau occurred in three patients (cases 4 to 6) between two and three months after the initial operation. In the first patient the correction achieved was not adequate and further elevation of the medial tibial plateau was undertaken by an osteotomy and bone grafting since the patient refused to remain in the frame any longer. In the second patient, the elevation achieved was thought to be satisfactory. The frame was readjusted and a tibial osteotomy

facilitated tibial lengthening. In the third patient premature consolidation was the result of a broken half pin because the local physiotherapist allowed her to go on a trampoline prematurely. This patient required further surgery. An initial dome osteotomy of the proximal tibia did not adequately correct the deformity and therefore an Ilizarov frame was reapplied and tibial lengthening also undertaken.

There were problems with pin-site infection in all patients, but this settled with appropriate pin-site care and antibiotics. There were no neurological complications.

Discussion

Early surgical intervention is advised in patients with progressive infantile Blount's disease.^{3,4,10,11} Despite early operative treatment a recurrence rate of up to 55% has been reported.⁴

In the relapsed patient the deformity is complex being a combination of the deformity due to Blount's disease and to postoperative changes.⁶ There is commonly premature fusion of the medial proximal tibial growth plate which leads to rapid recurrence and progression of the deformity.^{1,8,12,13}

The complexity of the deformity may not be fully appreciated on plain radiographs and three-dimensional CT can be very helpful. In our study the CT reconstruction images revealed abnormalities which were not readily understood on plain radiographs. This information is particularly relevant to the surgical technique of elevation of the hemiplateau using the Ilizarov frame.

The knee is unstable because of ligamentous laxity and there may be a lateral thrust.¹³ In our series a lateral thrust was present in three patients with a posterior slope on the CT scan. There may also be a leg-length discrepancy and in our series the preoperative discrepancy was 3 cm.

The severe deformity results in an incongruent knee and disturbance of the mechanical axis which leads to the development of early degenerative change.¹⁴ In patients with relapsed infantile Blount's disease, the presence of a bony bridge on the medial side results in inevitable recurrence after simple osteotomies.

A simple tibial osteotomy such as a dome osteotomy does not restore the normal anatomy of the joint since the lateral tibial plateau is relatively normal and the deformity is

largely confined to the medial tibial plateau. It is logical to use a technique which attempts to restore the normal anatomy of the medial plateau by its elevation. As a second stage to prevent further recurrence, epiphysiodesis of the lateral physal plate, if still open, should be carried out combined with leg lengthening to correct any current or anticipated leg-length discrepancy. Rotation and residual varus may also be corrected at this stage.

Sasaki et al¹³ described a transepiphyseal plate osteotomy of the medial tibial condyle associated with epiphysiodesis and a tibial valgus osteotomy. They reported a good result in one patient with relapsed infantile Blount's disease, but with 4 cm of shortening. This procedure was carried out in two stages. Gregosiewicz et al¹⁵ described a double elevating osteotomy and achieved good results in 11 of 13 legs. The procedure consisted of an osteotomy elevating the medial part of the proximal tibia and a wedge osteotomy of the proximal tibial metaphysis. Only one of their patients suffered from relapsed infantile Blount's disease and had 2.5 cm of shortening at skeletal maturity.

Schoenecker et al⁸ described a technique involving elevation of the medial tibial plateau and epiphysiodesis of the lateral aspect of the proximal tibial epiphysis and fibular epiphysis. In addition, some patients had a distal femoral osteotomy before elevation of the tibial plateau. Only four of their seven patients suffered from relapsed infantile Blount's disease with good results in two and fair in two. Leg-length discrepancy remained a problem in these patients.

All these techniques rely on acute correction by elevation of the depressed medial tibial plateau which may not be possible in patients with severe deformity as seen in this series. Wound closure may be compromised and a large bone graft required with the risk of slow incorporation. In addition, leg-length discrepancy cannot be addressed by these techniques. The technique which we describe of gradual correction using the Ilizarov frame also allows correction of the posterior slope which was necessary in four patients. With conventional techniques of acute correction the reported rate of neurovascular complications ranges from 3.3% to 18%, the rate of nonunion from 2.5% to 4% and the incidence of compartment syndrome is 6%.^{11,16-19}

At the latest review, two of the three patients who had undergone tibial lengthening had a longer Blount's leg (Table I). This was deliberate and based on calculations from growth charts designed to obtain equal limb length at skeletal maturity.

With this technique patients are mobile, and can maintain a good range of movement of the knee throughout the period of treatment. There are complications such as premature consolidation of the elevation osteotomy of the hemi-plateau and pin-site infection. Careful preparation and preoperative planning are important as in all patients undergoing treatment with the Ilizarov frame. The senior author does not recommend using this technique in patients under six years of age because the medial fragment is relatively

Fig. 7

Radiograph showing the left knee of the patient in Figure 1 after correction of the deformity.

small and it is difficult to obtain secure fixation with the half pins.

We were able to avoid premature consolidation in later patients in our series by increasing the rate of distraction. Dressings soaked in chlorhexidine and spirit, held in position at the skin-pin interface by plastic clips, helped to reduce the level of pin-site infection.

Our early results show that this technique is valuable in the treatment of relapsed infantile Blount's disease because it addresses all the components of the deformity and achieves a significant improvement in the anatomy of the knee (Fig. 7). So far there has been no recurrence of deformity but follow-up until at least skeletal maturity will be necessary.

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