Limb lengthening by physeal distraction

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I evaluated 10 consecutive lengthenings through the upper tibial physis in 9 patients. A bilateral frame consisting of two small-sized Wagner devices and two pairs of 4-mm transfixing pins with 5-mm-diameter central threads were used. The median lengthening was 6.7 cm. Complications were frequent. The risk of a growth disturbance is very high, and physeal distraction should therefore only be applied towards the end of the growth period.

Three efficient principles are currently applied in limb lengthening: physeal or callus distraction and diaphyseal lengthening with internal fixation and bone grafting. Physeal lengthening is a percutaneous and rather simple operation. In this procedure and in metaphyseal callus distraction, the bone consolidation is more rapid than in the diaphysis; and there is no need for bone grafting or plating.

Premature closure of the growth plate after physeal distraction frequently occurs, especially in a distraction rate of about 1 mm a day (Monticelli and Spinelli 1981). On the other hand, De Bastiani et al. (1986) found that in slow distraction (0.5 mm a day) the lengthened segment continued to grow, but at a slower rate. My purpose was to evaluate the results after concluded growth of our first physeal distractions and the function of the growth plate after distraction.

Patients and method

Ten consecutive lengthenings through the upper tibial physis in 9 patients (3 boys and 6 girls) were evaluated (Table 1). The median chronologic age at the beginning of treatment was 13 (10–18) years, with a corresponding skeletal age of 13 years. There were 4 cases of congenital shortening of the tibia and associated deformities, and 1 case each of enchondromatosis, metaphyseal dysostosis, sequelae of poliomyelitis, congenital dislocation of the hip with growth-plate disorder, and achondroplasia (Table 1). Three of the patients had highly irregular growth plates with retarded and asymmetric growth in the knee region. In 6 patients the primary disorder had required several operations. Four had also had femoral lengthening varying from 5 to 11.2 cm on the ipsilateral side. The expected leg-length discrepancy was calculated according to Moseley (1977).

A bilateral frame consisting of two small-sized Wagner apparatuses with a T-shaped pin clamp and two pairs of 4-mm transfixing pins with 5-mm-diameter central threads were used (Figure 1). All the pins were inserted from the lateral side, the epiphyseal pins placed parallel to the physis, one behind the other, under image-intensifier control. A fibular osteotomy with resection of about 1 cm of the lower third was performed. The distraction force applied was sufficient to cause the transfixing pins to bend (Figure 2). The patients were ambulatory on crutches 1–2 days after the operation. After separation through the growth plate, which occurred on the second to fourth day, a distraction of 0.25 mm was carried out four times a day 5 days of the week.

The median distraction period was 9 (4–15) weeks depending on the extent of the lengthening and complications during traction. When the traction was finished, the apparatus was kept as an external fixator for 17 (16–24) weeks, until the elongated part of the tibia was surrounded by bridging bone (Figure 2). Partial to full weight bearing was allowed on crutches. The device was then replaced by an orthosis that allowed knee exercise and weight bearing. The brace was used for 18 (16–32) weeks. The median period from application of the apparatus to full weight bearing without support was 14 (9–15) months.

Physiotherapy was given to prevent knee and ankle contractures, and the patients were encouraged to perform the prescribed exercise every day. A sling to prevent equinus deformity was also used in later cases. The patients were followed until cessation of growth.

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Table 1. Leg lengthening by distraction of the upper tibial physis

Pat. No.	Sex	Chron. age	Skeletal age	Etiology	Shortening (cm)		Tibial lengthening		Complication[a]	
					Preop.	Expected	cm	%		
1	F	12	10	Cong. tibial short. Foot anomaly	4.2	5.5	5.5	20	1	2
2	M	15	14	Cong. tibial short. Aplasia of fibula	8.2	9	9	30	4	7
3	M	13	13	Cong. tibial short. Foot deformity	6	8	7	25	3	5
4	F	12	12	Cong. tibial short. Ankle anomaly	2.5	3.5	3.5	12		
5	F	10	10	Metaphyseal dysosthosis	3	8.5	7.5	28	2	
6	M	18	15	Enchondromatosis	6	7,5	7.5	24	3	
7	F	13	13	Disorder of growth plates	4.5	6.5	6.5	19	1	
8	F	12	12	Sequelae of poliomyelitis	5.8	8	4.5	17	2	
9	F	14	14	Achondroplasia			8	38	1	2
							8	38	2	7
Average					5	7.1	6.7	25		

[a] 1. Pin-track infection.
2. Achilles tendon lengthening.
3. Achilles tendon lengthening and capsulotomy.
4. Flexion contracture of the knee.
5. Physiolysis of lower femur.
6. Fracture of tibial tuberosity.
7. Fracture of tibia.

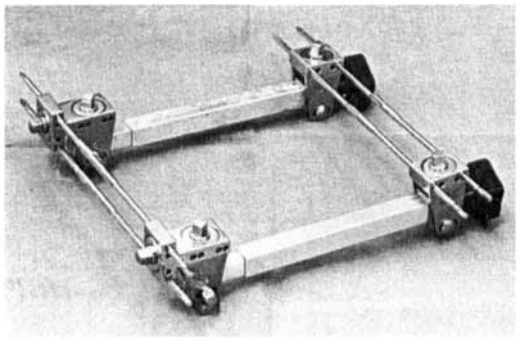

Figure 1. The distraction device consists of two small-sized Wagner apparatuses with a T-shaped pin clamp and two pairs of 4-mm transfixing pins with 5-mm-diameter central threads.

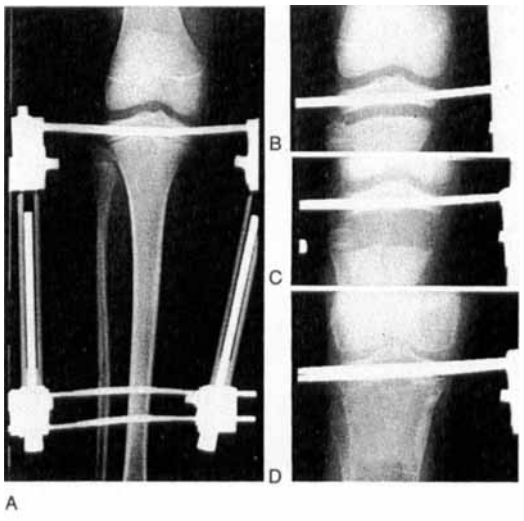

Figure 2. An 11-year-old girl with congenital tibial shortening and foot anomalies.
A. The lengthening device applied and the pins bended under distraction force before physiolysis.
B. Physiolysis 4 days after surgery.
C. A 4-cm lengthening 4 weeks after surgery.
D. The lengthening zone (5.5 cm) 4 months after the end of distraction with an uninterrupted cortical layer.

Results

The median lengthening was 6.7 (3.5–9) cm. The patient with achondroplasia had a lengthening of 8 cm on both sides. The median percentage of lengthening was 25 (12–38) percent. In 2 cases the expected lengthening was not reached; the difference was 1 cm in each. Correction of an angular deformity was done during traction in 2 cases.

When the treatment was finished, the physis appeared irregular or closed in all the cases. In the 6 patients below 13 years of age, the median additional growth of the short tibia after completed traction was 0.6 (0–2) cm and that of the contralateral, normal tibia

3.2 (1.2–5.8) cm. Only 1 patient had obvious, but retarded, growth from the distracted physis. Two patients had retardation of growth prior to the elongation. The retardation of tibial growth after distraction resulted in a median leg-length discrepancy of 1.2 (0–1.8) cm.

Complications

There were no neurologic or vascular complications or deep infections. Minor pin-track infection in 3 cases did not otherwise influence the treatment.

In seven limbs the *achilles tendon* had to be lengthened, in two combined with posterior capsulotomy. *Flexion contracture* of the knee occurred in 2 cases; 1 was successfully treated by a turnbuckle arrangement, but the other contracted a *slip of the lower femoral epiphysis* when correction was attempted by cautious manipulation under general anesthesia. An open reduction and fixation with two Kirschner wires were performed; but the growth plate closed, and a physiodesis of both femur and tibia of the contralateral leg had to be performed 2 years later. A *fracture through the base of the tibial tuberosity* occurred in 1 case during distraction, and a proximal transfer of the tuberosity became necessary. The distraction was, however, completed. *Fracture with angulation of the elongated area* occurred in 1 patient after removal of the distraction device. He was treated by closed reduction and a plaster cast for 6 weeks.

Discussion

The distraction frame used in this series probably has some advantages as compared with other frames using Kirschner wires. The threaded pins give a firm fixation, which might be the cause of the relatively few cases of pin-track infection. The apparatus allows for correction of an angular deformity by asymmetric distraction. Complications were frequent as in femoral lengthening (Bjerkreim and Hellum 1983). One reason for this could be that the lengthenings were rather extensive, and most of the patients had been operated on before. Four patients had also had additional lengthening of the ipsilateral femur — 3 before and 1 after the physeal distraction. Equinus deformities occurred in most cases in spite of physiotherapy and a sling for prevention.

It is of great importance to be aware of complications that may occur. Special attention should be paid to knee and foot deformities; and if necessary, the distraction can temporarily be stopped or reduced. It is also important to encourage weight bearing and exercise.

The risk of growth disturbance of the elongated physeal plate is very high, also found experimentally (Steen et al. 1987); and physeal distraction should only be applied towards the end of the growth period. Lengthening by physeal distraction still has some advantages, especially as regards diaphyseal lengthening, as osteotomy, plating, and bone transplantation are unnecessary.

References

De Bastiani G, Aldegheri R, Renzi Brivio L,Trivella G. Chondrodiatasis controlled symmetrical distraction of the epiphyseal plate. Limb lengthening in children. J Bone Joint Surg (Br) 1986;68(4):550–6.

Bjerkreim I, Hellum C. Femur lengthening using the Wagner technique. Acta Orthop Scand 1983;54(2):263–6.

Monticelli G, Spinelli R. Distraction epiphysiolysis as a method of limb lengthening. III. Clinical applications. Clin Orthop 1981;(154):274–85.

Moseley C F. A straight line graph for leg length discrepancies. J Bone Joint Surg (Am) 1977;59(2):174–9.

Steen H, Fjeld T O, Rønningen H, Langeland N, Gjerdet N R, Bjerkreim I. Limb lengthening by epiphyseal distraction. An experimental study in the caprine femur. J Orthop Res 1987;5(4):592–9.