Tibial lengthening

Epiphyseal and callus distraction compared in 39 patients with 3–14 years follow-up

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We examined 32 patients with 39 lengthenings (mean 8 cm) of the lower leg 3–14 years postoperatively. 23 distraction epiphyseolyses and 16 corticotomies with callus distraction had been carried out using the Ilizarov system. Both procedures yielded the same healing indices and the number of problems and complications was the same in the two groups. After distraction epiphyseolysis, serious complications of the knee and greater deviations from the normal leg axis were commoner than after callus distraction, which we now prefer.

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Submitted 95-08-16. Accepted 96-04-28

There are two methods of distraction osteogenesis in limb lengthening: epiphyseal and callus distraction. Today epiphyseal distraction is reserved for adolescent limb lengthening shortly before the end of growth. The reason is the controversial issue as to whether permanent damage is caused in the growth plate. While some authors observed a premature closure of the growth plate after distraction epiphyseolysis in animals (Jani 1975, Monticelli and Spinelli 1981, Steen et al. 1987, Fjeld and Steen 1990) and clinical studies (Karimova 1980, Conolly et al. 1986, Bjerkreim 1989), other authors found no impairment in animals (Fishbane and Riley 1978, Sledge and Noble 1978, Peltonen et al. 1988) and in clinical applications (Aldegheri et al. 1989b).

We compared tibial lengthenings achieved by distraction epiphyseolysis with callus distraction after corticotomy.

Patients and methods

From 1979–1991, 32 patients underwent 39 lengthenings of the lower leg: 23 distraction epiphyseolyses and 16 callus distractions. The lengthening techniques used have been described in detail (Franke et al. 1992). At the time of operation, the age of the patients was 5–25 years and the follow-up time was 3–14 years (Table 1). The etiology was congenital disorders 3 times more often than acquired diseases. Bilateral lengthenings, using the same procedure, were performed in patients with achondroplasia, pubertas praecox and Morbus Ollier. In 37 cases, the proximal tibia was chosen as the site of lengthening. In 2 cases, a distal tibial distraction epiphyseolysis was carried out. In cases of proximal lengthening of the tibia, the fibula was transfixed distally, whereas when the tibia was lengthened distally, the transfixation of the fibula was performed proximally. The Ilizarov circular fixator was used in all patients. Varus and valgus deformities of the lower leg up to 10° were corrected simultaneously in 11 distraction epiphyseolyses and 7 callus distractions. In adults or older children with a unilaterally shortened lower leg, the planned lengthening depended on the total length of

Table 1. Patient data

	Distraction epiphyseolysis	Callus distraction
No. of lengthenings	23	16
No. of patients	21	11
Sex (male / female)	10 / 11	4 / 7
Side (right / left)	13 / 10	7 / 9
Mean age (range) at operation (yr)	13 (5–15)	16 (11–25)
Age at follow-up (yr)	19–28	20–28
Mean (range) follow-up period (yr)	12 (6–14)	7 (3–9)
Diagnosis		
Congenital diseases		
Achondroplasia	6	2
Pubertas praecox	2	2
Morbus Ollier	0	2
Hypoplasia of the tibia	3	3
Hypoplasia of the fibula	5	1
Hemihypertrophy	3	0
Congenital pseudarthrosis	1	1
Acquired diseases		
Posttraumatic shortening	3	3
Posttraumatic pseudarthrosis	0	2

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the opposite side. The mean preoperative leg length inequality in unilateral cases was 8 (3–16) cm. In younger children with one-sided hypoplasia in whom potential differences in growth after lengthening and, consequently, subsequent differences in length could be predicted, the length was slightly overcorrected. This was calculated according to Moseley (1977).

The clinical and radiographic findings were evaluated before, during and after the lengthening procedure. The range of knee motion, the mechanical axis of the hip-knee-ankle, and the healing index, the treatment time from the application of the fixator to the time of fixator removal and full weight bearing, divided by the number of centimeters lengthened, were recorded. The difference in leg length was measured using orthoradiography (Green et al. 1946). As problems, we classified difficulties which could be solved without surgery or repeated narcoses. Complications included difficulties which either required narcoses and surgery or which jeopardized the success of the treatment or still existed after termination of the treatment (Correll and Kochs 1992).

Qualitative variables were analyzed by the chi-square test, normally distributed variables by the t-test. The significance level was set at $p < 0.05$.

Table 2. Results, problems and complications after 39 lengthenings of the tibia

	Distraction epiphyseolysis n 23	Callus distraction n 16
Results; median (range)		
Lengthening (cm)	8.4 (4–18)	8.6 (3–15)
Healing index (days/cm)	42 (33–53)	41 (36–64)
Problems		
Temporary joint contracture	10	8
Wire tract infection	11	8
Delayed bone healing > 50 days/cm	2	1
Temporary paralysis of peroneal nerve	3	1
Correctable angulation	6	3
Complications		
Fracture after fixator removal	3	2
Delayed bone healing, bone transplantation required	1	4
Premature bone healing, osteotomy required	1	0
Cutting through or breaking of wires, wire change required	3	0
Knee ankylosis	1	0
Outcome		
Pain in knee when walking and/or climbing stairs	3	2
Leg length discrepancy 0.5–1.5 cm	6	2
Knee flexion contracture 5°–10°	4	2
Ankle flexion contracture 5°–10°	3	2
Femorotibial valgus angle 8°–12°	5	1

Results

The lengthenings achieved and the healing indices were the same for the two procedures (Table 2). The tibial lengthenings achieved in the 7 patients who underwent bilateral lengthening were 9 (7–12) cm, regardless of the method used.

There were no significant differences in problems and complications between the two methods.

More serious complications of the knee joint developed after distraction epiphyseolysis (Table 2). In one case (a 7-year-old girl with unilateral lengthening because of hypoplasia of the tibia), the proximal wires penetrated the knee joint after the distraction had been performed. This meant that the fixator had to be removed prematurely and the joint had to be immobilized in a plaster cast. 6 months later, knee ankylosis had occurred.

Follow-up results

5 patients complained of pain in the knee when climbing stairs and after walking long distances, without any radiographic sign of arthrosis. No other patients had any pain. None of the patients regretted undergoing the lengthening procedures. In the final analysis of the leg length discrepancy (Table 2), the patients who had undergone callus distraction showed better results, although in none of the distraction epiphyseolyses could a premature closure of the growth plate be observed on radiographs taken every 2 years. A knee flexion contracture of 5°–10° occurred in 2 patients after corticotomy and in 4 cases after distraction epiphyseolysis. The knees of the other patients had normal motion. 5 legs that had undergone a distraction epiphyseolysis and 1 with callus distraction had a valgus angle of 8°–12°.

Discussion

The lengthening indices we obtained are comparable to those in other studies (De Bastiani et al. 1986, 1987, Cattaneo et al. 1988, Aldegheri et al. 1989a, b, Paley 1990). Problems and complications are common, but difficult to compare because of different classifications (Aldegheri et al. 1989a, b, Korzinek et al. 1990, Paley 1990, Pfeil and Niethard 1990, Franke et al. 1992).

In our patients, irrespective of the method used, more than one problem arose with each leg lengthen-

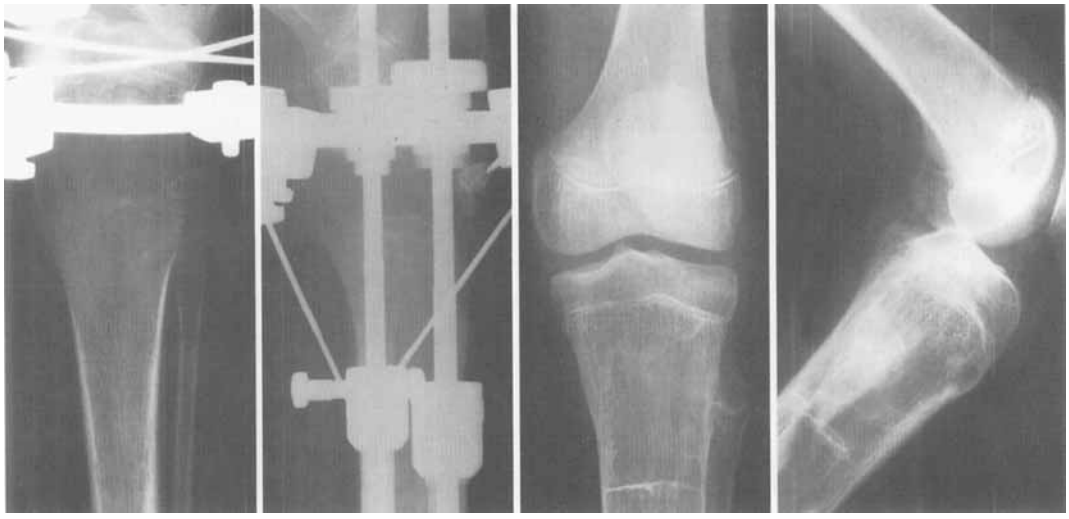

Figure 1. Distraction epiphyseolysis in a 9-year-old girl with hypoplasia of the left lower leg (shortening 6 cm). 3 years after lengthening by 7 cm. Premature closure of the proximal tibial growth plate did not occur.

ing. Nevertheless, the success of the treatment was not jeopardized. The commonest problems (temporary contracture of the joints and wire tract infections) can be improved by prophylactic measures (e.g., exercises, support, and skin care). Complications tended to occur more frequently and were more serious after distraction epiphyseolysis. One reason for the more frequent joint complications is the short distance between the proximal fixator wires and the knee joint. Because of the relatively few operations, the differences between the two groups were not significant.

At the follow-up examination, leg length discrepancies were rare and were not due to premature closure of the growth plate. Generally, they occurred after unilateral lengthenings and were due to inadequate lengthening. Other authors have reported growth plate damage after epiphyseal distraction (Karimova 1980, Conolly et al. 1986, Bjerkreim 1989).

Permanent restriction in the range of motion of the knee is often found after leg lengthening and was commonest in our patients after distraction epiphyseolysis, which underlines the problem of a joint near the fixation. In our opinion, fixation of the fibula is important to prevent axial deformity. Obviously, a valgus deformity caused by retardation of the fibula head is preferable during distraction epiphyseolysis.

Although serious complications occurred in one third of the patients, most patients had good subjective and objective outcomes. At the time of review, none of the patients regretted the operation. This underlines the psycho-sociological problems which are often associated with shortened legs.

With adequate experience, epiphyseal and callus distraction can lead to satisfactory results. However, we stopped using distraction epiphyseolysis in 1985 because of its age-limited applicability and the controversial question of growth plate damage. We prefer callus distraction after corticotomy because of the lower rate of complications and the possibility of fixation at a greater distance from the joints.

References

Aldegheri R, Renzi-Brivio L, Agostino S. The callotasis method of limb lengthening. Clin Orthop 1989a; 241: 137-65.

Aldegheri R, Trivella G, Lavini F. Epiphyseal distraction-chondrodiastasis. Clin Orthop 1989b; 241: 117-27.

Bjerkreim I. Limb lengthening by physeal distraction. Acta Orthop Scand 1989; 60: 140-2.

Cattaneo R, Villa A, Catagni M, Tentori L. Limb lengthening in achondroplasia by Ilizarov's method. Int Orthop 1988; 12: 173-9.

Conolly J F, Huurman W W, Lippiello L, Pankaj R. Epiphyseal traction to correct acquired growth deformities. Clin Orthop 1986; 202: 258-68.

Correll J, Kochs A. Probleme und Komplikationen bei der Unterschenkelverlängerung nach Ilizarov: Ursachen, Prävention und Therapie. Orthopädie Mitt 1992; 3: 228.

De Bastiani G, Aldegheri R, Renzi-Brivio L, Trivella G P. Chondrodiastasis-controlled symmetrical distraction of epiphyseal plate. J Bone Joint Surg (Br) 1986; 68: 550-6.

De Bastiani G, Aldegheri R, Renzi-Brivio L, Trivella G P. Limb lengthening by callus distraction (Callotasis). J Pediatr Orthop 1987; 7: 129-34.

Fishbane B M, Riley L H. Continuous transphyseal traction: experimental observations. Clin Orthop 1978; 136: 120-4.

Fjeld T O, Steen H. Growth retardation after experimental limb lengthening by epiphyseal distraction. J Pediatr Orthop 1990; 10: 463-6.

Franke J, Simon M, Hein G. Ilizarov-Techniken zur Beinverlängerung: Probleme und Ergebnisse. Orthopäde 1992; 21: 197-209.

Green W T, Wyatt G M, Anderson M: Orthoroentgenography as a method of measurement the bones of the lower extremity. J Bone Joint Surg 1946; 28: 60-5.

Jani L. Die Distraktionsepiphyseolyse: Tierexperimentelle Studie zum Problem der Beinverlängerung. Teil I. Z Orthop 1975; 113: 189-98.

Karimova L F. Zu Fragen der operativen Behandlung von Kindern mit Entwicklungsanomalien der Unterschenkel. Beitr Orthop Traumatol 1980; 27: 125-38.

Korzinek K, Tepic S, Perren S M. Limb lengthening and three-dimensional deformity corrections: a retrospective clinical study. Arch Orthop Trauma Surg 1990; 109: 334-40.

Monticelli G, Spinelli R. Distraction epiphyseolysis as a method of limb lengthening. I. Experimental study. Clin Orthop 1981; 154: 254-61.

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

Paley D. Problems, obstacles, and complications of limb lengthening by the Ilizarov technique. Clin Orthop 1990; 250: 81-104.

Peltonen J, Kahri A, Karaharju E, Alitalo I. Regeneration after physeal distraction of the radius in sheep. Acta Orthop Scand 1988; 59: 675-80.

Pfeil J, Niethard F U. Unterschenkelverlängerung mit dem Ilizarov-System: Darstellung der unterschiedlichen operativen Techniken und Analyse der 1986–1989 durchgeführten Unterschenkelverlängerungen. Orthopäde 1990; 19: 263-72.

Sledge B C, Noble J. Experimental limb lengthening. Clin Orthop 1978; 136: 111-9.

Steen H, Fjeld T, Rönningen H, Langeland N, Gjerded N R, Bjerkreim I. Limb lengthening by epiphyseal distraction. An experimental study in the canine femur. J Orthop Res 1987; 5: 592-9.