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Correction of relapsed or neglected clubfoot using a simple Ilizarov frame

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Abstract We present the results of using a simple Ilizarov fixator frame in treatment of 66 feet in 52 patients (mean age 8.5 years) of 58 relapsed and eight neglected clubfeet with grade III or IV severity with a mean follow-up of 40 (26–58) months. Our frame, in spite of being simple and easy for surgeons and patients to handle, achieved satisfactory correction comparable to the literature.

Résumé Nous présentons les résultats de l'utilisation d'un cadre simple de fixateur Ilizarov dans le traitement de 66 pieds bots chez 52 malades (âge moyen 8,5 années) avec un suivi moyen de 40 mois (26–58). Il s'agissait de pieds bots de niveau de sévérité III ou IV, 8 négligés et 58 récidives. Notre cadre, bien que simple et de maniement facile pour les chirurgiens et les malades, a conduit à une correction comparable aux résultats de la littérature.

Introduction

In most children, conventional surgical management of idiopathic clubfoot gives satisfactory results, but this is not the case in neglected or recurrent deformities. Recurrence may occur in up to 20% of operated clubfeet [2]. The treatment depends on the nature and severity of the deformity. A fixed or severe deformity is likely to require repeated soft-tissue release plus or minus some bony procedures, particularly in a child over 4 years of age. Repeated soft-tissue operations are likely to cause increased stiffness of the foot, while bony operations are likely to make a foot which is usually already small even smaller. An alternative is to use the Ilizarov technique, which allows gradual distraction and correction of all aspects of the deformity [2, 3].

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Patients and methods

Between 1998 and 2001, we treated 66 clubfeet in 52 children, 36 boys and 16 girls, of which 14 children had bilateral deformity (eight boys and six girls). Eight feet had no previous surgeries, the rest had from two to nine operations. For most patients, details of the previous operations were not available. The mean age at surgery was 8.5 (4–14) years with an average follow-up of 40 (26–58) months. The study group included 41 idiopathic clubfeet, of which eight were without previous surgery; 23 arthrogrypotic feet; and two clubfeet in a child with skeletal dysplasia. The severity of the deformity was assessed using Dimeglio's method [5]. Fifty-nine feet were graded as severe (grade III), and seven were very severe (grade IV).

Operations were performed under general anaesthesia; the frame was assembled before surgery. In most bilateral cases, both feet were operated at the same time.

Frame

The frame is composed of one or two tibial rings, calcaneal half ring and metatarsal 5/8 ring. The calcaneal half ring is attached to the tibial ring with a threaded rod that ends distally with a universal hinge situated in an antero-lateral position to the ankle and subtalar joints. On the opposite side of this rod (postero-medial to the ankle and subtalar joints), a distractor rod is applied. The calcaneal half ring and the metatarsal 5/8 ring are connected by two threaded rods, one on each side of the foot. Each one is attached proximally to a uniplanar hinge, which is connected to the free end of the calcaneal half ring (Fig. 1).

The frame is assembled in a way that is comparable to the degree of deformity. With more equinus than varus deformity, the distractor rod between the tibia and calcaneum is positioned in a more posterior than medial position and vice versa. Every tibial ring is attached with two crossed wires (1.5 mm) tensioned between 90–100 kg or one single wire and a Schanz' screw. A drop wire at a proximal level and one Schanz' screw at the level of the drop wire are applied using a single tibial ring. The half ring around the calcaneum is secured with a transverse wire and one or two Schanz' screws. The metatarsal 5/8 ring is secured with two crossing wires (Fig. 2).

The use of either one or two tibial rings or one or two Schanz' screws in the calcaneum is variable according to the age of the patient and the severity of the deformity. Centralisation of the frame starts with fixation of the calcaneal half ring with transverse wires parallel to the foot sole. This is considered to be the corner stone in the frame application. Then the tibial ring is secured with one wire, ensuring that the universal hinge is antero-lateral to the ankle and subtalar joints. The metatarsal 5/8 ring is secured to the

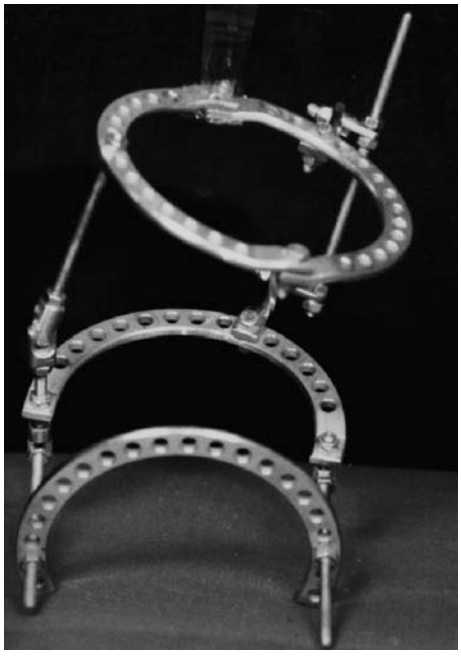

Fig. 1 Frame assembly

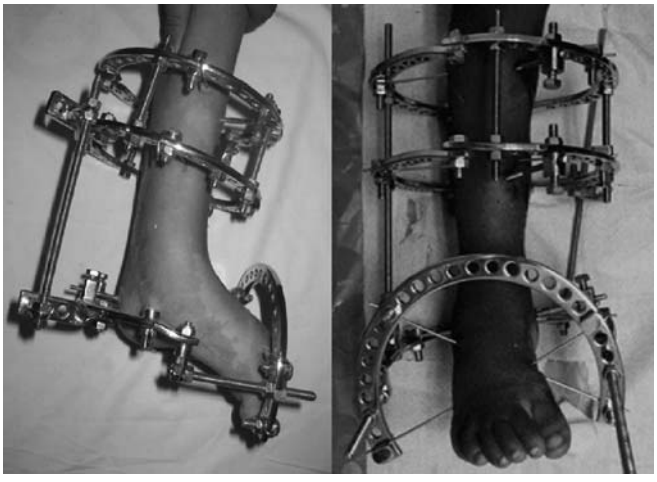

Fig. 2 Mounting of the frame

forefoot. Then we proceed with complete fixation of the frame to the foot and leg.

In the first few cases, we aimed at maximum correction intra-operatively, but we did not continue in later cases. Gradual distraction is started the day after surgery on variable rates on each rod. The children were usually discharged home within a week of operation. All the children were reviewed at weekly intervals while correction was proceeding and the frame adjustment made as required. Correction of supination of the forefoot is obtained by supinating the metatarsal ring (changing the position of the rods connecting it to the calcaneal half ring). The position of the postero-medial distraction rod may be shifted either medially or posteriorly according to the progress of deformity correction.

Radiographs were taken at 2-week intervals, and the position of the talus was monitored. To prevent flexion deformity of the toes, a wooden plate is attached with malleable wires parallel to the sole of the foot. When the foot is plantigrade, the child is allowed to bear weight in the frame using a cushioned sole. In one case, we did primary pinning of the toes to avoid flexion deformity, and in four cases percutaneous flexor tendons tenotomy at the time of frame removal for severe flexion deformity.

We aim at slight over-correction, and when this is achieved, the frame is retained for a further 4–6 weeks until removal under general anaesthesia. A below-knee plaster is then applied to maintain correction for another 4 weeks. During casting, the foot is supple, so the cast should be applied very meticulously with proper moulding of the arches and correction of any residual supination deformity. After removal of the cast, the parents are instructed to manipulate the foot and ankle using a night splint until the end of growth.

Results

The mean time to achieve correction of the deformity was 5.4 (4–8) weeks. All feet were painless and plantigrade (Fig. 3). Ankle dorsiflexion improved in all patients post-operatively. None of the operated feet showed increased stiffness in comparison to the pre-operative condition. Radiologically, the talo-first metatarsal angle improved with re-alignment of the long axis of the talus with the first ray. In the frontal plane, the talo-calcaneal angle showed lesser changes (Fig. 4).

During follow-up, eight feet in seven patients showed some recurrence of the metatarsus adductus but without any recurrence of other deformities. The feet were still graded as grade I. These patients were negligent in using the night splint.

Complications

Most children had pin-tract infection. Most responded to antibiotics, and five feet required removal of the infected pin. Wire cut-through occurred in two feet in the calcaneum. These two cases had maximum correction intra-operatively. Lengthening of the operated limb occurred in one leg (grade IV) due to epiphysiolysis of the distal tibial epiphysis but without any malalignment. Three feet developed a planovalgus deformity due to over-correction. Subluxation of the metatarso-phalangeal joints of the lesser toes occurred in five cases. One foot developed localised sloughing of the sole due to pressure from the wooden plate. Two cases developed differential lengthening of the metatarsals: One of them showed over-lengthening of the fifth metatarsus with flexion deformity of the lesser toe; the other showed over-lengthening of the first metatarsal bone.

Discussion

In clubfoot treatment, the aim is to obtain a fully corrected and mobile foot at maturity [9]. In the long term, a foot with some residual deformity but remains mobile may be superior to that with an absolute anatomical correction but which is stiff [8]. However, recurrent deformity in which the child walks on the side of the foot or where shoe fitting is a problem, requires attention [2].

Fig. 3a,b Seven-year-old child with bilateral deformity operated at age 1.5 years. Relapse on the right side. **a** Preoperative appearance of the feet. **b** Full correction of the right deformity after removal of the frame

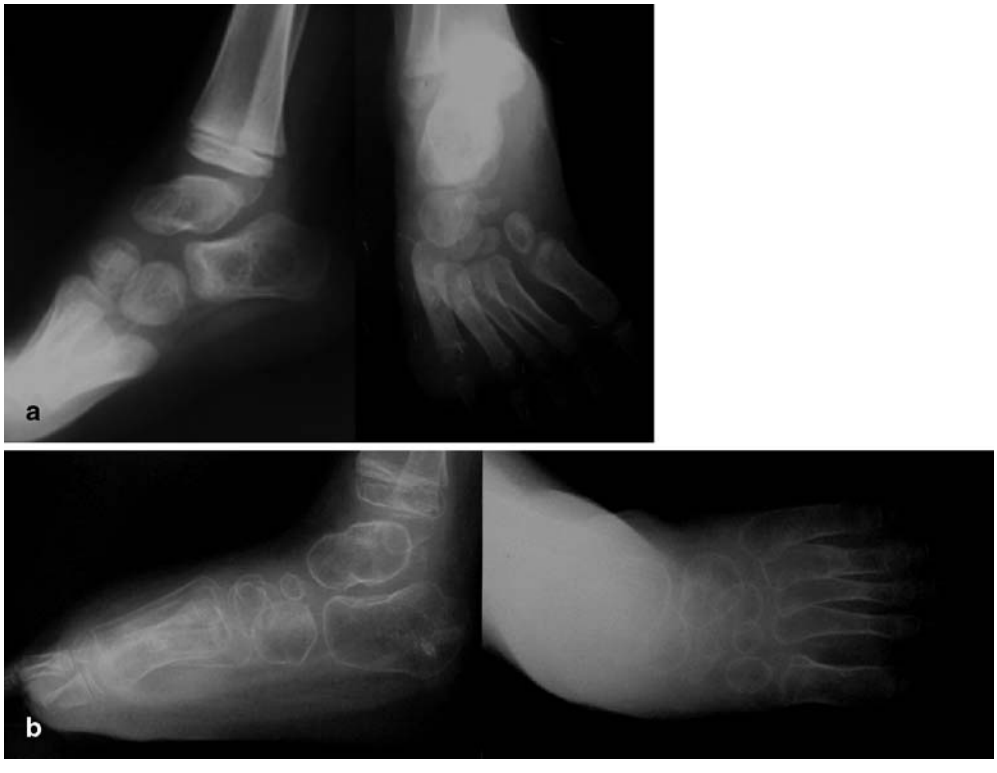

Fig. 4a,b Radiological appearance of the right foot in the same patient as in Fig. 3. **a** Preoperative, b post-operative

The Ilizarov technique achieves correction by distraction of the joints, allowing realignment [4]. The soft-tissue tension may also stimulate bone growth, but this is difficult to determine radiologically. Regarding our frame, we deal with the ankle equinus and subtalar varus as a single deformity with the apex of this deformity located antero-lateral to these two joints. This allows the use of a single hinge positioned antero-lateral to the ankle and subtalar joints and a single distractor rod positioned postero-medially. Also, the positioning of the hinge away from both joints allows simultaneous distraction and correction of the deformities, which ensure joint decompression. The use of two hinges in conventional frames to correct each of these deformities in its plane usually block each other, may lead to joint compression and cartilage damage and may prevent simultaneous correction of both deformities.

The presence of the lateral uniplanar hinge proximal and lateral to the midtarsal joint allows distraction of this joint and lateral translation of the forefoot over the hindfoot. In addition to this, we add some distraction on the lateral side to allow easy translation of the forefoot without any joint compression or crushing and provide foot lengthening, which is required in such cases.

We did not utilise the anterior rods between the tibial ring and the metatarsal half ring because they may block correction of the forefoot adduction and will not allow swinging of the forefoot over the hindfoot to realign the talus with the first metatarsus. For correction of supination deformity, we rotate the metatarsal ring over the calcaneal one, or it is corrected acutely in the cast after removal of the frame. However, we did not find the presence of some supination deformity, which is usually mild after correction of the varus deformity, to affect the outcome of the procedure. On the contrary, it may maintain the valgus position of the heel.

The distraction of the lateral rod between the calcaneum and the metatarsus at a lesser degree than the medial rod, allow lengthening of the whole foot and avoid any crushing of the lateral column during swinging of the forefoot. We have to obtain over-correction of the foot in the frame, as some loss of correction is a problem after frame removal. Acute intra-operative distraction should be avoided, as it was responsible for all our cases of wire cutting. After removal of the Ilizarov frame, the casting technique is very important. Proper moulding of the arch is mandatory to prevent flattening of the arches of the foot. Correction of a residual supination deformity can be easily achieved in the cast.

In the literature, it is pointed out that most feet will retain their pre-operative mobility. A pre-operatively stiff foot will remain like this [10]. However, in the current, study we noticed improvement in mobility in all cases. This may reflect the fact that we obtained good distraction without joint compression and cartilage damage. Grill and Franke [6] treated nine severely deformed feet using this method with a satisfactory outcome in terms of function and appearance. In their report, a plantigrade foot was achieved in all patients and confirmed radiographically. There was, however, stiffness of the subtalar and midtarsal joints in all feet. Henrik et al. [7] reviewed the outcome in seven patients with ten idiopathic club feet treated by the Ilizarov method for relapsed deformity. They reported six patients, and their parents were satisfied with the correction. None of these series included objective radiological data.

Several complications have been reported using the Ilizarov external fixator: pin-track infection, dysaesthesia, pain during treatment, subluxation of tarsal bones, transient nerve palsies, joint contractures and others [1, 6]. Choi et al. [3] reported epiphysiolysis of the distal tibial epiphysis and advised transfixion of the epiphysis when correcting severely deformed feet. Although we reported more complications, the majority were mild and did not produce permanent residual defects. The preliminary results in our series showed that our modification of the Ilizarov technique is effective in management of relapsed or neglected clubfeet in young children.

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