Circular External Fixator in the Treatment of Congenital Pseudarthrosis of the Tibia

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ABSTRACT

Three patients with congenital pseudarthrosis of the tibia were treated by circular external fixator (Ilizarov technique). The technique consists of resection of the pseudarthrosis with shortening and compression of the tibial fragments and metaphyseal lengthening of the tibia at the same time. Clinical union at the pseudarthrosis site and leg equality were achieved in two out of three cases. The causes of failure were due to inadequate resection, residual angular deformity at pseudarthrosis site and instability of the frame. There was no serious complications except minor wires tract infection. The results indicate that Ilizarov technique can achieve satisfactory bone union and offer encouragement in treating congenital pseudarthrosis of the tibia. The meticulous surgical techniques should be followed in order to obtain a satisfactory result.

Congenital pseudarthrosis of the tibia is a very rare condition. Anderson[1] reported the incidence of congenital pseudarthrosis of the tibia as one in 140,000 newborns. Many classifications of congenital pseudarthrosis of the tibia have been introduced.[2-6] However, Boyd's classification[7] is probably the most complete one. Type II cases are the most common and have the most dismal prognosis. A wide variety of surgical methods to promote bony union has been utilized to treat this condition. Treatment consisted of various form of bone grafting in combination with internal or external fixation[8-10], electrical stimulation[6,11,12], and free vascularised fibular grafts.[13-17] Amputation has always been an option in treatment. Successful treatment should consist of union of the pseudarthrosis and maintenance of that union without excessive shortening of the leg.

The principle of circular external fixator which is called the law of Tension- Stress has been described by Ilizarov[18,19] from Russia, in the mid 1950s. The application of this principle has helped in developing new methods of treating many medical problems. Plawecki[20] reported that solid union was achieved in a short period of time in three cases of congenital pseudarthrosis of the tibia treated by Ilizarov mehod. In this article, we reported the results in three patients with congenital pseudarthrosis of the tibia treated by circular external fixator.

MATERIALS AND METHODS

Two patients with type II, associated with neurofibromatosis, and a patient with type IV congenital pseudarthrosis of the tibia presented at orthopaedic clinic, Ramathibodi hospital from 1992 and 1994. The circular external fixator was used to treat the patients by distraction and compression technique at the same time. The pseudarthrosis site was resected completely, and the angular deformity was corrected. The frame with compression technique was applied to the resected site until stability was achieved. The compression force was adjusted during the course of treatment. The foot frame was supplemented to create a sufficiently stable assembly. A corticotomy was performed at the proximal tibial metaphysis, thereby preserving the periosteum and the medullary blood supply. The distraction technique at the rate of 1 mm. per day (0.25 mm. every 6 hours) was started on day 7 post operatively until the desirable length was obtained. The frame was removed after consolidation of the lengthening site. Full weight bearing was permitted during the course of treatment. The patellar weight bearing brace was used to protect the pseudarthrosis and lengthening site up to one year.

Case 1 (Fig 1)

A fifteen-year-old boy with a typical manifestation of neurofibromatosis presented with a pseudarthrosis of the left distal tibial diaphysis. There were multiple café-au-lait spots, cutaneous nodules, and thoracic scoliosis. The patient had not previously been treated. the patient was treated with circular external fixator by using the technique described. the frame was removed in 10 months. Consolidation of the pseudarthrosis site was obtained and the tibia was lengthened by seven centimeters. Unfortunately, there was valgus collapse of the lengthening site after removal of the frame due to inadequate new bone formation. Corrective osteotomy with bone graft was performed at the lengthening site and the leg was immobilized in an above knee plaster cast. The osteotomy site healed uneventfully in three months.

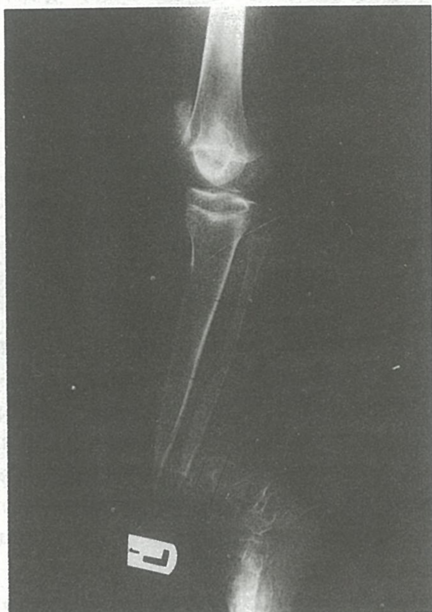


Fig. 1-A The radiograph showing congenital pseudarthrosis of the left tibia (type II).

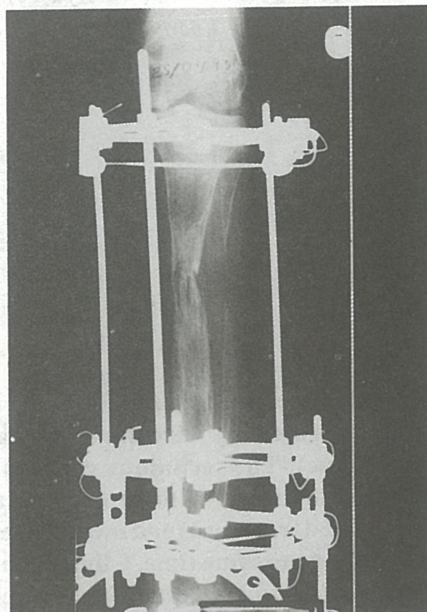
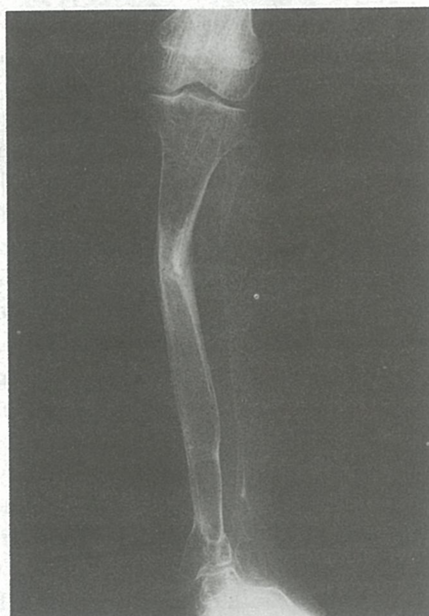


Fig. 1-B The radiograph of the congenital pseudarthrosis of the tibia after application of a ring external fixator with compression technique at the pseudarthrosis site and lengthening at the proximal tibia.



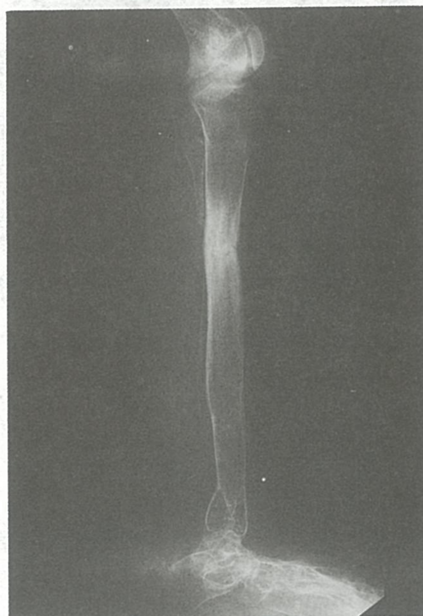


Fig. 1-C and D The radiograph after removal of the frame, consolidation at the pseudarthrosis site was obtained but there was mild collapse at the lengthening site.

Case 2 (Fig 2)

A six-year-old girl was diagnosed as having neurofibromatosis. She had a history of fracture of the left tibia after sustaining minor trauma at four years of age. She had been treated conservatively and surgically, but the fracture did not unite. She had five centimeters shortening of the left leg. Circular external fixator was used as described. The frame was removed in eight months. The leg length was equal, and there was five degrees loss of knee extension which subsequently recovered after removal of the frame. While waiting for bracing, the patient accidentally fell down and sustained refracture of the pseudarthrosis site. The frame was reapplied with the compression technique without opening the pseudarthrosis site. The pseudarthrosis was united within four months. The frame was removed, and the leg was protected in long leg plaster cast. Two months later, refracture of the pseudarthrosis site occurred for the second time, in plaster cast. The third operation was performed with resection and readjustment of the pseudarthrosis site and the frame was reapplied. The pseudarthrosis was united uneventfully in four months.

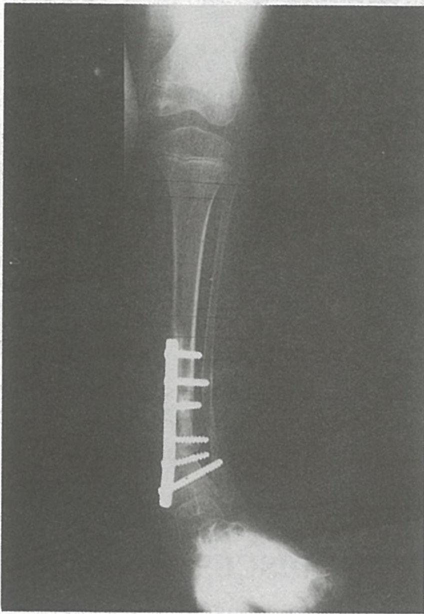


Fig. 2-A The radiograph showing failure to achieve union of congenital pseudarthrosis of the tibia after plating.

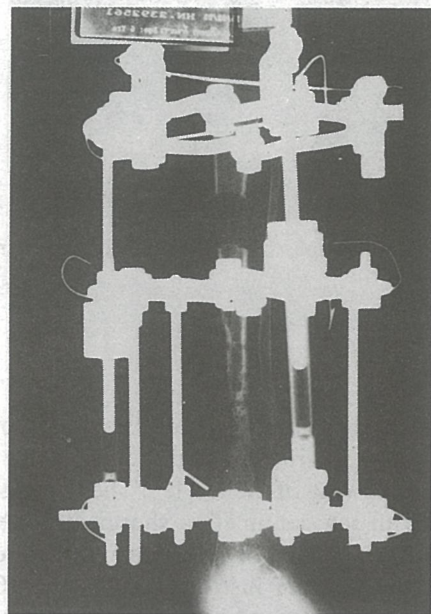
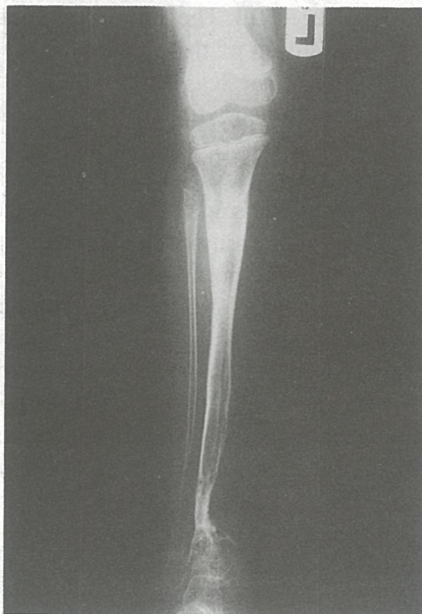


Fig. 2-B The radiograph showing congenital pseudarthrosis of the tibia after removal of the plate and application of a ring external fixator.



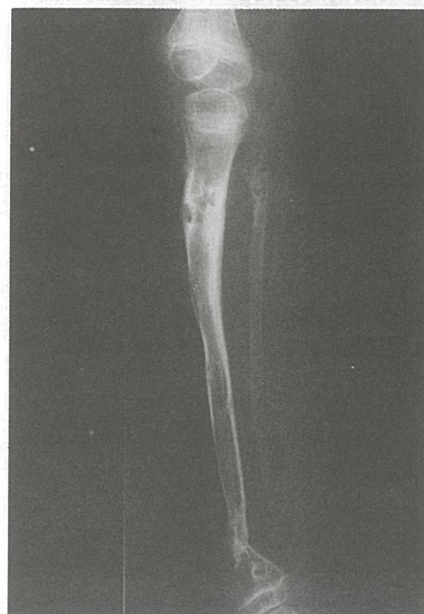


Fig. 2-C and D The pseudarthrosis site was united but, there was mild anterior angulation at the pseudarthrosis site.

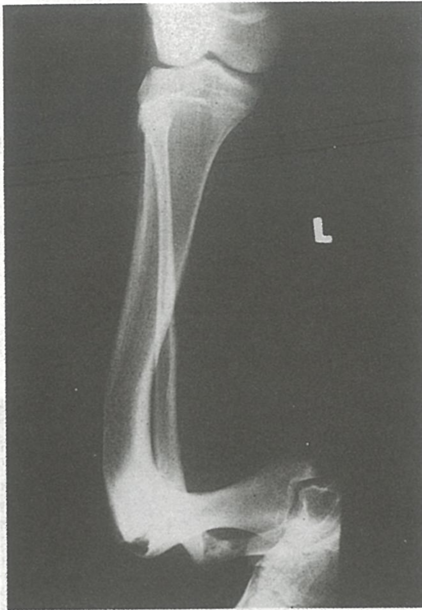


Fig. 3 A The radiograph showing congenital pseudarthrosis of the tibia type IV

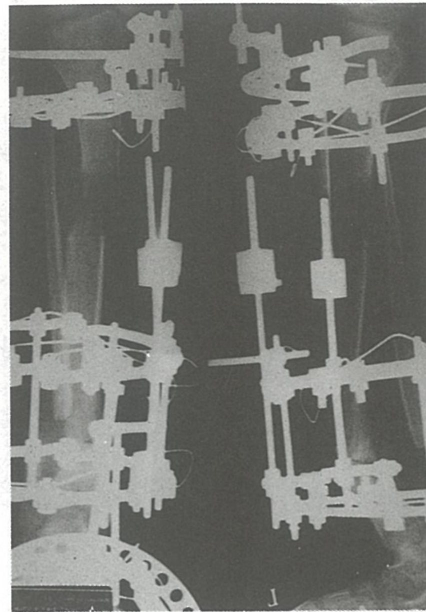


Fig. 3 B The radiograph of the congenital pseudarthrosis of the tibia after application of a ring external fixator, there was anterior angulation at the pseudarthrosis site which was failure to unite.

Case 3 (Fig 3)

A fifteen-year-old boy was diagnosed as Boyd's type IV congenital pseudarthrosis of the left tibia. He was born with anterior bowing of the left leg. The leg was severely angulated with ten centimeters shortening. He had not previously been treated. The frame was applied as described. At the time of instrumentation, the 20 degrees anterior angulation of the tibia had to be accepted due to fix dorsiflexion deformity of the ankle. At ten months follow-up, the pseudarthrosis site was partially united with retarded osteogenesis at the lengthening site. Then the frame was removed, and bone grafting procedure was performed both at the pseudarthrosis and lengthening sites. Chip grafts were simply laid over the posterior aspect of the pseudarthrosis site, and the leg was supported in an above knee plaster cast. Two months later, there was refracture of the pseudarthrosis and collapse of the lengthening site. The patient underwent further surgery to correct the deformity with intramedullary rod and bone grafts. The pseudarthrosis was united in 5 months and the leg was protected in brace.

RESULTS

Consolidation at the pseudarthrosis site was achieved in two out of three patients (cases 1 and 2) with circular external fixator. The lengthenings obtained in cases 1 and 2 were 70 mm. and 50 mm. There were no stiffness of the knee joint and neurovascular complications. There were minor wire tract infection at the upper ring in all cases, but it was resolved after removal of the frame. Retardation of osteogenesis at the lengthening sites was noted in case 1 and 3. Refractured of the pseudarthrosis site was found in case 2 and 3, but the union could be achieved in subsequent operation.

DISCUSSION

The treatment of congenital pseudarthrosis of the tibia remains one of the most challenging problems in paediatric orthopaedics. Several forms of treatment were being used, but no single procedure stood out as being clearly successful. The aim of treatment should consist of achieving union of the pseudarthrosis without excessive shortening of the leg. Most bone grafting procedures an usually combined with various types of internal fixation, with the idea that fixation of the fragment is most important. However, it is dificult to maintain a rigid fixation long enough to achieve union of the pseudarthrosis. In addition, excessive shortening of the leg usually occurs because of resection of the pseudarthrosis site. Recent advances in microsurgical techniques have stimulated the application of vascularised bone grafting for the management of congenital pseudarthrosis. Free vascularised fibular grafts provide the length that are needed. However, there are many factors that influence the outcome such as vascularity of the graft, the stability of fixation, and fractured of the graft.[16,21]

Circular external fixator has been used in the treatment of congenital pseudarthrosis of the tibia for more than 20 years in Russia. However, there are very few reports in the literatures. This device permits gradual

correction of any deformity in three dimensions. It is possible to achieve bone union at the pseudarthrosis site and to correct leg length inequality at the same time. It is also possible to preserve joint motion and to permit early weight bearing. Furthermore, this device obtains the capability of creating biological treatments with minimally invasive surgery. We are reporting our experience of the Ilizarov technique in the treatment of congenital pseudarthrosis of the tibia. We are able to achieve bone union at the pseudarthrosis site and to correct limb length inequality at the same time in two out of three cases. In cases 2, there was two times refracture of the pseudarthrosis site. Inadequate resection and residual anterior angular deformity of the pseudarthrosis site should be responsible for the cause of refracture. In the case 3, there was partial union at the pseudarthrosis site and subsequently refracture. Since there was severe residual anterior angulation deformity at the pseudarthrosis site, therefore, we believed that the causes of failure to achieve union of the pseudarthrosis site were inadequate resection and improper alignment of the bone. The common problem in our patients was wire tract infection expecially at the ring which was closed to the joint. This problem is related to the motion between wire, and the skin and lead to loosening of the wire. The knee is the most susceptible joint to this complication. Loose wire is the cause of instability of the frame which lead to delay in maturation of the regenerate new bone. Therefore, meticulous wire insertion techniques are one of the important factors for successful result.

Although this series is too small, we feel that the Ilizarov technique is very useful in treating congenital pseudarthrosis of the tibia. It is possible to achieve bone union and to correct the leg length inequality at the same time. It can achieve dramatic results if proper surgical techniques are followed such as adequate resection and proper aligment of the bone. However, the long term follow up is needed to comfirm whether or not the bone union is permanent.

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