TREATMENT OF ADOLESCENT TIBIA VARA BY
ASYMMETRICAL PHYSEAL DISTRACTION

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We have treated 12 adolescent patients with idiopathic tibia vara by asymmetrical phyleal distraction using a modified Wagner external fixator. There were no major complications and a mean correction of 13° was achieved.

The main advantages of the technique are that no osteotomy, internal fixation or bone graft is needed, and that the operation can be performed on both tibiae simultaneously. No shortening is produced and lengthening can be added to angular correction if required.

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Adolescent idiopathic tibia vara (ITV) is relatively common. There are rarely any functional abnormalities or symptoms but the appearance and the possibility of later degenerative disease of the knee are indications for corrective surgery in severe cases. In this age group, asymmetrical arrest of the growth cartilage, orthoses or corrective plaster casts have little value (Canadell and de Pablos 1988), and opening or closing wedge osteotomies are usually recommended (Smith and Harrison 1979; Sasaki et al 1986; Tachdjian 1990a; Henderson, Kemp and Greene 1992).

Phyleal distraction was originally described for simple bone lengthening but can also be used for angular correction (Monticelli and Spinelli 1984; Canadell and de Pablos 1985; Connolly et al 1986; Hamanishi et al 1990). We report the use of asymmetrical phyleal distraction using a Wagner apparatus in 12 adolescents with bilateral ITV. We have assessed this semi-invasive technique as an alternative to conventional osteotomies and discuss the suitability of the modified Wagner apparatus for this purpose.

PATIENTS AND METHODS

We treated eight boys and four girls all with bilateral ITV. Their mean age was 13.6 years (12.4 to 14.1). The mean tibial varus was 10° (8 to 13). One patient had bilateral short tibia as an associated deformity. None of the patients had any functional impairment or pain. All corrections were bilateral, and the average follow-up was 24 months (6 to 36).

Correcting device. We used an orthogonal configuration of the unilateral Wagner fixator-distractor (Jacquet-Howmedica, Geneva, Switzerland) (Figs 1a, b), modified to allow gradual correction of the deformity. This was achieved by transforming the longitudinal movement of distraction into a rotational movement at the level of the proximal pin-holding T-piece. Conversion of longitudinal into rotational movement was gained by interposing a smooth 2 mm thick stainless-steel washer (Fig. 1c) between the teeth of the T-piece and those of the body of the apparatus to allow rotational movement at this level and progressive correction of the varus/valgus angle by distraction at the telescopic body of the apparatus (Fig. 2). We used non-transfixing self-tapping 6 mm pins.

Surgical technique. The procedure was always performed simultaneously on both tibiae. Two pins were inserted in the tibial diaphysis and two in the proximal tibial epiphysis then secured to the device; the junction of the proximal T-piece with the body was unlocked by the previously mentioned washer. No surgery was performed on the fibula. Control radiography ensured the proper placement of the device (Fig. 3).

The day after surgery distraction began at a daily rate of 1.5 mm in two increments of 0.75 mm. When correction was complete the washer was removed to block varus/valgus movements and the patient was discharged from hospital. In one case, a bilateral tibial lengthening was needed in addition to the angular correction; further distraction at a daily rate of 1 mm (0.5 mm/12 hours) was performed after washer removal until the desired lengthening had been obtained. Radiographs of both tibiae were taken immediately after surgery and at 1, 2, 4 and 8 weeks. After the apparatus had been removed, anteroposterior and lateral orthostatic radiographs were taken at 3, 6 and 12 months then annually until skeletal maturity.

RESULTS

Complete correction of tibia vara was achieved in all our patients. Radiographs taken one week after surgery
Figure 1a, b – Modification of the Wagner device used for angular physeal distraction. Figure 1c – Washer placed between the proximal bar and the T-piece to allow tilting.

Fig. 2
Diagram to show the mechanism of angular correction by a unilateral external fixator.

Figures 3a, b – Postoperative appearance and radiograph showing the physeal line (arrows) distal to the epiphyseal pins. Figure 3c – At 15 days an opened wedge is clearly seen (arrows).
showed a slight, but definite opening of the medial part of the physeal line (Fig. 3c). This gradually increased until complete correction was obtained at two to three weeks postoperatively. Progressive and homogeneous calcification of the opening wedge was seen to be complete at about eight to ten weeks postoperatively. The mean correction was 13° (9 to 15), from a mean varus deformity of 10° to a mean valgus hypercorrection of 3°. The maximum correction was 15° and the minimum 9° (Figs 4 and 5). Angular correction from surgery to washer removal took an average of 15 days. The mean hospital stay was also 15 days. Excluding the case which also required tibial elongation the mean time to removal of the apparatus was 2.3 months (2 to 2.7).

No case required bone grafts. The fixators were generally well tolerated by the patients. They all used a wheelchair, but half of them were able to walk short distances without support. There were no severe complications such as septic arthritis, osteomyelitis or neurovascular damage. Minor pin-track infections were frequent, but they all responded to antibiotics and rest, and distraction never had to be discontinued. Some minor infections may have been missed, and we cannot therefore give accurate figures for the incidence. No patient
developed knee stiffness (see Fig. 3a). The distracted growth cartilage closed in all cases, but this was not a problem as all the patients were close to skeletal maturity. There was no recurrence of the radiographic angular deformity during follow-up.

**DISCUSSION**

Recommended treatments for tibia vara and other angular deformities in children include plaster casts (Oyemade 1981) and orthoses (Tachdjian 1990b), but their use except for children under six or seven years old is questionable (Smith 1982). Partial physeal blocking by epiphysiodesis (Phemister 1933; Bowen and Johnson 1984; Canale, Russell and Holcomb 1986; Timperlake et al 1991; Henderson et al 1992) or epiphyseal stapling (Blount and Clarke 1949) has been used, but the problem in adolescents is that the growth cartilage has little potential for growth. Timperlake et al (1991) have used asymmetrical percutaneous epiphysiodesis for the treatment of varus and valgus knees of adolescents with surprisingly good results, but others have reported that partial blocking of the growth plate is unpredictable even in the early stages of growth (Cañadell and de Pablos 1988; Henderson et al 1992). Growth charts for the correction of angular deformities (Bowen et al 1985) do not seem to be completely reliable (Cundy et al 1988).

Corrective osteotomies often require internal fixation and subsequent implant removal (Smith and Harrison 1979; Sasaki et al 1986; Tachdjian 1990a; Henderson et al 1992). Other disadvantages are that correction cannot be precisely adjusted postoperatively, and scarring is a frequent cosmetic problem. Opening wedge osteotomies for anything more than slight deformity may be difficult to achieve, may produce soft-tissue traction injuries, and may require bone grafts. Closing wedge osteotomies also produce unwanted shortening.

We found that asymmetrical physeal distraction was very effective, achieving complete correction in all patients by a semi-invasive technique. The scars of pin insertion were cosmetically acceptable. Simultaneous bilateral treatment is feasible and correction can be gradual and adjusted to avoid hyper- or hypocorrection. Bone grafting was never required.

Asymmetrical physeal distraction itself provides slight elongation and further bone elongation is possible when needed. Tolerance of the apparatus is sometimes a problem and there is the risk of pin-track infection. Meticulous wound care and close follow-up are essential. In this first series the period of hospitalisation averaged 15 days, but it may be possible to shorten this to four to five days since the simplicity of the apparatus enables the patient to adjust it at home.

We used a modified Wagner apparatus, which allows easier application and postoperative management and greater comfort to the patient than a circular device. An alternative is the dynamic axial fixator (DAF), designed in the University of Verona (De Bastiani et al 1989), but we feel that the modified Wagner apparatus has some advantages. First, the hinge lies close to the level of correction whereas in the DAF it is distal to it. Secondly, when elongation is needed after angular correction it is necessary either to block the spherical articulation of the DAF with cement or change the articulated body for a monobloc one (Aldegheri, Trivella and Lavini 1989a; Grill 1989). With the modified Wagner apparatus is cheaper than the articulated DAF with the necessary correction hinge.

Aldegheri, Trivella and Lavini (1989b) refer to this type of correction with the DAF as *hemicondrodiatasis*. We do not agree with the use of this term or with *condrodiatasis* (De Bastiani et al 1986a, b): they imply that elongation is possible without producing a fracture, which we and other authors do not believe (Monticelli and Spinelli 1981a; De Pablos and Canadell 1990; Hamanishi et al 1990). We prefer to call this technique asymmetrical physeal distraction.

Sudden physeal fracture may be painful; this sometimes occurs with the use of elastic circular fixators which may cause tension to accumulate. Sudden release of this gives pain, generally between the third and the sixth days after operation (Monticelli and Spinelli 1981a, b). More rigid distractors like the Wagner or the DAF (Canadell and de Pablos 1985; Hamanishi et al 1990) produce a more controlled and less sudden fracture with less intense pain, not usually requiring analgesia.

We used a distraction rate of 1.5 mm/day, slightly greater than the maximal rate recommended for elongation without angular correction (Monticelli and Spinelli 1981b). In asymmetrical distraction, this increment applied to the apparatus provides a smaller increment to the near side of the physis and practically none at the opposite side, which acts as a fulcrum. If the distance between the fulcrum and the apparatus is 15 cm and the epiphyseal width is 8 cm, then lengthening of the fixator by 1.5 mm results in an angular correction of 0.6° and an elongation of approximately 0.8 mm in the physis nearest the fixator, less than the recommended maximal daily rate (De Pablos and Canadell 1990). The correction that we achieved accords with that recommended for adults (Valenti et al 1990): this must be planned preoperatively to give slight hypercorrection.

Three possible complications of physeal distraction must be considered: premature physeal closure, septic arthritis and joint stiffness. In our series, premature physeal closure had no influence on remaining growth as all our patients were close to skeletal maturity. Recent studies suggest that the rate of distraction may be the most important factor in premature physeal closure and therefore recommend that this should not exceed a daily rate of 1 mm performed in at least two stages (De Pablos and Canadell 1990). The risk of septic arthritis is greater.
if the epiphyseal pins enter the joint space, as in distal femoral epiphyseal distraction. This does not apply to the proximal tibia, but the risk is always present, and close surveillance and meticulous daily wound care are therefore very important. We had no problem with stiffness of the joint adjacent to the correction. All our patients regained full mobility after removal of the apparatus.

In view of the results obtained in simple cases of ITV we have extended the indications for this technique to adolescent Blount’s disease and the sequelae of traumatic and septic injuries with or without physeal bone bridges (Canadell and de Pablos 1985).

Conclusions. Asymmetrical physeal distraction is a good alternative to conventional osteotomies, allowing easier, accurate correction with fewer disadvantages. The modified Wagner device was very effective for the treatment of ITV and has theoretical and practical advantages over other devices, especially circular fixators.

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REFERENCES


