

# Correction of asymmetric physeal closure

## Rotatory distraction in 3 cases

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Three cases of asymmetric physeal closure with angular deformities of the ankle, knee, and wrist, respectively, were corrected by rotatory physeal distraction. Osteotomy of the bony bridges was unnecessary.

De Bastiani et al. (1979) have developed a Dynamic Axial Fixator (DAF, Orthofix) for external fixation of fractures and for leg lengthening by using physeal (1984) or callus distraction (1987). Angular deformities of the joint have been corrected by Ilizarov (1969) and DeBastiani et al. (1984) by distracting the physis asymmetrically; the last-mentioned used a DAF in combination with a hinge. This asymmetric distraction method using a hinged DAF was applied also by Canadell and Pablos (1985) for breaking partially closed and bridged growth plates: the hinge converts the axial distraction to a rotatory force.

We report 3 cases in whom this rotatory distraction method was used for correction of physeal growth problems (Figure 1).

with two screws. The medial half of the distal tibial growth plate had fused, and the formation of a 1 x 2-cm bony bridge was confirmed by tomograms. Two cancellous screws were inserted into the distal tibial epiphysis parallel to the joint space. They were fixed by a standard type of DAF with a hinge. Slow distraction was carried out by turning the distractor one quarter of a turn every 12 hours (0.5 mm per day). Breakage of the bony bridge was observed radiographically after 18 days of distraction; by then the deformity had been corrected to 15°. The DAF was changed from a standard to a long type during the

### Case reports

#### Case 1

A 13-year-old boy visited our clinic with an inverted right foot: the right ankle joint showed a varus of 24° (Figure 2). His medial malleolus had been fractured when he was 10 years old and had been fixed

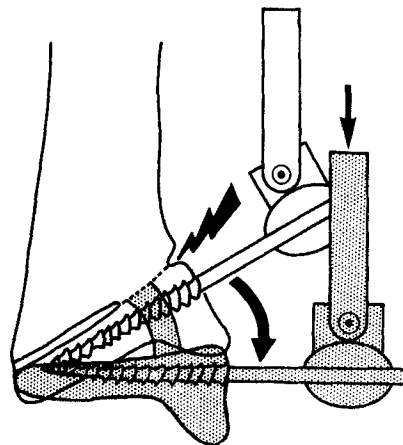


Figure 1. The mechanism of converting an axial distraction force (straight arrow) to a rotatory distraction force (curved arrow) by a hinge. Shaded area: location of the epiphysis and DAF after correction. The jagged arrow indicates the point from which cleavage of the bony bridge starts.

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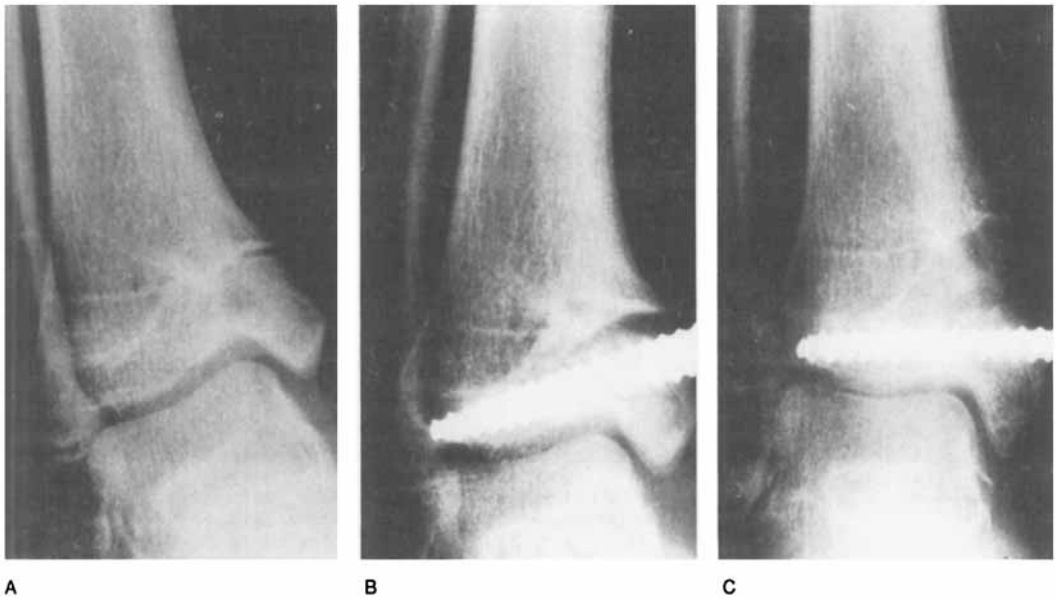


Figure 2. Case 1. A 13-year-old boy. Right ankle with 24° of varus due to partial closure of the distal tibial growth plate.

A. Before distraction.

B. Eighteenth day of distraction: 15° of varus. Cleavage of the bony bridge is now apparent.

C. Before removal of screws. Five degrees of valgus was obtained.



Figure 3. Case 2. A 14-year-old boy. Genu varum on the left due to unilateral Blount's disease.

A. Two cancellous screws were inserted into the epiphysis parallel to the joint space.

B. Fifty-seventh day of distraction. Totally, 21° of correction was obtained.

course because of shortening of the telescopic length of the inner component. The distraction was terminated on the 68th day when the ankle joint was corrected to 5° valgus, which was equal to that on the normal side. The DAF and four screws were removed at the outpatient clinic after 3 weeks of neu-

tralization and dynamization of the callus. The angulation of the distal fibula was also corrected, and the distal fibular growth plate fused spontaneously. Now, 2 years after removal of the DAF, the boy has reached skeletal maturity, and the correction has been completely maintained.



Before distraction.

Two (volar and dorsal) cortical screws are inserted into the epiphysis.

Five months after removal of the screws. Some overgrowth of the ulna is observed. An angular correction of 30° has been maintained. The ulnar tilt angle is 16°.

Figure 4. Case 3. A 14-year-old boy. Four years after fracture separation and 2 years after a Langenskiöld operation. The ulnar tilt angle is  $-14^\circ$ . Radial subluxation of the hand and epiphyseal fragmentation are observed.

### Case 2

A 14-year-old boy had genu varum on the left side due to unilateral Blount's disease. The difference in the femorotibial angle was  $20^\circ$ , and partial closure of the growth plate was observed on tomograms. Two cancellous screws were inserted into the proximal tibial epiphysis parallel to the joint space (Figure 3). A long type of DAF with a hinge was attached, and distraction of 0.5 mm per day was carried out. Breakage of the deformed growth plate appeared by Day 10, and a total  $21^\circ$  of rotatory correction was completed uneventfully by Day 57. The whole DAF and screws were removed after 3 weeks of neutralization and dynamization of the callus, and clinically the genu varum was fully corrected. The correction has been maintained 12 months after removal of the DAF, and he has nearly reached skeletal maturity.

### Case 3

A 14-year-old boy had suffered from epiphyseal slipping of the distal radius on the right when he was 9 years old. Slipping was reduced surgically. The bony bridge that had developed in the growth plate was excised, and autogenous fatty tissue was transplanted at age 11. The articular surface of the wrist

joint deviated radially, and the ulnar tilt angle was  $-14^\circ$  (Figure 4); the epiphysis was partially fragmented. Two small cortical screws were inserted from the radial side into the epiphysis parallel to the joint space, and a small type of a hinged DAF was applied. The distraction, 0.5 mm per day, was terminated on Day 45 when the ulnar tilt angle was  $+16^\circ$ . The whole DAF was removed after 4 weeks of neutralization of the callus. Some overgrowth of the ulna was observed, but the angular correction has been maintained 5 months after removal of the screws.

### Discussion

The hinge converts the axial distraction force to a rotatory force, theoretically assuming that the tip of the screw is a fulcrum of rotation (Figure 1). The degree of angular correction depends on the length of the screws, and appeared to be roughly  $0.5^\circ$  per day by 0.5 mm of axial distraction. The magnitude of the rotatory force appeared to be great enough to break the cancellous bony tissue directly, as observed in Case 1. There was no report of cleavage of any mature bony tissue by a mechanical distraction force in the literature until Canadell and Pablos (1985) reported physal distraction. In their Case 1, they

combined fibular osteotomy to correct the ankle deformity. In our Case 1 the distal growth plate of the fibula fused spontaneously, and a further osteotomy was unnecessary.

Correction of angular deformity of the wrist joint by physal distraction has not been reported previously. In our Case 3 the distal radial epiphysis was just thick enough to insert the two volar and dorsal screws.

In children younger than 10 years, one-step rotatory distraction is not recommended for fear of further asymmetric growth of the growth plate after correction, late growth of the adjacent fibula or ulna, and shortening due to early closure of the whole growth plate. When the angular deformity is associated with considerable shortening, callus or epiphyseal distraction may be carried out using an ordinary DAF subsequent to the rotatory correction.

Rotatory physal correction is a new one-step procedure to correct progressive angular joint deformities in children near skeletal maturity.

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