INTRODUCTION: Ankle valgus deformity is rare in children. It generally leads to difficulties wearing shoes, walking instability and mechanical pain. No medical treatment is effective and the only option is surgical correction of the deformity. Two main options are available: supramalleolar osteotomy and medial malleolar epiphysiodesis. We report our experience with epiphysiodesis using a transphyseal medial malleolar screw.

Patients and methods: This is a retrospective study of all children followed for ankle valgus and treated by transphyseal medial malleolar screw epiphysiodesis in our department. The study included 10 cases of ankle valgus deformity in seven children (four with multiple extostoses, two type 1 neurofibromatosis, one Larsen’s syndrome) who completed skeletal maturity. At surgery, median bone age was 12 years (10 to 13 years and 6 months) and the median tibiotalar angle was 17.5° (10° to 30°).

Results: At skeletal maturity, preoperative valgus was corrected in six patients (9/10 ankles). Valgus was not corrected in one patient (30° to 25°). No postoperative complications occurred.

Discussion: Epiphysiodesis by transphyseal medial malleolar screw is a simple, efficient and safe procedure to correct a significant or symptomatic ankle valgus deformity in children before skeletal maturity.

Level of evidence: Level IV, retrospective study.

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KEYWORDS
Ankle valgus; Medial malleolar epiphysiodesis; Child

Introduction
Ankle valgus is a rare deformity in children with fairly significant functional consequences. There are numerous etiologies, but the most frequent are neurological (cerebral
Children ankle valgus deformity treatment using a transphyseal medial malleolar screw

The main evaluation criterion was valgus correction at bone maturity. The difference between initial tibiotalar angle and that at bone maturity was used to define the degree of correction.

Surgical technique

Surgery was performed under general anesthesia with the patient in dorsal decubitus position on a radiolucent table with a cushion under the contralateral buttock placing the leg to be operated on in external rotation. Surgery was performed with a pneumatic tourniquet and under fluoroscopic control. A two centimetres incision was centered at the tip of the medial malleolus. The posterior tibial tendon was identified and reclined after the sheath was opened. The cortex was reamed at the tip of the malleolus. A 4.5 mm diameter cortical screw was placed without prior drilling. The direction of the screw was oblique on the coronal plane from below to above, and from inside to outside, while being placed precisely in the center of the medial malleolus. On the sagittal plane, the screw should be vertical. The head of the screw with no flange was buried to the edge of the cortex to avoid any local impingement. The incision was closed without a drain. There was no postoperative cast and immediate full weight bearing was allowed. The patient left the hospital the day after surgery.

Results

This retrospective monocentric study included 10 cases of ankle valgus in children treated by epiphysiodesis with a medial malleolar transphyseal screw between 1995 and 2004, who reached bone maturity (Table 1). Three girls (four ankles) and four boys (six ankles) were treated. The etiologies of ankle valgus were: multiple exostoses in four patients (six ankles), type 1 neurofibromatosis in two patients (two ankles) and Larsen’s syndrome in one patient (two ankles). Before surgery, an unattractive and symptomatic deformity was noted in six patients (eight ankles), while pain and difficulty wearing shoes was found in one patient (two ankles). The median chronological age at surgery was 11 years (from 9 years/6 months – 15 years). The median bone age at surgery, evaluated by the Greulich and Pyle method was 12 years (from 10 – 13 years/six months) in six patients (nine ankles). The remaining growth potential of the distal tibia was evaluated by the bone age of patients reported in the nomogram of Green and Anderson. Distal tibial growth represents 40% of total tibial growth [2]. We therefore estimated that potential distal growth was equivalent to two thirds of the potential proximal growth or 66% [1,3,4]. Based on our experience we estimated that by reducing medial physeal growth of the distal tibia by 1 cm we could reduce tibial articular valgus by approximately 10°. Thus for example, a patient with a bone age of 11 years has a proximal tibial growth potential of 2 cm. The growth potential of the distal tibia is therefore approximately 1.33 cm. If epiphysiodesis of the medial malleolus with a transphyseal screw is performed at this stage, a 10 to 15° correction of ankle valgus is obtained [5]. The median tibialarticular angle at surgery was 17.5° (10°–30°). Based on these data, we determined the optimal stage of bone maturity to perform surgery in rela-

Patients and methods

This aim of this retrospective monocentric study was to evaluate the efficacy and complications of treatment of ankle valgus in children by epiphysiodesis with a transphyseal medial malleolar screw.

All files of children with ankle valgus treated in our unit were reviewed. Patients treated by epiphysiodesis with a medial malleolar transphyseal screw and who had reached bone maturity were included in the study. Patient data included: gender, etiology, preoperative symptoms, chronological age, bone age and tibiotalar angle at surgery. All patients underwent anteroposterior (AP) and profile weight bearing X-rays of both ankles. Tibial articular angle was evaluated on AP weight bearing X-ray as the 90° angle between the diaphyseal tibial axis and the tangential line to the talar dome (Fig. 1). A tibiotalar angle of 10° or more was considered to be a pathological valgus deformity [1]. Less than 10° of valgus is considered to be well tolerated most probably because static disorders can be corrected by hindfoot joints mobility.

Figure 1 Measurement tibiotalar angle; AB: anatomical axis of the tibia; CD: tangential line to the talar dome; cd: perpendicular line to the anatomical axis of the tibia, passing through the intersection of the two preceding lines. This is used to determine tibiotalar valgus and estimate long-term correction.
Table 1  Patient characteristics.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Gender</th>
<th>Disease</th>
<th>Side</th>
<th>preoperative chronological age</th>
<th>Preoperative bone age</th>
<th>Preoperative tibiotalar angulation (°)</th>
<th>Tibiotalar angulation at bone maturity (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>NF1</td>
<td>r</td>
<td>11 years</td>
<td>Unknown</td>
<td>10</td>
<td>5</td>
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<td>2</td>
<td>M</td>
<td>ME</td>
<td>l</td>
<td>13 years</td>
<td>12 years</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>ME</td>
<td>r</td>
<td>15 years</td>
<td>13 1/2</td>
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<td>8</td>
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<td>4</td>
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<td>ME</td>
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<td>15 years</td>
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<td>5</td>
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<td>l</td>
<td>9 1/2</td>
<td>10 years</td>
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<td>5</td>
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<td>6</td>
<td>F</td>
<td>LaSd</td>
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<td>10 years</td>
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<td>20</td>
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<tr>
<td>7</td>
<td>F</td>
<td>ME</td>
<td>l</td>
<td>10 1/4</td>
<td>11 1/2</td>
<td>15</td>
<td>0</td>
</tr>
</tbody>
</table>

NF1: type 1 neurofibromatosis; ME: multiple exostoses, LaSd: Larsen’s syndrome, r: right, l: left.

Figure 2  Young girl with multiple exostoses who developed left ankle valgus. Preoperative tibiotalar angle was 15°, chronological age was 10 and a quarter years and bone age 10 years; a: preoperative AP view X-ray, b: AP X-ray at bone maturity (the direction of the screw should be as perpendicular as possible to the growth plate); b’: profile X-ray at bone maturity (the direction of the screw must be in the coronal plane as much as possible).

Discussion

Two types of surgical treatment are available for ankle valgus of all etiologies in children: medial malleolar epiphysiodesis and varus supramalleolar osteotomy. As previous studies have shown [6,7], epiphysiodesis with a transphyseal screw is effective and reliable with a very low risk of complications. The degree of correction is directly depen-
dent upon the growth potential of the distal tibia [1,3]. There is a risk of undercorrection if epiphysiodesis is performed in a patient with a low growth potential. On the other hand, if this procedure is performed too early, overcorrection and ankle varus may result. In one case of overcorrection, Stevens et al. [7] performed ablation of the screw. In this case, growth was able to continue resulting in normalisation of the tibiotalar angle. This suggests that overcorrection can be compensated for before bone maturity has been reached. However, we do not feel that this notion can be generalized. Thus, epiphysiodesis by transphyseal screw may be definitive even after ablation of the screw, as was discussed recently for epiphysiodesis in other areas [8]. We used 4.5 mm diameter cortical screws with no flange. Other authors report the use of smaller diameter screws (3.5 mm) and/or flanges with comparable results [6,7]. For the surgical technique, Stevens et al. [7] emphasize the direction of the screw: on the coronal/frontal plane, the end of the screw should be in the medial half of the metaphysis, on the sagittal plane in the posterior half. In our series we attempted to place the screw in a position that was as perpendicular as possible to the growth plate, and strictly in the middle of the medial malleus, taking care to avoid any intra-articular perforation. Postoperative outcome in our series was similar to that in the literature, with immediate weight bearing, simple self-rehabilitation, and a regular annual follow-up including evaluation of bone maturity.

Supramalleolar varus osteotomy is another possible technique. In a series of 55 supramalleolar osteotomies for ankle valgus in patients who could walk, Abraham et al. [9] report a greater mean degree of correction than in our series, with excellent and good clinical results in nearly all their cases. However, in that series, at the final follow-up evaluation 74% of the osteotomies included patients who had not yet reached full bone maturity. Moreover, there were a certain number of complications: Infections, delayed union and pseudarthroses, tibiofibular synostoses and premature closing of tibial growth cartilage. These complications were probably because patients had myelomeningocele. However of all the complications it is probably most important to avoid tibiofibular synostoses because if distal tibiofibular mobility is blocked, ankle joint function is compromised with short term (pain) and potentially long-term (osteoarthritis) consequences. Theoretically medial epiphysiodesis prevents this complication because it does not touch the distal tibiotalar dihedron. Nevertheless, once bone has matured, supramalleolar osteotomy is the only possible technique to correct ankle valgus.

Thus, these two surgical techniques are not opposed, but complementary: first line treatment of ankle valgus in an immature child would be medial malleolar epiphysiodesis with a transphyseal screw (Fig. 2). Any eventual overcorrection might be corrected by ablation of the screw before bone maturity. If bone is fully mature, ankle valgus can only be corrected by supramalleolar osteotomy.

Conclusions

Medial malleolar epiphysiodesis with a transphyseal screw is a simple, effective and reliable technique with very low morbidity, to treat ankle valgus in children before bone maturity.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References