VALGUS DEFORMITY OF THE ANKLE IN CHILDREN WITH SPINA BIFIDA APERTA

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Valgus deformity of the hindfoot can occur at the subtalar joint, the ankle joint, or at both sites. In children suffering from spina bifida, the ankle is often the main site of deformity. Thirty-five ankles with valgus deformity of the hindfoot were studied in 23 children with spina bifida. A radiological triad was observed in all patients: shortening of the fibula, lateral wedging of the distal tibial epiphysis, and lateral tilt of the talus at the ankle mortise. There was a definite correlation between the severity of wedging and the degree of talar tilt, and a fair correlation between the severity of wedging and the extent of fibular shortening. The results of operation in 12 feet are presented. It is concluded that any operations performed below the ankle on these patients (subtalar fusion or triple arthrodesis) is unlikely to succeed; the deformity needs to be corrected above the ankle (by epiphysiodesis or supramalleolar osteotomy). Radiological assessment of the ankle by taking weight-bearing films in the anteroposterior plane is essential to determine the true extent of the deformity before undertaking any operation.

Valgus deformity of the hindfoot is often seen in children suffering from spina bifida. It also occurs in various other neuromuscular disorders (Makin 1965) and in patients with congenital absence of the fibula (Coventry and Johnson 1952; Thompson, Straub and Arnold 1957; Farmer and Laurin 1960; Westin, Sakai and Wood 1976), hypoplasia (Bohne and Root 1977) or pseudarthrosis of the fibula (Langenskiöld 1967; Dooley, Menelaus and Paterson 1974; Hsu et al. 1974). Makin (1965) claimed that shortening of the fibula in infancy causes concomitant deformity of the tibia at the ankle and knee. He showed that a poorly developed lateral malleolus leads to wedging of the lower tibial epiphysis and valgus at the ankle. This deformity of the ankle has also been described by Paluska and Blount (1968), Hsu et al. (1972) and Wiltse (1972) after a segment of fibula has been excised for chronic osteomyelitis or a tumour, or when a graft has been taken for a Grice–Green or Batchelor type of subtalar fusion.

Hollingsworth (1975) made a radiological study of ankles in spina bifida children with valgus deformity; he noted fibular shortening, lower tibial epiphysial wedging and valgus tilt of the ankle mortise. Valgus instability of the ankle is a known phenomenon in tibial leg-lengthening operations if these are not combined with inferior tibiofibular fusion (Coleman and Noonan 1967). In children with no neurological involvement of the lower limbs the valgus normally occurs at the subtalar level. If such children need surgery, satisfactory procedures are extra-articular subtalar fusion or the Dillwyn Evans Mark II operation (Phillips 1983). However, these operations below the ankle tend to fail when undertaken for valgus deformity in patients with spina bifida; in them, the deformity occurs at the ankle subsequent to lateral wedging of the distal tibial epiphysis and fibular shortening. Fusion at the subtalar level would only exaggerate the pre-existing ankle valgus. Hence, the deformity should be corrected by an operation above the ankle, either an epiphysiodesis or a supramalleolar osteotomy.

PATIENTS AND METHODS

At Alder Hey Children’s Hospital, Liverpool, 23 spina bifida children with 35 valgoid hindfeet were studied. Twelve had bilateral and 11 unilateral hindfoot valgus. Sixteen feet were flail but assumed a valgus position on weight-bearing; in the remainder the muscle power was Grade 2 to 4 (MRC scale). Most children had involvement of either S1 or L5 segments. Seven patients had undergone operations below the ankle and four above (one bilaterally); the other 12 were merely observed. The age range was 3 to 17 years, with an average of 10 years 11 months.

Scnograms were taken to include the knees and ankles in all cases (Fig. 1). This was necessary in order to measure the length of the tibia and fibula accurately. Weight-bearing anteroposterior radiographs of the

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ankles were taken whenever feasible, as it was found that non-weight-bearing films did not reveal the exact amount of valgus tilt either at the subtalar or at the ankle level. All radiographs were examined for the amount of fibular shortening, judged by direct measurement on the scanograms and by the relationship between the distal fibular and tibial growth plates; for the extent of lateral wedging of the distal tibial epiphysis; and for the degree of talar tilt within the ankle mortise.

Figure 1
Scanogram showing both knee and ankle.

Shortening of the fibula in relation to the tibia. On the scanograms the tibia was measured from the plateau to the distal tip of the medial malleolus, and the fibula from the most proximal portion of the head to the distal tip of the lateral malleolus. The tibio-fibular length ratio was thus calculated.

The relationship of the lateral to the medial malleolus was also assessed in all patients, but the most reliable and accurate reading was found to be the relative levels of the distal growth plates (Fig. 2). Normally the distal fibular growth plate is at the level of the talar plateau: if it is between the top of the talus and the distal tibial growth plate the shortening is said to be mild; if it is in line with the distal tibial growth plate there is moderate shortening; and if it is proximal to the distal tibial growth plate there is severe shortening. Since the proximal ends of the tibia and fibula are at different levels it was also necessary to assess both the ratio of the lengths of the two bones and the relationship of the lateral to the medial malleolus. This was to establish whether the difference at the ankle was solely due to shortening of the fibula or whether an altered position of the fibula in its entirety was also a factor.

Figure 2
Shortening of the fibula, as judged by the relationship between the distal tibial and fibular growth plates (A), and the severity of wedging of the distal tibial epiphyses (B).

Lateral wedging of the distal tibial epiphysis. Wedging of the distal tibial epiphysis was noted not to involve the entire surface but only the lateral half (Shapiro, Simon and Glimcher 1979). Deformation usually began in its mid-portion, the medial half of the surface being level whereas the lateral half was found to slant proximally and laterally. The extent of wedging was graded from 0 to III (Fig. 2). When the distal tibial epiphysial surface was parallel to the growth plate, as in the normal, it was graded 0 (Fig. 3). When the wedging occurred from the central portion of the distal tibial epiphysial surface and angled upwards and laterally but the lateral margin of the epiphysis remained well separated from the growth
plate, it was graded I (Fig. 4). When the distal tibial epiphysial surface sloped into the lateral margin of the growth plate, it was graded II (Fig. 5). Grade III were those in which the distal tibial epiphysial surface slanted into the growth plate in its lateral third rather than its lateral edge (Fig. 6).

Tilt of the talus within the ankle mortise was calculated by measuring the angle between the perpendicular to the vertical axis of the tibia and the distal tibial epiphysial surface (Fig. 7). Normally the distal tibial epiphysial surface and the superior surface of the talus are at right angles to the vertical axis of the tibia. Moreover, the superior surface of the talus is almost flat so that when the bone is tilted the lateral portion of this surface is above the medial portion; whereas if the epiphysis is wedged laterally the talar plateau should remain horizontal.

RESULTS

Fibular shortening. The tibio-fibular length ratio ranged from 0.843 to 0.975 (average 0.895), the normal ratio being one. The fibular shortening varied from 0.6 cm to 4 cm (average 1.81 cm). Twenty-two out of 35 ankles showed more than 1.5 cm of shortening.

The distal fibular growth plate was at the level of the top of the talus in 2 cases, between the top of the talus and the distal tibial growth plate in 6, at the same level as the distal tibial growth plate in 19 and proximal to the distal tibial epiphysial plate in 8. Thus, 27 out of 35 ankles showed the distal fibular growth plate to be either level with the distal tibial growth plate or proximal to it, which denotes moderate to severe shortening.

Lateral wedging. This refers to the wedging of the surface of the distal tibial epiphysis and the subchondral bone, and does not involve the epiphysial growth plate (the growth plate itself was perpendicular to the long axis of the tibia). In 11 cases wedging was Grade O (Fig. 3), 10 were Grade I, 10 were Grade II and 4 were Grade III. Thus, 14 out of 35 ankles showed Grade II and III wedging, which denotes moderate to severe wedging.

Tilt of the talus within the mortise varied from 2° to 27° (average 10.2°). Twenty-one out of 35 ankles (that is 60% of children) had more than 10° of talar tilt (moderate); 10 ankles (28%) had a tilt of more than 15° (severe).

Procedures below the ankle (Table I). Extra-articular subtalar arthrodesis was performed in six out of 35 ankles and triple arthrodesis in one. The graft was taken from the proximal third of the ipsilateral tibia in the six cases of subtalar fusion. The results were assessed by taking weight-bearing anteroposterior films of the ankles and the length of follow-up was from 15 months to 34 years.

Table I. Radiographic findings after operations below the ankle (7 patients)

<table>
<thead>
<tr>
<th>Radiological deformity</th>
<th>Significant increase</th>
<th>Slight increase</th>
<th>No change</th>
<th>Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibular shortening</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Distal tibial wedging</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Talar tilt</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>0</td>
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Procedures above the ankle (Table II). Osteotomy above the ankle was performed in three patients and epiphysiodesis in a patient with bilateral involvement; this latter was lost to follow-up at the time of the present review, but when examined at skeletal maturity the ankle mortise was in good alignment with no talar tilt and with a satisfactory malleolar relationship.

DISCUSSION

In the normal ankle, the tip of the lateral malleolus is 3 to 4 mm lower than that of the medial malleolus. The growth plate of the fibula is at the level of, or just distal to, the ankle joint and this anatomical relationship continues throughout growth. The tibia and fibula, closely bound together, grow at different rates and yet the ankle joint remains in perfect alignment.

At birth, the tibia is 20% of its eventual total length and until it has achieved 50% of its length the distal tibial epiphysis grows more rapidly than the proximal. Therefore the proximal tibial epiphysis assumes a major role in growth. The fibula also has 20% of its eventual length at birth, but its distal epiphysis is dominant in growth only until the bone has grown to 30% of its eventual length. Thereafter the proximal epiphysis predominates (Makin 1965).
Devas and Sweetnam (1956) showed that powerful contraction of the flexor muscles approximates the fibula to the tibia. With muscular activity a “to and fro” movement of the fibula takes place. This facilitates the nutrition of the growth plate, which is nourished by transudation of fluid from the nearby capillaries. The paralysed limbs lack this phenomenon, causing delay in the appearance of the fibular epiphysis with resultant shortening of the fibula.

In children with paralysis of the lower limbs, such as those with spina bifida or poliomyelitis, a triad of deformity has been shown to arise in association with shortening of the fibula: the lateral malleolus is elevated, wedging of the distal tibial epiphysis takes place and the talus is tilted in the ankle mortise. A similar picture is also seen in children with cerebral palsy, but only to an insignificant extent; this was confirmed by studying 17 patients who presented with hindfoot valgus, in whom subtalar fusion was performed in eight feet with good results. In children with simple pes valgus, the deformity occurs at the subtalar level only, whereas in the spina bifida child this deformity is often greatly accentuated by the valgus tilt at the ankle level. On weight-bearing, the heels tilt to a markedly valgus position, the medial malleolus becomes prominent and weight is borne on the medial border of the foot (Fig. 8). Problems arise when fitting calipers, and pressure sores occur especially if there is much rigidity in the foot. Corrective surgical procedures which do not take the ankle valgus into consideration are bound to fail. Thus many of the failures of extra-articular subtalar arthrodesis have arisen because the valgus at the ankle was not recognised. This was confirmed in the present study (Fig. 9). For radiological assessment weight-bearing anteroposterior films are essential before embarking on any corrective surgery.

An attempt was made to see if there was any correlation between the triad of radiological findings, that is between the fibular shortening, the lateral distal tibial wedging and the talar tilt. A definite correlation between the severity of wedging and the degree of talar tilt was found. The average tilt was more than 15° whenever Grade II deformities predominated and 22° in Grade III wedging: 71% of Grade II and III combined had a tilt of more than 15°. There was also a good but not absolute correlation between the severity of wedging and the fibular shortening.
Fibular shortening results in a shallow ankle mortise and valgus instability. When a child with spina bifida takes weight on a paralytic valgus ankle, fusion of the talus to the calcaneus will produce a leverage effect which will again tend to increase the ankle instability. This accounted for the seven unsatisfactory results after operations below the ankle (Table I).

The solution to the problem of increasing valgus at the ankle lies therefore in maintaining the horizontal status of the ankle mortise by a procedure above the ankle and not one below it which only worsens the pre-existing valgus instability. The indication for such a procedure, as is apparent from this study, would be a talar tilt of 15° to 20° and Grade II to III wedging of the distal tibial epiphysis. The horizontal status of the ankle mortise can be restored by stapling the medial side of the distal tibial epiphysis if sufficient growth potential remains and especially if there is a suggestion of widening of the tibial growth plate medially; or by supramalleolar osteotomy of the tibia and fibula before or after growth is completed. This was performed in four of the patients in the present study with full correction in all, as confirmed by weight-bearing anteroposterior films of the ankles (Figs 10, 11 and 12).

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REFERENCES