CORRECTION OF COMBINED TIBIAL TORSION AND VALGUS DEFORMITY OF THE FOOT

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Patients with spina bifida cystica commonly have significant disability from a combination of valgus deformity of the ankle and subtalar joints with lateral tibial torsion and plano-abduction deformity of the foot. These deformities can be corrected by a single procedure which combines a supramalleolar tibial osteotomy with a lateral inlay triple fusion. This procedure was carried out on 20 feet in 15 patients and the results were reviewed after an average of three years (range 18 months to 7 years). In 75 per cent of feet the combination of deformities was fully corrected, ulcers and callosities were eliminated in 95 per cent, the use of calipers minimised in 95 per cent, and in all patients the problem of shoe-wrecking was reduced. Complications included recurrent valgus deformity, delayed union of the tibial osteotomy and failure of midtarsal fusion.

Children with spina bifida cystica who are expected to walk require a foot posture such that their weight is distributed over a large area of the plantar surface. If this criterion is not met, then trophic ulceration will occur in the second decade of life.

Spina bifida patients who develop a valgus deformity of the hindfoot frequently have an associated lateral tibial torsion, an abduction deformity of the midtarsal joint and a planus deformity of the medial longitudinal arch. They therefore take the greater part of their weight along the medial border of the foot. This is shown by the pattern of wear of their shoes which become distorted and are quickly ruined. The pattern of weight distribution is indicated clinically by a medially placed callosity caused by excessive friction as these patients commonly do not lift their feet at each step but scrape them along the ground. Trophic ulceration often follows; moreover the deformity tends to be progressive so that the amount of valgus may become greater than that seen in any other disorder. Such deformity is difficult or impossible to control by calipers, which produce undue pressure on the skin; the forces on the calipers are so great that they frequently break. The procedure discussed in this paper aims at preventing these problems.

THE DEFORMITY

The hindfoot is in valgus; this deformity is partly at the ankle and partly at the subtalar joint complex (Figs 1 and 2). Lateral tibial torsion complicates the ankle component of the deformity, a fact which is not always appreciated. The forefoot is flat and abducted (Fig. 3). The subtalar

component of the valgus deformity and the midtarsal component of the plano-abduction deformity are mobile and can be fully corrected passively. There is no concomitant equinus or calcaneus and the management

Fig. 1

Fig. 2

Figure 1—Photograph showing the valgus deformity of the ankle and subtalar joints. The lateral tibial torsion associated with the valgus deformity is not shown. Figure 2—Anteroposterior radiographs of the same feet.

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discussed in this paper is not appropriate if such deformities are present.

Approximately 10 per cent of patients with spina bifida cystica have a valgus or eversion deformity of the foot (Menelaus 1980). It is not possible to predict which will progress to the complex of lateral tibial torsion, ankle and subtalar valgus and plano-abduction deformity. Feet

Fig. 3

Photograph of the right foot bearing weight which shows the plano-abduction deformity. There was a small trophic ulcer on the medial border of this foot.

with an initial equinus deformity, as well as those with calcaneovalgus deformity, may progressively develop this combination of deformities, sometimes aggravated by iatrogenic factors, notably overcorrection of equinovarus deformity by soft-tissue release. Interestingly, Hollingsworth (1975) describes the ankle component of this deformity as resulting from or worsening after subtalar extra-articular arthrodesis by the Grice technique (Grice 1952) if the distal tibia is used as the donor site; Paluska and Blount (1968) describe a similar sequel if the graft is removed from the distal third of the fibula. Dias (1978) ascribes the development of the ankle component of the deformity to the absence of the normal muscular forces acting on the fibula. Fractures affecting the distal tibial and fibular epiphyses, often unrecognised, can contribute to this complex of deformities.

The combination of ankle and subtalar valgus, the associated lateral tibial torsion and the mobility of the subtalar and midtarsal deformities are the important factors to be appreciated in planning operative correction. If the lateral tibial torsion is not corrected then the knee faces forwards while the ankle faces laterally; the ankle, therefore, has an inappropriate axis of movement and will not roll into plantarflexion and dorsiflexion at each step. Instead the subtalar joint assumes the role of the ankle and rolls from neutral in the swing phase to valgus in the stance phase. This produces gross subtalar valgus deformity which will recur after operation unless the tibial torsion also is corrected.

OPERATION

This combines, in one stage and with minor but important modifications, a supramalleolar wedge osteotomy of the tibia similar to that described by Judet and Judet (1971)

and by Sharrard and Webb (1974) with the triple arthrodesis by inlay grafting described by Williams and Menelaus (1977).

The rotational deformity of the tibia and the valgus deformity of the ankle are corrected by supramalleolar osteotomy, which must be as close to the growth plate as possible. An anterior midline incision is used (Fig. 4a); through this the fibula also may be divided if this is necessary to allow closure of the wedge or correction of the rotation (Fig. 4b). Once corrected the position is held with one or two staples (Fig. 4c).

The lateral inlay triple arthrodesis is performed through a straight anterolateral incision on the dorsum of the foot (Fig. 4e). The foot may first be stabilised with Kirschner wires (Fig. 4f). The bone block for inlay is obtained from the distal tibia at the site of osteotomy (Figs 4d, 4g, 4h) rather than from the proximal tibial metaphysis as in the original description by Williams and Menelaus (1977). Unfortunately, the wedge excised in correcting the valgus deformity of the ankle is never appropriate for the inlay graft. A below-knee plaster cast protects both the osteotomy and the inlay graft for 12 weeks.

If one of the procedures fails to control the deformity then a staged approach may be more appropriate. In patients considered too young for lateral inlay triple fusion, an extra-articular subtalar arthrodesis, as described by Grice (1952), can be performed at the same time as the supramalleolar osteotomy.

Table I. Indications for operation

Indications	Number of limbs
Uncontrollable deformity	7
Ulcers or callosities	6
Problems with calipers	
Pressure sores	2
Repeated breakage of caliper	4
To achieve freedom from calipers	3
Shoe-wrecking	15

CLINICAL MATERIAL

Between 1973 and 1980 20 feet in 15 patients, all having lower lumbar or upper sacral myelomeningoceles, were corrected using the procedure described. Indications for operative correction were often multiple (Table I). Shoe-wrecking was an indication common to all patients with a surgical boot lasting an average of eight weeks before requiring repair. All patients required calipers before operation and all were community walkers using Hoffer's criteria (Hoffer *et al.* 1973). Any muscular imbalance had first been corrected by tenotomy or tendon transfer. Fifteen limbs had a one-stage procedure as described, five a two-stage procedure. The patient's age at operation was the major factor in deciding whether to use an inlay

Fig. 4

Diagrams illustrating the procedure for supramalleolar osteotomy and lateral inlay triple fusion (see text for description).

triple arthrodesis or an extra-articular subtalar arthrodesis. Of those undergoing a one-stage procedure, nine children with an average age of $10\frac{1}{2}$ years (range $8\frac{1}{2}$ to $14\frac{1}{2}$), had an inlay arthrodesis (14 feet) and one child aged seven years had a Grice arthrodesis (one foot). Of those children undergoing a two-stage procedure, three aged 11 years had an inlay arthrodesis (three feet) and two aged four years had a Grice arthrodesis (two feet); both types of procedure were followed by a tibial osteotomy two to six years later. A valgus deformity of the ankle up to 30 degrees and a lateral rotation deformity up to 45 degrees were corrected at the site of the supramalleolar osteotomy.

RESULTS

Patients were reviewed independently of the operating surgeon at an average of three years (range 18 months to 7 years) after operation, all but one patient having reached skeletal maturity at the time of review. The following criteria were used for review:

Walking ability. Two patients had dropped a grade in Hoffer's system (Hoffer *et al.* 1973) for reasons other than the condition of their feet: both had become household walkers because of the development of knee pain. The other 13 patients remained community walkers.

Use of calipers. One patient still required a double iron and T-strap and five patients used polypropylene ankle-

foot orthoses. Before operation, 13 patients had required irons and T-straps and two used polypropylene ankle-foot orthoses and wore surgical boots.

Durability of footwear. At review 14 patients were wearing desert boots or running shoes (sneakers) and these were lasting an average of 16 weeks before requiring repair or replacement. This contrasts with the life expectancy of the surgical boots necessary before operation which averaged eight weeks.

Clinical and radiographic examination. When the patients were examined standing, the heel was neutral in 11 of the 20 feet, it was in 10 to 15 degrees of valgus in eight, and in five degrees of varus in one. Radiographic assessment of the effectiveness of correction of the valgus deformity of the ankle demonstrated that the mortise was neutral in 13 ankles; four were in 5 to 10 degrees of valgus and three in 5 to 10 degrees of varus. Rotational correction, assessed using the transmalleolar axis (Staheli and Engel 1972), showed lateral tibial torsion to be 20 degrees in excess of normal (14 degrees) in five limbs. Movement of the ankle was reduced in 19 limbs, the most common reduction being in dorsiflexion. Such limitation had commonly been observed before operation. Cross-union between the tibia and the fibula occurred in 12 limbs with there being no correlation between this and the loss of ankle dorsiflexion, the quality of the end result or the performance of fibular osteotomy as part of the operative

procedure. Significant degeneration of the ankle was noted in one limb and six ankles had developed a curious flat-topped talus unrelated to variations of radiographic projection.

In two of the three limbs in which tibial osteotomy and a Grice subtalar arthrodesis had been performed, the arthrodesis was sound. The third foot awaits re-operation at skeletal maturity. The subtalar component of the lateral inlay was sound in all 17 feet subjected to this procedure; the midtarsal fusion was unsound in four of these feet, but no patient was adversely affected by the unsoundness.

Function was excellent in 18 feet at the time of review. The exceptions were one patient who was awaiting a further operation and one who had recently developed an ulcer on the heel secondary to a burn.

One patient, who had both feet operated on, had adopted a swing-through gait and on landing found that his left forefoot crossed on top of his right foot. Because of this the upper of his right desert boot required frequent repair. Rotational correction appeared to be excellent but clearly less medial rotation of either limb would have improved function.

Table II. Complications

Complications	Number of limbs
Related to tibial osteotomy	
Recurrence requiring re-operation	5
Wound infection	4
Delayed union	2
Related to inlay or subtalar fusion	
Fracture at site of graft	2
Infected pin track	1
Dorsolateral bony prominence	1
Non-union	1
Subtalar (Grice)	1
Midtarsal (inlay)	1
Generalised soft-tissue swelling at site of operation	2

Complications. A summary of all the complications is given in Table II. Undercorrection or recurrence of the valgus deformity of the ankle required a further osteotomy in four patients (four limbs), with a fifth patient (one limb) awaiting re-operation. Three of these five patients were under the age of eight and a half years at the time of the first operation. While up to 10 degrees of varus was produced at the ankle mortice this was not associated with clinical complications, presumably because of undercorrection of the subtalar valgus. At review the heel was never clinically in a position of significant varus. Delayed union of the tibial osteotomy was associated with wound infection in one limb, and occurred where

the tibial osteotomy had been performed four centimetres above the growth plate in another. Fracture of the graft site in two limbs complicated two-stage procedures early in the series, the proximal tibial metaphysis being the site in both instances. A dorsolateral bony prominence required excision, having formed after a lateral inlay arthrodesis in one foot; in another a painful pseudarthrosis at the talonavicular level required exploration and grafting after lateral inlay arthrodesis. An unusual generalised soft-tissue swelling at the site of operation had occurred in two patients (two limbs); it took two years to resolve in the first patient and, after 18 months, is beginning to resolve in the second.

Achievement of surgical aims and patient and parental satisfaction. In 13 patients (18 limbs) the surgical aims have been achieved, one patient awaits a further operation for recurrence and one patient still requires a double iron and T-strap. Twelve of the 15 patients and their parents are convinced that the operation has been worthwhile. The exceptions are the patient still requiring a double iron and T-strap, one girl affected by the generalised soft-tissue swelling and a third patient who has become a household walker because of knee pain and who with hindsight questions the need for operation.

DISCUSSION

When describing deformities of the foot in patients with spina bifida different authors use different nomenclatures; this, together with the seeming excellence of the results if patients are reviewed before they reach skeletal maturity, makes comparison difficult. With these reservations the seemingly high revision rate of 25 per cent reported here can be compared with the 14 per cent of Sharrard and Grosfield (1968). These authors reviewed their patients at an age of 2 to 16 years and reported satisfactory correction in 81 per cent. The revision operations in our series resulted in 90 per cent satisfactory correction at skeletal maturity. It is well recognised that deformities of the foot in patients with spina bifida progress with growth, particularly during adolescence (Sharrard 1973; Smith and Duckworth 1976). Dias (1978) has clearly documented rapid progression of the ankle component of the valgus deformity with increasing age and it is of interest that the majority of revision operations in this series were for recurrence of deformity at this level. This contrasts with the series of Sharrard and Webb (1974) where no recurrence of ankle valgus was encountered after supramalleolar tibial osteotomy and this may relate to the fact that their patients were older and follow-up was shorter than in our series. The extremely low revision rate with the lateral inlay triple fusion confirms the earlier reported figures (Williams and Menelaus 1977).

When considering valgus deformity of the foot in patients with spina bifida it is important to remember that undercorrection will result in significantly less

problems than overcorrection with the production of a varus deformity of the heel (Duckworth and Betts 1980).

With regard to the complications encountered, it must be remembered that delayed union, non-union, infection and chronic soft-tissue swelling more frequently complicate bony procedures in patients with spina bifida than similar procedures in other patients. For this reason the procedure described in this paper should only be performed for the pressing indications which existed in our patients. If deformity can be managed satisfactorily by a caliper then there is no indication for operative correction.

While previous reports have focused on each part of the complex of deformities under discussion, the technique reported here offers a solution to all the components of the deformity in a single operation. Thus, valgus deformity of ankle and subtalar joints, lateral tibial torsion, and abduction deformities are all corrected; the planus deformity persists but is not disadvantageous. Using the procedure described, the deformity was permanently corrected in 75 per cent of feet, ulcers and callosities were prevented, the use of calipers was minimised and shoe-wrecking was reduced in all patients.

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