Open Lateral Wedge Osteotomy of the Calcaneum for Severe Postural Pes Valgus in Children

G. DALL

SUMMARY
Conservative treatment for postural pes valgus in children is, on occasions, unsuccessful in the more severe cases. Where adequate conservative treatment had failed, it was decided to correct the deformity by performing an open lateral wedge osteotomy of the calcaneum, as advocated by Dwyer. When the Achilles tendon was short, an open elongation of the tendon was added to the procedure. In this series, 10 patients from 5 to 14 years of age with marked postural pes valgus were treated. Satisfactory results are reported after an average follow-up period of 9 years. A possible explanation for the success of the operation is discussed.


Many toddlers have valgus feet. If the condition persists, with continued weight-bearing, the heel is ground in to the valgus position and a postural pes valgus results. This later results in stretching of the plantar fascia and the first metatarsal ray becomes hyperextensible. The forefoot pronates and the talus gradually subluxates medially.

A variety of methods of conservative treatment have been advocated. Probably the commonest of these methods in use is the crooked and elongated heel with an inside raise to the heel. Rose¹ has stated that 'theoretically, to secure permanent correction of the pronated foot, the heel alone must be corrected so that the metatarsal rays come into a degree of flexion, in the hope that, if the position is maintained during growth, alteration in the shape of the metatarsal bones will occur so that the posture of the foot becomes one in which the metatarsal rays are fully extended'. However, Rose points out that to achieve correction not only the heel of the shoe should be raised, but an inner raise of the sole should be added. This sole raise is intended to compensate for the hyperextensible first metatarsal ray and so supinate the forefoot.

According to Manter² movement at the subtalar joint involves a rotation between the talus on one side and the rest of the foot on the other. When the talus is fixed, the action produces a combination of eversion, abduction and slight dorsiflexion of the foot about the talus, or, more briefly, pronation.

Likewise, Wiles⁴ has stressed the fact that the whole foot works together as a unit and moves almost as a solid piece around the talus at the talocalcaneal (subtalar) and talonavicular joints. Shephard¹ has referred to these two joints as the peritalar joint. Rose¹ has termed this the peritalar complex. He adds to this the calcaneo-contact articulation, which is the contact the heel makes with the ground while it is weight-bearing. He says that for practical purposes, the axis of the subtalar joint may be considered to be embedded in the calcaneum. The calcaneo-contact articulation causes a movement in space of the subtalar axis about which rotation of the talus can occur relative to the calcaneum.

Grice¹ emphasized the importance of the correct talocalcaneal relationship and devised the operation of extra-articular arthrodesis to maintain this correct relationship and ensure adequate support of the talus by the calcaneum in the immature valgus foot.

Baker and Hill⁵ devised a horizontal open lateral wedge osteotomy of the calcaneum, parallel to and just below the posterior talocalcaneal joint, to alter the alignment of the posterior part of the articular surface of the talus in order to correct valgus feet in patients with cerebral palsy. They claimed satisfactory correction on the basis that this procedure placed the sustentaculum tali under the talus, providing support for the talus. This corrected the pes planus without subtalar arthrodesis and without interfering with subtalar movement. The concept of calcaneal osteotomy is not new and was first described by Gleich in 1893, as reported by Lord⁶.

Gleich removed a medial and plantar-based wedge from the calcaneum, while Dwyer⁷ and Silver et al.⁸ employed an oblique lateral and open wedge osteotomy of the calcaneum. These authors described the results in patients with cerebral palsy.

Jones⁸ has stated that lateral open wedge osteotomy of the calcaneum does not achieve any material structural improvement in the longitudinal arch.

Koutsougiannis⁹ reported the results of displacement calcaneal osteotomy in mobile flat feet. The function was markedly improved in 17 of the 19 patients so treated. The heel valgus was improved in 30 of the 34 feet, but it was less successful in improving the longitudinal arch, especially when the flat-foot deformity was severe.

PATIENTS AND METHODS
In our series of patients with severe postural pes valgus, the technique advocated by Dwyer⁷ for grossly everted feet, particularly in cerebral palsy, namely lateral open wedge osteotomy of the calcaneum, was employed. It was felt that if the valgus heel could be corrected and the weight taken more laterally in relation to the weight-bearing base, the posture of the foot might re-align itself, if passive correction was possible.
It was consequently decided to apply this method of treatment in selected cases. In each case, prolonged conservative treatment in the form of wedge heels, medial sole raises, inside supports, irons and T straps had been given a thorough trial. The majority of valgus feet will respond to conservative treatment, provided the treatment is continued uninterruptedly until the improved posture can be maintained without the addition of any supportive measures. Only severe valgus feet judged to be mobile and passively correctable were operated on. All the cases were of primary pes plano valgus, and none was associated with genu valgum. The Achilles tendons were elongated where tight, but if only moderate tightness was present the wedge was merely inserted slightly more superiorly in the osteotomized calcaneum. Initially tibial bone was used for the wedge, but latterly double cortical thickness iliac bone wedges have been preferred. The iliac bone contains more cancellous bone and consequently locks more securely.

RESULTS

In this series, 20 feet (10 patients) were corrected by this procedure. The initial early results were reported, but not published, in 1969. The average follow-up period is now 9 years, and the first operation (Fig. 3) was done 12 years ago.

The average age at operation was 7.6 years, the youngest patient being 5 years and the oldest 14 years. There were 7 boys and 3 girls (Table I).

All the feet have now been satisfactorily corrected. One foot (Fig. 4) was, however, overcorrected and a varus heel resulted. A small lateral wedge was recently removed, and Figs 5 and 6 illustrate the improved position of the heel and of the foot in general. There is a slight residual varus of the right heel. The point worth making here is that if over- or undercorrection does follow, the problem is remediable and not irrevocable.
TABLE I. CLINICAL DETAILS OF THE PATIENTS IN THIS SERIES

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age at operation</th>
<th>Achilles tendons lengthened</th>
<th>Result</th>
<th>Follow-up (yrs)</th>
<th>Duration of conservative treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>5</td>
<td>Yes</td>
<td>Good — slight residual wasting of right calf</td>
<td>Left: 12</td>
<td>15 mo.</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>9</td>
<td>No</td>
<td>Good — right foot excellent, left foot slightly undercorrected</td>
<td>Right: 11½</td>
<td>18 mo.</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>7</td>
<td>Left side only</td>
<td>Excellent — both feet remain very well corrected</td>
<td>Left: 11½</td>
<td>4 yrs</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>7</td>
<td>Yes</td>
<td>Excellent — right foot slightly better than left</td>
<td>Left: 11</td>
<td>4 yrs</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>6</td>
<td>Yes</td>
<td>Good on left but right foot overcorrected, requiring closed lateral wedge osteotomy</td>
<td>Left: 10</td>
<td>15 mo.</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>7</td>
<td>Yes</td>
<td>Excellent</td>
<td>Left: 9½</td>
<td>3 yrs</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>6</td>
<td>No</td>
<td>Good</td>
<td>Left: 10</td>
<td>2½ yrs</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>8</td>
<td>No</td>
<td>Good — very slight overcorrection</td>
<td>Left: 7</td>
<td>1 yr</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>7</td>
<td>Yes</td>
<td>Excellent</td>
<td>Left: 7½</td>
<td>2½ yrs</td>
</tr>
<tr>
<td>10</td>
<td>M</td>
<td>14</td>
<td>Yes</td>
<td>Satisfactory — initially some pain on left side after sport (see text)</td>
<td>Left: 5½</td>
<td>2 yrs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Right: 5</td>
<td>At 6 yrs</td>
</tr>
</tbody>
</table>

Fig. 5. Patient 5. Position of the feet after closed wedge osteotomy of the right calcaneum.

Two other cases require additional comment: patient 2 developed a spasmodic flat-foot years after operation, following a severe emotional disturbance. No evidence of tarsal coalition could be established and after prolonged conservative treatment, it was decided to elongate the peroneal tendons. A dramatic response was achieved and a mobile, asymptomatic, normally aligned foot has been maintained.
Patient 10, the oldest in this series, viz. 14 years at the time of operative treatment, complained of some left-sided pain after sport, but this gradually improved and has now disappeared.

It is felt that correction should be undertaken before the age of 12 years, since after this age the passive correction is probably less complete and the peritalar complex has already become somewhat fixed in its abnormal arc of movement.

In this series, which has now been followed up for what is considered to be a reasonable period, there has been radiological improvement in all cases, as judged by radiographs with the subject erect.

An improvement in the talonavicular relationship as well as the talocalcaneal angle and elevation of the distal end of the calcaneus, resulting in an improved longitudinal arch, was noted clinically and on weight-bearing radiographs (Figs 7-12).

**DISCUSSION**

Rose* re-emphasized certain principles: (i) that the posture of the standing foot is not dependent upon muscular activity; (ii) that to improve the 'pronated' foot, some alteration in the skeletal structure of the foot must be achieved; (iii) that while the ankle and peritalar joints are somewhere in the middle of their range in the standing position, the joints at the bases of the metatarsal rays are always in full extension and it is this limiting extension of these joints which, in the main, determines the posture of the foot under these conditions. He adds the question of the relative length of the metatarsals but this then postulates the presence of a congenital element, which is beyond the scope of this paper.

The mechanical effects to which this operation owes its success are probably twofold:

1. As the foot deviates from the neutral into pronation, the tilting of the calcaneum into valgus reduces the vertical height of the posterior column of the weight-
Fig. 8. Patient 3, 11 years later.

Fig. 9. Patient 3. Radiographs before operation (top) and 4 years postoperatively (bottom). Note the improvement in the longitudinal arch.

Fig. 10. Patient 3. Radiograph taken in 1976 — antero-posterior view.
Fig. 11. Patient 3. Lateral radiograph — the longitudinal arch has maintained its corrected position.

Fig. 12. Patient 3. Axial views showing the satisfactory position of the calcaneum.

bearing foot (Fig. 13B). If the calcaneum starts from a rest position of varus (Fig. 13C), pronation of the foot does not result in such a reduction in vertical height of the posterior column, so that even with a hyperflexible first ray, the foot will then achieve a position of stability with a lesser degree of pronation.

2. If the calcaneo-contact ‘joint’ is medialized, the whole weight-bearing base of the foot is relatively medialized in relation to the weight-bearing line (Fig. 14). Thus, whatever the position of the foot, the weight-bearing line will fall more laterally over the base, with consequent reduction in the deleterious stretching effect on the medial plantar structures.

This procedure is not advocated in the mature foot where structural changes have already occurred and passive correction is not possible. It should be stressed once again that only severe valgus feet, which do not respond to prolonged conservative treatment, should be considered for surgical correction.

Satisfactory results have been obtained an average of 9 years after operative treatment. The initial result has been maintained in each case.

Fig. 13. Diagram illustrating the effect of a varus or valgus heel on the vertical height of the posterior column of the weight-bearing foot.

Fig. 14. Diagram illustrating the effect of medializing the calcaneo-contact ‘joint’ on the weight-bearing base.
Blood Viscosity in the Normal Newborn Baby

C. W. VAN DER ELST, A. F. MALAN, H. DE V. HEESE

SUMMARY

A viscometer was tested and the results were found to be accurate and reproducible for the ranges encountered in neonates. The viscosity was determined in 80 cord blood samples and the mean and 2 standard deviations (2 SD) were calculated at each shear rate. Changes in viscosity increased from birth to 12 hours, and then gradually decreased over the next 72 hours. The results are in keeping with the accepted normal values in the newborn.


Few workers have determined the viscosity of umbilical cord blood,\textsuperscript{1-3} and their results have differed. Studies on venous blood viscosity after birth\textsuperscript{4-6} have shown an even greater divergence of findings (Fig. 1). It is therefore difficult to define hyperviscosity and to determine which babies are at risk of the complications\textsuperscript{4} which may result from this condition.

The purpose of this study was to determine the accuracy and reliability of a cone and plate viscometer and to define normal absolute viscosity levels in the newborn population of our area.

MATERIALS AND METHODS

The Viscometer and its Reliability

The Model LVT Micro Viscometer (Wells-Brookfield, Stoughton, Mass., USA) consists of a conical disc which is rotated in a small rhodium cup containing the sample to be tested (Fig. 2). The drag on the rotating cone due to the viscosity of the fluid is reflected by a spring and pointer on a dial. The deflection of the pointer bears a linear relationship to the torque applied to the spring via the cone. With this reading and the use of precalculated range tables, the absolute viscosity in centipoise (cP) units is obtained. The cone can be made to rotate at different speeds (shear rates) by means of a gear transmission connected to a motor. The cup is surrounded by a water jacket connected to a constant-temperature water bath. The details of the geometry and operation of the instrument have been discussed elsewhere.\textsuperscript{4-9}

Fig. 1. Comparison of blood viscosity v. shear rate in 5 different studies.

REFERENCES


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