SUPRAMALLEOLAR DEROTATION OSTEOTOMY FOR LATERAL TIBIAL TORSION AND ASSOCIATED EQUINOVARUS DEFORMITY OF THE FOOT

DAVID McNicol, J. C. Y. LeONG, L. C. S. HSU

From the University of Hong Kong

The development of lateral tibial torsion in the paralysed lower limb is well documented, but its pathogenesis is poorly understood. This paper attempts to provide an explanation for its development when it is associated with a varus or equinovarus deformity of the hindfoot. Correction of the lateral tibial torsion by supramalleolar derotation tibial osteotomy and reorientation of the ankle mortise appear to unlock the talus from the laterally rotated position, correcting a mobile hindfoot varus deformity and altering soft-tissue tensions about the ankle so that the correction achieved is maintained. In the presence of a fixed hindfoot deformity, supramalleolar derotation tibial osteotomy is useful as a first-stage procedure before corrective osteotomies of the foot. The operation described is technically simple and carries a low morbidity. Twenty supramalleolar derotation tibial osteotomies in 18 patients have been performed with satisfactory results and few complications.

Children with deformities of the lower limbs resulting from poliomyelitis frequently present with foot problems. We have observed that the development of lateral torsion of the tibia, previously reported by other authors (Clark 1963; Makin 1965; Kinzinger 1977), is most frequently associated with a varus or equinovarus deformity of the hindfoot, which has developed as a result of unbalanced muscle action about the ankle. We have reviewed the possible pathomechanics in the genesis of this deformity and have developed a treatment programme based on the evidence available.

PATHOMECHANICS

Human cadaveric dissections (Hicks 1953) and mechanical model studies (Jones 1945; Rose 1958, 1962) have shown that the movements of the forefoot, hindfoot and leg are precisely and intimately related, such that supination of the forefoot and inversion of the hindfoot produce lateral rotation of the talus in the ankle mortise. This force, in turn, produces lateral rotation of the tibia. The reverse is, of course, also true, in that forefoot pronation and hindfoot eversion produce medial rotation of the talus in the ankle mortise with resultant medial rotation of the tibia. These experimental observations can be clearly demonstrated clinically when examining the foot of the newborn baby (Swann, Lloyd-Roberts and Catterall 1969). When the heel is placed in equinovarus, the forefoot supinates and the tibia rotates laterally, as is evident by posterior displacement of the lateral malleolus. Further evidence is found in historical descriptions of untreated congenital talipes equinovarus by Kinzinger (1977). Severe fixed equinovarus of the hindfoot was associated with lateral tibial torsion in addition to adduction and supination deformities of the forefoot. Thus, there appears to be well-documented experimental and clinical evidence that the varus or equinovarus position of the hindfoot is associated with forefoot supination and lateral rotation of the tibia.

MANAGEMENT

Rationale. On the basis of these cadaveric, mechanical and clinical observations, it seemed that a persistently lateral rotational force on the tibia applied by the talus, secondary to hindfoot varus produced by unbalanced muscle action, might result in lateral tibial torsion in the growing limb. We considered that once this torsion was established, the laterally rotated ankle mortise would “lock” the talus into a laterally rotated position and compound the problem, setting up a vicious circle which would inevitably lead to progression. Thus, derotation of the tibia and re-alignment of the ankle mortise with consequent “unlocking” of the talus seemed sensible. As a result of this manoeuvre spontaneous correction of the hindfoot varus occurs, provided that the hindfoot varus is mobile and passively correctable to the neutral position.

We also agreed with Lloyd-Roberts, Swann and Catterall (1974) that hindfoot varus seen in congenital talipes equinovarus and observed in our own patients,
was further exaggerated as a result of the rotation of the heel along the axis of the tibia away from the sagittal plane (Fig. 1). Derotation osteotomy seemed a feasible approach to correcting this additional component, which exaggerated the hindfoot varus deformity.

![Diagrammatic representation of the foot, viewed from the sole. The existing hindfoot varus is further exaggerated by the lateral tibial torsion as the heel is rotated along the axis of the tibia away from the sagittal plain. The normal position of the foot is shown by the dotted outline.](image)

The simple operative procedure of supramalleolar derotation tibial osteotomy has been used at the Duchess of Kent Children's Hospital, Hong Kong, since 1976.

**Operative procedure.** The operation is performed under general anaesthesia with the patient in the supine position. The affected limb is exsanguinated and a tourniquet applied about the upper thigh and inflated. The skin is prepared and the limb draped, ensuring that the knee is on view to provide orientation during derotation.

Fibular osteotomy in the lower third is first performed through a small posterolateral longitudinal incision and is necessary in order to allow complete derotation of the ankle mortise. Next a small oblique incision, from medial above to lateral below, is made over the anteromedial aspect of the distal tibia immediately medial to the tibialis anterior tendon (Fig. 2). This oblique skin incision becomes longitudinal after derotation. The wound is deepened to the periosteum which is incised longitudinally and the growth plate identified if present. The periosteum is lifted off the bone in a circumferential fashion. Periosteal stripping must be adequate to facilitate derotation, and is carried proximally to avoid damage to the growth plate.

A transverse osteotomy is marked out in the supramalleolar region avoiding the growth plate and above the level of the tibiofibular syndesmosis. Two Kirschner wires may be inserted on either side of the intended osteotomy site, opposite and parallel to one another, to act as visual guides as to the amount of derotation achieved (Fig. 3). The osteotomy site is predrilled with a fine drill and completed with a wide, thin osteotome. The hindfoot is held firmly and the ankle mortise medially rotated as a unit until lateral torsion has been eliminated as judged by assessing foot alignment with the tibial tubercle and patella. A single staple is placed across the osteotomy to hold the corrected position (Fig. 4). The skin is closed and an above-knee padded plaster applied, which is maintained for six weeks. Partial weight-bearing is permitted after three to four weeks.

**CLINICAL MATERIAL**

Between January 1976 and June 1978, 18 patients presented to the Duchess of Kent Children's Hospital with lateral tibial torsion. Two patients had bilateral deformities, producing a total of 20 limbs. There were 11 female patients and seven male, the youngest being six years nine months and the oldest 26 years. All patients were able to walk and had not been confined to bed.

**Underlying condition.** Thirteen patients had had poliomyelitis, two of whom had bilateral torsion deformities. A history of a febrile illness in early childhood was...
obtained in all these patients, although the exact date of the illness was sometimes uncertain. Lateral tibial torsion was seen in a further two patients with cerebral palsy, both with spastic hemiplegias; this palsy was first noticed in early childhood by the parents, but was presumably present since birth, there being no other relevant history of postnatal trauma or infection. Two patients had neuromyopathic disorders: one little girl had Charcot–Marie–Tooth disease which had begun insidiously during childhood; the other child had a muscular dystrophy. Finally, there was one patient with Marfan’s syndrome who was neurologically normal with no obvious primary muscular disease.

**Associated deformities.** Of the 15 poliomyelitic limbs 10 had an associated equinovarus deformity of the hindfoot, two had a varus deformity of the hindfoot, two had a cavovarus foot and one was short and flail. In this latter case, the foot had fallen into an equinovarus position under the influence of gravity. Of the two limbs affected by cerebral palsy, one had an associated equinovarus deformity of the hindfoot, the other a varus hindfoot. Both limbs affected by neuromyopathic disorders had equinovarus deformities of the hindfoot. The child with Marfan’s syndrome exhibited a varus deformity of the hindfoot.

Thus, all patients who presented with lateral tibial torsion had an associated varus or equinovarus deformity of the hindfoot. The deformities were further analysed to ascertain whether they were fixed or mobile.

**Group 1—mobile hindfoot varus.** In this group there were seven patients, five female and two male. One girl had bilateral deformities, producing a total of eight limbs. The youngest was six years nine months and the oldest 20 years, with an average age at the time of operation of 14 years 7 months. One patient had previously undergone an unsuccessful proximal tibial derotation osteotomy. Another, with bilateral lateral tibial torsion and equinovarus deformities, had had bilateral elongations of the calcaneal tendon.

**Group 2—fixed hindfoot varus.** In this group there were 11 patients, seven female and four male. One girl had bilateral deformities, producing a total of 12 limbs. The youngest was 10 years and the oldest 26 years, with an average at the time of operation of 16 years 6 months. One child had had a previous Batchelor’s subtalar fusion.

Patients in Group 1 underwent supramalleolar derotation osteotomy of the tibia, with a view to correcting varus deformities of the hindfoot and it is in this group that we are most interested. However, the 11 patients (12 limbs) in Group 2 also underwent supramalleolar derotation tibial osteotomy before corrective osteotomies of the foot or, in one case, the fitting of a brace. In these patients, because the deformities were fixed, derotation tibial osteotomy as a first-stage procedure, six weeks before triple arthrodesis, was employed to re-orientate the ankle mortise, not to correct hindfoot varus as detailed in Group 1 patients. It should be made clear that derotation osteotomy could have been performed elsewhere in the tibia in these cases, but we chose the supramalleolar site because, in our experience, the surgical procedure is simple and sure, and allows for easy maintenance of correction in a plaster cast.

**RESULTS**

**Group 1**

**Correction of deformities.** The lateral tibial torsion was corrected in all seven patients (eight limbs) as judged clinically after supramalleolar derotation tibial osteotomy. Hindfoot varus was corrected to the neutral position in five limbs; three were left with some residual hindfoot varus, perhaps because derotation was insufficient, but from a functional point of view these three feet did not require any further correction. One child with bilateral deformities also showed full correction of associated forefoot supination.

**Complications.** There was one case of non-union with anterior angulation of the distal fragment, in a 20-year-old male patient whose deformities were a result of poliomyelitis. The osteotomy had been too proximal in the tibial shaft. This required subsequent resection of the fibula and removal of the staple, with prolonged immobilisation in a plaster cast until union was complete.

**Subsequent procedures.** Two patients have undergone lateral transfer of the tibialis anterior tendon to help balance the foot. The patient suffering from Charcot–Marie–Tooth disease has had a Steinstrader stripping of the plantar fascia and basal metatarsal osteotomies to correct cavus and forefoot adductus. The hindfeet in all patients have remained in a satisfactory position and have not required further surgical procedures. All patients are brace-free.

**Group 2**

**Correction of deformities.** All 11 patients (12 limbs) in this group were judged to have sufficient correction of lateral tibial torsion to proceed with triple arthrodesis or bracing.

**Complications.** There was one case of premature fusion of the distal tibial epiphysis in a 13-year-old girl who had had poliomyelitis. In this case, the osteotomy was made too close to the growth plate with resultant damage to it. In addition, the staple had been placed across the growth plate. This was subsequently recognised and the staple removed. This child developed a superficial wound dehiscence in the fibular incision.

**Subsequent procedures.** Nine patients (10 limbs) have undergone triple arthrodesis, and one patient had fusions of the talonavicular and calcaneocuboid joints. The eleventh patient, who had a flail lower limb, has been fitted with a brace. All the other patients are brace-free.

**Radiographic appearances**

Lateral radiographs taken before operation showed a posteriorly displaced lateral malleolus and a “flat-topped”
tibia, has been used in the management of severe established talipes equinovarus to correct lateral tibial torsion (Lloyd-Roberts et al. 1974). Moreover, there is a growing body of evidence suggesting a neurological cause for talipes equinovarus (Ionesescu et al. 1974; Isaacs et al. 1977; Gray and Katz 1981). We also looked at other clinical situations where there is unbalanced muscle action about the ankle, such as is seen in cerebral palsy and muscular dystrophy, and have found an association between a varus or equinovarus hindfoot and the development of lateral tibial torsion.

Before 1976 at the Duchess of Kent Children’s Hospital, lateral tibial torsion in paralysed limbs had been treated by proximal tibial derotation osteotomy. Whilst it was successful in re-aligning the ankle mortise, there was no correction of the associated hindfoot varus deformity. Subsequently, derotation osteotomy at the supramalleolar level was tried and found to be successful in correcting lateral tibial torsion, associated hindfoot varus and forefoot supination. The success of this procedure, we believe, is due to “unlocking” of the talus from its laterally rotated position by derotation and realignment of the ankle mortise, although the mechanism is probably more complex than this. In addition, we postulate that there is an alteration in the soft-tissue tensions about the ankle after supramalleolar derotation tibial osteotomy. The medial tendons, in particular the tibialis posterior tendon, are functionally lengthened as the tendon insertion is brought closer to the muscle origin during derotation and the lateral tendons are functionally shortened as the muscle origin to insertion distance is increased. The extent of change in tendon length depends on the amount of derotation. The alteration in soft-tissue tension may play an important part in maintenance of correction as the muscle action about the ankle is now better balanced. It should, however, be emphasised that correction of hindfoot deformity is only possible by this method if the hindfoot varus is still mobile. Thus, if lateral tibial torsion is recognised before the development of fixed deformity and treated by supramalleolar derotation osteotomy, more mutilating procedures may be avoided when fixed deformity supervenes later in life. This does not imply, however, that other soft-tissue procedures will not be required. If an equinus deformity exists in addition to hindfoot varus, lengthening of the calcaneal tendon may be necessary. Likewise, tendon transfers may be helpful to balance the foot and maintain correction after supramalleolar derotation tibial osteotomy. It is reasonable to suspect that continued unbalanced muscle pull about the foot may result in the redevelopment of lateral tibial torsion, particularly in the growing child.

The operation of supramalleolar derotation osteotomy of the tibia is technically simple and carries a low morbidity. The osteotomy is made through cancellous bone and unites quickly and surely. Care, however, must be taken to avoid damage to the growth plate by an
osteotomy which is too low. Premature fusion will result and thus exacerbate existing leg-length inequality. On the other hand, if the osteotomy is too proximal, union may be delayed.

Our indications for supramalleolar derotation osteotomy of the tibia to correct lateral tibial torsion are threefold. When lateral tibial torsion occurs in association with mobile hindfoot varus deformity, the procedure is used to correct hindfoot varus and to help balance the foot. Forefoot supination will often correct as a secondary phenomenon. When lateral tibial torsion occurs in the presence of fixed hindfoot varus deformity, the procedure is used to realign the ankle mortise. In this situation it is carried out as a first-stage procedure, before further corrective osteotomies of the foot. We feel that, as part of a foot reconstruction programme, it enhances the final functional result. This procedure also facilitates the fitting of boots and braces in the paralysed limb where abnormally situated bony protuberances may rub and create pressure areas.

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REFERENCES