Angular deformity of the ankle with sparing of the distal fibula following meningococcal septicaemia

A CASE SERIES INVOLVING 14 ANKLES IN TEN CHILDREN

Progressive angular deformity of an extremity due to differential physeal arrest is the most common late orthopaedic sequela following meningococcal septicaemia in childhood. A total of ten patients (14 ankles) with distal tibial physeal arrest as a consequence of meningococcal septicaemia have been reviewed. Radiological analysis of their ankles has demonstrated a distinct pattern of deformity. In 13 of 14 cases the distal fibular physis was unaffected and continued distal fibular growth contributed to a varus deformity. We recommend that surgical management should take account of this consistent finding during the correction of these deformities.

Meningococcal septicaemia is a potentially life-threatening disease caused by the organism *Neisseria meningitides* and remains the most common infective cause of death in children. Improved survival over the last two decades has been attributed to several factors, including improved treatment protocols and centralisation of paediatric intensive care.

One consequence of these improvements in survival is the increase in patients presenting with bone and soft-tissue disorders secondary to the peripheral vascular occlusion associated with meningococcal septicaemia. The most common late orthopaedic sequelae are progressive angular deformities of the lower limb and limb-length discrepancies as a result of physeal arrests at different sites. Most patients will have multiple physeal involvement with the knee being the most common site. The angular deformities can be multiplanar and those around the knee seem particularly prone to recurrence.

Deformities of the ankle in these patients are less commonly reported but are likely to cause pain, gait disturbance, shoe wear and brace fitting problems.

We have reviewed ten patients with deformities of the ankle occurring secondary to distal tibial physeal arrest, which in most cases have been accentuated by sparing, and therefore relative overgrowth, of the distal fibula. We believe that this phenomenon has not been specifically reported in the literature.

**Patients and Methods**

Between 2004 and 2010 the senior author (FPM) identified multiplanar angular deformities of 14 ankles in ten patients (five girls, five boys) following meningococcal septicaemia.

All patients had developed meningococcal septicaemia requiring intensive care support at a mean age of 14 months (3 to 36) with evidence of peripheral lower limb ischaemia (Table I). All had developed a progressive ankle deformity secondary to a partial growth arrest of the distal tibial physis. The mean age at the time of this assessment was 8 years 1 month (range 4 years 3 months to 14 years 8 months).

Radiological assessment was performed using either radiographs or digital imaging. Angular deformity was measured in both coronal and sagittal planes using a goniometer or imaging software as appropriate. The coronal plane deformity was estimated by measuring the mechanical lateral distal tibial angle (mLDTA) and the sagittal deformity by measuring the anatomical anterior distal tibial angle (aADTA). The differential growth of the distal fibula with respect to the tibia was noted by assessing the relationship of the distal fibular growth plate to the lateral aspect of the ankle joint. It was not possible to precisely quantify the difference in growth between the two bones in all cases because of the irregular morphology of the distal tibia following growth arrest. It was also felt that these measurements would not be reproducible or add value to the study.
The results are given in Table I. The mean mLDTA was 112.6° (79° to 135°). No ankle had a normal mLDTA (defined as 88.6° ± 3.8°). Of the 14 ankles reviewed, 13 had a varus deformity and the remaining ankle had a valgus deformity of 10° (Fig. 1). The mean aADTA was 93.1° (72° to 116°). No ankle had a normal aADTA (defined as 79.8° ± 1.6°). The majority of the deformities in this plane were apex-anterior in direction (Fig. 2).

All of the varus ankles were noted to have sparing of the distal fibular growth plate in addition to the apparent sparing of the lateral side of the distal tibial physis.

Discussion
Distal tibial physeal arrest has been previously reported as a sequela of meningococcal septicaemia in children. We believe that this series is the largest to date which details the morphology and extent of the deformity prior to correction. We have also noted that in all but one of these cases the fibula has been unaffected, leading to fibular overgrowth, a previously unreported phenomenon.

The exact mechanism that leads to growth arrest is probably multifactorial. Grogan et al have suggested that there is a direct insult to the physis due to ischaemia driven by endotoxin-induced microvascular damage. Watson and
Ashworth\textsuperscript{11} have drawn comparisons with burns patients and suggested that dense scarring in areas of skin necrosis could tether growth in that area.

It is possible that full thickness involvement of the skin and the underlying tissues is a reflection of the interruption of angiosomal blood supply to that area. According to Taylor and Pan,\textsuperscript{12} the body is divided into a number of three-dimensional blocks of tissue supplied by a source artery. Neighbouring vascular territories are usually linked by either true anastomotic connections or by reduced calibre choke vessels. The anterior compartment of the leg has only one angiosomal supply via the anterior tibial artery and may be more vulnerable to ischaemia because of the paucity of vascular communications via choke vessels across the boundaries of this compartment. The medial subcutaneous area, where the only connections between the anterior and posterior tibial arteries are via the periosteum and cutaneous vessels, may be particularly susceptible. This is in comparison to the lateral and posterior aspects of the lower leg where at least two source vessels exist. Whether this principle can be used to explain the predilection for certain sites of physeal arrest following meningococcal septicaemia remains to be proven.

In our series we have noted that the majority of deformities occurring in the sagittal plane were apex-anterior in direction implying a posteromedial rather than anteromedial origin of growth disturbance in these cases. This observation would seem to contradict theories and clinical observations\textsuperscript{6} supporting an anteromedial vascular deficit and subsequent growth arrest. We acknowledge that a deficiency in this study is the lack of further imaging such as MRI that would have added support to this statement.

The fact that the lateral distal tibia and especially the distal fibula are usually unaffected in this condition is important to enable appropriate surgical treatment of this deforming condition. It is now our routine practice to perform an epiphysiodesis on the remaining functioning growth plates of the distal tibia and distal fibula. We hope this will reduce the risk of recurrence of angular deformity.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References