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VALGUS DEFORMITY FOLLOWING PROXIMAL TIBIAL METAPHYSEAL FRACTURE IN CHILDREN

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Seven children with fractures of the proximal tibial metaphysis, with primary valgus angulation and cortical diastasis medially, were seen at follow-up 18 months to 11 years after the accident to assess the trend of the valgus deformity. All the children had been treated non-operatively with a plaster cast. In six patients showing radiological signs of interposition of soft tissues medially in the fracture gap, the valgus angulation had progressed during the first year despite clinical healing. From 1–2 years after the accident the deformity slowly regressed due to corrective longitudinal growth. Routine surgery to remove the interposed soft tissue does not seem to be justified.

Key words: children's fractures; corrective growth; interposition of soft tissues in fractures; tibia; valgus deformity

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The fairly uncommon fractures of the proximal tibia in children are usually transverse fractures entailing a tendency to valgus deformity (Figure 1). The explanation is presumably that strong soft tissues – joint capsule, medial collateral ligament, and the pes anserinus muscle insertion – secure the epiphysis, in event of a valgus trauma, owing to their insertion distal to the epiphyseal line (Rang 1974). This is unlike the findings in the distal femoral epiphysis which commonly undergoes epiphysiolysis.

Since Cozen (1953) described 4 cases of progressing valgus deformity after healing of such fractures, fairly small materials of similar cases have been reported (Lehner & Dubas 1954, Cozen 1959, Taylor 1963, Rettig & Oest 1971, Salter & Best 1972, Weber 1977, Parsch et al. 1977), and the phenomenon has been discussed in several textbooks (Goff 1960, Pollen 1973, Rang 1974, Weber et al. 1980).

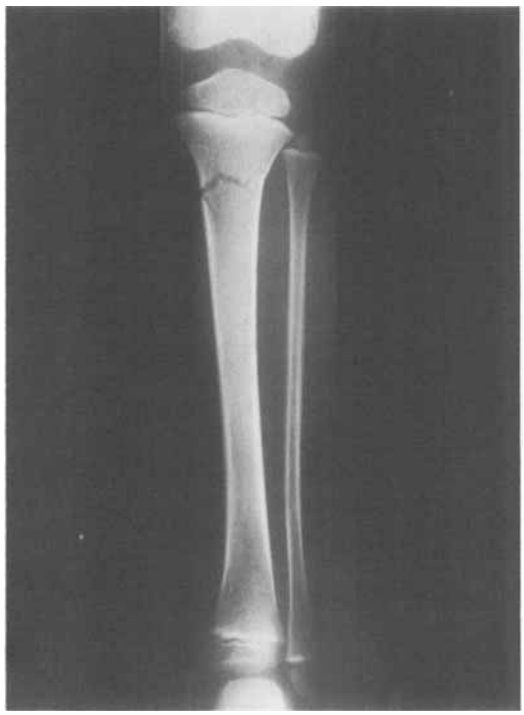

Figure 1. Fracture of the proximal tibial metaphysis due to a valgus trauma in a 5-year-old boy (Case 7).

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Weber (1977) assumed that the deformity was due to fibrous interposition medially in the fracture gap. At operation of two fresh fractures, he found interposition of soft tissues, viz. periosteum and pes anserinus fibres, in the medial part of the fracture gap. Weber removed the interposed fibres and closed the fracture gap, and follow-up of these patients showed that the expected valgus deformity did not occur.

The present series of non-operatively treated fractures of the proximal tibial metaphysis was analysed in order to ascertain whether surgery is justified. In the literature the author has not found any long-term follow-up studies of materials comprising patients with untreated valgus deformity with progression after clinical healing.

PATIENTS AND METHODS

During the period 1.1. 1969 to 31.12. 1979, a total of 13 children aged 0–14 years were treated in the Department of Orthopaedic Surgery, Hjørring Hospital, Denmark, for fracture of the proximal tibial metaphysis, taken to comprise the proximal quarter of the tibia. This material does not include epiphysiolyses or intra-articular fractures. All the fractures were closed.

These 13 fractures could be divided into two groups: One group of 7 fractures showing a few degrees of valgus and a corresponding cortical diastasis medially, and another group of 6 fractures which were merely fissures. The latter group of children, aged 1–6 years, was followed until clinical and radiological healing, which occurred 4–7 weeks after the trauma, without a valgus deformity developing. Accordingly, they were excluded from the study.

The valgus deformity was measured in degrees (Figure 2) by the (slightly modified) method of Karaharju et al. (1976). The measurements were made on the available anteroposterior X-rays of the injured tibiae from the time of the accident on. However, films at follow-up, during the period February–May 1980, were taken in a defined position of rotation of the lower leg and accurate placement of the central beam.

In a series of 44 healthy tibiae in 38 children aged 1–8 years, X-rayed because of a clinical suspicion of fracture, a valgus angle of –2° to 6° was measured by this method (median: 2°, quartiles: 0° and 4°). In 6 children whose right and left tibiae were X-rayed at the same time, the maximum difference between the sides was 2°.

The fractures were considered to have healed when full weight was borne on the leg without the plaster cast.

At follow-up, questions were asked about any complaints, the difference in length between the lower legs was measured, and clinical as well as radiological measurements were made to ascertain valgus deformity.

RESULTS

The material comprised 6 boys and 1 girl, 5 left-sided and 2 right-sided fractures. The mean age at the time of the accident was a little over 3 years, range almost 2–6 years.

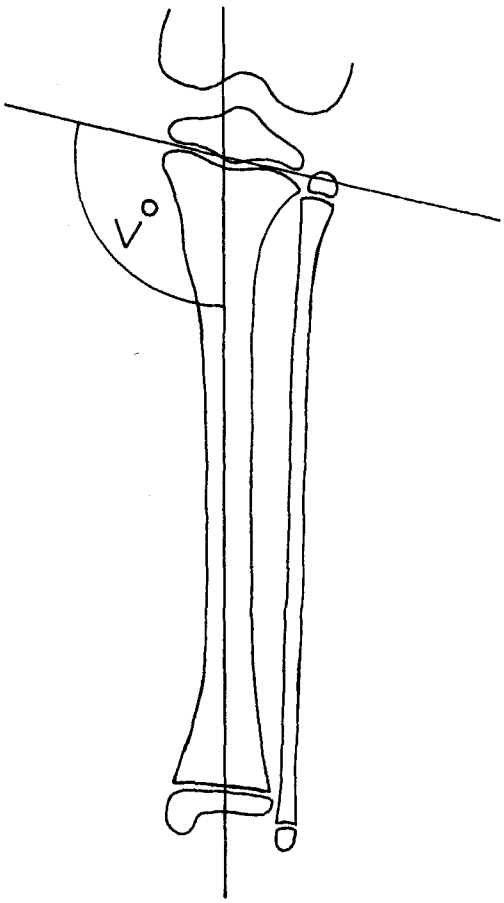

Figure 2. The valgus angle is calculated as the difference between the angle V and 90°. The longitudinal line is determined by two points, one of which has constantly been a midpoint measured in the distal metaphysis, close to the epiphyseal line, while the other point was fixed in the early measurements as a midpoint in the proximal metaphysis, immediately distal to the fracture, but 2 to 3 years after the accident (estimated time) or later, at a point corresponding to the distal one, in the proximal metaphysis, above the fracture site.

Table 1. Valgus angles measured on the day of the accident and at selected times thereafter. In Case 4 there are no observations between the time of clinical healing and the follow-up examination. The figures in brackets indicate the physiological valgus angulation in the uninjured tibia

Case no.	Age at accident (years)	Valgus Angle: At time of accident	After application of plaster cast (and reduction, if any)	At clinical healing	Approx. 1 year after accident	At follow-up	Follow-up period (years)
1	3	8°	11°	10°	17° (6°)	9° (5°)	11
2	4	5°	6°	10°	14° (6°)	6° (5°)	9
3	4	4°	9°	11°	14° (3°)	6° (3°)	8
4	3	9°	6°	5°		1° (0°)	5
5	6	4°	4°	2°	6°	6° (2°)	4
6	1	13°	7°	9°	13° (4°)	4° (1°)	3
7	5	9°	7°	6°	11° (0°)	7° (0°)	1½

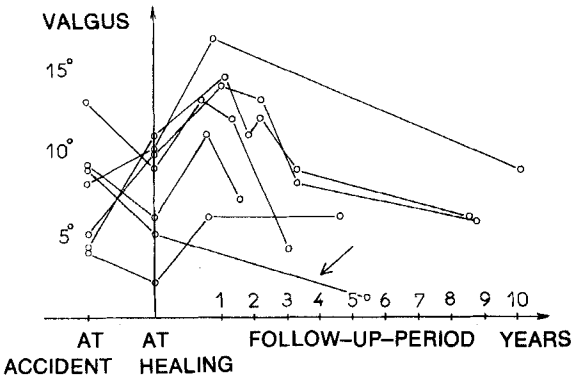

Figure 3. Development of the valgus angulation in the proximal tibia in the 7 patients of the material. If several measurements were available for a short period, only one was plotted. The patient marked by an arrow has presumably not had fibrous tissue interposition in the fracture gap.

The patients were treated with a plaster cast for 3 to 7 weeks.

Table 1 presents the results of most of the individual measurements, while Figure 3 sets out the results graphically.

In all 7 patients the primary X-rays showed a certain valgus angulation and a corresponding cortical diastasis of a few millimetres medially. In one patient (Case 4, Table 1) the valgus angulation had diminished and the diastasis had disappeared after closed reduction. This has presumably been possible because there has been no soft-tissue interposition in the fracture gap. This patient did not develop valgus deformity during the follow-up period (Figure 3). The remaining 6 patients exhibited, at the time of clinical union, radiological signs of non-union medially, at the site of the previous fracture gap (Figure 4). All

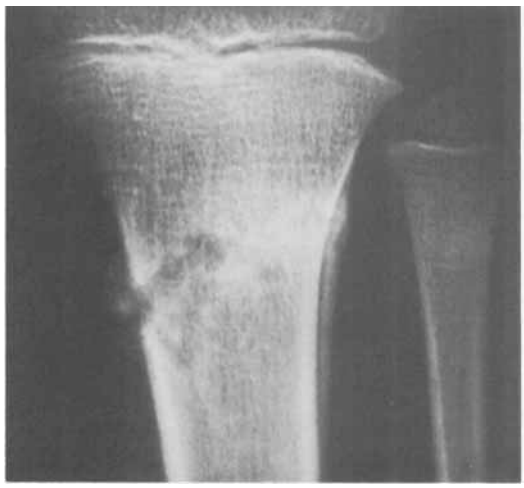

Figure 4. At the time of clinical healing 6 patients showed only faint radiological signs of healing medially, where presumably soft tissues had been trapped at the site of the previous fracture gap, despite solid callus laterally. All 6 patients developed progressive valgus deformity of the proximal tibia. This picture depicts the same fracture as is shown in Figure 1, but this one was taken 28 days after the accident.

these patients developed major or minor valgus deformity during the follow-up period. In 2 of them closed reduction had been attempted, with partial success (Cases 6 and 7, Table 1). In 2 patients the valgus angulation increased while they were wearing the plaster cast (Cases 1 and 3, Table 1). Whether this was due to insufficient immobilization of the fracture during the healing period or to a progressing valgus tendency beginning at the time of clinical healing was not determined.

The valgus angulation had increased in these 6 patients by 3° to 6° during the first year after the accident. This increase, plus that caused by the fracture and a possible physiological valgus, resulted in total valgus deformities of 6 to 17°. The valgus appeared to remain largely unchanged for a year or two after it had reached a maximum; thereafter it slowly subsided in all 6 patients.

The patients were followed for 18 months to 11 years after the accident. During this follow-up period the valgus deformity measured on the X-ray films decreased so much that at present only 2 patients (Cases 1 and 7, Table 1) still have a clinically visible valgus deformity. One of these two patients is the one whose follow-up period is the briefest, viz. 18 months, so that further spontaneous correction can be expected. These two patients are the only ones who showed a difference of more than 4° from the uninjured side at the final follow-up examination.

All patients – except for Case 4 who did not develop any valgus deformity – showed at follow-up an overgrowth of the injured lower leg so that there was a difference of up to ½–1½ cm between the two legs.

No patient had any complaints because of the valgus deformity. Only Case 7 still had a clinically distinct deformity.

DISCUSSION

From the literature it is apparent that both operative and non-operative methods have been applied in attempting to correct the valgus deformity.

Pollen (1973) recommends long-lasting immobilization in plaster (about 3 months), Cozen & Jackson (1971) report successful treatment of mild cases by corrective braces, but in most materials operative correction has been applied (Cozen 1953, Lehner & Dubas 1954, Taylor 1963, Rettig & Oest 1971, Cozen & Jackson 1971, Salter & Best 1972, Weber 1977, Parsch et al. 1977). In most cases a wedge osteotomy has been done proximally on the tibia, more rarely at a supracondylar site on the femur, and in one case epiphysiodesis. The procedure has been performed 1 to 3 years after the fracture, but the time of operation is not stated in all materials. After tibial osteotomy recurrences are reported to be common (Rettig & Oest 1971, Cozen & Jackson 1971, Weber 1977, Parsch et al. 1977). Salter & Best (1972), whose material is the largest one on record, recommend operation if

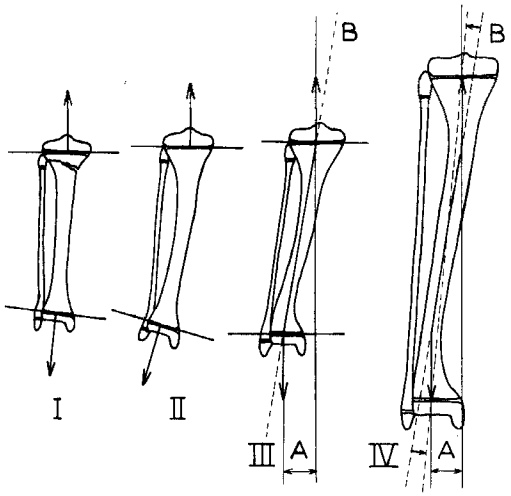

Figure 5. Changes in bone growth after union of the fractures in the 6 patients who developed progressive valgus deformity. The changes appear to pass through three trends, each illustrated separately by the differences between drawings I and II, drawings II and III, and drawings III and IV. Drawing I illustrates the initial position, drawing II the result of the increasing valgus angulation, drawing III the spontaneous reaction of the bone to this deformity: making correction possible through further longitudinal growth, i.e. an oppositely directed increasing varus bowing of the distal metaphysis, realigning the epiphyseal lines. Drawing IV illustrates the result of the subsequent, corrective longitudinal growth which makes the skew weight-bearing axis, line B, more vertical. The arrows illustrate the direction of growth. Chronologically the three phases overlap.

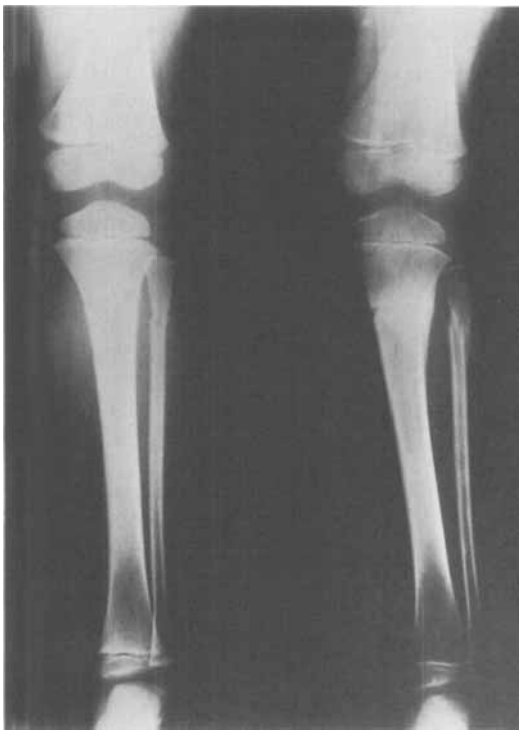

Figure 6. Fracture of the proximal tibial metaphysis in a 4-year-old boy. On the left the position at the accident, on the right the position at clinical healing 7 weeks later (Case 3).

there is approximately a 15° valgus deformity of the knee. They report satisfactory results of well-fixed tibial osteotomies at the site of the fracture plus simultaneous fibular osteotomy.

Salter & Best (1972) and Parsch et al. (1977), in their materials, noted a tendency for a greater increase in the valgus deformity in patients with marked physiological valgus of the knee.

Weber (1977) observed that even though the expected valgus deformity did not develop after operative removal of interposed soft tissues, there occurred a growth stimulation of 1 cm in one out of two operated patients.

Lehner & Dubas (1954) noted a progression of the valgus angulation as early as 4 weeks after the fracture and stated that this progression appeared to stop in a year or two, in conformity with the present findings.

After tibial fractures in children Guldhammer (1963) found an overgrowth of at most 15 mm, during a maximum period of 2 years after healing. Thus, the growth stimulation and the progression of the valgus deformity appear to take place synchronously.

In the present study the growth disturbance after union appeared to comprise three different trends, two of which were corrective (Figure 5):

First trend: Increasing valgus deformity in the proximal tibial metaphysis.

Second trend: Increasing, corrective varus

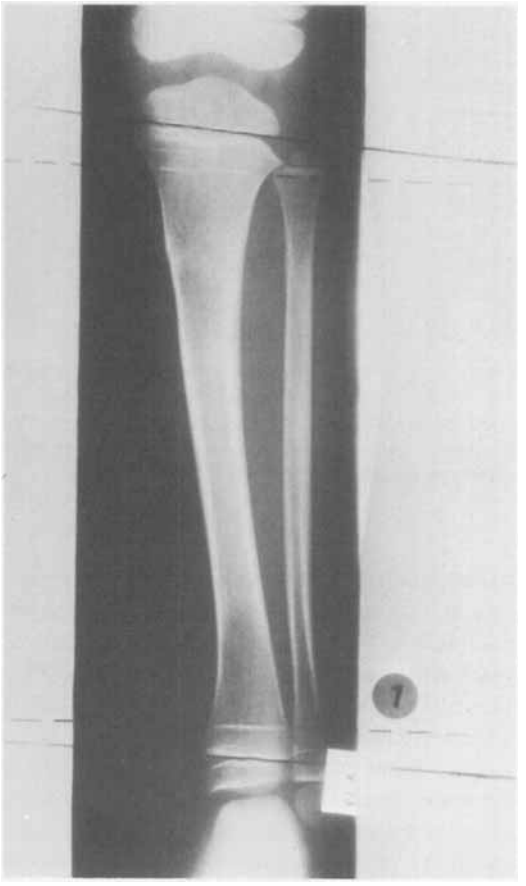

Figure 7. One year after the accident the valgus deformity is apparent. No parallelism exists between the Harris lines and the epiphyseal lines either in the proximal or in the distal metaphyses. In the distal metaphysis there is initial varus bowing, but the epiphyseal lines are not yet realigned. The Harris lines in the proximal metaphysis are situated proximal to the earlier fracture site which is faintly visible as a thickening proximally in the medial cortical area (Case 3).

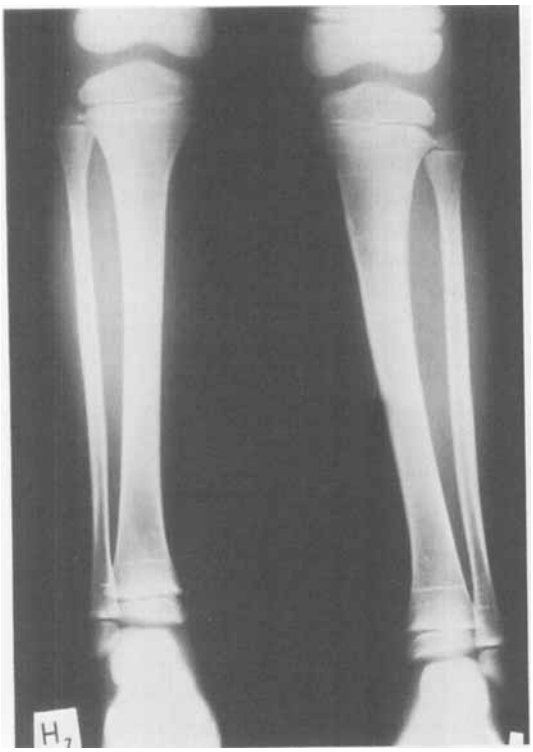

Figure 8. Two years after the accident the overgrowth and the faintly S-shaped bowing of the previously injured leg have become clearly apparent. At this time the epiphyseal lines are again realigned. The uninjured leg is shown on the left for comparison (Case 3).

bowing in the distal metaphysis. This was apparent, at the earliest, about 6 months after the fracture, and the phase was completed in about 2 years, when the epiphyseal lines became parallel. The result of these two tendencies is a faintly S-shaped bowing of the bone.

Third trend: A correction of the long axis of the bone, in step with the longitudinal growth, which appears when growth occurs in anatomical directions after realignment of the epiphyseal lines, despite a somewhat S-shaped bowing of the shaft (cf. Figure 5).

Figures 6–9 show such a course of growth in a patient. The tendencies are clearly apparent from the presence of Harris lines (Harris 1926).

There have been only a few studies to elucidate the role of the epiphyseal plates in re-modelling of bones after fracture healing with angular deformity. The majority has been focused on the correction of the angulation at the fracture site, a correction which *per se* is fairly slight (Bennek & Steinert 1966, Hansen et al. 1976). The above observations of corrective growth are in keeping with the results of animal experiments done by Ryöppy & Karaharju (1974), Karaharju et al. (1976), and two clinical-radiological studies by Friberg (1979). Their studies demonstrated correction by longitudinal growth owing to asymmetrical growth in the epiphyseal plates after healing with deformity of fractures of the shafts

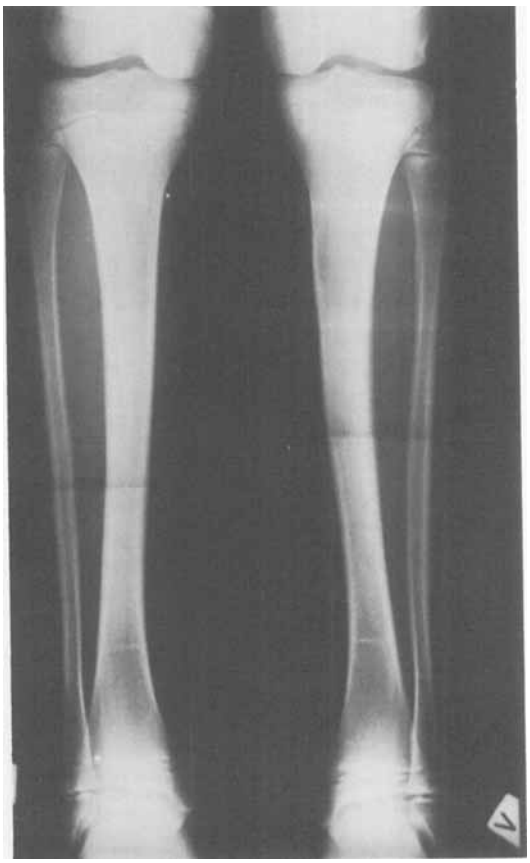

Figure 9. An X-ray taken 8 years after the accident, when the patient was 13 years of age. The previously injured leg, seen on the right, has a slight S-shape, with a more oblique central part of the shaft. Owing to the corrective growth, the valgus angulation has decreased from 14° to 6°. Clinically there was merely a hint of the valgus deformity. At follow-up the patient had no complaints (Case 3). (The solid transverse lines are explained by the X-ray having been taken with two films in each cassette).

of long bones. In the first three studies mentioned the correction was measured in relation to the shaft, while Friberg's latter study, like the present one, demonstrated a continuous correction of the mutual position of the epiphyseal plates. Thus, the mutual anatomical position of the epiphyseal plates appears to be the primary object of the corrective growth, and a reasonable estimate of the possibility of correction can be obtained only by evaluating the position of both epiphyseal plates, together with an estimate of future residual growth.

The present findings appear to support the assumption that fibrous interposition is a prerequisite for the valgus deformity increasing with growth.

Although the valgus deformity may be quite marked for a time, a satisfactory spontaneous correction seems to occur. It is concluded from the present study that there is no need for a routine operation to look for soft tissues that may have become trapped in the fracture gap.

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