Acta orthop. scand. *54*, 858–861, 1983

CORRECTION BY GROWTH OF ROTATIONAL DEFORMITY AFTER FEMORAL FRACTURE IN CHILDREN

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Fourteen children with femoral shaft fractures were studied for 10 years after fracture or until growth plate closure, using repeated anteversion measurements. A mean anteversion difference of 9.6 degrees between the fractured and intact sides after fracture consolidation decreased to 5.6 degrees ($p < 0.01$), indicating that children have a considerable ability to correct a rotational deformity by growth, especially during the first years after fracture. It was also found that tibial pin traction results in a greater rotational deformity than does bilateral Bryant traction.

Key words: children; femur; fracture; growth; radiography; rotational deformity

Accepted 7.vii.83

Femoral shaft fractures in children often heal with rotational deformity, as well as angular deformity and shortening (Verbeek et al. 1976). It is well-known that angular deformity and shortening to a great extent are spontaneously corrected during the remaining growth period (von Vontobel et al. 1961)

Less attention has been paid to the possible correction of rotational deformity, and published results are inconsistent (von Vontobel et al. 1961, Weber 1969, Verbeek et al. 1976, von Laer & Herzog 1978, Benum et al. 1979, Verbeek 1979, Brouwer 1981). Von Vontobel et al. (1961), Weber (1969) and Benum et al. (1979) stated that no correction occurs. Verbeek (1976) reported no spontaneous correction, but after further measurements he reported correction after severe deformities (Verbeek 1979). Von Laer & Herzog (1978) also stated that correction occurs after deformities exceeding 10 degrees.

The aim of this study was to investigate whether rotational correction occurs after femoral shaft fractures in children, and, if so, when. The study was made with the help of anteversion (= AV) angle measurements by radiography at different examinations.

MATERIAL AND METHODS

Fourteen children with femoral shaft fractures, treated at the Department of Orthopaedic Surgery, University Hospital of Lund, were prospectively followed during a period of 10 years after injury or until closure of the growth plates. The patients, eight boys and six girls, were between 1 year 9 months and 13 years 8 months at the time of injury (mean age 6 years 3 months).

Five patients younger than 5 years were treated with a bilateral Bryant traction. Nine patients older than 5 years were treated with a tibial pin traction in a horizontal frame.

After fracture consolidation (2–3 months after the fracture), AV-angle measurements on both the fractured and intact sides were performed (AV-registration 1). 1–4.5 years after fracture (mean 3.4 years) and 9–10 years after fracture the AV-angle measurement was repeated (= AV-registration 2 and 3).

The AV-angle measurements were made according to Norman (1979). The error of method has been estimated to ±3.5 degrees (Henriksson 1980). The AV-angle difference between left and right hip in children without a history of hip injury or hip disease has

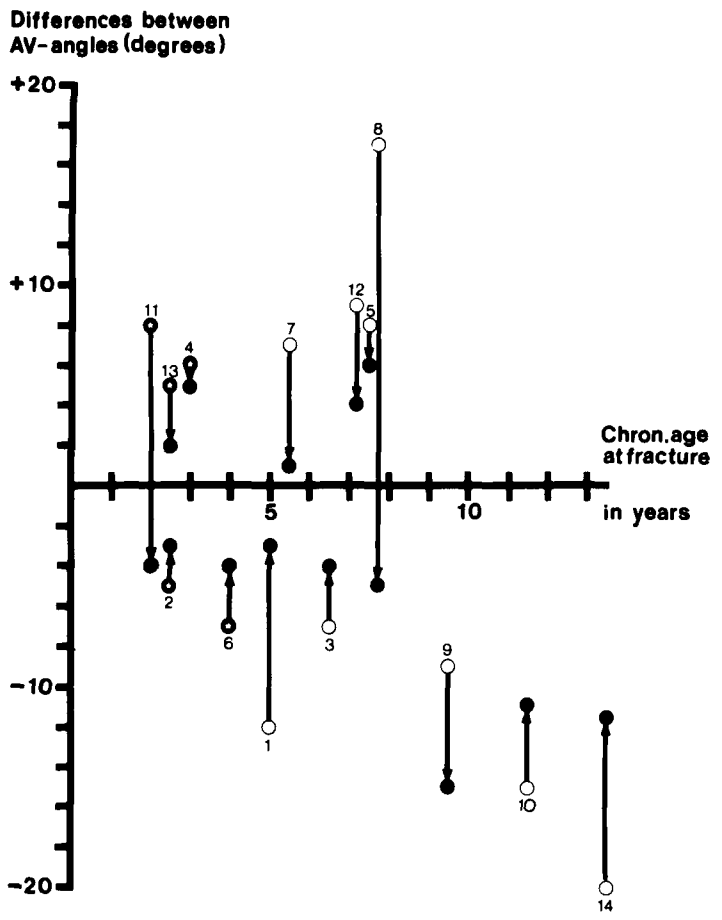

Figure 1. Results of radiographic determination of AV-angles in different cases at different times in relation to age at fracture. Numbers refer to individual cases.
○ = AV-registration 1, tibial pin traction.
◘ = AV-registration 1, bilateral Bryant traction.
● = AV-registration 3 (in case 14 2nd registration).

been estimated to 0.6 degrees with a s.d. of 5.7 degrees (Henriksson 1980).

RESULTS

AV-angle measurement after fracture consolidation demonstrated a difference (fractured femur compared with intact side) of between +17 degrees and −20 degrees. The AV-angle at the fractured side was increased in seven patients and decreased in seven patients. The rotational deformity was significantly smaller ($p < 0.01$) in children younger than 5 years of age treated with bilateral Bryant traction than in children older than 5 years of age treated with tibial pin traction in a horizontal frame.

Between the 1st and 2nd registrations, the sum of the AV-angle differences of 135 degrees in 14 children (mean 9.6 degrees) was reduced to 78.5 degrees (mean 5.6 degrees). This reduction is significant ($p < 0.01$). The individual changes are presented in Figures 1 and 2.

No change of the mean-angle difference occurred between the 2nd and 3rd examinations, but individual variations were seen. There was no difference in correction capacity related to age at fracture.

DISCUSSION

The results of this investigation, where repeated AV-angle measurements were made during the years following fracture, demonstrate that children have an ability to correct a rotational de-

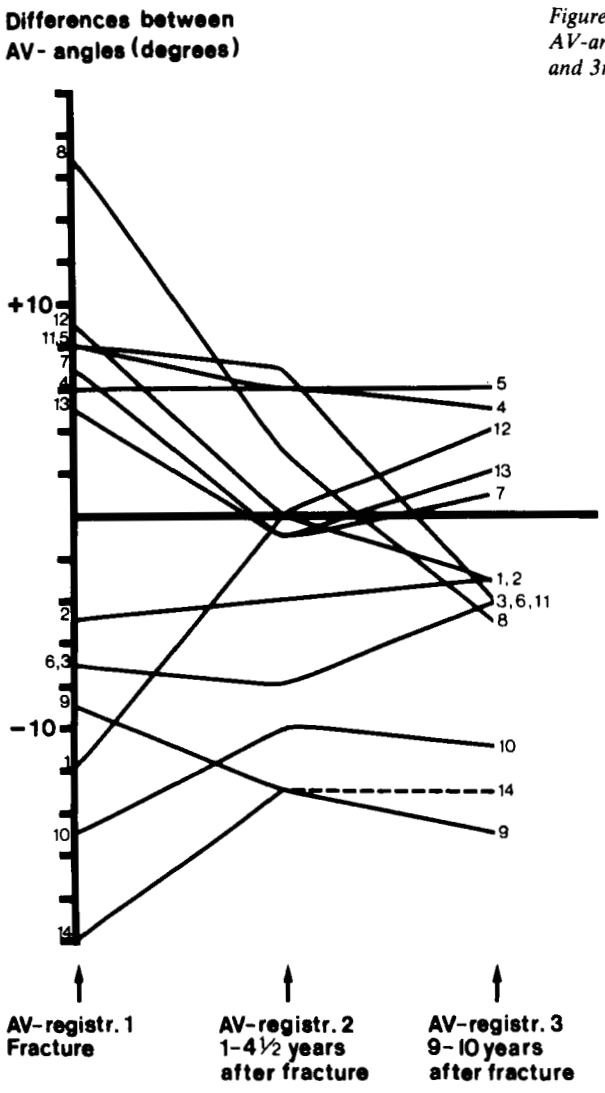

Figure 2. Results of radiographic determination of AV-angles in different cases at different times (1st, 2nd and 3rd registrations). Case numbers as in Figure 1.

formity after femoral shaft fracture. In both outward and inward rotational deformity there is a correction towards the same AV-angle as that on the intact side. The correction is numerically larger in patients with a great initial deformity. In patients with a deformity exceeding 7 degrees there was a mean correction of about 4.8 degrees and in patients with a deformity less than or equal to 7 degrees the mean correction was about 3.0 degrees.

It was not possible to reveal any difference in correction with age at fracture.

Children older than 5 years of age, treated with a tibial pin traction in a horizontal frame, had significantly greater rotational deformity at fracture consolidation than younger children treated in a bilateral Bryant traction. Benum et al. (1979) found that adhesive traction of only the fractured extremity resulted in a larger number of rotational deformities than tibial or femoral pin traction. Bilateral Bryant traction probably gives smaller deformities than adhesive traction of only the fractured extremity.

The significant correction occurred between

the 1st and 2nd investigations within 1–4.5 years after the fracture. It is probable that most of the correction occurs during the time closest to fracture. Even after 5 years individual variations were seen, but no change of the mean AV-angle difference occurred.

Verbeek et al. (1976) found no significant correction of rotational deformity. They performed AV-angle measurements at 2–3 year intervals 1–6 years after fracture, so no correction immediately after the fracture could be registered. Some of the patients were reexamined 6 years after the first study and Verbeek (1979) found a significant correction, which, he said, took several years. Benum et al. (1979) found no correction 5–13 years after fracture, but these authors point out that any possible correction before 5 years after fracture could not be registered.

The AV-angle measurement was made by using the short proximal femoral axis. Remodelling after angular deformity of the diaphysis may change this axis, but there is probably no significant change in the material.

In the treatment of femoral shaft fractures in children, severe rotational deformities should be avoided, but it appears from this investigation that deformities of 15–20 degrees are spontaneously corrected to a great extent some time after fracture. As the longitudinal growth of the femur mainly takes place from the distal growth plate, the correction of rotational deformity is probably also mainly located in this region.

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