OVERGROWTH OF THE FEMUR AFTER FRACTURE IN CHILDHOOD
AN INCREASED EFFECT IN BOYS

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Forty-four children, treated conservatively for fracture of the shaft of a femur, were studied radiographically to assess the consequent increase in longitudinal growth of the bone. Overgrowth averaged 8.1 mm and was shown to be significantly greater in boys than in girls. Overgrowth did not appear to be influenced by the age of the patient, the type of injury, the type or site of the fracture, the amount of overlap of the fragments or by the handedness of the patient.

It is well recognised that there is acceleration of the growth rate of the immature femur after a fracture (Truesdell 1921; Edvardsen and Syversen 1976). Most reports have been based on clinical measurement, which means that errors of 5 mm are possible in the measurement of limb length (Barford and Christensen 1958–9; Kohan and Cumming 1982). Radiographic measurement is accurate to within 1 mm but has been used in few papers (Meals 1979; Reynolds 1981), some of which have reported either small or incompletely analysed series (David 1924; Greville and Ivins 1957). All studies have assumed that the femora were of equal length before fracture.

We have made a radiographic study of 50 children after closed fracture of one femur with a view to analysing the results according to a number of factors, including the sex of the child and the type, site and overlap of the fracture.

PATIENTS AND METHODS

A consecutive series of 50 children aged from seven months to 12 years 3 months were treated conservatively for a single closed fracture of the femur under the direction of one orthopaedic surgeon. There were 44 children with a complete fracture of the shaft of the femur and six infants with a greenstick supracondylar femoral fracture. No attempt was made to reduce the fracture by manipulation, all were treated by traction through adhesive strapping applied to the skin. For babies under two years of age, Bryant's traction (1876, p 405) was used. Older children were in traction either on a Thomas' splint or by Hamilton Russell's method. Traction was released when the femur had united and the child was allowed up on crutches, not bearing weight on the injured limb until the fracture had consolidated.

Anteroposterior and lateral radiographs of the femur were taken regularly. The first set of radiographs to demonstrate bridging callus was selected for study and measured to determine the degree of overlap of the bone ends for each patient. This was recorded in millimetres. Scanograms of both femora (Tupman 1962) were obtained for all patients at an average of 3 years 2 months after the injury (range 18 months to 6 years 3 months). The excess length of the injured femur over that of the uninjured side was also recorded in millimetres. The overgrowth in the injured femur was then taken as the sum of the average overlap at the time union of the fracture was first seen, plus the excess length of the injured femur at review. It was assumed that femoral lengths were equal before the injury.

The age, sex and handedness of the patients, with details of the cause of fracture, were collected from the case notes, and the site and type of fracture were determined from the radiographs. Each of these factors was analysed in relation to the measured overgrowth.

RESULTS

It became clear that supracondylar fractures in infants
behaved differently from shaft fractures in their response to the factors which were being investigated. The six cases of supracondylar fracture formed a separate group which was too small for analysis and were therefore excluded from the series, leaving 44 fractures of the shaft of the femur. We found an average overgrowth of 8.1 mm after shaft fracture and 1.0 mm after greenstick supracondylar fracture. The main finding was that there is a significant difference in overgrowth between boys and girls, as shown in Table I.

Table I. Mean overgrowth after femoral fracture in boys and girls

<table>
<thead>
<tr>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Mean overgrowth (mm)</td>
</tr>
<tr>
<td>All cases</td>
<td>29</td>
</tr>
<tr>
<td>Grouped by size of overgrowth</td>
<td></td>
</tr>
<tr>
<td>&gt;10</td>
<td>11</td>
</tr>
<tr>
<td>&lt;10</td>
<td>18</td>
</tr>
</tbody>
</table>

Difference between boys and girls is significant, p < 0.025.

The girls showed significantly less overgrowth than the boys and, to avoid bias caused by sex distribution, analysis of other factors is reported separately for each sex. Detailed results are given in Table II, which also records the statistical significance of any differences.

In general, the subdivision into smaller groups meant that variation within them was too great to allow determination of significant differences between them. The table does, however, show some tendencies. In girls there was increased overgrowth in the non-dominant femur. In boys there seemed to be more overgrowth between the ages of four and seven years, and there was also a tendency for greater overlap at union to result in more overgrowth. Proximal fractures tended to produce more overgrowth in boys, but in girls distal fractures produced more.

No significant correlation was found in relation to the type of fracture (we did not include a separate group for comminuted fractures), or high or low energy causes of fracture.

**DISCUSSION**

Reynolds (1981) has shown that significant overgrowth is unlikely to occur more than two years after fracture; only four of our 44 shaft fractures were followed-up for less than this, and none for less than 18 months. The mean overgrowth of 8.1 mm in our study accords well with that quoted elsewhere (Meals 1979; Kohan and Cumming 1982).

Our study shows that the increased growth which occurs after the fracture of a femur in a child is significantly greater in boys than in girls. Although this has been observed previously in a small series (Barfod and Christensen 1958–9) it was then attributed to an unequal sex distribution of fracture types in the patients studied. In order to avoid this bias, our results have been presented separately for the two sexes and show that the difference in overgrowth cannot be accounted for on the basis of the abnormal sex distribution of any other factor.

The most important factor influencing the degree of overgrowth of a fractured femur is the sex of the patient. The growth plates in a child are sensitive to the hormonal environment, and it may be that before puberty there is greater activity in the growth plate of the normal female than in the normal male. It is tempting to postulate that hyperaemia results in growth stimulation which has a greater effect on the relatively dormant growth plate of the male child.

Our results in girls tend to support the hypotheses that overgrowth may be greater when the non-dominant limb is injured (Meals 1979; Kohan and Cumming 1982) and that in both sexes greater overlap leads to increased overgrowth (Kohan and Cumming 1982) but our figures are not statistically significant. We were unable to prove...
any association between overgrowth and age (Greville and Ivins 1957; Edvardsen and Syversen 1976; Kohan and Cumming 1982). Our results did not show any association between overgrowth and type of fracture (Barfod and Christensen 1958–9), site of fracture or type of accident.

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REFERENCES


