DEGENERATIVE CHANGES AT THE KNEE AND ANKLE RELATED TO MALUNION OF TIBIAL FRACTURES

15-YEAR FOLLOW-UP OF 88 PATIENTS

D. K. E. VAN DER SCHOOT, A. J. DEN OUTER, P. J. BODE, W. R. OBERMANN, A. B. VAN VUGT

From the University Hospital, Leiden, The Netherlands

We re-examined clinically and radiologically 88 patients with a fracture of the lower leg at a mean follow-up of 15 years. Forty-three fractures (49%) had healed with malalignment of at least 5°. More arthritis was found in the knee and ankle adjacent to the fracture than in the comparable joints of the uninjured leg. Malaligned fractures showed significantly more degenerative changes.

Eighteen patients (20%) had symptoms in the fractured leg. There was a significant correlation between symptoms in the knee and arthritis but not between symptoms and ankle arthritis or malalignment.

We conclude that fractures of the lower leg should be managed so that the possibility of angular deformity and thereby late arthritis is minimised.

The importance of residual angular deformity after tibial fractures is still uncertain. It has been suggested that a deformity of more than 5° in any direction could lead to late degenerative changes in the adjacent joints (Sarmiento and Latta 1981; Watson-Jones 1981). The uneven distribution of weight caused by such angulation led Rosemeyer and Pföringer (1979) to suggest the term 'prearthrotic deformity', but there is no firm clinical evidence to corroborate this hypothesis. Kristensen, Kjaer and Blicher (1989) found no increased osteoarthritis of the ankle 20 years after fractures of the tibial shaft which had healed with an angular deformity of over 10°.

We have re-examined 88 patients both clinically and radiologically 15 years after a tibial fracture with special attention to angular deformity, osteoarthritis of the knee or ankle and any residual complaints.

PATIENTS AND METHODS

During the period 1973 to 1975 203 patients were treated at our hospital for a fracture of the lower leg. We excluded those with a history of additional fractures and joint or ligament injuries of either leg before or at the same time as the index fracture. None of the patients included had any recorded evidence of joint injury in the same accident. We also excluded patients under 16 years of age or with open epiphyseal plates, and all patients with rheumatic or orthopaedic disease. This left 106 patients with an isolated fracture of one leg. No patient had died but four were lost to follow-up. Fourteen had sustained later injuries or fractures of one or both lower limbs during the period of follow-up and they were excluded to eliminate other factors which could influence the development of osteoarthritis and clinical symptoms apart from those of the initial tibial fracture and any malalignment.

A total of 88 patients was available for follow-up and all gave informed written consent to examination and radiography. There were 76 men and 12 women; their median age at the time of the accident was 24 years (16 to 53). The mechanism of injury was a traffic accident in 49% and sport in 36%. The AO classification of the fractures is shown in Table I. Eight were in the proximal, 54 in the middle, and 16 in the distal thirds of the tibial shaft. Ten fractures were spiral or segmental. There were 70 closed fractures and 12 grade-I and six grade-II open fractures.

Table I. AO classification of the 88 fractures of the tibial shaft followed for a mean of 15 years

<table>
<thead>
<tr>
<th>Fracture Type</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spiral A1</td>
<td>7</td>
</tr>
<tr>
<td>Oblique A2</td>
<td>18</td>
</tr>
<tr>
<td>Transverse A3</td>
<td>29</td>
</tr>
<tr>
<td>Butterfly fragment B1/2</td>
<td>27</td>
</tr>
<tr>
<td>Comminuted C1</td>
<td>7</td>
</tr>
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</table>
In 28 patients the fibula was not fractured. Seventy fractures were treated conservatively and 18 by operation. All the fractures had united within 26 weeks and there were no cases of deep infection.

The average follow-up was 15 years (13 to 17) and all 88 patients were interviewed and examined. Rotational deformity was measured clinically in a sitting position with the knee and the ankle flexed to 90°. Anteroposterior (AP) and lateral radiographs were taken of both knees, both ankles and of the whole of both legs. The leg radiographs were compared and measured to determine the angular deformity in each plane caused solely by the fracture. The maximum true angulation was calculated, using the method of Ries and O’Neill (1987), from the apparent angulation on the routine AP and lateral views. We classified both angular and rotational deformities into three groups: 0° to 4°, 5° to 9° and ≥10°.

The radiographs of only the knee and ankle of both legs were reviewed and compared for osteoarthritic change by one senior consultant in radiology without knowledge of the site or side of the original fracture. Osteoarthritis was classified as follows:

- **Grade I.** Slight narrowing of the joint space, and/or small osteophytes, and/or irregularity of the subchondral bone.
- **Grade II.** Moderate narrowing, osteophytes, irregularity of the subchondral bone with some sclerosis.
- **Grade III.** Severe narrowing, large osteophytes, subchondral sclerosis and cysts.

We used the chi-squared test for statistical analysis. When the fractured leg was compared with the opposite side we used the McNemar test for paired data. A p value of <0.05 was considered significant.

### RESULTS

Table II gives the deformities which had resulted from the fracture. Forty-three patients (49%) had a true angular

<table>
<thead>
<tr>
<th>Degrees</th>
<th>0 to 4</th>
<th>5 to 9</th>
<th>≥10</th>
</tr>
</thead>
<tbody>
<tr>
<td>True angular deformity</td>
<td>45</td>
<td>33</td>
<td>10</td>
</tr>
<tr>
<td>Rotational deformity</td>
<td>68</td>
<td>11</td>
<td>9</td>
</tr>
</tbody>
</table>

Healed tibial fracture in a 50-year-old man 14 years after a traffic accident (a,b). The fracture had been treated in plaster and shows recurvatum deformity of 14°. The patient had mild knee symptoms. Radiographs of the ankle of the fractured leg showing grade-II arthritis with sclerosis, anterior osteophytes and medial subchondral cysts (c,d). Radiographs of the knee of the fractured leg showing grade-I arthritis with narrowing of the medial compartment and minimal signs of patellofemoral osteoarthritis (e,f).
Ten of the 16 patients (63%) with fractures of the distal third of the tibial shaft had degenerative changes in the knee (3) or ankle (8) compared with 30 of the 62 patients (48%) with fractures of the proximal and middle part (p = 0.22, not significant).

Of the 43 patients in whom the fracture had healed with a true angular deformity of 5° or more, 25 (58%) had changes in the knee and/or ankle of that leg (Figs 1 and 2), but McNemar’s test showed no significant difference between the changes in the ankle (20 patients, 47%) and in the knee (11 patients, 26%). Of the 45 patients with fractures which had healed with an angular deformity of 0° to 4° only 14 (31%) had changes in the adjacent joints (p = 0.02).

Of the 20 patients with fractures which had healed with a rotational deformity of 5° or more, seven (35%) showed evidence of osteoarthritis in the adjacent knee or ankle. Of the 68 patients with fractures which had healed without a rotational deformity, 32 (47%) had arthritis (p = 0.90, not significant).

Eighteen patients (20%) had some symptoms from the fractured leg. Six complained of occasional tenderness at the old fracture site, and 12 had symptoms at the knee or ankle or both. We found a significant relationship between knee symptoms and osteoarthritis of this joint, but not between symptoms and ankle degeneration or malalignment (Tables IV and V). All the patients had been able to resume their normal working activities after treatment, but three (3%) reported that they had not been able to regain their previous level of performance at sport.

### Table III. The number of patients with osteoarthritis of the knee and/or ankle 15 years after fractures of the lower leg

<table>
<thead>
<tr>
<th>Grade of arthritis</th>
<th>Total</th>
<th>None</th>
<th>I to III</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fractured leg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knee</td>
<td>5</td>
<td>3/56</td>
<td>2/32</td>
<td>NS</td>
</tr>
<tr>
<td>Ankle</td>
<td>7</td>
<td>3/71</td>
<td>4/17</td>
<td>0.03</td>
</tr>
<tr>
<td>Non-fractured leg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knee</td>
<td>85</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ankle</td>
<td>83</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Number of patients*</td>
<td>48</td>
<td>27</td>
<td>11</td>
<td>2</td>
</tr>
</tbody>
</table>

* 14 patients had changes in both joints
DISCUSSION

Teitz, Carter and Frankel (1980) noted pain and radiological changes in the ipsilateral ankle after isolated tibial shaft fracture and suggested that this was due to altered strain patterns caused by tibiofibular length discrepancy. A biomechanical study by Debrunner (1967) showed increased compression in the medial compartment of the knee in legs which showed a varus deformity. When compensation by the lateral muscle groups failed, osteoarthritis developed in the medial compartment of the knee. Kettelkamp et al (1988) used a biomechanical analysis to show that varus or valgus deformity at the knee increased the force on either the medial or lateral tibial plateau, and a cadaver study by Tarr et al (1985) indicated that angular deformity of the distal third of the tibia produced significant changes in the contact area at the ankle.

Varus malalignment of the tibia is compensated for by pronation at the ankle (Olerud 1985) and a valgus deformity by increased supination. Malalignment into recurvatum can be compensated for by a flexed position of the knee and forward angulation by dorsiflexion of the ankle. The pronation and dorsal flexion capacity of the ankle is limited and varies between individuals. If the compensation of a tibial malalignment fails it is conceivable that a slight angulation of the tibia can cause changes in the contact pattern of the joint surface of the knee and ankle and thereby elicit symptoms.

Our series showed a surprisingly high incidence of degenerative changes in the knee and ankle of the fractured leg. Although we tried to exclude such patients from our analysis, it is possible that this was at least partly due to trauma sustained by the joints at the time of the accident. The other possibility is that the changes were due to malalignment, but we found no relation between malalignment and clinical symptoms.

Both excess and diminished pressure on a joint surface are destructive to cartilage and could lead to degenerative changes (Resnick and Niwayama 1988). A mathematical analysis by Puno et al (1987) showed that angular malunion of the tibia causes angular malalignment of the knee and ankle in a horizontal plane. They found that a larger percentage of the angular deformity was reflected inferiorly when the deformity was nearer the ankle. Our study did not show this increased effect on the ankle after more distal fractures.

We found a statistically significant relationship between tibial malalignment and degenerative changes in the knee and ankle. This tends to corroborate the theoretical and experimental studies discussed above although we were able to relate symptoms to osteoarthritic changes only at the knee. We consider that there is enough evidence to advise that fractures of the tibia should be managed so that angular deformity is minimised (Den Outer et al 1990). This may help to prevent late osteoarthritis leading to clinical complaints at the knee.

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


