BODY-WEIGHT RELATED TO LOSS OF REDUCTION OF FRACTURES OF THE DISTAL TIBIA AND ANKLE

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A series of 3061 patients with fracture of the distal tibia or ankle was studied for a possible link between overweight and failed reduction. The relative body-weight was recorded as the preoperative self-reported body mass index (BMI) of each patient. There were 109 patients (3.6%) with failure of internal fixation or of closed reduction severe enough to necessitate re fixation or corrective osteotomy.

The mean BMI in all age- and gender-specific groups studied was found to be significantly higher in patients with failed reduction than in those with an uneventful course (p < 0.01). The relative risk of loss of reduction for patients with a BMI greater than 1 so above the BMI of the corresponding age and gender group of the general population was 3.72 for distal tibial fractures and 3.04 for ankle fractures.

Overweight should be recognised as a significant factor in predicting a complicated course after a fracture of the lower leg. Awareness of the increased risk of loss of reduction in overweight patients is important in all phases of management.


Overweight is known to be associated with an increase in musculoskeletal problems (Kohatsu and Schurman 1990; Rissanen et al 1990; Vingård 1991; Böstman 1993), but there are few reports of the consequences of high relative body-weight in patients with skeletal injuries.

The management of fractures of the lower leg may be complicated by mechanical failure of internal fixation, or by redisplacement after closed reduction, both of which may result in loss of an acceptable position. Reoperation is expensive and the ultimate outcome may be worse. The recognition of any factors which influence the failure rate in common fractures is of importance.

The purpose of this study was to test the hypothesis that overweight patients with fractures of the distal tibia or displaced malleolar fractures have a higher incidence of loss of reduction.

PATIENTS AND METHODS

The study included 3061 adult patients with fractures of the distal tibia or ankle admitted to Helsinki University Central Hospital during the eight-year period from 1985 to 1992. Of these, 521 had fractures of the lower half of the tibial shaft or the distal metaphyseal region of the tibia; 408 were initially treated by closed reduction and 113, mainly with pilon fractures, had open reduction and internal fixation. There were 2540 patients with displaced malleolar fractures, all treated by open reduction and internal fixation. The departmental policy is to treat intra-articular fractures of the ankle by open reduction and internal fixation when there is displacement of 2 mm or more. Extra-articular fractures of the distal tibial shaft or metaphysis with a lateral displacement of not more than one half of the diaphyseal diameter were initially treated by closed reduction and plaster-cast immobilisation. Both open and closed reductions were usually performed within 24 hours of the injury. Standard AO/ASIF screws and plates (Müller et al 1979) were used for internal fixation.

The age, gender, type of fracture, body-weight and height, and maintenance of reduction were recorded for all 3061 patients. Body-weight and standing height were self-reported values before the first operation, primarily for purposes of anaesthesia. Mechanical failures of treatment were recorded when they were severe enough to necessitate a further open reduction and fixation at the ankle or a corrective osteotomy of the distal tibia for angular malunion. Failures of internal fixation caused by deep infection were excluded. Displaced fractures of the shaft of the distal tibia, initially treated by closed reduction but subsequently requiring repeated closed reduction or internal fixation for increased displacement or rotatory malposition, were also excluded unless corrective osteotomy became necessary later for frank malunion. These secondary measures were usually needed because of inherent instability of the fractures (Böstman 1986), and were regarded as part of routine treatment rather than as indications of failure.
The body mass index (BMI; weight in kg divided by height in (m²)) recorded the relative body-weight (Keys et al 1972). Since age and gender have a significant influence on relative body-weight, age- and gender-specific mean BMI values were calculated for use in the comparison between patients with uneventful recovery and those with failed reduction. Baseline anthropometric data for the general population in the same area (Heliövaara and Aromaa 1980) were used to estimate the relative ratio of obese persons among the patients. The limit for obesity was set at the age- and gender-specific mean BMI + 1 σ of the general population. By definition, 83% of each age and gender group weighed less than this (Dawson-Saunders and Trapp 1990).

The mean BMI + 1 σ of the general population in women varied from 22.7 + 3.2 kg/m² at 20 to 29 years of age to 28.2 + 4.8 kg/m² at 60 to 69 years. In men this was 23.9 + 2.9 kg/m² at 20 to 29 years, reaching 26.0 + 3.5 kg/m² at 50 to 59 years.

To compare the severity of fractures in the obese with that in the non-obese patients, the malleolar fractures were grouped as uni-, bi- and trimalleolar according to the number of fragments which required reduction and fixation. Whenever syndesmotic transfixation was necessary for total disruption, the fracture was classified as severe irrespective of the number of fragments. No attempt was made to grade the severity of the distal tibial or the pilon fractures.

Continuous data were analysed by Student’s t-test and categorical data by the chi-squared test.

Table 1. Obesity and failed reduction in 3061 patients with fracture of the distal tibia or ankle

<table>
<thead>
<tr>
<th>Fracture site</th>
<th>Obese</th>
<th>Non-obese</th>
<th>Relative risk of the obese (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total number</td>
<td>With failed reduction</td>
<td>Percentage</td>
</tr>
<tr>
<td>Distal tibia</td>
<td>152</td>
<td>23</td>
<td>15.1</td>
</tr>
<tr>
<td>Ankle</td>
<td>642</td>
<td>36</td>
<td>5.6</td>
</tr>
</tbody>
</table>

* BMI: body mass index (BMI) greater than mean BMI + 1 σ for the matching age and gender group of the general population.

RESULTS

A total of 109 operations (3.6%) were required because of loss of reduction as defined above (Table 1): 77 were open re reductions with refixation within six weeks of the initial treatment, and 32 were corrective osteotomies performed later for angular malunion. Twenty-four of these 32 patients had fractures of the distal shaft or metaphysis of the tibia, initially managed by closed reduction and plaster, and 22 had varus malunion. The most common type of failure of internal fixation, seen in 51 patients, was loosening of the screws and plate placed to fix a displaced fracture of the lateral malleolus.

The mean age of the patients with uneventful recovery was 42.6 years and that of the patients with failed reduction 45.1 years; this difference is not statistically significant. There was, however, a significant difference in the relative body-weights of these two groups of patients. The mean BMI was significantly (p < 0.01) higher in all age- and gender-specific subgroups of patients with loss of reduction (Fig. 1). The contrast was greatest in women aged from 35 to 50 years, the mean BMI values being 28.9 kg/m² (SEM 0.4) for failed reduction and 26.8 kg/m² (SEM 0.2) for uneventful recovery. Obese patients, as defined above in relation to the general population, were significantly over-represented among the patients with failed reduction (p < 0.001, Table 1). The estimated relative risk of failed reduction for obese patients was of the magnitude of 3 to 4, and more than one half of the failures was in the obese.
cohort, both for distal tibial and ankle fractures (Table I).
The highest failure rate among the obese patients was after
fractures of the distal tibia, at 23 of 152 (15.1%).

There was a relatively small statistical difference
between the obese and the non-obese patients for the initial
severity of the malleolar fractures (Table II; p = 0.05).

DISCUSSION
This study has shown an indisputable association between
increased relative body-weight and loss of reduction of
fractures of the distal lower leg. The association was
strong, and a true causal effect seems plausible, since the
over-representation of overweight patients among the fail-
ures was not merely due to the occurrence of more severe
fracture types in the obese.

In clinical practice, the exact cause of loss of of reduc-
tion in an individual patient can rarely be determined with
certainty. The mechanisms by which overweight exerts its
effect probably include a whole spectrum, ranging from
sporadic accidental moments of early full weight-bearing to
a systematic non-compliance with the prescribed weight-
bearing instructions. The impaired control of posture and
the physical clumsiness of the overweight patient moving
around on crutches are probably to blame. Even if the
weight-bearing status of, for example, an average-weight
patient with a unimalleolar fracture does not account for
possible failure of internal fixation, this may not be valid
for the overweight. It may be impossible for patients with
marked overweight to achieve partial weight-bearing.

The author was unable to find any previous investigation
of this aspect of fracture outcome. An analogous increase in
complication rate for fractures of the lower leg has been
reported in alcoholics and mentally disturbed patients
(Karlström and Olerud 1974; Caregge, Csongradi and
Bleck 1991). The possible role of alcoholism as a con-
 founding factor in the present study, is unlikely, since no
clear association has been found between alcohol intake
and adiposity (Hellerstedt, Jeffery and Murray 1990).

This study focused on failures severe enough to require
re fixation or corrective osteotomy. No exact general criteria
for the need for secondary operations could be established,
but the reoperation rate for the 2540 patients with ankle
fractures is close to the rate reported for early complica-
tions in two other, large clinical series (Lindsjö 1985; Broos
and Bisschop 1991). One possible criticism of the present
study is that body-weight and height were self-reported, but
this applied to all patients, the obese as well as the non-
obese. It seems that these possible inaccuracies are unlikely
to have caused the strong association.

Stigmatisation of the overweight and obese patients
should, of course, be avoided, but the findings have some
clinical implications. Obesity can be identified and recog-
nised as an important predictor of failure of reduction on
admission. Awareness of the increased risk of failure in
overweight patients can help the management, and this

| Table II. Severity distribution of 2540 displaced malleolar fractures in
<table>
<thead>
<tr>
<th>Obese</th>
<th>Non-obese</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
</tr>
<tr>
<td>Unimalleolar</td>
<td>271</td>
</tr>
<tr>
<td>Bimalleolar</td>
<td>205</td>
</tr>
<tr>
<td>Trimalleolar</td>
<td>166</td>
</tr>
<tr>
<td>Total</td>
<td>642</td>
</tr>
</tbody>
</table>

* including all fractures with total syndesmotic disruption

could possibly be decreased by using stronger internal
fixation techniques and prolonged periods of non-weight-
bearing for overweight patients. This may, to some extent,
limit the goals of rehabilitation, but the avoidance of
malunion and reoperation probably outweighs the disad-
vantages. An interesting incidental finding was that the
percentage of obese persons in the 3061 fracture cases
suggested that the obese also had an increased suscepti-
bility to fractures of the distal leg in general, but this will
require further study.

This study was supported by a grant from the Paule Foundation.
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.

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