LOCKED NAILING FOR NONUNION OF THE TIBIA

J. W. ROSSON, R. B. SIMONIS

From St Peter's Hospital, Chertsey

We treated 24 patients with nonunion of tibial shaft fractures by locked intramedullary nailing, 18 by open and six by closed techniques. Union was achieved in 22 patients, failing only in two patients with active infection. Locked nailing prevented recurrence of deformity and allowed the patients to mobilise without external support. Supplementary bone grafting was essential only for major defects.

Failure of union of a fracture of the tibial shaft may be influenced by the nature of the fracture, the severity of associated soft-tissue injury, concurrent systemic disease and the method of treatment. With appropriate primary treatment the incidence of nonunion should become minimal, but the problem is still relatively common. A number of methods of stimulating union after early failure have been described. These include fibular osteotomy followed by weight-bearing in a cast, autogenous bone grafting with or without additional stabilisation, internal or external fixation with compression, open or closed intramedullary nailing and even electromagnetic stimulation (Jones and Barnett 1955; Olerud and Karsström 1972; Christensen 1973; Freeland and Mutz 1976; Bassett, Mitchell and Gaston 1981; DeLee, Heckman and Lewis 1981; Clancey, Winquist and Hansen 1982).

We report the use, since 1987, at a secondary referral centre, of the Grosse Kempf interlocking nail for a consecutive series of 24 such patients.

PATIENTS AND METHODS

The details of the 24 patients are given in Table I. Fourteen had originally had closed fractures. All cases had been referred from other hospitals, often many months after injury, and it proved impossible to grade the ten open fractures. The mean interval between fracture and secondary surgery was 20 months (10 to 54).

Six patients had been treated by closed methods alone, including os calcis traction and plaster. The other 18 patients had had a total of 28 previous operations. External fixators had been used in ten of these, plates in

J. W. Rosson, MS, FRCS, Senior Orthopaedic Registrar
R. B. Simonis, FRCS, Consultant Orthopaedic Surgeon
Rowley Bristow Orthopaedic Unit, St Peter's Hospital, Chertsey, Surrey KT16 OPZ, England.

Correspondence should be sent to Mr R. B. Simonis.

© 1992 British Editorial Society of Bone and Joint Surgery
0301-620X/92/3348 $2.00

THE JOURNAL OF BONE AND JOINT SURGERY

358
Table I. Details of 24 patients treated for nonunion of tibial shaft fractures

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (yr)</th>
<th>Fracture level</th>
<th>Number of previous operations</th>
<th>Months from original injury</th>
<th>Type of nonunion</th>
<th>Time to union (mth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36</td>
<td>Middle*</td>
<td>2</td>
<td>39</td>
<td>Atrophic</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>27</td>
<td>Distal*</td>
<td>1</td>
<td>13</td>
<td>Atrophic*</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>62</td>
<td>Middle*</td>
<td>1</td>
<td>11</td>
<td>Atrophic</td>
<td>Failed</td>
</tr>
<tr>
<td>4</td>
<td>26</td>
<td>Middle</td>
<td>2</td>
<td>24</td>
<td>Hypertrophic</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>36</td>
<td>Proximal</td>
<td>1</td>
<td>24</td>
<td>Hypertrophic</td>
<td>Failed</td>
</tr>
<tr>
<td>6</td>
<td>39</td>
<td>Distal*</td>
<td>0</td>
<td>10</td>
<td>Hypertrophic</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>23</td>
<td>Distal*</td>
<td>2</td>
<td>20</td>
<td>Hypertrophic*</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>23</td>
<td>Middle*</td>
<td>1</td>
<td>13</td>
<td>Hypertrophic</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>35</td>
<td>Distal*</td>
<td>0</td>
<td>35</td>
<td>Hypertrophic*</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>28</td>
<td>Middle</td>
<td>1</td>
<td>10</td>
<td>Hypertrophic</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td>36</td>
<td>Segmental*</td>
<td>1</td>
<td>15</td>
<td>Hypertrophic</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>77</td>
<td>Middle*</td>
<td>0</td>
<td>16</td>
<td>Atrophic</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>22</td>
<td>Distal*</td>
<td>2</td>
<td>20</td>
<td>Atrophic</td>
<td>9</td>
</tr>
<tr>
<td>14</td>
<td>33</td>
<td>Distal*</td>
<td>2</td>
<td>54</td>
<td>Atrophic</td>
<td>12</td>
</tr>
<tr>
<td>15</td>
<td>30</td>
<td>Distal*</td>
<td>0</td>
<td>11</td>
<td>Hypertrophic*</td>
<td>4</td>
</tr>
<tr>
<td>16</td>
<td>52</td>
<td>Distal</td>
<td>1</td>
<td>12</td>
<td>Atrophic</td>
<td>12</td>
</tr>
<tr>
<td>17</td>
<td>24</td>
<td>Distal</td>
<td>2</td>
<td>19</td>
<td>Hypertrophic</td>
<td>12</td>
</tr>
<tr>
<td>18</td>
<td>21</td>
<td>Distal</td>
<td>2</td>
<td>41</td>
<td>Hypertrophic*</td>
<td>3</td>
</tr>
<tr>
<td>19</td>
<td>22</td>
<td>Distal</td>
<td>3</td>
<td>31</td>
<td>Hypertrophic</td>
<td>8</td>
</tr>
<tr>
<td>20</td>
<td>22</td>
<td>Distal</td>
<td>1</td>
<td>36</td>
<td>Atrophic</td>
<td>13</td>
</tr>
<tr>
<td>21</td>
<td>21</td>
<td>Distal*</td>
<td>0</td>
<td>14</td>
<td>Hypertrophic</td>
<td>3</td>
</tr>
<tr>
<td>22</td>
<td>23</td>
<td>Distal</td>
<td>0</td>
<td>12</td>
<td>Atrophic</td>
<td>8</td>
</tr>
<tr>
<td>23</td>
<td>26</td>
<td>Middle</td>
<td>2</td>
<td>21</td>
<td>Atrophic</td>
<td>14</td>
</tr>
<tr>
<td>24</td>
<td>23</td>
<td>Proximal*</td>
<td>1</td>
<td>12</td>
<td>Atrophic*</td>
<td>15</td>
</tr>
</tbody>
</table>

*closed fracture, closed nailing

Case 13. Figure 1 – Nonunion after plate fixation. Figure 2 – Ten months after open nailing.
patients, full weight-bearing was allowed with no external protection of the limb.

RESULTS

Angular and rotational deformities were corrected in all patients but pre-existing shortening was unchanged. Union was obtained in 22 of the 24 patients (Table I). The mean interval between surgery and radiographic union was nine months (2 to 15, Figs 1 and 2), evidence of bone bridging the defect on four views of the tibia being required as proof of union. Clinical union with pain-free weight-bearing always preceded this radiographic confirmation, as reported by Olerud and Karlström (1972).

In three patients, the preservation of length after removal of avascular bone resulted in a substantial defect at the fracture site; all these cases needed autogenous bone grafting before union was achieved (Figs 3 and 4).

In two patients there was overt sepsis at the time of surgery, and in both cases there was failure of union. One elderly man was taking azathioprine and prednisolone for a dermatological condition; his wound continued to drain, and at six weeks a decision was made to amputate. The second was a younger man seen 24 months after an open fracture. After three months of continued infection the nail was removed and a circular fixator was applied. Eventually this tibia united.

Four other patients, all with records of previous infection, developed superficial infection after nailing, all of which resolved with bedrest and antibiotics. Loss of position of the fracture was seen in only one case, in which failure to lock statically resulted in increased shortening. Despite this error union occurred and the patient’s mobility was improved.

DISCUSSION

The value of intramedullary stabilisation of ununited fractures of the tibial shaft has been reported (Clancey et al 1982), and the use of an open technique has been recommended by Johnson and Marder (1987), as permitting correction of deformity and allowing the inclusion of bone grafts. We prefer closed nailing when this is
surgically possible. The advantage is that less trauma to
the soft tissues leads to quicker recovery; only one of our
six patients treated by closed methods had union delayed
beyond six months. Of the 18 patients in whom correction
of deformity could be achieved only by open surgery, 16
progressed to union. Our results, therefore, support the
use of an open technique when necessary.

In contrast to previous reports, we used locked nails
in all our patients; we believe that this has important
advantages. Short fracture fragments, both proximally
and distally, can be stabilised by the screws and therefore
more patients are suitable for intramedullary fixation.
The additional stability also prevents both rotation and
further shortening, so that additional external support is
not necessary. The open excision of enough fibrous tissue
to allow correction of deformity, together with a fibular
osteotomy, must destabilise the fracture; a locked nail
can control this instability.

The position of the fracture deteriorated in only one
patient because of failure to recognise that static locking
was needed. Such locking is often necessary in the first
instance, but we feel that subsequent dynamisation is
desirable to increase the load through the fracture, except
in patients with major defects requiring supplementary
bone grafts.

In contrast to Johnson and Marden (1987), our initial
bone grafting used only the products of intramedullary
reaming. Three of our patients did require subsequent
bone grafting, but all three had large defects (Fig. 3), and
the use of a statically locked nail allowed us to maintain
length. When there is a substantial defect, we now add
supplementary autogenous bone at the time of the initial
procedure.

Conclusions. Our experience of these 24 patients shows
that the technique should not be used in the presence of
sepsis. It confirms that intramedullary stabilisation is an
excellent method of achieving union in the absence of
sepsis. Locked nails prevent shortening and recurrence
of deformity, and obviate the need for external support,
allowing rapid rehabilitation.

Our current methods are:
1) routine fibular osteotomy;
2) closed nailing if technically possible;
3) for open nailing, exposure of the bone using Judet-
type decortication;
4) correction of malalignment with minimal resection of
bone;
5) use of the maximum possible diameter of nail;
6) use of static locking, initially with dynamisation at two
to three months; and
7) additional use of bone grafts only for major defects.

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

Bassett CAL, Mitchell SN, Gaston SB. Treatment of ununited tibial
diaphyseal fractures with pulsing electromagnetic fields. J Bone

Christensen NO. Küntscher intramedullary reaming and nail fixation
for non-union of fracture of the femur and the tibia. J Bone Joint

Clancy GJ, Winquist RA, Hansen ST. Non-union of the tibia treated
with Küntscher intramedullary nailing. Clin Orthop 1982; 167:
191-6.

DeLee JC, Heckman JD, Lewis AG. Partial fibulectomy for ununited

Freeland AE, Matz SB. Posterior bone-grafting for infected ununited

Johnson EE, Marden RA. Open intramedullary nailing and bone-
grafting for non-union of tibial diaphyseal fracture. J Bone Joint

Jones KG, Barnett HC. Cancellous-bone grafting for non-union of the
tibia through the posterolateral approach. J Bone Joint Surg [Am]

Olerud S, Karlström G. Secondary intramedullary nailing of tibial