POSTERIOR INTERNAL COMPRESSION ARTHRODESIS OF THE ANKLE

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We have reviewed the results of 19 ankle arthrodeses in 18 patients by a new technique of posterior internal compression. Sixteen of the ankles fused at a mean time of 14 weeks and the other three after re-operation. Complications included one case each of infection, Sudeck’s atrophy and non-fatal pulmonary embolism.

Clinical assessment using Mazur’s ankle score showed excellent or good results in nine ankles and three painfree ankles in patients who were wheelchair-bound for other reasons. The mean position of fusion was in 1.7° equinus and 0.8° varus, and the mean range of midtarsal movements was 15.8°. Twelve patients showed radiographic signs of talonavicular or subtalar osteoarthritis.

Arthrodesis of the ankle, first described by Albert (1879), has given good results in the treatment of various types of arthritis, but many complications have been associated with the operation, including nonunion, infection and malposition of the foot (Charnley 1951; Ratliff 1959; Thomas 1969; Lance et al 1979; Morrey and Wiedeman 1980; Ahlberg and Henricson 1981; Ross and Matta 1985; Scranton 1985; Baciu 1985; Campbell 1990; Helm 1990). The many techniques of ankle arthrodesis differ in surgical approach, preparation of the articular surface, type of fixation and postoperative management (White 1974; Marcus, Balourdas and Heiple 1983). Those which use stable internal fixation with supplementary bone grafting have given a high incidence of union and fewer complications (Marcus et al 1983; Morgan et al 1985; Ross and Matta 1985; Scranton 1985; Dennis et al 1990).

At the University Hospital, Nottingham, one of the authors (CLC) has developed a technique of ankle arthrodesis which uses internal fixation by screws, modifying the method described by White (1974). We report a retrospective study of the results of this technique.

PATIENTS AND METHODS

From 1979 to 1990, 19 ankles in 18 patients were arthrodesed using a posterior approach and internal fixation with compression, all the operations being performed by one of the two senior authors (CLC, CJH). Seven of the patients were women and 11 were men, and their mean age at operation was 47.5 years (15 to 74). Ten operations were on the right ankle and nine on the left. The diagnosis was post-traumatic osteoarthritis in 12 ankles, primary osteoarthritis in four, gouty arthritis in one, rheumatoid arthritis in one and drop foot deformity in one.

Surgical technique. The patient is placed in a prone position with a support under the tibia to allow free movement of the foot. A straight midline posterior

Fig. 1

Diagrams to show the technique of posterior internal compression arthrodesis of the ankle.

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incision about 15 cm long is made, and a Z-plasty division of the calcaneal tendon is performed, to provide exposure of the distal tibia and the tibiotalar joint. A deep slot is then cut into this joint and packed with cancellous bone chips taken from the posterior iliac crest.

Great care is taken to orientate the ankle to the correct position in both anteroposterior and mediolateral planes. Rigid internal fixation is obtained by using two cancellous AO screws with washers. These screws pass from the posterior surface of the distal tibia in an oblique direction across the tibiotalar joint and down into the neck of the talus (Fig. 1). Care is taken not to enter the talonavicular joint. The calcaneal tendon is repaired, the wound is closed in layers and the ankle splinted in a non-weight-bearing below-knee cast for three months.

Clinical assessment. Seventeen of the 18 patients were reviewed by the junior authors (LS, JH) after an average follow-up of 70 months (7 to 138). The other patient had died 84 months after his operation; his notes and radiographs were reviewed.

We used the 100-point grading system of Mazur, Schwartz and Simon (1979) to evaluate the clinical results. In this system ten points are given for full ankle movement; the maximum score after ankle arthrodesis is therefore 90 points. We recorded a score of 80 to 90 points as an excellent result, 70 to 79 points as good, 60
to 69 points as fair and fewer than 60 points as poor (Stewart, Beeler and McConnell 1983; Dennis et al. 1990). One patient (case 5) was blind and had poor balance, and another (case 15) had severe rheumatoid arthritis. As both were wheelchair-bound, the scoring system could not be used.

**Radiographic assessment.** Fifteen patients had a full set of radiographs of the operated ankle at follow-up. Four ankles, in three patients, were not radiographed: one patient was pregnant, one had died, and one was unfit to attend and was examined at home. A standing lateral view was used to measure the sagittal position of the fusion, and a posterior axial view for the coronal position. Both these angles were compared with a normal value from the non-operated side. Two lateral stress radiographs, one in maximum dorsiflexion and one in maximum plantar flexion, were used to measure the range of midtarsal movement as the change in angle between the first metatarsal and the neck of the talus. For cases 6 and 15, who were unable to stand, the position of the arthrodesis was related to the ‘normal’ angle between tibia and talus (118°), and between tibia and os calcis (0°).

We also evaluated degenerative changes in the midtarsal and subtalar joints, using the classification of Mazur et al. (1979) to grade them as mild, moderate or severe.

**RESULTS**

Details of the patients and the results are presented in Table I. Primary fusion was achieved in 16 of the 19 operated ankles in an average of 14 weeks (Fig. 2). Three ankles required re-operation: two for nonunion after six months and 11 months, and one because of a screw fracture after three months.

Table I. Details of 18 patients who had posterior internal compression arthrodesis of the ankle

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (yr) and sex</th>
<th>Diagnosis*</th>
<th>Follow-up (mth)</th>
<th>Time to fusion (mth)</th>
<th>Position of arthrodesis</th>
<th>Degenerative changes</th>
<th>Mazur ankle score</th>
<th>Complications/comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20 F</td>
<td>Trauma</td>
<td>70</td>
<td>18</td>
<td></td>
<td></td>
<td>69</td>
<td>Re-operation for nonunion after 11 months</td>
</tr>
<tr>
<td>2</td>
<td>42 M</td>
<td>Trauma</td>
<td>27</td>
<td>3.5</td>
<td>9° Ca 6° varus 9°</td>
<td>Mild/Nil</td>
<td>32</td>
<td>Sudeck's atrophy Pain from iliac crest graft site</td>
</tr>
<tr>
<td>3</td>
<td>15 M</td>
<td>Trauma</td>
<td>64</td>
<td>3</td>
<td>0° 0° 12°</td>
<td>Nil/Nil</td>
<td>84</td>
<td>Nil</td>
</tr>
<tr>
<td>4</td>
<td>25 M</td>
<td>Trauma</td>
<td>7</td>
<td>3</td>
<td>8° Eq 7° varus 18°</td>
<td>Nil/Nil</td>
<td>71</td>
<td>Nil</td>
</tr>
<tr>
<td>5</td>
<td>74 M</td>
<td>OA</td>
<td>24</td>
<td>3.5</td>
<td>16° Ca 10° valgus 10°</td>
<td>Nil/Nil</td>
<td>84</td>
<td>Blind, poor balance Wheelchair-bound</td>
</tr>
<tr>
<td>6</td>
<td>74 M</td>
<td>OA</td>
<td>84 (died)</td>
<td>4</td>
<td>5° Ca 0°</td>
<td>Severe/Severe</td>
<td>57</td>
<td>Removal of screws after 11 months</td>
</tr>
<tr>
<td>7</td>
<td>40 F</td>
<td>Trauma</td>
<td>111</td>
<td>3.5</td>
<td>14° Eq 0° 19°</td>
<td>Mild/Moderate</td>
<td>69</td>
<td>Nil</td>
</tr>
<tr>
<td>8</td>
<td>51 M</td>
<td>Gout/OA</td>
<td>38</td>
<td>4</td>
<td>10° Eq 7° valgus 24°</td>
<td>Mild/Moderate</td>
<td>71</td>
<td>Nil</td>
</tr>
<tr>
<td>9</td>
<td>68 F</td>
<td>Trauma</td>
<td>6</td>
<td>3</td>
<td>0° 1° valgus 7°</td>
<td>Mild/Mild</td>
<td>78</td>
<td>Nil</td>
</tr>
<tr>
<td>10</td>
<td>66 F</td>
<td>OA</td>
<td>25</td>
<td>2</td>
<td>5° Ca 2° varus 27°</td>
<td>Severe/Mild</td>
<td>84</td>
<td>Nil</td>
</tr>
<tr>
<td>11</td>
<td>64 M</td>
<td>Trauma</td>
<td>41</td>
<td>6</td>
<td>1° Eq 0° 14°</td>
<td>Nil/Nil</td>
<td>79</td>
<td>Pulmonary embolism</td>
</tr>
<tr>
<td>12</td>
<td>31 M</td>
<td>Trauma</td>
<td>113</td>
<td>2</td>
<td>5° Eq 3° varus 17°</td>
<td>Mild/Mild</td>
<td>57</td>
<td>Removal of screws after 18 months</td>
</tr>
<tr>
<td>13</td>
<td>49 M</td>
<td>Trauma</td>
<td>110</td>
<td>3</td>
<td>8° Eq 10° varus 18°</td>
<td>Mild/Severe</td>
<td>90</td>
<td>Nil</td>
</tr>
<tr>
<td>14</td>
<td>39 M</td>
<td>Trauma</td>
<td>113</td>
<td>3.5</td>
<td>6° Eq 0° 4°</td>
<td>Mild/Nil</td>
<td>83</td>
<td>Nil</td>
</tr>
<tr>
<td>15</td>
<td>61 F L RA R RA</td>
<td>OA</td>
<td>120</td>
<td>3</td>
<td>11° Eq 2° varus –</td>
<td>–/–</td>
<td>–</td>
<td>Severe rheumatoid arthritis Wheelchair-bound</td>
</tr>
<tr>
<td>16</td>
<td>37 F</td>
<td>Trauma</td>
<td>138</td>
<td>3</td>
<td>4° Ca 0° 26°</td>
<td>Nil/Nil</td>
<td>81</td>
<td>Nil</td>
</tr>
<tr>
<td>17</td>
<td>32 F</td>
<td>Foot drop</td>
<td>125</td>
<td>8</td>
<td>1° Eq 0° 12°</td>
<td>Mild/Nil</td>
<td>34</td>
<td>Re-operation for nonunion after six months</td>
</tr>
<tr>
<td>18</td>
<td>67 M</td>
<td>Trauma</td>
<td>28</td>
<td>6</td>
<td>1° Eq 7° varus 20°</td>
<td>Mild/Mild</td>
<td>66</td>
<td>Re-operation for screw fracture after 3 months</td>
</tr>
</tbody>
</table>

*OA, osteoarthritis; RA, rheumatoid arthritis
†Ca, calcaneus; Eq, equinus
The position of fusion in the sagittal plane ranged from 14° equinus to 16° calcaneus, averaging 1.7° equinus compared with the contralateral non-operated ankle in a standing position. In the coronal plane the range was from 10° valgus to 10° varus, averaging 0.8° varus.

Midtarsal movement ranged from 4° to 27°, averaging 15.8°. Talonavicular osteoarthritis was found in nine of the 15 patients: it was mild in seven, moderate in none, and severe in two. There was subtalar osteoarthritis in seven patients: mild in three, moderate in two, and severe in two.

The Mazur ankle score ranged from 32 to 90 points with an average of 70. Five results were rated as excellent, four as good, three as fair and three as poor. The two wheelchair-bound patients (cases 5 and 15) had no pain in their operated ankles.

Complications. There were complications after six of the 19 operations (32%), including delayed union in two ankles and fracture of a screw in one. In these three cases re-operation was successful, in two using the same fixation method and in one by external fixation and compression. In one of these patients (case 17) the re-operation was further complicated by skin necrosis and infection.

One patient, with severe pain in the ankle before fusion for post-traumatic osteoarthritis, developed Sudeck's atrophy, and also had pain from the site of the iliac crest graft. One patient had a deep-vein thrombosis and non-fatal pulmonary embolism postoperatively. Two patients had screws removed 11 and 18 months postoperatively; in one of these cases a screw had been directed too dorsally and had perforated the anterior cortex of the talus.

DISCUSSION

The aim of ankle arthrodesis is solid fusion in the correct position. It has been shown that compression and the use of bone grafts can both hasten solid fusion and increase the success rate (Charnley 1951; Johnson and Boseker 1968; White 1974; Müller et al 1979). Methods of arthrodesis which shorten the leg by excision of articular surfaces without narrowing the intermalleolar distance may result in problems with fitting shoes (Ahleberg and Henricson 1981; Marcus et al 1983; Stewart et al 1983; Scranton 1985).

The method that we describe in this article uses both bone grafting and compression. The anterior parts of the talar dome and the tibial plafond are left untouched, and there is therefore no additional loss of height. Using internal fixation of only the tibiotalar joint avoids one of the disadvantages of external compression devices: the risk of pin-track infection. It also avoids the bad effect of compression on the subtalar joints where these are included in the fixation (Morrey and Wiedeman 1980).

The incidence of failure of fusion has been reported to vary from 0% to 23% (Charnley 1951; Ratliff 1959; Thomas 1969; Morrey and Wiedeman 1980; Ahleberg and Henricson 1981; Boobbyer 1981; Marcus et al 1983; Stewart et al 1983; Morgan et al 1985; Ross and Matta 1985; Scranton 1985; Campbell 1990; Dennis et al 1990; Helm 1990). Our primary fusion rate was 84%, and re-operation was successful in all three failures.

White (1974) stressed the advantages of the posterior approach in obtaining the correct position for ankle arthrodesis. The optimal position in the sagittal plane is in 5° to 10° equinus when compared with the normal ankle in the standing position (Ratliff 1959; Lance et al 1979; Morrey and Wiedeman 1980; Ahleberg and Henricson 1981; Boobbyer 1981; Morgan et al 1985; Dennis et al 1990). Morrey and Wiedeman (1980) found that excessive equinus was associated with pain, but Helm (1990) considered that equinus of up to 30° did not cause pain. In the coronal plane, malposition in either varus or valgus produced more subtalar pain than did the neutral position (Morrey and Wiedeman 1980; Boobbyer 1981; Morgan et al 1985; Helm 1990). Scranton (1985) showed that more than 7° varus was likely to lead to lateral metatarsalgia, while a valgus position was better tolerated. In our patients the mean position was 1.7° equinus and 0.8° varus.

A more precise position of the arthrodesis may be achieved by using cannulated 7.0 mm cancellous screws. Guide wires can then be inserted to check the radiographic position of the arthrodesis before the final screw fixation. Intra-operative radiography is, in any case, mandatory, to ensure satisfactory positioning of the ankle and the screws. We do not consider, however, that the posterior compression technique is appropriate when there are major valgus or varus deformities to be corrected.

Ankle arthrodesis causes abnormal forces at the subtalar and midtarsal joints, and many studies have shown decreased and painful movement in these joints (Mazur et al 1979; Morrey and Wiedeman 1980; Ahleberg and Henricson 1981; Stewart et al 1983; Dennis et al 1990). In our series, as in other studies, the stress films showed no more dorsiflexion at the midtarsal joints than did the standard weight-bearing films indicating that all active midtarsal movement occurs in plantar flexion. Other authors have reported an average midtarsal range of movement between 13° and 18° (Mazur et al 1979; Morrey and Wiedeman 1980; Dennis et al 1990); our mean value was 15.8°. Helm (1990) found subtalar osteoarthritis in 23 of 34 patients, but only three of these had severe changes. Morrey and Wiedeman (1980) described mild to moderate degenerative changes in 40% of operated patients. In our series, 31% had mild, 12% had moderate and 19% had radiologically severe osteoarthritic changes in the talonavicular or subtalar joints or in both.

The incidence of infection after an operation for ankle arthrodesis has been reported to be as high as 23% (Johnson and Boseker 1968; Lance et al 1979; Morrey
and Wiedeman 1980; Ahlberg and Henricson 1981; Marcus et al 1983; Morgan et al 1985; Helm 1990), and other complications such as nerve compression (Ahlberg and Henricson 1981) and peroneal tendon irritation (Stewart et al 1983) have also been described. In our series, although a number of the arthrodeses followed open fracture-dislocation or previous attempts at arthrodesis, the complication rate was low, the most serious being pulmonary embolism after a deep-vein thrombosis in the calf of the operated leg.

**Conclusions.** We believe that posterior internal compression arthrodesis of the ankle is a suitable alternative to other reported methods, allowing good positioning of the arthrodesis, and sound fusion with few complications.

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**


