Low tibial osteotomy for varus-type osteoarthritis of the ankle

In this retrospective study we have assessed the results of low tibial valgus osteotomy for varus-type osteoarthritis of the ankle and its indications.

We performed an opening wedge osteotomy in 25 women (26 ankles). The mean follow-up was for eight years and three months (2 years 3 months to 17 years 11 months).

Of the 26 ankles, 19 showed excellent or good clinical results. Their mean scores for pain, walking, and activities of daily living were significantly improved but there was no change in the range of movement. In the ankles which were classified radiologically as stage 2 according to our own grading system, with narrowing of the medial joint space, and in 11 as stage 3a, with obliteration of the joint space at the medial malleolus only, the joint space recovered. In contrast, such recovery was seen in only two of 12 ankles classified as stage 3b, with obliteration of the joint space advancing to the upper surface of the dome of the talus. Low tibial osteotomy is indicated for varus-type osteoarthritis of stage 2 or stage 3a.

Osteoarthritis of the ankle has various causes, of which malunited and intra-articular fractures are the most common.\(^1,2\) Adult flat foot may predispose to valgus-type osteoarthritis\(^3\) and idiopathic varus osteoarthritis is also recognised.\(^4,5\) Since 1982 we have undertaken low tibial valgus osteotomy for this type of osteoarthritis and reported good results in patients with symptoms of intermediate severity.\(^6\) However, since the number of patients has increased, we have encountered those in whom the operation has failed. This study was carried out to clarify the limitations of the operation. To exclude the effects of different techniques, we limited analysis to patients who had undergone opening wedge osteotomy.

**Patients and Methods**

Between 1987 and 2002, 25 patients (26 feet) with varus-type osteoarthritis of the ankle had a low tibial osteotomy in our hospital. Although one died and three were lost to follow-up, their records contained sufficient detail for assessment. All were women, with a mean age of 54 years (37 to 76). The mean follow-up was eight years three months (2 years 3 months to 17 years 11 months).

Varus-type osteoarthritis of the ankle is classified into four stages:\(^6\) 1) no narrowing of the joint-space, but early sclerosis and formation of osteophytes; 2) narrowing of the medial joint space; 3) obliteration of this space with subchondral bone contact and 4) obliteration of the whole joint space with complete bone contact. In this study, stage 3 was further classified into stage 3a and 3b. In the former, obliteration of the joint space was limited to the medial malleolus and in the latter, the obliteration extended to the roof of the dome of the talus (Fig. 1). In our study, three joints were in stage 2, 11 in 3a and 12 in 3b.

Before operation weight-bearing anteroposterior (AP) and lateral radiographs were taken. The angle between the tibial shaft and its distal joint surface on the AP view (TAS angle) and the same angle on the lateral view (TLS angle) were measured.\(^4,7\) They indicated the angle of varus and the amount of anterior opening of the joint. In normal Japanese subjects, the mean TAS and TLS angles are 88.1° and 81.0°, respectively.\(^7\) The tibial axis was defined as the line between the midpoints of the tibial shaft 8 cm and 13 cm above the tip of the medial malleolus. In a previous series we aimed to achieve a TAS angle of between 93° and 94° and a TLS angle of 81° or 82°.\(^6\) However, since then we have recognised that over-correction of varus gave better results than under-correction, especially for advanced osteoarthritis. Therefore, we now aim for a TAS angle of 96° to 98° with a TLS angle similar to before. We used an anteromedial opening wedge osteotomy to correct the varus and anterior opening of the distal joint surface.
Correction was obtained by the shape of the bone graft as measured during pre-operative planning.

An oblique fibular osteotomy was performed through a lateral incision with excision of a segment 5 mm in length. The tibial osteotomy was then performed by an opening-wedge technique, using bone graft from the ilium or tibia. After measurement and shaping, the graft was inserted and the osteotomy fixed by a 4- or 5-hole AO/ASIF narrow plate (Synthes, Philadelphia, Pennsylvania) or a 6- or 8-hole form plate (Osteo, Selzach, Switzerland). A cast was used for four weeks, and full weight-bearing allowed after two months. Simultaneous reconstruction of the lateral ligament was not performed.

The clinical rating scale of Takakura et al\(^8\) was used to evaluate function of the ankle before and after operation. On a 100-point score, 40 points were for pain and 20 each for walking ability, activities of daily living and range of movement. The results were classified as excellent for scores above 90 points, good for 80 to 89, fair for 70 to 79 and poor for less than 70 points. The angle between the crural axis and the plantar surface was measured for evaluation of movement.

The TAS and TLS angles were measured before operation, at six to 12 months after surgery and at the latest follow-up. Varus tilt of the talus was measured as the angle between the distal articular surface of the tibia and the upper surface of the dome of the talus on a weight-bearing AP view.

**Statistical analysis.** The clinical and radiological results were evaluated by a paired \(t\)-test. The relationship between stage 2 and stage 3 was determined by the Kruskal-Wallis test and the difference in outcome between stage 3a and stage 3b by the Mann-Whitney \(U\) test. A \(p\) value of < 0.05 was considered statistically significant.

**Results**
The clinical scores improved from a mean of 51.0 points (30 to 75) pre-operatively to 79.2 points (41 to 100) at the

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**Table I. Mean (range) clinical scores for the 26 ankles according to our rating scale\(^6\)**

<table>
<thead>
<tr>
<th></th>
<th>Pain (40)</th>
<th>Walking (20)</th>
<th>ADL(^*) (20)</th>
<th>ROM(^†) (20)</th>
<th>Total (100)</th>
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<tr>
<td>Pre-operative</td>
<td>14.2 (0 to 20)</td>
<td>9.6 (5 to 20)</td>
<td>10.2 (4 to 18)</td>
<td>17.0 (8 to 20)</td>
<td>51.0 (30 to 75)</td>
</tr>
<tr>
<td>Follow-up</td>
<td>33.1 (10 to 40)</td>
<td>15.4 (5 to 20)</td>
<td>14.6 (6 to 20)</td>
<td>16.1 (6 to 20)</td>
<td>79.2 (41 to 100)</td>
</tr>
</tbody>
</table>

\(^*\) ADL, activities of daily living

\(^†\) ROM, range of movement
The degree of pain improved markedly from a mean of 14.2 points (0 to 20) before surgery to 33.1 points (10 to 40) at follow-up. The walking ability and activities of daily living also improved significantly but the score for range of movement was slightly reduced, although the difference was not significant. The overall evaluation was excellent in four ankles, good in 16, fair in two, and poor in four. In the patient who had bilateral osteotomies, one ankle was good and the other poor.

The mean dorsiflexion and plantar flexion were 12.5˚ (5˚ to 25˚) and 38.8˚ (20˚ to 55˚), respectively before operation and 11.9˚ (5˚ to 25˚) and 34.4˚ (10˚ to 60˚) at follow-up, indicating slight reduction in these movements. The results indicate that relief from pain and preservation of movement can be achieved by this operation.

Radiological evaluation showed that the mean TAS angle had been corrected from 82.7˚ (76˚ to 87˚) pre-operatively to 98.2˚ (90˚ to 113˚) at follow-up and the mean TLS angle from 78.5˚ (71˚ to 86˚) to 84.7˚ (67˚ to 98˚) (Table II). The mean varus tilt angle improved from 7.3˚ (0˚ to 27˚) pre-operatively to 5.0˚ (-1˚ to 19˚) at follow-up, but the stage was not improved to stage 1 in patients with residual varus tilt. The mean TAS, TLS and varus tilt angles at six to 12 months after surgery were not significantly different from those at final follow-up.

All three ankles in stage 2 and ten of the 11 in stage 3a before operation had improved to stage 1 at follow-up (Fig. 2). The remaining ankle in stage 3a deteriorated to stage 3b; the post-operative TAS angle (90˚) was insufficient. Of the 12 ankles in stage 3b, two improved to stage 1 and six to stage 2, three were unchanged and one deteriorated to stage 4. There were significant differences in the outcome between stages (p < 0.01) and the outcome in stage 3b was significantly worse than that in stage 3a (p < 0.01; Figs 3 and 4).

To investigate the causes of the poor outcome, we examined the pre-operative varus tilt angle in the 15 ankles which improved to stage 1 and the 11 which did not improve to stage 1. The mean angle was 3.2˚ (0˚ to 8˚) in the former and 11.8˚ (6˚ to 27˚) in the latter. In all patients with a pre-operative varus tilt angle greater than 10˚, the joint space did not improve to normal.

Union was achieved in 22 ankles from seven to 13 weeks after surgery. In the four ankles with nonunion at more than six months after operation, bone grafting was undertaken and union achieved. Plates and screws were removed in 18 ankles between five months and three years after surgery. There were four ankles with a poor outcome. Arthrodesis was performed in two. The remaining two ankles are being treated conservatively with intra-articular injections of hyaluronic acid.

**Discussion**

The aetiology of varus-type osteoarthritis, although unclear, is thought to be acquired, since the ankles of infants are in valgus. We consider that the changes are due to the Japanese lifestyle, in which people sit cross-legged or with the legs tucked underneath the body. Biomechanical studies have shown that varus tilt of the distal articular surface of the tibia causes stress concentration on the medial side of the ankle and have demonstrated the usefulness of valgus correction.

Evaluation of the loading line on weight-bearing and AP full-length radiographs of the leg have shown that correction close to the ankle is more useful than that near the knee.

In applying these findings to our patients we found that the joint space was restored in ten patients in stage 3a but in...
only two in stage 3b, indicating that intact cartilage on the talar dome is necessary to support load.

When comparing the clinical outcome with the radiological stages, the 15 patients who improved to stage 1 had a good outcome. In the six who improved to stage 2, albeit with persistent narrowing of the joint space, the clinical result was still relatively good. In contrast, in the remaining patients with persistent loss of joint space (stage 3b or stage 4), the outcome was generally poor.

We aimed at slight overcorrection of the TAS angle, similar to high tibial osteotomy in which overcorrection is recommended to compensate for loss of cartilage on the medial side of the knee. In cases of post-traumatic varus deformity with no loss of cartilage we correct only to the neutral position. However, Cheng et al have indicated that normal values can be attained in osteoarthritic ankles.

The mean follow-up TAS and TLS angles in our patients were 98.2° and 84.7° respectively. Both were more overcorrected than planned. However, the long-term outcome remained good up to stage 3a. Our concern that overcorrection of the TLS angle would restrict dorsiflexion proved to be groundless.

Although instability of the ankle is considered to be a cause of varus-type osteoarthritis, this relationship is unclear. We did not reconstruct the lateral ligament in this series of patients but have done so in the past when undertaking closing wedge osteotomy. Takakura et al reported that a varus deformity of the distal tibia is a risk factor for chronicity after lateral ligament injury of the ankle and we considered that bony correction alone would help to attain stability.

With regard to varus tilt, all 12 ankles in which the varus tilt angle was 5° or less had a normal joint space at follow-up. If the varus tilt angle was 5° or less, good results were obtained by osteotomy alone. However, none of the seven ankles in which the varus tilt angle was more than 10° attained a normal joint space, indicating that stage 3b may be beyond the limit. Perhaps a combination of osteotomy and reconstruction of the lateral ligament would have provided better results for these ankles, although we consider this to be unlikely.
Low tibial osteotomy provides good long-term results in varus osteoarthritis of the ankle limited to stage 2 and stage 3.

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


