LOW TIBIAL OSTEOTOMY FOR OSTEOARTHRITIS OF THE ANKLE

RESULTS OF A NEW OPERATION IN 18 PATIENTS

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Primary osteoarthritis of the ankle with no history of trauma is rare. We report the use of a low tibial osteotomy on 18 ankles in 18 patients, two men and 16 women.

The osteotomy is designed to correct the varus tilt and anterior opening of the distal tibial joint surface where it has been shown by weight-bearing radiographs and arthroscopy that there is healthy articular cartilage on the lateral side of the ankle. An opening-wedge osteotomy was used to achieve slight overcorrection.

Follow-up of the 18 ankles at an average of 6 years 11 months (2.7 to 12.10) showed the results by our own scoring system to be excellent in six ankles, good in nine, and fair in three with no poor results. Of the three patients with fair results, two had been undercorrected and the third had little residual articular cartilage. Arthroscopic examination of ten ankles showed repair by fibrocartilage in seven.

We conclude that slight overcorrection of deformity by low tibial osteotomy is effective in treating intermediate-stage primary osteoarthritis of the ankle.

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Primary osteoarthritis of the ankle with pain and limited range of motion is relatively rare; secondary arthritis after trauma or infective arthritis is more common (D'Ambrosia and Shoji 1977; Harrington 1979). Radiological examination in primary osteoarthritis has shown a characteristic varus deformity combined with anterior opening of the tibiotalar joint and often hypoplasia of the medial malleolus (Katsui et al 1980). Primary osteoarthritis was found principally among women, and 80% of those affected had bilat-

eral involvement. We used weight-bearing radiographs to classify the arthritis into four stages (Fig. 1):

Stage 1. No joint-space narrowing, but early sclerosis and osteophyte formation.

Stage 2. Narrowing of the joint space medially.

Stage 3. Obliteration of the joint space with subchondral bone contact medially.

Stage 4. Obliteration of the whole joint space with complete bone contact.

For clinical use, we simplified the classification, describing stage 1 as early, stages 2 and 3 as intermediate, and stage 4 as late (Takakura et al 1986).

The early stage of primary osteoarthritis of the ankle can be treated by arch supports with lateral wedging and lateral ligamentous reconstruction. Advanced changes require replacement arthroplasty or arthrodesis, but the management of the intermediate stage is difficult. We considered that partial, local narrowing of the joint space could be corrected by low tibial osteotomy designed to shift the loading stress. We assessed such ankles by weight-bearing radiographs and arthroscopy which are essential to determine the state of the articular cartilage (Takakura et al 1986).

We now report on our operative indications, technique and results.

PATIENTS AND METHODS

From May 1981 to May 1991, we performed osteotomy on 18 ankles in 18 patients for primary osteoarthritis. These osteotomies represented only 1.5% of the 1170 operations on the foot and ankle performed during this period. There were 2 men and 16 women, with a mean age of 58.5 years (44 to 72). All ankles showed varus deformity with anterior opening on the lateral radiographs. The joint space in all was narrowed medially and remained intact on the lateral side of the tibiotalar joint. All were in the intermediate stages (2 or 3). Valgus and anterior open-wedge osteotomies were performed. In three joints stress radiographs had shown lateral instability and these had reconstruction of the lateral ligament at the same time as the osteotomy. In 13 cases arthroscopy had confirmed that there was articular cartilage on the lateral side of the joint.

Assessment. We used a rating scale for ankle function before and after the operation (Takakura et al 1990). On a

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Fig. 1a

Fig. 1b

Fig. 1c

Fig. 1d

Classification of the stages of primary osteoarthritis of the ankle. Figure 1a – Stage 1. There is subchondral bony sclerosis and bony spurs, but no joint-space narrowing. Figure 1b – The medial joint space is narrowed. Figure 1c – There is direct contact of the subchondral bone of the tibia and the talus on the medial side. Figure 1d – There is subchondral bone contact throughout the tibiotalar joint.

100-point system, 40 points were for pain and 20 each for walking ability, activities of daily living and range of motion. We classified the results as 'excellent' for scores above 90, 'good' for scores from 80 to 89, 'fair' for scores from 70 to 79, and 'poor' for scores of less than 70.

Radiographic results were assessed by the stage of osteoarthritis as shown by joint-space narrowing and sclerosis. We also used weight-bearing radiographs of the ankle and whole lower extremities before and after osteotomy to confirm that the appropriate osteotomy had been performed.

Planning the operation. Several angles were measured on weight-bearing anteroposterior and lateral radiographs. The angle between the tibial shaft and the tibial joint surface on the anteroposterior view (TAS) recorded the varus angulation (Fig. 2a). In normal Japanese people, the mean TAS angle is about 89° (Katsui et al 1980; Monji 1980). The angle of the tibial joint surface on the lateral view (TLS) indicated the amount of anterior opening of the joint (Fig. 2b); the normal TLS angle is about 80° to 81° (Katsui et al 1980; Monji 1980). We also measured the angle of the medial malleolus (TMM) to record distal opening of its articular surface (Fig. 2c). These measurements were used to draw diagrams of the necessary corrections before operation. The horizontal tibial cut is planned to be 5 cm proximal to the tip of the medial malleolus, and the fibula is cut

at the same level. Displacement of the tibia is by opening a wedge and of the fibula by the closed-wedge method, aiming for slight overcorrection so that the distal joint surface of the tibia is in 4° to 5° of valgus (TAS angle 93° to 94°). The TLS angle is also overcorrected by opening an 81° or 82° anterior wedge (Fig. 3).

Technique of operation. Under general anaesthesia, a thigh tourniquet is applied. The ankle is examined using an arthroscope less than 3 mm in diameter, inserted from both medially and laterally to confirm the presence of intact articular cartilage.

Fibular osteotomy is performed first, through a lateral incision. An oblique saw cut is made, excising a 5 mm segment to allow closing when the tibia is displaced. Tibial osteotomy is then performed through a longitudinal antero-medial incision. The periosteum of the tibia is reflected, and a horizontal saw cut is made, preserving a small part of the posterolateral tibial cortex to act as a fulcrum for the opening wedge and to provide stability. The planned anterior and medial opening is made gently and the open wedge is filled with bone graft from the ilium or from the tibia near the osteotomy site. The position is fixed by a 4- or 5-hole plate on the medial cortex. The wounds are sutured and a below-knee cast is applied.

Patients are allowed up, non-weight-bearing, on the day after operation. At two weeks a walking cast is used for

Fig. 2

Radiological measurements. Figure 2a – The TAS angle records the varus position of the distal tibial joint surface on the anteroposterior view. Figure 2b – The TLS angle records the anterior opening of the tibial joint surface on the lateral view. Figure 2c – The TMM angle records the distal opening of the joint surface of the medial malleolus.

Fig. 3a

Fig. 3b

Planning diagrams for low tibial osteotomy. Figure 3a – The opening by X mm is designed to correct the TAS angle to 94° . Figure 3b – The opening by X mm corrects the TLS angle to 82° .

Fig. 4a

Fig. 4b

Fig. 4c

Fig. 4d

A 51-year-old woman with the intermediate stage of osteoarthritis in her right ankle (a) had closed-wedge osteotomy and reconstruction of the lateral ligament. A weight-bearing radiograph 7 years 5 months later (b) showed a good joint space. She had no pain or instability. Arthroscopy showed loss of articular cartilage on the tibia and talus before osteotomy (c) and regeneration by fibrous cartilage 1 year 10 months later (d).

another two weeks. This is removed four weeks after operation and range-of-motion exercises are begun. Full weight-bearing on the ankle is allowed after two months.

RESULTS

Early in the series, we used closed-wedge osteotomy in five patients (Fig. 4), and oblique osteotomy in one. Bone union, however, was slow and the next 12 patients had open-wedge osteotomy. Below-knee casts were used from three weeks to 18 weeks (mean 5.2). There was delayed union of the tibia in four cases, but all united within six months.

Follow-up was from 2 years 7 months to 12 years 10 months (mean 6 years 9 months). Mean pain scores were

16.4 before operation and 34.6 after operation. Walking ability improved from 11.7 to 16.7, ability to perform activities of daily living from 12.5 to 16.5 and range of motion from 15.1 to 15.2. The total mean score improved from 55.7 to 83.9 (Table 1). Relief of pain and the ability to walk improved greatly, but joint mobility was unchanged. The overall results were excellent in six cases, good in nine, fair in three, and poor in none.

Our radiological analysis showed that preoperative narrowing of the joint space was improved in 13 patients (Fig. 5), and was unchanged in five. The three patients with only fair results had continuing mild pain.

The mean TAS angle after operation was improved from 82.3° to 93.8° average, the mean TMM angle from 43.5° to 26.9° , and the mean TLS angle from 77.4° to 81.6° (Table

Fig. 5a

Fig. 5b

Fig. 5c

A 44-year-old woman with the intermediate stage of osteoarthritis in her right ankle (a) had open-wedge osteotomy with bone graft from the tibia. The joint space was improved by six weeks after osteotomy (b). The anterior osteophyte had been resected arthroscopically. At 3 years 2 months after osteotomy (c) she had no pain and an excellent result.

Table I. Scored results of 18 ankle osteotomies (see text) (mean $\pm$ SD)

	Preoperative	Review
Pain (40 points)	16.4 $\pm$ 4.6	34.6 $\pm$ 5.3
Function (60)		
Walking (20)	11.7 $\pm$ 3.7	16.7 $\pm$ 3.2
Activities of daily living (20)	12.5 $\pm$ 4.7	16.5 $\pm$ 4.7
Range of motion (20)	15.1 $\pm$ 3.8	15.2 $\pm$ 3.9
Total (100)	55.7 $\pm$ 9.5	83.9 $\pm$ 13.2

II). In two of the patients with fair results the TAS angle was undercorrected to 89° and 87° respectively. In the remaining patient there was narrowing of the whole joint space and not just on the medial side. In retrospect we consider that the indication for operation on this patient was incorrect.

Long-leg radiographs taken before and after osteotomy showed that the mean femorotibial angle tended to decrease: from 176.6° (172 to 184) before osteotomy to 174.4° (171 to 178) after tibial osteotomy.

Arthroscopic examination was performed on 10 of the 18 patients at the time of removal of the screws and plate, from 10 months to 2 years 4 months after osteotomy. In seven joints which had been corrected to an appropriate angle, new fibrous tissue was seen in the ulcerated area of

the medial joint surface (Fig. 4d). In two ankles, biopsy of the tissue in the repaired area showed fibrous tissue and fibrous cartilage within granulation tissue.

DISCUSSION

Osteoarthritis of the ankle is usually secondary to trauma such as fracture or ligamentous injury (D'Ambrosia and Shoji 1977; Harrington 1979). Primary osteoarthritis with no history of trauma or general disorder is rare, but the number of such cases has risen in step with the ageing of the Japanese population. Radiological measurements in these cases show varus tilt, anterior opening of the distal joint surface, and distal opening of the articulation with a hypoplastic medial malleolus (Katsui et al 1980; Monji 1980). It is not clear whether this is caused by a congenital

Table II. Preoperative and postoperative radiological measurements in degrees (mean $\pm$ SD)

Angle*	Preoperative	Review
TAS	82.3 $\pm$ 4.1	93.8 $\pm$ 5.4
TMM	43.5 $\pm$ 13.2	26.9 $\pm$ 10.9
TLS	77.4 $\pm$ 6.1	81.6 $\pm$ 7.1

* see Fig. 2

Fig. 6

Diagrams to show the mechanism of the development of osteoarthritis of the ankle. Figure 6 – When the distal tibial joint surface is in varus, the loading shifts to the medial aspect with stress concentration. Figure 7 – On a lateral view, anterior loading is increased by the anterior opening of the joint.

Fig. 7

abnormality or is acquired. Such ankles have not been recognised in children, and we consider therefore that the changes are probably due to the Japanese life-style, in which people often sit cross-legged or with their legs tucked beneath them. There are few reports of such ankle conditions outside Japan (Sosa and Pasini 1975).

The mechanism of this condition requires discussion. A varus position of the tibiotalar joint is compensated for by a valgus position at the subtalar joint. If the varus deformity at the tibiotalar joint exceeds this possible compensation by the subtalar joint, there is stress concentration on the medial part of the ankle and the medial malleolus (Fig. 6).

On analysis of this mechanism from the lateral view, the angle of anterior opening of the distal joint surface increases in osteoarthritis of the ankle. In addition, the talus is subluxated anteriorly by stretching of the anterior talofibular ligament and chronic lateral instability is produced by dysfunction of this ligament. Thus, loading stress is concentrated on the front of the ankle and osteoarthritis develops (Fig. 7).

These changes in stress concentration can be likened to those seen in acetabular dysplasia at the hip, and a comparable change in loading may give good results in the intermediate stages of osteoarthritis.

Valgus and anterior open-wedge osteotomy shifts the load from medial to lateral and increases the loading area to include intact articular cartilage. Our advice on the degree of angular correction is based on photoelastic experiments in models and upon our clinical results. We now aim at a TAS angle of about 94° , which is a slight overcorrection. The mean angle which we achieved was 93.8° . The TLS angle was corrected to a mean of 81.6° .

Most Japanese people over 50 years of age, especially women, have varus angulation at the knee, with an angle of more than 180° between the femoral and tibial axes. Most of the patients with primary ankle osteoarthritis, however, had slightly valgus knees: femorotibial angles were from

172° to 184° (mean 176.6) before osteotomy. None reported knee pain or other knee problems.

Arthroscopic examination about one year after osteotomy showed that fibrous cartilage had covered previously ulcerated areas, demonstrating the value of shifting the load concentration laterally.

In our early cases, we reconstructed the lateral ligament at the time of osteotomy in ankles which had been shown to be unstable. Even without ligamentous reconstruction, however, we found that ankle stability was gradually regained after adequate correction of the tibiotalar angle, and we no longer advise simultaneous reconstruction of the lateral ligament.

We found that open-wedge osteotomy, although it required bone grafting, produced more rapid bone union than did closed-wedge osteotomy (Takakura et al 1986). The closed-wedge also tended to weaken the lateral muscles of the leg. We have tried both oblique and dome-shaped osteotomy but conclude that open-wedge osteotomy is best.

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