Acta orthop. scand. 53, 687–696, 1982

ENDOPROSTHETIC ARTHROPLASTY OF THE ANKLE JOINT

A Clinical and Radiological Follow-up

P. HERBERTS, I. F. GOLDIE, L. KÖRNER, U. LARSSON, G. LINDBORG & B. E. ZACHRISSON

Department of Orthopaedic Surgery, Sahlgren Hospital and the Departments of Orthopaedic Surgery and Diagnostic Radiology, East Hospital, Göteborg, Sweden

Eighteen ICLH ankle arthroplasties in 16 patients were followed up 15 to 52 months postoperatively (mean 36 months) by a review of the records, and clinical and radiological examinations. Five arthroplasties were performed for osteoarthrosis, 13 for rheumatoid arthritis. The overall clinical result was rated excellent in 2, good in 8, fair in 6, and poor in 2 joints. In osteoarthritic joints the results were somewhat poorer, no patient obtaining a rating of excellent but 2 of good, 2 of fair, and one of poor. Radiolucent zones greater than 2 millimeters were seen around the tibial component in 7 cases. Loosening defined as radiographic signs of movement between the prosthetic components and bone was present in 4 cases. The high occurrence of obvious loosening and large radiolucent zones indicates that mechanical problems will be encountered frequently in the future. From the results of this study it is concluded that ankle arthroplasty has a definite place in the treatment of severe arthritis in rheumatoid patients.

Key words: ankle; arthroplasty

Accepted 13.xii.81

Crippling arthritis of the ankle joint is a major clinical problem in rheumatoid arthritis (RA) and in post-traumatic osteo-arthrosis (OA). The incidence of ankle joint engagement in patients with generalized RA varies considerably in different materials. Wörner (1973) found an incidence of about 50 per cent, while Clayton & Smyth (1969) report a figure of about 10 per cent. The traditional method for surgical treatment of severe ankle joint arthritis is arthrodesis. Despite excellent results being reported after arthrodesis in some studies (Mazur et al. 1979), other authors are more guarded and recommend respect for this type of surgery (Kenwright 1972, Lance et al. 1979). Several techniques for arthroplasty of the ankle joint have been developed (e.g. Kempson 1975, Pappas et al. 1976, Waugh et al. 1976, Freeman et al. 1979, Newton 1979). The place of total joint replacement in the surgical treatment of severe ankle joint arthritis, however, has not been generally appraised, even if documentation supporting the use of arthroplasty, when specially indicated, is now appearing in the literature (Demottaz et al. 1979). The purpose of the present study has been to describe the clinical and radiological results of ankle joint replacement after an average of 3 years.

PATIENTS AND METHODS

From 1975 through 1978, 24 arthroplasties of the ankle joint in 22 patients were performed in the Departments of Orthopaedic Surgery at Sahlgren Hospital and East Hospital, Göteborg by two of the authors (P.H. and I.F.G.). In all of the cases the ICLH prosthesis was implanted. In 17 joints the surgery was performed because of RA and in 7 joints because of OA. The 15 RA patients were all women, while the OA patients were 6 men and one woman. The mean age at operation was

0001-6470/82/040687-10 $02.50/0

52 years (range 29–75 years). The main indication for surgery in all cases was severe pain either at rest or during activity.

The surgery was performed according to the operative technique recommended by the designers of the ICLH prosthesis. The main feature of the ICLH arthroplasty is the strictly standardized procedure which includes access to specially developed guide instruments. The guide instruments allow precise bone resection both in the tibia and in the talus in planes parallel to each other and to the horizontal. The aim of the procedure is to obtain a proper alignment of the prosthetic components with minimal resection of bone and with as little trauma to the soft tissues as possible.

At the follow-up in February through September 1980 one RA patient had died. Two others were confined to nursing homes because a general deterioration of their RA and they could not return for the follow-up. Three arthroplasties had been converted to arthrodeses because of major complications including one RA patient, a woman, who had a deep infection and two OA patients with mechanical loosening. The two OA patients were one man and one woman aged 32 and 44 years, respectively. The patients with arthrodesis were not included in the follow-up. The material is summarized in Table 1.

Of the 16 patients remaining for the follow-up 5 were men and 11 women. The indication for surgery was OA in the men and RA in the women. Bilateral arthroplasty was performed on 2 women. The mean age at operation of the followed up patients was 51 years (range 29–75 years). The follow-up was performed an average of 36 months postoperatively (range 15–52 months). The mean follow-up time was 31 months for the OA patients and 38 months for the RA patients.

The clinical follow-up was prospective and performed by the authors who had not performed the operations, using a standardized scheme in which pain, synovitis, stability, motion, and function were described and evaluated in detail. The clinical examination at the final follow-up also included a special goniometer measurement of ankle joint motion, which was performed at the same time as the radiographic examination. The clinical results were rated as excellent, good, fair, and poor according to the criteria listed in Table 2.

Table 1. Clinical material. Number of arthroplasties

	RA	OA	Total
Number of performed arthroplasties	17	7	24
Lost to follow-up	3	0	3
Not followed up because of arthrodesis	1	2	3
Left for follow-up	13	5	18

Table 2. Criteria for the clinical rating

Excellent:	No pain at rest of during activity No use of brace or aids No limp or only a slight limp Almost unlimited walking distance Ability to walk normally up and down stairs
Good:	No pain at rest, mild pain during activity No use of brace, occasional use of one crutch or cane Slight limp Ability to walk 30 minutes without pain Ability to walk up and down stairs using the bannister
Fair:	Mild pain at rest (night), moderate during activity No use of brace, always one crutch or cane Moderate limp Ability to walk less than 30 minutes without pain Ability to walk up and down stairs using any method
Poor:	Patients not fulfilling the above criteria

The radiographic study included a review of all films taken of the operated joint and, furthermore, a radiographic examination performed at the final follow-up. All examinations included AP and lateral views. The radiographic follow-up examinations were performed under image intensified monitoring in order to obtain the best views for the relevant information, including tangential views of the surface of the prostheses. Stress radiographs were obtained from all patients. Twelve patients were also examined with AP and lateral views standing up with full load on the arthroplasty.

Migration of the components of the arthroplasty was measured on the radiographs by comparing the postoperative films with those taken at the follow-up in the same projection. Radiolucent zones around the arthroplasty were evaluated. The greatest width and extension of the zones were measured and the presence of circumferential sclerosis was recorded. Loosening of the prosthesis was considered to be present only if movements between the components of the arthroplasty and bone could be seen in the image intensifier or on stress radiographs.

RESULTS

Clinical examination

At the follow-up 2 arthroplasties were rated as excellent, 8 as good, 6 as fair, and 2 as poor (Table 3). The 2 patients rated as excellent both had rheumatoid arthritis.

Table 3. Clinical results. Number of arthroplasties

	RA	OA	Total
Excellent	2	0	2
Good	6	2	8
Fair	4	2	6
Poor	1	1	2
Total	13	5	18

The various parameters of the clinical examination at the follow-up were compared with the preoperative condition. It was found that pain during activity and at rest had decreased in most patients (Figure 1). Two patients had more pain postoperatively than before operation. They both had rapidly deteriorating rheumatoid disease, and had unresolved subtalar joint problems as well. All the other patients had less pain during activity at the follow-up than preoperatively.

The functional capacity of the patients was generally increased by the arthroplasty. This was especially true for the maximum walking capacity (Figure 2) and the ability to walk up and down stairs, whereas the use of walking aids and the ability to squat were affected to a lesser degree. The pattern of walking was generally improved but at the follow-up 3 patients, one OA and two RA, had a more marked limp than preoperatively.

Swelling and effusion were markedly decreased by the arthroplasty and the 6 preoperatively unstable joints were all stable postoperatively.

Dorso-plantar flexion as measured clinically was increased in 14 joints but decreased in 4. Generally, the rheumatoid joints gained more range of motion than did the osteoarthrotic ones (Figure 3).

Complications

There were no general complications in the material. One case of superficial infection was recorded. This patient healed after revision of the wound and antibiotic treatment. In two cases a fissure of the medial malleolus resulted from the surgery. Both healed uneventfully after 4 weeks in plaster.

Three patients were re-operated with arthrodesis within 1 year postoperatively because of severe pain at rest and during activity. Up to the time of writing, i.e., after more than 1 year, only one of the arthrodeses has healed. This occurred 1.5 years postoperatively. The patients

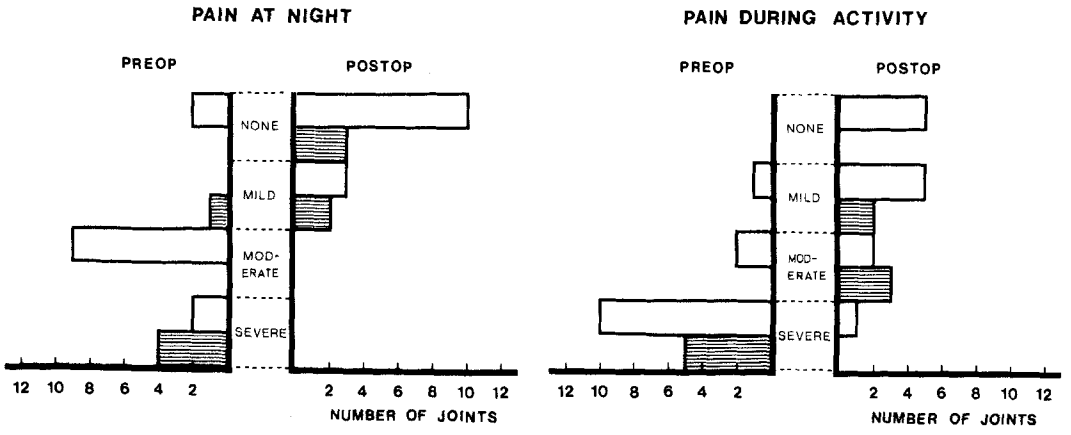

Figure 1. Preoperative and postoperative rating of pain at night and during activity in 18 ankle joint arthroplasties.

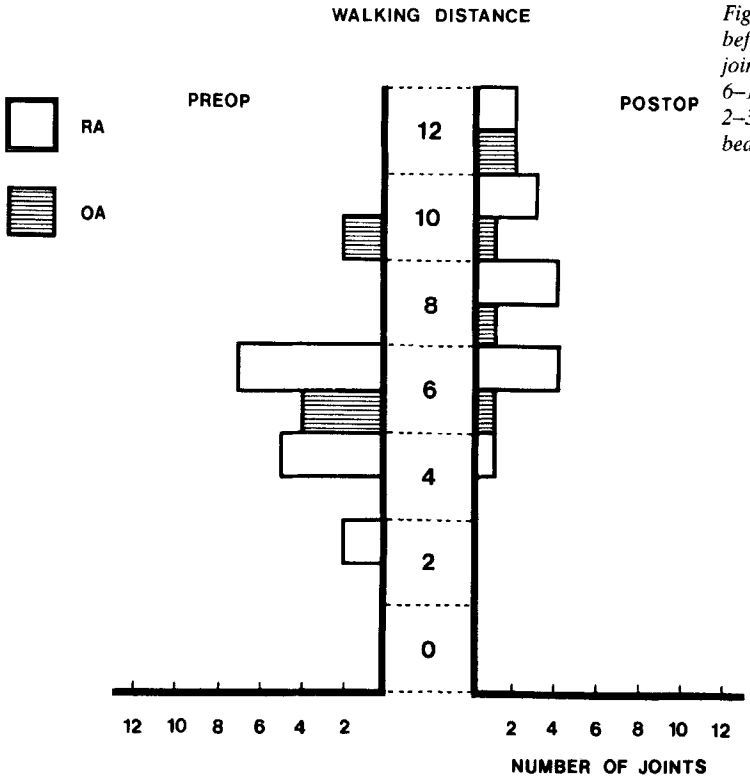

Figure 2. Maximum walking distance before and after surgery in 18 ankle joint arthroplasties. (Unlimited = 12, 6–12 blocks = 10, 4–6 blocks = 8, 2–3 blocks = 6, indoors = 4, chair to bed = 2, unable to walk = 0).

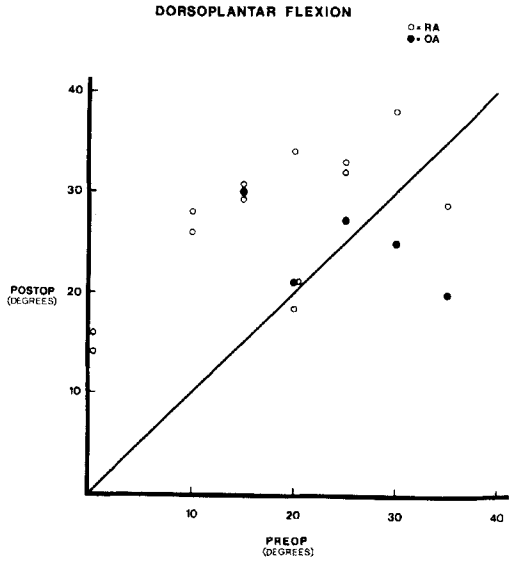

Figure 3. Relation between range of dorso-plantar flexion before and after 18 ankle joint arthroplasties as measured clinically.

with arthrodesis are not included in the follow-up. At the re-operation loosening was found to be present in all 3 cases. In one patient positive cultures of *staphylococcus aureus* were obtained at surgery. The other 2 arthroplasties were considered to be mechanically loose. None of the 3 patients re-operated and treated with arthrodesis showed any radiological signs of malalignment or other technical errors arising from the primary surgery.

Stress radiography for detection of loosening was not performed before the arthrodeses. In one case of mechanical loosening the preoperative radiographs were perfectly normal, while in the other radiolucent zones developed rapidly with the onset of pain. The radiographs of the infected patient were of poor technical quality and did not permit analysis of zones or migration. Thus, the diagnosis of the early major complications was established entirely on a clinical basis by the presence of severe pain.

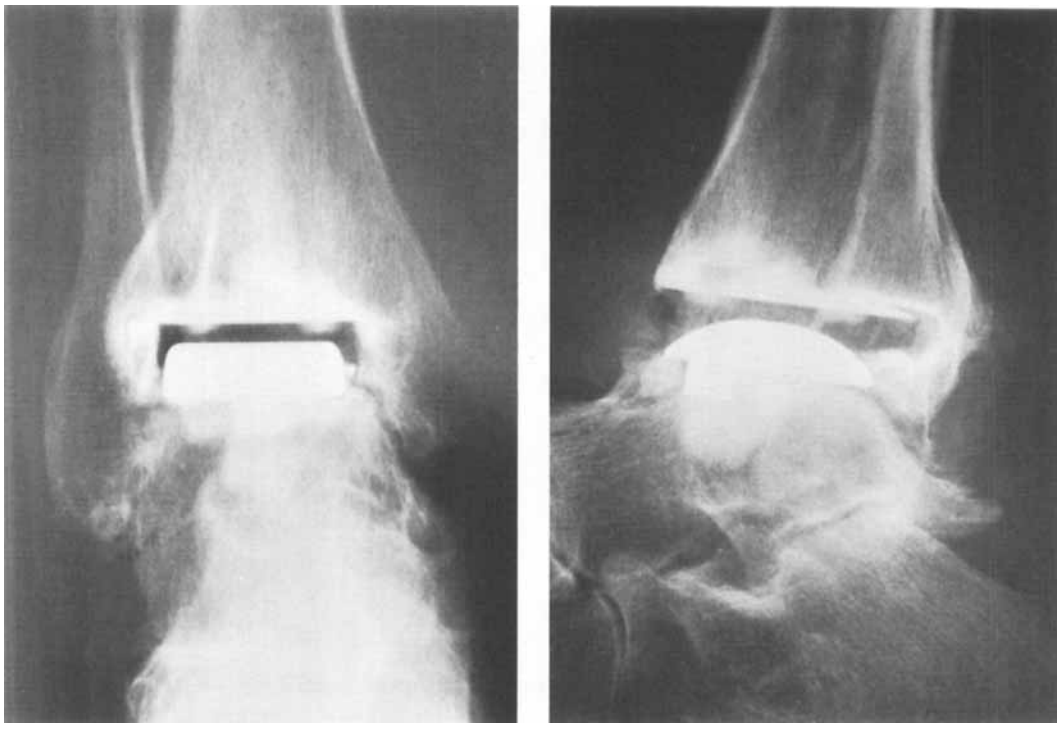

Figure 4. AP and lateral views of an ICLH ankle joint arthroplasty 25 months postoperatively showing good alignment and small zones.

Radiographic examination

The alignment of the prostheses at the time of the postoperative radiographs was generally very good (Figure 4). In the frontal plane only one arthroplasty deviated more than 5 degrees from the ideal 90 degrees as measured on the tibial component. In the sagittal plane the deviation from 90 degrees was more frequent, 7 arthroplasties having an anglular deviation of more than 5 degrees. When comparing the postoperative alignment with the alignment at follow-up only 2 arthroplasties had changed position.

The range of motion in the arthroplasty resulting from maximum active dorsal extension and plantar flexion ranged from 8 to 34 degrees with a mean of 18 degrees. The clinically measured range of motion averaged 28 degrees (range 14–38). The relation between the clinical and roentgenological range of motion for each patient is shown in Figure 5. Changes in Chopart's joint

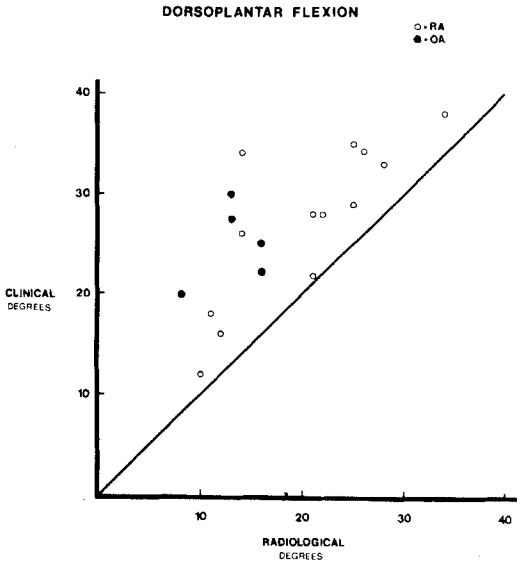

Figure 5. Relation between range of dorso-plantar flexion as measured clinically and radiographically in 18 ankle joint arthroplasties.

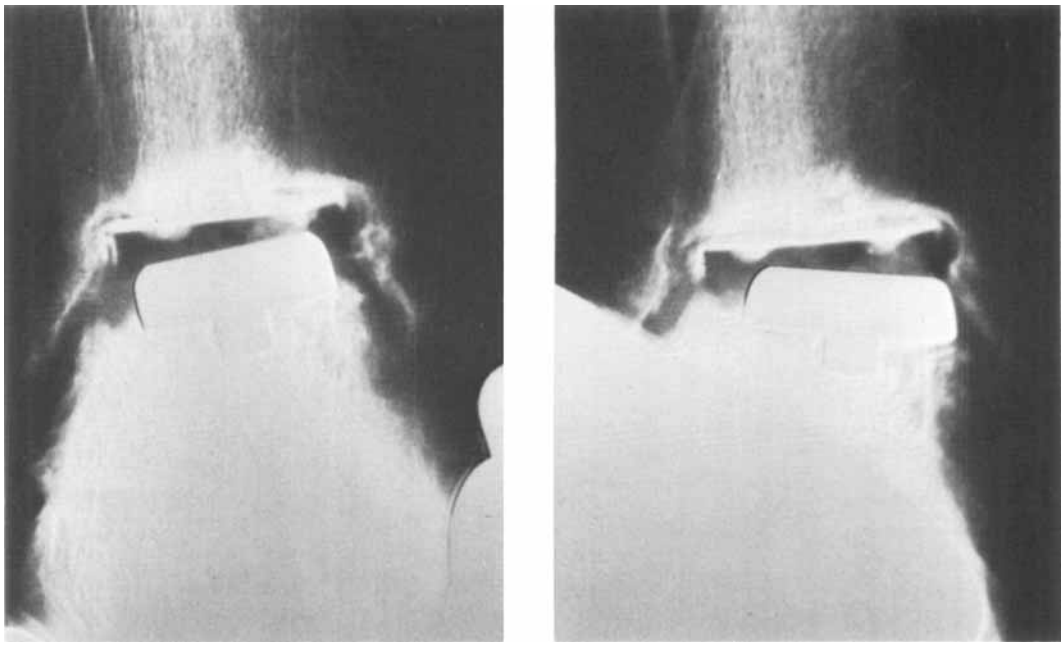

Figure 6. Frontal views of an ICLH ankle joint arthroplasty 30 months postoperatively showing instability at passive provocation in supination and pronation.

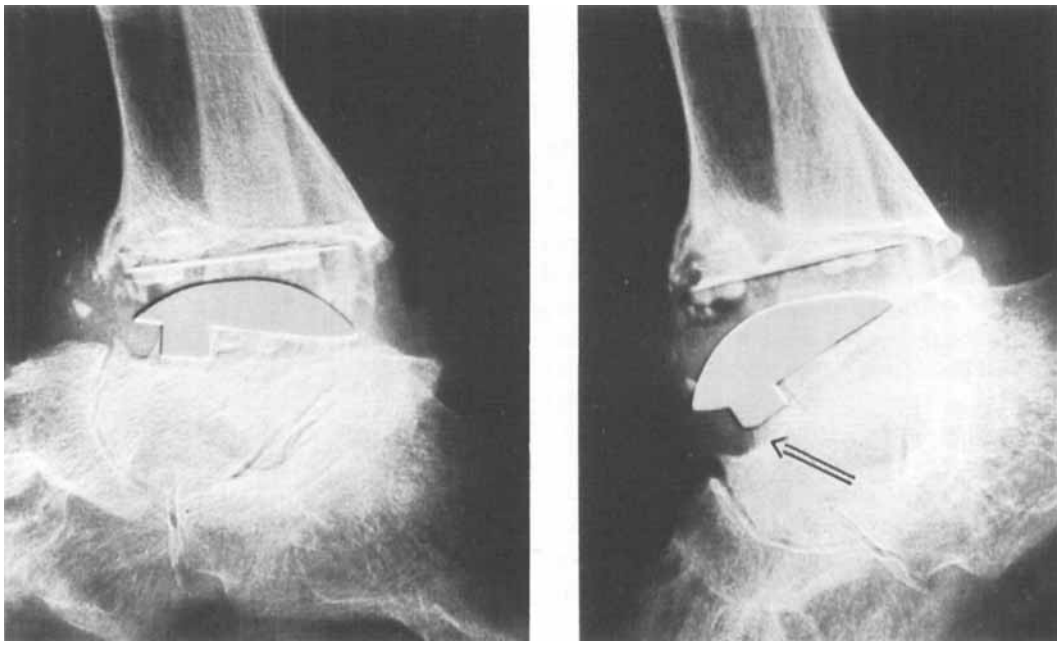

Figure 7. Lateral views of an ICLH ankle joint arthroplasty 30 months postoperatively showing loosening of the talar component visible at active flexion and extension. Note the zone between the prosthesis and the talus appearing in plantar flexion (arrow).

including reduced joint space and/or subchondral sclerosis were found to be present in 3 out of the 9 patients with the greatest difference between the clinical and radiographical range of motion. Among the 9 patients with the smallest difference these changes were more frequent, appearing in 6 patients.

The stress radiographs for the assessment of stability showed that all arthroplasties were stable in the coronal and sagittal planes. When applying stress in pronation and supination 10 arthroplasties were found to have an instability of between 3 and 14 degrees (mean 5.5 degrees). One of these cases is illustrated in Figure 6.

Loosening was diagnosed in 4 arthroplasties (Figure 7). In all 4 cases the talar component was loose. No tibial component could be shown to be loose. All loose talar components had migrated when compared to the immediate postoperative positions. The follow-up times for the patients with the loose components were not different from those of the whole material. All four patients with loosening were operated on because of rheumatoid disease.

In 15 arthroplasties of 13 patients the talar component could be shown to have subsided 2 millimetres or more into the talus. The average migration was 4 millimetres with a range of 2 to 13 millimetres. A typical pattern of migration is illustrated in Figure 8. In 5 arthroplasties the tibial component had migrated into the tibia a distance of between 3 and 6 millimetres. In two of the cases with loosening of the talar component tibial component migration was also present.

Radiolucent zones exceeding 2 millimetres were not found in any of the immediate postoperative radiographs. At the follow-up, radiolucent zones exceeding 2 millimetres appeared in 7 arthroplasties (5 RA patients and 2 OA patients). In all 7 cases the tibial component was affected but in 3 cases the talar component was involved as well (Figure 9). Although the width of the zones to some extent was found to increase with time there was no significant relation between follow-up time and the incidence of zones. The radiographs taken in the weight-bearing position did not yield any specific information.

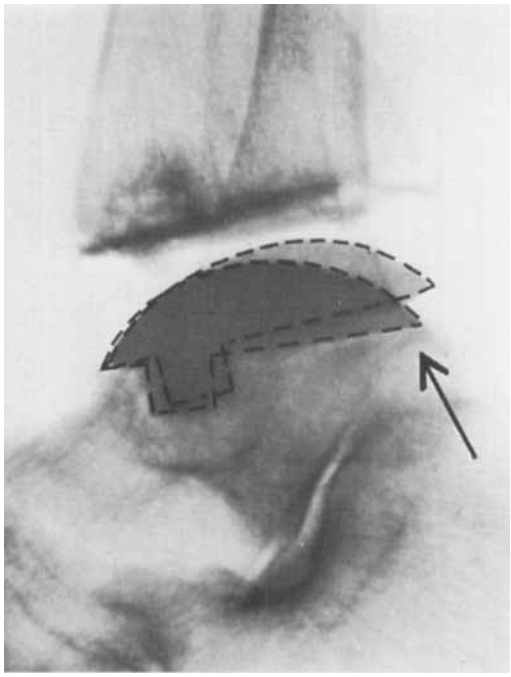

Figure 8. Lateral view of an ICLH ankle joint arthroplasty showing migration of the talar component. Double exposed picture of the postoperative position and the position at follow-up 30 months later. Note the sinking which is most marked dorsally (arrow).

DISCUSSION

Arthroplasty of the ankle joint is a comparatively new procedure. Therefore, the previously presented materials – like the present one – are small and the follow-up time is limited. Even though this necessitates a guarded attitude towards the conclusions, we consider it worthwhile to report and compare our experiences with those of others.

Three patients with severe early complications had to be excluded from the follow-up because of arthrodesis performed within the first year after surgery. The three arthrodeses showed very slow healing. This indicates that arthrodesis can not be regarded as a safe and simple salvage procedure after failed arthroplasty even if solid ankle fusion is compatible with excellent clinical results (Mazur et al. 1979). Therefore, total ankle joint replacement must not be regarded as a first step

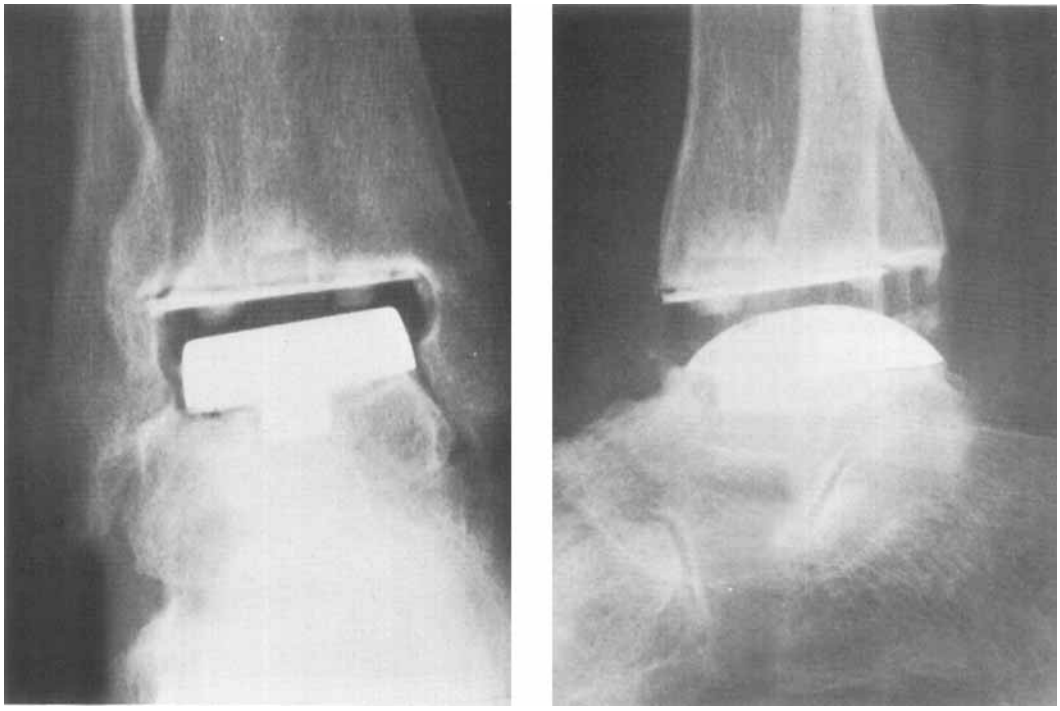

Figure 9. AP and lateral views of an ICLH ankle joint arthroplasty 49 months postoperatively showing well defined radiolucent zones surrounding both prosthetic components.

on the way towards arthrodesis in the surgical treatment of severe destructive arthritis. It is best and safest to perform arthrodesis primarily if the patient is a doubtful candidate for arthroplasty.

The clinical results in this material after a follow-up time of 3 years are comparable to those reported by others (Scholtz 1976, Demottaz et al. 1979). In contrast to the results of 21 cases reported by Demottaz, our 13 RA patients seem to have somewhat better clinical results than our 5 OA patients. However, it is important to emphasize that all patients, even those rated as poor, were far better after surgery than before. In our material, two OA patients with high functional demands and two RA patients with generally increased activity of the disease were those who obtained the poorest ratings and deteriorated during the follow-up time. In all other patients the results achieved 6 months after surgery remained unchanged during the follow-up period.

Most patients gained somewhat in motion after arthroplasty. On average two-thirds of the clinically measured range of motion was performed in the arthroplasty, a figure that corresponds closely to the figure reported by Demottaz et al. (1979) of 72 per cent. We feel that talo-crural motion is especially important for RA patients in whom subtalar and tarsal movements quite often are restricted and painful because of the arthritis.

For adequate radiographic follow-up of ankle arthroplasties as well as of total knee replacements it is important to have access to standardized AP and lateral projections (Egund et al. 1979). The beam must be directed tangentially to the surface of the prosthetic components in order to permit proper evaluation of alignment, zones and prosthesis migration. The present radiographic follow-up study was facilitated by TV-monitoring which was used to obtain correct angling of the X-ray tube at the examination. Furthermore, stress radiographs were valuable for the assessment of stability and loosening but examination in a weight-bearing position gave no further information.

Most joints were in slight varus preoperatively. At the follow-up several prostheses still had a slight varus tilt but only one was over 5 degrees. We feel that the soft tissue release in order to correct varus deformity is difficult to achieve in the ankle joint and can not be done reproducibly when the deformity exceeds 10 degrees.

In the present investigation we have chosen a definition of loosening which is based entirely on the radiological finding of movement between the joint components and bone when subjected to stress. We have used this definition for the sake of clarity and simplicity well aware that the concept of clinical loosening is more complex than this. Thus, several of the arthroplasties not classified as loose with the definition applied in this paper might in fact be so. This is especially true for the migrating prostheses showing large and expanding radiolucent zones. The fairly high occurrence of prosthetic migration and radiolucent zones indicates that further mechanical problems will be encountered in the future. According to our definition loosening was present in 4 cases, although migration of the talar component was an almost constant finding at the follow-up. Loosening was always accompanied by large radiolucent zones and migration of the talar prosthetic component.

The incidence of talar migration in this material is very high. Migration was less frequently diagnosed in the tibial component. In the tibia the surface of contact with bone is wide with strong cortical areas in contrast to the talus, where the surface is small with mainly cancellous bone. This probably explains the constant sinking of the talar component when exposed to the high stresses of the ankle joint, amounting to five times the body weight (Stauffer 1976).

The significance of the radiolucent zones is unclear. Zones were not seen around the talus as often as around the tibia. This is probably due to the sinking of the talar component, which compresses the zones and makes them invisible on radiographs. Several of the arthroplasties had zones that enlarged slowly during observation. Whether this continuous increase in width will finally cause mechanical loosening is as yet unclear. Information from total hip replacements indicates that the zones might well grow for 1 or 2 years and then stabilize not causing loosening. However, Charnley (1979) states that the behaviour of bone in contact with cement is an important criterion of long-term success. Therefore, one must expect that the appearance of zones and migration will have a greater influence on the clinical results with time.

According to Mazur et al. (1979) an ankle replacement should fulfil certain high standards in order to be superior to an arthrodesis. These standards include freedom from pain, stability, good patterns of joint motion, walking and running, and low complication rates. The patients in this material do not meet all these requirements. This is certainly true for patients in several materials of ankle arthrodesis as well (e.g. Bernhard & Wiedermann 1980). Therefore we find it questionable whether such high standards can be maintained for results of surgery on patients with a generalized crippling disease such as rheumatoid arthritis. In fact, most of the RA patients classified as fair in our material did very well in view of their multiple joint involvement that inevitably affected also their functional rating for the ankle joint.

In our material the clinical results of the arthroplasty tend to be better in RA patients without a generally deteriorating disease process. There are many reasons for this. Arthroplasty allows ankle joint motion which in RA patients can not be compensated for in other joints because of general arthritis. It also means rapid recovery in a situation where prolonged immobilization will lead to permanent confinement to bed or a wheelchair. Furthermore, the physical demands of the average RA patient are limited, leading to less stress on the arthroplasty. Therefore it seems reasonable, on the basis of our experience, to recommend arthroplasty as an alternative to arthrodesis in RA patients.

REFERENCES

Bernhard, M. F. & Wiedermann, G. P. (1980) Complications and long-term results of ankle arthrodesis following trauma. *J. Bone Joint Surg.* **62-A**, 777–784.

Charnley, J. (1979) *Low friction arthroplasty of the hip.* p. 86. Springer-Verlag, Berlin

Clayton, M. & Smyth, C. J. (1969) Situation of the foot regarding early synovectomy in rheumatoid arthritis. In: *Early synovectomy in rheumatoid arthritis* (Ed. Hijmans, W. W. D., Paul, H. & Herschel, H.) p. 146. Excerpta Medica Foundation, Amsterdam.

Demottaz, J. D., Thomas, W. H., Sledge, G. B., Simon, S. R. & Mazur, J. M. (1979) Clinical study of total ankle replacement with gait analysis. *J. Bone Joint Surg.* **61**-A, 976–988.

Egund, N., Jónsson, G. & Lindstrand, A. (1979) Radiographic examination of knee joint arthroplasties (in Swedish). Hygiea **88**, 480.

Freeman, M. A. R., Todd, R. C., Bamert, P. & Day, W. H. (1978) ICLH arthroplasty of the knee: 1968–1977. *J. Bone Joint Surg.* **60**-B, 339–344.

Freeman, M. A. R., Kempson, G. E., Tuke, M. A. & Samuelsson, K. M. (1979) Total ankle replacement with the ICLH prosthesis. *Int. Orthop.* **2**, 327–331.

Kempson, G. E. (1975) The design of an ankle prosthesis. *J. Bone Joint Surg.* **57**-B, 401.

Kenwright, J. (1972) Arthrodesis of the knee and ankle joint. Dissertation, Karolinska Hospital, Stockholm, Sweden, 18–20.

Lance, E. M., Paval, A., Fries, I., Larsen, I. & Petterson, A. L. (1979) Arthrodesis of the ankle joint. *Clin. Orthop.* **142**, 146–158.

Mazur, J. M., Schwartz, E. & Simon, S. R. (1979) Ankle arthrodesis. *J. Bone Joint Surg.* **61**-A, 964–975.

Newton, S. E. III (1979) An artificial ankle joint. *Clin. Orthop.* **142**, 141–145.

Pappas, M., Buechel, F. F. & DePalma, A. F. (1976) Cylindrical total ankle joint replacement. *Clin. Orthop.* **118**, 82–92.

Scholtz, K. C. (1976) Total ankle replacement arthroplasty. In: *Foot science* (Ed. Bateman, J. E.) pp. 106–135. W. B. Saunders, Philadelphia.

Stauffer, R. N. (1976) Total ankle joint replacement as an alternative to arthrodesis. *Geriatrics* **31**, 79–85.

Waugh, T. R., Evanski, P. M. & McMaster, W. C. (1976) Irvine ankle arthroplasty. *Clin. Orthop.* **114**, 180–184.

Wörner, A. (1973) Über den prozentuellen Anteil der Glenkbeteiligigung beim Krankenheitsbild der chronischen Polyarthritis. Dissertation, Mainz University.

Correspondence to: Peter Herberts, M.D., Ph.D., Department of Orthopaedic Surgery, East Hospital, S-416 85 Göteborg, Sweden.