

Total ankle replacement. First 25 cases

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Purpose. To assess the short term clinical and radiological results obtained in patients treated by total ankle arthroplasty.

Materials and methods. A review was made of 25 patients with ankle osteoarthritis treated by total ankle arthroplasty. Patients' average age was 58.2 years, and average follow-up was 29.5 months. In 17 cases ankle osteoarthritis was of posttraumatic origin. In all cases the HINTEGRA® prosthesis was implanted. Achilles tendon lengthening was performed in 6 cases. The review consisted of an interview and clinical and radiographic examination. The AOFAS ankle and hindfoot scoring system was used to assess clinical and functional results.

Results. The average AOFAS score improved from 24.0 to 80.1 points. Pain was the parameter with the best evolution. Average ankle range of motion improved from 19° to 26°. Five cases needed revision surgery: 2 ankle arthrodeses due to prosthetic loosening, 2 instances of Achilles tendon lengthening and the relief of a tibio-talar impingement syndrome. The prosthetic survivorship rate at 29.5 months of follow-up was 92%. All patients, except for the two cases that required ankle arthrodesis, were satisfied or very satisfied with the operation.

Conclusions. Total ankle arthroplasty is an effective method to treat ankle osteoarthritis. Short term results are similar or superior to ankle arthrodesis.

Key words: ankle, osteoarthritis, arthroplasty.

Artroplastia total de tobillo. Primeros 25 casos

Objetivo. Valorar los resultados clínicos y radiológicos a corto plazo en pacientes sometidos a una artroplastia total de tobillo.

Material y método. Se revisaron 25 pacientes con artrosis de tobillo tratados mediante artroplastia total de tobillo. La edad media de la serie fue de 58,2 años y el seguimiento medio fue de 29,5 meses. En 17 casos el origen de la artrosis era postraumático. En todos los casos la prótesis implantada fue el modelo HINTEGRA®. En 6 casos se asoció el alargamiento del tendón de Aquiles. La revisión consistió en una anamnesis, exploración clínica y control radiológico. Se utilizó la escala de AOFAS de tobillo y retropié para la cuantificación de los resultados clínicos y funcionales.

Resultados. La puntuación media de la escala AOFAS pasó de 24,0 a 80,1 puntos. El dolor fue el parámetro que mejor evolucionó. La movilidad media del tobillo pasó de 19° a 26°. Cinco casos requirieron cirugía de revisión: dos artrodesis de tobillo por aflojamiento protésico, dos alargamientos de Aquiles y una liberación de *impingement* tibio-astragalino. La tasa de supervivencia de la prótesis a los 29,5 meses de seguimiento fue del 92%. Todos los pacientes, excepto los dos casos en que se practicó la artrodesis, se mostraron satisfechos o muy satisfechos con la operación.

Conclusiones. La artroplastia total de tobillo es un método eficaz para el tratamiento de la artrosis de tobillo. Los resultados a corto plazo son similares o superiores a la artrodesis.

Palabras clave: tobillo, artrosis, artroplastia.

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Arthrodesis has long been considered the method of Choice to treat severe cases of ankle osteoarthritis and arthritis. Nevertheless, arthrodesis is not exempt from complications. In the short term, the most frequent ones are nonunion, persistence of pain, malunion and infection. With the techniques currently employed, the non-union rate ranges between 5% and 35%¹⁻⁶. Furthermore, arthrodesis always leads to a disruption of hindfoot biomechanics and of the gait pattern⁷⁻⁹. In the long term, damage to neighboring joints seems inevitable¹⁰⁻¹³.

Total ankle replacement has certain theoretical advantages over arthrodesis: a decreased disruption of the gait pattern and a lower involvement of the neighboring joints. However, first generation prostheses were used in the 60's and 70's with unacceptably high rates of complications and poor results¹⁴⁻¹⁶. In the 90's new prosthetic designs started being developed – the so-called second generation prostheses -, which were characterized by three significant improvements: the presence of a mobile component, cement-free fixation to the bone and the need of minimal bone resection. Satisfactory results have been published with these types of implants¹⁷⁻²².

The purpose of this paper is to review the short-term results obtained in 25 patients subjected to total ankle replacement with a second-generation prosthesis.

MATERIALS AND METHODS

Demographic data

Between April 2001 and April 2006 25 total ankle arthroplasties were carried out in our hospital by implanting a HINTEGRA® prosthesis (Newdeal SA, Lyon, France). All the procedures were performed by the same surgeon. All patients have been followed up periodically.

Mean patient age was 58.2 years (range: 31-74); the ratio between men and women was 14/11, and the operated ankle was the right one in 13 cases and the left one in 12. Mean follow-up was 29.5 months (range: 6-65). The patients' occupation was as follows: 13 were not in employment, 6 had a sedentary job and 6 had jobs that required them to stand or make physical efforts. Thirteen patients lived out of the Barcelona province.

In all patients arthroplasty was indicated on the basis of severe pain and functional limitation that had not improved with conservative treatment; there was always significant joint damage. Preoperative clinical examination was aimed at making sure that the origin of the pain was indeed the ankle, since some patients presented with x-rays signs of incipient subtalar osteoarthritis. The etiology of the joint involvement was as follows: post-traumatic osteoarthritis in 17 cases (fig. 1), idiopathic osteoarthritis in 4, rheumatoid arthritis in 2, psoriatic arthritis in one and flatfoot-derived ankle osteoarthritis in another. Fourteen patients had been subjected to at least one surgical procedure on the same ankle. The surgical maneuvers associated to the arthroplasty were as follows: lengthening of the Achilles tendon in 6 cases and resection of a bony eminence in the back of the foot in 2 cases.

The prosthesis

Hintegra® is an anatomical unconstrained, uncemented prosthesis made up of 3 components: the tibial component

is flat; the talar component is tapered and, like the human talus, medially its radius of curvature is smaller than laterally so as to better recreate the movement of the ankle and to promote more effective ligament tension pattern. Both metal components are made of a chromium-cobalt alloy and the contact surfaces with the bone are coated with hydroxyapatite. The mobile component is made of high-density polyethylene, with a flat surface for the tibia and a concave surface for the talus.

Surgical technique

A 10-12 cm longitudinal incision is made into the anterior aspect of the ankle. The ankle is approached by passing between the anterior tibial tendon and the extensor hallucis longus muscle and separating the neurovascular bundle laterally. The anterior ankle capsule and the tibial and talar osteophytes are resected. It is important to expose the antero-medial angle of the medial malleolus, since this will be the reference point for the first cutting guide. At this stage, the lateral malleolus cannot be seen.

The distal tibial cut is carried out with the tibial cutting guide, which is placed using as references the anterior tibial tuberosity, the tibial crest and the antero-medial angle of the medial malleolus. A flat cut is made that runs 2-3 mm above the highest point of the tibial joint surface. A gauge is used to calculate the size of the tibial component, which is determined by the antero-posterior distance of the cut performed.

The first talar cuts are performed with the talar cutting guide, which is attached to the tibial cutting guide. With the foot in neutral position (both in flexion-extension and in varus-valgus), the talus is also fixated with 2 pins. This guide makes it possible to carry out the proximal talar cut and create a protuberance at the level of the talar neck (fig. 2). The next guide makes it possible to determine the size of the talar component and perform the medial, lateral and posterior talar cuts. Subsequently, the tibial, talar and mobile trial components are placed and their correct position is verified with the image intensifier. The mobility, stability and alignment of the ankle are also tested. The anterior border of the talar dome is resected and finally, with the last guide, two perforations are made for the small stems on the talar component.

To improve dorsal ankle flexion, it is important to extract the fragments that remain in the posterior section of the joint and resect, at least partially, the posterior capsule. To do this it is useful to use a Hintermann distractor, which requires the insertion of a Kirschner wire in the antero-medial region of the tibia and another one in the talus.

The implantation of the final components starts with the impaction of the talar component, followed by the impaction of the tibial component; subsequently the mobile



Figure 1. Post-traumatic ankle osteoarthritis in a 47-year old patient (A). In this case, the anatomic alterations resulting from the trauma did not prevent the implantation of a prosthesis (B).

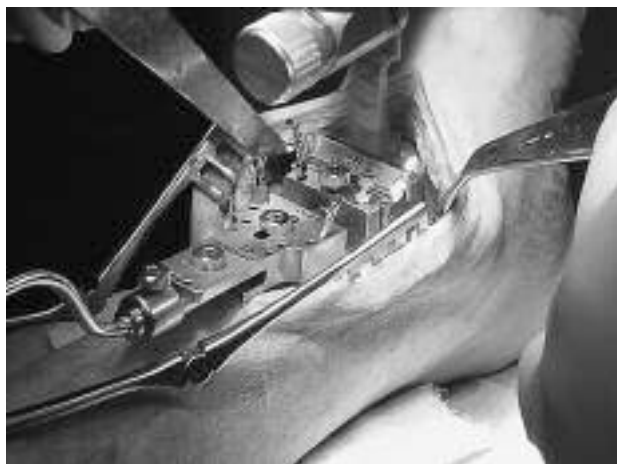


Figure 2. Proximal cut of the talar dome. The talar cutting guide is attached to the tibial cutting guide and both are fixated to the bone. The prosthetic instruments are straightforward and enhance the accuracy of the cuts performed.



Figure 3. View of the ankle with the tibial, talar and polyethylene components in place. It remains to place the screws that will allow the primary fixation of the metal components to the bone. The Hintermann distractor has been placed in the anteromedial region of the ankle.

polyethylene component is introduced and, finally, the tibial component is fixated with 2 screws (fig. 3). If necessary, 2 screws can be placed in the talar component to enhance fixation. Layer-by-layer suturing is used and a drainage is left in place. Now is the time to determine the need to lengthen

the Achilles tendon: if the foot does not passively exceed 0° dorsal flexion with the knee in extension, a percutaneous lengthening of the said tendon is carried out. Finally, a compression cast boot is applied with the ankle in neutral position.

Table 1. Results according to the AOFAS scale (mean values)

	Pre-op	Post-op	(Maximum)
Pain	0.0	33.6	(40)
Function			
Limitation to activity	0.6	7.6	(10)
Walking distance	1.0	4.2	(5)
Walking surface	0.2	2.6	(5)
Limp	0.5	7.0	(8)
Ankle mobility	2.9	5.3	(8)
Hindfoot mobility	2.3	2.3	(6)
Stability	7.5	7.7	(8)
Alignment	9.0	9.8	(10)
Total	24.4	80.1	(100)

Post-operative period

The drainage was withdrawn after 24 hours and the plaster cast was exchanged at 4-5 days to inspect the wound. The cast and the suture were removed after 15 days and a Walker-type splint was applied. Weight-bearing was commenced according to tolerance, with the Walker splint being withdrawn only during physical therapy sessions. At 6-8 weeks from surgery the Walker splint is removed for good. If the Achilles tendon had to be lengthened, cast immobilization must be maintained during the first 4 weeks. Functional rehabilitation starts when the cast is removed, its goals being to stretch and strengthen the triceps surae muscle, restore joint balance and improve proprioception. Clinical and radiographic follow-up is carried out at one, two, three and six months and every six months thereafter.

Assessment of results

All patients were examined by the same person. The examination consisted in the drawing up of a clinical history, a physical examination and an x-ray control. The AOFAS (*American Orthopaedic Foot and Ankle Society*) scale for the ankle and hindfoot was used²³, which evaluates pain, function and alignment and whose maximum score is 100 points. Patients were asked to rate their degree of satisfaction with the treatment.

Clinical examination included the assessment of ankle alignment and mobility with patients in sitting and standing positions as well as an evaluation of the patients' gait. The radiographic examination comprised anteroposterior and profile weight-bearing x-rays and profile weight-bearing x-rays with the ankle in flexion and extension. A study was made of mobility, alignment, component loosening and subsidence and of the condition of the subtalar joint. X-ray

Table 2. Mobility of the ankle (mean values)

	Pre-op	Post-op	Increase
Dorsal flexion	2° (-15° - 15°)	6° (-10° - 15°)	+ 4°
Plantar flexion	17° (5° - 30°)	20° (5° - 40°)	+ 3°
Range	19° (5° - 40°)	26° (5° - 50°)	+ 7°

alignment on the frontal plane was considered normal when the varus/valgus angulation of the joint line was less than 5°, slightly malaligned when it was between 5° and 10°, moderately malaligned between 10 and 15° and severely malaligned when greater than 15°.

In order to carry out a statistical analysis of results, the Statgraphics 4.0 software was used, applying Mann-Whitney's U test both for parametric and non-parametric results. A significance value of $p = 0.05$ was accepted.

RESULTS

At the time of this review, 2 patients had been reoperated to perform an ankle arthrodesis. To retain the homogeneity of the series, we considered valid the clinical and radiographic parameters presented by these patients immediately after the arthrodesis.

AOFAS scale

The mean AOFAS score rose from 24.0 points pre-op to 80.1 at follow-up. Table 1 shows the breakdown of this scale. Pain was the parameter that evolved best, rising from 0 to 33.6 points (maximum 40). It must be remembered that the main indication for arthroplasty was pain. As regards the origin of the joint condition, there were few differences in the results: patients with post-traumatic osteoarthritis improved 56.6 points on average, while non-traumatic patients improved 54.9 points on average, which does not constitute a statistically significant difference ($p > 0.05$).

Age was not a determining factor in the results either. Patients younger than 60 (12 subjects) improved 57.0 points, while those older than 60 (13) improved 55.1 points. The difference is not significant either ($p > 0.05$).

Mobility of the ankle

The data obtained from the clinical study of ankle mobility (fig. 4) are shown in table 2. It is obvious that we did not achieve a very significant increase in the range of motion (mean: 7°). Nevertheless, Only one patient lost the mobility of their ankle (5°). The group of 12 patients with greater range of motion included the 7 patients with greater preoperative range of motion, that is, pre-operative mobility greatly influences postoperative mobility. As regards the etiology of osteoarthritis, the mean joint range of post-trau-



Figure 4. Assessment of plantar flexion (A) and dorsal flexion (B) following total ankle replacement (weight-bearing views).

matic ankles was 15° pre-op and 23.2° post-op, whereas values in non-traumatic ankles were 27.5° and 31.9° respectively. This difference is not significant ($p > 0.05$) but shows a slightly greater increase in mobility in post-traumatic ankles. The 6 patients subjected to Achilles tendon lengthening simultaneously to the arthroplasty improved their range of motion by 6.7° as compared with the 7.1° improvement achieved by the other patients. This difference is not statistically significant ($p > 0.05$). This result could seem contradictory but it should be remembered that the criterion followed to indicate the lengthening was inability to reach 0° dorsal ankle flexion following prosthetic implantation, and the mean dorsal flexion in these 6 patients was 8.3° at follow-up.

X-ray results

The x-ray study showed the following results: preoperative alignment on the frontal plane was considered normal in 15 cases, mild varus/valgus angulation in 7 cases and moderate varus/valgus angulation in 3 cases. After the procedure, 23 cases presented with correct alignment and 2 had a mild varus malalignment. Therefore, in 8 cases we succeeded in correcting a mild or moderate malalignment (fig. 5). Signs of loosening of both the tibial and talar components were seen in one patient (an ankle arthrodesis was performed) and of the tibial component only in one patient (he remains asymptomatic). Loosening and subsidence of the talar component were seen in one patient (an ankle arthrodesis was performed). One case presented with fibular malleolus osteolysis without clinical repercussions. The status of the subtalar joint before the procedure was normal in 6 cases, it presented with mild osteoarthritis in 12, moderate osteoarthritis in 4 and an arthrodesis in 3. At follow-up we

did not see any cases in which joint damage had worsened. Radiographic ankle mobility, considering only the relative mobility of the tibial and talar with respect to each other (fig. 6), produced results similar to those for clinical mobility, but with a mean decrease of 7.4° . The results are to be expected since clinical mobility also includes the other joints in the foot.

Complications and reoperations

The most usual complication in this series was the skin necrosis of the wound edges in the immediate post-operative period. This happened in 12 cases (48%). In patients older than 60 the incidence was 53.8%, as compared with 41.6% in patients younger than 60 (this difference was not significant: $p > 0.05$). In traumatic patients the incidence was 52.9%, as compared with 37.5% in non-traumatic ones (non-significant difference: $p > 0.05$). All wounds were treated by means of debridement and regular dressing changes with cicatrizing agents and evolution was satisfactory in 100% of cases (fig. 7); no patient required plastic surgery. Mean time elapsed to full wound healing was 9.9 weeks (range: 4-14 weeks).

Three cases resulted in the loosening of the prosthetic components. One of them remains asymptomatic. In the other two cases the prosthesis was explanted and an arthrodesis was performed with the addition of autologous and homologous bone grafts; fusion was achieved in 12 weeks. The first of these cases sustained a stress fracture in the tibial malleolus 7 months after the arthroplasty, which was treated with immobilization and protection from weight-bearing; 2 years later the patient presented with pain and prosthetic loosening, although no direct relationship can be established between the fracture and the loosening. The



Figure 5. Frontal x-rays before (A) and after the procedure (B). Note how the varus malalignment of the ankle was corrected after the arthroplasty; the separation between the talus and the tibial malleolus was increased.

second case was a clear error in the surgical indication: the ankle was severely altered because of previous trauma but in spite of that the arthroplasty was indicated since the patient already had an arthrodesis in the contralateral ankle. Survivorship of the prosthesis in this series is, therefore, 92% at 29.5 months' mean follow-up.

Two patients presented with retraction and persistent pain at the level of the Achilles tendon, so they were subjected to a percutaneous tendon lengthening at 9 and 13 months from the arthroplasty respectively. Evolution was satisfactory: pain disappeared, although the improvement in mobility was only marginal.

Two patients presented with pain in the antero-medial region of the ankle, which was diagnosed as tibiotalar *impingement*. One patient required a surgical procedure to debride the area; the evolution was satisfactory.

The number of reoperations in this series was 5, including 2 ankle arthrodeses.

Patient satisfaction

The degree of patient satisfaction at the time of follow-up was as follows: 16 patients were highly satisfied, 7 pa-

tients were satisfied and 2 patients unsatisfied (these were the two patients who required an arthrodesis). Of the 6 patients with sedentary jobs, 5 have resumed their occupations, and of the 6 who had jobs requiring them to stand or to make physical efforts, 4 are still doing those jobs.

DISCUSSION

Total ankle replacement is a type of surgery that has been infrequently performed in our country. In the last 10 years there have been 2 publications on this subject in the Journal of the Spanish Society of Orthopedic and Trauma Surgery^{16,24} and another two in the Journal of the Spanish Society of Foot and Ankle Medicine and Surgery^{25,26}.

Initial results of this series of patients subjected to total ankle replacement through implantation of a second generation prosthesis can be considered satisfactory. These results are obviously poorer than those obtained in total hip or knee arthroplasties, but we think that our yardstick should not be these arthroplasties but rather ankle arthrodeses. In this regard, the results of this review can be considered equivalent



Figure 6. Range of motion assessment on the basis of a weight-bearing x-ray of the ankle, following implantation of a total ankle prosthesis: (A) plantar flexion; (B) dorsal flexion.



Figure 7. Evolution of the skin necrosis in the surgical wound, treated with dressing. (A) three weeks post-op; (B) 6 weeks; (C) 9 weeks; (D) 12 weeks.

or even better than the initial results of some arthrodesis series^{2-5,27}.

Cutaneous complications at the level of the surgical wound appeared in an alarming number of cases (48%), although evolution was invariably satisfactory. Older age and

a traumatic origin of the osteoarthritis favor this complication, although differences are not significant. We should obviously be especially careful when handling soft tissues in this type of surgery. Five cases required revision surgery (20%), a figure similar to that of other series^{17-20,28}. In 3 of

these 5 cases, the revision surgery was really "minor surgery" and did not involve the Exchange of prosthetic components.

The majority of patients in this series (68%) are of a traumatic origin. In principle it may seem logical to think that results in these patients should be poorer because of their anatomic alterations, their higher rate of previous surgeries, their greater degree of soft tissue involvement and their greater stiffness. As in other series^{19,25,29}, the results of our review do not show significant differences on the AO-FAS scale between traumatic and non-traumatic osteoarthritis, Albert ours is a small sample. The patient's age has not influenced the results of our study, although there are Studies that have shown this to be a crucial factor²⁸. This difference is probably due to the fact that our follow-up has been rather short.

Clinically, at the time of follow-up 15 patients (60.0%) reported complete absence of pain. Nine (36%) did not have any limitation for their activities of daily living and their pain free walking distance was higher than 3 km in 17 patients (68%). Limping was either mild or nonexistent in 21 cases (84%), although most patients (23) reported some difficulty to walk on uneven ground. No changes were observed in hindfoot mobility or ankle stability. The clinical examination did not reveal pain in the subtalar joint.

The mobility of the ankle is an important aspect since that is where the main difference between arthroplasty and arthrodesis lies. Mean post-operative range of motion was 26°, slightly higher than the 22° considered necessary to walk on even ground³⁰. The truth is that in terms of mobility the improvement was slight (only 7°), this being an aspect that heavily depends on the surgical technique and the prosthetic design. The most influential prognostic factor for postoperative mobility is preoperative mobility. In patients of a non-traumatic origin, the increase in mobility was smaller than that in post-traumatic patients, but the postoperative range was significantly greater because of a greater preoperative range. Limitations are usually greater in dorsal flexion and to address this problem it is often useful to carry out a wide resection of the posterior ankle capsule, which is normally retracted. An Achilles tendon lengthening can also help improve dorsal flexion, although this is a moot point. Some author perform these lengthenings in a high percentage of their cases²¹, while others are less enthusiastic for fear of impairing the ankle's flexing power²⁰. The criterion followed in this series was to lengthen the Achilles tendon when it was not possible to achieve neutral ankle flexion with the prosthesis already in place. We are currently carrying out a study in conjunction with the physical rehabilitation department of our Hospital to try to assess the potential loss of flexing power following lengthening; if such a loss is not significant then probably the trend will be to lengthen the tendon more frequently.

The indications of total ankle replacement are a fundamental aspect²⁶. Patients included in this series were meticulously evaluated and the surgical indication was based, whenever possible, on the proposal for indications and contraindications published by Valderrábano and Hintermann²⁵. In spite of this, one of the two cases in which arthroplasty failed was due to a clear indication error. In order to indicate an arthroplasty, certain requirements are needed: good bone stock, adequate ankle-hindfoot alignment, acceptable ankle mobility (at least 10°), ankle stability and a sound neurovascular status. There may be patients who do not meet one of these criteria, but this may be circumvented by some surgical maneuvers previous or even simultaneous to the arthroplasty itself: ligament repairs, tendon lengthenings, tibial or calcaneal osteotomies, etc. Often arthroplasty must be considered as one more step in the overall reconstruction of the ankle and the foot²⁴. In any event, an ankle prosthesis can be considered for all cases of osteoarthritic ankles. In our hospital, two arthrodeses have been indicated for each ankle arthroplasty in the last few years.

Total ankle replacement is a demanding surgery with a long learning curve. Naturally, the cases included in this review represent only the beginning of one surgeon's learning curve. The short-term results presented herein warrant a certain degree of optimism with respect to arthroplasty as a method to treat certain cases of ankle osteoarthritis and arthritis. Pain relief, function and patient satisfaction could be considered the same or better than those obtained with an arthrodesis in the short term. We must keep working to see whether these results are maintained over time and to make them better in the next 25 cases.

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Conflict of interests

The authors have declared to have no conflict of interests.