Eur J Orthop Surg Traumatol (2002) 12: 198–205
DOI 10.1007/s00590-002-0053-2

ORIGINAL ARTICLE

Jean Pierre Delagoutte

Retrospective analysis of 110 ankle prostheses

Received: 19 July 2002 / Accepted: 3 October 2002 / Published online: 18 December 2002

Abstract This study presents results of 110 third-generation ankle arthroplasties performed at four principle centers with a follow-up of 3 years. Prostheses used were the Star, the LCS, and the Ramses. Indications were represented by arthrosis (72 cases, almost all of which were post-traumatic) and rheumatoid arthritis (27 cases). There were 63 women and 47 men, with an average age of 56 years. Results were generally good, especially in relation to pain, which improved in 70% of cases. Function results were less favorable, particularly in relation to dorsal flexion, which did not improve after operation. Walking perimeter increased in more than 40% of cases. In the "Conclusion," we discuss indications for ankle arthroplasty instead of arthrodesis, as of the latter are not always good, and complications are frequent.

Keywords Ankle · Prostheses · Arthroplasty

Etude rétrospective de 110 prothèses totales de cheville

Résumé Le but de ce travail est de présenter les résultats à moyen terme de l'arthroplastie totale de cheville de troisième génération; ils reposent sur l'analyse de 110 dossiers provenant de quatre centres principaux; les prothèses utilisées sont les suivantes : Star, LCS et Ramses. Les indications sont représentées par l' arthrose (72 cas) la plupart du temps post-traumatique et la polyarthrite rhumato (27 cas) chez 63 femmes et 47 hommes, d'âge moyen 56 ans. Les résultats sont, en règle générale, bons, surtout sur la douleur qui est améliorée dans plus de 70% des cas; ils sont moins favorables sur la fonction, en particulier la flexion dorsale n'est pas significativement meilleure après l'intervention ; le périmètre de marche est augmenté dans plus de 40% des cas. Les auteurs dicutent, en conclusion, les indications de l'arthroplastie de cheville par rapport à l'arthrodèse dont ils rappellent les complications qui ne sont pas mineures et dont les résultats à long terme ne sont pas toujours aussi bons qu'il est classique de l'écrire.

Introduction

Due to generally poor results, ankle arthroplasty is a constant subject of research. Over the past decade, implant quality has improved. In addition, ankle arthrodesis complications, particularly for the distal foot joint, increase the success of ankle arthroplasty. Since the end of the 1960s, three generations of prostheses have been developed.

The concept of the first generation implants was borrowed from techniques used in other joints in France, where Lord and Marotte [14] a tibiocalcaneal implant, first of the rotular type and, later, the cylindrical type according to the principle of the "ball and socket" shape of the hip prosthesis. These models were rapidly forsaken because of loosening and rocking in varus.

Second-generation implants (for example Newton, ICLH, St. Georg; Bath and Wessex, Oregon; and Tomeno, France [22]) have a concave tibial piece in polyethylene and a convex dome in metal. Results were good over the short term (2 years) but loosening appeared after 5 years. Furthermore, the patient's pain increased with time due to ligamental traction and implant migration in the cancellous epiphysis bone; intraarticular

The author wrote this article with the collaboration of F. Bonnomet (Strasbourg, Department of Prof. Kempf), D. Chauveaux (Bordeaux), P. Diebold (Nancy), G. Mendolia (Saint Martin les Boulogne), C. Savornin (Paris), N. Vix (Châlons-en Champagnet and Department of Prof. Segal, Reims) J.C. Vogt (Strasbourg)

J.P. Delagoutte
Service de Chirurgie Orthopédique et Traumatologique,
CHU Nancy, Hôpital Central, 29 avenue du Maréchal
de Lattre de Tassigny C.O. n° 34,
54035, Nancy Cedex, France
E-mail: fredpfeffer@libertysurf.fr
Tel.: +33-3-83852727
Fax: +33-3-83851350

malleolar impingement was also noted. These prostheses were forsaken at the beginning of the 1980s.

Research continued, and the principle of the Oxford knee prosthesis with a mobile plateau at low constraint was applied to the ankle. Buechel and Pappas introduced the notion of mobile polyethylene meniscus between the metal tibial and talar pieces. This idea lead to the development of third-generation implants. Here we propose classification of these implants.

The principle of third-generation implants is the same for all models, with an intermediary piece between the two metallic parts at the tibia and on the talus. Pappas [2] proposed classification of these implants: (1) Constrained prostheses have only one plane of motion in flexion and extension. (2) Nonconstrained prostheses allow motion in the three space dimensions. (3) Congruent prostheses offer a large area of contact between the two metal pieces and work with a normal ligamental lever arm in ankle inversion and eversion. (4) Noncongruent prostheses, in which the contact surface is limited, the concordance of geometry is restricted, the lever arm is short, and stability is limited. Since constraints are concentrated on a small area, the meniscus polyethylene wears out and the ligamental system becomes highly solicited. This in turn creates pain.

The shape of the superior and inferior faces of the meniscus differs in each variety of prostheses: trochleoplane prosthesis (Buechel Pappas, LCS), trochleospherical prosthesis (Akile), spheroplane prosthesis (Ramses). Although results obtained with all these third-generation prostheses are now good, on average, innovations are still numerous: fixation without cement, increased fixation of the tibial part with new keel, introduction of the hydroxyapatite coating, and use of the ceramic Takahura [20] for the tibial and talar implants. Moreover, some factors are very important: ligamental system balance, sufficient articular freedom in the three planes of the space, good joint axiation, good implant positioning, and concordance of their centers of rotation. The ancillary material must be adequate and bone resection must be minimal in order to allow an eventual ulterior arthrodesis.

It should be kept in mind that complexity of the ankle joint's biomechanics is such that a prosthesis able to strictly reproduce the natural ankle motion is not yet available. We can give some guidelines concerning mobility of the Chopart's and subtalar joints once the ankle prosthesis has been implanted: 30° for walking on a flat ground, 50° for stairs, 10° of dorsal flexion, 25° of plantar flexion, and 10–15° in rotary mobility.

The purpose of this article is to report our results concerning the use of third-generation prostheses and compare them with previously published reports.

Materials and methods

In our series, we implanted third-generation prostheses only: LCS, Buechel Pappas (Depuy, 36 cases, 33%) (Figs. 1 and 2); Star,

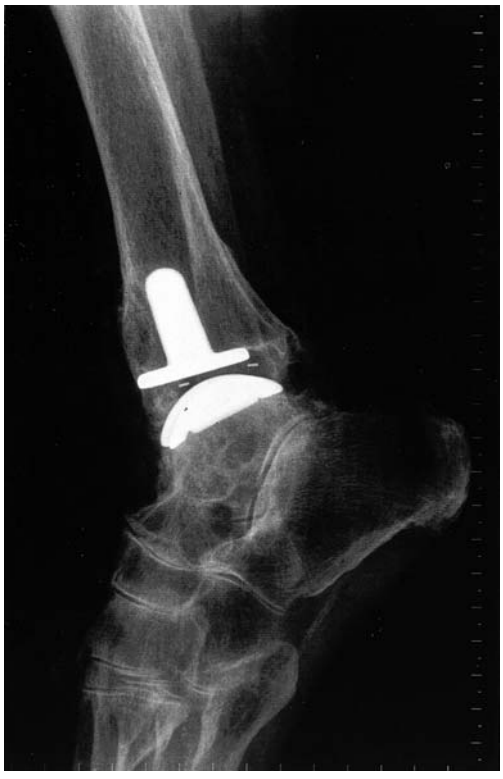

Fig. 1 Ankle prosthesis LCS

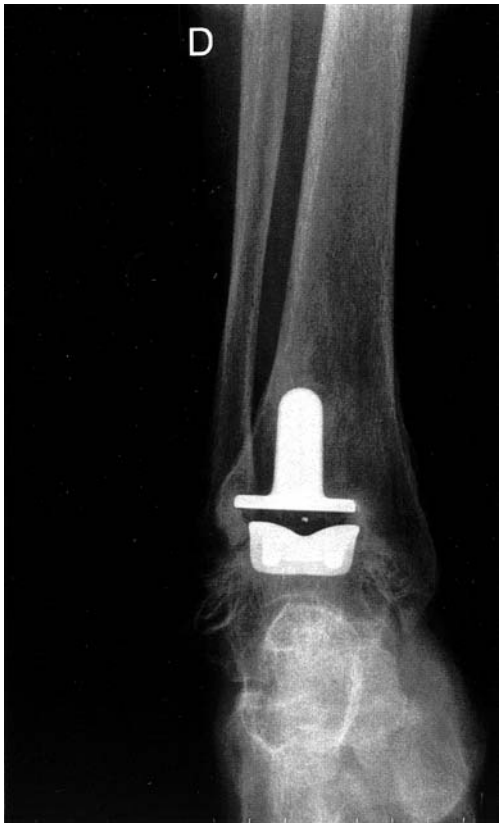

Fig. 2 Ankle prosthesis LCS

Kofoed Link, (eight cases, 7%) (Fig. 3); and Ramses, Talus group (66 cases, 60%) (Figs. 4 and 5) (Table 1). All these implants have three parts – two metallic parts for the tibial and talar resurfacing; and a polyethylene meniscus, which is free between the two other parts. The Star implant has two lateral edges on the talar piece, which are in front of the two malleolus. The LCS stem is inserted in the tibia through a window at the anterior face of the bone; a postoperative immobilization is required to obtain consolidation of this osteotomy. Both LCS and Ramses prostheses are not cemented. The Link prosthesis was, in the beginning, cemented; actually, Kofoed thinks it is possible to use his implant without cement.

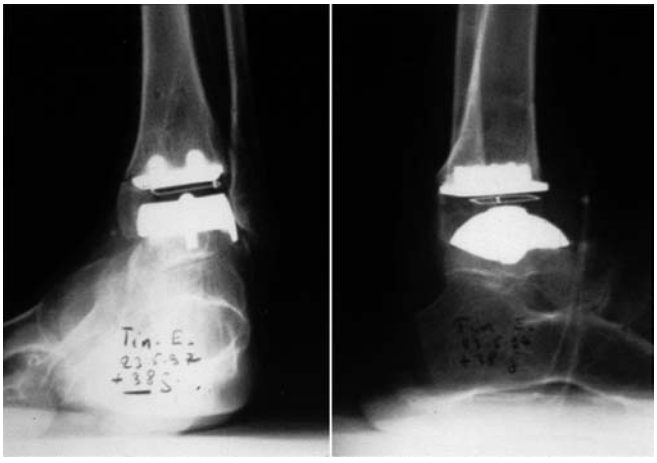

Fig. 3 Ankle prosthesis Star

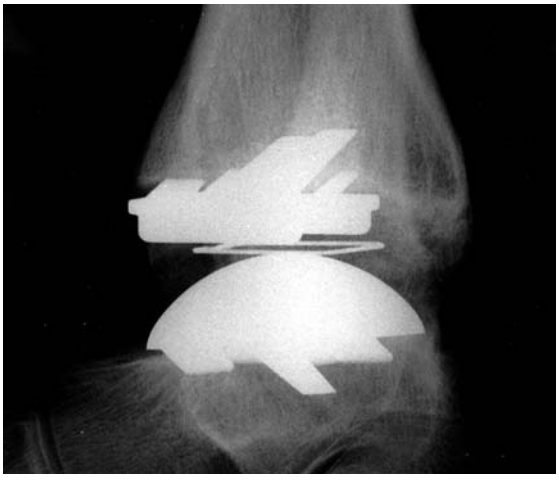

Fig. 4 Ankle prosthesis Ramses

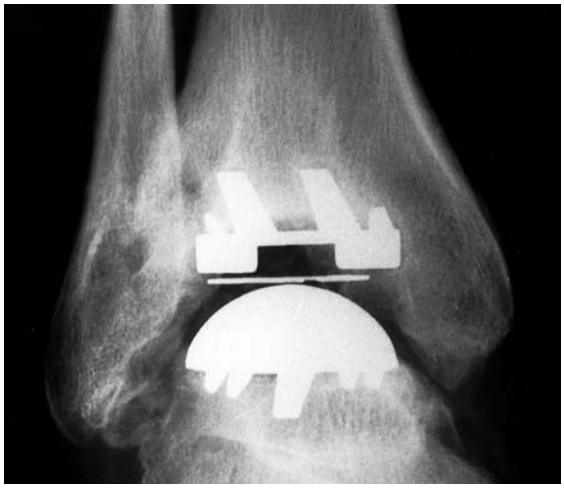

Fig. 5 Ankle prosthesis Ramses

Table 1 Prosthesis type

Ramses	LCS	Star
66 (60%)	36 (33%)	8 (7%)

Between January 1991 and December 1998, 110 ankle prostheses were implanted in 63 women (57%) and 47 men (43%) at 22 different hospitals. Fifty-eight cases were operated in four hospitals: Boulogne sur Mer (Dr. Mendolia), Reims CHU (Prof. Segal), Strasbourg CHU (Prof. Babin), and Strasbourg Clinique du Diaconnat (Dr. Vogt). On average, patients were 56 years old (range 24–80 years). There were 57 right cases (52%) and 53 left cases (48%). Patients were sedentary in 59 cases (54%), active in 33 (30%), and very active in 18 (16%). Indications were arthrosis in 72 cases (65%), rheumatoid lesion in 27 (24.5%), or complications of an osteochondral lesion of the talar bottom in 11 (osteochondral fracture eight, osteochondritis three) (Tables 2 and 3). Patients suffered from permanent pain in 73 cases (66%) or experienced pain after a little effort in 35 cases (32%). The pain limited walking to less than 500 m in 85 cases (77%), with the use of crutches in 80 cases (73%). In nine cases, the patient described a sensation of ankle instability.

After examination, we noted a varus in 22 cases (20%), valgus in 16 (14.5%) and equinus in eight (7%). In 68 cases, no deformation was observed. Skin was normal in 58% of the cases and atrophic in eight. In all cases, skin atrophy was due to a prolonged corticotherapy (rheumatoid arthritis). Scars of previous operations were noticed in 34 cases. The midfoot was painful for patients with rheumatoid arthritis. Mobility was decreased by 5° in dorsal flexion (0–30°) and 17° in plantar flexion (0–45°).

Preoperative X-rays in front and in profile showed destruction of the joint in 50% of the cases, but the articular congruency was respected in front and in profile in 90% and 87% of the cases respectively. Osteophytes and geodes respectively were noted at the tibia or talus in 62% and 20% of cases. On the Méary incidence, there was a varus (9°) in 25 cases and a valgus (7°) in 16 (15%). On the profile incidence, there was an anterior subluxation of the talus (5 mm) in 33 cases (30%). In 43 cases (39%), there were lesions at the subtalar or Chopart joint.

Operating procedure

Patients were placed in the supine position. A tourniquet was used in 91% of cases (); skin incision was anterior in 98% of cases (108

Table 2 Global etiology

Arthrosis	PR	Osteochondral lesion of the talus
72 (65.5%)	27 (24.5%)	11 (11%)
Posttraumatic 67	–	–
Primitive 5	–	–

Table 3 Etiology of posttraumatic arthrosis in 67 cases

Malleolus fracture	Distal tibial fracture	Ankle dislocation	Chronic instability
39 (58%)	20 (30%)	3 (4.5%)	5 (7.5%)

patients) and lateral in all other cases. A cortical defect was necessary to implant the LCS prostheses; its refection was good in all the cases. Prosthesis was implanted with cement in 75 cases (68%) and without cement in 35 cases (32%). The operation lasted 114 min on average; drainage was systematic (260 ml). Immobilization was performed for 27 days, on average. Partial weight bearing was possible after removal of the drain, and a total weight bearing was allowed after 27 days, on average. Hospitalization duration was 7.5 days, on average.

Complications

Complications occurred either during or after operation.

Intraoperative incidents

Eight lateral malleolus fractures (with Link or LCS); one patient suffered from rheumatoid arthritis. Treatment was orthopedic.

Five medial malleolus fractures (in the three types of implants). We performed five osteosynthesis with a screw and obtained good results. These fractures happened in two thirds of rheumatoid arthritis cases treated with Link and LCS implants, and in one third of rheumatoid arthritis cases treated with any type of implant (Link, LCS, and Ramses). They were without consequences in the final results. All publications report such fractures but at varying rates. To avoid them, a preventive osteosynthesis by screw is suggested before medial osteotomy of the tibia.

Postoperative X-rays revealed technical imperfections

Frontal plane

In the frontal plane, positioning mistakes occurred in 19 of 46 cases in the Link and LCS series (five valgus of 6°, all in rheumatoid arthritis cases; 14 varus of 5°; six in rheumatoid arthritis cases); and three of 66 cases in the Ramses series. Articular congruency was ''good'' in 35 cases (12 rheumatoid arthritis) and ''poor'' in six cases (all with rheumatoid arthritis). Two cases of a too-thin polyethylene insert were reported with a postoperative instability (Ramses series). We observed a progressive variation in one case in the Ramses series due to insufficient fibular muscles and talar implant luxation. A post-foot valgus was noted in one case in the Ramses series, requiring an arthrodesis.

Sagittal plane

In the sagittal plane, 25 cases of equinus were noted in the Link and LCS series (of 8° in seven cases of rheumatoid arthritis). In both Link and LCS series, talar implant positioning relative to the tibia could be either in front (14 cases in varus, six with rheumatoid arthritis; and three cases in valgus) or in the sagittal plane (12° equinus in 25 cases, of which three had rheumatoid arthritis; and eight cases in talus of 10°, of which one had rheumatoid arthritis).

In the front plane LCS and Link series, we obtained good prostheses positioning in 39 cases (15 with rheumatoid arthritis). In the sagittal plane LCS and Link series, we reported 37 cases (12 with rheumatoid arthritis).

The posterior edge of the tibial component was in retroposition in 16 cases (on average by 4.5 mm). The retroposition was by 6 mm in case of rheumatoid arthritis (four cases).

Immediate follow-up

In 90 cases, the immediate consequences were positive: 41 of 46 in the Link-LCS series (four of 15 rheumatoid arthritis cases) and 49 of 66 in the Ramses series. Twenty-one cases of headline delay were observed – four in the Link-LCS series (one with rheumatoid arthritis with skin graft) and 17 in the series Ramses (three scabs with excision). These problems were noted in all series and could be due to tourniquet use. Therefore, it may be necessary to operate without a tourniquet, at least in cases of rheumatoid arthritis. These complications are indeed expensive, because patients must be hospitalized from 1 week to 54 days.

In cases of prior operation, skin was often damaged and soft tissue needed to be handled with particular care during the operation. We reported scars in 37 cases, atrophic skin in eight (Ramses series, rheumatoid arthritis), previous external fixators in three, and previous osteosynthesis in seven (posttraumatic arthritis).

We only had one case of deep infection (0.8%) in our series. This patient suffered from posttraumatic arthritis on a vicious callus of a supramalleolar fracture that was treated by osteosynthesis; the arthroplasty had been done at the same time as the correction of the vicious callus by osteotomy. A fistulization appeared 2 months after the operation, and it was necessary to do an ankle arthrodesis 7 months later. Three factors explain this type of complication: fragility of the soft tissues at the ankle, immunosuppressive treatment followed by patients with rheumatoid arthritis, and the iterative operations in cases of posttraumatic arthritis.

We noticed no cases of algo-neuro-dystrophic syndrome in our series and no early loosening. A prosthesis replacement was necessary in three cases in the Link-LCS series, always after the first 3 months postoeration: one case was for a lateral malleolar impingement and two were for prostheses nonfixation after 10 and 23 months.

An arthrodesis was performed in three Link-LCS series cases (because of either infection, loosening, or mechanical pain with reduction of walking 500 m; and in seven Ramses series cases at the first year (three cases of loosening and four of inframalleolar syndrome). We observed no neurological complications.

Inframalleolar syndrome with pain was noted in six Ramses series cases. In the Link-LCS series, X-rays revealed 12 cases of lateral impingement and three of medial impingement without pain. Shortening of the calcaneus tendon was noted in 28 Ramses series cases, eight of which were treated with operation.

In our series, 27 patients (24.5%) suffered from rheumatoid arthritis. We implanted 12 Ramses prostheses, 11 noncemented LCS prostheses, and four cemented Link prostheses. On average, patients were 54 years old. Twenty were sedentary, six were a little active, and one was very active. The issue of pain was important in 16 cases, and occurred during effort in 16 cases. In one case, this item was missing. We had three cases of valgus (8°), two of varus (7°), and ten of anterior subluxation (5–10 mm). Subtalar and Chopart joints were attempted in 21 cases. Most patients had had many operations before (hip, knee); only one had never had a lower-limb operation. In most cases, the ankle was well aligned. In one case, the forefoot was operated at the same time, but no arthrodesis of the back foot was performed. Follow-up for this group was 5.5 years.

We reported one skin problem that was solved after excision. We removed no implant. A bad positioning of the implant was noted in 18 cases – six in varus, five in valgus, three in equinus, four in retroposition of the talar implant, and four in anteflexion of the tibial implant. X-rays detected six radiolucent lines without loosening, the prostheses being stable. In one case, there was a loosening with impaction of the anterior part of the prosthesis, but evolution was good and the implant has not been removed.

We noted a motion of 10° in dorsal flexion and 20° in plantar flexion. The immediate results on pain reduction were good in 18 cases and fair in nine. There was no axial deviation. We observed five cases of lateral malleolar impingement. Orthopaedic shoes were necessary in two cases only.

Results

We reported results of 110 cases of prostheses: 66 Ramses cases and 44 LCS and Link cases. Follow-up for the first group was from 3–37 months and for the second group, 37 months.

Pain

In the majority of cases (73.9% at the third month and 86.4% at the last follow-up), ankle arthroplasty reduced pain. At the last follow-up, pain was absent or extremely low in 81.8% of cases; in nine cases, pain occurred at the slightest effort, and most of the time (six cases) pain was due to a supramalleolar syndrome that appeared during the first surgery. Of those six patients, four were reoperated with a tibiotalar arthrodesis (Table 4).

Mobility

Results for mobility were not as successful as those for pain. In the Link-LCS groups, at the latest follow up, dorsal flexion had decreased from 7° in the preoperative state to 45° in the postoperative state. In the Ramses group, global mobility was better; this improvement was certainly due to the lengthening of the Achilles tendon, which we performed more systematically (20 of 66 cases). Twenty-eight patients presented a ''short Achilles tendon syndrome,'' in which tendon extension restored dorsal flexion (Table 5).

Clinical deformity and shoe bearing

These item were studied in the Link-LCS series only. In the postoperative state, more patients presented deformation in valgus in comparison with the preoperative state. This deformation had no consequence on shoe bearing, since 90% of the patients wore normal shoes.

Function

This item was reported for the Ramses series only (Table 6). Only 31.8% of patients had a limited walking perimeter after surgery. Prior to surgery, more than two thirds of patients were limited in their walking – 24.2% could walk less than 1 k and three quarters limped; only 24.2% walked without limping. Fifty percent used stairs without pain and without the help of a banister, one-third needed to use a banister, and, for three patients, this function was impossible. The monopodal position was stable for 78.8% of patients and unstable for 21.2%. In most cases, monopodal instability was due to pain (20%). In two cases, the polyethylene meniscus was too thin, which determined monopodal instability, often because of pain (12 cases). Walking stability was good in 50% of cases; 21% had a dynamic stability on irregular ground.

Table 4 Pain result at final follow-up

None	18.2%
Exceptional	68.2%
After 500 m	6.8%
After a little effort	2.2%
Permanent	4.5%

Table 5 Mobility results at final follow-up

Type of flexion	Preoperative	Postoperative
Dorsal	7	45
Plantar	19.5	20

Table 6 Walking perimeter results in Ramses series

Not limited	31.8%
> 1 km	43.9%
< 1 km	24.2%

Radiological results

Radiological studies allowed assessment of implant positioning in front and in profile, as well as adaptation and adequacy between implant and bony structures. These studies were performed at 3 months for the Link-LCS group. Adequacy between implant and bony structures, as well as coupling of the prosthetic pieces between themselves, was very satisfactory. We should emphasize, however, that this item was reported in only 37 cases. It is worthwhile mentioning that the ancillary material for these prostheses was very rudimental, and assessment of implant positioning was sometimes difficult and not rigorous.

Study of the positioning of the tibial piece relative to the talar piece (at the posterior edge) at the third month showed good alignment in 21 cases only (45.7%).We often (25 cases) noticed a retroposition of the tibia relative to the talus (8 mm at the last follow-up). In the case of posttraumatic arthritis, this abnormality was due to repetitive talus dislocations.

At the three-month followup, radiological analysis in front showed a large number of prostheses (19%) implanted in varus (5°) for the tibial and talar pieces. This result was difficult to explain, since the same analysis performed at the last follow-up revealed an increased number of prostheses implanted in valgus (13.6%) (Table 7). At the last follow-up, on the frontal radiographs we also noted a large number of submalleolar impingement (54.3%), more particularly a lateral talomalleolar impingement (27.3%). On the sagittal X-rays, analysis showed a positioning in equinus of both tibial and talar pieces (54.3%), besides the frequent anterior subluxation. These results confirmed the difficult

Table 7 Deformity results at final follow-up

None	61.4%
Varus	4.5%
Valgus	13.6%
Medial rotation	4.5%
Lateral rotation	2.3%
Not indicated	13.6%

positioning of the prosthesis on the talus. Despite these abnormalities, most prostheses were congruent.

We studied the rate of loosening for both series at the last follow-up and found the rate was 81.8% in the SOTEST series and 95.5% in the Ramses series (Table 8). However, our follow-up was short. When present, the radiolucent line was tibial. In the cases of the two reoperated Ramses prostheses, an arthrodesis was performed.

Subjective appreciation

Most patients of both series were satisfied with the operation (80.4%). Only 4.4% were disappointed. The rest were lost to follow-up (Table 9).

Social and professional rehabilitation

Patients of the Ramses and Link-LCS series stopped working for 4 and 3 months, respectively. Twenty-nine patients went back to work (18 patients in the Link-LCS series, 11 in the Ramses series). Three patients performed intensive work. Twenty-four patients in the LCS series were retired. Two patients started a new job. In 12 cases, patients became invalid and stopped working (two cases of arthritis and ten of rheumatoid arthritis).

Particulars of rheumatoid arthritis cases

Among the 44 LINK-LCS cases, 15 concerned patients with rheumatoid localization, Results were slightly different from those of the global series. For these 15 patients, no pain was reported (100% versus 73.9% in the global series), and mobility was better in dorsal flexion (6) and remained the same in plantar flexion (21°). Articular congruency was good (86.7% versus 70.5% in the global series); and there was no real loosening, although 13.3% of cases were doubtful. Patients were satisfied in 93.3% of cases versus 88.6% in the global series. No patient was reoperated in this series (no arthrodesis, in particular).

In summary, our series confirmed the following published results regarding ankle prosthesis:

1. Clinical results in terms of pain and mobility were obtained 3 months after surgery; we noticed no significant improvement after this period.
2. Dorsal flexion results were poor; we would recommend using the lengthening of the Achilles tendon strategy.
3. Patients were generally satisfied after surgery, in particular those suffering from rheumatoid arthritis.

Table 8 Loosening at final follow-up

	Series type	
	Sotest	Ramses
No	81.8%	95.5%
Yes	4.5%	4.5%
Doubtful	6.8%	0%
Radiolucent line	6.8%	0%

Table 9 Satisfaction index at final follow-up

	Series type	
	Sotest	Ramses
Satisfied	88.60%	75.80%
Disappointed	11.40%	24.20%

Discussion

Resuls of second-generation implants were generally poor, and ankle arthrodesis in these cases gave better results at the 6- or 9-year follow-up. Kitaoka [9], in a series of 204 prostheses, experienced a 36% failure rate; the poor results were due to the patient age and anterior surgeries. Ankle mobility was poor also. Pyewich [19], in a group of 100 cases with a follow-up between 2 and 12 years, reported 55% painless ankles with a motion of 36° and 29% loosening. Jarde [8], in a series of 21 cases with a follow-up of 37months, reported five cases of loosening and two of infection. A subtalar arthrodesis was not recommended, and patients suffered frequently from postoperative pain Jarde recommended an ankle prostheses only for patients older than 60 years. Demottaz [4] reported on 21 cases at 15 months of follow-up and found 10% loosening. Functional score was better, but mobility was unchanged. He performed a study on walking capability, which revealed the leg muscles were not active and prosthetic mobility was not well used. Instead, there was compensation with the proximal thigh muscles. He also compared patients' pain after either arthroplasty or arthrodesis, which relieved pain in 19% and 85% of cases respectively.

On the other hand, other publications on arthrodesis reported good results: (76% for Morgan [18] and Bresler and Mole [1]), but these authors mentioned a loss of foot mobility in 70% of cases. Furthermore, damaging the subtalar joint was not symptomatic in the series of Bresler and Mole [1]. Nevertheless, arthrodesis presented some complications: infection is common and fusion is sometimes impossible to obtain (Cracciolo [3]). Helm [7], in a series of 47 cases with a followup of 50–63 months, observed two amputations and seven nonunions. Footing, walking on uneven ground, or walking without shoes was not possible. Duquennoy [5] reported positive results in only two-thirds of 52 patients with a follow-up of 7.2 years. Subtalar joint was often painful and stiff. the follow-ups were long (13 months on average), and returning to work was impossible in 47% of cases. In some cases, pain reappeared after 10 or 12 years, not only at the ankle but also at the forefoot. The new

arthroscopy technique has not improved these results and is not possible in all cases. Finally, arthrodesis does not have all the desired qualities, nor does it always provide good results.

Conversly, the latest publications on ankle arthroplasty indicate that third-generation prostheses give good results . Buechel [2] published his first results with a follow-up of 10 years at which time prosthesis survival was 75% and mobility gain 25%. Results were good in 85% of cases, with a minimal follow-up of 6 years. Kofoed [10, 11, 12] published results from 52 cases with a follow-up of 9 years. Prosthesis survival reached 75%, results were identical for both rheumatoid arthritis and arthrosis, subtalar joint was never degraded, and the functional score improved. He reported 11 failures and five revisions and obtained better results with noncemented implants. In another publication [13], he reported only one failure in a series of 20 patients and all active patients were able to return to work.

We need to elaborate on postoperative infection problems. After ankle arthroplasty, infection incidence is unfortunately high (up 30% in some series). However, our extent of infection incidence is relatively low (0.8%). It is interesting to compare this level of infection incidence with that of other arthroplasties (hip and knee, in particular). It varies from 1.18 to 2.63% for the hip arthroplasty and from 1.46 to 3.33% for knee arthroplasty (Centers for Disease Control, 1998). Our level of infection is good compared to that of other arthroplasties. On the other hand, it is important to mention the infection level in ankle arthrodesis. For MacGuire [15, 16], septic complications were very high. Extent of infection was lower for arthrodesis performed under arthroscopy, but this method is used only in cases of proper foot-prosthesis alignment.

All these results are a veritable rehabilitation of the ankle prosthesis. Our results agree to others previously published in the literature. Our series consisted only of third-generation prostheses and is therefore homogenous, although the number surgeons is high and the follow-up time short (from 3 to 4 years). Nevertheless, we can draw some conclusions: a small amount of complications, a good analgesic effect, an improved mobility, a short delay before returning to work (3–4 months), an increased walking perimeter, and a high degree of satisfaction among patients (80% on average).

We wish now to discuss the problem of the ankle prosthesis in rheumatoid arthritis. Tilleman [21] reported a series of 55 implants (41 patients). At the follow-up of 3.6 years, 91% had a functional joint; two arthrodeses were performed – two for necrosis and two for periarticular ossification. Giannini [6] reported six cases of rheumatoid arthritis in a series of 11 prostheses. Results were good without other precision. Kofoed [10, 11, 12] compared 25 cases of arthrosis and 27 of rheumatoid arthritis. Extent of failure was the same – five and six for arthrosis and rheumatoid arthritis respectively, and results were good for both groups.

Interestingly, the percentage of indication for rheumatoid arthritis is different in the north and south of Europe: it reaches 50–100% and 20–30% (25% in our series) respectively. Results are comparable in both parts of Europe. This fact is perhaps due to a more important development of the prosthesis in the north, according to the protocol of treatment. In all cases of rheumatoid arthritis, the ankle must be well aligned with the prostheses. Results are comparable in all series. Before performing the arthroplasty, it is possible to do an arthrodesis of the subtalar or talonavicular joint in order to stabilize the middle foot.

Conclusion

The ankle arthroplasty technique does not replace ankle arthrodesis. Each method has its own indications. For the prosthesis, the joint must be stable and well centered, the talus without necrosis, the malleolus normal or without vicious callus, the articular congruency good, and the subtalar joint well aligned. For cases that do not meet these criteria, arthrodesis reestablishes a normal walking axis and has a good analgesic effect. Prosthesis is indicated not only in the case of arthrosis but also in cases of rheumatoid arthritis. Presently, we recommend cementless implants, which have a low percentage of loosening. Postoperative immobilization is nevertheless necessary for 4–6 weeks.

We now provide some practical recommendations: Bony resections must be sufficient, with osteophytes excised; the insert must be sufficiently thick; and the implant must be correctly positioned, in particular, not too anterior on the talus. An articular surface of the malleolus is possible, in particular with the lateral malleolus, and, in cases of equinus, lengthening of the Achilles tendon is possible and results with this technique are now good.

Finally, although the future of ankle arthroplasty looks highly promising, it is wise not to jump to conclusions but rather wait for some years and additional surveys that prove without ambiguity the reliability of such surgical techniques. Alterior works are required in this field and toward this objective.

References

1. Bresler F, Mole D, Schmitt D (1994) Tibio-talar arthrodesis under arthroscopy. Rev Chir Orthop 80(8):744–748
2. Buechel FF, Pappas MJ (1988) New Jersey low contact stress total ankle replacement. Biomechanical rationale and review of 32 cementless cases Foot Ankle 8:279–80
3. Cracciolo A, Cimino WR, Lian G (1992) Arthrodesis of the ankle in patients who have rheumatoid arthritis. J Bone Joint Surg [Am] 74: 903–909
4. Demottaz JD, Mazur JM, Thomas WH, Pledge CB, Simon SR (1979) Clinical study of total ankle replacement with gait analysis. A preliminary report. J Bone Joint Surg [Am] 61:976–988

5. Duquennoy A, Mestdagh H, Tillie B, Stahl P (1985) Functional results of tibio-tarsal arthrodesis. About 52 reviewed cases. Rev Chir Orthop 71(4):251–261
6. Giannini S, Leonardi A, 0'Connor JJ (2000) Total ankle replacement; review of the design and the current status. Foot Ankle Surgery 6:77–78
7. Helm R, Stevens J (1986) Long-term results of total ankle replacement. J Arthroplasty 1(4):271–277
8. Jarde O, Gabrion A, Meire P, Trinquier-Lautard JL, Vives P (1997) Complications and failures of total ankle arthroplasty. A propos of 21 cases. Rev Chir Orthop 83(7):645–651
9. Kitaoka HB, Patzer GL, Ilstrop DM, Wallrichs SL (1994) Survivorship analysis of the Mayo total ankle arthroplasty. J Bone Joint Surg [Am] 76:974–979
10. Kofoed H (1986) A new total ankle joint prosthesis. In: Kossowsky N and Kossowsky R (eds) Material sciences and implant orthopaedic surgery. Nijhoff, Dordrecht pp 75–84
11. Kofoed H (2000) The prosthesis of the ankle. In: Ankle arthroplasty. Springer, Berlin Heidelberg New York
12. Kofoed H, Stürup J (1995) Comparison of the ankle arthroplasty and arthrodesis; a prospective series with long-term follow-up. The Foot 4:6–9
13. Kofoed H, Sorensen TS, Ranawat CS (1998) Total ankle replacement in rheumatoid arthritis. J Bone Joint Surg [Br] 80:328–332
14. Lord G, Marotte JH (1980) L'arthroplastie totale de cheville Expérience de 10 ans A propos de 25 observations personnelles Rev Chir Orthop 66:527–530
15. MacGuire MR, Kyle RF, Gustilo RB (1982) Total ankle arthroplasty and ankle arthrodesis; a retrospective evaluation of a series of patients in Minneapolis and Saint Paul. Orthop Trans 6:376
16. MacGuire MR, Kyle RF, Gustilo RB Premer RF (1988) Comparative analysis of ankle arthroplasty versus arthrodesis. Clin Orthop 226:174–181
17. Mendolia G and the Talus group (1997): la prothèse de cheville, Maîtrise orthopédique; février 1997
18. Morgan CD, Henke JA, Bailey RW, Kaufer H (1985) Long-term results of tibio-talar arthrodesis. J Bone Joint Surg [Am] 67:546–550
19. Pyevcih MT, Saltzman CL, Callaghan JJ, Alvine FG (1998) Total ankle arthroplasty. A unique design. Two to 12 year follow-up. J Bone Joint Surg [Am] 80(10):1410–1420
20. Takakura Y, Tanaka Y, Sogimoto K, Tamais, Masuhara K (1990) Ankle arthroplasty. A comparative study of cemented metal and uncemented ceramic prostheses. Clin Orthop 252:209–216
21. Tillemann K (1981) Surgical treatment of the foot in rheumatoid arthritis. Reconstr Surg Traumatol 18:195–204
22. Tomeno B, Cornic (1981) Que faut-il penser de l'arthroplastie de cheville. Rev Chir Orthop 67:141–145