Long-term behavior of ankle fusion: assessment of the same series at 7 and 23 years (19-36 years) follow-up

Comparaison des résultats d'une cohorte à 7 ans et 23 ans (19-36 ans) de recul

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RÉSUMÉ

Une dégradation fonctionnelle et radiographique à long terme est attendue après arthrodèse talo-crurale, mais cette notion n’a jamais été confirmée par l’analyse consécutive d’une même cohorte à deux reculs successifs. Le but de cette étude était de vérifier cette hypothèse par l’évaluation répétée d’une même population d’arthrodèses de cheville.

Une cohorte de 52 arthrodèses talo-crurales constituée et analysée en 1984 au recul moyen de 7 ans (2-22 ans) a été évaluée en 2000 selon les mêmes critères. Parmi les 52 patients, il y a eu 6 perdus de vue (11,5 %), 20 décédés (38,4 %) et un amputé de jambe, laissant 25 patients (48 %) éligibles pour l’étude et sur lesquels les résultats de 1984 et 2000 sont analysés. Il s’agissait de 25 patients (18 hommes, 7 femmes) âgés en moyenne de 62 ans +/- 12,6 (40-94 ans) lors de l’évaluation en 2000 au recul moyen de 23 ans +/- 4,5 (19-36 ans). L’évaluation fonctionnelle a été menée selon le score en 100 points de Duquennoy. L’arthrose des articulations sous-talienne et médiotarsienne a été évaluée en préopératoire et aux différents reculs avec une même cotation.

Il n’y a pas eu de dégradation significative du résultat fonctionnel entre 1984 et 2000, le score moyen passant de 65,8 +/- 22,6 (19-92) à 64,7 +/- 18,3 (34-90) (p = 0,67). Quinze patients (60 %) avaient un très bon ou bon résultat à 7 ans de recul, et 14 (56 %) à 23 ans de recul. Entre 1984 et 2000, dix patients avaient amélioré leur score (en moyenne 10,4 points - de 1 à 21), 2 patients avaient un score identique et 13 avaient réduit leur score (en moyenne de 10 points - de -1 à -24). Dix de ces 13 derniers patients avaient vu apparaître entre 1984 et 2000 des pathologies intercurrentes (cardiaques ou neurologiques) sévères qui expliquaient cette dégradation. Au recul, seize chevilles étaient indolores ou responsables de douleurs météorologiques. Douze patients considéraient leur cheville comme oubliée (score EVA à 10), et aucun ne regrettaient l’intervention pratiquée.


Notre étude disposant d’un très long recul et de deux évaluations successives avec les mêmes critères ne confirme pas la dégradation fonctionnelle tardive après arthrodèse talo-crurale. En revanche, la dégradation radiographique est indiscutable concernant surtout l’articulation sous-talienne, avec cependant une expression clinique rare et peu sévère malgré un recul minimal de 19 ans et sans arthrodèse complémentaire entre 4 et 23 ans de recul.

Mots clés : Arthrodèse de cheville, résultats à long terme, fonction, dégradation.

ABSTRACT

Purpose of the study

Theoretically, long-term functional and radiographic degradation is predictable after ankle fusion, but sound evidence from the consecutive analysis of the same cohort is lacking. The purpose of this study was to check the hypothesis by repeating assessment in the same cohort of patients who underwent ankle fusion.

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INTRODUCTION

Late failures after ankle fusion have been reported by several studies, notably in follow-ups of more than 10 years [Fuchs et al. [1], Coester et al. [2], Bertrand et al. [3]]. However, all these studies were retrospective and evaluated a given population with no idea of clinical or radiographic progression. It is commonly admitted that there is a late degradation around ankle arthrodesis, even though to our knowledge there has been no study evaluating arthrodesis in a single population with two successive follow-ups, the only objective means to confirm this notion. Similarly, most publications do not detail the initial stage of neighboring joint involvement [Fuchs et al. [1], Coester et al. [2]], the usual seat of painful deterioration. We should consider that the ankles with arthrodeses can be the seat of serious lesions, notably in the post-traumatic situation, involving other joints than the tibiotalar joint whose degradation can contribute to altering the functional result [Coester et al. [2]]. Following these observations, we repeated the evaluation of a population known to have ankle arthrodeses, already evaluated in 1984 [Duquennoy et al. [4]] and examined with the same clinical and radiographic protocol in 2000. The objective of this study was to specify whether functional and radiographic degradation existed after ankle arthrodesis. If such degradation was observed, we attempted to detail the extent and the onset delay.

MATERIAL AND METHODS

Material

In 2000 we evaluated a population of patients who had undergone arthrodesis constituted and analyzed in 1984 in a publication in the Revue de Chirurgie Orthopédique [Duquennoy et al. [4]]. This was a series of 52 arthrodesis procedures done between 1963 and 1981 in 52 patients (31 men, 21 women) aged 46.5 years at surgery. The mean follow-up at the 1984 evaluation was 7 years (range, 2-22 years). The evaluation of this cohort in 2000, 16 years later (mean, 23 years after the initial intervention), was made difficult because all the patients had moved. A systematic search for these patients in association with the police department and municipal governments, phone directories, general practitioners, and the national health insurance allowed us to find all but six members (11.5%) of the cohort. We were able to evaluate 25 arthrodeses clinically and radiographically in 25 patients, 48% of the initial cohort. Twenty patients had died (38.4%) and one patient had undergone amputation of the leg for osteoarthritis in 1994. The mean age of these 25 patients (18 men, 7 women) was 62 years ± 12.6 (range, 40-94 years) at the time of evaluation in 2000 and the mean follow-up was 23 years ± 4.5 (range, 19-36 years). The indication for arthrodesis was tibiotalar degradation secondary to trauma in 23 cases (17 bimalleolar fractures (nine of which were...
open fractures), two fractures of the tibial pilon and two enucleations of the talus complicated by necrosis), and two neurological sequelae (one case of poliomyelitis and one case of sciatic paralysis). The surgical technique varied, reflecting 18 years of practice in a university hospital unit before 1981: Meary technique 13 times, Charnley technique six times if there was a history of sepsis or severe deformation, Crawford-Adams technique four times, and two cases of trans-articular fixation with cylindrical bone autograft pinning according to Duquennoy and Soulier. Five ankles had undergone subtalar arthrodesis at the same time as tibiotalar fusion because of symptomatic osteoarthritis in this joint.

**Evaluation method**

The evaluation was conducted retrospectively on the 25 patients according to the clinical and radiographic criteria that had been used in 1984. The functional evaluation was conducted according to the 100-point score reported in Duquennoy et al. [4]. Beginning with the observed value, four categories were designated: “very good” if the score was 81 points or greater (corresponding to a pain-free ankle with no other discomfort), “good” if the score was between 61 and 80 points (the patient had some pain after exercise or walking, described a slight instability on rough terrain, and declared discomfort when coming down stairs), “fair” for a score between 31 and 60 points (the walking test was limited, the patient suffered in daily activities, and limped substantially), “poor” if the score was less than 31 points (severe invalidity). X-rays included a Meary frontal view, a lateral view of the weightbearing view of the ankle, and lateral views of the ankle and foot in maximum plantar flexion and extension. The sagittal position of the arthrodesis was determined on the lateral image as measured by the angle between the talus axis and the tibial diaphysis axis (the position was neutral when the angle measured 105°). The position of the arthrodesis in the frontal plane was judged on the Meary-type image (the position was neutral when the tibial axis crossed the junction of the internal third and external two-thirds of the heel). Subtalar and mediotarsal joint arthrodesis was evaluated preoperatively and at the follow-ups in 1984 and 2000 according to the same grading detailed in *table I*.

In addition to the assessment following the 1984 protocol, we analyzed the functional result using an analogic satisfaction index varying from 0 (poor result) to 10 (ankle forgotten). Finally, the forefoot’s range of movement was measured radiographically on lateral images of the ankle and foot in maximum plantar flexion and extension. The variation of the angle between the axis of the first metatarsal and the axis of the tibial diaphysis indicated the forefoot’s range of movement value.

**Statistical methods**

We used nonparametric tests to compare the numeric data (Mann-Whitney U test) and the chi square test with Yates correction to compare the categorical data. A *p*-value of 0.05 was used for significance.

**RESULTS**

**Functional results**

There was no significant deterioration of the functional result between 1984 and 2000, with the mean score changing from 65.8 ± 22.6 (range, 19-92) to 64.7 ± 18.3 (range, 34-90) (*p* = 0.67). If the results are grouped into four categories from very good to poor (*table II*), between 1984 and 2000 the results in the good and fair groups were closer together, with fewer patients with very good results but also the disappearance of the poor results. Fifteen patients out of 25 (60%) had very good or good results at 7 years of follow-up and 14 (56%) at 23 years of follow-up. Between 1984 and 2000, ten patients improved their score by a mean of 10.4 points (from 1 to 21), two patients retained an identical result, and 13 patients observed a reduction in their functional score by a mean of 10 points (from -1 to -24). Between 1984 and 2000, ten of these 13 patients experienced onset of severe intercurrent pathologies that explained this functional degradation (four cases of congestive heart failure, two amputations of the contralateral leg because of arteritis, two cases of severe obesity (BMI>30), one case of evolving Paget disease, and one case of hemiplegia). These intercurrent problems contributed to reducing the results of the walking test, increasing the difficulty in climbing stairs and running, which had

**table I.** *X-ray evaluation of the severity of subtalar and transverse tarsal joint osteoarthritis.*

<table>
<thead>
<tr>
<th>Stage</th>
<th>Subtalar joint</th>
<th>Transverse tarsal joint</th>
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<tbody>
<tr>
<td>AR0</td>
<td>No sign of osteoarthritis</td>
<td>No sign of osteoarthritis</td>
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<tr>
<td>AR1</td>
<td>Pre-osteoarthritis with posterior marginal, condensation of surfaces</td>
<td>Isolated osteophyte on the dorsal side of the talus with no interline changes</td>
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<tr>
<td>AR2</td>
<td>Clear osteoarthritis with posterior subtalar narrowing, condensation and posterior osteophytosis</td>
<td>Partial narrowing, condensation, and osteophytes</td>
</tr>
<tr>
<td>AR3</td>
<td>Partial or complete posterior narrowing with anterior subtalar involvement</td>
<td>Complete narrowing</td>
</tr>
<tr>
<td>FUS</td>
<td>Fusion with complete disappearance of joint space</td>
<td>Fusion with complete joint space disappearance</td>
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Finally, of the 17 patients who did not participate in sports, seven had stopped a former activity, but the decision was not related to the arthrodesis, and ten could not take part in sports because of the arthrodesis, but more particularly because of a limitation related to the intercurrent diseases (the ten cases cited above). At the mean follow-up of 23 years, the assessment on an analogic scale revealed that 12 patients considered their ankle forgotten (VAS 10), and the mean index of satisfaction for the 25 patients was 9.1. None of the patients regretted the ankle surgery. On clinical examination, 11 patients retained subtalar mobility (painful in only four cases) and 14 had complete stiffness (nine of which had surgical fusion). Transverse tarsal joint range of movement was maintained and pain-free for 23 cases (two surgical arthrodeses).

Radiographic results

In the frontal plane, 12 ankles were centered, eight were in valgus (six at 10°, one at 15°, one at 20°), and four were in varus (one at 5°, two at 10°, and one at 20°). The ankles in varus had a mean score (58 points) lower than the centered ankles (65 points) or the ankles in valgus (67 points), but without reaching the significance threshold (p = 0.3). In the sagittal plane, 11 ankles were centered (talus neck/tibial axis angle at 105°), six showed an equinus of 5°, five an equinus of 10°, and two were positioned in talus 5° and 10°. The position of the arthrodesis in the sagittal plane showed no significant difference on the functional score.

The progression of the subtal joint concerned only 16 cases because nine ankles had surgical arthrodesis (five at the time of tibiotalar arthrodesis and four done within 4 years of the tibiotalar arthrodesis because of painful degeneration demonstrated on x-ray). The progression of these 16 cases, detailed in fig. 1, showed that overall all the subtalar joints became osteoarthritic and that the situation worsened between 1984 and 2000, the majority proceeding from stage AR1 (arthrodesis level 1) to stage AR2. On the other hand, this arthrosis was symptomatic in less than one out of three cases when including the four subtal secondary arthrodeses (done within 4 years) and the four ankles with pain at subtalar mobilization at the maximum follow-up. For the transverse tarsal joint, the progression detailed in fig. 2 only concerns 23 cases because there were two arthrodeses for early deterioration within 4 years of the talocrural arthrodesis. Overall, for the transverse tarsal joint, the deterioration occurred later and was less severe than for the subtal joint, with the majority having stage AR1 at 23 years of follow-up. Radiographic assessment of the midfoot mobility showed the following range of movement: five cases with a 25° or greater range of movement, five cases with 20° range of movement, six cases with 15°, six cases with 5°-10°, and two cases with no mobility (corresponding to the two surgical arthrodeses of the midfoot). Ten ankles had hypermobility greater than 15° retained as greater than normal [Bertrand et al. [3]], which was painless and had no influence on the functional score. We considered this hypermobility occurred to compensate the stiffening related to

<table>
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<th>TABLE II. – Progression of the Duquennoy 100-point functional score for 25 patients at a mean 7 and 23 years of follow-up.</th>
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<tr>
<td>Poor 1984 (n = 3)</td>
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<tr>
<td>Fair 1984 (n = 7)</td>
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<tr>
<td>Good 1984 (n = 5)</td>
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<tr>
<td>Very good 1984 (n = 10)</td>
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“Very good” indicates a score ≥ 81 points, “good” if the score is between 61 and 80 points, “fair” if the score is between 31 and 60 points, “poor” if the score is < 31 points. There was no significant change in function: 65.8 ± 22.5 (range, 19-92) in 1984 and 64.7 ± 18.3 (range, 34-90) in 2000 (p = 0.67).
influencing the functional results was the onset of intercur-
ble deterioration after ankle fusion. Finally, the main factor
in the same population, indispensable for detecting a possi-
study is the only one to have two consecutive assessments
only a mean of 9.3 years of follow-up. Most notably, our
evaluated 24 cases with a mean follow-up of 12.8 years,
rent diseases, related to age and to the long follow-up
period and two successive evaluations using the same crite-
ria, did not confirm the concept of a late functional deterio-
ration after tibiotalar arthrodesis. However, the degradation
visible on x-rays is indisputable, particularly in terms of the
subtalar joint, although clinical expression is rare (less than
one-third of patients complain of pain on mobilization) and
slight despite a minimum follow-up period of 19 years
(no complementary arthrodesis between 4 and 23 years of
follow-up). Our sample was a small one, but it was larger
than the samples in other publications analyzing ankle
arthrodoses with a 20-year follow-up. The mean follow-up
period in our study was longer (23 years) and was com-
pared to ankle replacement, arthrodesis is consi-
dered palliative surgery, particularly if compared to the
results in terms of mobility and gait quality [Trouillier et al.
[6], Valderrabano et al. [7], Beyaert et al. [8]]. However,
contrary to total ankle replacement, our study showed the
very-long-term reliability of arthrodesis, since there were
only six complementary fusions (two in the transverse tarsal
joint and four in the subtalar joint, all early and within
4 years) and there was no significant functional deteriora-
tion between the follow-up at 7 and 23 years. The comple-
mentary arthrodesis rate seems high (24%) but those done
in our series, within 4 years, stem more from the influence
of the initial trauma than early degradation of the adjacent
joints. We should emphasize that ankle arthroplasty is not
exempt from secondary arthrodesis in the same region: in a
meta-analysis on 1086 third-generation prostheses, Stengel
et al. [9] reported 6.3% secondary arthrodesis after only
5 years of follow-up. Our study confirms the repercussions
seen on x-ray of tibiotalar arthrodesis on the subtalar joint
that has already been observed with the same frequency in
other studies: Fuchs et al. [1] observed 14 cases of severe
osteoarthritis out of 18 and two features of spontaneous
fusion of the subtalar joint at 23 years of follow-up. As in
our work, these authors underlined the relatively good toler-
arance found, since these lesions did not affect the SF-36
core [Fuchs et al. [1]]. The fear that ankle fusion may have
an influence on the subtalar joint therefore seems warranted,
but mainly from a radiographic point of view, since even
after more than 20 years, its clinical expression is limited.
This negative progression of the subtalar joint should
undoubtedly be minimized since it is observed long after the surgery (> 20 years), i.e., after the longest follow-up periods for ankle prostheses: 9.4 years for Kofoed [10], 12 years for Buechel et al. [11], 9 years for Knecht et al. [12], and 9 years for Kitaoka and Patzer [13]. In addition, the long-term behavior for the subtalar joint after ankle replacement is not currently discussed. To our knowledge, only Knecht et al. [12], after a mean follow-up of 9 years, have reported arthritic progression of the subtalar joint in 19% of their series, and in 15% for the transverse tarsal joint, although they give no information on the clinical repercussions. The position of the ankle arthrodesis influences the restrictions and progression of the subtalar joint [Wayne et al. [14]], but this was not confirmed in our study, undoubtedly because of the small sample size and the very long follow-up period, which may be of greater influence than the position of the fusion (which in our population was for the most part within the limits of the current recommendations).

The progression of the transverse tarsal joint seems less unfavorable and in ten cases out of 25 showed compensating hypermobility. The better tolerance of the transverse tarsal joint was already underscored by Fuchs et al. [1] who observed only seven of 18 cases of severe arthrosis at 23 years of follow-up, but without specifying the time to lesion appearance. Our study showed that this deterioration was later than for the subtalar joint, which occurred within 10 years, with aggravation until 20 years, whereas the transverse tarsal joint was had deteriorated particularly beyond the 7-year follow-up. The in vitro biomechanical data showed that the tibiotalar locking only slightly modified the restrictions in the midfoot, notably in terms of the substantial modifications in the subtalar joint [Wayne et al. [14]]. The compensating hypermobility of the transversal tarsal joint does not stem exclusively from the ankle arthrodesis, since this is also observed with arthroplasty: Coetzee and Castro [15] observed a mean gain in range of movement since this is also observed with arthroplasty: Coetzee and Patzer [13]. In addition, the long-term behavior for the subtalar joint after ankle replacement is not currently discussed. To our knowledge, only Knecht et al. [12], after a mean follow-up of 9 years, have reported arthritic progression of the subtalar joint in 19% of their series, and in 15% for the transverse tarsal joint, although they give no information on the clinical repercussions. The position of the ankle arthrodesis influences the restrictions and progression of the subtalar joint [Wayne et al. [14]], but this was not confirmed in our study, undoubtedly because of the small sample size and the very long follow-up period, which may be of greater influence than the position of the fusion (which in our population was for the most part within the limits of the current recommendations).

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Fuchs et al. [1] observed satisfactory long-term functional tolerance since two out of three of their patients had little or no functional difficulty during work more than 20 years after their ankle arthrodesis. We observed the same tolerance for sports activity, and, as in the study by Coester et al. [2], none of the patients regretted the surgery that they had undergone.

Several authors consider that arthrodesis should be reserved for contraindications for total ankle replacements and their failures [Kofoed [10], Buechel et al. [11]]. However, conversion of a failed ankle prosthesis to a fusion is a difficult procedure: Carlsson et al. [16] reported 38% of nonunions that required repeated surgery and Gabrion et al. [17] reported 12% nonunions. Moreover, Gabrion et al. [17] emphasized that the result of ankle arthrodesis after ankle replacement is less good than primary fusion. The contribution of arthroscopy to the ankle arthrodesis procedure is seductive because of reduced incision [Pierre et al. [18], Winson et al. [19]] and for Zvijac et al. [20] because of a shorter time to healing than the open technique. This technical progress should not allow one to forget that the main principle is to obtain fusion with proper orientation. The technique using arthroscopy has not yet demonstrated its superiority in terms of healing (7.6% nonunions for Winson et al. [19], 15% for Pierre et al. [18]), nor in terms of fusion orientation (three out of four equinus for Pierre et al. [18], and 12% equinus greater than 7° for Winson et al. [19]), and its indications should be taken cautiously, limiting them to deformations that are not very severe with no advanced necrosis of the talus.

CONCLUSION

The classical notion of late functional degradation after ankle arthrodesis has not been confirmed with this study, which, in addition to the longer follow-ups and the higher number of cases published today, provides a consecutive evaluation of a single population. On the other hand, the deterioration of the underlying joints seen on x-ray is indisputable, particularly pronounced and early for the subtalar joint, less severe and later for the transverse tarsal joint. This study can serve as a basis of comparison in terms of survival rates and functional objective for the long-term analysis of ankle arthrodeses and replacement.

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