

ORIGINAL PAPERS

Secondary subtalar arthrodesis using the Vira system for treating the sequelae of calcaneus fractures

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PALABRAS CLAVE

Fractura de calcáneo;
Secuelas;
Artrodesis
subastragalina;
Osteotomía de calcáneo

Abstract

Purpose: To assess the efficacy of the Vira[®] system for the treatment of calcaneal fractures by means of a secondary subtalar arthrodesis.

Materials and methods: We prospectively assessed 23 secondary subtalar arthrodeses. Eighteen cases were "in situ" arthrodeses, 4 out of them were combined with a lateral decompression and 5 were corrections of malunions by means of calcaneus osteotomies. All cases were addressed with the Vira[®] system, without bone grafting. Mean time to surgery was 22 months. A clinical assessment using the AOFAS scale, and a radiographic and CT-evaluation were performed.

Results: Mean preoperative AOFAS scale was 41.1 points, with a score of 71.6 points being reached at the end of follow-up. All but 3 of the 11 patients without disability returned to their usual occupations. Mean temporary disability in the patients that were discharged was 123 days. There were 2 cases of delayed healing of the subtalar arthrodesis; these had to be reoperated with an autologous graft. There were no surgical or postsurgical complications.

Conclusion: The Vira[®] system is efficient for secondary arthrodesis, providing the patient with enough stability to permit early weightbearing and rehabilitation. It also assures a high healing rate with no need for additional bone grafting.

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Artrodesis subastragalina secundaria mediante el sistema Vira[®] en el tratamiento de las secuelas de las fracturas de calcáneo

Resumen

Objetivo: Evaluar la eficacia del sistema Vira[®] en el tratamiento de las secuelas de las fracturas de calcáneo mediante artrodesis subastragalina secundaria.

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Material y métodos: Evaluamos prospectivamente 23 artrodesis subastragalinas secundarias. Dieciocho casos fueron artrodesis in situ; 4 de ellas asociaron descompresión lateral y 5 fueron correcciones de consolidación viciosa mediante osteotomía de calcáneo. En todos los casos, la fijación se realizó con el sistema Vira® sin injerto. El tiempo medio de evolución desde la fractura fue de 22 meses. Se realizó una evaluación clínica mediante la escala AOFAS y una evaluación radiográfica y de TAC.

Resultados: La puntuación media en la escala AOFAS previa a la cirugía fue de 41,1 puntos y se alcanzaron 71,6 puntos al final del seguimiento. De los 11 pacientes sin incapacidad volvieron a su ocupación habitual todos, salvo 3. La media de incapacidad temporal en los pacientes a los que se les dio el alta fue de 123 días. Dos casos presentaron retardo de consolidación de la artrodesis subastragalina y precisaron reintervención con injerto autólogo. No se registraron complicaciones quirúrgicas ni posquirúrgicas.

Conclusión: El sistema Vira® es eficaz en la artrodesis secundaria y aporta estabilidad suficiente para permitir el apoyo y la rehabilitación precoces, con una elevada tasa de fusión, sin necesidad de injerto óseo adicional.

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Introduction

The most frequent complication found in the long-term evolution of intra-articular calcaneus fractures is the degeneration of the subtalar joint.^{1,2} Such is the case that the long-term results of surgical or conservative treatment of these fractures is fundamentally conditioned by the grade of arthrosis of the subtalar joint and the symptoms expressed by the patient.³ Reduced viability of the articular cartilage has been shown to follow calcaneus fractures,⁴ and may be the cause of mid and long-term post-traumatic degeneration, even following a perfect surgical restoration of the joint. The incidence of subtalar post-traumatic degeneration is variable, as no reliable research exists on the subject; the energy of the trauma itself, the severity of the fracture, the type of treatment, and occupational activity are all possible factors that influence its development.³

The most highly touted treatment for symptomatic subtalar arthrosis following a calcaneus fracture is arthrodesis, which at times is accompanied by procedures such as lateral decompression or corrective osteotomy.

The Vira® system was initially designed for surgical treatment of severe articular fractures of the calcaneus, where it acts as a minimally invasive primary reconstruction-arthrodesis system.⁵⁻⁷ However, its use has also been indicated in the treatment of severe calcaneus fracture sequelae by means of secondary subtalar arthrodesis. The objective of our study is to evaluate the efficacy of this treatment, possible applications, and results in this type of case.

Materials and methods

We performed a prospective analysis of 23 patients diagnosed with symptomatic subtalar arthrosis following calcaneus fractures who were treated with secondary subtalar arthrodeses with a minimum follow up period of one year. All patients were treated between November 2006 and November 2008, with a mean 18-month follow-up

period (range: 12 - 24 months). The treatment of the initial fracture was conservative in all cases, and the mean time for development of the condition since the initial procedure was 22 months (range: 13 - 65 months).

The patients included in this study were all male, with a mean age of 47 years (range: 29 - 55 years), of which 13 (56.5%) were habitual smokers.

In 11 of the patients, the initial lesion classified as a Sanders⁸ grade IV; in 3 patients it classified as a grade III, and in one case it classified as a grade II. It was impossible to establish the grade of initial fracture for the remaining 8 cases due to lack of data since the patients had been treated at other clinics. We used the Rammelt and Zwipp⁹ classification system for preoperative evaluation of the patients' condition. Following this method, 12 patients were evaluated as type I, post-traumatic arthrosis without misalignment; 7 patients were type II, varus or valgus of the hindfoot; and the remaining 8 patients were type III, with a loss of height. We did not register any type IV patients, with lateral calcaneus translation, nor any type V, with talar inclination.

Regarding surgical procedure, *in situ* arthrodeses were performed in 18 cases; 4 of these cases were accompanied by lateral decompression and 5 were accompanied by corrections of malunions through calcaneus osteotomy. Lateral decompression was indicated by symptoms presented by the patient.

Different techniques were employed for calcaneus osteotomies, depending on the deformity and the required corrections (fig. 1). Romash's¹⁰ technique for sliding and valgus repositioning of varus deformities and raising the tuberosity was used in 2 cases. In 2 other cases an external wedge subtraction and internal addition were performed for non-flattened varus hindfoot, and in one case a distraction osteotomy was performed to reposition the subtalar joint itself to correct the valgus deformity.

In all cases, fixation was performed using the Vira® system using the same bone material drilled out from the implant placement as a graft. The instrumental system guider was used to place the implant and to reposition the great tuberosity of the calcaneus in those cases where osteotomy

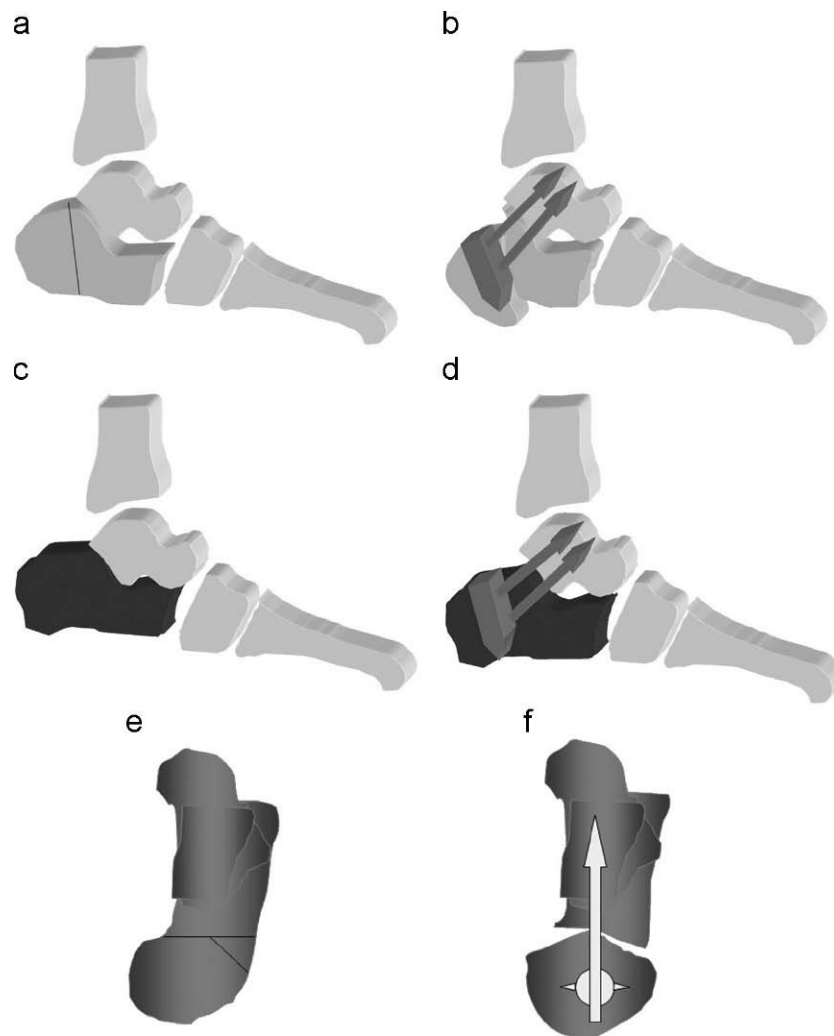


Figure 1 Schematic depiction of the corrective techniques used in this study. a and b) Romash type sliding osteotomy with valgus repositioning. c and d) Distraction and varus repositioning. e and f) Addition-subtraction wedge osteotomy with valgus repositioning.

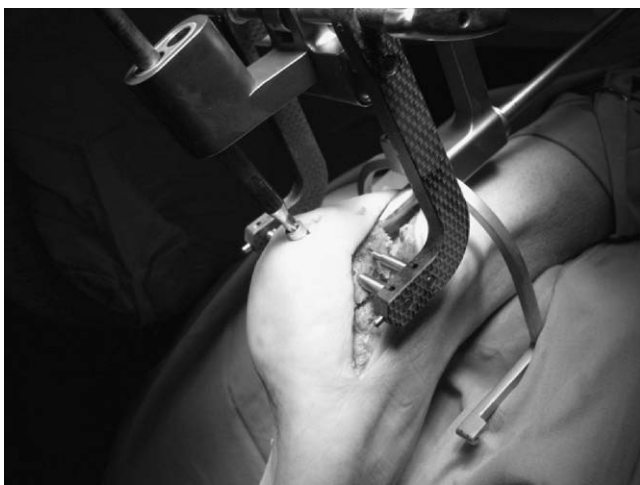


Figure 2 Intraoperative image of the insertion of the implant with the application guider in position, taken during a sliding osteotomy.

was required (fig. 2). Following surgery, immediate weight bearing was allowed without need for immobilization.

Patients were clinically evaluated using the AOFAS scale,¹¹ and lateral and axial radiographs of the calcaneus were taken to measure the Böhler angle, as well as CT scans at a 4-month follow-up to check on the progress of fusion and alignment (fig. 3).

All patients included in the study signed specific informed consents. One of the authors who was not present at the surgeries (TS) gathered and reviewed the data.

The results of the two groups were analyzed as non-parametric samples using the Mann-Whitney U test.

Results

Clinical evaluation

Mean patient score on the AOFAS scale prior to surgery was 41.1 points (range: 24-66 points) and the general clinical

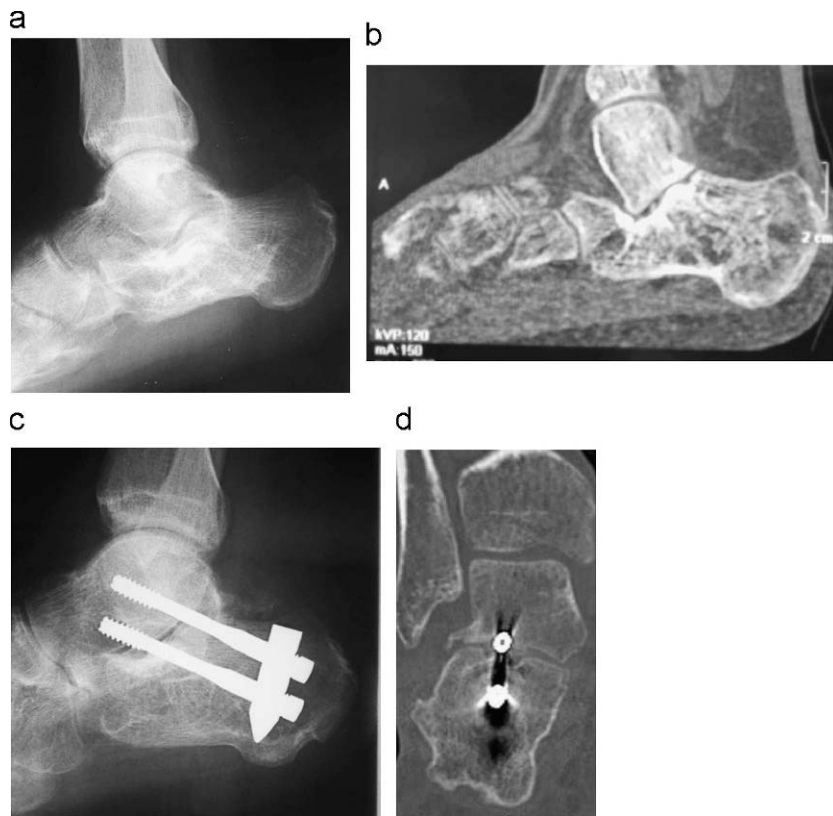


Figure 3 An illustrative case of the study of a secondary subtalar arthrodesis with correction by distraction. a) Preoperative radiograph. b) Preoperative CT scan. c) Final follow-up radiograph in which the position of the implant and the improved Böhler angle can be observed. d) CT at 4 months post-operation. Observe the consolidated graft at the centre of the subtalar joint that surrounds the implant.

evaluation according to the AOFAS scale reached a mean of 71.6 points. According to an independent analysis of the results, *in situ* arthrodeses without correction averaged a preoperative score of 50.5 points and a postoperative score of 74.9 points on the AOFAS scale, while in the cases with osteotomies, the original mean score was 34.4 points, and the score following surgery was 63.3 points. The clinical results were significantly better ($p < 0.001$) in the cases of *in situ* arthrodeses, although osteotomy patients showed greater improvement with respect to initial condition.

Occupational evaluation

12 patients suffered from a complete incapacitation previous to the surgical intervention. Of the 11 patients without major incapacitation, all were able to resume their occupational activities except for three that, following an evaluation by the Spanish Institute of Social Security, were conferred full disabled status. The mean temporary incapacity in patients who were discharged was 123 days.

Radiographic evaluation

The mean preoperative Böhler angle in cases of *in situ* fusion was 11.29° (range: $0-40^\circ$). In patients who required corrections, the mean angle was -4.7° (range: -10 to 20°).

Following osteotomy, the mean was 9.3° (range: $0-30^\circ$), which remained stable throughout the follow-up period.

All osteotomies showed consolidation; in 4 cases, the correction obtained was considered satisfactory and in one case it was considered insufficient. Consolidation of the subtalar arthrodesis was delayed in two cases that were treated by *in situ* arthrodesis (8.6%). The 4-month radiographic analysis showed osteolysis around the screws placed in the talus and a lack of bone bridges. Both cases required consistent reinterventions to remove the implant and cruentate and provide graft support, finally achieving consolidation.

Complications

Two cases presented minor complications: one case of slow healing and one of persistent discomfort in the Achilles heel. Both issues were resolved by the end of the follow-up period. No major complications were recorded.

Discussion

60% of patients who receive conservative treatment for intra-articular fractures of the calcaneus require an intervention for the treatment of sequelae at some point.⁸

In general, this intervention is a secondary subtalar arthrodesis, which must be accompanied by a canalicular decompression or correction of deformities.

According to Csizky et al,¹² the prognostic factors that favour a late subtalar arthrodesis in displaced fractures of the calcaneus are, in order of importance, a negative Böhler angle, patient occupation, grade IV fractures, and having received a previous conservative treatment. In contrast, a correctly performed surgical treatment of intra-articular calcaneus fractures avoids complications and sequelae on a long-term basis.¹³ However, the conservative treatment is preferred by many traumatologists even today,¹⁴ hence it is common to receive patients presenting with sequelae.

Multiple techniques exist for arthrodesis of the subtalar joint, whether *in situ* or accompanied by decompression or correction. The most commonly used surgical approach is the external submaleolar, which permits good access to both subtalar joints, although it is more radical than the posterior approach.¹⁵ Some articles on arthroscopic arthrodesis techniques have also been published with encouraging results.¹⁶

Regardless of the chosen approach, it is best to set the joint with osteosynthesis material in order to avoid long periods of immobilization.¹⁷ Various articular fixation systems have been proposed, such as staples, screws, needles, and even plates, in order to promote bone fusion and reduce the convalescence period of the patients. When accompanied by a corrective osteotomy, the stability achieved using implants is even greater, maintaining the correction, ensuring consolidation, and avoiding the need for immobilization.

The Vira[®] system was designed to bear the heavy mechanical demands on comminuted fractures of the calcaneus, where it acts as an implant for primary reconstruction-arthrodesis. This system sports various advantages.⁵ Firstly, the stability and resilience of the implant permit immediate weight bearing by the patient, even following an osteotomy; secondly, an additional bone graft is unnecessary, as the bone material removed during screw placement should be sufficient, and finally, its minimally invasive methods avoid the complications inherent to extended approaches for the hindfoot, above all in corrections, where the guided reduction system is very useful.

The population studied by this project is heterogeneous with cases that fit all 3 of the different types of sequelae following calcaneus fractures according to the Pammelt and Zwipp classification.⁹ Furthermore, the number of patients and the follow-up time limited the validity of the analysis. However, we believe it to be useful to group these patients with the goal of testing the implant in different conditions. These circumstances obliged us to separate the clinical results from patients with and without correction, since cases with greater deformities that required an osteotomy started with significantly worse clinical evaluations and attained lower final scores at the end of the follow-up. According to Huang et al,¹⁸ the cases that present with severe deformities show significantly worse results from *in situ* fusion than those achieved when accompanied by a sliding osteotomy, which is why this treatment is recommendable in cases of clinically relevant malunion.

Following a literature review of similar studies, we can highlight the work done by Bednarz et al¹⁹ with 23 patients treated using subtalar arthrodesis, who averaged an AOFAS

score of 75 points at their 33-month follow-up, with 4 (14.2%) instances of unsuccessful fusion and one infection. Jardé et al,²⁰ in their study of 57 patients, recognized the value of subtalar arthrodesis in the treatment of calcaneus fracture sequelae, and conclude that this treatment is effective in 2 out of 3 cases. Thermann et al²¹ evaluated 17 patients with secondary arthrodeses, who averaged an AOFAS score of 69 points, while those treated by primary arthrodesis averaged a score of 88 points. Burton et al,²² in their 15-patient study with over 2 years of follow-up, found a mean score of 76.1 points following subtalar arthrodesis for calcaneus fractures in their clinical evaluation. Finally, Flemister et al²³ achieved a global mean of 75 points on the AOFAS scale for 86 cases treated by arthrodesis, with 4 (4.6%) cases of unsuccessful fusion and 4 (4.6%) infections. However, the most positive results published correspond to Chen et al²⁴: 32 patients intervened using subtalar distraction arthrodesis averaged 83 points on the AOFAS scale for a maximum of 92 points, with 2 cases of unsuccessful fusion and no negative results.

Arthroscopic subtalar arthrodesis is also producing excellent results. Glanzmann and Sanhueza-Hernández¹⁵ presented 39 cases of subtalar arthrosis of various origins, and achieved a mean of 84 AOFAS points without complications or unsatisfactory results.

Our study achieved the most modest clinical results, but one must bear in mind that this study was performed with the workplace in mind, where the influence of a possible economic compensation may condition the results in the majority of diseases, the sequelae of calcaneus fractures being no exception. Working patients are not only 3 times more likely to require a secondary arthrodesis, but also the results of this procedure are worse than in the normal population.¹¹ In spite of these circumstances, the results presented in this study are encouraging and achieve an elevated level of satisfaction with a rate of unsuccessful consolidation that is in line with the medical literature.

The incidence of complications is low, even more so if we take into consideration that this is a surgical procedure of the calcaneus. In this respect, the Vira[®] system meets the objectives of any minimally invasive surgery, with high effectiveness and a low rate of complications by being a less aggressive surgical procedure. As such, it is a useful technique for the surgical treatment of sequelae of intra-articular fractures of the calcaneus and provides the advantages of a low rate of complications, an elevated stability allowing immediate weight bearing, and a minimally invasive procedure without the need for an additional bone graft.

Conflict of interest

One of the authors (F L-O M) is the designer of the Vira[®] system and owner of the corresponding patent. The rest of the authors affirm that they have no conflicts of interest.

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