



Primary fusion in worker's compensation intraarticular calcaneus fracture. Prospective study of 169 consecutive cases

Felipe López-Oliva^{a, *}, Tomás Sánchez-Lorente^b, Adela Fuentes-Sanz^c, Yolanda Aldomar-Sanz, Francisco Forriol^d

^a Department of Orthopaedic Surgery, Fundación Jiménez Díaz, Madrid; ^b Hospital de Talavera, Madrid; ^c MATSS n 61, Majadahonda, Madrid; ^d University CEU, Boadilla del Monte, Madrid, Spain

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ABSTRACT

Purpose: To study the results of reconstruction and primary fusion in worker's compensation intraarticular calcaneus fractures.

Patients and Methods: We carried out a prospective study of 169 acute intraarticular calcaneus fractures treated by reconstruction and primary fusion with the minimally invasive Vira[®] system, in severe calcaneus fractures. The evaluation was performed by clinical, radiological and biomechanical analysis.

Results: AOFAS score averaged 77.26 points at the end of follow up. Forty-two cases (24.9%) obtained excellent results, 108 (63.9%) good, 12 (7.1%) mild and 7 (4.1%) poor. The improvement in Böhler's angle after surgery was significant ($p = 0.05$) and this did not vary during the follow up. Subtalar arthrodesis was achieved in all cases and only three cases needed bone grafting. Five major post-surgical complications were observed, and one deep infection in a case of open Gustilo Grade III fracture. In the kinetic study, the support time of the operated foot was lower than that of the contralateral foot ($p < 0.21$). The axial force of the heel contact and the single limb support of the operated foot reduced the toe-off axial forces. In the foot with arthrodesis the posterior forces increased ($p < 0.01$). The pressures were lower in the region of the heel and the mid-foot and in the external part of the forefoot, and increased in the big toe.

Conclusions: Calcaneal workplace injuries are challenging to treat. Primary subtalar fusion with a minimally invasive method allows rapid recovery for these patients with a satisfactory clinical, functional and radiological outcome.

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Introduction

The vast majority of calcaneal fractures present after high-energy trauma and can have a direct impact on the function of the subtalar joint.¹ The patient profile frequently consists of a male patient of working age who has had an accident in the workplace. For this reason, the socio-economic impact of these injuries is considerable. Ideally our treatment strategy should aim for a quick recovery and restoration of function. Such parameters should be taken into consideration before planning the appropriate treatment strategy as type of fracture, age, accident mechanism, associated comorbidities, smoking, presence of other injuries, multiple trauma and the surgeon's experience.²

The incidence of additional surgery secondary to the development of post-traumatic osteoarthritis of the subtalar joint has been reported to be 23% in Sanders Type III injuries and approximately 73% in fractures of Type IV.³ In these patients, subtalar fusion has produced acceptable results with shorter convalescence regardless of the severity of the initial injury.^{4–6} This approach has been suggested for many years⁷ and should be included in the initial treatment options.⁸

The Vira[®] system can be used when indicated to promote arthrodesis of the subtalar joint with a minimal invasive approach.^{9,10} This surgical method requires no graft, since it makes use of the bone from the drilling process. It also allows walking as early as two weeks after surgery, even in bilateral cases, thus reducing the time for the patient to return to the day-to-day activities of living.

The aim of the present study therefore was to analyse the medium- and long-term results obtained in patients with acute fracture of the calcaneus as a result of accidents in the workplace, treated by primary, minimally invasive subtalar joint arthrodesis using the Vira[®] system.

Patients and methods

Over a five-year period, patients presenting in our institution with comminuted calcaneal fractures were eligible to participate. Ethics Committee approval was obtained. Inclusion criteria were adult patients (≥ 16 years of age) who sustained the injury at the work place or patients suffering from diabetes (Type 2), and the fracture was type III or IV according to the Sanders classification system³ (Table 1). Exclusion criteria were fracture patterns Type I or II and elderly patients above the age of 65 years. Fractures were initially

* Corresponding author at: Department Orthopaedic Surgery, Fundación Jiménez Díaz, Pza Cristo Rey, Madrid, Spain.
E-mail address: flopezoliva@hotmail.es (F. López-Oliva).

Table 1
Classification of operated fractures

Sanders Type	cases	%
IIB	2	1.2
IIIAB	21	12.4
IIIC	10	5.9
IIIBC	5	3.0
IV	131	77.5
Total	169	100.0

assessed with plain radiography and a CT scan was obtained for all patients as part of the preoperative work up.

Details such as patient demographics, fracture pattern, other associated injuries, length of hospital stay, and local and systemic complications were documented prospectively.

The system used comprises a nail for the greater calcaneal tuberosity, traversed by two cannulated (tubero-talar) screws which, on entering the heel, thread into the latter and the body of the talus. The body of the talus is the densest and most stiff cancellous bone in the body, and as such the nail affords good holding and support for the fractured calcaneus, allowing the tubero-talar screws to maintain the alignment and tension of soft tissues achieved with the instrumentation. The system allows to restore and maintain the anatomical relationship between the talus and skeletal structure of the heel, fixing and favouring subtalar arthrodesis by using the specific Vira® guide. The surgical technique has been published previously in detail.⁹ With the Vira® system ankle and foot immobilisation is not necessary after surgery as the system allows immediate partial weight bearing depending on the surgeon's criteria and the patient's tolerance, even in bilateral cases.

Patients recruited underwent radiographic and clinical studies, using the American Orthopaedic Foot and Ankle Society score. The lateral projection permitted us to measure Böhler's tubero-articular angle, which determines the degree of ascent of the posterior tuberosity of the calcaneus. In the normal calcaneus, the posterior angle formed by the two lines is between 25° and 40°; after surgery, this value indicates the degree of reconstruction. In all cases, a CT scan was performed 3 months after surgery to assess the state of fusion of the subtalar joint.

Functional post-surgical assessment

Yearly after the operation, all patients were interviewed by a single physician (TSL), using the AOFAS scale;¹¹ changes in footwear were also recorded.

Gait analysis

In 32 patients with unilateral calcaneus fracture, a barefoot gait analysis was performed 6 months after surgery. The biomechanical parameters of a control group (contralateral healthy limb) and arthrodesis group (arthrodesis limb) were compared. The plantar pressure distribution was studied with the use of a pedobarographic platform (Emed, NOVEL, Germany). Patients were asked to walk back and forth at a self-selected velocity along the walkway. For each patient, three trials were recorded and the last trial was analysed. We evaluated the entire foot, which was divided into six anatomical regions: hindfoot, midfoot, forefoot (medial, middle and lateral) and toes. The pressures (kPa) generated in each region of both feet were measured.

The kinetic parameters or ground reaction forces (GRF) were recorded using two 90×60 cm force platforms (Kistler, Winthertur, Switzerland), placed one in front of another. Patients were asked to walk barefoot over the platform five times. The last trial was chosen for the data analysis. We obtained the axial and anterior–posterior

forces during barefoot walking for both extremities, and stance phase time, double support and time to change from anterior to posterior force were also studied.

Statistical analysis

The criteria for assessment or dependent variables were the post-surgical Böhler angle and the result on the AOFAS scale. A paired Student's t test was carried out to corroborate the increase in Böhler's angle after surgery. Similarly, the points on the AOFAS score were compared with other relevant variables and possible associated dependent variables. This analysis was performed using variance analysis and Student's t test for independent variables. Finally, we performed the same analysis taking the AOFAS score as a dependent variable in ranks (Excellent, good, fair, poor). To do this, we compared the proportions using chi-squared.

Results

In total 146 consecutive patients (145 male) treated for 169 severe fractures of the calcaneus met the inclusion criteria. The mean follow up was 33 months (range 12–60). The mean age was 41 (range 16–60) years. 88 (60.3%) patients were regular smokers.

The most frequent cause of injury was high-energy trauma, which was responsible for the fracture in 134 cases (79.3%), and in over half of the cases (52.7%) there were other associated traumatic injuries. In 91 (53.8%) cases the fracture affected the right calcaneus. Seven fractures (4.1%) were open fractures – 3 of Grade I, 3 of Grade II and 1 of Grade III according to the Gustilo classification.

Clinical results

As far as the AOFAS scale was concerned, the mean result at the end of follow up was 77.26 points (95% confidence interval: 75.11–79.41, SD: 14.11) (range: 35–94). On the quantitative AOFAS scale, 42 cases (24.9%) were very good, 108 (63.9%) good, 12 (7.1%) fair and 7 (4.1%) poor. The quantitative AOFAS scale did not undergo any statistical variation in relation to whether or not it was bilateral or there was any associated injury present. That is, the quantitative AOFAS scale was independent of all these variables. We only found a certain association ($p=0.06$) between the mean AOFAS score and the patient's previous state of health, the score being 8 points lower where previous disease was present. Most patients (73.4%) could wear normal shoe ware. The clinical results were not influenced by other personal variables analysed, such as age ($p=0.122$), associated injuries ($p=0.748$), concurrent disease ($p=0.466$), diabetes ($p=0.466$) or smoking ($p=0.584$) (Figs 1, 2).

We observed a relationship between the mean value for Böhler's angle and the different categories on the AOFAS scale, which was that the worst AOFAS scores belonged to the worst angles *a priori*. However, this association was not statistically significant ($p=0.39$). What was observed for the pre-surgical Böhler angle was reproduced when we assessed the post-surgical variations in the Böhler value in each qualitative group on the AOFAS scale (Table 2).

Radiographic results

The mean increase in Böhler's angle was 6.7° (0–30°), and 81.1% had increases of up to 9°, while 17.8% of cases were found to have increases of 10° or more. We found a high correlation between the number of cases treated and the Böhler's angle reconstruction ($p=0.01$): as a result of the learning curve, later patients were found to have better reconstructions.

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