Sanders Type IIC Tongue-Type Fractures of the Calcaneus: Is Percutaneous Surgery the Treatment of Choice? Short-Term Functional and Radiographic Evaluation

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ABSTRACT

Objective: Our research aims to describe the functional and radiographic outcomes and complications of percutaneous surgery in Sanders type IIC tongue-type calcaneal fractures. **Materials and Methods:** 9 articular displaced calcaneus fractures in 9 patients were evaluated with lateral and anteroposterior radiographs and preoperative axial computerized tomography. Non-weight-bearing foot radiographs **-**lateral and anteroposterior**-** were taken in the immediate postoperative period, and weight-bearing radiographs were taken at the sixth and twelfth weeks, and when finishing follow-up. Böhler's angle was measured, and subtalar and calcaneocuboid osteoarthritis grade was quantified. The AOFAS score, wound complications, neurological injuries, and the need for additional surgeries such as hardware removal and subtalar arthrodesis were considered. **Results:** 3 women and 6 men complied with follow-up during 21.1 months. The patients' average age was 42, +-12. The preoperative Böhler angle was 7° (+-6.2°) and the final postoperative angle was 33.6° (+-4.1).(p<0.00001). Subtalar range of motion presented a minor restriction in every patient. Neither subtalar nor calcaneocuboid osteoarthritis was observed. The AOFAS score was good in 4 patients and excellent in 5 of them. 100% of the patients presented good and excellent outcomes. We did not record wound infections or complications. **Conclusion:** Percutaneous surgery in Sanders type IIC tongue-type calcaneal fractures allows us to reach a significant reduction with good functional outcomes and minor soft-tissue complications.

Keywords: Calcaneus; minimally invasive procedure; percutaneous treatment: fractures; approach; complications.
Level of Evidence: IV

Fracturas de calcáneo tipo IIC de Sanders en lengüeta: ¿Es la cirugía percutánea el tratamiento de elección? Evaluación funcional y radiográfica a corto plazo

RESUMEN

Objetivos: Describir los resultados radiográficos, funcionales y las complicaciones de la cirugía percutánea en pacientes con fracturas de calcáneo tipo IIC de Sanders en lengüeta. **Materiales y Métodos:** Se evaluaron 9 fracturas articulares de calcáneo desplazadas en 9 pacientes con radiografías de pie, de frente y de perfil, y tomografía computarizada preoperatorias. Se tomaron radiografías de pie, de frente y perfil, sin carga en el posoperatorio inmediato y con carga a las semanas 6 y 12, y al final del seguimiento. Se midió el ángulo de Böhler y se cuantificó el grado de artrosis subastragalina y calcaneocuboidea. Se evaluaron las siguientes variables: puntaje AOFAS, complicaciones de la herida, lesión neurológica y necesidad de cirugías adicionales, como retiro del material de osteosíntesis y artrodesis subtalar. **Resultados:** El seguimiento fue de 21.1 meses. La edad promedio de los pacientes (3 mujeres y 6 hombres) era de 42 ± 12. El ángulo de Böhler preoperatorio fue de 7º (±6,2º) y de 33,6º (±4,1°) en el posoperatorio final (p <0,00001). Hubo una restricción leve de la movilidad subtalar en todos los pacientes. No se observó artrosis subtalar ni calcaneocuboidea. El puntaje AOFAS fue bueno en 4 pacientes y excelente en 5. Todos obtuvieron buenos y excelentes resultados. No se observaron infecciones de la herida, lesiones neurológicas ni complicaciones de la herida. **Conclusión:** La cirugía percutánea en fracturas de calcáneo tipo IIC de Sanders en lengüeta permite lograr una reducción adecuada con buenos resultados funcionales y bajas tasas complicaciones de parte blandas.

Palabras clave: Calcáneo; procedimiento miniinvasivo; cirugía percutánea; fractura; abordaje; complicaciones.
Nivel de Evidencia: IV

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INTRODUCTION

Calcaneal fractures represent 60% of traumatic injuries of the adult foot and 2% of the total.1 These injuries generate a high socio-economic impact due to the long periods of absenteeism from work as a consequence of the high percentage of sequelae they generate. Although there is no consensus on the treatment of displaced calcaneal joint fractures, open reduction and osteosynthesis through the extended lateral approach have been the gold standard in the last three decades.2 This approach allows excellent visualization to reduce this fracture, but the rate of complications is high, despite meticulous soft tissue management.[3] This has led to the development of less invasive surgeries that include lateral, medial, and posterior mini-approaches and arthroscopically assisted percutaneous fixation.[4] These techniques reduce soft tissue trauma and the risk of complications with an acceptable reduction.

Percutaneous techniques were described in 1855 by Clark.[5] Westhues and Gissane described percutaneous procedures that were modified and popularized by Essex-Lopresti.

The results are promising in terms of decreased rates of infections and wound complications, although there are controversies about the indication and long-term outcomes in terms of functional score, range of motion, patient satisfaction, degree of osteoarthritis and the need for additional procedures.[6]

The objective of our research was to describe the radiographic and functional outcomes and the complications of percutaneous treatment in patients with Sanders type IIC calcaneal fractures with a tongue-type fracture pattern.

MATERIALS AND METHODS

We retrospectively evaluated nine patients (3 women and 6 men) with nine Sanders type IIC displaced articular calcaneal fractures with a tongue-type fracture pattern, treated percutaneously with screws, between January 2019 and January 2020. The exclusion criteria were: ipsilateral fractures of the ankle and foot, skeletally immature patients, follow-up <12 months, previous surgeries on the same foot and ankle, joint depression fractures, and Sanders types I, III and IV fractures.

The Sanders and Essex-Lopresti classifications were used.[7]

Radiographic evaluation

The patients were evaluated before surgery with anteroposterior and lateral standing radiographs. The radiation was 4 mA and 60 Kv in the lateral projection and 3.2 mA and 57 Kv in the anteroposterior projection. The beam was focused on the medial malleolus in the lateral image and the medial cuneiform in the anteroposterior image. The beam was parallel in the lateral image and inclined 15º in the inferior apical direction in the anteroposterior. The distance from the tube to the cassette was 120 cm in both projections.

Before surgery, a multiplanar computed tomography was performed with slices <1 mm, in the axial, sagittal and semi-coronal planes (30° angle), and 3D reconstruction was used (Figure 1). Intraoperative Broden and axial views of the calcaneus with an image intensifier were used to verify the reduction of the posterior facet and to control the osteosynthesis.[8]

In the immediate postoperative period, anteroposterior and lateral standing radiographs, with and without weight-bearing, were taken at weeks 6 and 12, and at the end of follow-up. On the lateral radiograph, the Böhler angle was measured, consisting of two lines, one from the highest point of the anterior tuberosity to the highest point of the posterior facet and the other tangential to the superior border of the posterior tuberosity. Its value ranges from 20° to 40°.9 It was quantified if there were changes >5° that indicated the collapse of the calcaneal height.[10] The degree of osteoarthritis in the subtalar and calcaneocuboid joints was evaluated.[11]

Clinical evaluation

Function was assessed using the AOFAS (American Orthopedic Foot and Ankle Score). The result was classified as: excellent >90, good >80, fair >70 and poor ≤70.5.

Subtalar range of motion was evaluated comparatively. It was classified into: normal or mild, moderate, and severe restriction, according to the AOFAS score.[5]

Wound complications were recorded and divided into: minor (edge necrosis, superficial dehiscence) and major (deep infections, deep dehiscence, and osteomyelitis).[12] Neurological injury and the need for additional surgeries were also evaluated, such as removal of osteosynthesis material and subtalar arthrodesis.

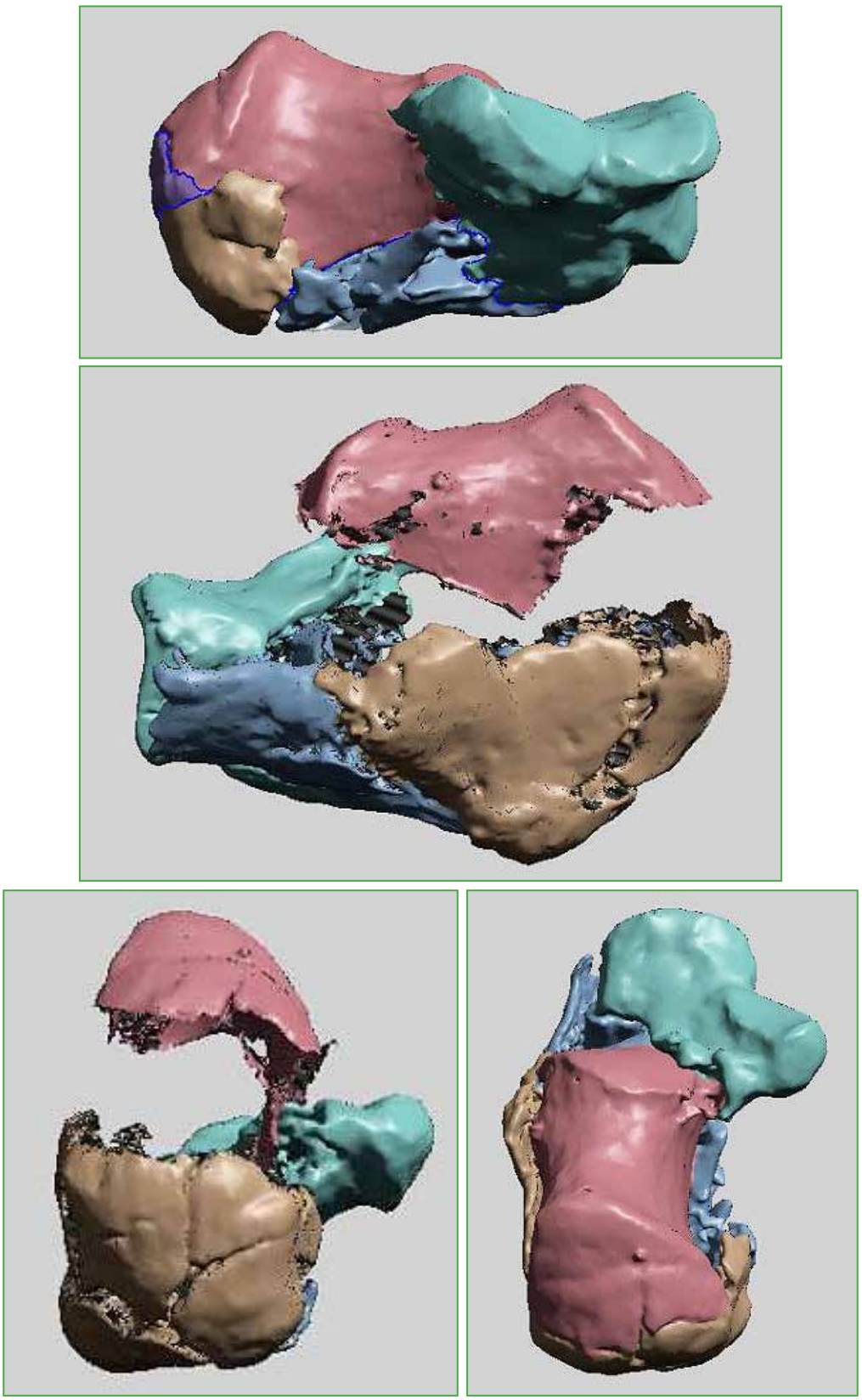

Figure 1. Preoperative planning with 3D computed tomography.

The statistical analysis was carried out through descriptive measures (mean and standard deviation, maximum and minimum). Data were loaded into the EPIDAT version 4.2 system. A p-value <0.05 was considered statistically significant.

Surgical technique

The patient is placed in the lateral decubitus position. An image intensifier is used to perform intraoperative controls of the foot, in the anteroposterior, lateral, axial, and Broden views.

A 5 mm lateral para-achillary incision is made and a 5 mm Steinmann pin is placed in the superolateral aspect of the tuberosity. It is inserted through the tongue and directed towards its lower anterior sector.

The reduction is done in four steps. First, the heel and forefoot are brought into varus, generating a lateral displacement of the posterior facet (this stage is to separate the fragments). In the second step, the forefoot is grasped with one hand and the Steinmann pin emerging from the skin with the other, levering it 5mm distally. In this way, the tongue fragment is raised and reduced. In the third step, the nail is brought into valgus to drive the posterior facet toward the sustentaculum tali. It is controlled with an image intensifier and then the Steinmann pin is anchored to the anterior tuberosity (Figure 2).

Figure 2. Reduction of the tongue fragment with the 5-mm Steinmann pin.

If the reduction of the Böhler and Gissane angles is good, stabilization with screws is carried out. We use different options: 3.5mm cortical screws, 4.0mm cancellous cannulated screws; 6.5 mm cancellous cannulated screws, and 5 mm locking screws. The construct depends on the size of the fragments and the pattern of the fracture evaluated before 3D reconstruction. In some cases, we fixate the tongue with screws from the superolateral and superomedial level to the anterior tuberosity, from the posterior tuberosity to the anterior tuberosity (Figure 3), or from the posterior tuberosity to the tongue fragment (Figure 4).

In the postoperative period, a posterior splint is placed for 10 days and ankle and subtalar range of motion is initiated. Partial weight-bearing with crutches and a splint is indicated starting at four weeks and, progressively, until weeks 10-12 when weight-bearing is total.

Figure 3. **A.** Type IIC tongue-type fracture. **B.** Steinmann pin reduction. **C.** Construct with three screws: two from the tongue to the anterior tuberosity and one from the posterior to the anterior tuberosity. **D.** Radiographic control 13 months after surgery.

Figure 4. A. Preoperative lateral foot radiograph. **B-D.** Computed tomography of the foot; axial, sagittal, and coronal slices. **E.** Intraoperative foot radiograph. Reduction with Steinmann pin and 2-screw construct from the posterior tuberosity to the tongue fragment. **F and G.** Anteroposterior and lateral weight-bearing radiographs of the foot, 15 months after the operation.

RESULTS

The average age of the patients was 42.1 years (±12) (range: 19-60). The average follow-up was 21.1 months (±5.2) (range: 13-27). The preoperative Böhler angle was 7° (±6.2) (range: -3/17) and the final postoperative angle was 33.6° (±4.1) (range: 28-40). This correction was statistically significant ($p < 0.00001$) (Table).

Table. Results

Patients	Preoperative Böhler angle	Postoperative Böhler angle	AOFAS score	Wound complications	Infections	Subtalar-calcaneocuboid osteoarthritis	Subtalar arthrodesis	Age	Follow-up
1	5°	28°	95	No	No	Without osteoarthritis	No	19	27 months
2	17°.	35°	87	No	No	Without osteoarthritis	No	47	20 months
3	15°	30°	87	No	No	Without osteoarthritis	No	30	25 months
4	10°	38°	87	No	No	Without osteoarthritis	No	60	24 months
5	6°	30°	85	No	No	Without osteoarthritis	No	50	14 months
6	-3°	37°	87	No	No	Without osteoarthritis	No	40	23 months
7	5°	32°	87	No	No	Without osteoarthritis	No	50	26 months
8	6°	40°	87	No	No	Without osteoarthritis	No	35	13 months
9	2°	32°	85	No	No	Without osteoarthritis	No	48	18 months

AOFAS = *American Orthopaedic Foot and Ankle Society*.

Mild restriction of subtalar range of motion was observed in all patients. No subtalar or calcaneocuboid osteoarthritis was detected. The AOFAS score was good in four patients and excellent in five. All obtained good (44.4%) and excellent (55.6%) results. No wound infections, neurological injuries, or wound complications occurred. It was not necessary to perform subtalar arthrodesis or remove the osteosynthesis material.

DISCUSSION

Calcaneal fractures account for 2% of all fractures and most occur in adults.

Treatment remains controversial, because similar results have been published for conservative and surgical management,[13] but most orthopedic surgeons favor surgery due to its satisfactory results.[14]

Surgical approaches continue to generate controversy, although minimally invasive techniques have been shown to reduce soft tissue complications and infections compared with the extended lateral approach.[6]

A wide variety of percutaneous techniques have emerged to reduce soft tissue problems.6,15 There is no consensus on what types of fractures should be treated percutaneously. Some authors indicate this procedure for Sanders type II, III and IV fractures,[16,17] while others only for type IIA, B and C with arthroscopic assistance to control joint reduction, except in type IIC where the facet joint is displaced, but intact.[18]

In our series, there were no wound or soft tissue complications. Placement of screws through small incisions decreases the risk of soft tissue complications and the formation of adhesions and stiffness in the subtalar joint. This fibrosis is secondary to the different types of approaches and the placement of plates, despite meticulous anatomical preparation and reduction.[19]

The AOFAS score was excellent and good in all cases, with an average of 87. Rammelt et al. reported a score of 92 in 33 patients with type IIA and B fractures.[18] In our series, all were type IIC fractures, comparable to the Tornetta series who used the Maryland score with excellent and good outcomes in 85% of 41 patients, at 3.4 years of follow-up.[20]

After percutaneous reduction, the use of an external fixator or Kirschner pins through the skin as definitive fixation increases the risk of infection by 3.5%.[21] Tornetta changed this type of screw fixation in calcaneal fractures, because patients reported discomfort related to nails when wearing shoes.[20]

Schepers recommended placing screws alone in fractures without comminution and when bone quality is good.[22] In a biomechanical study, the stability achieved with intramedullary screws is shown to be higher than with traditional plates, possibly because they are anchored to areas of greater density in the calcaneus.[23]

No loss of Böhler angle reduction of more than 5° was observed in any of the patients. This improved from 7° in the preoperative period to 33° in the final postoperative period without loss of reduction. Some studies have demonstrated the restoration of the angle with percutaneous surgery.[24,25]

Loss of subtalar range of motion was mild in all patients. This could be attributed to the fact that our fractures were type IIC and had an intact posterior facet, little fibrosis in the subtalar region due to minimal deperiostization, and less osteosynthesis.

The limitations of this study are the small number of patients, the short follow-up period and the absence of a control group.

CONCLUSIONS

Percutaneous surgery for Sanders type IIC calcaneal fractures with a tongue-type fracture pattern allows adequate reduction to be achieved with good functional outcomes and a low rate of soft-tissue complications.

Conflict of interest: The authors declare no conflicts of interest.

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