

# Evaluation of patients submitted to minimally invasive surgery (suprafibular access) for treatment of calcaneal fractures

## Avaliação de pacientes submetidos à cirurgia minimamente invasiva (via de acesso suprafibulares) para tratamento de fraturas de calcâneo

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### ABSTRACT

**Objective:** To evaluate the functional results of the treatment of calcaneal fractures using the minimally invasive approach, focusing on the rate of complications involving the soft tissues. **Methods:** From 2006 to 2010, 27 intraarticular calcaneal fractures were treated by the minimally invasive technique. Sanders' tomographic classification was used in the preoperative evaluation. The surgical access route was the lateral economic, with minimum fixation, focusing on the talocalcaneal joint, without causing dislocation of the soft tissues, with fixation only with wires and screws, and without the use of a plate or graft. For the clinical-functional evaluation, the functional scale of the American Orthopaedic Foot & Ankle Society (AOFAS) was used. The initial and subsequent pre- and postoperative radiographs were evaluated, checking the Böhler and Gissane angles. **Results:** The radiological values obtained were normalized in 100% of cases, with only one patient having a radiographic result considered unsatisfactory; 50.1% of the patients presented good clinical results. The AOFAS functional scale presented a mean score of 71 points (ranging from 60 to 90). The mean postoperative Böhler angle was 18° and the Gissane angle was 88°. No patient presented infection in the region of the surgical wound during our follow-up. No

### RESUMO

**Objetivo:** Avaliar os resultados funcionais obtidos no tratamento de fraturas de calcâneo com abordagem minimamente invasiva, enfatizando a incidência de complicações de partes moles. **Métodos:** Entre 2006 e 2010, 27 fraturas intra-articulares do calcâneo foram tratadas com técnica minimamente invasiva. A classificação tomográfica de Sanders foi empregada na avaliação pré-operatória. A via de acesso cirúrgico foi a lateral econômica e fixação mínima, focada na articulação talocalcânea, sem promover deslocamento de partes moles, com fixação feita apenas com fios e parafusos, não utilizando placa ou enxerto. Para a avaliação clínico-funcional, utilizou-se a escala funcional da *American Orthopaedic Foot & Ankle Society* (AOFAS). As radiografias pré e pós-operatórias, iniciais e tardias, foram avaliadas com aferições dos ângulos de Böhler e Gissane. **Resultados:** Os valores radiológicos obtidos foram normalizados em 100% dos casos, com apenas um paciente com resultado radiográfico considerado insatisfatório; 50,1% dos pacientes apresentaram resultados clínicos bons. A escala funcional da AOFAS apresentou valor médio de 71 pontos (variando de 60 a 90). A média do ângulo de Böhler pós-operatório foi 18° e a do ângulo de Gissane 88°. Nenhum paciente apresentou infecção na região da ferida operatória

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### Conflict of interest:

none reported.

### Source of funding:

own.

### Received on:

March 03, 2017

### Accepted on:

May 15, 2017

complications affecting the soft tissues were observed. There were no skin complications or infections; five cases presented residual pain; and post-traumatic arthritis was observed in two cases. **Conclusion:** The study demonstrated satisfactory clinical-functional results, with improvements and a low rate of complications.

#### Keywords:

Calcaneus/injuries; Fractures, bone; Surgical procedures, minimally invasive

## INTRODUCTION

Calcaneal fractures correspond to 2% of all fractures of the human body. They usually occur after high-energy trauma, such as falls from heights or car accidents<sup>(1-4)</sup>, and 50% are associated with other fractures, such as those of the tibial plateau, hip and lumbar spine.<sup>(5-8)</sup> The calcaneus is the most commonly fractured tarsal bone, accounting for approximately 60% of major tarsal injuries, of which about 75% are intra-articular<sup>(9-11)</sup>.

These fractures are marked by poor outcomes, and are associated with unsatisfactory clinical and functional results, due to the complexity and difficulty in maintaining their congruence and reduction<sup>(1,4,9,12)</sup>. They may cause disability due to chronic joint stiffness and pain, as well as severe hindfoot deformities<sup>(13)</sup>.

Regarding the therapeutic approach adopted, in series of retrospective studies<sup>(9,13-15)</sup>, it has been noted that most authors agree that conservative treatment should generally be used in fractures with slight or no displacement, in elderly patients and in patients with comorbidities<sup>(3,5,10,12,16)</sup>. Most articular fractures have better results with surgical treatment, and are indicated for patients who are non-smokers and meet the clinical conditions for surgery with Sanders Type II, III and IV fractures<sup>(3,6,9,10)</sup>. Patients not suitable for surgery or who do not accept the indication can be treated conservatively, but with early mobilization of the ankle and subtalar joints<sup>(1,5,9,11,12)</sup>.

The surgical treatment performed most often in recent years is open reduction through an extended lateral approach, and osteosynthesis with plate and screws; however, it cannot be claimed that the use of the extended incision is the most frequent option in these cases.<sup>(6,13,14)</sup> Many of these patients develop soft tissue complications, 32.8% of cases in conventional surgery with extended lateral approach<sup>(14)</sup>, and about 43.5% require supplementary procedures to remove implants<sup>(16)</sup>. Other authors have published results of smaller incisions and fixation with wires and screws, reporting a lower incidence of soft tissue complications<sup>(5,9,15)</sup>.

durante nosso seguimento. Não foram observadas complicações de partes moles. Não houve complicações de pele ou infecções, cinco casos apresentaram dor residual; e em dois casos ocorreu artrite pós-traumática. **Conclusão:** O estudo demonstrou resultados clínico-funcionais satisfatórios, com melhora dos índices radiológicos e baixa taxa de complicações.

#### Descritores:

Calcâneo/lesões; Fraturas ósseas; Procedimentos cirúrgicos minimamente invasivos

Based on these studies and on personal experience, we chose to use the lateral economical approach and minimal fixation, focusing on the talocalcaneal joint, without causing soft tissue displacement, with fixation only with wires and screws, not using a plate or graft. This surgical method is a minimally invasive technique.

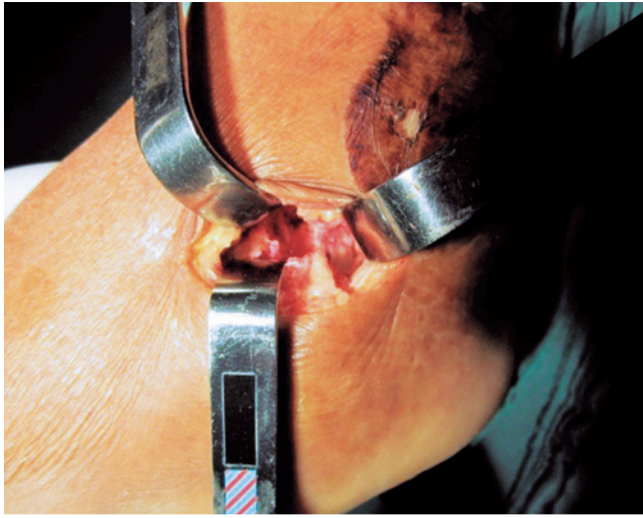
The aim of this study was to evaluate the functional results obtained in treatment with this surgical technique, highlighting the incidence of soft tissue complications.

## METHODS

A retrospective study approved by the Institutional Review Board was carried out under protocol number 233.735. Twenty-seven patients with intra-articular and displaced calcaneal fractures were diagnosed between 2006 and 2010. Skeletally mature patients diagnosed with calcaneal fractures and operated with minimally invasive technique (Figure 1) with a minimum postoperative time of two years and who agreed to participate in the research by signing a document (Informed Consent Form) which was attached to their medical records were enrolled in the study.

Patients were evaluated in an outpatient setting with postoperative radiographs, in which we measured the Böhler and Gissane angles in the immediate and late postoperative period. The patients also answered the American Orthopedic Foot and Ankle Society (AOFAS) questionnaire, which measures the subjective pain scale, foot function, and foot and ankle alignment. Regarding the statistical analysis for comparison of groups with quantitative variables, Student's t-test was used for independent samples and the Mann-Whitney U test for non-parametric data. The value of  $p \geq 0.05$  was considered statistically significant.

In the present sample, the mechanism of injury, in all cases, was axial with fall from height<sup>(1,5,9)</sup>. We adopted the Sanders tomographic classification, which takes into account the number and displacements of fragments<sup>(5,6,15)</sup>.



**Figure 1** | Approach with exposure of the calcaneus in the fracture area.

The patients selected for this study had fractures classified as Sanders II and III (joint displaced with two and three-part fractures). No type of postoperative immobilization was required, which facilitated dressing changes and local hygiene. Early mobility could be authorized after the surgery, thus improving the patients' quality of life.

## RESULTS

The analysis of results included the evaluation of the radiographic data by measuring the Böhler and Gissane angles, and clinical data, using the AOFAS scale<sup>(3,9,10,15,16)</sup>. As a reference we used the range of 20° to 40° for the Böhler angle and 130° and 145° for the Gissane angle<sup>(8)</sup>.

Of the patients who underwent the proposed surgical treatment, seven had results considered normal, i.e., Böhler and Gissane restored to normal. In regard to the Böhler angle, 19 patients had satisfactory results and only one subject had a result considered unsatisfactory according to clinical evaluation. In regard to the Gissane angle, 15 patients recorded the reference value, while the other 12 patients had increased Gissane angle values in comparison to the reference value. There may have been a small variance in the measurement of these angles on the radiographs; although they were standardized and performed by an experienced professional, a small rotation during the test may have influenced the values obtained.

At the end of the evaluation, 24 patients walked without limitations, two limped, and one had to use a crutch, while they all had difficulty walking on uneven ground. As a re-

sult of the AOFAS scale, we obtained a mean of 71 points (ranging from 60 to 90). On the AOFAS scale, excellent results range between 90 and 100 points; good results range between 80 and 89; fair between 70 and 79 and poor results were those below 69.

The values of the angles and measurements taken are shown in Table 1. All patients had an improvement in the postoperative radiographic angles, but 12 of them did not recover 100% of the angles. We must consider the small difference that can exist in the measurement of the angles due to the positioning of the patient during the radiograph, as well as the inter-observer standard deviation, when measuring angles with the aid of the goniometer.

The mean postoperative Böhler angle in the patients analyzed was 18° and the Gissane angle was 88°, with normal values ranging from 20° to 40° for the first and approximately 100° for the second.

None of the patients presented with infection in the region of the surgical wound during our follow-up. There were no skin complications or infections; five patients had residual pain, and in two cases, there was posttraumatic arthritis.

## DISCUSSION

The AOFAS questionnaire is well suited to assess function, pain and alignment of the calcaneus<sup>(4,8,10)</sup>. When applying this questionnaire, we found that 16.6% of the patients had results considered poor, 33.3% fair results and 50.1% good results. We know that the treatment of this fracture, with the L-shaped incision, has very good results in terms of restoration of the calcaneus anatomy and application of the AOFAS questionnaire<sup>(13-17)</sup>. However, they present poor results in terms of soft tissue complications, such as skin necrosis, suture dehiscence and tissue fibrosis, and sural nerve injury. With the use of the minimally invasive technique, we did not have any soft tissue complications like those described in the open technique<sup>(13-15)</sup>. We operated on all of these patients on the basis of improved skin quality, which occurred between 12 to 17 days after the fractures.

Jordaan et al.<sup>(18)</sup> showed in their study that the tarsal sinus approach was adequate for exposure and for reduction and restoration of the Böhler angle. In 2013, Xia et al.<sup>(19)</sup> used this approach in combination with fixation using a specific plate to obtain adequate reduction through radiographic control of these fractures. In this study, the individuals had a vast improvement in the Böhler angle but did not have the same success with the Gissane angle.

**Table 1** | Functional evaluation

Patients	Age (years)	Sex	Date of surgery	Fracture side	Sanders Classification	Preoperative Böhler angle	Preoperative Gissane angle	Postoperative Böhler angle	Postoperative Gissane angle	AOFAS
MCC	53	Male	January 22, 2008	Right	2C	12	60	34	89	77
MAPS	48	Female	September 15, 2006	Left	2B	10	65	34	86	72
NJS	57	Male	August 5, 2009	Right	3AB	8	54	16	84	58
LCP	25	Male	January 22, 2007	Right	3AC	15	86	26	102	82
HNP	71	Male	March 2, 2009	Right	3BC	6	62	12	70	81
CPC	33	Male	October 20, 2010	Right	3AC	10	74	18	82	83
AR	47	Male	June 3, 2009	Left	3AC	4	82	6	88	87
AS	55	Female	September 23, 2009	Right	2B	12	88	14	100	87
AFS	68	Male	September 10, 2009	Right	3BC	14	86	20	90	90
AFDS	39	Female	May 12, 2008	Bilateral	3AC	6	92	10	100	57
AMS	50	Male	February 10, 2010	Right	3BC	12	90	40	98	73
MCC	53	Male	April 24, 2010	Bilateral	3AC	10	72	14	76	82
SJB	41	Female	July 11, 2008	Left	3AB	16	84	23	92	60
ENS	33	Male	June 13, 2009	Right	3AC	8	78	15	86	71
EBC	47	Male	April 4, 2008	Right	3AB	8	70	12	82	82
JCA	55	Male	February 26, 2009	Left	2B	12	86	20	92	70
CRG	42	Male	July 8, 2009	Right	3AC	10	86	18	96	74
CWT	40	Female	September 13, 2009	Right	2A	12	60	34	89	90
CDN	42	Male	November 20, 2006	Right	2A	10	65	34	86	88
AD	49	Male	August 5, 2006	Right	2B	8	54	16	84	80
GBN	55	Male	February 22, 2009	Left	3AC	15	86	26	102	75
SGS	25	Female	November 24, 2006	Right	2A	6	62	12	70	85
IS	45	Male	October 20, 2010	Right	2B	10	74	18	82	83
LP	40	Female	June 3, 2007	Left	2C	4	82	6	88	87
NC	55	Male	April 23, 2009	Right	2B	12	88	14	100	87
VC	42	Male	September 10, 2006	Right	3AC	14	86	20	90	75
JVT	50	Male	March 28, 2008	Left	2B	6	92	10	100	85

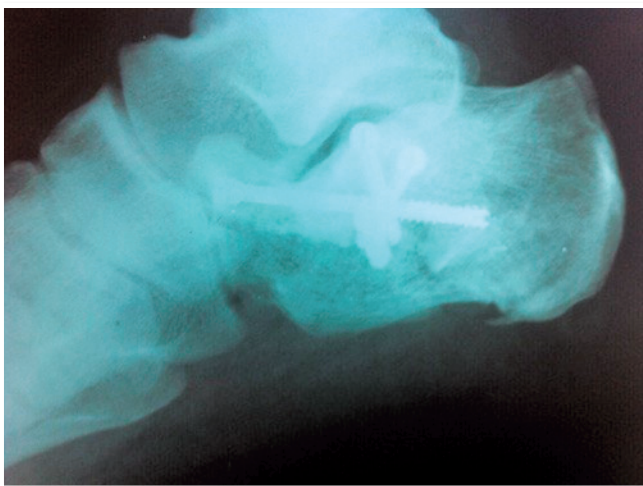
In 2014, Xia et al.<sup>(20)</sup> showed in a randomized study that there was no significance in terms of the reduction of calcaneal fractures by open approach or minimally invasive technique. The same authors did not have any surgical wound complications involving soft tissues.

Figures 2 and 3 show the type of fixation performed in our study and the satisfactory results.

The present study aimed to evaluate the treatment of calcaneal fractures by the minimally invasive approach, retrospectively collecting clinical data. As expected, our results demonstrated that the Böhler angle and the Gissane angle were all significantly corrected postoperatively, without postoperative wound complications, infection, or loss of reduction during follow-up.

Using the abovementioned technique, we obtained adequate visualization of the fracture site, without damaging soft parts that serve as a blood supply for healing and fracture consolidation, achieving good reduction of the posterior facet of the calcaneus and adequate fixation. This fact is consistent with other studies that consider the technique safe and effective for the treatment of calcaneal fractures<sup>(17)</sup>, including the low rate of wound complications<sup>(18)</sup>.

The limitation of our study is the small number of patients with a short follow-up time. With this study, however, it will be possible to carry out a study with a longer follow-up and a larger number of cases, using new tools for postoperative evaluation, such as evaluation of fracture reduction using computed tomography<sup>(17,18)</sup>.



**Figure 2** | Postoperative radiograph with consolidation of the calcaneal fracture by minimally invasive approach with fixation using percutaneous screws in the lateral position.



**Figure 3** | Postoperative radiograph with consolidation of the calcaneal fracture by minimally invasive approach with fixation using percutaneous screws in the axial position.

## CONCLUSION

Use of the surgical technique with suprafibular incision has proved to be a good alternative for the treatment of the Sanders Type II and III calcaneal fractures described above. It has been related to a low incidence of soft tissue complications, with adequate healing, without fibrosis, and without wound dehiscence, allowing adequate fixation and favoring early postoperative mobility.

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