



Original Article

Surgical treatment of intraarticular fractures of the calcaneus: comparison between flat plate and calcaneal plate[☆]



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ABSTRACT

Objective: To evaluate the clinical results of surgical treatment of intraarticular fractures of the calcaneus, comparing the use of calcaneal plate and flat plate.

Methods: This was a retrospective study assessing the postoperative results of 25 patients between 2013 and 2015. Patients undergoing surgical treatment of intraarticular fractures of the calcaneus without concomitant surgical lesions were included. Patients who did not complete appropriate follow-up after surgery were excluded from the study.

Results: The unavailability of calcaneal plates at resource-limited settings, associated with the availability and lower cost of flat plates, may have been a confounding factor in the present study. However, there was no statistical difference between the outcomes of fractures treated with calcaneal plates or flat plates.

Conclusion: Statistical inference shows that, when calcaneal plates are not available, it is possible to use flat plates with similar clinical outcomes.

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Tratamento cirúrgico das fraturas intra-articulares do calcâneo: comparação dos resultados entre placa reta e placa própria para calcâneo

RESUMO

Objetivo: Avaliar os resultados clínicos do tratamento cirúrgico das fraturas intra-articulares do calcâneo (TCFIAC) e comparar o uso de placa própria para calcâneo (PPC) e placa reta (PR).

Métodos: Estudo retrospectivo que avaliou o resultado pós-operatório de 25 pacientes entre 2013 e 2015. Foram incluídos pacientes submetidos ao TCFIAC e que não apresentavam lesões cirúrgicas concomitantes. Pacientes que não foram devidamente acompanhados no pós-operatório foram excluídos da análise.

Palavras-chave:

Calcâneo/lesões

Calcâneo/cirurgia

Fraturas ósseas/cirurgia

Fixação interna de fraturas

[☆] Study conducted at the Universidade Luterana do Brasil (Ulbra), Hospital Universitário, Departamento de Ortopedia e Traumatologia, Canoas, RS, Brazil.

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Resultados: A indisponibilidade da PPC em serviços com recursos limitados, associada à disponibilidade e ao menor custo da PR, pode ter sido fator de confusão no presente estudo. Contudo, não houve diferença estatística entre os resultados das fraturas tratadas com PPC ou PR.

Conclusão: A inferência estatística permite concluir que, na ausência da PPC, é possível usar a PR com desfechos clínicos semelhantes.

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Introduction

Calcaneal fractures correspond to 2% of skeletal fractures and about 60% of fractures of the tarsal bones.^{1,2} Despite the great development of orthopedic traumatology in the last century, treatment of these fractures is still controversial and results are often unsatisfactory, due to the complex anatomical shape of the calcaneus, its cancellous structure, and the fact that it is subjected to constant weight load.³⁻⁶ Thus, this injury causes major socioeconomic and functional impairment to patients, and represents a burden to public and private compensation policies.¹

In recent decades, with the improvement of imaging studies, a better understanding of the mechanisms of trauma, and observance of the principles of anatomical reduction and absolute stability for joint fractures, it is now possible to improve clinical outcome for this type of fracture. For this purpose, several types of implants are available, including calcaneal plates (CP) and flat plates (FP).⁷

Therefore, this study aimed to evaluate the clinical outcomes of surgical treatment of intra-articular fractures of the calcaneus (STIAFC) and compare the use of CP and FP.

Material and methods

This was a retrospective cohort study, which evaluated late postoperative results of 25 patients operated between January 2013 and January 2015. This study was approved by the Research Ethics Committee under No. 117817/2014/CAAE 40266114.9.0000.5328.

Inclusion criteria comprised patients who underwent surgical treatment by open reduction and internal fixation (ORIF) of a unilateral calcaneal intra-articular closed fracture without other associated fractures, who had preoperative computed tomography and radiographs of the foot, ankle, and calcaneus, and who had signed an informed consent form.

Exclusion criteria were patients who were operated using the Essex-Lopresti technique or those in whom a minimally invasive surgery was performed; fractures treated conservatively due to patient's own reasons or lack of surgical indication; associated fractures; lack of adequate skin condition, edema, and blisters in the lateral aspect of the foot, not resolved by the date of the surgery; absence of clinical conditions due to vascular disorders, heart disease, or decompensated diabetes; severe traumatic brain injury; psychosocial problem; heavy smoking; refusal to undergo surgical

treatment; bilateral fractures; and refusal to sign the informed consent form.

During this period, 64 feet of 52 patients were operated by the same surgeon. All patients were called for reevaluation; 25 patients undergoing STIAFC met the inclusion criteria and were included in the study.

All patients were evaluated by the same surgeon who performed all surgeries. The following assessment scales were used: American Orthopaedic Foot and Ankle Society (AOFAS), the Global Social Functioning Scale (GSFS), visual analog (VAS), and the Medical Outcomes Study 36 (SF-36).⁸

Clinically, the following aspects were analyzed: subtalar joint in the standing and supine positions; varus and valgus deviation of the hindfoot; abduction; adduction; pronation and supination of the forefoot; range of motion for ankle flexion and extension; appearance of surgical scars; and need for crutches. For the classification of fractures, the Sanders⁹ and Essex-Lopresti¹⁰ classifications were used.

Similarly, all patients underwent late postoperative analysis with radiographic study in Bröden's view; calcaneus radiographs in profile and axial; bilateral radiographic evaluation of the feet with monopodal support; radiographic evaluation of the ankle in profile, anteroposterior, and in 15° of internal rotation; and bilateral computed tomography with 5-mm thick axial, coronal, and sagittal cuts.

The sample was divided into two groups according to the type of ORIF made. Group I consisted of patients treated with 3.5-mm one-third tubular FP. Group II included patients undergoing treatment with CP.

The criterion for the choice of material was random and based on the possibility of using CP, which was not always available. As fixation criteria, isolated FP or two combined FP were used when CP was not available. CP was used whenever available.

All patients were operated with the classic L-shaped lateral access route, starting 3 cm from the posterior region of the lateral malleolus, passing 3 cm below that, extending to the calcaneocuboid joint. Due to the high risk of skin necrosis, dissection was made at the subperiosteal level. The flap was folded down and maintained cranially with three 2.0 mm Kirschner wires attached to the talus, with visualization of the sheath of the peroneus muscles, which was preferably preserved. Under direct visualization of the fracture, reduction was carried out, with temporary fixation using Kirschner wires performed after intraoperative radiographic confirmation of the reduction. Definite fixation was made with either CP or FP. After closure by planes, an elastic compression bandage was made with Portovac[®] drain for 48 h and casting for four

Table 1 – Demographic and clinical characteristics of the sample.

	Type of plate				p ^a
	CP (n = 14)		FP (n = 11)		
Age	47.7	10.4	45.5	11.29	0.617 ^a
Sex					0.230
Female	3	21.4%	0	0.0%	
Male	11	78.6%	11	100.0%	
Trauma mechanism					1.000
Bicycle × motorcycle collision	1	7.1%	0	0.0%	
Fall from height	13	92.9%	11	100.0%	
Operated side					0.414
Right	7	50%	8	72.7%	
Left	7	50%	3	27.3%	
Rearfoot position in orthostasis					0.695
Neutral	8	57.1%	5	45.5%	
Valgus	6	42.9%	6	54.5%	
Subtalar arthrosis					1.000
No	5	35.7%	3	27.3%	
Yes	9	64.3%	8	72.7%	

CP, calcaneal plates; FP, flat plates.
^a p-value for Fisher's exact test.

weeks. Partial load was authorized at the sixth postoperative week. Autografts to fill the space created inside the calcaneus were not used.

Quantitative variables were described as mean and standard deviation; categorical variables were described as simple (n) and relative (%) frequency. To assess the mean difference between types of material, the t-test for independent samples test was used. To verify the existence of an association between types of material and categorical variables, Fisher's exact test was used. The significance level was set at 5%. Statistical analyses were performed with SPSS version 18.0.

Results

Regarding gender, among patients undergoing treatment with CP, 11 (78.6%) were men and three (21.4%) were women. Among patients who were treated with RP, 11 (100%) were men.

Regarding type of trauma, of the patients undergoing treatment with CP, one (7.1%) had suffered trauma due to a bicycle collision with a motorcycle and 13, fall from height; in turn, all 11 (100%) patients treated with FP had suffered a fall from height (Table 1).

The operated side of patients treated with CP was the right side in seven patients (50%) and left in seven (50%). Among patients undergoing treatment with FP, eight (72.7%) had the right side operated and three (27.3%), left.

Regarding the postoperative position of the hindfoot while standing, among patients who underwent treatment with CP, eight (57.1%) presented the hindfoot in a neutral position, and six (42.9%), hindfoot in valgus. In turn, among patients who underwent treatment with FP, five (45.5%) presented the hindfoot in a neutral position and six (54.5%) in valgus.

Regarding subtalar arthrosis, among patients who underwent treatment with CP, five (35.7%) evolved without subtalar

arthrosis and nine (64.3%) presented it. Among patients who underwent treatment with RP, three (27.3%) evolved without subtalar arthrosis, while eight (72.7%) developed the condition (Table 1).

Regarding the classification of fractures, 19 patients (76%) had joint depression fracture and six (24%), tongue-type fracture. As for the Sanders classification, eight (32%) patients had type 2 A fracture; two (8%), type 2B; six (24%), type 3AB; three (12%), type 3AC; two (8%), type 3BC; and four (16%), type 4 (Table 2).

The results of both groups regarding waiting time for surgery and physical examination are shown in Table 3. Regarding clinical assessment scales, Tables 4 and 5 show results without statistical difference between the two types of plates. Therefore, there was no difference in clinical outcomes between ORIF in the comparison of CP and FP.

Table 2 – Classification of fractures.

	Type of plate				p ^a
	CP (n = 14)		FP (n = 11)		
<i>Essex-Lopresti classification</i>					0.350
Joint depression	12	85.7%	7	63.6%	
Tongue	2	14.3%	4	36.4%	
<i>Sanders classification</i>					0.655
2A	5	35.7%	3	27.3%	
2B	1	7.1%	1	9.1%	
3AB	2	14.3%	4	36.4%	
3AC	3	21.4%	0	0%	
3BC	1	7.1%	1	9.1%	
4	2	14.3%	2	18.2%	

CP, calcaneal plates; FP, flat plates.
^a p-value for Fisher's exact test.

Table 3 – Results of the groups in relation to the waiting time for surgery and measurements of the physical examination.

	Type of plate				p
	CP (n = 14)		FP (n = 11)		
	Mean	SD	Mean	SD	
Waiting time until surgery (days)	23.1	17.28	19.5	6.67	0.913 ^a
Difference in calf diameter	1.9	0.53	1.5	1.35	0.308 ^a
Width of the hindfoot	6.7	0.71	7.1	0.82	0.270 ^b
Ankle extension	11.5	10.41	11.8	7.17	0.676 ^a
Ankle flexion	24.6	9.90	27.2	9.87	0.519 ^b
Forefoot supination	13	12.88	20.7	11.19	0.084 ^a
Forefoot pronation	13.4	9.81	11.1	9.97	0.359 ^a
Subtalar supination	7.6	6.12	4	7.75	0.057 ^a
Subtalar pronation	1	6.6	0.1	1.58	0.240 ^a

Data presented as mean and standard deviation (SD). CP, calcaneal plates; FP, flat plates.

^a p-value for Mann-Whitney test.

^b p-value for independent sample t-test.

Table 4 – Results assessed by the clinical assessment scales.

	Type of plate				p
	CP (n = 14)		FP (n = 11)		
	Mean	SD	Mean	SD	
PF-SF36 Scale Scores	52.9	36.15	52.3	28.84	0.912 ^a
RP-SF36 Scale Scores	25.0	39.22	25.0	35.36	0.804 ^a
BP-SF36 Scale Scores	47.0	34.90	54.3	27.67	0.578 ^b
GH-SF36 Scale Scores	74.6	27.77	74.7	25.41	0.889 ^a
VT-SF36 Scale Scores	65.7	20.27	71.8	24.52	0.502 ^b
SF-SF36 Scale Scores	63.4	36.51	63.9	36.43	0.846 ^a
RE-SF36 Scale Scores	38.1	43.8	36.4	43.35	0.907 ^a
MH-SF36 Scale Scores	69.1	20.12	68.7	25.85	0.964 ^b
PF-SF36 Norm-based Scale Scores	37.4	15.15	37.1	12.10	0.967 ^b
RP-SF36 Norm-based Scale Scores	35.1	11.7	35.0	9.98	0.804 ^a
BP-SF36 Norm-based Scale Scores	40.0	14.94	43.2	11.85	0.575 ^b
GH-SF36 Norm-based Scale Scores	52.1	13.1	52.2	11.89	0.889 ^a
VT-SF36 Norm-based Scale Scores	54.1	9.61	57.0	11.62	0.502 ^b
SF-SF36 Norm-based Scale Scores	41.2	15.85	41.3	15.80	0.868 ^a
RE-SF36 Norm-based Scale Scores	35.8	13.61	35.2	13.70	0.907 ^a
MH-SF36 Norm-based Scale Scores	46.6	11.43	46.3	14.70	0.962 ^b
PCS-SF36	38.1	13.37	39.2	9.47	0.817 ^b
MCS-SF36	47.3	10.9	47.4	13.92	0.975 ^b

Data were presented as means and standard deviations (SD). CP, calcaneal plates; FP, flat plates.

^a p-value for Mann-Whitney test.

^b p-value for independent sample t-test.

Table 5 – Results according to the assessment scales.

	Type of plate				p ^a
	CP (n = 14)		FP (n = 11)		
	Mean	SD	Mean	SD	
VAS	4.6	2.73	3.6	2.38	0.344
AOFAS	66.1	26.37	52	20.64	0.160
Radiological width of the hindfoot	4.7	0.38	4.4	0.60	0.217
Pitch angle of the calcaneus	21	5.88	16.6	5.66	0.74
Talus declination angle	18	4.79	18.9	2.95	0.587

Data presented as mean and standard deviation (SD). CP, calcaneal plates; FP, flat plates.

^a p-value for independent sample t-test.

Discussion

Calcaneal joint fractures are severe injuries and may cause permanent and disabling sequelae. They usually affect young and economically active men, and thus these fractures can have an important socioeconomic impact.

In this sample, we found that 88% of patients were male and had a mean age of 47.6 years. According to the literature, the most common cause of intra-articular fractures of the calcaneus is a fall from height,¹ which was confirmed in the present study, as this cause accounted for 96% of the fractures.

The Essex-Lopresti¹⁰ radiological classification is a classical tool that determines the line of fracture and allows treatment planning. Tomographic classifications help to assess the severity and prognosis of the injury; the Sanders classification is the most commonly used.⁹ However, tomographic classifications are not uniform and each group aims to create its own classification, which makes it difficult to compare results as well as to identify the type of injury they describe. Tomography is considered to be an excellent test to identify details of the fragments and the joint impairment; however, it is not available in all services. This limitation justifies the use of a radiological classification.

According to the Essex-Lopresti classification, intra-articular fractures can be tongue-type or joint depression type. In most series, joint depression is the most frequent type of fracture, accounting for 43%–61% of intra-articular fractures.^{11,12} In the present study, 76% of fractures were joint depression-type and 24%, tongue-type.

For open surgery, there is a consensus to wait between seven and 14 days between trauma and operation, so that the edema reduces and blister formation is prevented, except in open fractures, which should receive immediate surgical treatment, or when percutaneous fixation is indicated.^{7,13} In the present study, the mean time between trauma and operation of the 25 fractures was 23.1 days (SD 17.28) for CP and 19.5 days for FP (SD 6.67).

The lateral L-shaped access route has been widely used because it allows better visibility of the fracture, fragment reduction, and internal fixation.^{7,13} In this study, the extended lateral L-shaped access was efficient; it was used as a standard technique for all cases.

Wound necrosis is usually the result of improper incision and exposure or long surgery.¹⁴ Necrosis is observed more frequently in the end of the lateral L-shaped incision.¹⁵ In the present study, a patient treated with CP needed surgical debridement due to skin necrosis, which solved the problem without the need of a skin graft.

Symptoms associated with implants problems, which are rarely reported in the literature, include prominent implant, skin irritation, and heel pain. Problems usually arise because plate and screws cause irritation to the skin, tendons, or nerves, or because a screw penetrates the facet joint.^{16,17} Tendon involvement due to implants can result in tendinitis or rupture, and lead to tendinitis and secondary pain.¹⁸ In the present study, the CP had to be removed in one patient due to skin irritation and pain. Furthermore, in three patients who were treated with FP, the synthesis material had to be removed due to FP and screw prominence.

The use of bone graft is controversial; some authors consider it to be osteoinductive and osteoconductive, while others consider it unnecessary.^{7,19} It is noteworthy that the use of bone graft increases the incidence of morbidity, as another incision is made for graft harvesting. In the present study, bone grafts from the iliac bone were not used. Instead, a graft taken from the lateral wall of the calcaneus was used to fill the remaining bone loss after fracture reduction.

Assessing the results using the AOFAS scale, the literature presents rates of excellent results, ranging from 42.22% to 62%.²⁰⁻²² In this study, 47.6% of the results were considered good or excellent. It is not possible to state with certainty that the type of fracture may have influenced the score, as in the present sample, the number of tongue-type fractures was small when compared with joint depression.

Post-traumatic arthrosis usually occurs in the subtalar and calcaneocuboid joints.²³ The literature reports an incidence rate of 1.2% in studies with long term follow-up.^{6,16} When intractable pain cannot be controlled by analgesics, subtalar arthrodesis may be the best option.¹⁶ In the present study, one patient treated with FP, with a fracture classified as Sanders 4, presented intractable pain and underwent subtalar arthrodesis, which improved the symptoms.

There are many controversies regarding the type of implant and its selection criteria. For ORIF, most studies applied a plate to the lateral wall of the calcaneus.²⁴ Regarding stabilization screws for the sustentaculum tali, there are also controversies regarding whether they should be fixated through the plate. Plates in several shapes can be used for ORIF of calcaneal fractures, and different types of synthetic materials are advocated by different authors.²⁴⁻³⁰

Modern plates have a lower profile, which has solved problems related to excessive skin tension, prominence of the implant under the skin, and subsequent dehiscence of the surgical wound.²⁴ The choice for a lateral plate depends on the severity of the calcaneal fracture and on bone quality. Simple fractures in good quality bone appear to be adequate for FP fixation, while complex fractures with comminution may require CP or even locking plates.²⁴

FP has been used for many years. In the early 1990s, due to post-operative complications at the time, ORIF techniques using two FPs for fixation were developed. Then, the development of single, H- and Y-shaped plates started.³⁰

The literature features numerous articles on the use of locked plate with minimally invasive technique. Few studies, however, address the use of FP for the treatment of calcaneal fractures, which, for the Brazilian surgeon, is still a reality, due to the country's health care system.

Although this was a retrospective study, it helped to assess the outcome of patients. It can be concluded that the results were very similar to those reported in the literature. The present study also indicates the need to develop treatment protocols that allow prospective studies, which could provide more reliable information on fractures, both pre-operatively and during their evolution.

Another important factor is that CP is not always available, especially in public services that face financial difficulties. In turn, FP is more readily available and inexpensive. These factors impact surgical treatment. The unavailability of CP in public services, associated with the availability and lower cost

of FP, may have been confounding factor in the present study. However, this study demonstrated that there appears to be no significant impairment in the treatment of calcaneal fractures when CP is not available.

Conclusion

Statistical inference allows for the conclusion that, in the absence of CP, FP can be used with similar clinical outcomes.

Conflicts of interest

The authors declare no conflicts of interest.

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