



# Outcomes of Early Weight Bearing in Displaced Intra-articular Calcaneus Fractures Treated with Screws-Only Fixation Technique

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Received: 30 May 2022 / Accepted: 9 January 2023 / Published online: 19 January 2023  
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## Abstract

**Background** Displaced intraarticular calcaneus fracture indicates surgical treatment. The current trend is open reduction and internal fixation with a plate or multiple screws through the sinus tarsi approach. Most postoperative protocols are prolonged non-weight bearing that causes a high socioeconomic burden. This study aims to determine the safety of the early weight-bearing protocol of screws-only fixation in calcaneal fracture.

**Materials and Methods** Evaluate displaced intraarticular calcaneus fractures treated with screws-only technique via the sinus tarsi approach in our institution. The first group, from July 2017 to December 2018, allowed patients to start partial weight bearing as tolerated at 4 weeks after surgery. The second group prospectively from January 2019 to March 2020, which assign patients to keep non-weight bearing for 8 weeks. The functional outcomes (Thai Foot and ankle ability measure subjective form, FAAM) were measured 6 months after surgery. The radiographic outcome (Bohler's angle and Gissane angle) was measured on the first day postoperative and 6 months follow-up, and the changes in these angles were recorded.

**Results** There were 28 patients in each group. The outcomes were collected and compared by a *T*-test. In the early weight-bearing group, The FAAM, Bohler's angle loss, and Gissane's angle change were  $76.4 \pm 14.8$ ,  $2.4 \pm 3.5$ , and  $6.6 \pm 7.8$ , respectively. In the delayed weight-bearing group, The FAAM, Bohler's angle loss, and Gissane's angle change were  $81 \pm 14.8$ ,  $2 \pm 1.8$  and  $2.6 \pm 6.1$ , respectively. There was no statistically significant difference in FAAM score, Bohler's angle loss, and Gissane's angle change between early and delayed weight-bearing groups.

**Conclusion** Screws fixation in calcaneal fracture may be safe to allow early weight-bearing protocol.

**Keywords** Calcaneal fracture · Screw fixation · Early weight bearing · Functional outcome

## Introduction

Calcaneus fractures are the most common tarsal bone fracture, of which 60–75% are displaced intraarticular fractures that require surgical intervention [1]. Surgical option includes open reduction and internal fixation or percutaneous fixation, which provide anatomical reduction of the articular surface and restore fracture configuration [2–4]. The minimally invasive reduction and fixation through the sinus tarsi approach reported better functional outcomes and wound-related complications [4].

After surgical treatment, early exercise and weight-bearing protocols can significantly improve the functional recovery of patients [5, 6]. The average non-weight bearing protocol was 9 weeks to reduce the risk of secondary displacement, but it causes a high socioeconomic burden and also decreases muscle strength and bone mass [3, 7]. Early partial weight-bearing accelerates physical recovery and daily activities, return to work, reduces the articular surface's residual displacement, and improves functional outcomes [7, 8]. The most surgical fixation of calcaneal fracture in Maharat Nakhon Ratchasima Hospital is a screws-only technique due to the lower cost of the implant and soft tissue dissection. Our patients start partial weight-bearing 4 weeks after surgical fixation due to indispensable quickly back to work.

We conducted this study to evaluate functional and radiographic outcomes in early weight-bearing patients versus delayed weight-bearing and to define the safety of

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early weight-bearing in screws-only fixation of a calcaneal fracture.

## Materials and Methods

This study collected the data in the case of displaced intraarticular calcaneal fracture fixation with 3.5 mm cortical screws via sinus tarsi approach (Fig. 1A, B) by a single experienced foot and ankle orthopedic surgeon. The retrospective review was performed in the first group (The early weight-bearing group) in 28 patients treated between July 2017 and December 2018. After the operation, all patients were kept in a posterior plaster slab and appointed to an orthopedic surgery clinic. The postoperative radiographic was performed at the first postoperative visit. The patient continued to keep in a posterior plaster slab. At the 4 weeks second postoperative visit, the postoperative radiographic was performed, and the partial weight-bearing protocol was allowed as tolerated without a walking boot, then gradually increased weight-bearing until full weight-bearing. In the second group (Delayed weight-bearing group), we used the same follow-up protocol, but 28 patients were assigned to keep non-weight bearing for 8 weeks, then the partial weight-bearing was allowed as tolerated without walking boot. All patients completed the Foot and ankle ability measurement (FAAM) in the Thai version to evaluate functional outcomes and the final radiographic was performed at 6 months [9] (Fig. 2). The radiographic parameters, including Gissane's and Bohler's angles at initial postoperative, follow-up, and when fractures were healed, were measured by two orthopedic residents at different times and places. The differences between Gissane's and Bohler's angles from the first



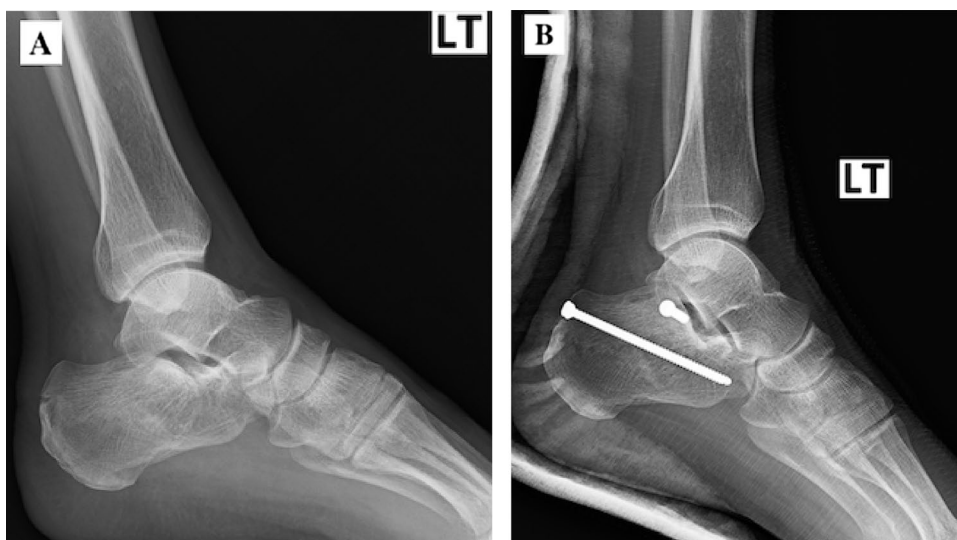
**Fig. 2** Postoperative lateral radiograph demonstrating reduction and healing of fracture with screws-only fixation at 6 months

postoperative to 6 months of radiographic assessment were defined as Gissane's angle change and Bohler's angle loss as the radiographic outcome.

## Statistical Analysis

The data were categorized into continuous data and categorical data. The continuous data and independent variables were analyzed using an independent *t*-test and Mann–Whitney *U* test. Chi-square analyzed the categorical data. The correction of factors was analyzed using linear regression, which represented into 95% Confidence interval with a *P* value of  $<0.05$  and was considered statistically significant.

**Fig. 1** **A** Preoperative lateral radiograph demonstrating displaced intraarticular calcaneal fracture with collapsed Bohler's angle. **B** Immediate Postoperative lateral radiograph demonstrating screws-only fixation construction



### Results

In the early weight-bearing group, 28 patients (6 females, 22 males) with means age  $46 \pm 11$  years were reviewed. Their radiographs were classified with Essex-Lopresti (19 joint depression and 9 tongue-type) and Sander (15 type-II and 13 type-III) classifications.

In the delayed weight-bearing group, 28 patients (4 females, 24 males) with means age  $48 \pm 12$  years were assigned to keep non-weight bearing until 8 weeks. Their radiographs were classified with Essex-Lopresti (11 joint depression and 17 tongue-type) and Sander classification (20 type-II and 8-type III).

There are no statistically significant differences between the two groups according to Sex, Age, Smoking, Occupation, and time to surgery. The difference between preoperative ( $8.3 \pm 16$  vs  $8.7 \pm 15.9$ ;  $P=0.93$ ) and postoperative Bohler's angle ( $20.6 \pm 10.5$  vs  $24.3 \pm 7.0$ ;  $P=0.13$ ) was not statistically significant. The preoperative ( $127 \pm 11.9$  vs  $8.7 \pm 15.9$ ;  $P=0.93$ ) and postoperative Gissane's angle

( $8.3 \pm 16$  vs  $8.7 \pm 15.9$ ;  $P=0.93$ ) were statistically different (Table 1).

In the early weight-bearing group, The FAAM, Bohler's angle loss, and Gissane's angle change were  $76.4 \pm 14.8$ ,  $2.4 \pm 3.5$ , and  $6.6 \pm 7.8$ , respectively. In the delayed weight-bearing group, The FAAM, Bohler's angle loss, and Gissane's angle change were  $81 \pm 14.8$ ,  $2 \pm 1.8$  and  $2.6 \pm 6.1$ , respectively. There was no statistically significant difference in FAAM score ( $P=0.54$ ), Bohler's angle loss (0.69), and Gissane's angle change (0.22) between early and delayed weight-bearing groups (Table 2).

### Discussion

Displaced intra-articular calcaneal fractures require operative management to prevent poor functional outcomes and late subtalar arthrodesis [1–3, 10]. Previously, lateral extensile incision to apply plate fixation comes with wound complications, traumatic arthritis, and ankylosis of the subtalar joint. Screws fixation through the sinus tarsi approaches or percutaneously has become popular due to

**Table 1** Demographic data and radiographic classification of included patient

		All	Early weight bearing	Delayed weight bearing	P value
Sex	Female	10	6	4	0.49
	Male	46	22	24	
Side	Left	30	14	16	0.60
	Right	26	14	12	
Age		$46.7 \pm 11.5$	$45.6 \pm 10.8$	$47.8 \pm 12.3$	0.48
Smoking	Yes	23	12	11	0.79
	No	33	16	17	
Occupation	Heavy labor	31	16	15	0.79
	Non-heavy labor	25	12	13	
Essex lopresti classification	Joint depression	30	19	11	0.03
	Tongue type	26	9	17	
Sander classification	Sander II	35	15	20	0.17
	Sander III	21	13	8	
Time to surgery (days)		$7.9 \pm 3.7$	$8.3 \pm 4.3$	$7.1 \pm 3$	0.23
Bohler's angle	Initial	$8.5 \pm 15.8$	$8.3 \pm 16$	$8.7 \pm 15.9$	0.93
	Post-op	$22.4 \pm 9.1$	$20.6 \pm 10.5$	$24.3 \pm 7$	0.13
Gissane angle	Initial	$121.6 \pm 14.9$	$127.1 \pm 11.9$	$116.11 \pm 15.8$	0.004
	Post-op	$122.1 \pm 11.6$	$128.4 \pm 10.1$	$115.67 \pm 9.34$	<0.001

**Table 2** The result of a study in two groups FAAM, Bohler's angle loss, Gissane's angle change

	Early weight bearing	Delayed weight bearing	95% CI	P value
FAAM	$76.4 \pm 14.8$	$81 \pm 14.8$	(- 6.25, 11.79)	0.54
Bohler's angle loss	$2.4 \pm 3.5$	$2 \pm 1.8$	(- 1.24, 1.99)	0.69
Gissane's angle change	$6.6 \pm 7.8$	$2.6 \pm 6.1$	(- 6.90, 1.61)	0.22

the lower rate of complications [11]. Many studies have proposed the screws-only fixation technique with good radiographic and functional outcomes [12–14]. Recent meta-analyses showed similar fixation effectiveness and functional outcomes in treating displaced intra-articular calcaneus fractures with cannulated screws fixation and plate fixation [15].

The aim of surgical treatment is not only to restore calcaneal configuration but also to provide stability for early rehabilitation protocol. The cadaveric study showed similar construction strength when comparing the screws-only technique with plate fixation [16–19]. Although the biomechanical study of screws-only fixation does not recommend early weight-bearing protocol, in the clinical application, early weight-bearing within 6 weeks after surgery of calcaneal fracture does not affect maintaining reduction, functional outcome, and complications [7, 20].

Postoperative Bohler's angle has been used to assess the prognostic outcome [2]. The collapse of Bohler's angle can be found in postoperative radiographic assessment with various operative techniques [11–15]. An average postoperative Bohler's angle in this study is in the normal range of Bohler's angle, and the loss of Bohler's angle is similar to the previous screws-only technique study [12]. Even if the patient bears their weight at 4 weeks, there was no statistically significant difference between the two groups and Bohler's and Gissane's angle loss. The functional outcome of early and delayed weight-bearing groups showed fair and good results in the early functional assessment, but there was no statistically significant difference.

This study has some limitations. First, the early weight-bearing group is a historical group because there is no previous study about early weight-bearing in the screws-only fixation technique. Second, the follow-up period is too short. Late osteoarthritis of the subtalar joint may be developed, and long-term follow-up is needed for reliability.

## Conclusion

Screw fixation in calcaneal fracture may be safe to allow early weight-bearing protocol.

## Declarations

**Conflict of interest** There are no conflicts of interest.

**Ethical standard** This article does not contain any studies with human or animal subjects performed by any of the authors.

**Informed consent** For this type of study informed consent is not required.

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