Title: Do heel-unloading orthoses improve clinical outcomes in patients after surgical treatment of calcaneal fracture? A propensity-matched, multicenter analysis of the TRON database

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Do heel-unloading orthoses improve clinical outcomes in patients after surgical treatment of calcaneal fracture? A propensity-matched, multicenter analysis of the TRON database.

Abstract

Background: Postoperative protocols after surgical treatment of calcaneal fracture have not been standardized to date. There are only a few reports on the efficacy of heel-unloading orthoses (HUOs) (Mars shoe, Graffin orthosis), and its efficacy is uncertain.

Objectives: The purpose of this study was to compare postoperative radiologic and clinical outcomes in patients with calcaneal fractures who used Graffin orthosis.

Study design: Multicenter retrospective study

Methods: We finally extracted 182 patients from a database of the Trauma Research Group of [redacted] (TRON) and divided them into two groups: Group C (underwent

19 casting or splinting only), and Group O (Graffin orthosis was used). A propensity score
20 algorithm was used to match group C to group O in a 1:1 ratio. We evaluated American
21 Orthopaedic Foot and Ankle Society (AOFAS) score at three and six months after
22 surgery and at final follow-up. Differences in reduction of the Böhler angle between the
23 two groups were evaluated radiographically. All data were analyzed with a *t*-test or
24 Fisher's exact test. P <0.05 was considered statistically significant.
25
26 **Results:** In Group C vs. Group O, The AOFAS score three months after surgery in
27 Group O was significantly higher than that in Group C (69.57 vs. 77.22; P=0.004).
28 However, there were no statistically significant differences between Group C versus
29 Group O in AOFAS scores at six months after surgery and at final follow-up (81.92 vs.
30 85.67 and 89.18 vs. 88.13; P=0.087 and 0.597, respectively). There was no significant
31 statistical difference in the reduction of the Böhler angle (5.07 vs. 5.89; P=0.529).
32
33 **Conclusion:** At three months postoperatively, the orthosis group showed predominantly
34 better functional results. We believe that HUO are useful for patients who require an
35 early return to work and to daily life.
36

37

Background

Calcaneal fractures comprise 2% of all fractures and account for approximately 60% of all tarsal injuries.[1] Recent meta-analyses suggested that surgery is associated with a higher likelihood of resuming pre-injury work and reaching a higher level of physical function and fewer problems in daily life compared to conservative treatment.[2] Various methods of treatment for calcaneus fractures have been described including non-surgical treatment and open reduction internal fixation by using a dedicated plate or canulated cancellous screw.[3]

To date, postoperative protocols after calcaneus fracture surgery have not been standardized. A previous study suggested immobilization with a splint or cast for up to six weeks postoperatively, after which partial weight bearing should be started.[4] In contrast, other studies indicated that early weight bearing after surgery has no deleterious effect on clinical and radiologic outcomes of comminuted calcaneal fractures. Moreover, functional evaluations showed good values of American Orthopaedic Foot and Ankle Society (AOFAS) scores.[5,6] Thus, early physical activity following a calcaneal fracture may be one of the key factors affecting the quality of life and ability to return to work.[7]

Graffin in France published a method of resecting the lower surface of the calcaneus, which is the posterior 2/3 of the calcaneus, in a short leg walking cast[8] Heel-unloading orthoses (HUOs) including the Settner shoe, Mars shoe, München shoe, and Graffin orthosis in Japan (Figure 1) make patients with calcaneus fractures walk after surgery by shifting the load to the forefoot and midfoot and achieve early mobilization.[9–12] A prior study also reported that the heel-unloading brace for calcaneal fracture improved the range of motion (ROM) of the ankle joint.[13] However, few studies have validated the efficacy and biomechanics of the Graffin orthosis after surgery.

This study aimed to evaluate only the use of the Graffin orthosis after calcaneal fracture surgery and not the biomechanics of this orthosis by propensity-matched analysis in a multicenter study.

Methods

Study Design and Setting

This multicenter, retrospective study was approved by the ethics commission at each participating hospital. All patients provided informed consent to participate in the study. Hospitals of the Trauma Research Group of [redacted] (TRON) have registered orthopedic trauma surgery cases in the TRON database annually since 2014. The 11 hospitals

73 participating in the database are all associated with the Department of Orthopedic
74 Surgery of [redacted], and surgeries are performed by multiple orthopedic
75 surgeons at each hospital. We collected cases of calcaneal fractures from this database
76 that were treated surgically.
77 *Participants*
78 We extracted 271 patients with calcaneal fracture undergoing surgery between
79 January 2014 and March 2019. We excluded patients who could not be followed up for
80 more than 3 months, had calcaneal avulsion fractures of the insertion of the Achilles
81 tendon and fracture of the sustentaculum tali, used a different orthosis, and had missing
82 data. Finally, 169 patients were included in this study (Figure 2). Backgrounds and
83 operative procedures of the patients are described in Table 1.
84 We divided the subjects into two groups: Group C, which underwent conventional
85 postoperative casting or splinting and did not use Graffin orthoses after the operation,
86 and Group O, which used Graffin orthoses after postoperative swelling improved. To
87 adjust for baseline differences between the two groups, a propensity score algorithm
88 was used to match Group C to Group O in a 1:1 ratio of 55 cases in each group.
89 Propensity score matching is a well-validated statistical technique that creates
90 comparable groups and allows for accurate assessment of treatment effect. Patients were

matched for age, sex, body mass index (BMI), smoking history, diabetes mellitus, non-union, infection, fracture type (Sanders classification), operation (plate, canulated cancellous screw, pinning), and injury mechanism[14] (Figure 2). The demographic data of the patients are summarized in Table 2. There were patients with multiple fractures in both groups: Group C: lumbar vertebrae 4, distal radius 4, pelvis 2, distal femur 1, distal phalanx 1, tarsus 3, and distal tibia 1; Group O: lumbar vertebrae 2, distal radius 2, pelvis 2, distal femur 1, and tarsus 1.

Surgical treatment

All patients were placed in the supine, lateral, or prone position. We used spinal anesthesia or regional nerve block. Orthopedic surgeons conducted all operative procedures and decided how to perform postoperative management.[14,15] A full-thickness L-shaped lateral incision or sinus tarsi approach was used. Stabilization was obtained with a plate (The Locking Calcaneal Plate, DePuy Synthes, USA or VariAx Foot locking plate system, Stryker, USA) and titanium screws or with titanium cannulated cancellous screws (4.0–6.5-mm diameter, DePuy Synthes or MEIRA, Japan). To achieve reduction in the percutaneous surgeries, stabilization was obtained with 2–3-mm K-wires.

Follow-Up Routine

All patients received antibiotics for 1–3 days after the surgery according to hospital protocol. A splint or cast was applied to all patients to reduce postoperative swelling. In both groups, patients were basically immobilized in a cast or splint for 2 weeks after surgery. However, some patients required immobilization for 2-4 weeks depending on the condition of the wound and type of surgery. The cast or splint applied immobilization below the knee. We custom-measured and made these orthoses for each patient. The Graffin orthosis was used to relieve the load on the calcaneus. The patients in Group O did not wear the Graffin orthosis except during gait training.

Patients in both groups started with ROM exercises (plantarflexion and dorsiflexion of the ankle joint) as soon as possible depending on the condition of the wound and the stability of the fracture. At the start of ROM, we confirmed that there was no abnormality in the patient's pain or radiographic findings. Partial weight bearing was begun after approval of the physician. The amount of weight bearing was gradually increased to full weight bearing in response to the patient's pain. Pins in patients with pinning were removed around 4–8 weeks after confirming good callus and fracture union on radiographs.

Clinical assessment and evaluation of postoperative management and complications

126 We evaluated AOFAS scores at three and six months after surgery and at final follow-
127 up to assess functional outcome during the follow-up period (supplemental table 1). To
128 evaluate the condition of postoperative management in both groups, we compared the
129 time from the date of surgery to the start of the ROM training, that to the start of partial
130 weight bearing, and that to the start of full weight bearing. We also compared wound
131 dehiscence, nonunion, neurapraxia, pulmonary embolism, and peroneal tendon
132 dislocation as complications.
133 *Radiographical evaluation*
134 Radiographic data were obtained by reading the radiographic computerized images,
135 available in the computer system of each institution. The radiographic evaluation
136 comprised the analysis of conventional radiographs, including lateral and Harris axial
137 views in the preoperative, postoperative, and follow-up periods, and preoperative
138 computed tomography scans (2- to 3-mm slice thickness, multiplanar reconstruction) to
139 evaluate fracture type. The fractures were classified according to the Essex-Lopresti
140 classification (tongue type or joint depression type) [15] and Sanders classification.[14] Each
141 measurement was made twice at a two-week interval by one orthopedic surgeon at each
142 hospital, and the final measurement was the average of the two values. Intraobserver
143 reliability for a single orthopedic surgeon (KY) at his hospital was measured using

intraclass correlation coefficient (ICC). Intraobserver reliability was found to be good for the Böhler angle (ICC=0.931).

Statistical Analysis

Categorical data were compared between the two groups using Fisher's exact test, and a *t*-test was used for continuous variables. To assume sample size using power analysis, we used the results based on previous study, which suggested a 4.5-point difference in AOFAS score. The standard deviation was 7.9[16] This resulted in 49 patients in each group. All statistical tests were performed using EZR software version 1.40 (Jichi Medical School, Tochigi, Japan) with the significance level set at $P < 0.05$.[17]

Results

AOFAS score

There was a statistically significant difference between Group C versus Group O in the AOFAS scores at 3 months after surgery (69.57 vs. 77.22; P=0.004). However, there were no significant differences between the two groups in the AOFAS scores at 6 months after surgery and at the final follow-up (9 months to 1 year) (81.92 vs. 85.67 and 89.18 vs. 88.13; P=0.087 and 0.597, respectively) (Figure 3). AOFAS component scores at 3 months after surgery were statistically different (Table 3). The AOFAS

scores for Pain and Maximum walking distance in blocks were significantly higher in Group O than those in Group C (5.07 vs. 5.89; P=0.529), but the degree of improvement in AOFAS from 3 months was less in Group O than in Group C.

Radiographical evaluation, postoperative care, and complications

The day on which ROM exercise started was significantly earlier in Group O than Group C (Table 4). There was no statistical difference between the two groups for the day on which partial weight-bearing and full weight-bearing started and in the decrease of the Böhler angle. One fibular tendon dislocation occurred in each group; otherwise, no other complications were observed in either group.

Discussion

There have been few studies on the postoperative treatment of calcaneal fractures, and in actual clinical practice, the duration of the use of casting or splinting and timing of the start of weight bearing may depend largely on the judgment of the surgeon and the institution. In recent years, the effectiveness of early weight bearing has been reported .[18,19] In this study, we investigated the clinical function and radiologic evaluation of Graffin orthoses assuming that they would enable early postoperative

179 rehabilitation. To the best of our knowledge, only one other study has compared
180 matched patient backgrounds.[12]

181 The most important finding of our study is that the AOFAS score was significantly
182 better in group O than in group C at 3 months after surgery. In terms of the AOFAS
183 components, Pain and Walking distance scores at 3 months after surgery were
184 predominantly higher in Group O, which means that pain was significantly lower and
185 maximum walking distance longer at 3 months after surgery in Group O. With regard to
186 pain, Kienast and colleagues showed that the number of patients complaining of pain
187 was 12% lower in the early weight-bearing group at 3 months postoperatively after plate
188 fixation .[19] Other literature has noted a decrease in postoperative VAS scores with
189 HUOs.[13] We assume that this is because the HUO allows weight bearing at an early
190 stage to prevent muscle atrophy and facilitate ROM restoration.[20] In addition, we
191 surmise that the recovery of ROM and prevention of muscle atrophy will protect the
192 ankle joint and subtalar joint from excessive load when walking, which will also reduce
193 pain.

194 The present study showed a better result in maximum walking distance at 3 months
195 after surgery in Group O (Group C: 3.31±1.17 blocks, Group O: 3.78±1.05 blocks;
196 P=0.043). Although there have been no previous reports on this point, the patients in

Group C required an assistive device (e.g., crutches), whereas those in Group O were able to walk from an early stage without an assistive device and without putting weight on the heel. Also, Group O experienced less pain, which may have influenced the difference in walking distance at 3 months after surgery. The degree of improvement in AOFAS score from 3 months after surgery to the final observation was less in Group O than in Group C. However, the AOFAS scores at the final observation were similar, which means that functional recovery was delayed in group C compared to group O (supplemental table 2,3). This leads us to believe that the Graffin orthosis may have the potential to improve function at an early stage. The Graffin orthoses is not suitable for older adults with an unstable gait or patients with polytrauma. However, the present study shows that the Graffin orthosis may be useful for unilateral fractures or for patients who require an early return to work and to daily life after calcaneus fracture surgery.

We also showed no significant difference between the two groups in the amount of decrease in the Böhler angle and in wound complications at the final follow-up. Regarding the relationship between the Böhler angle and postoperative function, it was reported that the decrease in Böhler angle was associated with poor results at the time of consultation two years after surgery and with AOFAS components (Pain, Walking

distance, and Walking surface), and it is important in the evaluation of outcome .[21,22] The literature suggests that loss of correction under weight bearing from 4–5 weeks after surgery is unlikely to occur,[18] which is consistent with the present study results. The present study shows that Graffin orthoses enable early weight bearing, which improves the patient's activities of daily living and preserves the position of the reduction on radiographic images.

This study has several limitations. First, it is a retrospective multicenter study. Although we were able to exclude confounders because of propensity score matching followed by testing, not all unmeasured confounders can be excluded. For example, the severity of fracture may bias the use or non-use of the Graffin orthosis. In addition, the indications for surgery and the protocol for postoperative weight bearing varied among institutions and were determined by multiple surgeons. There is a report of fewer postoperative complications occurring in surgeries performed by experienced surgeons[22]; however, the quality of the surgery could not be considered in this study. Also, generally, comparing differences between baseline and intervention data is effective when evaluating the effectiveness of treatment using orthoses. However, calcaneal fractures are acute injuries and most patients are unable to walk before or immediately after surgery, and in fact, most hospitals did not include the AOFAS score

in their baseline data. Due to the presence of surgical intervention, the results obtained may not be purely orthotic in nature. However, one strength of this study was the matching of preoperative information such as fracture type to minimize the impact of surgery. Another limitation concerns Graffin orthoses. We did not evaluate any HUO other than the Graffin orthosis. The Graffin orthosis was developed in Japan and is considered to be similar in concept to other HUOs. However, only a few papers in Japanese have examined load distribution with the Graffin orthosis, and no comparison with other HUOs has been performed.[11] Therefore, this result may not be applicable to all HUOs. Also, in our statistical analysis, we were not able to calculate the maximum allowable walking distance. The results of the present study showed statistical significance for the AOFAS score in the early postoperative period, but it is unclear whether Graffin orthoses are actually clinically superior. A minimal clinically important difference in the AOFAS score has been reported for the hallux valgus, but there is no literature on the calcaneus, and further study is needed.[23] In addition, the results of this study may be different for different races. There are differences in body weight among races that may affect pain and fracture crushing. Finally, in terms of race and health care disparities, these factors have been reported to influence treatment choices.[24]

Conclusions

In conclusion, we used propensity score matching in a multicenter study to compare the usefulness of Graffin orthoses in postoperative patients with calcaneal fractures. Although there was no difference in the final results of the functional assessment, the patients in Group O showed superior clinical function at 3 months after surgery. We believe that Graffin orthoses may be useful for unilateral fractures or for those patients who require an early return to work and to daily life after calcaneal fracture surgery.

Conflict of Interest:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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346 **Figure legend**

347 **Figure 1.** Image of a heel-unloading orthosis (Graffin orthosis).

348

349 **Figure 2.** Flow diagram of the participants included in the study. Group C underwent

350 conventional postoperative casting or splinting only without the heel-unloading orthosis

351 (Graffin orthosis), and Group O used Graffin orthosis after splinting.

352

353 **Figure 3.** Box plots of AOFAS score at 3 months and 6 months after surgery and at the

354 final follow-up visit in both groups are shown. Each box represents the 25th and 75th

355 percentiles, the line within the box represent the median, and the whisker bars represent

356 the 10th and 90th percentiles. White box: Group C (underwent casting or splinting only

357 without Graffin orthosis), Gray box: Group O (Graffin orthosis was used after

358 splinting).

Table 1. Characteristics and operative procedures of the 182 patients

Characteristic	Group C N=108	Group O N=74	P Value	95%CI
Age, yrs, mean (SD)	57.55 (17.65)	58.53 (13.05)	0.684	-5.72, 3.76
Sex, male/female n	70/38	50/24	0.752	
BMI, kg/m^2 mean (SD)	22.68 (3.82)	22.91 (3.57)	0.690	-1.35, 0.90
Current smoking, yes/no n	58/29	41/24	0.231	
Diabetes mellitus, n (%)	20 (18.5)	8 (11.1)	0.212	
Open fracture, n (%)	22 (20.4)	2 (2.7)	<0.001	
Injury mechanism, n (%)			0.849	
Tumble	22 (20.4)	13 (17.6)		
Fall from a high place	82 (75.9)	60 (81.1)		
Traffic accident	3 (2.8)	1 (1.4)		
Others	1 (0.9)			
Infection, n (%)	9 (8.5)	3 (4.1)	0.364	
Non-union, n (%)	1 (0.9)	0 (0.0)	1	
Essex-Lopresti classification, n (%)			0.529	
Tongue type	58 (53.7)	35 (47.3)		
Depression type	49 (45.4)	39 (52.7)		
Sanders classification, n (%)			NA	
I	16 (15.4)	9 (12.6)		
II	48 (46.2)	28 (39.4)		
III	34 (32.7)	29 (40.8)		
IV	6 (5.8)	5 (7.0)		
Operation, n (%)			0.103	
Pinning	37 (34.3)	27 (36.5)		
Plate	30 (27.8)	13 (17.6)		
CCS	27 (25.0)	30 (40.5)		
Plate + CCS	3 (2.8)	2 (2.7)		
Pinning + CCS	9 (8.3)	2 (2.7)		
Pinning + Plate	2 (1.9)	0 (0.0)		

SD = standard deviation; BMI = body mass index; CCS = canulated cancellous screw.

Table 2. Preoperative and surgical related characteristics of the patients after propensity score matching

Characteristic	Group C N=55	Group O N=55	P Value	95%CI
Age, yrs, mean (SD)	56.80 (16.63)	58.87 (13.12)	0.470	-7.73, 3.58
Sex, male/female n	40/15	37/18	0.678	
BMI, kg/m^2 mean (SD)	23.16 (3.57)	22.55 (3.41)	0.364	-0.71, 1.93
Current smoking, yes/no n	31/24	37/18		
Diabetes mellitus, n (%)	6 (10.9)	6 (10.9)	1.00	
Open fracture, n (%)	5 (9.3)	2 (3.6)	0.271	
Injury mechanism, n (%)			0.383	
Tumble	9 (16.4)	7 (12.7)		
Fall from a high place	44 (80.0)	48 (87.3)		
Traffic accident	2 (3.6)	0 (0.0)		
Infection, n (%)	5 (9.4)	2 (3.7)	0.270	
Non-union, n (%)	0 (0.0)	0 (0.0)	1	
Essex-Lopresti classification, n (%)			0.250	
Tongue type	34 (61.8)	27 (49.1)		
Depression type	21 (38.2)	28 (50.9)		
Sanders classification, n (%)			0.161	
I	7 (12.7)	9 (16.4)		
II	31 (56.4)	23 (41.8)		
III	14 (25.5)	19 (34.5)		
IV	3 (5.5)	4 (7.3)		
Operation, n (%)			0.145	
Pinning	16 (29.1)	20 (36.4)		
Plate	20 (36.4)	9 (16.4)		
CCS	14 (25.5)	22 (40.0)		
Plate + CCS	2 (3.6)	2 (3.6)		
Pinning + CCS	2 (3.6)	2 (3.6)		
Pinning + Plate	1 (1.8)	0 (0.0)		
Bone graft or bone graft substitutes, n (%)	23 (41.8)	35 (53.6)	0.044*	

Operative time, min, mean (SD)	77.31 (51.63)	80.33 (54.31)	0.767	-23.13, 17.11
Follow-up period from surgery, days, mean (SD)	313.83 (154.39)	298.72 (143.36)	0.661	-0.44, 0.57
AOFAS, mean (SD)				
3 months after surgery	69.57 (14.12)	77.22 (12.51)	0.004*	-12.73, -2.56
6 months after surgery	81.92 (12.11)	85.67 (8.92)	0.087	-8.06, 0.56
Date of last visit	89.18 (9.51)	88.13 (9.84)	0.597	-2.89, 5.00
Difference in AOFAS at 6 months and 3 months after surgery	13.11 (8.28)	9.94 (9.52)	0.088	-0.49, 6.82
Difference in AOFAS at last visit and at 3 months after surgery	20.31 (12.64)	13.31 (12.45)	0.009*	1.82, 12.17
Decrease of Böhler angle, mean (SD)	5.07 (6.49)	5.89 (6.87)	0.529	-0.74, 3.70

SD = standard deviation; BMI = body mass index; CCS = canulated cancellous screw; AOFAS = American Orthopaedic Foot and Ankle Society.

*$p<0.05$

Table 3 AOFAS component scores at 3 months

	Group C	Group O	P Value	95%CI
AOFAS, mean (SD)	69.57 (14.12)	77.22 (12.51)	0.004*	-12.73, -2.56
Pain, mean (SD)	26.48 (7.31)	30.56 (5.29)	0.001*	-6.50, -1.64
Activity limitation, mean (SD)	5.63 (2.32)	6.26 (2.37)	0.166	-1.52,0.27
Walking surfaces, mean (SD)	3.57 (1.30)	3.57 (1.31)	1.000	-0.91, 0.68
Maximum walking distance, blocks, mean (SD)	3.39 (1.07)	3.81 (1.07)	0.041*	-0.83, -0.02
Gait abnormality, mean (SD)	5.93 (2.43)	6.22 (2.15)	0.503	-1.17, 0.58
Sagittal motion, mean (SD)	5.96 (2.15)	6.07 (2.02)	0.782	-0.49, 0.50
Hindfoot motion, mean (SD)	4.56 (1.72)	4.56 (1.62)	1.000	-0.64, 0.63
Ankle-hindfoot stability, mean (SD)	5.81 (3.52)	6.81 (2.87)	0.108	-2.22, 0.22
Alignment, mean (SD)	8.24 (2.77)	9.35 (1.70)	0.014*	-1.98, -0.23

AOFAS = American Orthopedic Foot and Ankle Society; SD = standard deviation.
*$p<0.05$.

Table 4. Results of radiographic evaluation and timing to the start of each rehabilitation after surgery in both groups

Characteristic	Group C	Group O	P Value	95%CI
ROM exercise day, mean (SD)	15.92 (14.20)	9.32 (9.78)	0.007*	0.99, 9.97
Partial weight bearing day, mean (SD)	39.48 (11.27)	34.08 (49.63)	0.454	-7.31, 21.02
Full weight bearing day, mean (SD)	62.27(18.51)	60.40 (21.50)	0.644	-6.25, 8.63

SD = standard deviation; ROM = range of motion; day = number of days from date of surgery.

*$p<0.05$.

Supplemental Table 1 AOFAS Score (Ankle-Hindfoot Scale :100points Total)

Ⅰ Pain (40 points)

None	40
Mild, occasional	30
Moderate, daily	20
Severe, almost always present	0

II Function (50 points)

Activity limitations, support requirement	
No limitations, no support	10
No limitation of daily activities, limitation of recreational activities, no support	7
Limited daily and recreational activities, cane	4
Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace	0

Maximum walking distance, blocks	
Greater than 6	5
4-6	4
1-3	2
Less than 1	0

Walking surfaces	
No difficulty on any surface	5
Some difficulty on uneven terrain, stairs, inclines, ladders	3
Severe difficulty on uneven terrain, stairs, inclines, ladders	0

Gait abnormality	
None, slight	8
Obvious	4
Marked	0

Sagittal motion (flexion plus extension)	
Normal or mild restriction (30° or more)	8

Moderate restriction (15°-29°)	4
Severe restriction (less than 150)	0

Hindfoot motion (inversion plus eversion)	
Normal or mild restriction (75%-100% normal)	6
Moderate restriction (25%-74% normal)	3
Marked restriction (less than 25% normal)	0

Ankle-hindfoot stability (anteroposterior, varus-valgus)	
Stable	8
Definitely unstable	0

III Alignment（10 points）

Good, plantigrade foot, midfoot well aligned	15
Fair, plantigrade foot, some degree of midfoot malalignment observed, no symptoms	8
Poor, nonplantigrade foot, severe malalignment, symptoms	0

Total=100

Supplemental Table 2 AOFAS component scores at 6 months

	Group C (N=55)	Group O (N=55)	P Value	95%CI
AOFAS, mean (SD)	81.92 (12.11)	85.67 (8.92)	0.087	-8.06, 0.56
Pain, mean (SD)	30.21 (6.01)	32.92 (5.44)	0.023*	-5.03, -0.38
Activity limitation, mean (SD)	7.58 (2.08)	7.62 (2.23)	0.925	-0.91-0.83
Walking surfaces, mean (SD)	4.12 (1.28)	4.48 (0.87)	0.117	-0.79, 0.09
Maximum walking distance, blocks, mean (SD)	4.08 (1.05)	4.31 (0.85)	0.243	-0.61, 0.16
Gait abnormality, mean (SD)	7.25 (1.78)	6.67 (1.91)	0.125	-0.16, 1.33
Sagittal motion, mean (SD)	6.83 (1.84)	7.00 (1.75)	0.650	-0.89, 0.56
Hindfoot motion, mean (SD)	5.38 (1.23)	5.31 (1.27)	0.807	-0.44, 0.57
Ankle-hindfoot stability, mean (SD)	7.71 (1.29)	7.67 (1.62)	0.889	-0.55, 0.63
Alignment, mean (SD)	8.75 (2.63)	9.69 (1.22)	0.027*	-1.77, -0.10

AOFAS = American Orthopedic Foot and Ankle Society; SD = standard deviation.
*$p<0.05$.

Supplemental Table 3 AOFAS component scores at final follow up

	Group C (N=55)	Group O (N=55)	P Value	95%CI
AOFAS, mean (SD)	89.18 (9.51)	88.13 (9.84)	0.597	-2.89, 5.00
Pain, mean (SD)	33.47 (5.22)	33.48 (5.66)	0.994	-2.22, 2.20
Activity limitation, mean (SD)	8.96 (1.68)	8.04 (2.30)	0.029*	0.09-1.73
Walking surfaces, mean (SD)	4.35 (1.23)	4.61 (0.80)	0.227	-0.69, 0.16
Maximum walking distance, blocks, mean (SD)	4.55 (0.71)	4.59 (0.72)	0.807	-0.32, 0.25
Gait abnormality, mean (SD)	7.59 (1.47)	6.96 (1.78)	0.060	-0.03, 1.30
Sagittal motion, mean (SD)	7.43 (1.41)	7.22 (1.60)	0.497	-0.40, 0.82
Hindfoot motion, mean (SD)	5.63 (0.99)	5.35 (1.25)	0.221	-0.17, 0.74
Ankle-hindfoot stability, mean (SD)	7.71 (1.27)	8.00 (0.00)	0.132	-0.66, 0.09
Alignment, mean (SD)	9.49 (1.84)	9.89 (0.74)	0.171	-0.98, 0.18

AOFAS = American Orthopedic Foot and Ankle Society; SD = standard deviation.
*$p<0.05$.