Early Weightbearing Versus Nonweightbearing After Operative Treatment of an Ankle Fracture

A Multicenter, Noninferiority, Randomized Controlled Trial

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Background: Acute ankle fractures can occur during sports activities, and unstable ankle fractures are commonly treated operatively. However, controversy exists about the optimal time to allow weightbearing.

Hypothesis: Early weightbearing after the stable fixation of an ankle fracture is not inferior to nonweightbearing in terms of ankle function assessed at 12 months after injury.

Study design: Randomized controlled trial; Level of evidence, 1.

Methods: A total of 258 patients were assessed for eligibility. Of these patients, 194 were randomly allocated to either the early weightbearing group (95 patients who were allowed weightbearing at 2 weeks postoperatively) or the nonweightbearing group (99 patients who were not allowed weightbearing until 6 weeks postoperatively). The primary outcome measure was the mean difference in the Olerud-Molander ankle score (OMAS) between the groups, assessed at the 12-month follow-up examination. The secondary outcome measures were the time to return to preinjury activities and patients' subjective satisfaction. Complications such as hardware loosening or failure, fracture displacement, and nonunion were evaluated.

Results: The mean difference in the OMAS for the early weightbearing group compared with the nonweightbearing group was 1.6 (95% CI, –1.9 to 5.0) in the intention-to-treat analysis. The lower limit of the 95% CI (–1.9) exceeded the noninferiority margin of –8, indicating that early weightbearing was not inferior to nonweightbearing. The difference in the proportion of patients who were satisfied or very satisfied with their treatment was not statistically significant (84.3% vs 76.2%; P = .19); however, the time taken to return to preinjury activities was shorter with early weightbearing than with nonweightbearing (9.1 ± 3.0 vs 11.0 ± 3.0 weeks; $P < .001$). No cases of nonunion were observed in either group.

Conclusion: Early weightbearing after the operative treatment of an unstable ankle fracture was not inferior to nonweightbearing in terms of OMAS assessed at 12 months after injury. The patients' subjective satisfaction was similar between the groups, although the time taken to return to preinjury activities was shorter in the early weightbearing group.

Registration: NCT02029170 (ClinicalTrials.gov identifier).

Keywords: ankle fracture; surgery; early weightbearing; nonweightbearing

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Acute ankle fractures can occur during sports activities, and the incidence is likely to increase as the amount of participation in sports-related activities increases.[13,31,44] In a study of 992 sports-related acute fractures, 96 (10%) were ankle fractures.[31] Unstable ankle fractures are commonly treated operatively. After the open reduction and internal fixation (ORIF) of fractures, nonweightbearing (NWB) for 6 weeks with active range of motion exercise in a removable cast or brace has been considered the standard approach traditionally.[17,29,35,37] A period of approximately 6 weeks is recognized as needed to achieve sufficient fracture healing that can resist the strain caused by weightbearing.[21] The theoretical risks of displacement of fixed fractures, implant failure, and loss of reduction have been deterring surgeons from permitting early weightbearing (EWB).[29,35,37] However, several studies have reported that EWB started at 2 weeks postoperatively is safe; decreases ankle stiffness, muscle atrophy, and bone atrophy; and aids in early return to activities.[7,18,19,33,39,40,47] If EWB is not worse than NWB in terms of clinical outcomes and fixation stability, it may have secondary advantages over NWB, such as an earlier return to preinjury activities and the patients' satisfaction about being allowed to walk early. Multiple, prospective, randomized controlled trials comparing EWB and NWB after ORIF of ankle fractures indicated no difference in outcomes.[1-3,14,15,23,32,34,41] However, many of these trials had small sample sizes without power analysis. In addition, most of the studies were superiority trials but reported on the equivalence of the 2 treatments. Failure to observe sufficient evidence for the rejection of the null hypothesis ($P > .05$) does not necessarily suggest the equivalence of 2 treatments, but rather only shows that the difference is not statistically significant or the absence of evidence of a difference.[4,25,30,43] Noninferiority and equivalence testing are valuable in controlled trials for the comparative assessment of treatments with similar primary endpoints but potentially important differences in the secondary outcomes.[43]

We designed a multicenter, noninferiority, randomized controlled trial to determine if EWB after the operative treatment of an unstable ankle fracture is not inferior to NWB in terms of the Olerud-Molander ankle score (OMAS) assessed at 12 months after injury.

METHODS

This study was a multicenter, noninferiority, randomized controlled trial that assessed patients from 6 university hospitals. The study was designed and implemented following the CONSORT (Consolidated Standards of Reporting Trials) statement and was approved by the institutional review board of each participating hospital. This study was registered at ClinicalTrials.gov (NCT02029170).

Eligibility Criteria

Patients with an unstable ankle fracture that was treated with ORIF were prospectively enrolled into the study from 2014 to 2017 after they provided written informed consent (Figure 1). The inclusion criteria were age 18 to 65 years and unstable ankle fractures, including unimalleolar fractures and bimalleolar fractures, that were stabilized after satisfactory reduction and firm internal fixation. The exclusion criteria were ankle fractures whose stability after ORIF was questioned by the operating surgeon, fractures that required syndesmotic screw fixation, and cases with residual widening of the medial clear space or syndesmotic clear space after ORIF. We regarded the fixation to be unstable when a crack occurred in the fractured fragment during implant insertion or when a slight degree of movement was detected at the fragment while assessing the ankle's range of motion after fixation.

Trimalleolar fractures, open fractures, pathologic fractures, and concurrent injuries that precluded following the rehabilitation protocol were also criteria for exclusion. Patients with obesity (body mass index, >30; weight, >100 kg), diabetes or neuroarthropathy, and other conditions that would hinder following the study protocol were excluded.

Randomization

At the 2-week postoperative visit, the patients were informed of the study procedure and the purpose of the study. After providing written informed consent, the patients were randomly allocated, with the use of sealed envelopes, to 1 of the 2 study groups: EWB group or NWB group (Table 1). A randomization list was generated using 1:1 allocation with random block sizes of 2 and 4. Randomization was stratified by the type of ankle fracture (lateral malleolar, medial malleolar, and bimalleolar) and by the study center. A biostatistician who was not involved in the clinical care of the patients prepared sealed envelopes using a computerized random number generator. The group allocation was concealed from the investigators, and the consecutively numbered sealed envelopes were opened at the 2-week postoperative visit to allocate patients into either group.

Interventions

All patients enrolled in the study underwent ORIF of an unstable ankle fracture with the use of rigid osteosynthesis techniques. Postoperatively, the ankles in both groups

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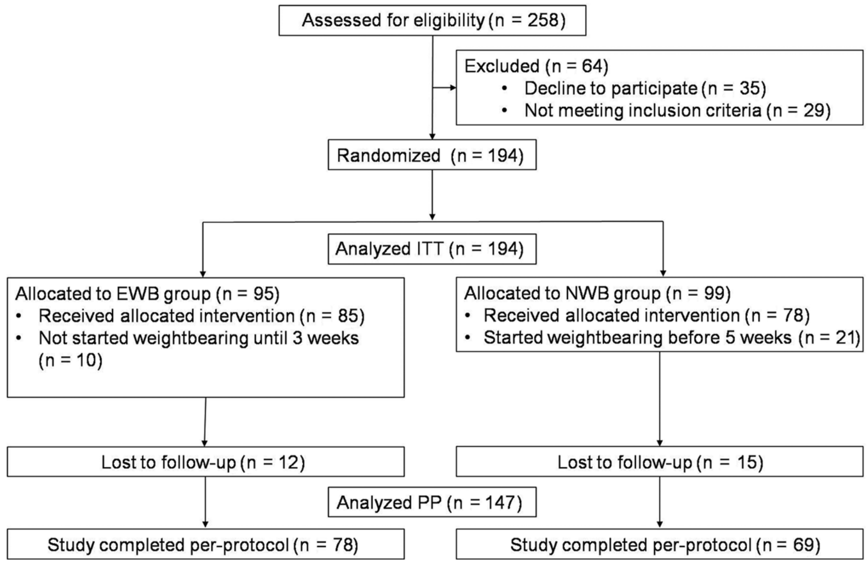

Figure 1. CONSORT (Consolidated Standards of Reporting Trials) flow diagram. EWB, early weightbearing; ITT, intention-to-treat; NWB, nonweightbearing; PP, per-protocol.

TABLE 1
Patients' Preoperative Data[a]

	EWB (n = 95)	NWB (n = 99)	*P* Value
Age, y	42.7 ± 14.2	43.1 ± 14.2	.84
Sex, male/female	54/41	60/39	.59
Weight, kg	68.0 ± 12.2	66.9 ± 12.0	.52
Height, cm	166.8 ± 9.3	167.0 ± 9.6	.84
BMI	24.3 ± 2.9	23.9 ± 3.2	.33
Type of fracture			.51
Lateral malleolus	48	54	
Medial malleolus	16	11	
Bimalleolus	31	34	

[a]Values are presented as mean ± SD, except for sex and type of fracture (N). BMI, body mass index; EWB, early weightbearing (group consisting of patients who were allowed to bear weight at 2 weeks postoperatively); NWB, nonweightbearing (group consisting of patients who were not allowed to bear weight until 6 weeks postoperatively).

were immobilized in a posterior short-leg splint and maintained in an NWB state with crutches for 2 weeks until the wound healed. Patients who were allocated to the EWB group were allowed to bear weight, as tolerated, in a removable walking cast at 2 weeks postoperatively for the next 4 weeks. Daily active and passive range of motion exercises of the ankle joint were encouraged at 2 weeks postoperatively, after wound healing. Patients who were allocated to the NWB group were maintained in an NWB state in a removable splint with crutches until 6 weeks postoperatively. Range of motion exercises of the ankle joint were started at 2 weeks postoperatively, similar to the EWB group. Six weeks after the operation, the cast or splint was removed in both groups and more active exercise was recommended.

Outcome Measures

The primary outcome measure was the mean difference in the OMAS between the EWB and NWB groups, assessed at the 12-month follow-up examination by independent investigators who were blinded to the study.[28] The 100-point, 9-category OMAS is a validated scoring system that covers aspects such as pain, stiffness, swelling, stair climbing, running, jumping, squatting, use of supports, ability to work, and activities of daily living.[28] The OMAS was also assessed at 6, 8, and 12 weeks postoperatively to illustrate the trajectory of the treatment responses and to investigate the patients' recovery of function. The secondary outcome measures were the time taken to return to preinjury activities and patients' subjective satisfaction. The patients were asked to report when they were able to bear full weight without assistive devices, such as a crutch or a splint, and the time when they resumed their preinjury activities. They were also asked to rate their overall satisfaction with their allocated treatment, with either "very satisfied," "satisfied," "fair," "dissatisfied," or "very dissatisfied," at the 12-month follow-up visit. The outcome assessors were blinded to the group allocation after 6 weeks postoperatively when the cast or splint was removed. Radiographs were obtained at 4, 6, 8, and 12 weeks and 12 months postoperatively to assess for any loss of reduction or implant failure and to evaluate for fracture union. A reduction loss or implant failure was defined as one that occurred without the patient's instigation of inappropriate activity. Reduction loss was defined as a >2-mm displacement of the initial reduction. Implant failure was defined as breakage of the implant or backing out of screws or Kirshner (K)-wires.

On an intention-to-treat (ITT) basis, patients who were crossed over to the other treatment arm were analyzed according to their initial group allocation. Additionally, a per-protocol (PP) analysis was performed in patients who followed the assigned protocol and completed the 12-month follow-up. When patients did not follow their assigned protocol over a 1-week period, it was considered failure to follow the protocol. For an example, when patients in the EWB group did not start bearing weight until 3 weeks postoperatively, or when patients in the NWB group started bearing weight before 5 weeks postoperatively, they were considered to have failed to follow the protocol and were excluded in the PP analysis. The primary analysis for the study was the ITT analysis.

Statistical Analysis

The sample size was determined using methods appropriate for noninferiority trials, assuming 90% power and a significance level of .05. In a previous study on the functional outcomes of EWB versus NWB after surgery for an ankle fracture in 46 patients, Simanski et al[33] reported that the 2 groups showed similarly good results in the OMAS (87 ± 14 vs 79 ± 19 points; P = .25), with a pooled SD of 16.7. This study was used for the calculation of the sample size. To obtain a power of 90% and for the lower limit of a 1-sided 95% CI to exceed a noninferiority margin (Δ_{NIM}) of –8, a sample size of 150 patients was required. Assuming a dropout rate of 20%, we selected 192 as an ideal sample size for the study. We determined the noninferiority margin according to a previous study that concluded no clinically significant difference between the EWB and NWB groups with a mean difference of 8 points in the OMAS.[33] This study investigated a population that was similar to our trial population and used interventions similar to those being studied in the current trial. During the design stage of the current trial, no estimate for minimal clinically important difference (MCID) existed for OMAS. A recent study suggested the MCID for the OMAS to be 11.5 points, and another recent noninferiority trial used a noninferiority margin of 8.8 points for the OMAS.[16,21] A noninferiority margin of 8 points used in the current trial is narrower than these values; in contrast to a superiority trial, a narrower (tighter) margin provides assurance that the experimental group is equal or not substantially inferior to the comparator group.[30,43]

Data normality was assessed using the Kolmogorov-Smirnov test. The baseline patient characteristics were compared between the 2 groups using the independent t test or the Mann-Whitney U test. Differences in categorical variables were tested using the chi-square test. Statistical significance was set at $P < .05$. All analyses were completed by a biostatistician using SAS 9.4 (SAS Institute).

RESULTS

A total of 258 patients were assessed for eligibility (Figure 1). Of these patients, 194 were randomly allocated to either the EWB group (95 patients who were allowed weightbearing at 2 weeks postoperatively) or the NWB group (99 patients who were not allowed weightbearing until 6 weeks postoperatively). Table 1 presents the patients' baseline characteristics, which were not significantly different between the 2 groups. Twelve (13%) patients in the EWB group and 15 (15%) patients in the NWB group did not visit the clinic for their final 12-month follow-up examination. Ten (11%) patients in the EWB group did not start bearing weight until 3 weeks postoperatively. Twenty-one (21%) patients in the NWB group started bearing weight before 5 weeks postoperatively. Patients who did not complete or those who changed their assigned treatment were excluded in the PP analysis, leaving 78 and 69 patients in the EWB and NWB groups, respectively, for this analysis. For the ITT analysis, the data of 95 and 99 patients in the EWB and NWB groups, respectively, were analyzed. Owing to considerable loss to follow-up, missing data were analyzed, which were found to be missing at random. For missing data, a multiple-imputation approach using Markov chain Monte Carlo methods was applied.

In the ITT analysis, the mean OMASs at the 12-month follow-up were 88.5 ± 12.2 and 86.9 ± 12.2 (P = .38) in the EWB group and the NWB group, respectively (Table 2). The mean difference between the 2 groups was 1.6 (95% CI, –1.9 to 5.0). The lower limit of the 95% CI (–1.9) exceeded the noninferiority margin of –8, indicating that EWB was not inferior to NWB after the operative treatment of an ankle fracture (Figure 2). However, as the 95% CI included 0 points, the superiority of one treatment over the other could not be proven. A similar result was found in the PP analysis. The mean OMASs at the 12-month follow-up were 89.9 ± 9.2 and 85.5 ± 12.7 (P = .02) in the EWB group and the NWB group, respectively (Table 2). The mean difference between the 2 groups was 4.4 (95% CI, 0.8-8.1). Similarly, the lower limit of the 95% CI (0.8) exceeded the noninferiority margin of –8, indicating that EWB was not inferior to NWB (Figure 2). Furthermore, as the entire 95% CI was over 0 points, the EWB group had significantly superior outcomes compared with those of NWB group in PP analysis.

In the ITT analysis, the time taken to bear full weight was significantly shorter in the EWB group than in the NWB group (6.2 ± 2.1 vs 8.1 ± 1.5 weeks; $P < .001$). The time taken to return to preinjury activities was also significantly shorter in the EWB group than in the NWB group (9.1 ± 3.0 vs 11.0 ± 3.0 weeks; $P < .001$) (Table 3). The OMAS assessed at the 6- and 8-week follow-ups was significantly higher in the EWB group than in the NWB group; however, at the 12-week and 12-month follow-ups, the differences were not statistically significant (Table 3).

The difference in the proportion of patients who were satisfied or very satisfied with their treatment between the 2 groups was not statistically significant (84.3% vs [EWB] vs 76.2% [NWB]; P = .19) (Table 4). In the PP analysis, similar results to the ITT analysis were obtained with respect to the times taken to return to full weightbearing and to preinjury activities. However, the OMAS assessed at all time periods was significantly higher in the EWB group than in the NWB group (Table 3).

No cases of delayed union or nonunion were observed in either group. However, there were 3 cases with backing out of the K-wires (1 case in the EWB group and 2 cases in the NWB group). We believe that the backing out of K-wires in

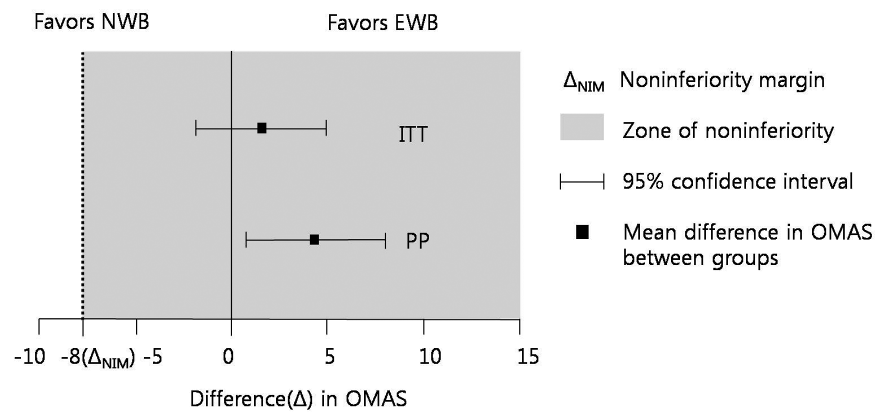

Figure 2. Difference in Olerud-Molander ankle score (OMAS) between the early weightbearing (EWB) group and the nonweightbearing (NWB) group assessed at the 12-month follow-up, presented as means and 95% CIs. The lower limits of the 95% CI in the intention-to-treat (ITT) analysis (–1.9) and the per-protocol (PP) analysis (0.8) exceeded the noninferiority margin (Δ_{NIM}) of –8, indicating that early weightbearing was not inferior to nonweightbearing.

TABLE 2
Primary Outcome Measures[a]

12-Month OMAS	EWB Group	NWB Group	Difference	*P* Value
Intention-to-treat analysis	88.5 ± 12.2	86.9 ± 12.2	1.6 (95% CI, –1.9 to 5.0)	.38
Per-protocol analysis	89.9 ± 9.2	85.5 ± 12.7	4.4 (95% CI, 0.8 to 8.1)	.02

[a]Values are presented as mean ± SD or mean (95% CI). EWB, early weightbearing; NWB, nonweightbearing; OMAS, Olerud-Molander ankle score.

TABLE 3
Secondary Outcome Measures[a]

	EWB Group	NWB Group	*P* Value
Intention-to-treat	n = 95	n = 90	
Time to full weightbearing, wk	6.2 ± 2.1	8.1 ± 1.5	<.001
Time return to preinjury activities, wk	9.1 ± 3.0	11.0 ± 3.0	<.001
OMAS			
6 wk	47.0 ± 12.5	43.3 ± 7.8	.014
8 wk	57.0 ± 11.7	53.7 ± 8.7	.031
12 wk	72.8 ± 11.0	70.1 ± 11.5	.094
12 mo	88.5 ± 12.2	86.9 ± 12.2	.376
Per-protocol	n = 78	n = 69	
Time to full weightbearing, wk	5.9 ± 1.6	8.4 ± 1.4	<.001
Time return to preinjury activities, wk	8.8 ± 2.5	11.7 ± 2.6	<.001
OMAS			
6 wk	48.4 ± 11.7	41.7 ± 7.3	<.001
8 wk	58.8 ± 11.1	53.2 ± 8.7	.002
12 wk	74.3 ± 9.6	69.0 ± 10.6	.004
12 mo	89.9 ± 9.2	85.5 ± 12.7	.02

[a]Values are presented as mean ± SD. EWB, early weightbearing; NWB, nonweightbearing; OMAS, Olerud-Molander ankle score.

these cases was not caused by weightbearing because the 2 cases in the NWB group were detected 4 weeks postoperatively, before weightbearing. In all cases with backing out of K-wires, the wires were not fixed to the far cortices of the lateral malleolus and were not fully embedded into the fractured bone. All backed-out K-wires were removed after the bone union, as they were symptomatic. No case of reduction loss was observed in either group.

TABLE 4
Patients' Subjective Satisfaction

Satisfaction	EWB Group (n = 83)[a]	NWB Group (n = 84)
Very satisfied	22 (26.5)	24 (28.6)
Satisfied	48 (57.8)	40 (47.6)
Fair	10 (12.0)	16 (19.0)
Dissatisfied	3 (3.6)	4 (4.8)
Very dissatisfied	0 (0)	0 (0)

[a]Values are presented as number of patients (percentage). EWB, early weightbearing; NWB, nonweightbearing.

DISCUSSION

The most important finding of this study was that EWB after the operative treatment of an unstable ankle fracture was not inferior to NWB in terms of OMAS assessed at 12 months after injury. EWB did not increase the incidence of reduction loss, implant failure, delayed union, or nonunion. The patients' subjective satisfaction was similar between the groups, although the time taken to return to preinjury activities was shorter in the EWB group.

Ankle fracture is one of the most common injuries treated by orthopaedic surgeons. The major goal of treatment is to restore ankle function through satisfactory fracture reduction. However, for young and active patients, early return to preinjury activities without jeopardizing the functional outcome and without increasing complications, such as fixation failure or wound problem, is also a major treatment goal.[11] Most patients intend to return to normal activities as soon as possible. However, the appropriate rehabilitation strategies after surgical intervention are still controversial.[24,33] NWB for 6 weeks has been considered the standard approach, as it is recognized that it takes approximately 6 weeks to achieve sufficient fracture healing that can resist the strain caused by weightbearing.[21,29,35] The theoretical risks of displacement of fixed fractures, implant failure, and loss of reduction have been deterring surgeons from permitting EWB.[29,35] However, in a biomechanical analysis of 24 fresh-frozen cadaveric models of EWB after ORIF of unstable ankle fractures, no relevant fracture displacement, hardware failure, or new fractures occurred after axial compression loading at a rate of 3 Hz from 0 to 1000 N for 250,000 cycles, which simulated 5 weeks of full weightbearing.[38] Possibly, fixation failure might be caused not by repeated loads of body weight but by a sudden, uncontrolled high load or a rotation force imposed on the ankle, as in unexpected falls.[42] In a biomechanical study in 10 anatomic specimens of the lower limbs, the fibula was found to receive an average of 17% of an axial load on the lower limb.[12] Another study reported that the load distribution to the fibula averaged 7.12% of the total force transmitted through the tibia and fibula.[44] The displacement force that may be imposed on the fixed fibula during weightbearing must be much smaller than that imposed on the weightbearing portion of the distal tibia, such as in tibial pilon fractures.[45]

Many clinical outcome studies have shown the safety of EWB started at 2 weeks postoperatively, with no cases of fixation failure reported.[14,18,32,34,41] Schubert et al[32] and Dehghan et al[14] allowed weightbearing in an orthosis, as tolerated, from 2 weeks postoperatively after ORIF of unimalleolar, bimalleolar, or trimalleolar ankle fractures in 25 and 56 patients, respectively, and found no cases of loss of fixation or loss of reduction. Gul et al[18] allowed immediate unprotected full weightbearing without an orthosis in 25 patients with operated Weber A/B/C fractures and observed no fixation loss. Smeeing et al[34] allowed protected weightbearing at 10 days postoperatively in 36 patients and unprotected weightbearing without an orthosis after 24 hours postoperatively in 42 patients with operated supination-external rotation type 2 to 4 ankle fractures and observed no fixation failure.

The risks and benefits of EWB after the operative fixation of ankle fractures are not definite. Basic science shows that mechanical loading helps fracture healing. Animal experiments, cell culture studies, and finite-element models have found that controlled or moderate axial loading leads to a greater volume of callus and a faster time to union than no loading.[5,12,22] However, there is insufficient clinical evidence to support that EWB after ORIF of an ankle fracture leads to faster or better bone healing[10,29,35] Nevertheless, restricting patients from bearing weight until 6 weeks postoperatively may be associated with a high physiologic cost.[9,46] NWB requires the patient's body weight to be supported with crutches or a walking frame. Accordingly, in a previous study, NWB resulted in a 4-fold increase in the energy expended for ambulation compared with full weightbearing.[46] Some studies have indicated that mobility aids used during NWB, such as crutches, are considerably associated with falls due to imbalance.[6,8,20] In fact, with respect to the possibility of unexpected falls, restricting patients from weightbearing and placing them in a position of imbalance with the use of crutches may cause a higher risk of fixation failure from unexpected falls than allowing tolerable weightbearing, which provides a better balance. Furthermore, NWB can lead to a higher incidence of deep vein thrombosis.[23,39] Conversely, EWB can lead to an earlier return to normality.[10,18,33,34,39] In the present study, the time taken to return to preinjury activities was significantly shorter in the EWB group than in the NWB group in both ITT and PP analyses (Table 3). The OMAS assessed at the 6- and 8-week follow-ups was significantly higher in the EWB group than in the NWB group, which may indicate earlier recovery of function in the EWB group (Table 3). However, the interesting point was that the patients' subjective satisfaction with their treatment was not statistically significantly different between the 2 groups (84.3% vs 76.2%; $P = .19$) (Table 4). We expected that the patients' subjective satisfaction would be higher in the EWB group, as they were not confined to crutches and were allowed to walk earlier. However, patient satisfaction can be multifactorial with different causes. We acknowledge that the patients' convenience may not be the only factor explaining their subjective satisfaction. However, there is a possibility of recall bias as patients' satisfaction was assessed at the

12-month follow-up visit. Assessment at multiple time periods could have had a different result.

The strengths of this study include having a large sample size, involving multiple centers with multiple surgeons, and having a noninferiority, randomized trial design. However, this study had a few limitations. This study was powered to show noninferiority of functional outcomes but was not powered to show a difference in rare complications, such as reduction loss, implant failure, or nonunion, between EWB and NWB groups, which may have required larger numbers of patients. However, the present study found no evidence that EWB would lead to fixation failure. The 3 cases where backing out of the K-wires was observed might raise concerns that EWB at 2 weeks postoperatively permits harmful motion within the fracture line. However, the 2 cases in the NWB group occurred before weightbearing, which led us to conclude that they were not caused by the difference in the time of weightbearing but by an inappropriate fixation of K-wires, as the wires were not fixed to the far cortices and not fully embedded into the fractured bone. The secondary outcome analyses, such as the time to full weightbearing, time to return to preinjury activities, and patients' subjective satisfaction, were not powered and should be interpreted as exploratory results requiring further research. Although all participating surgeons at different centers followed generalized principles of ankle fracture osteosynthesis, there is the possibility of a difference in outcomes because of the difference in surgical techniques and devices. However, we believe that this bias could be minimized with randomization stratified by the study center and by the type of ankle fracture. The participation of multiple surgeons is likely to improve the generalizability of our findings, with increased external validity and applicability of results to clinical practice. Moreover, selection and confounding biases with respect to potential risk factors for complications with fracture healing, such as body mass index, tobacco consumption, and use of nonsteroidal anti-inflammatory drugs, were prevented by randomization and concealed allocation because all differences between the randomized groups must therefore be at random. Excluding patients at risk of fixation failure could have caused selection bias and may have favorably affected the EWB group. To increase the applicability and the generalizability of the study, it could have been better to include all patients, even those with the risk of fixation failure. However, patients' safety was our priority. In fact, the exclusion was done before randomization to minimize bias, and it is known that narrow eligibility criteria improve the internal validity of the clinical trials.[26]

We acknowledge that only 147 (76%) patients were included in the PP analysis. Only 69 (70%) patients in the NWB group followed and completed the assigned postoperative rehabilitation protocol of starting weightbearing at 6 weeks postoperatively. Twenty-one (21%) patients started bearing weight before 5 weeks postoperatively, and 15 (15%) patients were lost to follow-up at 12 months postoperatively. We believe that this low compliance to the protocol in the NWB group was inevitable because patients in this group were informed before the study enrollment that patients in the other treatment arm would start bearing weight at 2 weeks postoperatively and that it was possible to bear weight early. Accordingly, they began to bear weight as soon as they felt secure with less pain. Excluding these patients with less painful ankles from the NWB group could induce bias favoring the EWB group.[25,27] We conducted an ITT analysis including these patients and also performed a PP analysis in patients who completed the allocated protocol. Loss to follow-up is well known to be a difficult and common problem when studying patients treated for an injury.[21,25] To address this issue, we performed multiple data imputations, which is a recognized method of analyzing missing data.[36] Interestingly, not all patients wanted to walk early. Some patients preferred stability and certainty toward treatment, such as 10 patients (12%) in the EWB group who did not start bearing weight until 3 weeks postoperatively. The reasons for delaying weightbearing in these 10 patients were pain in 6 patients and uncertainty and fear about bearing weight in 4 patients.

Given that both treatments resulted in good clinical outcomes without showing superiority over one another, and without increased rate of fixation failure, it may be reasonable to take into account the patients' postoperative treatment preferences when deciding the time to allow weightbearing after surgery for an ankle fracture. A more individualized pain-adapted time of weightbearing may be reasonable, and it may be more important to educate patients about the possibility of the surgical results being affected by unexpected falls from stairs or slippery floors than to restrict weightbearing to prevent fixation failure.[42]

CONCLUSION

EWB after the operative treatment of an unstable ankle fracture was not inferior to NWB in terms of OMAS assessed at 12 months after injury. The EWB did not increase the incidence of reduction loss, implant failure, delayed union, or nonunion. The patients' subjective satisfaction with their treatment was not statistically significantly different between the 2 groups, although the time taken to return to preinjury activities was significantly shorter in the EWB group.

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