RESEARCH ARTICLE

Early Unprotected Weight Bearing and Pre-Scheduled Supervised Rehabilitation Program after Surgical Treatment of Ankle Fractures

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Abstract

Background: Ankle fractures represent one of the most common orthopedic injuries in the lower extremity**.** Weight-bearing and rehabilitation protocols after surgical treatment of ankle fracture have recently evolved from traditional methods to full weight-bearing protocols. However, more evidence is needed on unprotected immediate weight-bearing along with a standardized rehabilitation program. The purpose of this study was to evaluate effects of unprotected immediate weight-bearing as tolerated and an eight-week prescheduled supervised rehabilitation program on the mid-term clinical and functional outcomes of surgically treated ankle fractures, and to compare functional results with the unaffected side.

Methods: Eighty patients (24F and 56M) who underwent rigid fixation of bimalleolar ankle fractures were included (mean age 41.57±13.22 years). Preoperative radiographs and computed tomography scans were used to evaluate and classify the fractures. The fractures were classified using Lauge-Hansen classification system. Ankle ROMs, Pain Disability Index (PDI), American Orthopedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scores, and Short Form-36 scores were evaluated. Patients were allowed unprotected weight-bearing on the immediate postoperative period and a standardized supervised prescheduled rehabilitation program was undertaken following surgery.

Results: The mean follow-up period was 30.32±6.91 months. Based on Lauge-Hansen classification, supination-external rotation injuries were found in 32(40%) patients, supination adduction injuries in 14(17.4%) patients, pronation-external rotation injuries in 28(35%) patients, and pronation-abduction fractures in 6(7.6%) patients. The solid union was achieved in all patients at the final follow-up. The mean PDI score was 12.78±14.78, and the AOFAS score was 80.93±17.24. Although patients' health-related quality of life was at a good level, the injured-side ankle ROM was lower than the healthy side ($P \leq 0.05$).

Conclusion: Satisfactory clinical and functional outcome can be achieved at mid-term with unprotected weight-bearing as tolerated and pre-scheduled supervised eight-week rehabilitation program following rigid internal fixation of ankle fractures. However, this protocol is not studied in patients with associated comorbidities.

Level of evidence: III

Keywords: Bimalleolar ankle fracture, Early weight-bearing, Functional outcome, Surgery, Rehabilitation, Physical therapy

Introduction

Ankle fractures represent one of the most common orthopedic injuries in the lower extremities, and the incidence is increasing every year (1,2). Approximately two-thirds of ankle fractures are isolated malleolar fractures (3). While most stable fractures are treated conservatively, displaced unstable fractures

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require operative treatment (4). The targeted optimal treatment of these fractures involves anatomic reduction and rigid fixation of the joint surface and restoration of length and rotation of tibia and fibula (5). The final achievement of painless ankle joint movement and weight-bearing are considered satisfactory functional results (6).

Rehabilitation interventions following bimalleolar ankle surgery traditionally begin either during immobilization by temporarily removing splint or following an immobilization period. Recent studies suggest that mobilization should begin as early as possible following surgery as tolerated (1,2,7-10). On the other hand, due to its complex anatomy, a standardized physiotherapy program has not been described until now (11-13). In addition, although some authors suggest that excess weight-bearing is associated with loss of reduction and slower healing, recent studies showed that early weight-bearing tends to accelerate return to work and daily activities (2,15-16). However, there is a limited number of research evaluating unprotected immediate weight-bearing along with standardized rehabilitation programs (10,16,17). Therefore, the purpose of this study was to evaluate the effects of unprotected immediate weight-bearing as tolerated and an eight-week prescheduled supervised rehabilitation program on the mid-term clinical and functional outcomes of surgically treated ankle fractures, and to compare functional results with the unaffected side.

Materials and Methods

Patients who underwent ankle fracture surgery at the Orthopedics and Traumatology Department of a University hospital were evaluated retrospectively. The study was approved by the Clinical Research and Ethics Committee of the authors' affiliated institution.

The inclusion criteria were as follows: available preoperative anteroposterior, mortise, lateral radiographs and computed tomographic scans, ankle fractures treated surgically by the same surgical team, age 18-65 years, the articular incongruity of more than 2 mm on X-ray, postoperative immediate weight-bearing and supervised prescheduled rehabilitation program. Exclusion criteria were as follows: superficial wound infection, revision surgery in the early follow-up period (within one month) due to inadequate fixation of the fragments, pre-existent cognitive disability, body mass index >30, diabetes mellitus, rheumatologic disease, chronic kidney disease, contralateral ankle joint diseased-affected, incomplete data.

In the present study, 125 patients who had surgically treated ankle fractures were evaluated. Forty-five patients were excluded from the study: superficial wound infection (n=6), revision surgery in the early follow-up period (within one month) due to inadequate fixation of the fragments (4), diabetes mellitus (n=9), chronic kidney disease (3), rheumatologic disease (3), contralateral ankle joint diseased affected (n=7), incomplete data (n=13). The final study sample consisted of 80 patients.

Surgical technique

Surgical technique and implant selection were determined according to the surgeon's preference. The fibula was anatomically reduced and fixed in the first place before fixing the medial malleolar compartment unless the lateral malleolar fracture was comminuted. If comminution of the fibula was severe medial side was fixed first since over-reduction of the lateral side might have prevented the anatomical reduction of the medial malleolar fracture. Lag screws either with tubular plates or with anatomic locking plates were used. Medial malleolar fractures were fixed either with 2 cannulated 4 mm lag screws or with K wires and cerclage. Secure and rigid fixation of the fragments was targeted in all cases. The syndesmosis injury was also evaluated intraoperatively by using the dorsiflexion-external rotation stress test and fixed accordingly [Figure 1]. Following secure fixation of the fractured fragments, skin incisions were closed with interrupted sutures and the ankle was supported in a well-padded elastic bandage. The leg was elevated, and ice bags were applied.

Prescheduled supervised rehabilitation program

All patients received standard care during the hospitalization period (i.e., ice, transfer activities, mobilization, and exercise). All patients received the same supervised standardized exercise program after discharge from the hospital and this exercise program

Figure 1. Preoperative and postoperative AP and lateral radiographs of 39 years old female patient with supination-external rotation-IV ankle injury according to Lauge-Hansen classification system.

was performed 3 times a week for 8 weeks: Unprotected weight-bearing was limited by the patient tolerance of weight (with walking aid), they were encouraged for full weight-bearing at the acute postoperative period and were instructed to discontinue the walking aid when they felt safe. Ankle mobility exercises and passive range of motion (ROM) exercises (0 to 2 weeks); active-assistive/active exercises (2 to 4 weeks); progressive resistive exercises (4 to 6 weeks), proprioceptive, balance, and gait training, and promote the return of functional activities and working abilities (6 to 8 weeks).

Evaluations

Patients were evaluated postoperatively at the latest follow-up. Demographic variables, employment status, and full weight-bearing time of the patients were recorded. The fractures were classified using the Lauge-Hansen classification system by the same observer (18). Patients' outcome was measured by radiographic findings and clinical and functional assessments. Radiological evaluations of the patients to detect union and any signs of ankle arthritis were performed with standard anteroposterior, lateral, and mortise ankle radiographs.

Both injured and healthy-side ankle range of motion was assessed by using a universal goniometer. Pain Disability Index (PDI) was used to determine the degree to which aspects of patients' life affected by chronic pain. Patients rated their disability level on a scale ranging from 0 (no disability) to 10 (total disability) in 7 areas (19). The American Orthopedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score was used to assess clinical and functional outcomes (20). The total score is on a scale of 0 to 100, with 100 indicating no symptoms or impairments. Short Form-36 (SF-36) was used to determine a patient's health-related quality of life (21). The total score of the questionnaire ranged from 0 to 100, with a higher score indicating better quality of life.

Statistical analysis

Statistical analysis was performed using the software package SPSS (Version 21, SPSS Inc, Chicago, IL, United States). Continuous variables were presented as mean ± standard deviation, while categorical variables were presented as absolute numbers and percentages. The distribution of data was evaluated using the Kolmogorov-Smirnov test. The data was not normally distributed. Mann-Whitney U test was used to compare the means of the affected and healthy limbs. Spearman's correlation coefficient was used to assess the correlation between PDI, AOFAS, and SF-36 scores. The statistical significance level was set as $P<0.05$.

Results

A total of 80 patients (24 women and 56 men; mean age 41.57±13.22 years, mean BMI 26.89±5.18) participated in the study. The mean follow-up period of the patients was 30.32±6.91 months [Table 1]. Radiological evaluation of the patients in this follow-up period showed solid union of the fracture and no signs of osteoarthritis.

The mean PDI score was found 12.78±14.78. The mean AOFAS score was 80.93±17.24. The health-related quality of life of the patients was at a good level [Table 2].

The ankle range of motion of the injured side was found lower than in the healthy side ($P\leq0.05$) [Table 3]. When the relationship between AOFAS and PDI and SF-36 scores of the patients were investigated, AOFAS scores showed significant negative correlations with all sub-parameters of PDI ($P\leq0.01$). AOFAS scores showed significant positive correlations with all subscales of SF-36 ($P\leq0.001$) [Table 4].

When the relationship between full weight-bearing time, Pain Disability Index, AOFAS, and SF-36 scores of

Table 1. Descriptive Characteristics of Patients

Variables	Min-Max	Mean±SD
Age (years)	20–65	41.57±13.22
BMI (kg/m^2)	20.06–29.98	25.16±2.87
Education (year)	0–16	8.12±4.70
Follow-up period (month)	23.10–43.83	30.32±6.91
Time until full weight-bearing (month)	0.5–4	1.73±1.09
Return to work (day)	60-195	90.43±35.06
	n	**%**
Gender		
Female	24	30.0
Male	56	70.0
Dominant side		
Right	74	92.5
Left	6	7.5
Affected side		
Dominant	43	53.8
Non-dominant	37	46.2
Employment status		
White collar	9	11.25
Blue collar	22	27.5
Pink collar	19	23.75
Student	3	3.75
Housewife	20	25.0
Retired	7	8.75
Lauge-Hansen Classification		
Supination/external rotation II	9	11.2
Supination/external rotation IV	23	28.8
Supination/adduction I	9	11.2
Supination/adduction II	5	6.2
Pronation/external rotation I	10	12.5
Pronation/external rotation II	6	7.5
Pronation/external rotation III	12	15.0
Pronation/abduction I	3	3.8
Pronation/abduction III	3	3.8

Min: minimum; Max: Maximum SD: Standard deviation; kg: kilogram; m: meter

Table 2. Pain, PDI, AOFAS and SF-36 Scores of the Patients

Variables	Min-Max	Mean±SD
PDI		
Family/home responsibilities	0–10	2.45±2.93
Recreation	0–10	2.62±3.07
Social activity	0–10	1.75±2.63
Occupation	0–10	2.62±3.40
Sexual life	0–10	0.98±2.34
Self-care	0–10	1.42±2.51
Life support activities	0–10	0.90±2.20
Total	0–53	12.78±14.78
AOFAS	19–100	80.93±17.24
SF-36		
Physical functioning	0–100	71.29±26.71
Role limitations due to physical problems	0–100	59.61±43.62
Bodily pain	10–100	66.85±27.37
General health perceptions	5–100	64.87±20.73
Mental health	0–100	62.61±22.33
Role limitations due to emotional problems	0–100	60.25±44.31
Social functioning	12.50–100	75.83±25.92
Vitality	0–100	55. 83±24.68

PDI: Pain Disability Index; AOFAS: The American Orthopedic Foot and Ankle Society Ankle-Hindfoot Score; SF-36: Short Form-36; SD: Standard deviation

Table 3. Comparison of Healthy and Injured-Side Ankle Range of Motion of the Patients

Variables	Injured-side		Healthy-side		*P*
	Min-Max	Mean±SD	Min-Max	Mean±SD	
Dorsi flexion	30–0	14.85±6.73	30–0	19.25±7.14	0.000
Plantar flexion	50–0	33.70±11.24	55–15	38.36±9.72	0.007
Inversion	35–0	19.11±9.12	35–8	22.78±7.77	0.009
Eversion	25–0	12.39±8.05	25–0	15.91±7.36	0.006

SD: Standard deviation

the patients were investigated, the moderate positive correlations were detected between full weight-bearing time and all sub-scales of PDI except sexual function. In addition, weak to moderate negative correlations were detected between full weight-bearing time and all sub-scales of SF-36 except general health perceptions and role limitations due to emotional problems [Table 5].

Discussion

The most important finding of this study is that a satisfactory clinical and functional outcome can be achieved at mid-term with unprotected weight-bearing as tolerated and pre-scheduled supervised eight-week rehabilitation program following rigid internal fixation of ankle fractures in patients without associated comorbidities. The normal range of motion of the ankle joint, although limited when compared to the healthy side, was found at a level that the functionality of the patients was not affected.

The improvement in physical function following an ankle fracture is rapid in the first phase (approximately 80% in 6 months), but slows gradually over time, and may not be complete even at the 24th month following the injury (1). Despite this knowledge about the healing period, the reported studies include 6-month and 1-year results. Accordingly, the average two-year follow-up period in the present study strengthens its clinical results.

Various postoperative rehabilitation regimes can be

Table 4. Relationship Between AOFAS Scores with PDI and SF-36 Scores

Variables	AOFAS	
	r	*P*
PDI		
Family/home responsibilities	-0.582	0.000
Recreation	-0.567	0.000
Social activity	-0.522	0.000
Occupation	-0.563	0.000
Sexual life	-0.340	0.003
Self-care	-0.435	0.000
Life support activities	-0.473	0.000
Total	-0.652	0.000
SF-36		
Physical functioning	0.655	0.000
Role limitations due to physical problems	0.620	0.000
Bodily pain	0.689	0.000
General health perceptions	0.447	0.000
Mental health	0.485	0.000
Role limitations due to emotional problems	0.617	0.000
Social functioning	0.496	0.000
Vitality	0.537	0.000

PDI: Pain Disability Index; AOFAS: The American Orthopedic Foot and Ankle Society Ankle-Hindfoot Score; SF-36: Short Form-36

Table 5. Relationship Between Full Weight Bearing Time with PDI and SF-36 Scores of the Patients

Variables	Full weight bearing time	
	r	*P*
PDI		
Family/home responsibilities	0.325	0.008
Recreation	0.339	0.006
Social activity	0.408	0.001
Occupation	0.423	0.000
Sexual life	0.144	0.254
Self-care	0.408	0.001
Life support activities	0.364	0.003
Total	0.444	0.000
AOFAS	-0.214	0.090
SF-36		
Physical functioning	-0.401	0.001
Role limitations due to physical problems	-0.367	0.003
Bodily pain	-0.248	0.048
General health perceptions	-0.260	0.038
Mental health	-0.344	0.005
Role limitations due to emotional problems	-0.221	0.079
Social functioning	-0.539	0.000
Vitality	-0.338	0.006

PDI: Pain Disability Index; AOFAS: The American Orthopedic Foot and Ankle Society Ankle-Hindfoot Score; SF-36: Short Form-36

followed after surgical treatment of an ankle fracture (postoperative early mobilization, cast immobilization with or without weight-bearing, protected or unprotected weight-bearing, etc.). Although traditionally postoperative six weeks of non-weight bearing for healing is advised, weight-bearing and rehabilitation protocols have recently differed from the traditional protocols (15,16). Early weight-bearing at postoperative 1-2 weeks may be considered a safe alternative to immobilization, and early mobilization and weight-bearing in the acute postoperative period have been suggested as having a positive effect on treatment outcomes in these contemporary studies, but some studies still report that early mobilization and weight-bearing has limited benefits (7-9,22, 23). Furthermore, a very recent meta-analysis reported that early weight-bearing equates to delayed weight-bearing in terms of patient outcomes at 6 to 12 months of follow-up (21). Bäcker et al in a recent study suggested weight-bearing following 2 weeks of immobilization (24). In our study, ambulation and weight-bearing in tolerated amounts were started at the acute postoperative day in all patients. Radiologic findings and lack of non-union in our series of patients support the positive effects of active exercise on the union of the fracture. We suggest that early mobilization and weight-bearing can be efficacious based on the clinical and radiologic results of the present study.

Increased risk of complications after early weight-bearing along with active mobilization has not been reported in recent studies (2,15,16,25). Starkweather et al reported that patients who walked on postoperative day 1 had slightly more wound problems than others (10). A retrospective cohort study reported that 10.2% of the patients had wound-related complications, while the implant-related complications were 4.4% (17). Exceptionally, if the rigid fixation goal cannot be managed during the operation, immediate weight-bearing and early mobilization should not be performed due to the possibility of early implant failure and revision. Since these results in a delay to return to daily activities and work, every effort should be undertaken to achieve rigid fixation goals in these types of fractures. Accordingly, in a study by Gul et al the encouraging outcome of early tolerable unprotected weight-bearing was reported in 25 patients with Weber Type B and C ankle fractures (9). Weight-bearing was started in the present study with tolerable weight and full weight-bearing was achieved at around six weeks postoperatively. Osteoporotic changes and muscle atrophy can be reduced by early weight-bearing and the length of hospital stay can be shortened (21). In recent studies, even in selected elderly patients, it has been reported that early weight-bearing improves the quality of life and functionality and increases the rate of home discharge without increasing complications (25,26).

The patients in the present study were discharged from the hospital within a maximum of 3 days and

visited the outpatient clinic once every two weeks for the supervised planning of appropriate rehabilitation programs and follow-ups. Ankle fractures are costly for both the individual and society, not only regarding the cost of surgery and post-surgical hospital stay but also concerning the duration of occupational disability. In this regard, early functional return is very important in decreasing these costs (27). Unprotected weight-bearing as tolerated improved short-term functional outcomes, led to earlier return to work and sports (14,15). Following ankle surgery, early weight-bearing has been shown to facilitate an early return to daily life activities and work, when immobilization, early weight-bearing, and late weight-bearing are all compared (2). Our patients returned to work in a short period (approximately 3 months), except for one patient whom he did not want to return to his previous occupation.

One of the limitations of our study is that we did not include patients with associated comorbidities. This is because these patients usually have decreased bone quality that may lead to premature implant failure along with early weight-bearing. Therefore, one should keep in mind that early weight-bearing as tolerated is not tested in this patient group. Another limitation is that we excluded patients (4 cases) with implant failure in the early postoperative period (within one month). The failure of the implants was either due to inadequate fixation or faulty diagnosis of the fracture mechanism and fixation of the fragments accordingly. Therefore, the failure was not associated with early weight-bearing affecting the interpretation of the results.

In the present study, we evaluated the effects of pre-scheduled supervised rehabilitation and immediate unprotected weight-bearing as tolerated on the functional outcome of patients without comorbidities. Satisfactory clinical and functional improvements were demonstrated following operative treatment of ankle fractures, but the ROM on the affected side was found to be lower than on the healthy contralateral side but had no effect on functionality.

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