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Original Article

Predicting factors for better outcomes of stable supination external rotation type 2 ankle fractures

Efthymios Iliopoulos*, Jay James Watson, Felicity Auld, Richard Freeman, Natasha Hossain

Brighton & Sussex University Hospitals, NHS Trust, Brighton, BN2 5BE, United Kingdom

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ABSTRACT

Purpose: Stable Weber B ankle fractures are treated by a walking boot for 6 weeks and bearing full weight through the boot as tolerated. The aim of the present study was to assess the outcome parameters of this treatment protocol, evaluate the efficacy of using the walking boot, and investigate any possible predicting factors that could affect the outcomes.

Methods: All the patients with stable Weber B ankle fractures, treated in our hospital between January 2018 and December 2018, were prospectively included to the study. The patients were evaluated clinically, and the patient-reported outcome measures data were collected at the 2 and 6 weeks post-injury. Chi square, Spearman's rho test, independent samples and paired sample *t*-tests were used for the monovariant analysis.

Results: A total of 128 consecutive patients (aged 52.2 ± 19.1 years) with supination external rotation type 2 fracture were finally included to the study. At the 2 weeks follow-up, the reported outcome measures scores were in moderate levels, but improved significantly at the 6 weeks follow-up ($p < 0.0001$). Multivariant analysis revealed that the ability to bear full weight without the boot at the 2 weeks after diagnosis was the only variable, which made statistically unique contribution to the foot and ankle disability index score at the 6 weeks ($p = 0.005$).

Conclusion: Conservative treatment using a walking boot with advice to bear full weight of stable ankle Weber B fractures can bring to good functional outcomes. The ability to bear full weight without the aid of the walking boot at 2 weeks after diagnosis was the only significant predicting factor for better outcomes at 6 weeks after diagnosis.

Introduction

Ankle fractures are common injuries, and the incidence is increasing in recent years. It is reported that the incidence of ankle fractures in the United Kingdom is around 125 patients per 100,000 populations. Most of these injuries (70%) are isolated lateral malleolus fractures with most of them being stable.[1] In order to determine the stability of these fractures and consequently decide the need of surgical fixation, several tests have been proposed the last decades. Since the reliability of non-weight bearing radiographs has been proven to be uncertain, several dynamic tests were proposed, with performing the weight bearing plain anteroposterior radiographs a few days after injury over the last years.[2] Other dynamic tests, such as external rotation stress radiographs and gravity stress radiographs, have been proven to be not easily reproducible and overestimated the instability respectively.[3–5]

Once the stability of the ankle fracture has been determined, conservative management of these fractures should be followed, as it has been proven to have very good outcomes.[6,7] Functional rehabilitation with early weight bearing through a walking boot has been proven to have similar functional outcomes with casting and non-weight bearing, while significant complications are avoided.[8] The type of bracing does not seem to affect the outcome of these injuries.[9]

The aim of the present study was to evaluate the outcome parameters at 6 weeks of functional treatment of the isolated distal fibula supination external rotation (SER) stable fractures (SER type 2 fractures). Secondary aims were to evaluate the efficacy of using the walking boot, investigate any possible predictors that might affect these outcomes, and possibly identify the patients who are suitable for accelerating their rehabilitation and reducing their

* Corresponding author.
E-mail address: iliopoulose@gmail.com (E. Iliopoulos).
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follow-up appointments. Our hypothesis is that the SER type 2 fractures identified with weight bearing radiographs can be safely treated conservatively using a walking boot with good functional outcomes.

Methods

A total of 198 patients with isolated distal fibula fractures were evaluated during the timeframe of the study. After exclusions (33 patients were lost in the follow-up, 35 were not SER injuries, and 2 were unstable SER type 4 fractures requiring fixation), 128 consecutive prospectively recruited patients (40 male and 88 female) with SER type 2 fractures (aged 52.2 ± 19.1 years) were finally included in the study. Most of the patients were female (68.8%) and the mean BMI of the cohort was 27.0 ± 5.8.

Cohort-treatment protocol

All the patients with isolated distal fibula fractures, treated in our hospital between January 2018 and December 2018, were prospectively included to the study. All patients were evaluated in the hospital's Accident and Emergency department at the day of the injury clinically, and non-weight bearing ankle radiographs were obtained. After diagnosis the patients were referred to the virtual fracture clinic, and a remote clinic guided by a doctor and a senior physiotherapist. Unstable ankle fracture and/or dislocations requiring fixation were excluded from the study.

The rest were managed by the virtual fracture clinic. The patients were instructed to use the walking boot when mobilising. They were given crutches and were advised to use them as needed and increase their weight bearing over time as tolerated. Instructions for early physiotherapy exercises were given to the patients as well. In a follow-up/assessment appointment in the specialised ankle fracture clinic of the Trauma and Orthopaedics department, the fracture stability was evaluated by weight bearing ankle radiograph during the first 2 weeks after injury. When the medial clear space on the mortise exceeded the superior joint space (positive talar shift), the fracture was considered to be unstable.[10] Unstable Weber B fractures (SER type 4 requiring fixation) and other types of ankle fractures, which were treated conservatively (i.e. Weber A type fractures) were also excluded from the study. Patients with pre-injury neurological or other conditions affecting their ability to walk normally were also excluded. The included patients were treated conservatively. They were instructed to bear full weight by using the walking boot for further 4 weeks (total 6 weeks from the injury). According to the patient's choice, the use of crutches was optional at that time. They were also encouraged to perform regular ankle range of motion (ROM) exercises. After 6 weeks of follow-up, patients were instructed to gradually remove the boot and continue physiotherapy exercises as tolerated.

Patient's evaluation

The patients were evaluated clinically and radiologically at the 2 and 6 weeks after the injury in the specialised ankle fracture clinic. The patients were asked to complete 2 patient-reported outcome measures (PROMs) at these 2 time points, respectively. The Chertsey outcome score for trauma (COST)[11] and the foot and ankle disability index (FADI) were assessed.[12] The ability to bear weight with and without walking boot at the 2 and 6 weeks follow-up was measured and documented as well. A pressure balance plate (SECA balance plate 876, Hamburg, Germany) was used to measure the patients' body weight and the amount of weight they were able to apply through the injured leg with and without the boot. This was documented as a percentage of their body weight. Patients who were able to bear the full weight were instructed to walk 2-3 steps in walking boot without the use of crutches. They were instructed to stop the trial, if they felt pain (visual Analog scale score >1). The same procedure was repeated again without the boot. The swelling was evaluated by measuring the perimeter of the ankle at the level of the malleoli, on both sides. The perimeter difference between ankles was documented. The ROM of the ankle joint was clinically evaluated as well, and the difference between the ankles was recorded. Demographic data of the patients were also collected.

Two blinded examiners evaluated the weight bearing ankle radiographs from the 2 and 6 weeks appointments, with the aim to identify any delayed talar shift and/or fracture displacement, which may occur between these two time points. Further fracture site displacement > 1 mm was considered as significant and documented as displaced.

Statistical analysis

Statistical analysis was performed through the SPSS 23.0 statistical program (SPSS Inc, Chicago, IL, USA). Chi square, Spearman's rho test, independent samples and paired sample *t*-tests were used for the monovariant analysis. Multiple regressions were used for the multivariate model. At the 2 weeks assessment, the contribution of each 6 independent variables (age, gender, body mass index (BMI), ROM) difference, ankle swelling difference and the ability to bear full weight and perform 2–3 steps pain free without the boot was measured as predicting factors of better PROM scores at the 6 weeks follow-up appointment. Statistical significance was set to 0.05.

Results

At the 2 weeks follow-up, the PROM scores were in moderate levels (mean COST score 37.15 ± 15.78 and mean FADI score 55.83 ± 21.48). The affected ankle ROM was limited at this time by average of 23.62° ± 14.60° (comparing with the normal ankle), which was affecting both the extension and the flexion of the ankle joint. The affected ankle perimeter was on average (1.60 ± 1.18) cm more than the normal one ($p < 0.05$). Using no walking boot, 80.4% of patients were able to bear full weight and performed 2-3 steps without pain at 2 weeks follow-up. Additional 9.9% of patients achieved full weight bearing with the walking boot (total 90.3%) and only 9.7% were unable to bear full weight. For those patients who were unable to bear weight fully without the boot, the boot improved their ability to bear weight significantly ($p < 0.001$) by 29.57% of body weight.

All the patients were able to bear full weight with and without the boot at the 6 weeks follow-up and performed 2–3 steps without pain. None of the patients developed deep vein thrombosis, or was identified to have delayed talar shift or further displacement of the fracture (> 1 mm) comparing to the previous radiographs at the 2 weeks follow-up. The COST and FADI scores reached good levels at this time and improved significantly comparing to 2 weeks follow-up ($p < 0.0001$) (mean COST score 49.77 ± 17.27 and mean FADI score 71.15 ± 18.03). The affected ankle ROM improved significantly to 12.45° ± 13.05° difference ($p < 0.001$) and the ankle perimeter reduced significantly to 1.10 ± 0.87 cm difference with the normal side ($p < 0.001$) (Table 1).

Monovariant analysis revealed that the ability to bear full weight at the 2 weeks follow-up led to significantly higher FADI score levels at the 6 weeks follow-up. None of the other parameters at the 2 weeks follow-up have a significant impact on the functional scores at the 6 weeks follow-up. Table 2 summarised the results of the monovariant analysis.

Table 1
The outcomes at 2 and 6 weeks follow-up.

Index	Follow up		*p* value
	Two weeks	Six weeks	
FADI score	55.83 ± 21.48	71.15 ± 18.03	<0.0001
Function	53.58 ± 22.83	69.97 ± 19.41	<0.0001
Pain	66.34 ± 18.92	77.42 ± 15.56	<0.0001
COST score	37.15 ± 15.78	49.77 ± 17.27	<0.0001
Symptoms	37.41 ± 17.83	49.99 ± 19.83	<0.0001
Function	28.83 ± 19.61	42.62 ± 20.42	<0.0001
Mental status	45.00 ± 18.49	58.80 ± 20.23	<0.0001
Ankle ROM difference (degree)	23.62 ± 14.6	12.45 ± 13.05	<0.001
Ankle perimeter difference (cm)	1.60 ± 1.18	1.10 ± 0.87	<0.001
Full WB without boot	Frequencies	Valid (%)	
Yes	74	80.4	
No	18	19.6	
Full WB with boot	Frequencies	Valid (%)	
Yes	84	90.3	
No	9	9.7	

SD: standard deviation, FADI: foot and ankle disability index, COST: Chertsey outcome score for trauma, ROM: range of motion, WB: weight bearing.
Data are presented as mean ± SD, or percentage (%).

Multiple regressions were performed to assess the contribution of variables measured at 2 weeks follow-up to the PROM outcomes at 6 weeks follow-up. Ages, gender, BMI, ROM, ankle swelling, the ability to bear full weight and perform 2–3 steps pain-free without the boot were added to the model as independent variables. The ability to bear full weight without the boot at the 2 weeks follow-up was the only variable which made statistically unique contribution to the 6 weeks FADI score ($p = 0.005$) (Table 3).

Discussion

The present prospective study confirms in a large cohort of patients. Early weight bearing and functional treatment of SER type 2 ankle fractures is safe and has good functional outcomes. This finding enhances the already existing literature in this field.[7] Brink et al.[9] reported good functional outcomes following treatment of those fractures with aircast ankle brace or DonJoy ROM walker brace. At the present study, the patients were instructed to wear the walking boot for total 6 weeks after the injury. It would be interesting in a future study to investigate if there is a difference between using a protective ankle brace or nothing instead.

The weight-bearing radiographs used to determine the stability of SER ankle fractures have been shown to be reliable up to 2 weeks post-injury, because no fractures were further displaced and no patients required delayed fixation. Our results are similar to the recent study from Seidel et al.,[4] where the weight bearing radiographs were proven to be reliable in identifying the stability of these types of ankle fractures. Study of Holmes et al.[5] illuminated the strength of the weight bearing views as a predictor factor of the stability of SER ankle fractures.

Table 3
Multiple regression with FADI score at 6 weeks as dependent variable.

	Beta	*p* value	95% *CI*	
			Lower	Upper
Age	− 0.194	0.122	−0.42	0.05
Gender	0.008	0.945	−9.15	9.80
BMI	−0.005	0.968	−0.80	0.77
Ankle ROM difference	−0.066	0.625	−0.41	0.25
Ankle perimeter difference	0.019	0.886	−3.77	4.35
Ability to full WB at 2 weeks	0.375	0.005	5.45	28.48

CI: confidence intervals, BMI: body mass index, ROM: range of motion, WB: weight bearing.

The ability to bear full weight has been traditionally used for the diagnosis of ankle fractures, as this is one of the Ottawa ankle rules, which have been widely used in emergency departments from early 1990s.[13] Recently the ability to bear weight immediately after the injury has been proven to be reliable predicting factor of the stability of the ankle fractures.[14] In the present study, we expand the use of this reliable test and propose it as a predicting factor for better 6-week functional outcomes of stable SER ankle fractures. A future study to assess whether the number of steps these patients are able to perform at an early stage affects outcomes will be interesting.

The necessity of performing routine follow-up radiographs for this type of injury is questioned. None of the follow-up radiographs performed 6 weeks after the injury revealed delayed talar shift or further fracture displacement. This observation is in relation to the recent study of van Gerven et al.,[15] which identified that the routine follow-up radiographs for ankle fractures (in general) seldom lead to change of the treatment management.

In this study, assessing the ability to bear full weight without the assistance of walking orthopaedic boot and to perform 2–3 steps without pain 2 weeks after injury predicted better functional outcomes. This fact led us to reconsider our follow-up protocol, as clinical appointments at the 6-week post-injury time point showed no significant value in identifying any problems. The proposed change is to have an evaluation appointment after 2 weeks, and when patients being able to perform 2–3 steps without pain and walking boot they will have the option of a patient-initiated follow-up appointment instead of a formal follow-up appointment 6 weeks after injury. This will reduce the burden of the foot and ankle fracture clinics and reduce the costs for the Trust, without compromising the safety of the patients. Applying this change to our hospital will directly save £ 6584.79 per year for the National Health Service in the United Kingdom (calculating the local charging system and the ankle fracture burden of the Trust) and will create spaces in the outpatients' clinics, increasing the Trust's income by £ 16,709.69 per year. A total profit was £ 29,879.27 per year.

In conclusion, conservative treatment using a walking boot with advice to full weight bearing for isolated distal fibula supination

Table 2
Monovariant analysis (Spearman's rho test used for the continues variables and independent variables *t*-test were used for the binary variables).

Variables	FADI score at 6 weeks follow-up		COST score at 6 weeks follow-up	
	Coefficient	*p* value	Coefficient	*p* value
Age	−0.159	0.137	0.046	0.656
Gender	–	0.703	–	0.534
BMI	−0.059	0.596	0.026	0.805
Ankle ROM difference	−0.050	0.681	−0.043	0.717
Ankle perimeter difference	−0.124	0.304	−0.117	0.321
Ability to full WB at 2 weeks follow-up	–	0.001	–	0.096

-: not mentioned.
FADI: foot and ankle disability index, COST: Chertsey outcome score for trauma, BMI: body mass index, ROM: range of motion, WB: weight bearing.

external rotation type 2 ankle fractures leads to good functional outcomes. The ability to bear full weight without the aid of the walking boot at the 2 weeks follow-up appointment, and to perform 2–3 steps without pain, was the only significant predicting factor for better outcomes at 6 weeks post injury.

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Nil

Ethical statement

Not required. This study was a part of a service evaluation project (audit), and was submitted and accepted by the local audit department (Reg.No: 2584).

Declaration of competing interest

The authors declare that there is no conflict of interests.

Author contributions

Efthymios Iliopoulos conceived the study and guided the study design, collected data, performed the statistical analysis and wrote the manuscript.

Jay James Watson collected the data and wrote part of the first draft of the manuscript.

Felicity Auld was the lead for the recruitment of the patients and collected some of the data.

Richard Freeman helped with the design of the study, some data collection and the proofreading/editing the manuscript.

Natasha Hossain helped with the design of the study, the guidance of the patients' flow, and the proofreading/editing of the final version of the manuscript.

References

1. Court-Brown CM, McBirnie J, Wilson G. Adult ankle fractures—an increasing problem? *Acta Orthop Scand*. 1998;69:43–47. https://doi.org/10.3109/17453679809002355.
2. Lampridis V, Gougoulias N, Sakellariou A. Stability in ankle fractures: diagnosis and treatment. *EFORT open Rev*. 2018;3:294–303. https://doi.org/10.1302/2058-5241.3.170057.
3. Gill JB, Risko T, Raducan V, et al. Comparison of manual and gravity stress radiographs for the evaluation of supination-external rotation fibular fractures. *J Bone Joint Surg Am*. 2007;89:994–999. https://doi.org/10.2106/JBJS.F.01002.
4. Seidel A, Krause F, Weber M. Weightbearing vs gravity stress radiographs for stability evaluation of supination-external rotation fractures of the ankle. *Foot Ankle Int*. 2017;38:736–744. https://doi.org/10.1177/1071100717702589.
5. Holmes JR, Acker WB, Murphy JM, et al. A novel algorithm for isolated Weber B ankle fractures: a retrospective review of 51 nonsurgically treated patients. *J Am Acad Orthop Surg*. 2016;24:645–652. https://doi.org/10.5435/JAAOS-D-16-00085.
6. Gougoulias N, Khanna A, Sakellariou A, et al. Supination-external rotation ankle fractures: stability a key issue. *Clin Orthop Relat Res*. 2010;468:243–251. https://doi.org/10.1007/s11999-009-0988-2.
7. Dietrich A, Lill H, Engel T, et al. Conservative functional treatment of ankle fractures. *Arch Orthop Trauma Surg*. 2002;122:165–168. https://doi.org/10.1007/s004020100342.
8. Port AM, McVie JL, Naylor G, et al. Comparison of two conservative methods of treating an isolated fracture of the lateral malleolus. *J Bone Joint Surg Br*. 1996;78:568–572.
9. Brink O, Staunstrup H, Sommer J. Stable lateral malleolar fractures treated with aircast ankle brace and DonJoy ROM-Walker brace: a prospective randomized study. *Foot Ankle Int*. 1996;17:679–684. https://doi.org/10.1177/107110079601701106.
10. Dawe EJC, Shafafy R, Quayle J, et al. The effect of different methods of stability assessment on fixation rate and complications in supination external rotation (SER) 2/4 ankle fractures. *Foot Ankle Surg*. 2015;21:86–90. https://doi.org/10.1016/j.fas.2014.09.010.
11. Iliopoulos E, Agarwal S, Khaleel A. Chertsey Outcome Score for Trauma: development and validation of a new unifying patient reported outcome measure for orthopaedic trauma. *Chin J Traumatol*. 2017;20:329–332. https://doi.org/10.1016/j.cjtee.2017.08.006.
12. Martin RL, Burdett RG, Irrgang JJ. Development of the foot and ankle disability index (FADI). *J Orthop Sports Phys Ther*. 1999;29:32–33.
13. Lucchesi GM, Jackson RE, Peacock WF, et al. Sensitivity of the Ottawa rules. *Ann Emerg Med*. 1995;26:1–5. https://doi.org/10.1016/s0196-0644(95)70229-6.
14. Kwon J, Ghorbanhoseini M, Chien BY, et al. Does a patient's self-reported ability to weightbear immediately after injury predict stability for ankle fractures. *Foot Ankle Orthop*. 2016;1. https://doi.org/10.1177/2473011416S00164.
15. van Gerven P, Weil NL, Termaat MF, et al. Routine follow-up radiographs for ankle fractures seldom add value to clinical decision-making: a retrospective, observational study. *J Foot Ankle Surg*. 2018;57:957–960. https://doi.org/10.1053/j.jfas.2018.03.035.