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Protocol Article

A study protocol for a randomised trial of bracing after ankle fracture

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ABSTRACT

INTRODUCTION. Ankle fractures are common and debilitating injuries usually treated with immobilisation using a foot-ankle brace (walker). Emerging evidence suggests that a less restrictive ankle stirrup may accelerate recovery without increasing complications, and patients tend to prefer ankle stirrups. However, evidence supporting their non-inferiority is inconclusive. The aim of this study is to assess whether ankle stirrups are non-inferior to walkers in improving function and pain measured by the Manchester-Oxford Foot Questionnaire three months after ankle fracture.

METHODS. The trial will be a two-phase, multicentre, pragmatic, non-inferiority randomised controlled trial. Patients ≥ 18 years with surgically or non-surgically treated ankle fractures will be included. A three-month pilot phase will assess trial feasibility, including recruitment rates. The full trial will randomise a maximum of 1,400 patients. The sample size is estimated to be sufficient to assess non-inferiority in the overall population and to explore non-inferiority in six subgroups stratified by sex and age (males 18-39 years, males 40-59 years and 60+ years) and treatment (surgical or non-surgical).

CONCLUSIONS. The bracing after ankle fracture trial will determine whether ankle stirrups are non-inferior to walkers in terms of patient-reported function and pain. Secondarily, the study will assess whether the ankle stirrup facilitates faster recovery of function, earlier return to work, and reduced healthcare costs. Findings will support evidence-based decision-making with respect to patient preferences.

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Ankle fractures are the third most common fracture in the emergency department [1, 2] and result in pain and reduced ankle function [3]. Also, emerging evidence indicates that immobilisation prolongs patients' recovery [4-6]. However, robust evidence is necessary for definitive conclusions.

In Scandinavia, foot-ankle braces (walkers) are used to immobilise the fracture while healing. Even though patients acknowledge the need for immobilisation, a qualitative study of ten patients found that they

experienced difficulty adhering to the immobilisation recommendation after ankle fracture [7]. An RCT by Smeeing et al. [5] found that braces and elastic bandages, which allow greater ankle movement than walkers, did not result in poorer functional outcomes and may facilitate a faster return to work without increasing complications. However, the RCT was terminated when only half of the required sample had been included, thus questioning the statistical power of the findings [5].

To further inform trial design, eight patients (male and female, aged 28-66 years) were interviewed and shared their perspectives on the walker, ankle-supporting elastic bandages, ankle stirrups and research question. The patients preferred ankle stirrups as they allowed movement during use. The same patients also expressed an aversion to the walker and were concerned that ankle-supporting elastic bandages provided insufficient support.

The bracing after ankle fracture (BAF) trial aims to test whether an ankle stirrup is non-inferior to a walker in reducing ankle pain and improving function, as measured by the Manchester-Oxford Foot Questionnaire (MOXFQ) three months after ankle fracture.

Methods

Patient involvement

A patient representative with equal decision rights is a member of the research group. The MOXFQ was selected based on a comparison of the validity and reliability of the four most commonly used ankle patient-reported outcome measures, along with patients' preferences [8]. A user panel composed of patients who have experienced ankle fractures will be recruited for the trial. The user panel will follow the trial throughout the execution phase and will participate in presentations and dissemination activities in the presentation phase [9].

Design

The study is a pragmatic, multi-centre, assessor and statistical analyst-blinded, non-inferiority trial preceded by a pilot. The pilot will assess the inclusion rate by enrolling 5% of the planned BAF trial, corresponding to seven patients per subgroup (maximum 70 patients), or until the end of a three-month pilot period. Trial logistics will be evaluated. Following the pilot phase, the definitive trial will be conducted. The precise-2 tool was used to assess the level of practicality. Recommendations for Interventional Trials (SPIRIT) statement, and trial reporting will adhere to the Consolidated Standards of Reporting Trials (CONSORT) 2025 explanation and elaboration guidelines for randomised trials [10, 11]. Administrative and Open science information are included in the Supplementary Table.

Trial setting

Scandinavian (Denmark, Norway, Sweden and Finland) orthopaedic departments (recruitment centres) will be invited to participate. There will be no restrictions on the brand of ankle stirrups or walkers that can be used. Ankle stirrups are already being used, so there is no further need for education.

Eligibility criteria

The trial will include patients 18 years or older with a surgically or non-surgically treated ankle fracture. Exclusion criteria: pathological fractures, insufficient proficiency in Danish, Norwegian, Swedish or Finnish (spoken or written), open fractures (skin perforation), prolonged need for immobilisation (e.g. non-union or insufficient wound healing), inability to adhere to trial procedures (e.g. neuropathy or severe psychiatric disorder), restricted weight-bearing or lacking interest in participating. Any exclusion cause will be recorded.

The recruitment centres must adhere to the trial procedures and are compensated for each included patient and

for each patient who completes the primary outcome period (t_2).

Intervention and comparator

Ankle fractures are managed surgically or non-surgically, depending on the extent and pattern of the fracture. Unstable fractures (i.e. bimalleolar and trimalleolar fractures) are usually treated surgically, whereas potentially stable fractures (i.e. lateral malleolar) are typically treated non&;surgically.

Non-surgically treated ankle fractures are immobilised in a walker. Approximately one week after the fracture, stability is assessed. If stable, the walker is used for another five weeks (in total six weeks from the time of fracture).

Surgically treated patients usually have their ankle immobilised in casts or a walker and are instructed not to weight-bear for the first two weeks after surgery to allow the wound to heal. If the wound is healed, a walker is used for an additional four weeks (in total six weeks from the time of the fracture).

Referrals for rehabilitation are made pending doctors' assessments. Weight-bearing will be unrestricted for both groups, with the only difference being the use of the brace. All other aspects of care will follow usual clinical practice.

Discontinuation

All patients, regardless of whether they complete treatment or not, will be included in the intention-to-treat (ITT) analysis. Patients who fail to adhere to the treatment will be excluded from the per-protocol analysis.

Strategies to improve adherence

Patients usually use the provided brace and follow the instructions. Crossover will be recorded at t_1.

Concomitant care

Concomitant care will be permitted, and referral to rehabilitation will be recorded at t_1.

Outcomes

Primary outcome

The MOXFQ index score three months after ankle fracture is the primary outcome [12, 13]. The MOXFQ is a valid and reliable patient-reported outcome, preferred by patients, and is divided into three domains: pain, function and social interaction [8, 12, 13]. Responses are provided on a five-point Likert scale ranging from zero to four. The index score is calculated by summing the raw scores of the 16 items to an index score ranging from 0 to 100, (100 most severe), using the formula [13]:

$$\frac{i1+i2+\cdots+i16}{64} \times 100$$

Secondary outcomes

Self-reported physical activity will be measured using the short-form International Physical Activity Questionnaire (IPAQ-SF), and patients will be grouped into low, moderate and high physical activity levels [14-16].

Health-related Quality Of Life (HRQOL) will be measured using the EuroQol, five-dimension, five-level questionnaire (EQ-5D-5L) [17].

Ankle dorsiflexion is measured by clinicians using the knee-to-wall test, which measures ankle mobility as degrees of motion in standing.

Plantar flexor muscle strength for the injured and the contralateral ankle is measured by clinicians using the heel rise test. Patients perform as many single-leg heel raises at a cadence of one per second until fatigue or a maximum of 50 is reached. Normal function is defined as a difference in heel raises between legs exceeding 10% [18].

Hospital costs from an ankle fracture will be measured from a hospital perspective and will include procedure costs.

Return to work will be measured as the number of days from ankle fracture to the date patients return to work (full-time or part-time).

Non-inferiority will be assessed for the whole sample and for the following subgroups: males 18-39 years, females 18-39 years, males 40-59 years, females 40-59 years, males 60+ years, females 60+ years and for the treatment groups (surgical and non-surgical).

Exploratory outcomes

Physical activity will be objectively measured in a subgroup of patients (n = 280) using a SENS accelerometer.

A cost-utility analysis with a societal perspective and a one-year follow-up will be conducted alongside the clinical trial and reported as the incremental cost per quality-adjusted life year.

The overall carbon footprint of the trial will be estimated by registering activities and summing the carbon usage associated with activities from the onset of the ankle fracture through 12 weeks of follow-up (t_2). The outcome will not be measured because we could not obtain a cradle-to-gate estimate from the brace producers.

Baseline characteristics

The study will record the following baseline characteristics: age, sex, fracture side, fracture type (AO classification), smoking status, BMI, length of education, type of surgical treatment, cohabiting status (living alone or with a partner), work-related physical requirements (blue-collar or white-collar) and usual employment status.

Harms

Only patients who are cleared for unrestricted weight-bearing after their ankle fractures will be randomised. Nonetheless, safety reporting begins at randomisation and continues until the one-year follow-up. AEs (adverse events: undesirable events such as skin irritation) and SAEs (serious adverse events: complications that require hospitalisation or death, such as deep vein thrombosis or pulmonary embolism due to immobilisation or reoperations for malunion) will be collected at each timepoint.

Participant timeline

At t_0, patients will be randomised to receive either a walker or an ankle stirrup. For non-surgically treated patients randomisation occurs after the fracture, once stability has been confirmed. For surgically treated patients, randomisation occurs two to three weeks after the fracture. At t_1, braces are removed and patient-reported outcome measures (PROMs), ankle range of motion (ROM) and plantar flexor muscle strength are measured (approximately six weeks after the fracture). At t_2 (primary outcome) PROMs, ankle ROM and ankle strength are measured (approximately 12 weeks after the ankle fracture). At t_3 and t_4, only PROMs are measured (**Table 1**).

TABLE 1 Standard Protocol Items: Recommendations for Interventional Trial (SPIRIT) 2025 diagram of the schedule of enrolment, interventions and assessments.

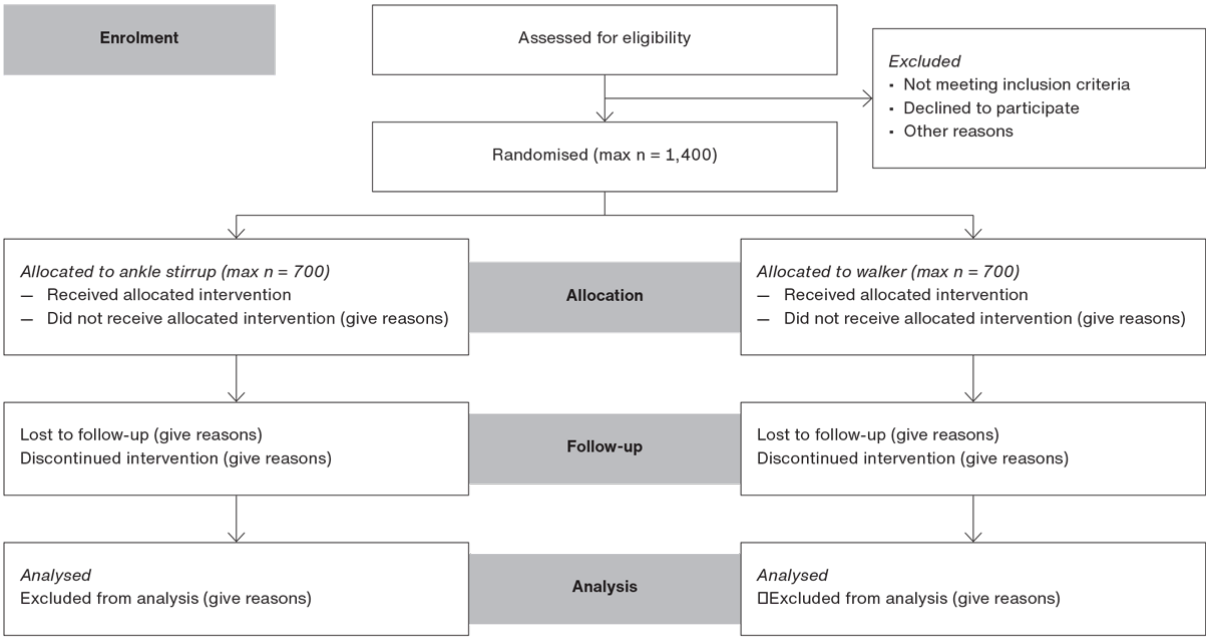
	Trial period						
	enrolment		post-randomisation				close-out
	baseline: $-t_i$-0						
	$-t_i$	0	6 wks: t_1	12 wks (primary): t_2	26 wks: t_3	52 wks: t_4	t_x
Enrolment							
Eligibility screen	X						
Fracture stability assessment	X						
Informed consent	X						
Randomisation		X					
Intervention and comparator							
Intervention		X	X				
Comparator		X	X				
Assessments							
Baseline		X					
MOXFQ (primary)		X	X	X	X	X	
IPAQ-SF (secondary)		X	X	X	X	X	
EQ-5D-5L (secondary)		X	X	X	X	X	
Knee to wall (secondary)		X	X	X			
Heel raise test (secondary)		X	X	X			
Hospital hosts (secondary)		X	X	X			
Time to return to work (secondary)		X	X	X	X	X	
Complications (secondary)			X	X	X	X	
Cost-utility analysis (exploratory)		X	X	X	X	X	
SENS accelerometer (exploratory)		X	X	X			
Carbon footprint (exploratory)		X	X	X			

EQ-5D-5L = EuroQol 5-dimension 5-level questionnaire; IPAQ-SF = International Physical Activity Questionnaire - Short Form; MOXFQ = Manchester-Oxford Foot Questionnaire.

Sample size

A minimal clinically important difference (MCID) of 13 points is considered reasonable [13]. With a standard deviation of 14 points, the non-inferiority limit is set at seven points [8]. The statistical significance level will be one-sided at 2.5%, and the power (1-beta) will be 80%, yielding a needed sample of 63 patients per arm. Twelve extra patients (10%) will be recruited to mitigate potential drop-out. To ensure sufficient power for subgroups and population representativeness, inclusion will continue across all subgroups. Recruitment will stop when the last subgroup (probably females aged 18-39 years, as they comprise approximately 10% of the ankle fracture population) reaches 140, or a maximum of 1,400 patients in total have been included (**Figure 1**).

FIGURE 1 Consolidated Standards of Reporting Trials (CONSORT) 2010 flow diagram.



Recruitment

To maintain a high recruitment rate, newsletters will be distributed to recruitment centres.

Sequence generation

Randomisation is internet-based using REDCap Randomise. For balanced treatment groups, the randomisation will be performed in blocks of four, six and eight. A data manager, uninvolved in the trial, prepares the randomisation sequence to ensure an even distribution of surgically and non-surgically treated patients in groups and an even distribution to the intervention and control group at each recruitment centre.

Blinding

The data collection is blinded to local project managers at baseline assessment. The researchers, including data analysts, will be blinded to treatment allocation until reporting and interpretation will be blinded. Unblinding will occur only if required for the management of a SAE and reporting.

Data collections

Baseline characteristics and data on complications will be collected from patient records. Primary and secondary outcomes will be collected electronically and supplemented with phone calls if necessary. The local project manager will collect the knee-to-wall and heel-raise tests.

Data management

Patients will receive an electronic link and enter information directly to RedCap.

Data sharing statement

Access to individual de-identified participant data and related study documents (e.g., protocol, statistical analysis plan (SAP)) will be provided to anyone who requests it.

Statistical analysis

Non-inferiority will be assessed by 95% CI. The 95% CI must be above the non-inferiority margin for the ankle

stirrup to be declared non-inferior in the ITT analysis. The ITT analysis will be adjusted for the stratification variables age, sex and treatment (surgical or non-surgical). Additionally, a sensitivity analysis will include adjustment for: BMI, cohabiting status, smoking status and baseline MOXFQ index score. A linear mixed regression model will be used. Missings will not be imputed.

A SAP will be published before the first patient is randomised in phase two.

Trial monitoring

Reports on the number of patients recruited and completion rates for each centre are sent to each recruitment centre every three months.

Ethics

Data monitoring committee

Every six months, a data monitoring committee consisting of orthopaedic surgeons and a statistician will conduct an interim analysis of any SAEs to assess causality and decide whether the trials can continue for each subgroup. Patients experiencing an SAE will be followed per protocol. The Data Monitoring Committee can stop inclusion in specific subgroups.

Research ethics approval

Regulations of the national ethics committees of participating countries and national data protection regulations will be followed, and ethical approval will be sought in each country before any patients in that country are screened.

Protocol amendments

Any deviations from protocol based on the pilot study will be reported in the statistical analysis plan. Any other deviations will be reported in the primary outcome article.

Consent or assent

Physiotherapists, nurses or doctors (project managers) will screen eligible patients, and patients will be informed of the trial to ensure reflection time before the visit at t_0. Patients and project managers will sign a standardised informed consent form.

Trial registration: Clinicaltrials NCT07163091.

Discussion

The current multi-centre RCT will provide evidence with a very low risk of bias. Despite methodological rigidity, there are some limitations, such as a lack of patient blinding, and a bimodal ankle fracture population: males dominate ages 18-59 years, and females dominate 60+ years [19]. Older patients often prioritise regaining independence in daily activities [12], whereas younger patients in our trial design were more concerned with returning to sport and work. Age-related frailty and osteoporosis may also create different stabilisation needs, potentially influencing non-inferiority outcomes across subgroups. As young females constitute only ~ 10% of cases, we capped total recruitment at 1,400 to ensure at least 140 young females. This strategy is expected to yield a representative sample, provide a high level of generalisability and allow assessment of non-inferiority across age, sex and treatment with low uncertainty.

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