Is post-operative non-weight-bearing necessary? Study protocol for a pragmatic randomised multicentre trial of operatively treated ankle fracture (DoWeCAST?).

Ramy E Khojaly (ramykhojaly1@gmail.com)
Royal College of Surgeons in Ireland https://orcid.org/0000-0002-2286-4745
Ruairí Mac Niocaill
Waterford Regional Hospital
Muhammad Shahab
Waterford Regional Hospital
Danilo Vukanic
Galway University Hospitals
Matthew Nagle
Cork University Hospital Group
Stephen Kearns
Galway University Hospitals
Colm Taylor
Cork University Hospital Group
Fiachra E. Rowan
Waterford Regional Hospital
May Cleary
University College Cork National University of Ireland

Study protocol

Keywords: Ankle fracture, osteosynthesis, fracture fixation, open reduction and internal fixation, weight-bearing, immobilisation, cast, orthosis, walking boot

Posted Date: March 16th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-17345/v1

Version of Record: A version of this preprint was published on May 27th, 2021. See the published version at https://doi.org/10.1186/s13063-021-05319-0.

Abstract

Background

Post-operative management regimes vary following open reduction and internal fixation (ORIF) of unstable ankle fractures. There is an evolving understanding that extended periods of immobilisation and limitation of weight-bearing may lead to poorer clinical outcomes. Traditional non-weight bearing cast immobilisation may prevent loss of fixation, and this practice continues in many centres. The purpose of this trial is to investigate the safety and efficacy of immediate weight-bearing (IWB) and range of motion (ROM) exercise regimes following ORIF of unstable ankle fractures with a particular focus on functional outcomes and complication rate.

Methods

A pragmatic randomised controlled multi-centre trial, comparing IWB in a walking boot and ROM within 24 hours versus non-weight bearing (NWB) and immobilisation in a cast for six weeks, following ORIF of all types of unstable adult ankle fractures (lateral malleolar, bimalleolar, trimalleolar with or without syndesmotic injury) is proposed. All patients presenting to three trauma units will be included. Exclusion criteria will be skeletal immaturity and tibial plafond fractures. The three institutional review boards have granted ethical approval. The primary outcome measure will be the functional Olerud-Molander Ankle Score (OMAS). Secondary outcomes include; Wound infection (deep and superficial), displacement of osteosynthesis, total arc of ankle motion (plantar flexion and dorsal-flection), RAND 36-Item Short Form Survey (SF-36) scoring, time to return to work and postoperative hospital length of stay. The trial will be reported in accordance with the CONSORT statement for reporting a pragmatic trial and this protocol follow the SPIRIT guidance.

Discussion

Traditional management of operatively treated ankle fractures includes an extended period of non-weight bearing. There is emerging evidence that earlier weight-bearing may have equivocal outcomes and favourable patient satisfaction but with higher wound-related complications. These studies often preclude more complicated fracture patterns or patient-related factors. To our knowledge, immediate weight-bearing (IWB) following ORIF of all types of unstable ankle fractures has not been investigated in a controlled prospective manner. This pragmatic randomised-controlled multi-centre trial will investigate immediate weight-bearing following ORIF of all ankle fractures pattern in the usual condition of care. It is hoped that these results will contribute towards the modern management of ankle fractures.

Administrative Information

Note

the numbers in curly brackets in this protocol refer to SPIRIT checklist item numbers. The order of the items has been modified to similar group items (see http://www.equator-network.org/reporting-

guidelines/spirit-2013-statement-defining-standard-protocol-items-for-clinical-trials/).

Title	Is post-operative non-weight-bearing necessary? A pragmatic randomised multicentre trial of operatively treated ankle fracture (DoWeCAST?).
Trial registration .	'retrospectively registered' ISRCTN - ISRCTN76410775 30/06/2019
Protocol version	Version (3) June 2019
Funding	Investigator-initiated and funded
Author details	Ramy Khojaly[1,2], Ruairi MacNiocaill[1], Muhammad Shahab[1], Danilo Vukanic[3], Matthew Nagle[4], Stephen Kearns[3], Colm Taylor[4], Fiachra E. Rowan[1], May Cleary[1,5]. 1. Department of Trauma and Orthopaedic Surgery, University Hospital Waterford, Waterford, X91 ER8E, Ireland 2. Department of Surgery, Royal College of Surgeons in Ireland, Dublin, D02 YN77, Ireland. 3. Department of Trauma and Orthopaedic Surgery, Galway University Hospital, Galway H91 YR71, Ireland 4. Department of Trauma and Orthopaedic Surgery, Cork University Hospital, Cork, T12 DFK4, Ireland. 5. Department of Orthopaedic Surgery, University College Cork, Cork, T12 YN60, Ireland
Name and contact information for the trial sponsor	Ramy Khojaly, MBBS. Clinical Lecturer in Orthopaedic Surgery, Department of Surgery, Royal College of Surgeons in Ireland. Email: ramykhojaly@rcsi.com Telephone: +353 – 51 842 198
Role of sponsor	None

Introduction

Background and rationale

Ankle fractures are common and affect young adults as well as elderly(1). Typically, the treatment of an unstable ankle fracture is with surgical fixation, immobilisation and modified weight-bearing for six weeks. Immobilisation can have implication for patient function and may reduce independence, mobility and return to work.

There is emerging evidence that extended periods of immobilisation and limitation of weight-bearing may lead to poorer outcomes (2). Traditional non-weight bearing (NWB) cast immobilisation periods of six or more weeks were used to protect soft tissue envelope and osteosynthesis (3). Newer trends in earlier mobilisation compete with traditional NWB doctrine and poor consensus exists as to the best post-operative strategy (4,5). This could be explained by the contradicting literature when it comes to the assessment of weight-bearing regimens following ankle fracture fixation (2,6–12).

Objectives

The research question underpins the objective of this randomised controlled trial: Is it necessary to completely immobilise patients and prevent them from weight-bearing for six or more weeks following ORIF of unstable ankle fractures?. Secondary objective is to determine whether immediate protected weight-bearing and ankle range of motion post open reduction internal fixation of unstable ankle fractures improves functional outcome, and permit early return to work compared to postoperative ankle immobilisation in a non-weight bearing cast. Also, to determine whether the rate of complications such as wound healing, infection and fixation failure, with immediate weight-bearing and ROM is comparable to rates with the usual post-op protocols. Finally, to determine the cost-effectiveness of this method of treatment which can be determined by analysis of the ability of patients to return earlier to work and the cost of either intervention, including the length of hospitalisation.

Trial design

The study will be a prospective, pragmatic randomised controlled trial (p-RCT), un-blinded with participants allocated in a 1:1 ratio to one of two parallel groups. Patients will be randomised using computerised block randomisation (twenty patients per block). The study is multi-centre and will include three major orthopaedic centres in Ireland.

Methods: Participants, Interventions And Outcomes

Study Setting

This pRCT will be conducted at three academic trauma units at three different urban centres in Ireland. Each centre serves a referral population of > 500,000 and receives all grades of trauma from both urban and rural environments on a 24-hour basis. A trauma team is on call daily and includes two trainee surgeons and a consultant orthopaedic surgeon. Surgeries are performed by in part, in total or supervised by consultant orthopaedic surgeons. Regional and general anaesthesia is used at the discretion of the anaesthetist. Ankle fracture surgery is conducted on both a day case or overnight basis. Ward based physiotherapy is provided daily to facilitate early discharges. All hospital personnel contributing towards recruitment and patient pathway in this trial will undergo training in the objectives and methodology of the study.

Patient recruitment and consent:

All patients admitted to the hospital with ankle fracture (AO/OTA 44A1.3 to 44A3.3, 44B and 44C) deemed appropriate for surgical intervention will be asked to participate in the trial and provided with a patient information leaflet (Appendix 1), given time to read the document and ask questions. If the patient agrees to enter the trial, they will sign the consent form in the presence of the admitting doctor on the morning of or the night before their surgery.

Randomisation process:

Randomisation will occur upon skin closure. The circulating theatre nurse will consult the randomised block database and inform the surgical team that a walking boot (Group A) or a cast (Group B) is to be applied. The patient's details will be entered into the database and they will be assigned a trial number.

Intervention:

In accordance with a pragmatic study, surgical approach and choice of implant will be at the surgeon's discretion. Surgeons may or may not be authors in the study. Surgical practice at the three institutions is to achieve anatomical reduction and rigid fixation. The commonly used osteosynthesis systems for fixation is the Small Fragment System, with One-Third Tubular plate commonly used. The use of locking mode is not routinely used. Other systems are also available. All patients will be assessed by a physiotherapist for gait stability and provided with walking aids according to randomisation. Patients in the walking boot group (Group A) will be instructed to weight-bear as tolerated immediately with or without walking aids for balance. Patients in the NWB group (Group B) will be instructed to strictly non-weight bear using crutches or frame for a total of six weeks. Group A will be instructed to remove the walking boot four times a day at minimum to perform ankle range of motion exercises until they attend outpatient physiotherapy following their first post-operative visit. All patients will receive a post-operative care information sheet according to their grouping (Appendix 2 and 3).

Follow up:

Patients will be followed up in an outpatient setting at two weeks, six weeks, twelve weeks, six months and one year postoperatively. At each visit, the OMAS and SF-36 Health questionnaire will be collected by one of two study investigators. Surgeons that may or may not be authors in the study reviewing patients in either group will also record surgical site assessment, x-ray evaluation, ankle ROM (using goniometry), information regarding return to work, confirmation of physiotherapy referral and confirmation of collection of OMAS and SF-36 questionnaire according to a Case Report Form (Appendix 4).

Eligibility Criteria

Inclusion Criteria

All skeletally mature, acute ankle fractures treated with anatomical reduction and stable internal fixation including; (AO/OTA 44A1.3 to 44A3.3, 44B and 44C)

- Isolated lateral malleolus fractures
- Isolated medial malleolus fractures
- Bi-malleolar fractures
- Tri-malleolar fractures
- Syndesmosis injuries that have been surgically fixed with either screw or tightrope.

- Closed, grade I, or grade II open fractures.

Exclusion Criteria

- Skeletal immaturity
- Gustilo grade-III open fractures
- Tibial plafond fractures
- Polytraumatised patients
- Non-ambulatory status before injury
- Expected insufficient stable fracture fixation with standard surgical technique
- Pre-existent cognitive disability, neurological disease or inability to comply with non-weight-bearing mobilisation and inability to comply with follow-up.
- Grossly comminuted fragility fractures

Who Will Take Informed Consent?

The admitting trainee or consultant surgeon will obtain consent after providing appropriate information and patient information leaflet (Appendix 1).

Additional consent provisions for collection and use of participant data and biological specimens

Not applicable as no biological specimens were collected as part of this trial.

Interventions

Explanation for the choice of comparators

The traditional non-weight bearing (NWB) cast immobilisation is a common practice in many centres, and this protocol could be not necessary.

Intervention Description

Patients will be allocated randomly to one of two groups;

Group A:

- Will receive a walking boot orthosis postoperatively in theatre and allowed weight bearing as tolerated and range of motion (ROM) exercises immediately.

- Will be encouraged to elevate the affected foot in the first two weeks to reduce swelling.
- The first follow up appointment will be after two weeks. This visit is for surgical site inspection, removal of sutures, check x-ray and referred to physiotherapy to continue ROM exercises and weight-bearing as tolerated progressing to full weight-bearing.

Group B:

- Will receive full below-knee cast postoperatively in theatre and prevented from weight-bearing with for six weeks.
- Will be encouraged to elevate the foot in the first two weeks to reduce swelling.
- The first follow up appointment is after two weeks. This visit is for surgical site inspection, removal of sutures, check x-ray and re-application of a full below-knee cast.
- The second follow up is after six weeks, for removal of cast and referral to physiotherapy to commence ankle ROM exercises and weight-bearing as tolerated progressing to full weight-bearing.

Criteria For Discontinuing Or Modifying Allocated Interventions

The trial will be terminated early if 20% complication rate detected in either of the treatment groups (10,13).

Strategies To Improve Adherence To Interventions

Surgeon:

As the intervention is visible and the trail could not be blinded, the operating surgeon will not be informed with the randomisation sequence until after the end of surgical fixation.

A regular internal audit process is established to ensure adherent to the ankle trial protocol and increase compliance with recruitment process; this will provide detailed information about all patients with an ankle fracture that is admitted to hospital (included or excluded from the trail).

Participant:

In the post-operative setting on the ward and before discharge, a physiotherapist will reinforce the patient's role in the trial and provide them with information leaflet appropriate to their grouping. At subsequent outpatient follow up attendances, patients will be reminded of the trial. The trial Case Report Form (Appendix 4) will record if the patients have received outpatient physiotherapy.

Relevant concomitant care permitted or prohibited during the trial

The choice of and duration of DVT prophylaxis will be at the surgeon’s discretion.

Provisions For Post-trial Care

None.

Outcomes

The primary outcome measure is the functional Olerud-Molander Ankle Score (OMAS). This score ranges from 0 to 100, with 100 representing the normal ankle function (14). Secondary outcome measures include; complication rate (infection and fixation failure), total arc of ankle motion (plantar flexion and dorsal-flection) measured in degrees using a goniometer, RAND 36-Item Short Form Survey (SF-36) scoring, the time needed to return to work in days and postoperative hospitalisation length in days.

Participant Timeline

	Enrolment	Research Follow-ups				
TIMEPOINT	***At admission***	**2 weeks**	***6 weeks***	***12 weeks***	***6 months***	***1 year***
ENROLMENT:						
Eligibility screen	X					
Informed consent	X					
Allocation	X					
INTERVENTIONS:						
IWBAT Boot	←	—	→			
NWB Cast	←	—	→			
ASSESSMENTS:						
Length of post-op hospitalization	X					
OMAS		X	X	X	X	X
RAND SF-36		X	X	X	X	X
Return to work assessment		X	X	X	X	X
Total ankle Arc		X	X	X	X	X
Surgical site check		X	X			
X-ray assessment		X	X	X	X	X

Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) Figure of enrolment, interventions and assessments.

Key: IWBAT immediate weight-bearing as tolerated, NWB non-weight-bearing, OMAS Olerud Molander Ankle Score, RAND SF-36 36-items Short Form Health Survey.

Sample Size

An a priori power analysis for the superiority of treatment with immediate weight-bearing and ROM will be conducted for this hypothesis. To detect a clinically significant 10 points difference on the Olerud and Molander Ankle Score (OMAS) at six weeks with a standard deviation of 19(15–18). Alpha = 0.05 and β = 0.20 (80% power), two-sided test and a maximum loss of follow up of 20%, a sample size of 70 per each group is necessary.

Recruitment

Please see the recruitment above. As this is a multi-centre pragmatic trial examining a common fracture, the target number is achievable.

Assignment Of Interventions:

Allocation

Sequence generation

An online computer-generated block randomisation list (20 patients per block) will be created at the start of the trial via the website http://www.randomization.com.

Concealment mechanism

Circulating theatre nurse will check the randomisation sequence by accessing the trial excel sheet and inform the surgeon upon skin closure surgery and enter the patient's details in randomisation slot.

Implementation

Who will generate the allocation sequence: The Principal investigator.

Who will enrol participants: admitting trainee surgeon.

Who will assign participants to interventions: Circulating theatre nurse.

Assignment of interventions:

Blinding

Who will be blinded

It is not possible to blind the intervention from the participant nor the surgeons as it is external and visible (cast or boot). However, to reduce the risk of bias, the surgeon will be blinded with the sequence of randomisation until the surgery is completed.

Procedure For Unblinding If Needed

It is not possible to blind the intervention.

Data collection and management

Plans For Assessment And Collection Of Outcomes

At each follow-up visit, the OMAS and SF-36 Health questionnaire will be collected from the participants by outpatient clinic nurse. The attending orthopaedic consultant or NCHD fills up a case report form, and this includes documentation of the following information; surgical site assessment, x-ray evaluation, ankle total arc measure (goniometry), information regarding return to work, confirmation of physiotherapy referral and confirmation of collection of OMAS and RAND SF-36 Health survey.

Plans To Promote Participant Retention And Complete Follow-up

We have developed a patients tracking system to allow the researchers to monitor follow up carefully. As part of this system, a weekly list of expected patients is provided to the research nurse in the OPD, and this list is reviewed on a daily bases to record attendance. In case of a patient being absent from the clinic, another appointment for the following week will be arranged, the RAND SF-36 and the OMAS score will be posted to the patients with pre-paid envelope enclosed and the patient will be contacted to encourage follow up.

Data Management

Three forms are collected at each follow-up visit and stored securely in the trial locker, two PROM forms, the RAND SF-36 and OMAS and the case report form. Periodically, all data is transferred to a temporal database located within the HSE computer system by two researchers, and a read-only copy is stored in a separate folder. This is then cross-checked before data is transferred to STATA16 and PRISM for statistical analysis and reporting by the research team and statistician.

RAND SF-36 is multiple steps analysis; this will be performed with oblique scoring rather than the orthogonal-factor analytic model (19). Normative data for the Irish population will be used as a reference (20).

Confidentiality

Data management will be in accordance with the General Data Protection Regulation

(GDPR) Health Service Executive (HSE) and Health Research regulations (21,22). Data will be kept anonymously in the database within the HSE local hospital computer system in protected folders to ensure confidentiality. Paperwork will be stored in the trail locker in a locked researcher office within the hospitals.

Plans for collection, laboratory evaluation and storage of biological specimens for genetic or molecular analysis in this trial/future use

Statistical Methods

Statistical methods for primary and secondary outcomes

Unpaired t-test will be used for continuous data such as, OMAS, SF-36, total ankle arc, return to work (days), length of hospital stay (days). For categorical data such as rate of infection and other demographic data, Chi-squared test or Fisher's exact test will be used as indicated. Adjustment for strong predictors of the outcome, such as fracture complexity determined by fracture classification will be performed if necessary. Continuous data will be summarised as mean and standard deviation and confidence intervals (CI) (95% CI and p-value threshold ≤ 0.05) A p-value of < 0.05 will be considered significant. Categorical data will be presented as frequencies and proportions. STATA16 and PRISM software will be used for statistical analysis. Analysis will be conducted on the intention-to-treat (ITT) basis.

Interim Analyses

No planned interim analysis.

Methods For Additional Analyses (e.g. Subgroup Analyses)

Additional subgroup analysis comparing the outcomes of different fracture complexity pattern will be performed.

Methods in analysis to handle protocol non-adherence and any statistical methods to handle missing data

Any protocol non-adherence will be disclosed and handled accordingly. Effort will be made to prevent missing of data as much as possible, and unavoidable missing data, such as withdrawals from the study or loss of follow up data will be analysed on an intention to treat basis including sensitivity analysis. Methods such as Observation carried forward (LOCF), or imputation will only be used when scientifically justified (23–25).

Plans to give access to the full protocol, participant level-data and statistical code

The full protocol is available at the registry website and will be published in one of the trial protocols journals.

Oversight And Monitoring

Composition of the coordinating centre and trial steering committee

Four authors at the coordinating centre (University Hospital Waterford) take responsibility for the scientific validity of the study protocol, assessment of study quality and conduct, as well as, for the scientific quality of the final study report.

Composition of the data monitoring committee, its role and reporting structure

The authors understand the composition for a data monitoring committee for this trial is not necessary and will not add much to the study. This non-funded trail does not involve the administration of medication and does not expose patients to significant harm; the composition of DMC may even be counterproductive (26).

Adverse Event Reporting And Harms

Collected case report forms are checked daily by the research team before stored in the trial locker; any adverse event or harm will be communicated with the study team.

Frequency And Plans For Auditing Trial Conduct

The trial conduct is continuously audited in the departmental audit meeting (three monthly).

Plans for communicating important protocol amendments to relevant parties (e.g. trial participants, ethical committees)

Any change to the trial protocol will be communicated with the ethical committees and trial registry.

Dissemination Plans

The result of this trial will be published in one of the medical journals.

Discussion

Some studies have investigated early weight-bearing (EWB) following fixation of ankle fractures, some of which reported favourable outcomes (2,6–10) and others raised concerns of increasing complication rate (9,11,12). The National Institute for Health and Care Excellence (NICE) has recommended the subject as worthy of further research (27), and this has been reinforced by a recent audit of the UK Practice (3).

To our knowledge, immediate weight-bearing (IWB) following ORIF of all types of unstable ankle fractures has not been investigated with a randomised controlled trial. This pragmatic randomised-controlled multi-centre trial will investigate the safety and efficacy of IWB following ORIF of all ankle fracture patterns in the usual condition of care and help in formulating a widely accepted guideline for postoperative management of ankle fractures.

Trial status

The recruitment has started on the 7th of January 2019 and expected to complete in July 2020. One year follow up is planned. At the time of manuscript submission, 90 patients have been recruited. This protocol is the fifth version and dated 5th of February 2020.

Abbreviations

ORIF
open reduction and internal fixation
IWB
immediate weight-bearing
ROM

range of motion
NWB
non-weight bearing
OMAS
Olerud-Molander Ankle Score
EWB
early weight-bearing
HSE
Health Service executive
LOCF
Observation carried forward
BOCF
baseline observation carried forward
GDPR
General Data Protection Regulation
DMC
Data Monitoring Committee
ITT
intention-to-treat

Declarations

Acknowledgements

None.

Authors' contributions {31b}

RK conceived this trial, has initiated the trial and wrote the protocol. Invited the three contributing centres and granted ethical approval from each. RM is a site lead investigator and a major contributor in formulating and writing the manuscript. FR has contributed to setting up the inclusion and exclusion criteria and reviewed and adjusted the Protocol. MS is contributing to the data collection and analysis. SK is a site lead investigator. DV is a site co-investigator and data manager. MT is a site co-investigator and data manager. CT is a site lead investigator. MC is the senior author and has a contributor in adjusting and reviewing the protocol. All authors read and approved the manuscript.

Funding {4}

Investigator-initiated and funded.

Availability of data and materials {29}

No personal data will be available. The coded datasets used and analysed during this trial will be available from the corresponding author on reasonable request in accordance with the GDPR and Health Research Regulations 2018(21,22).

Ethics approval and consent to participate {24}

The following Research Ethics Committees have approved the study:

1/ Research Ethics Committee of Waterford University Hospital on the 14th of November 2018.

2/ Research Ethics Committee of Galway University Hospital, reference number: C.A. 2248 on 20th of September 2019.

3/ Research Ethics Committee of Cork University Hospital, reference number: ECM 4 (z) on 22nd of October 2019.

Informed consent will be obtained from all study participants.

Consent for publication {32}

Consent to publish anonymised data, was explicit within the consenting process. No identifiable personal data will be published.

Competing interests {28}

The authors declare that they have no competing interests.

Author Details

Ramy Khojaly[1,2], Ruairi MacNiocaill[1], Muhammad Shahab[1], Danilo Vukanic[3], Matthew Nagle[4], Stephen Kearns[3], Colm Taylor[4], Fiachra E. Rowan[1], May Cleary[1,5].

1. Department of Trauma and Orthopaedic Surgery, University Hospital Waterford, Waterford, X91 ER8E, Ireland
2. Department of Surgery, Royal College of Surgeons in Ireland, Dublin, D02 YN77, Ireland.
3. Department of Trauma and Orthopaedic Surgery, Galway University Hospital, Galway H91 YR71, Ireland
4. Department of Trauma and Orthopaedic Surgery, Cork University Hospital, Cork, T12 DFK4, Ireland.
5. Department of Orthopaedic Surgery, University College Cork, Cork, T12 YN60, Ireland

References

1. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. Injury. 2006 Aug;37(8):691–7.

2. Dehghan N, McKee MD, Jenkinson RJ, Schemitsch EH, Stas V, Nauth A, et al. Early Weightbearing and Range of Motion Versus Non-Weightbearing and Immobilization After Open Reduction and Internal Fixation of Unstable Ankle Fractures: A Randomized Controlled Trial. J Orthop Trauma. 2016 Jul;30(7):345–52.
3. BONE Collaborative. Weight-bearing in ankle fractures: An audit of UK practice. Foot Edinb Scotl. 2019 Feb 14;39:28–36.
4. Coles CP, Tornetta P, Obremskey WT, Spitler CA, Ahn J, Mirick G, et al. Ankle Fractures: An Expert Survey of Orthopaedic Trauma Association Members and Evidence-Based Treatment Recommendations. J Orthop Trauma. 2019 Sep;33(9):e318–24.
5. Swart E, Bezhani H, Greisberg J, Vosseller JT. How long should patients be kept non-weight bearing after ankle fracture fixation? A survey of OTA and AOFAS members. Injury. 2015 Jun 1;46(6):1127–30.
6. van Laarhoven CJ, Meeuwis JD, van der WerkenC null. Postoperative treatment of internally fixed ankle fractures: a prospective randomised study. J Bone Joint Surg Br. 1996 May;78(3):395–9.
7. Black JDJ, Bhavikatti M, Al-Hadithy N, Hakmi A, Kitson J. Early weight-bearing in operatively fixed ankle fractures: A systematic review. The Foot. 2013 Jun 1;23(2):78–85.
8. Gul A, Batra S, Mehmood S, Gillham N. Immediate unprotected weight-bearing of operatively treated ankle fractures. Acta Orthop Belg. 2007 Jun;73(3):360–5.
9. Thomas G, Whalley H, Modi C. Early Mobilization of Operatively Fixed Ankle Fractures: A Systematic Review. Foot Ankle Int. 2009 Jul 1;30(7):666–74.
10. Smeeing DPJ, Houwert RM, Briet JP, Groenwold RHH, Lansink KWW, Leenen LPH, et al. Weight-bearing or non-weight-bearing after surgical treatment of ankle fractures: a multicenter randomized controlled trial. Eur J Trauma Emerg Surg Off Publ Eur Trauma Soc. 2018 Sep 24;
11. Lehtonen H, Järvinen TLN, Honkonen S, Nyman M, Vihtonen K, Järvinen M. Use of a cast compared with a functional ankle brace after operative treatment of an ankle fracture. A prospective, randomized study. J Bone Joint Surg Am. 2003 Feb;85(2):205–11.
12. Early mobilization in a removable cast compared with immobilization in a cast after operative treatment of ankle fractures: a prospective randomize... - PubMed - NCBI [Internet]. [cited 2019 Dec 29]. Available from: https://www-ncbi-nlm-nih-gov.ezproxy.library.qmul.ac.uk/pubmed/17257532
13. Zaghloul A, Haddad B, Barksfield R, Davis B. Early complications of surgery in operative treatment of ankle fractures in those over 60: a review of 186 cases. Injury. 2014 Apr;45(4):780–3.
14. Olerud C, Molander H. A scoring scale for symptom evaluation after ankle fracture. Arch Orthop Trauma Surg Arch Orthopadische Unf-Chir. 1984;103(3):190–4.
15. O WT, E BK, P A, E W, M MM, M C-BC. A prospective randomised controlled trial of the fibular nail versus standard open reduction and internal fixation for fixation of ankle fractures in elderly patients. Bone Jt J [Internet]. 2016 Sep 1 [cited 2020 Jan 8]; Available from: http://online.boneandjoint.org.uk/doi/abs/10.1302/0301-620X.98B9.35837

16. Matthews PA, Scammell BE, Ali A, Coughlin T, Nightingale J, Khan T, et al. Early motion and directed exercise (EMADE) versus usual care post ankle fracture fixation: study protocol for a pragmatic randomised controlled trial. Trials. 2018 May 31;19(1):304.
17. Weil NL, Termaat MF, Rubinstein SM, El Moumni M, Zuidema WP, Derksen RJ, et al. WARRIOR-trial - is routine radiography following the 2-week initial follow-up in trauma patients with wrist and ankle fractures necessary: study protocol for a randomized controlled trial. Trials. 2015 Feb 27;16(1):66.
18. Carter TH, Oliver WM, Graham C, Duckworth AD, White TO. Medial malleolus: Operative Or Non-operative (MOON) trial protocol - a prospective randomised controlled trial of operative versus non-operative management of associated medial malleolus fractures in unstable fractures of the ankle. Trials. 2019 Sep 12;20(1):565.
19. Laucis NC, Hays RD, Bhattacharyya T. Scoring the SF-36 in Orthopaedics: A Brief Guide. J Bone Joint Surg Am. 2015 Oct 7;97(19):1628–34.
20. Blake C, Codd MB, O'Meara YM. The Short Form 36 (SF-36) Health Survey: normative data for the Irish population. Ir J Med Sci. 2000 Jul 1;169(3):195.
21. reg_2014_536_en.pdf [Internet]. [cited 2020 Feb 2]. Available from: https://ec.europa.eu/health/sites/health/files/files/eudralex/vol-1/reg_2014_536/reg_2014_536_en.pdf
22. Harris S. DATA PROTECTION ACT 2018 (SECTION 36(2)) (HEALTH RESEARCH) REGULATIONS 2018. :18.
23. Bell ML, Fiero M, Horton NJ, Hsu C-H. Handling missing data in RCTs; a review of the top medical journals. BMC Med Res Methodol. 2014 Nov 19;14(1):118.
24. National Research Council (US) Panel on Handling Missing Data in Clinical Trials. The Prevention and Treatment of Missing Data in Clinical Trials [Internet]. Washington (DC): National Academies Press (US); 2010 [cited 2019 Dec 28]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK209904/
25. Trials NRC (US) P on HMD in C. Conclusions and Recommendations [Internet]. National Academies Press (US); 2010 [cited 2020 Jan 3]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK209905/
26. Committee for medicinal products for human use (CHMP) guideline on Data Monitoring Committees. Stat Med. 2006 May 30;25(10):1639–45.
27. Fractures (non-complex): assessment and management [Internet]. NICE. [cited 2018 Sep 19]. Available from: https://www.nice.org.uk/researchrecommendation/post-operative-weight-bearing-in-people-with-ankle-fractures-what-is-the-most-clinically-effective-and-cost-effective-strategy-for-weight-bearing-in-people-who-have-had-surgery-for-internal-fixation-of-an-ankle-fracture

Appendixes

1-Patient information leaflet (Appendix 1)

2-Post-operative care information sheet (cast) (Appendix 2).

3- Post-operative care information sheet (boot) (Appendix 3).

4- Case Report Form (Appendix4).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- PostoperativeinstructionCast.pdf
- PostoperativeinstructionBoot.pdf
- PILAnkle.pdf
- CaseReportForm.pdf