The Ankle Injury Management (AIM) trial: a pragmatic, multicentre, equivalence randomised controlled trial and economic evaluation comparing close contact casting with open surgical reduction and internal fixation in the treatment of unstable ankle fractures in patients aged over 60 years

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Declared competing interests of authors: Sarah E Lamb is the chairperson of the National Institute of Health Research Health Technology Assessment programme Clinical Evaluation and Trials Board and is on the Clinical Trials Unit Standing Advisory Committee. Keith Willett declares design royalties from Zimmer Biomet, outside the submitted work, for intramedullary bone fixation implants.

Published October 2016
DOI: 10.3310/hta20750

Scientific summary

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Health Technology Assessment 2016; Vol. 20: No. 75
DOI: 10.3310/hta20750

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Background

Ankle fractures account for 9–17% of all fractures treated by orthopaedic surgeons in acute care hospitals in the UK. The decision to treat an unstable or displaced ankle fracture by surgery in older adults, compared with younger adults, is complicated by a higher prevalence of comorbidities, increased risk of infection and surgical wound problems, and inadequate fixation because of poor bone quality. The alternatives to surgery, traditional casting techniques, are associated with poorer alignment and healing of the fracture, which are thought to result in a worse patient outcome. A modified casting technique, close contact casting (CCC), has been developed to overcome some of the challenges of conservative ankle fracture management. CCC may offer an alternative to open reduction and internal fixation (ORIF) in older adults.

Objectives

1. To determine if the application of CCC for unstable and/or displaced ankle fractures in adults aged over 60 years results in an equivalent clinical outcome compared with the standard care of ORIF.
2. To estimate the cost-effectiveness of the two treatments to the NHS, and the broader societal perspective, including to the individual and their family.
3. To explore the experiences of the participants of the interventions and the impact of taking part in the trial.

Methods

Design

This was a pragmatic, multicentre, equivalence randomised controlled trial. The study incorporated evaluation of clinical effectiveness and cost-effectiveness, with an embedded qualitative study.

Setting

The study was conducted in the trauma and orthopaedic departments of 24 hospitals from 22 NHS trusts.

Participants

Adults aged over 60 years with an unstable and/or displaced ankle fracture. Those with critical limb ischaemia, insulin-dependent diabetes mellitus, active leg ulceration, open fractures, serious concomitant disease (i.e. metastatic disease or terminal illness), substantial degenerative or inflammatory arthritis in the ankle, unfit for general anaesthetic, or substantial cognitive impairment (Mini Mental State Examination scores of < 16 out of 30) were excluded.

Interventions

Participants were individually randomised to receive either ORIF or CCC in a 1 : 1 allocation ratio. We used the remote 24-hour telephone randomisation service available from the University of Aberdeen, Aberdeen, UK. Sequence generation was by random block size and stratification by centre and fracture pattern, using trans-/infrasyndesmotic and suprasyndesmotic categories. ORIF was conducted as per local hospital practice. As a new casting technique, we aimed to standardise CCC application, which was conducted in theatre under anaesthetic. CCC was applied by surgeons who had attended study-specific training and all procedures were required to have direct consultant supervision.

Follow-up

Follow-up was conducted at 6 weeks and 6 months after randomisation. Participants attended the clinic to complete follow-up questionnaires and clinical assessments. The 6-month follow-up was conducted by a blinded assessor. If participants were unable to be followed up in the clinic, then a telephone or postal follow-up was attempted.

Clinical outcomes and analysis

The primary outcome measure was a patient-reported outcome of ankle function, the Olerud–Molander Ankle Score (OMAS), at 6 months. The OMAS is a 0–100 scale, with higher scores indicating better ankle function. The secondary outcomes were quality of life (as measured by the European Quality of Life 5-Dimensions and Short Form questionnaire-12 items), pain, physical impairments (as measured by ankle range of motion and the timed up and go test), patient satisfaction and radiological outcomes (malunion and non-union).

The target sample size was 620 and the margin of equivalence was $\pm$ 6 points on the OMAS. The primary analysis was per protocol, with an intention-to-treat (ITT) analysis as a sensitivity analysis, in accordance with guidance regarding equivalence trial analysis. The primary analysis was a linear regression model adjusted for age, sex, centre, fracture pattern and baseline score.

Economic analysis

An evaluation of cost-effectiveness of CCC compared with ORIF was conducted as part of the trial. The economic evaluation was conducted for both the UK NHS and societal perspectives. We conducted analyses for both the per-protocol and ITT populations. Consistent with the evaluation of clinical effectiveness, the primary analysis was per protocol. We collected NHS and private health-care resource used over 6 months from self-reported questionnaires. We used multiple imputation, with chained equations in which data were missing at random.

Qualitative study

A purposive sample of 36 participants undertook unstructured interviews in the clinic environment at 6–10 weeks after treatment. Interviews were transcribed verbatim and analysed using a phenomenological approach.

Results

We recruited 620 participants, 95 during a pilot phase in one centre and 525 from the multicentre phase of the Ankle Injury Management (AIM) trial, between June 2010 and November 2013. Participants were aged, on average, 71 years, and 74% were female. Ankle fracture types included were trans-/infrasyndesmotic [542 out of 620 (87%)], and suprasyndesmotic [78 out of 620 (13%)]. The baseline characteristics of the participants in the intervention groups were well matched. At the 6-month primary end point, 90% (558/620) of participants were analysed for the primary outcome in the per-protocol analysis and 96% (593/620) in the ITT analysis.

Clinical results

The majority of participants [579 out of 620 (93%)] received their allocated treatment; 52 out of 275 (19%) who received CCC per protocol had a later conversion to ORIF because of loss of fracture reduction. In both per-protocol and ITT analyses, there was no evidence of difference between CCC and ORIF at 6 months after randomisation. In the per-protocol analysis, OMASs were 66.0 points [standard deviation (SD) 21.1 points] for ORIF vs. 64.5 points (SD 22.4 points) for CCC [mean difference –0.65 points, confidence interval (CI) –3.98 to 2.68 points; standardised effect size –0.04, 95% CI –0.23 to 0.15]. There were no differences between the secondary outcomes of quality of life (SF-12 mental and physical component summary scores), range of ankle motion, ankle pain, mobility and patient satisfaction. Infection and/or wound problems were more common with ORIF [29/298 (10%) vs. 4/275 (1%)], as were additional

operating theatre procedures relating to surgical wounds or implants [17/298 (6%) in the ORIF group and 3/275 (1%) in the CCC group]. The number of plaster sores and pain from casts was similar between groups, but there were more plaster saw lacerations in the CCC group [5/275 (2%) vs. 1/298 (0.3%)]. Less common but serious complications such as deep-vein thrombosis, pulmonary embolism and wound infections occurred in both treatment groups, but were infrequent overall. Malunion occurred in 38 out of 249 (15%) participants in the CCC group compared with 8 out of 274 (3%) in the surgery group ($p < 0.001$). Fracture non-union was lower in the surgery group than in the CCC group for the lateral malleolus [0/274 (0%) vs. 8/248 (3%); $p = 0.002$] and the medial malleolus [3/274 (1%) vs. 18/248 (7%); $p < 0.001$]. There was no evidence of a learning effect.

Economic results

Over the trial period, CCC showed evidence of a modest mean cost savings to both the NHS (mean difference –£644, 95% CI –1390 to 76)] and society (mean difference –£683, 95% CI –1851 to 536)], albeit estimates showed some imprecision. The cost savings were driven largely by savings in index procedure theatre time, but were partially eroded over time as a result of increased readmission and health services costs. Incremental quality-adjusted life-years were not different following CCC or ORIF. Over common willingness-to-pay thresholds, the probability that CCC was cost-effective was very high (> 95% for NHS and 85% for societal perspective). Results were consistent between the per-protocol and ITT populations.

Qualitative study

The lived experience of patients were similar regardless of treatment, as both groups suffered and endured the impact of ankle fracture and lived non-weight-bearing with a cast, and both lived with uncertainty regarding future function and the need for further interventions. Participants with CCC were pleased to avoid surgery but lived with concerns around swelling, healing and further damage to their ankle; participants with ORIF were pleased that their ankle was fixed, but lived with concerns around metalwork and infection.

Participants took part in the trial for altruistic reasons, for personal benefit and because they trusted the clinicians. Preferences were expressed for particular treatments and there was some evidence of therapeutic misconception. The themes were suffering, getting on with daily life, struggling to move, and treatment and being in the trial. Suffering reflected the emotional work participants undertook in relation to feeling vulnerable and being old, but also in order to maintain relationships for the future. Getting on with daily life demonstrated how participants proactively recreated meaningful lives within the limitations they faced because of the impact of injury. Struggling to move conveyed the work participants undertook to move their fragile bodies around a confined life space. Participants also moved forward with a heightened sense of emotional fragility. Treatment and being in the trial identified the different experiences of the two treatments, how participants actively managed their symptoms and how they made sense of the trial.

Conclusions

Implications for health care

We conclude that, at 6 months, the two treatments result in equivalent ankle function at reduced mean cost to health services and society. The clinical equivalence and cost-effectiveness of CCC as an alternative to ORIF surgery should be of interest to patients, clinicians and commissioners/payers. In this trial, reflecting current surgical opinion, approximately one in five patients who received CCC later needed to return to theatre for ORIF surgery because of unacceptable fracture position (loss of fracture reduction). Therefore, CCC substantially reduces the number of patients requiring surgery and the exposure to the risks of surgical complications that, although somewhat infrequent, can be clinically serious. CCC should be deliverable in the NHS, as it was introduced into practice as a modification of existing casting methods with limited training requirements.

Recommendations for research

We are currently conducting extended follow-up of the AIM trial cohort to investigate if the clinical effectiveness and cost-effectiveness outcomes are maintained at least 2 years after randomisation. This longer-term follow-up aims to address concerns from clinicians over potential later complications or additional procedures (e.g. intolerance of metalwork resulting in removal, post-traumatic osteoarthritis and possible ankle joint fusion or replacement) and their potential to impact on ankle function. It should also identify if the higher rates of radiological malunion and non-union associated with CCC affect overall outcome over a time period in which we would expect delayed clinical issues to manifest. In addition, we have identified that there is substantial loss of ankle function and quality of life after ankle fracture in older adults with either treatment, indicating the need to develop interventions that optimise recovery. Further study of the relationships between patient factors, radiological fracture patterns and outcomes, treatment responses and prognosis would also contribute to understanding the roles of key injury and patient characteristics in the treatment pathway.

Trial registration

This trial is registered as ISRCTN04180738.

Funding

Funding for this study was provided by the Health Technology Assessment programme of the National Institute for Health Research. This report was developed in association with the National Institute for Health Research Oxford Biomedical Research Unit funding scheme. The pilot phase was funded by the AO Research Foundation.

Health Technology Assessment

HTA/HTA TAR

ISSN 1366-5278 (Print)

ISSN 2046-4924 (Online)

Impact factor: 4.058

Health Technology Assessment is indexed in MEDLINE, CINAHL, EMBASE, The Cochrane Library and the ISI Science Citation Index.

This journal is a member of and subscribes to the principles of the Committee on Publication Ethics (COPE) (www.publicationethics.org/).

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This report

The research reported in this issue of the journal was funded by the HTA programme as project number 07/37/61. The contractual start date was in January 2010. The draft report began editorial review in March 2015 and was accepted for publication in December 2015. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The HTA editors and publisher have tried to ensure the accuracy of the authors' report and would like to thank the reviewers for their constructive comments on the draft document. However, they do not accept liability for damages or losses arising from material published in this report.

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