BMJ Paediatrics Open

Effectiveness of pre-formed foot orthoses in reducing lower limb pain, swollen and tender joints, and in improving quality of life and gait parameters in children with Juvenile Idiopathic Arthritis: a randomised control trial (Protocol)

Journal:	*BMJ Paediatrics Open*
Manuscript ID	bmjpo-2017-000121
Article Type:	Protocol
Date Submitted by the Author:	30-May-2017
Complete List of Authors:	Fellas, Antoni; University of Newcastle, Faculty of Health and Medicine Singh-Grewal, Davinder; University of Sydney, Clinical A/Prof- Paediatric Rheumatologists & Paediatrician Consultant, Sydney Children Hospitals Network Chaitow, Jeffrey; Sydney Children's Hospitals Network Randwick and Westmead, Rheumatology Santos, Derek; Queen Margaret University, Edinburgh, Podiatry Coda, Andrea; Newcastle University - Australia , Podiatry
Keywords:	Rheumatology

Effectiveness of pre-formed foot orthoses in reducing lower limb pain, swollen and tender joints, and in improving quality of life and gait parameters in children with juvenile idiopathic arthritis: a randomised control trial (Protocol)

Antoni Fellas[A*]
*Corresponding Author
Email: Antoni.Fellas@uon.edu.au

Davinder Singh-Grewal[B, C, E, F]

Jeffrey Chaitow[B]

Derek Santos[D]

Andrea Coda[A]

[A] School of Health Sciences, Faculty of Health and Medicine, University of Newcastle, Australia

[B] The Sydney Children's Hospital Network Randwick, and Westmead

[C] University of Sydney Discipline of Paediatrics and Child Health, Sydney, Australia

[D] School of Health Sciences, Queen Margaret University, Edinburgh, UK, EH21 6UU.

[E] University of New South Wales, School of Women's and Children's Health

[F] University of Western Sydney, Discipline of Paediatrics

Abstract

Background: Many children and adolescents with juvenile idiopathic arthritis experience lower limb problems which may lead to physical disabilities significantly impacting on their quality of life and symptoms. Emerging evidence has identified the effective role of podiatry in the management of juvenile idiopathic arthritis, suggesting the clinical benefit of different orthotic therapies.

Methods: This study will be a parallel group designed, multi-centre, randomised control trial, aiming to recruit 60 children and adolescents with juvenile idiopathic arthritis aged between 5 and 18. Those recruited will need to be diagnosed according to the ILAR criteria, and present with lower limb joint pain, swelling and/or tenderness. Participants will be recruited from three outpatient hospital clinics in New South Wales, Australia. Participants will be randomly allocated to receive a trial or control intervention. The trial group will be prescribed a customised pre-formed foot orthoses; instead the control group will receive a flat 1mm insole with no corrective modifications. Primary outcome measures recorded will be pain and quality of life. Secondary outcomes will be swollen and tender joint count, and gait parameters (such as plantar pressures, walking speed, stance and swing time). The allocated foot orthoses will be worn for 12 months, with data collected at baseline, 3, 6 and 12 months' intervals. Group allocation will be concealed and all analyses will be carried out on an intention-to-treat.

Discussion: The purpose of this trial is to explore the efficacy of a cost-effective, non-invasive podiatric intervention that will be prescribed at the initial biomechanical consultation. This approach will promote early clinical intervention, which is the gold standard in paediatric rheumatology. Furthermore, this study has the potential to provide new evidence for the effectiveness of a mechanical intervention alone to reduce swollen and tender joints in juvenile idiopathic arthritis.

This clinical trial has been registered with the Australian New Zealand Clinical Trials Registry: ACTRN12616001082493p.
Ethics for this randomised control trial has been approved (16/09/21/4.03).

What is already known about this subject?

Custom or customised foot orthoses may reduce lower limb pain and improve quality of life in children with juvenile idiopathic arthritis. No research has explored the effectiveness of a mechanical intervention alone for reducing swollen and tender lower limb joints in juvenile idiopathic arthritis.

How might it impact on clinical practice in the foreseeable future?

This study may inform clinical practice on the benefit of prescribing a customised pre-formed foot orthoses as part of a multidisciplinary approach, in the management of lower limb problems in juvenile idiopathic arthritis.

Keywords: Juvenile idiopathic arthritis, children, foot orthoses, lower limb, foot, ankle, pain, swelling, tenderness, gait parameters, protocol, podopaediatric

Introduction

Juvenile Idiopathic Arthritis (JIA) is the most common chronic rheumatic disease that affects children and adolescent and may cause short-term and long-term disability (1). Prevalence estimated in developed countries range from 16 to 400 per 100,000 (1, 2). The lower limb appears to be more commonly involved in JIA, particularly the oligoarticular subtype (1, 3). The manifestation of JIA includes joint swelling, effusion, tenderness, and painful limitation with joint movement, discrepancies in limb development and fatigue (1, 4). Lower limb impairments may reduce physical activities compared to healthy children (5-7). As a result; this may account, for the lower aerobic capacity among children with JIA (8). Initially the main aim for the multidisciplinary team should be to relieve pain and discomfort, to reduce joint inflammation, promote function and prevent deformities. However; the provision of health care to children with JIA has been reported to be particularly challenging (9-12), with podiatric care currently very limited within paediatric rheumatology in Australian hospitals.

Few studies have evaluated the effectiveness of a custom or customised pre-formed foot orthoses (FOs) in children with JIA (13, 14). A meta-analysis of the effectiveness of a custom or customised FOs in children with JIA indicated that FOs may hold clinical importance in outcomes such as pain and quality of life; however, between-group differences in means were predominately insignificant with imprecise and broad confidence intervals (15). Further research is needed to quantify the effectiveness of FOs in reducing pain and improving quality of life in children with JIA. A recent study in patients with early rheumatoid arthritis suggests that by correcting alignment of foot and ankle joint using a customised pre-formed FOs, it may result in a reduction of swelling and joint tenderness (16). The effectiveness of a pre-formed FOs in lower limb swollen and tender joints in JIA has never been investigated. This randomised control trial aims to provide new evidence on the effectiveness of a non-invasive, mechanical therapy for the reduction of swollen and tender joint counts in children with JIA. It will also further explore the effectiveness of customised pre-formed FOs in reducing lower limb pain, improving quality of life and gait parameters in children and adolescents affected by this rheumatic disease.

Objectives

The objective of this study is to investigate the effectiveness of a customised pre-formed FOs in reducing lower limb pain, swollen and tender joints, and in improving quality of life and gait in children with JIA.

Hypotheses:

Primary Outcomes

1. Pre-formed FOs will reduce lower limb pain using visual analogue scale (VAS) in children with JIA
2. Pre-formed FOs will improve quality of life in children with JIA using the Pediatric Quality of Life Questionnare™ (PedsQL) Rheumatology Module – version 3.0 for children and parents; and the Juvenile Arthritis Foot Disability Index (JAFI)

Secondary Outcomes

3. Pre-formed FOs will reduce swelling and tenderness of lower limb joints in children with JIA by visual inspection and palpation.
4. Pre-formed FOs will have an effect on quantitative kinematic and kinetic parameters of gait in children with JIA when barefoot, with shoes alone, and with shoes and FOs.

Trial Design

To test the hypothesis, this study will be a parallel group designed, multi-centre, randomised control trial. The allocation ratio of participants to their groups will be 1:1.

Methodology

Study Setting

This randomised control trial will be conducted across three outpatient paediatric rheumatology clinics in New South Wales, Australia: John Hunter Children's Hospital (Newcastle); Sydney Children's Hospital Network (Randwick and Westmead).

Eligibility Criteria

The inclusion and exclusion criteria are as follows:

Inclusion Criteria:

- Diagnosed with JIA according to ILAR (International League of Associations for Rheumatology) criteria.
- Age 5 to 18 years old.
- Active lower-limb joint arthritis involvement.

- No previous use of FOs, or previous failure of foot orthotic management, where the patient has not worn any FOs for a period of at least 3 months.
- If disease modifying anti-rheumatic drugs and/or biological therapy are used, not having started these drug therapies within 6 months of enrolling in the trial.

Exclusion Criteria:

- Inability to walk barefoot or shod for 15 meters without assistive devices.
- Concomitant musculoskeletal disease, central or peripheral nerve disease and endocrine disorders, including Diabetes Mellitus.
- History of lower limb surgery that required general anesthetic.
- Currently using FOs.
- Where prescription of FOs is contraindicated: for example, significant osseous abnormalities noted in the lower limbs and/or vertebrae during the physical evaluation. Unwillingness to wear appropriate footwear for fitting orthoses.

Control Group

Participants in the control group will receive a flat insole without any corrective modifications. The control insole will be made with 1mm thick leather board, top covered by a 'Dual Opulex Performance' 1.5mm thick material made from a neoprene base and a stretch nylon top. The top cover is representative of standard insole appearance regularly supplied by podiatrists.

Trial Group

The trial group will receive a customised, pre-formed FOs with the same 'Dual Opulex Performance' top cover. The prescription of the FOs (SlimFlex Simple, Algeos PTY LTD) will be customised at chair side according to each individual biomechanical need, and supplied on the same day of the initial assessment. Supplying the FOs on the same day of the initial assessment promotes early clinical intervention which is the gold standard approach in JIA (1, 17). Chief investigator (AF) will issue the trial and control orthoses to participants.

Compliance/Adherence

Adherence to the control and trial intervention will be monitored with visual inspection of FOs at follow-up consultations. Chief investigator (AF) will provide verbal and written instructions to both participants and parent on how to correctly wear the FOs, as well as clinical support if any problems arise. In case patient's foot size will increase during the data collection period and become unsuitable, the exact same prescription will be replicated in a new longer device and supplied to the participant.

Pharmaceutical changes will be recorded over the 12-month period. If changes occur to participant's medications, it will be noted and patients will be classified as "Medication-Changed". This approach is fundamental to account for any positive effect to be solely attributed to the FOs intervention and not to the medication changes.

Outcomes

Primary outcomes

1. Pain

Participants in both groups will be asked to rate their lower limb pain on a 100mm VAS. Pain will be self-reported by participants and their parents/carer. Pain scores will be collected at baseline, 3 month, 6 month and 12 month follow-up consultations. A clinical important difference is considered when there is an 8mm difference between time intervals (18). When measuring pain with the 100mm VAS, a lower score indicates less pain and therefore is a better outcome.

2. Quality of life

A. PedsQL

Quality of life will be measured using the PedsQL. The PedsQL (module 3) is a self-reported questionnaire which will be independently supplied to both the participants and parents/carer (19). The PedsQL 3.0 Rheumatology Module is specific for children with JIA by measuring different outcome subheadings such as: 'pain and hurt', 'daily activities', 'treatment', 'worry', and 'communication' (19). A clinical important difference is considered when there is a 5 point difference between time intervals (19). The PedsQL questionnaire is scored out of 100 points, and a higher score is indicative of a better quality of life. The PedsQL is available in different age ranges: 5-7; 8-12; and 13-18.

B. JAFI

The JAFI quality of life questionnaire comprises of 3 sections (27 responses): foot and ankle impairment, activity limitation and participation restriction. Quality of life using the PedsQL and the JAFI will be measured at baseline, 3 and 6 months follow-up assessments. Similarly to pain, quality of life is self-assessed and will also be collected at the 12 month time point.

Secondary outcomes

1. Swollen and tender joint

Currently there are no specific tools that have been developed to comprehensively record swollen and tender lower limb joints in JIA. Helliwell et al (2007) developed a tool to record swollen and tender foot and ankle joints specifically for adult rheumatoid arthritis (20). For this randomised control trial, a newly modified version of the Helliwell et al (2007) will be developed. The hip will not be included

in the swollen lower limb joint count, as it is clinically difficult and unreliable to detect the presence of swelling in this deep joint (21, 22). Joint count for swelling and tenderness will be recorded at baseline, 3 and 6 month follow-up assessments. The assessment tools for swelling and tenderness are depicted in Figures 1 and 2 respectively.

2. Gait parameters

Gait analysis will be completed at baseline, 3 and 6 months. In-shoe and plantar pressure analysis will be carried out by using the latest Wireless F-Scan and HR Mat (Tekscan™, Boston, USA) respectively. Both systems are equipped with the same sensors resolution allowing for calibration and data analysis comparison. Barefoot, shod, and shoes with the FOs recordings sequence will be randomised to account for fatigue potentially exhibited by symptomatic JIA children during acquisition of gait data. Outcome measures for gait parameters include:

a) Peak pressure and pressure time integral data will be extrapolated from the following anatomical areas: total contact; heel; midfoot; rearfoot; 1st metatarsal head; 2nd metatarsal head; 3rd/4th metatarsal head; 5th metatarsal head; lesser digits; distal phalanx of hallux.
b) walking speed (m/sec)
c) Stance time (sec)
d) Swing time (sec)

Biomechanical Assessment:

Standard biomechanical test will be performed on all children with JIA to inform orthotic therapy prescription: range of motion of lower limb joints; leg length discrepancy test and other validated weight-bearing test (such as Foot Posture Index) will also be carried out.

Timeline of Participants

Participants will only be required to attend 3 data collection sessions; baseline, 3 and 6 months (12 month outcomes are self-assessed); and it is expected that each meeting will last no more than 1 hour. Participants, in both groups, will be supplied their allocated FOs at the same day of baseline assessment and will be required to wear their FOs for 12 months. Figure 3 depicts a schematic diagram of the participant timeline.

Sample Size

Currently, there are insufficient data to conduct power calculations for each outcome. However, sufficient data are available with regards to pain outcome. Power calculations are therefore based on the outcome of pain measured on VAS. For a 5% 2-sided t-test with α=0.05 and power 80% for a randomised control trial design with baseline and 3 post-intervention observations, and a moderate effect size, it was estimated that a total of 46 subjects would be required (23 controls and 23 trial) (23, 24). The study will be overpowered to an estimated 30 subjects per group to allow for dropouts during the 12 months' data collection period.

Recruitment

Participants will be recruited from the outpatient paediatric rheumatology clinics listed in the study setting section. Parents and patient will be asked if they would like to be part of the study when attending their scheduled consultation with the paediatric rheumatologist. If the patients are eligible and their parents/carers are interested in being involved they will then be referred to the chief investigator (AF).

Allocation

Sequence generation

Immediately after consent is obtained; participants will be randomly allocated in blocks of 10, to either a control or trial group using a computer random number generator. This will be conducted by the chief investigator (AF).

Allocation concealment

Allocation concealment will be achieved by using sequentially numbered, opaque and sealed envelopes.

Blinding

Participants and their carer's in both groups will be blinded to what intervention they receive. The external aesthetic appearance of both the control and trial FOs will be the same by using the 'Dual Opulex Performance' top cover. To reduce bias during the data analysis stage; once data collection is complete, the participant's and parents/carers identity and their intervention will be coded and de-identified. Outcome assessors will be blinded to primary outcomes as they are self-reported; but not to secondary outcomes, as the assessor will be required to conduct the assessments and record data. For this trial, there were no sufficient funding available to support additional research assistant to blind secondary outcome measure.

Data Analysis

All data collected during the study from baseline, 3, 6 and 12 months will be represented graphically using the histograms and/or box-plots. Normality will be checked using the Shapiro Walks test. Where the variable presents ordinal data, the appropriate non-parametric test will be used. A series of between and within group analyses will be carried out. Analyses will be conducted with intention to treat.

Comparison between control and trial Group

To test the hypothesis, the control group will be compared with the trial group. Pair wise statistical analysis will be carried out using an unpaired t-test or Mann Whitney U test, depending on the distribution of the data.

Within each individual Group Analysis

To investigate the relationships between the groups at baseline, 3, 6 and 12 months, a repeated measures ANOVA will be carried out for parametric data where sphericity exist; or a Friedman test where non-parametric and/or no-sphericity exists.

Data Management

All electronic data will be kept on a University approved and prescribed laptop that will be password protected. The data will also be stored on a backup external hard drive that will be under lock and key in a metal cabinet on the University premises. The information from the research project will be stored for a period of 5 years after the completion of the research project, in accordance with the University of Newcastle's "stored data policy S000922".

Consent

Written and verbal consent will be obtained prior to the participant's involvement in the study. Parents/guardians of the child will sign consent forms on their behalf. This will be processed and obtained by the chief investigator (AF).

Ethics

Ethics has been approved by the Hunter New England Human Research Ethics Committee (16/09/21/4.03). Site authorisation has also been approved for all data collection sites by the relevant research governance committees.

Ethical considerations:

- Participants can withdraw from the trial at any stage without providing any reason.
- If participants in the trial group benefited from the FOs and their symptoms improved, they will be informed to keep them and given referral information to seek out further podiatric care if needed.
- If the trial intervention is found to be beneficial and data analysis confirms this; participants in the control group will be given the option of a free consultation and prescription of the trial FOs used in the study.

Privacy and confidentiality

To protect the confidentiality of participants involved, once the data collection process has been completed all identifying information will be removed and non-identifiable. All data presented on the final published paper will not contain any participant identifying information.

Contribution of Authors

All authors drafted, reviewed and approved the final manuscript.

Competing Interest

All authors declare they have no competing interests

Funding Statement

Funding: University of Newcastle – (part of a PhD scholarship).

Registration

This clinical trial has been registered with the Australian New Zealand Clinical Trials Registry: ACTRN12616001082493p.

Abbreviations

JIA: Juvenile idiopathic arthritis; FOs: foot orthoses; VAS: visual analogue scale; PedsQL: Pediatric Quality of Life Questionnaire; JAFI: Juvenile Arthritis Foot Disability Index; ILAR: International League of Associations for Rheumatology

References

1. Ravelli A, Martini A. Juvenile idiopathic arthritis. The Lancet. 2007;369(9563):767-78.
2. Manners PJ, Diepeveen DA. Prevalence of juvenile chronic arthritis in a population of 12-year-old children in urban Australia. Pediatrics. 1996;98(1):84-90.
3. Szer IS, Kimura Y, Malleson PN, Southwood TR. Arthritis in children and adolescents: juvenile idiopathic arthritis: Oxford university press USA; 2006.
4. Prakken B, Albani S, Martini A. Juvenile idiopathic arthritis. The Lancet. 2011;377(9783):2138-49.
5. Takken T, van der Net J, Kuis W, Helders PJ. Physical activity and health related physical fitness in children with juvenile idiopathic arthritis. Annals of the rheumatic diseases. 2003;62(9):885-9.
6. Tarakci E, Yeldan I, Kaya Mutlu E, Baydogan SN, Kasapcopur O. The relationship between physical activity level, anxiety, depression, and functional ability in children and adolescents with juvenile idiopathic arthritis. Clinical Rheumatology. 2011;30(11):1415-20.
7. Lelieveld OTHM, Armbrust W, van Leeuwen MA, Duppen N, Geertzen JHB, Sauer PJJ, et al. Physical activity in adolescents with juvenile idiopathic arthritis. Arthritis & Rheumatism. 2008;59(10):1379-84.
8. Brostrom E, Haglund-Akerlind Y, Hagelberg S, Cresswell AG. Gait in children with juvenile chronic arthritis. Timing and force parameters. Scand J Rheumatol. 2002;31(6):317-23.
9. Foster H, Rapley T. Access to pediatric rheumatology care—a major challenge to improving outcome in juvenile idiopathic arthritis. The Journal of rheumatology. 2010;37(11):2199-202.
10. Foster HE, Eltringham MS, Kay LJ, Friswell M, Abinun M, Myers A. Delay in access to appropriate care for children presenting with musculoskeletal symptoms and ultimately diagnosed with juvenile idiopathic arthritis. Arthritis Care & Research. 2007;57(6):921-7.
11. Coda A, Jones J, Grech D, Grewal DS. A Survey of Parent and Carer experiences and expectations of paediatric rheumatology care in New South Wales. Australian Health Review. 2016.
12. Amine B, Rostom S, Benbouazza K, Abouqal R, Hajjaj-Hassouni N. Health related quality of life survey about children and adolescents with juvenile idiopathic arthritis. Rheumatology International. 2009;29(3):275-9.
13. Powell M, Seid M, Szer IS. Efficacy of custom foot orthotics in improving pain and functional status in children with juvenile idiopathic arthritis: a randomized trial. Journal of Rheumatology. 2005;32(5):943-50.
14. Coda A, Fowlie PW, Davidson JE, Walsh J, Carline T, Santos D. Foot orthoses in children with juvenile idiopathic arthritis: a randomised controlled trial. Archives of Disease in Childhood. 2014;99(7):649-51.
15. Fellas A, Coda A, Hawke F. Physical and mechanical therapies for lower limb problems in juvenile idiopathic arthritis: a systematic review with meta- analysis Unpublished Manuscript. 2017;School of Health Sciences, Faculty of Health and Medicine, University of Newcastle.
16. Cameron-Fiddes V, Santos D. The use of 'off-the-shelf' foot orthoses in the reduction of foot symptoms in patients with early rheumatoid arthritis. The Foot. 2013;23(4):123-9.
17. The Royal Australian College of General Practitioners. Clinical guideline for the diagnosis and management of juvenile idiopathic arthritis 2009. Available from: http://www.racgp.org.au/your-practice/guidelines/musculoskeletal/juvenileidiopathicarthritis/
18. Dhanani S, Quenneville J, Perron M, Abdolell M, Feldman BM. Minimal difference in pain associated with change in quality of life in children with rheumatic disease. Arthritis Care & Research. 2002;47(5):501-5.
19. Varni JW, Seid M, Smith Knight T, Burwinkle T, Brown J, Szer IS. The PedsQL™ in pediatric rheumatology: reliability, validity, and responsiveness of the Pediatric Quality of Life Inventory™ Generic Core Scales and Rheumatology Module. Arthritis & Rheumatism. 2002;46(3):714-25.
20. Helliwell P. The foot and ankle in rheumatoid arthritis: a comprehensive guide: Elsevier Health Sciences; 2007.

21. Argyropoulou M, Fanis S, Xenakis T, Efremidis S, Siamopoulou A. The role of MRI in the evaluation of hip joint disease in clinical subtypes of juvenile idiopathic arthritis. The British journal of radiology. 2002;75(891):229-33.
22. Murray J, Ridley N, Mitchell N, Rooney M. Juvenile chronic arthritis of the hip: value of contrast-enhanced MR imaging. Clinical radiology. 1996;51(2):99-102.
23. Noordzij M, Tripepi G, Dekker FW, Zoccali C, Tanck MW, Jager KJ. Sample size calculations: basic principles and common pitfalls. Nephrology dialysis transplantation. 2010:gfp732.
24. Cohen J. Statistical power analysis for the behavioural sciences. Hillside. NJ: Lawrence Earlbaum Associates. 1988.

Figure List

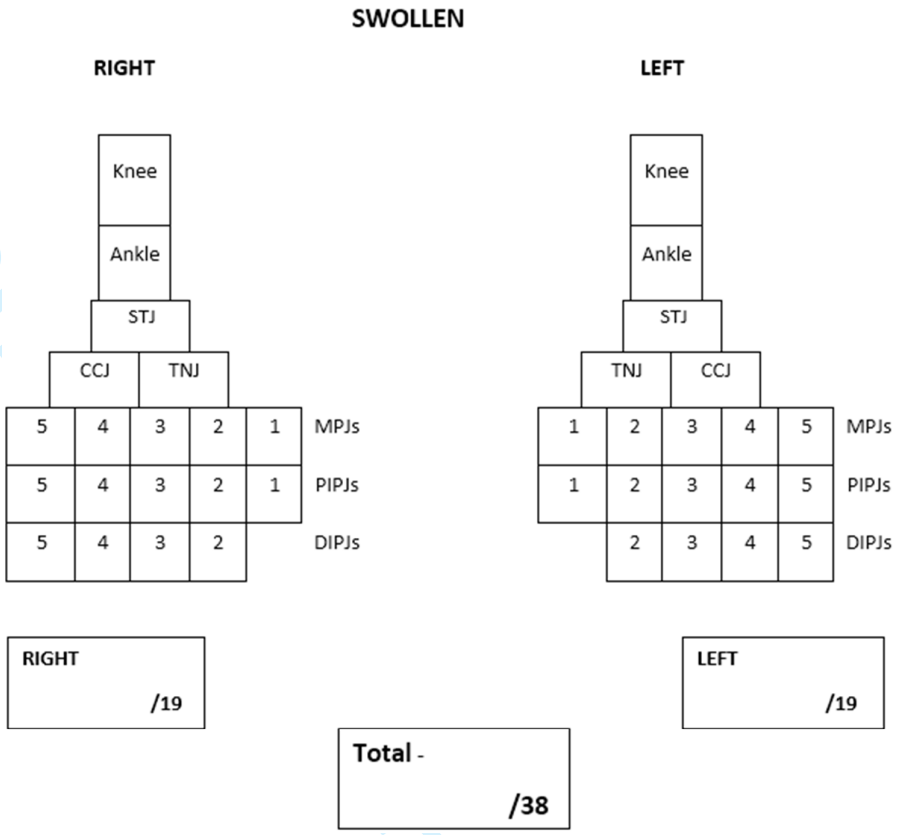


Figure 1. Swollen lower limb joint count

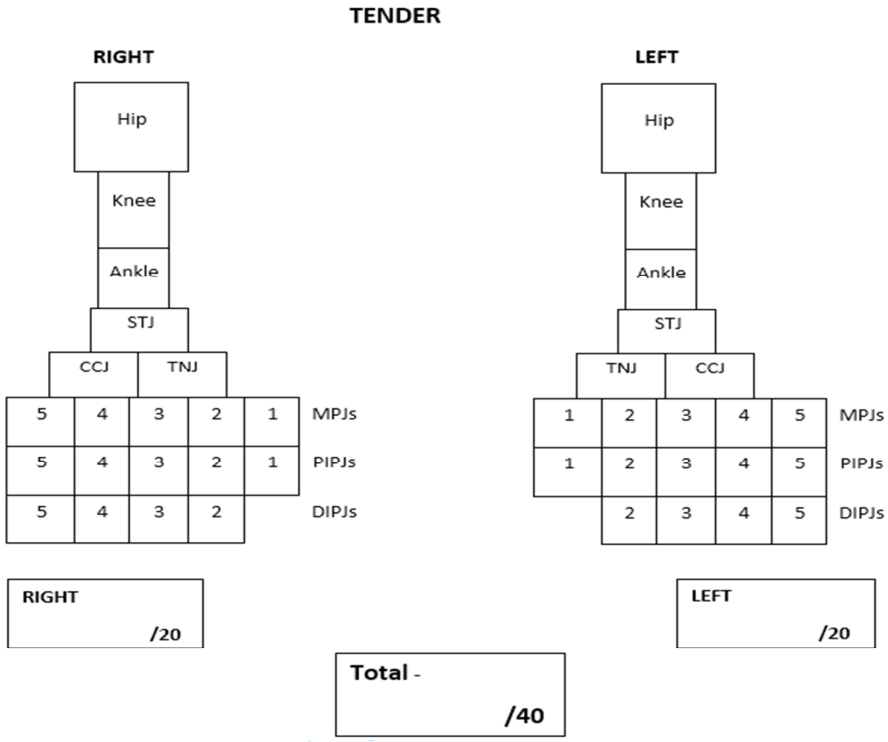


Figure 2. Tender lower limb joint count

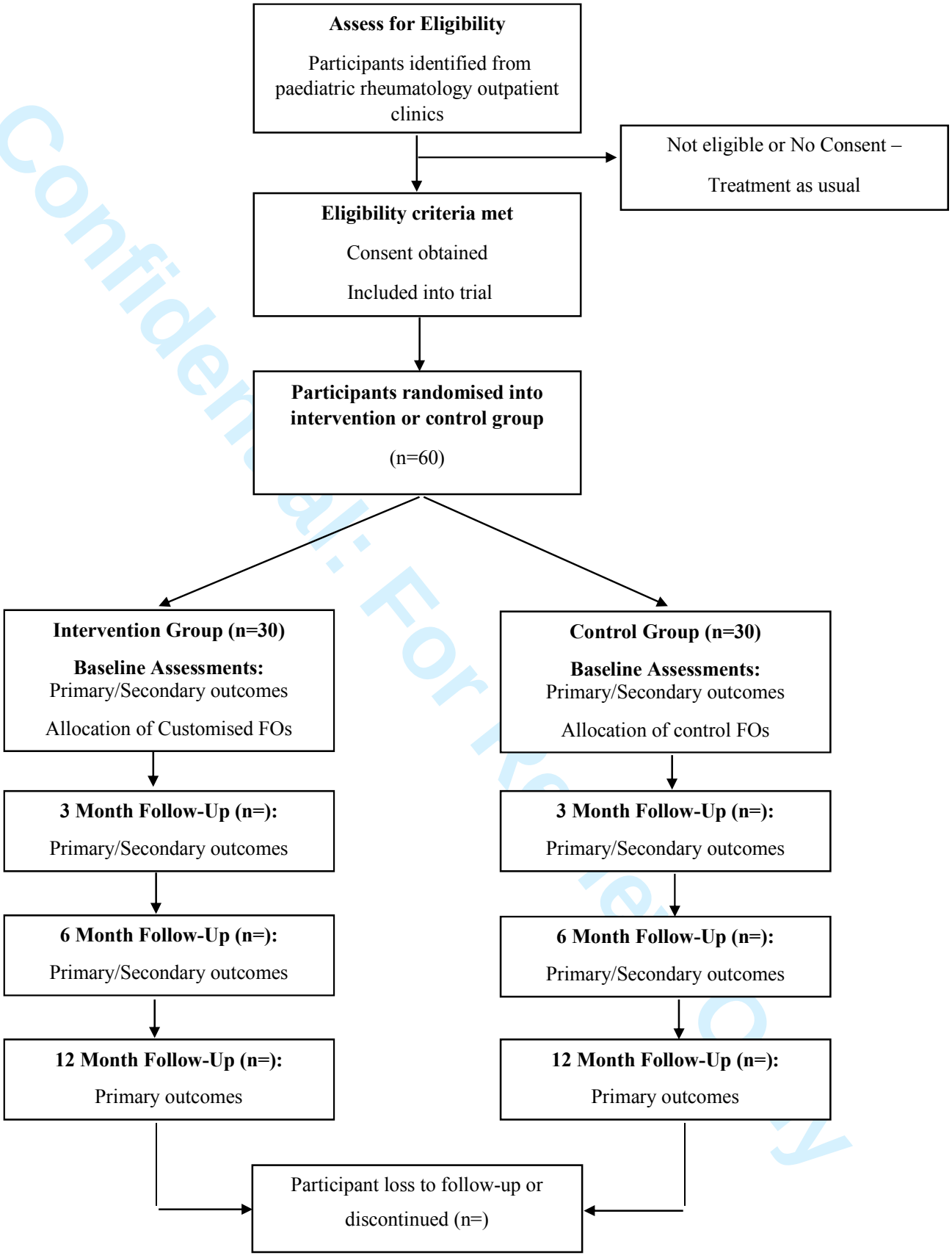


Figure 3. Participant Timeline

BMJ Paediatrics Open

Effectiveness of pre-formed foot orthoses in reducing lower limb pain, swollen and tender joints, and in improving quality of life and gait parameters in children with Juvenile Idiopathic Arthritis: a randomised control trial (Protocol)

Journal:	*BMJ Paediatrics Open*
Manuscript ID	bmjpo-2017-000121.R1
Article Type:	Protocol
Date Submitted by the Author:	14-Aug-2017
Complete List of Authors:	Fellas, Antoni; University of Newcastle, Faculty of Health and Medicine Singh-Grewal, Davinder; University of Sydney, Clinical A/Prof- Paediatric Rheumatologists & Paediatrician Consultant, Sydney Children Hospitals Network Chaitow, Jeffrey; Sydney Children's Hospitals Network Randwick and Westmead, Rheumatology Santos, Derek; Queen Margaret University, Edinburgh, Podiatry Coda, Andrea; Newcastle University - Australia , Podiatry
Keywords:	Rheumatology

Effectiveness of pre-formed foot orthoses in reducing lower limb pain, swollen and tender joints, and in improving quality of life and gait parameters in children with juvenile idiopathic arthritis: a randomised control trial (Protocol)

Antoni Fellas[A*]
*Corresponding Author
Email: Antoni.Fellas@uon.edu.au

Davinder Singh-Grewal[B, C, E, F]

Jeffrey Chaitow[B]

Derek Santos[D]

Andrea Coda[A]

[A] School of Health Sciences, Faculty of Health and Medicine, University of Newcastle, Australia

[B] The Sydney Children's Hospital Network Randwick, and Westmead

[C] University of Sydney Discipline of Paediatrics and Child Health, Sydney, Australia

[D] School of Health Sciences, Queen Margaret University, Edinburgh, UK, EH21 6UU.

[E] University of New South Wales, School of Women's and Children's Health

[F] University of Western Sydney, Discipline of Paediatrics

Abstract

Background: Many children and adolescents with juvenile idiopathic arthritis experience lower limb problems which may lead to physical disabilities significantly impacting on their quality of life and symptoms. Emerging evidence has identified the effective role of podiatry in the management of juvenile idiopathic arthritis, suggesting the clinical benefit of different orthotic therapies.

Methods: This study will be a parallel group designed, multi-centre, randomised control trial, aiming to recruit 60 children and adolescents with juvenile idiopathic arthritis aged between 5 and 18. Those recruited will need to be diagnosed according to the ILAR criteria, and present with lower limb joint pain, swelling and/or tenderness. Participants will be recruited from three outpatient hospital clinics in New South Wales, Australia. Participants will be randomly allocated to receive a trial or control intervention. The trial group will be prescribed a customised pre-formed foot orthoses; instead the control group will receive a flat 1mm insole with no corrective modifications. Primary outcome measure recorded will be pain. Secondary outcomes will be quality of life, foot disability, swollen and tender joint count, and gait parameters (such as plantar pressures, walking speed, stance and swing time). The allocated foot orthoses will be worn for 12 months, with data collected at baseline, 4 weeks, 3, 6 and 12 months' intervals. Group allocation will be concealed and all analyses will be carried out on an intention-to-treat.

Discussion: The purpose of this trial is to explore the efficacy of a cost-effective, non-invasive podiatric intervention that will be prescribed at the initial biomechanical consultation. This approach will promote early clinical intervention, which is the gold standard in paediatric rheumatology. Furthermore, this study has the potential to provide new evidence for the effectiveness of a mechanical intervention alone to reduce swollen and tender joints in juvenile idiopathic arthritis.

This clinical trial has been registered with the Australian New Zealand Clinical Trials Registry: ACTRN12616001082493p.
Ethics for this randomised control trial has been approved (16/09/21/4.03).

What is already known about this subject?

Custom or customised foot orthoses may reduce lower limb pain and improve quality of life in children with juvenile idiopathic arthritis. No research has explored the effectiveness of a mechanical intervention alone for reducing swollen and tender lower limb joints in juvenile idiopathic arthritis.

How might it impact on clinical practice in the foreseeable future?

This study may inform clinical practice on the benefit of prescribing a customised pre-formed foot orthoses as part of a multidisciplinary approach, in the management of lower limb problems in juvenile idiopathic arthritis.

Keywords: Juvenile idiopathic arthritis, children, foot orthoses, lower limb, foot, ankle, pain, swelling, tenderness, gait parameters, protocol, podopaediatric

Introduction

Juvenile Idiopathic Arthritis (JIA) is the most common chronic rheumatic disease that affects children and adolescent and may cause short-term and long-term disability (1). Prevalence estimated in developed countries range from 16 to 400 per 100,000 (1, 2). The lower limb appears to be more commonly involved in JIA, particularly the oligoarticular subtype (1, 3). The manifestation of JIA includes joint swelling, effusion, tenderness, and painful limitation with joint movement, discrepancies in limb development and fatigue (1, 4). Lower limb impairments may reduce physical activities compared to healthy children (5-7). As a result; this may account, for the lower aerobic capacity among children with JIA (8). Initially the main aim for the multidisciplinary team should be to relieve pain and discomfort, to reduce joint inflammation, promote function and prevent deformities. However; the provision of health care to children with JIA has been reported to be particularly challenging (9-12), with podiatric care currently very limited within paediatric rheumatology in Australian hospitals.

Few studies have evaluated the effectiveness of a custom or customised pre-formed foot orthoses (FOs) in children with JIA (13, 14). A meta-analysis of the effectiveness of a custom or customised FOs in children with JIA indicated that FOs may hold clinical importance in outcomes such as pain and quality of life; however, between-group differences in means were predominately insignificant with imprecise and broad confidence intervals (15). Moreover, a randomised control trial investigating the effectiveness of a multidisciplinary foot care programme found no statistical significant difference between groups (16). The programme included a multifaceted approach to foot care in JIA; including ultrasound guided intra-corticosteroid injections, paediatric rheumatology, podiatry and physiotherapy (16). The authors reported challenges in participant recruitment and retention; leading to an underpowered study which may have been vulnerable to type II error (16). Until more research is conducted, the effectiveness of FOs in children with JIA remains to be further explored (15). A recent study in patients with early rheumatoid arthritis suggests that by correcting biomechanical misalignments and reducing mechanical trauma of foot and ankle joints using a customised pre-formed FOs, it may result in a reduction of swelling and joint tenderness (17). The effectiveness of a customised pre-formed FOs alone for the reduction of lower limb swollen and tender joints in JIA, has never been investigated. This randomised control trial aims to provide new evidence on the effectiveness of a non-invasive, mechanical therapy for the reduction of swollen and tender joint counts in children with JIA. It will also further explore the effectiveness of customised pre-formed FOs in reducing lower limb pain, improving quality of life and gait parameters in children and adolescents affected by this rheumatic disease.

Objectives

The objective of this study is to investigate the effectiveness of a customised pre-formed FOs in reducing lower limb pain, swollen and tender joints, and in improving quality of life and gait in children with JIA.

Hypotheses:

Primary Outcomes

1. Pre-formed FOs will reduce lower limb pain using visual analogue scale (VAS) in children with JIA

Secondary Outcomes

1. Pre-formed FOs will improve quality of life in children with JIA using the Pediatric Quality of Life Questionnaire™ (PedsQL) Rheumatology Module – version 3.0 for children and parents.
2. Pre-formed FOs will improve foot disability in children with JIA using the Juvenile Arthritis Foot Disability Index (JAFI).
3. Pre-formed FOs will reduce localised swelling and tenderness of lower limb joints in children with JIA by visual inspection and palpation.
4. Pre-formed FOs will have an effect on quantitative kinematic and kinetic parameters of gait in children with JIA when barefoot, with shoes alone, and with shoes and FOs.

Trial Design

To test the hypothesis, this study will be a parallel group designed, multi-centre, randomised control trial. The allocation ratio of participants to their groups will be 1:1.

Methodology

Study Setting

This randomised control trial will be conducted across three outpatient paediatric rheumatology clinics in New South Wales, Australia: John Hunter Children's Hospital (Newcastle); Sydney Children's Hospital Network (Randwick and Westmead).

Eligibility Criteria

The inclusion and exclusion criteria are as follows:

Inclusion Criteria:

- Diagnosed with JIA according to ILAR (International League of Associations for Rheumatology) criteria.
- Age 5 to 18 years old.
- Active involvement of the lower limb (including foot/ankle and/or hip and knee involvement)
- No previous use of FOs, or previous failure of foot orthotic management, where the patient has not worn any FOs for a period of at least 3 months.
- If disease modifying anti-rheumatic drugs and/or biological therapy are used, not having started these drug therapies within 6 months of enrolling in the trial.

Exclusion Criteria:

- Inability to walk barefoot or shod for 15 meters without assistive devices.
- Concomitant musculoskeletal disease, central or peripheral nerve disease and endocrine disorders, including Diabetes Mellitus.
- History of lower limb surgery that required general anesthetic.
- Currently using FOs.
- Where prescription of FOs is contraindicated: for example, significant osseous abnormalities noted in the lower limbs and/or vertebrae during the physical evaluation. Unwillingness to wear appropriate footwear for fitting orthoses.

Control Group

Participants in the control group will receive a flat insole without any corrective modifications. The control insole will be made with 1mm thick leather board, top covered by a 'Dual Opulex Performance' 1.5mm thick material made from a neoprene base and a stretch nylon top. The top cover is representative of standard insole appearance regularly supplied by podiatrists.

Trial Group

The trial group will receive a customised, pre-formed FOs with the same 'Dual Opulex Performance' top cover. The prescription of the FOs (SlimFlex Simple, Algeos PTY LTD) will be customised at chair side according to each individual biomechanical need, and supplied on the same day of the initial assessment. Supplying the FOs on the same day of the initial assessment promotes early clinical intervention which is the gold standard approach in JIA (1, 18). Chief investigator (AF) will issue the trial and control orthoses to participants.

Footwear

Participants in both the control and trial group will receive footwear education and recommendations. Footwear advice will focus on suitable cushioning properties and supportive features of a shoe, appropriate sizes, and details related to orthoses fitting. Information will be conveyed in a manner that is easy to understand for both participants and their parents.

Usual Care

Throughout the duration of the trial, participants in both the control and trial groups will continue their usual outpatient care at the John Hunter Children's Hospital and Sydney Children's Hospital Network. Outpatient care may include but not limited to: a paediatric rheumatologist, specialist nurse, physiotherapist, occupational therapist, psychologist etc.

Compliance/Adherence

Adherence to the control and trial intervention will be monitored with visual inspection of FOs at follow-up consultations. Participants will be asked to fill a self-reported diary that will have to be completed for the duration of the trial in order to record the overall number of days per week they have worn their FOs. Participants will be required to bring their diary to their next follow-up consultation and will be given a new one to complete and return. Chief investigator (AF) will provide verbal and written instructions to both participants and parent on how to correctly wear the FOs, as well as clinical support if any problems arise. In case patient's foot size will increase during the data collection period and become unsuitable, the exact same prescription will be replicated in a new longer device and supplied to the participant.

Pharmaceutical changes will be recorded over the 12-month period. If changes occur to participant's medications, it will be noted and patients will be classified as "Medication-Changed". This approach is fundamental to account for any positive effect to be solely attributed to the FOs intervention and not to the medication changes.

Outcomes

Primary outcomes

1. Pain

Participants in both groups will be asked to rate their lower limb pain on a 100mm VAS. Pain will be self-reported by participants and their parents/carer. A clinical important difference is considered when there is an 8mm difference between time intervals (19). When measuring pain with the 100mm VAS, a lower score indicates less pain and therefore is a better outcome. Pain scores will be collected

at baseline, 4 weeks, 3, 6 and 12 month follow-up consultations, with 12 month representing the end-point for primary outcome assessment.

Secondary outcomes

1. Quality of life

Quality of life will be measured using the PedsQL. The PedsQL (module 3) is a self-reported questionnaire which will be independently supplied to both the participants and parents/carer (20). The PedsQL 3.0 Rheumatology Module is specific for children with JIA by measuring different outcome subheadings such as: 'pain and hurt', 'daily activities', 'treatment', 'worry', and 'communication' (20). A clinical important difference is considered when there is a 5 point difference between time intervals (20). The PedsQL questionnaire is scored out of 100 points, and a higher score is indicative of a better quality of life. The PedsQL is available in different age ranges: 5-7; 8-12; and 13-18. Quality of life is self-assessed and will be measured at baseline and 3, 6 and 12 months' time point.

2. Foot disability

Foot disability will be measured using the JAFI which comprises of 3 components (27 responses in total): foot and ankle impairment, activity limitation and participation restriction (21). The JAFI has shown to be a reliable and valid measure of foot-related disability in children with JIA (21). Foot disability using the JAFI will be measured at baseline and 3, 6 and 12 months' time.

3. Swollen and tender joint

Helliwell et al (2007) developed a tool to record swollen and tender foot and ankle joints specifically for adult rheumatoid arthritis (22). This tool was used in an earlier podiatric based study in rheumatoid arthritis (17); and with some further modifications (adding hip, knee, distal and proximal interphalangeal joints), will be used to assess lower limb joint swelling and tenderness count for this randomised control trial. Joint count for swelling and tenderness will be recorded at baseline, 3 and 6 month follow-up assessments. The assessment tools for swelling and tenderness are depicted in Figures 1 and 2 respectively.

4. Gait parameters

Gait analysis will be completed at baseline, 3 and 6 months. In-shoe and plantar pressure analysis will be carried out by using the latest Wireless F-Scan and HR Mat (Tekscan™, Boston, USA) respectively. Both systems are equipped with the same sensors resolution allowing for calibration and data analysis comparison. Barefoot, shod, and shoes with the FOs recordings sequence will be

randomised to account for fatigue potentially exhibited by symptomatic JIA children during acquisition of gait data. Outcome measures for gait parameters include:

a) Peak pressure and pressure time integral data will be extrapolated from the following anatomical areas: total contact; heel; midfoot; rearfoot; 1st metatarsal head; 2nd metatarsal head; 3rd/4th metatarsal head; 5th metatarsal head; lesser digits; distal phalanx of hallux.
b) walking speed (m/sec)
c) Stance time (sec)
d) Swing time (sec)
e) Double limb support (sec)
f) Stride length (cm)

Biomechanical Assessment:

Standardised assessments such as the paediatric pGALS Legs and Foot Posture Index will be conducted to clinically assess the lower limb, and inform the prescription and modifications of foot orthoses. Muscle bulk and limb length discrepancies will be observed and recorded as part of the pGALS Legs assessment. The following additional biomechanical and anatomical test will be carried out: range of motion of lower limb joints; gait analysis; presence of enthesitis (Achilles and plantar fascia); and presence of tendonitis (e.g. tibialis posterior, peroneal and Achilles tendons).

Timeline of Participants

Participants will only be required to attend 3 data collection sessions; baseline, 3 and 6 months (12 month outcomes are self-assessed); and it is expected that each meeting will last no more than 1 hour. Participants, in both groups, will be supplied their allocated FOs at the same day of baseline assessment and will be required to wear their FOs for 12 months. Figure 3 depicts a schematic diagram of the participant timeline.

Sample Size

Currently, there are insufficient data to conduct power calculations for each outcome. However, sufficient data are available with regards to pain outcome. Power calculations are therefore based on the outcome of pain measured on a 100mm VAS, with a minimal clinical significance of 8mm (19). For a 2-sided t-test with α=0.05 and power 80% for a randomised control trial design with baseline and 3 post-intervention observations, and a moderate effect size, it was estimated that a total of 46 subjects would be required (23 controls and 23 trial) (23, 24). The study will be overpowered to an estimated 30 subjects per group to allow for dropouts during the 12 months' data collection period.

Recruitment

Participants will be recruited from the outpatient paediatric rheumatology clinics listed in the study setting section. Parents and patient will be asked if they would like to be part of the study when attending their scheduled consultation with the paediatric rheumatologist. If the patients are eligible and their parents/carers are interested in being involved they will then be referred to the chief investigator (AF).

Allocation

Sequence generation

Immediately after consent is obtained; participants will be randomly allocated in blocks of 10, to either a control or trial group. Their allocation to each group will be achieved with a pre-determined generated list. This will be achieved using a computer random number generator (https://www.random.org/sequences/).

Allocation concealment

Allocation concealment will be achieved by using sequentially numbered, opaque and sealed envelopes. Both sequence generation and allocation concealment will be conducted by research team member. During this independent allocation process, the research team member will not be involved at any stage as part of the recruitment process, orthotic prescription of the control or trial intervention; data collection and will not have any prior or ongoing contact with enrolled participants.

Blinding

Participants and their carer's in both groups will be blinded to what intervention they receive. The external aesthetic appearance of both the control and trial FOs will be the same by using the 'Dual Opulex Performance' top cover. To reduce bias during the data analysis stage; once data collection is complete, the participant's and parents/carers identity and their intervention will be coded and de-identified. Outcome assessors will be blinded to all self-reported outcomes such as pain (VAS), quality of life (PedsQL) and foot disability (JAFI).

Data Analysis

All data collected during the study from baseline, 3, 6 and 12 months will be represented graphically using the histograms and/or box-plots. Normality will be checked using the Shapiro Wilks test. Where the variable presents ordinal data, the appropriate non-parametric test will be used. A series of between and within group analyses will be carried out. Analyses will be conducted with intention to treat.

Comparison between control and trial Group

To test the hypothesis, the control group will be compared with the trial group. Pair wise statistical analysis will be carried out using an unpaired t-test or Mann Whitney U test, depending on the distribution of the data.

Within each individual Group Analysis

To investigate the relationships between the groups at baseline, 3, 6 and 12 months, a repeated measures ANOVA will be carried out for parametric data where sphericity exist; or a Friedman test where non-parametric and/or no-sphericity exists.

Limitations

Few limitations should be noted as part of in this protocol. The swelling and tenderness outcome may be vulnerable to ascertainment bias, as the outcome assessor will not be blinded against interventions. Due to limited funding available as part of this PhD scholarship and logistical travelling restrictions no blinded assessor for this outcome will not be available. Moreover, joint disease in JIA may be subclinical and therefore may not be detected using physical examination alone. The use of a standardised lower limb physical examination tool may improve the validity of findings in the swollen and tender joint outcome. Lastly, the orthoses intervention will vary based on the individual biomechanical needs of each participants and therefore may differ. In order too enhance the reproducibility of the trial intervention, each FOs modifications will be standardised using a clinical decision pathway (figure 4).

Data Management

All electronic data will be kept on a University approved and prescribed laptop that will be password protected. The data will also be stored on a backup external hard drive that will be under lock and key in a metal cabinet on the University premises. The information from the research project will be stored for a period of 5 years after the completion of the research project, in accordance with the University of Newcastle's "stored data policy S000922".

Consent

Written and verbal consent will be obtained prior to the participant's involvement in the study. Parents/guardians of the child will sign consent forms on their behalf. This will be processed and obtained by the chief investigator (AF).

Ethics

Ethics has been approved by the Hunter New England Human Research Ethics Committee (16/09/21/4.03). Site authorisation has also been approved for all data collection sites by the relevant research governance committees.

Ethical considerations:

- Participants can withdraw from the trial at any stage without providing any reason.
- If participants in the trial group benefited from the FOs and their symptoms improved, they will be informed to keep them and given referral information to seek out further podiatric care if needed.
- If the trial intervention is found to be beneficial and data analysis confirms this; participants in the control group will be given the option of a free consultation and prescription of the trial FOs used in the study.

Privacy and confidentiality

To protect the confidentiality of participants involved, once the data collection process has been completed all identifying information will be removed and non-identifiable. All data presented on the final published paper will not contain any participant identifying information.

Contribution of Authors

All authors drafted, reviewed and approved the final manuscript.

Competing Interest

All authors declare they have no competing interests

Funding Statement

Funding: University of Newcastle – (part of a PhD scholarship).

Registration

This clinical trial has been registered with the Australian New Zealand Clinical Trials Registry: ACTRN12616001082493p.

Abbreviations

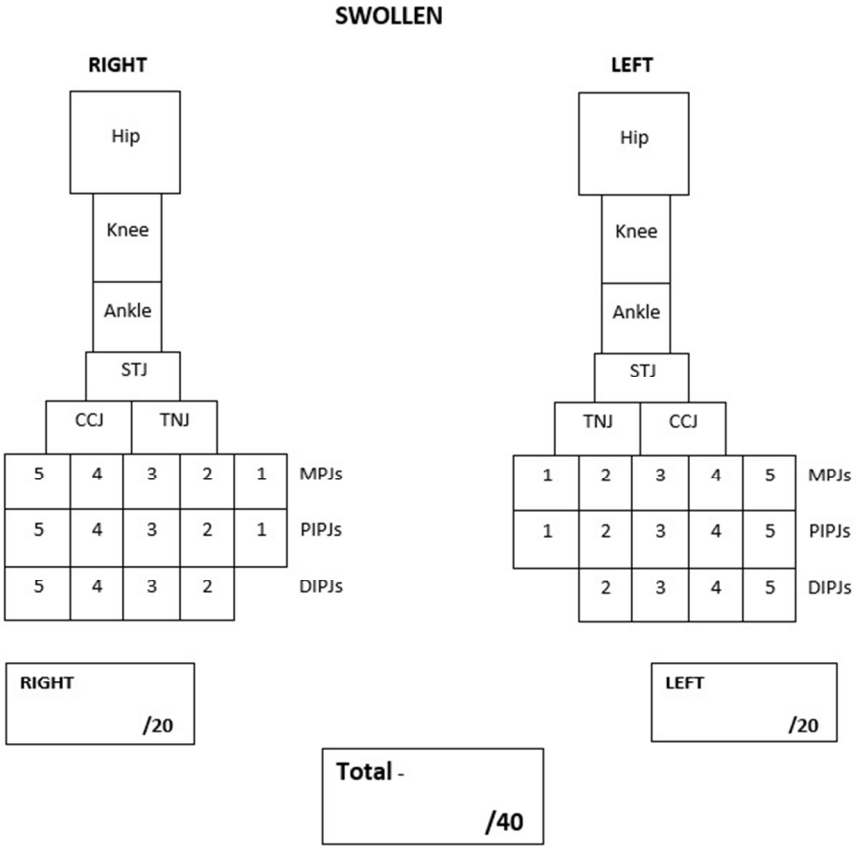
JIA: Juvenile idiopathic arthritis; FOs: foot orthoses; VAS: visual analogue scale; PedsQL: Pediatric Quality of Life Questionnaire; JAFI: Juvenile Arthritis Foot Disability Index; ILAR: International League of Associations for Rheumatology

References

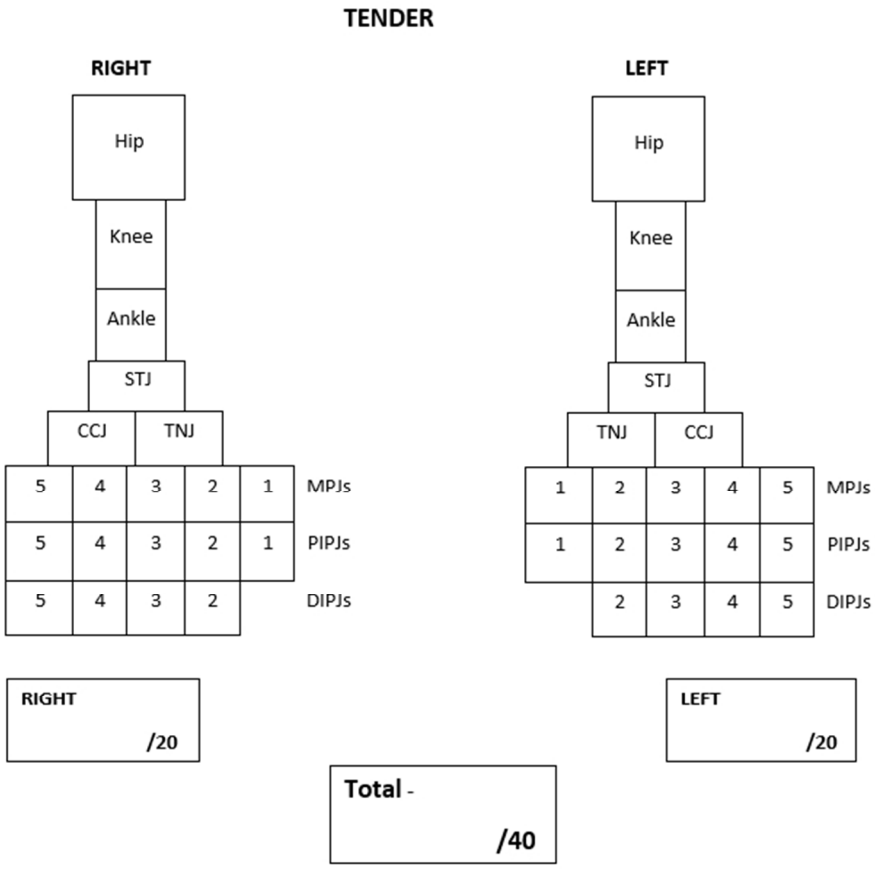
1. Ravelli A, Martini A. Juvenile idiopathic arthritis. The Lancet. 2007;369(9563):767-78.
2. Manners PJ, Diepeveen DA. Prevalence of juvenile chronic arthritis in a population of 12-year-old children in urban Australia. Pediatrics. 1996;98(1):84-90.
3. Szer IS, Kimura Y, Malleson PN, Southwood TR. Arthritis in children and adolescents: juvenile idiopathic arthritis: Oxford university press USA; 2006.
4. Prakken B, Albani S, Martini A. Juvenile idiopathic arthritis. The Lancet. 2011;377(9783):2138-49.
5. Takken T, van der Net J, Kuis W, Helders PJ. Physical activity and health related physical fitness in children with juvenile idiopathic arthritis. Annals of the rheumatic diseases. 2003;62(9):885-9.
6. Tarakci E, Yeldan I, Kaya Mutlu E, Baydogan SN, Kasapcopur O. The relationship between physical activity level, anxiety, depression, and functional ability in children and adolescents with juvenile idiopathic arthritis. Clinical Rheumatology. 2011;30(11):1415-20.
7. Lelieveld OTHM, Armbrust W, van Leeuwen MA, Duppen N, Geertzen JHB, Sauer PJJ, et al. Physical activity in adolescents with juvenile idiopathic arthritis. Arthritis & Rheumatism. 2008;59(10):1379-84.
8. Brostrom E, Haglund-Akerlind Y, Hagelberg S, Cresswell AG. Gait in children with juvenile chronic arthritis. Timing and force parameters. Scandinavian Journal of Rheumatology. 2002;31(6):317-23.
9. Foster H, Rapley T. Access to pediatric rheumatology care—a major challenge to improving outcome in juvenile idiopathic arthritis. The Journal of rheumatology. 2010;37(11):2199-202.
10. Foster HE, Eltringham MS, Kay LJ, Friswell M, Abinun M, Myers A. Delay in access to appropriate care for children presenting with musculoskeletal symptoms and ultimately diagnosed with juvenile idiopathic arthritis. Arthritis Care & Research. 2007;57(6):921-7.
11. Coda A, Jones J, Grech D, Grewal DS. A Survey of Parent and Carer experiences and expectations of paediatric rheumatology care in New South Wales. Australian Health Review. 2016.
12. Amine B, Rostom S, Benbouazza K, Abouqal R, Hajjaj-Hassouni N. Health related quality of life survey about children and adolescents with juvenile idiopathic arthritis. Rheumatology International. 2009;29(3):275-9.
13. Powell M, Seid M, Szer IS. Efficacy of custom foot orthotics in improving pain and functional status in children with juvenile idiopathic arthritis: a randomized trial. Journal of Rheumatology. 2005;32(5):943-50.
14. Coda A, Fowlie PW, Davidson JE, Walsh J, Carline T, Santos D. Foot orthoses in children with juvenile idiopathic arthritis: a randomised controlled trial. Archives of Disease in Childhood. 2014;99(7):649-51.
15. Fellas A, Coda A, Hawke F. Physical and mechanical therapies for lower limb problems in juvenile idiopathic arthritis: a systematic review with meta- analysis Journal of the American Podiatric Medical Association. 2017; http://dx.doi.org/10.7547/15-213 (In Press).
16. Hendry GJ, Watt GF, Brandon M, Friel L, Turner DE, Lorgelly PK, et al. The effectiveness of a multidisciplinary foot care program for children and adolescents with juvenile idiopathic arthritis: an exploratory trial. Journal of Rehabilitation Medicine. 2013;45(5):467-76.
17. Cameron-Fiddes V, Santos D. The use of 'off-the-shelf' foot orthoses in the reduction of foot symptoms in patients with early rheumatoid arthritis. The Foot. 2013;23(4):123-9.
18. Practitioners TRACoG. Clinical guideline for the diagnosis and management of juvenile idiopathic arthritis. 2009.
19. Dhanani S, Quenneville J, Perron M, Abdolell M, Feldman BM. Minimal difference in pain associated with change in quality of life in children with rheumatic disease. Arthritis Care & Research. 2002;47(5):501-5.
20. Varni JW, Seid M, Smith Knight T, Burwinkle T, Brown J, Szer IS. The PedsQL™ in pediatric rheumatology: reliability, validity, and responsiveness of the Pediatric Quality of Life

Inventory™ Generic Core Scales and Rheumatology Module. Arthritis & Rheumatism. 2002;46(3):714-25.
21. Andre M, Hagelberg S, Stenstrom CH. The juvenile arthritis foot disability index: development and evaluation of measurement properties. Journal of Rheumatology. 2004;31(12):2488-93.
22. Helliwell P. The foot and ankle in rheumatoid arthritis: a comprehensive guide: Elsevier Health Sciences; 2007.
23. Noordzij M, Tripepi G, Dekker FW, Zoccali C, Tanck MW, Jager KJ. Sample size calculations: basic principles and common pitfalls. Nephrology dialysis transplantation. 2010:gfp732.
24. Cohen J. Statistical power analysis for the behavioural sciences. Hillside. NJ: Lawrence Earlbaum Associates. 1988.

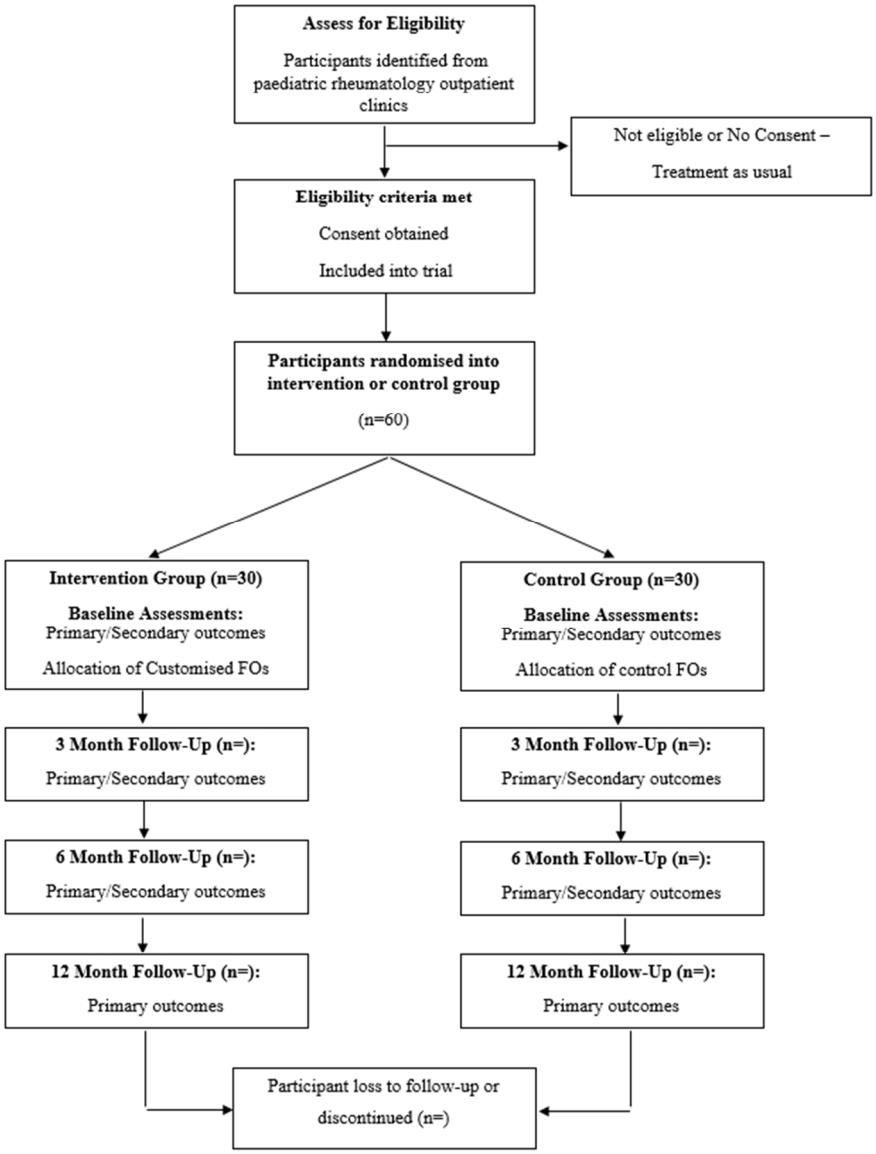
Figure List



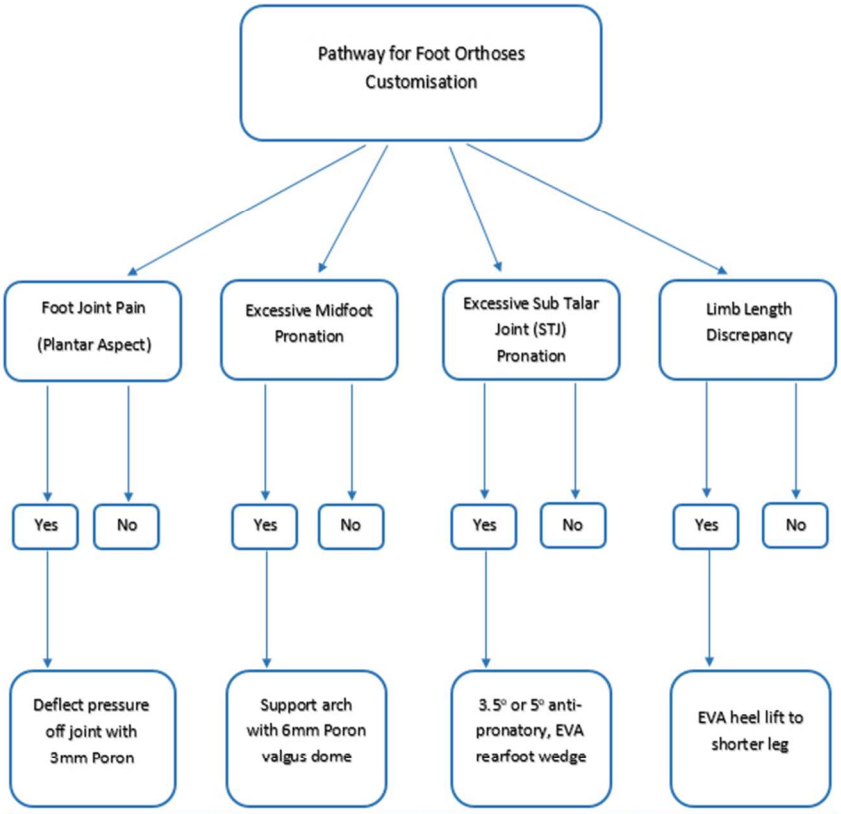
186x169mm (96 x 96 DPI)



182x168mm (96 x 96 DPI)



187x221mm (96 x 96 DPI)



Joint pain	Excessive midfoot pronation	Excessive Sub Talar Joint (STJ) pronation	Limb length discrepancy (LLD)
The physical examination carried out by the CI, will enable to determine the pathological joints on the plantar surface of foot. If symptomatic, the CI will deflect pressure by offloading the joint using 3mm Poron. The deflection will be glued on top of the FOs in correspondence of the painful joint.	In order to reduce excessive midfoot pronation, the CI will prescribe 6mm Poron valgus dome on the top surface of FOs. The valgus dome (semi-circular shape) will be bevelled to promote comfort. The valgus dome will be applied from the distal aspect of the sustentaculum tali extending to the proximal aspect of the 1st met phalangeal joint.	The CI will record the Resting Calcaneal Stance Position and the Neutral Calcaneal Stance Position from each patient. Based on the results obtained, the CI will provide either 3.5° or 5° degree anti-pronatory wedge, using high density EVA. The supplied wedge will aim to reduce excessive STJ pronation. The wedge will be applied underneath the surface of the FOs extended corresponding to the sustentaculum tali covering whole plantar surface of calcaneus.	If significant discrepancy exists (>5mm difference), the CI will apply a heel lift to the shorter limb, using high density EVA. The height of the heel raise supplied will be half of the overall amount recorded during the assessment. For example a 14mm LLD difference, the CI will apply a 7mm heel lift. The heel lift will be positioned underneath the FOs and it will be extended and bevelled till the proximal portion of the medial longitudinal arch.

178x227mm (96 x 96 DPI)

BMJ Paediatrics Open

Effectiveness of pre-formed foot orthoses in reducing lower limb pain, swollen and tender joints, and in improving quality of life and gait parameters in children with Juvenile Idiopathic Arthritis: a randomised control trial (Protocol)

Journal:	*BMJ Paediatrics Open*
Manuscript ID	bmjpo-2017-000121.R2
Article Type:	Protocol
Date Submitted by the Author:	28-Sep-2017
Complete List of Authors:	Fellas, Antoni; University of Newcastle, Faculty of Health and Medicine Singh-Grewal, Davinder; University of Sydney, Clinical A/Prof- Paediatric Rheumatologists & Paediatrician Consultant, Sydney Children Hospitals Network Chaitow, Jeffrey; Sydney Children's Hospitals Network Randwick and Westmead, Rheumatology Santos, Derek; Queen Margaret University, Edinburgh, Podiatry Coda, Andrea; Newcastle University - Australia , Podiatry
Keywords:	Rheumatology

Effectiveness of pre-formed foot orthoses in reducing lower limb pain, swollen and tender joints, and in improving quality of life and gait parameters in children with juvenile idiopathic arthritis: a randomised control trial (Protocol)

Antoni Fellas[A*]
*Corresponding Author
Email: Antoni.Fellas@uon.edu.au

Davinder Singh-Grewal[B, C, E, F]

Jeffrey Chaitow[B]

Derek Santos[D]

Andrea Coda[A]

[A] School of Health Sciences, Faculty of Health and Medicine, University of Newcastle, Australia

[B] The Sydney Children's Hospital Network Randwick, and Westmead

[C] University of Sydney Discipline of Paediatrics and Child Health, Sydney, Australia

[D] School of Health Sciences, Queen Margaret University, Edinburgh, UK, EH21 6UU.

[E] University of New South Wales, School of Women's and Children's Health

[F] University of Western Sydney, Discipline of Paediatrics

Abstract

Background: Many children and adolescents with juvenile idiopathic arthritis experience lower limb problems which may lead to physical disabilities significantly impacting on their quality of life and symptoms. Emerging evidence has identified the effective role of podiatry in the management of juvenile idiopathic arthritis, suggesting the clinical benefit of different orthotic therapies.

Methods: This study will be a parallel group designed, multi-centre, randomised control trial, aiming to recruit 60 children and adolescents with juvenile idiopathic arthritis aged between 5 and 18. Those recruited will need to be diagnosed according to the ILAR criteria, and present with lower limb joint pain, swelling and/or tenderness. Participants will be recruited from three outpatient hospital clinics in New South Wales, Australia. Participants will be randomly allocated to receive a trial or control intervention. The trial group will be prescribed a customised pre-formed foot orthoses; instead the control group will receive a flat 1mm insole with no corrective modifications. Primary outcome measure recorded will be pain. Secondary outcomes will be quality of life, foot disability, swollen and tender joint count, and gait parameters (such as plantar pressures, walking speed, stance and swing time). The allocated foot orthoses will be worn for 12 months, with data collected at baseline, 4 weeks, 3, 6 and 12 months' intervals. Group allocation will be concealed and all analyses will be carried out on an intention-to-treat.

Discussion: The purpose of this trial is to explore the efficacy of a cost-effective, non-invasive podiatric intervention that will be prescribed at the initial biomechanical consultation. This approach will promote early clinical intervention, which is the gold standard in paediatric rheumatology. Furthermore, this study has the potential to provide new evidence for the effectiveness of a mechanical intervention alone to reduce swollen and tender joints in juvenile idiopathic arthritis.

This clinical trial has been registered with the Australian New Zealand Clinical Trials Registry: ACTRN12616001082493p.
Ethics for this randomised control trial has been approved (16/09/21/4.03).

What is already known about this subject?

Custom or customised foot orthoses may reduce lower limb pain and improve quality of life in children with juvenile idiopathic arthritis. No research has explored the effectiveness of a mechanical intervention alone for reducing swollen and tender lower limb joints in juvenile idiopathic arthritis.

How might it impact on clinical practice in the foreseeable future?

This study may inform clinical practice on the benefit of prescribing a customised pre-formed foot orthoses as part of a multidisciplinary approach, in the management of lower limb problems in juvenile idiopathic arthritis.

Keywords: Juvenile idiopathic arthritis, children, foot orthoses, lower limb, foot, ankle, pain, swelling, tenderness, gait parameters, protocol, podopaediatric

Introduction

Juvenile Idiopathic Arthritis (JIA) is the most common chronic rheumatic disease that affects children and adolescent and may cause short-term and long-term disability (1). Prevalence estimated in developed countries range from 16 to 400 per 100,000 (1, 2). The lower limb appears to be more commonly involved in JIA, particularly the oligoarticular subtype (1, 3). The manifestation of JIA includes joint swelling, effusion, tenderness, and painful limitation with joint movement, discrepancies in limb development and fatigue (1, 4). Lower limb impairments may reduce physical activities compared to healthy children (5-7). As a result; this may account, for the lower aerobic capacity among children with JIA (8). Initially the main aim for the multidisciplinary team should be to relieve pain and discomfort, to reduce joint inflammation, promote function and prevent deformities. However; the provision of health care to children with JIA has been reported to be particularly challenging (9-12), with podiatric care currently very limited within paediatric rheumatology in Australian hospitals.

Few studies have evaluated the effectiveness of a custom or customised pre-formed foot orthoses (FOs) in children with JIA (13, 14). A meta-analysis of the effectiveness of a custom or customised FOs in children with JIA indicated that FOs may hold clinical importance in outcomes such as pain and quality of life; however, between-group differences in means were predominately insignificant with imprecise and broad confidence intervals (15). Moreover, a randomised control trial investigating the effectiveness of a multidisciplinary foot care programme found no statistical significant difference between groups (16). The programme included a multifaceted approach to foot care in JIA; including ultrasound guided intra-corticosteroid injections, paediatric rheumatology, podiatry and physiotherapy (16). The authors reported challenges in participant recruitment and retention; leading to an underpowered study which may have been vulnerable to type II error (16). Until more research is conducted, the effectiveness of FOs in children with JIA remains to be further explored (15). A recent study in patients with early rheumatoid arthritis suggests that by correcting biomechanical misalignments and reducing mechanical trauma of foot and ankle joints using a customised pre-formed FOs, it may result in a reduction of swelling and joint tenderness (17). The effectiveness of a customised pre-formed FOs alone for the reduction of lower limb swollen and tender joints in JIA, has never been investigated. This randomised control trial aims to provide new evidence on the effectiveness of a non-invasive, mechanical therapy for the reduction of swollen and tender joint counts in children with JIA. It will also further explore the effectiveness of customised pre-formed FOs in reducing lower limb pain, improving quality of life and gait parameters in children and adolescents affected by this rheumatic disease.

Objectives

The objective of this study is to investigate the effectiveness of a customised pre-formed FOs in reducing lower limb pain, swollen and tender joints, and in improving quality of life and gait in children with JIA.

Hypotheses:

Primary Outcomes

1. Pre-formed FOs will reduce lower limb pain using visual analogue scale (VAS) in children with JIA

Secondary Outcomes

1. Pre-formed FOs will improve quality of life in children with JIA using the Pediatric Quality of Life Questionnaire™ (PedsQL) Rheumatology Module – version 3.0 for children and parents.
2. Pre-formed FOs will improve foot disability in children with JIA using the Juvenile Arthritis Foot Disability Index (JAFI).
3. Pre-formed FOs will reduce localised swelling and tenderness of lower limb joints in children with JIA by visual inspection and palpation.
4. Pre-formed FOs will have an effect on quantitative kinematic and kinetic parameters of gait in children with JIA when barefoot, with shoes alone, and with shoes and FOs.

Trial Design

To test the hypothesis, this study will be a parallel group designed, multi-centre, randomised control trial. The allocation ratio of participants to their groups will be 1:1.

Methodology

Study Setting

This randomised control trial will be conducted across three outpatient paediatric rheumatology clinics in New South Wales, Australia: John Hunter Children's Hospital (Newcastle); Sydney Children's Hospital Network (Randwick and Westmead).

Eligibility Criteria

The inclusion and exclusion criteria are as follows:

Inclusion Criteria:

- Diagnosed with JIA according to ILAR (International League of Associations for Rheumatology) criteria.
- Age 5 to 18 years old.
- Active involvement of the lower limb (including foot/ankle and/or hip and knee involvement)
- No previous use of FOs, or previous failure of foot orthotic management, where the patient has not worn any FOs for a period of at least 3 months.
- If disease modifying anti-rheumatic drugs and/or biological therapy are used, not having started these drug therapies within 6 months of enrolling in the trial.

Exclusion Criteria:

- Inability to walk barefoot or shod for 15 meters without assistive devices.
- Concomitant musculoskeletal disease, central or peripheral nerve disease and endocrine disorders, including Diabetes Mellitus.
- History of lower limb surgery that required general anesthetic.
- Currently using FOs.
- Where prescription of FOs is contraindicated: for example, significant osseous abnormalities noted in the lower limbs and/or vertebrae during the physical evaluation. Unwillingness to wear appropriate footwear for fitting orthoses.

Control Group

Participants in the control group will receive a flat insole without any corrective modifications. The control insole will be made with 1mm thick leather board, top covered by a 'Dual Opulex Performance' 1.5mm thick material made from a neoprene base and a stretch nylon top. The top cover is representative of standard insole appearance regularly supplied by podiatrists.

Trial Group

The trial group will receive a customised, pre-formed FOs with the same 'Dual Opulex Performance' top cover. The prescription of the FOs (SlimFlex Simple, Algeos PTY LTD) will be customised at chair side according to each individual biomechanical need, and supplied on the same day of the initial assessment. Supplying the FOs on the same day of the initial assessment promotes early clinical intervention which is the gold standard approach in JIA (1, 18). Chief investigator (AF) will issue the trial and control orthoses to participants.

Footwear

Participants in both the control and trial group will receive footwear education and recommendations. Footwear advice will focus on suitable cushioning properties and supportive features of a shoe, appropriate sizes, and details related to orthoses fitting. Information will be conveyed in a manner that is easy to understand for both participants and their parents.

Usual Care

Throughout the duration of the trial, participants in both the control and trial groups will continue their usual outpatient care at the John Hunter Children's Hospital and Sydney Children's Hospital Network. Outpatient care may include but not limited to: a paediatric rheumatologist, specialist nurse, physiotherapist, occupational therapist, psychologist etc.

Compliance/Adherence

Adherence to the control and trial intervention will be monitored with visual inspection of FOs at follow-up consultations. Participants will be asked to fill a self-reported diary that will have to be completed for the duration of the trial in order to record the overall number of days per week they have worn their FOs. Participants will be required to bring their diary to their next follow-up consultation and will be given a new one to complete and return. Chief investigator (AF) will provide verbal and written instructions to both participants and parent on how to correctly wear the FOs, as well as clinical support if any problems arise. In case patient's foot size will increase during the data collection period and become unsuitable, the exact same prescription will be replicated in a new longer device and supplied to the participant.

Pharmaceutical changes will be recorded over the 12-month period. If changes occur to participant's medications, it will be noted and patients will be classified as "Medication-Changed". This approach is fundamental to account for any positive effect to be solely attributed to the FOs intervention and not to the medication changes.

Outcomes

Primary outcomes

1. Pain

Participants in both groups will be asked to rate their lower limb pain on a 100mm VAS. Pain will be self-reported by participants and their parents/carer. A clinical important difference is considered when there is an 8mm difference between time intervals (19). When measuring pain with the 100mm VAS, a lower score indicates less pain and therefore is a better outcome. Pain scores will be collected

at baseline, 4 weeks, 3, 6 and 12 month follow-up consultations, with 12 month representing the end-point for primary outcome assessment.

Secondary outcomes

1. Quality of life

Quality of life will be measured using the PedsQL. The PedsQL (module 3) is a self-reported questionnaire which will be independently supplied to both the participants and parents/carer (20). The PedsQL 3.0 Rheumatology Module is specific for children with JIA by measuring different outcome subheadings such as: 'pain and hurt', 'daily activities', 'treatment', 'worry', and 'communication' (20). A clinical important difference is considered when there is a 5 point difference between time intervals (20). The PedsQL questionnaire is scored out of 100 points, and a higher score is indicative of a better quality of life. The PedsQL is available in different age ranges: 5-7; 8-12; and 13-18. Quality of life is self-assessed and will be measured at baseline and 3, 6 and 12 months' time point.

2. Foot disability

Foot disability will be measured using the JAFI which comprises of 3 components (27 responses in total): foot and ankle impairment, activity limitation and participation restriction (21). The JAFI has shown to be a reliable and valid measure of foot-related disability in children with JIA (21). Foot disability using the JAFI will be measured at baseline and 3, 6 and 12 months' time.

3. Swollen and tender joint

Helliwell et al (2007) developed a tool to record swollen and tender foot and ankle joints specifically for adult rheumatoid arthritis (22). This tool was used in an earlier podiatric based study in rheumatoid arthritis (17); and with some further modifications (adding hip, knee, distal and proximal interphalangeal joints), will be used to assess lower limb joint swelling and tenderness count for this randomised control trial. Joint count for swelling and tenderness will be recorded at baseline, 3 and 6 month follow-up assessments. The assessment tools for swelling and tenderness are depicted in Figures 1 and 2 respectively.

4. Gait parameters

Gait analysis will be completed at baseline, 3 and 6 months. In-shoe and plantar pressure analysis will be carried out by using the latest Wireless F-Scan and HR Mat (Tekscan™, Boston, USA) respectively. Both systems are equipped with the same sensors resolution allowing for calibration and data analysis comparison. Barefoot, shod, and shoes with the FOs recordings sequence will be

randomised to account for fatigue potentially exhibited by symptomatic JIA children during acquisition of gait data. Outcome measures for gait parameters include:

a) Peak pressure and pressure time integral data will be extrapolated from the following anatomical areas: total contact; heel; midfoot; rearfoot; 1st metatarsal head; 2nd metatarsal head; 3rd/4th metatarsal head; 5th metatarsal head; lesser digits; distal phalanx of hallux.
b) walking speed (m/sec)
c) Stance time (sec)
d) Swing time (sec)
e) Double limb support (sec)
f) Stride length (cm)

Biomechanical Assessment:

Standardised assessments such as the Foot Posture Index will be conducted to clinically assess the lower limb, and inform the prescription and modifications of foot orthoses. Muscle bulk and limb length discrepancies will be observed and recorded as part of the pGALS Legs assessment. The following additional biomechanical and anatomical test will be carried out: range of motion of lower limb joints; gait analysis; presence of enthesitis (Achilles and plantar fascia); and presence of tendonitis (e.g. tibialis posterior, peroneal and Achilles tendons).

Timeline of Participants

Participants will only be required to attend 3 data collection sessions; baseline, 3 and 6 months (12 month outcomes are self-assessed); and it is expected that each meeting will last no more than 1 hour. Participants, in both groups, will be supplied their allocated FOs at the same day of baseline assessment and will be required to wear their FOs for 12 months. Figure 3 depicts a schematic diagram of the participant timeline.

Sample Size

Currently, there are insufficient data to conduct power calculations for each outcome. However, sufficient data are available with regards to pain outcome. Power calculations are therefore based on the outcome of pain measured on a 100mm VAS, with a minimal clinical significance of 8mm (19). For a 2-sided t-test with α=0.05 and power 80% for a randomised control trial design with baseline and 3 post-intervention observations, and a moderate effect size, it was estimated that a total of 46 subjects would be required (23 controls and 23 trial) (23, 24). The study will be overpowered to an estimated 30 subjects per group to allow for dropouts during the 12 months' data collection period.

Recruitment

Participants will be recruited from the outpatient paediatric rheumatology clinics listed in the study setting section. Parents and patient will be asked if they would like to be part of the study when attending their scheduled consultation with the paediatric rheumatologist. If the patients are eligible and their parents/carers are interested in being involved they will then be referred to the chief investigator (AF).

Allocation

Sequence generation

Immediately after consent is obtained; participants will be randomly allocated in blocks of 10, to either a control or trial group. Their allocation to each group will be achieved with a pre-determined generated list. This will be achieved using a computer random number generator (https://www.random.org/sequences/).

Allocation concealment

Allocation concealment will be achieved by using sequentially numbered, opaque and sealed envelopes. Both sequence generation and allocation concealment will be conducted by research team member. During this independent allocation process, the research team member will not be involved at any stage as part of the recruitment process, orthotic prescription of the control or trial intervention; data collection and will not have any prior or ongoing contact with enrolled participants.

Blinding

Participants and their carer's in both groups will be blinded to what intervention they receive. The external aesthetic appearance of both the control and trial FOs will be the same by using the 'Dual Opulex Performance' top cover. To reduce bias during the data analysis stage; once data collection is complete, the participant's and parents/carers identity and their intervention will be coded and de-identified. Outcome assessors will be blinded to all self-reported outcomes such as pain (VAS), quality of life (PedsQL) and foot disability (JAFI).

Data Analysis

All data collected during the study from baseline, 3, 6 and 12 months will be represented graphically using the histograms and/or box-plots. Normality will be checked using the Shapiro Wilks test. Where the variable presents ordinal data, the appropriate non-parametric test will be used. A series of between and within group analyses will be carried out. Analyses will be conducted with intention to treat.

Comparison between control and trial Group

To test the hypothesis, the control group will be compared with the trial group. Pair wise statistical analysis will be carried out using an unpaired t-test or Mann Whitney U test, depending on the distribution of the data.

Within each individual Group Analysis

To investigate the relationships between the groups at baseline, 3, 6 and 12 months, a repeated measures ANOVA will be carried out for parametric data where sphericity exist; or a Friedman test where non-parametric and/or no-sphericity exists.

Limitations

Few limitations should be noted as part of in this protocol. The swelling and tenderness outcome may be vulnerable to ascertainment bias, as the outcome assessor will not be blinded against interventions. Due to limited funding available as part of this PhD scholarship and logistical travelling restrictions no blinded assessor for this outcome will not be available. Moreover, joint disease in JIA may be subclinical and therefore may not be detected using physical examination alone. The use of a standardised lower limb physical examination tool may improve the validity of findings in the swollen and tender joint outcome. Lastly, the orthoses intervention will vary based on the individual biomechanical needs of each participants and therefore may differ. In order too enhance the reproducibility of the trial intervention, each FOs modifications will be standardised using a clinical decision pathway (figure 4).

Data Management

All electronic data will be kept on a University approved and prescribed laptop that will be password protected. The data will also be stored on a backup external hard drive that will be under lock and key in a metal cabinet on the University premises. The information from the research project will be stored for a period of 5 years after the completion of the research project, in accordance with the University of Newcastle's "stored data policy S000922".

Consent

Written and verbal consent will be obtained prior to the participant's involvement in the study. Parents/guardians of the child will sign consent forms on their behalf. This will be processed and obtained by the chief investigator (AF).

Ethics

Ethics has been approved by the Hunter New England Human Research Ethics Committee (16/09/21/4.03). Site authorisation has also been approved for all data collection sites by the relevant research governance committees.

Ethical considerations:

- Participants can withdraw from the trial at any stage without providing any reason.
- If participants in the trial group benefited from the FOs and their symptoms improved, they will be informed to keep them and given referral information to seek out further podiatric care if needed.
- If the trial intervention is found to be beneficial and data analysis confirms this; participants in the control group will be given the option of a free consultation and prescription of the trial FOs used in the study.

Privacy and confidentiality

To protect the confidentiality of participants involved, once the data collection process has been completed all identifying information will be removed and non-identifiable. All data presented on the final published paper will not contain any participant identifying information.

Contribution of Authors

AF, DSG, DS, JC and AC were actively involved in the conception and design of the study. AF and AC drafted the protocol, and DSG, DS and JC revised the draft and critically appraised for intellectual content. Finally, all authors read and approved the final manuscript prior to submitting for publication.

Competing Interest

All authors declare they have no competing interests

Funding Statement

Funding: University of Newcastle – (part of a PhD scholarship).

Registration

This clinical trial has been registered with the Australian New Zealand Clinical Trials Registry: ACTRN12616001082493p.

Abbreviations

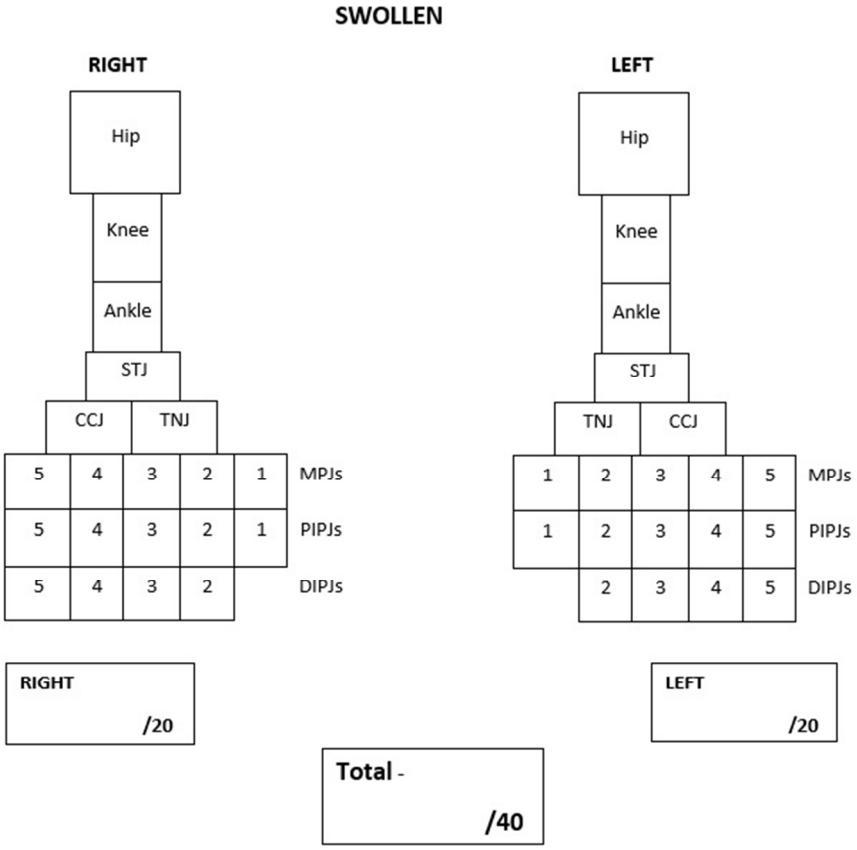
JIA: Juvenile idiopathic arthritis; FOs: foot orthoses; VAS: visual analogue scale; PedsQL: Pediatric Quality of Life Questionnaire; JAFI: Juvenile Arthritis Foot Disability Index; ILAR: International League of Associations for Rheumatology

References

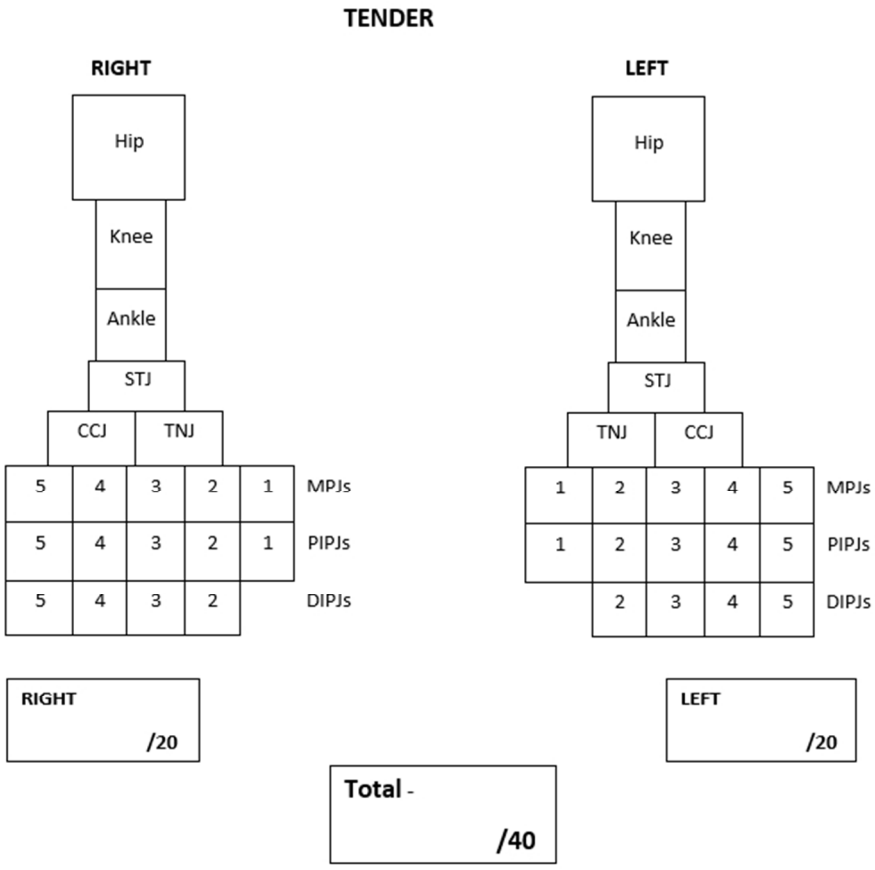
1. Ravelli A, Martini A. Juvenile idiopathic arthritis. The Lancet. 2007;369(9563):767-78.
2. Manners PJ, Diepeveen DA. Prevalence of juvenile chronic arthritis in a population of 12-year-old children in urban Australia. Pediatrics. 1996;98(1):84-90.
3. Szer IS, Kimura Y, Malleson PN, Southwood TR. Arthritis in children and adolescents: juvenile idiopathic arthritis: Oxford university press USA; 2006.
4. Prakken B, Albani S, Martini A. Juvenile idiopathic arthritis. The Lancet. 2011;377(9783):2138-49.
5. Takken T, van der Net J, Kuis W, Helders PJ. Physical activity and health related physical fitness in children with juvenile idiopathic arthritis. Annals of the rheumatic diseases. 2003;62(9):885-9.
6. Tarakci E, Yeldan I, Kaya Mutlu E, Baydogan SN, Kasapcopur O. The relationship between physical activity level, anxiety, depression, and functional ability in children and adolescents with juvenile idiopathic arthritis. Clinical Rheumatology. 2011;30(11):1415-20.
7. Lelieveld OTHM, Armbrust W, van Leeuwen MA, Duppen N, Geertzen JHB, Sauer PJJ, et al. Physical activity in adolescents with juvenile idiopathic arthritis. Arthritis & Rheumatism. 2008;59(10):1379-84.
8. Brostrom E, Haglund-Akerlind Y, Hagelberg S, Cresswell AG. Gait in children with juvenile chronic arthritis. Timing and force parameters. Scandinavian Journal of Rheumatology. 2002;31(6):317-23.
9. Foster H, Rapley T. Access to pediatric rheumatology care—a major challenge to improving outcome in juvenile idiopathic arthritis. The Journal of rheumatology. 2010;37(11):2199-202.
10. Foster HE, Eltringham MS, Kay LJ, Friswell M, Abinun M, Myers A. Delay in access to appropriate care for children presenting with musculoskeletal symptoms and ultimately diagnosed with juvenile idiopathic arthritis. Arthritis Care & Research. 2007;57(6):921-7.
11. Coda A, Jones J, Grech D, Grewal DS. A Survey of Parent and Carer experiences and expectations of paediatric rheumatology care in New South Wales. Australian Health Review. 2016.
12. Amine B, Rostom S, Benbouazza K, Abouqal R, Hajjaj-Hassouni N. Health related quality of life survey about children and adolescents with juvenile idiopathic arthritis. Rheumatology International. 2009;29(3):275-9.
13. Powell M, Seid M, Szer IS. Efficacy of custom foot orthotics in improving pain and functional status in children with juvenile idiopathic arthritis: a randomized trial. Journal of Rheumatology. 2005;32(5):943-50.
14. Coda A, Fowlie PW, Davidson JE, Walsh J, Carline T, Santos D. Foot orthoses in children with juvenile idiopathic arthritis: a randomised controlled trial. Archives of Disease in Childhood. 2014;99(7):649-51.
15. Fellas A, Coda A, Hawke F. Physical and mechanical therapies for lower limb problems in juvenile idiopathic arthritis: a systematic review with meta- analysis Journal of the American Podiatric Medical Association. 2017; http://dx.doi.org/10.7547/15-213 (In Press).
16. Hendry GJ, Watt GF, Brandon M, Friel L, Turner DE, Lorgelly PK, et al. The effectiveness of a multidisciplinary foot care program for children and adolescents with juvenile idiopathic arthritis: an exploratory trial. Journal of Rehabilitation Medicine. 2013;45(5):467-76.
17. Cameron-Fiddes V, Santos D. The use of 'off-the-shelf' foot orthoses in the reduction of foot symptoms in patients with early rheumatoid arthritis. The Foot. 2013;23(4):123-9.
18. Practitioners TRACoG. Clinical guideline for the diagnosis and management of juvenile idiopathic arthritis. 2009.
19. Dhanani S, Quenneville J, Perron M, Abdolell M, Feldman BM. Minimal difference in pain associated with change in quality of life in children with rheumatic disease. Arthritis Care & Research. 2002;47(5):501-5.

20. Varni JW, Seid M, Smith Knight T, Burwinkle T, Brown J, Szer IS. The PedsQL™ in pediatric rheumatology: reliability, validity, and responsiveness of the Pediatric Quality of Life Inventory™ Generic Core Scales and Rheumatology Module. Arthritis & Rheumatism. 2002;46(3):714-25.
21. Andre M, Hagelberg S, Stenstrom CH. The juvenile arthritis foot disability index: development and evaluation of measurement properties. Journal of Rheumatology. 2004;31(12):2488-93.
22. Helliwell P. The foot and ankle in rheumatoid arthritis: a comprehensive guide: Elsevier Health Sciences; 2007.
23. Noordzij M, Tripepi G, Dekker FW, Zoccali C, Tanck MW, Jager KJ. Sample size calculations: basic principles and common pitfalls. Nephrology dialysis transplantation. 2010:gfp732.
24. Cohen J. Statistical power analysis for the behavioural sciences. Hillside. NJ: Lawrence Earlbaum Associates. 1988.

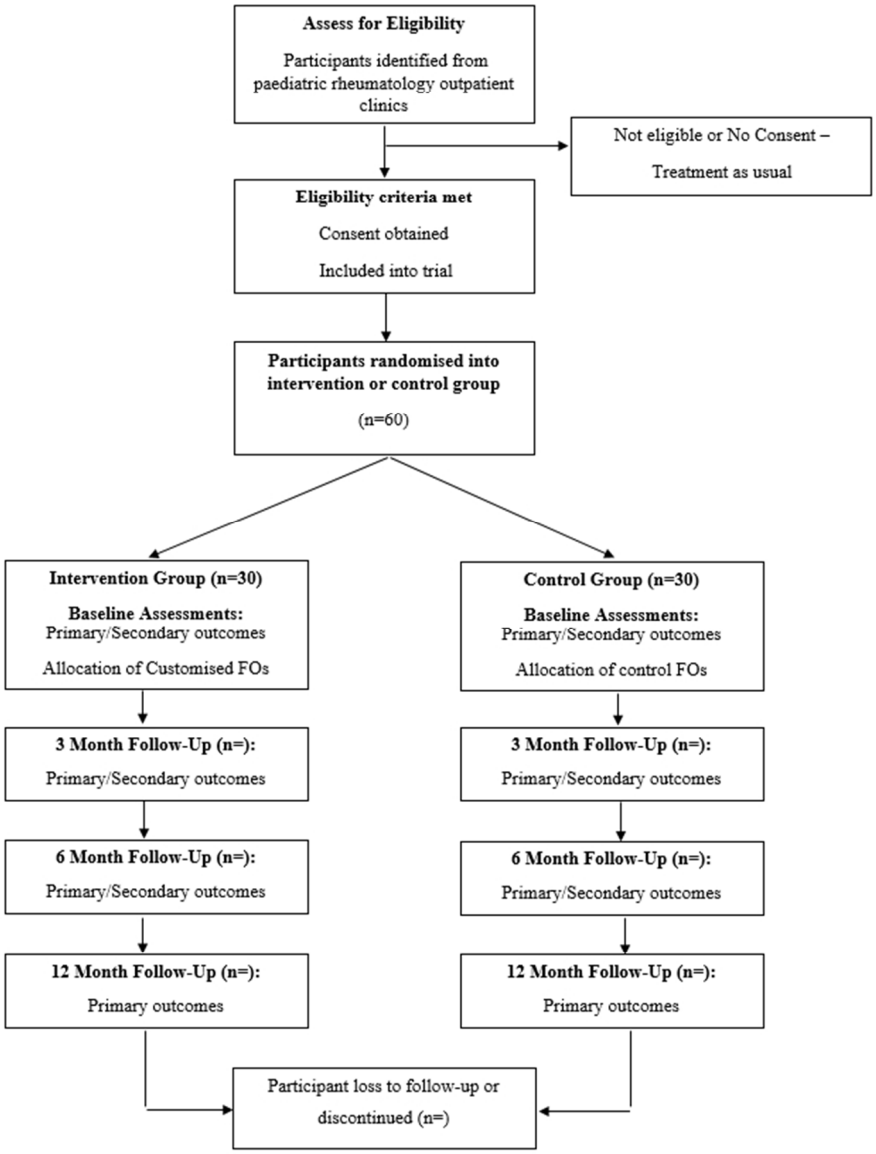
Figure List



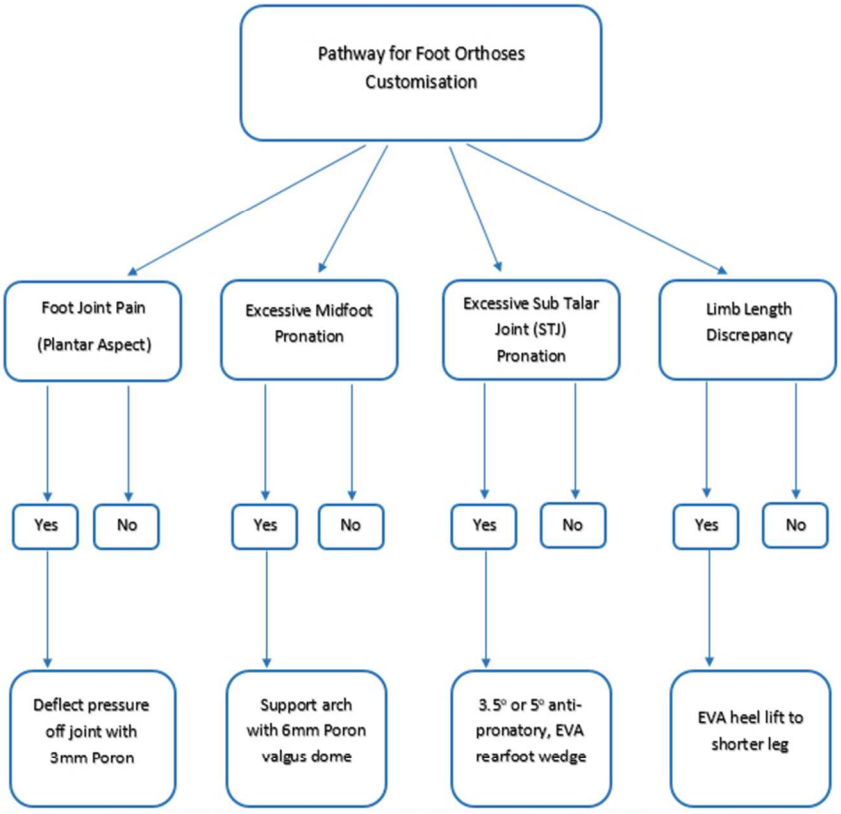
186x169mm (96 x 96 DPI)



182x168mm (96 x 96 DPI)



187x221mm (96 x 96 DPI)



Joint pain	Excessive midfoot pronation	Excessive Sub Talar Joint (STJ) pronation	Limb length discrepancy (LLD)
The physical examination carried out by the CI, will enable to determine the pathological joints on the plantar surface of foot. If symptomatic, the CI will deflect pressure by offloading the joint using 3mm Poron. The deflection will be glued on top of the FOs in correspondence of the painful joint.	In order to reduce excessive midfoot pronation, the CI will prescribe 6mm Poron valgus dome on the top surface of FOs. The valgus dome (semi-circular shape) will be bevelled to promote comfort. The valgus dome will be applied from the distal aspect of the sustentaculum tali extending to the proximal aspect of the 1st met phalangeal joint.	The CI will record the Resting Calcaneal Stance Position and the Neutral Calcaneal Stance Position from each patient. Based on the results obtained, the CI will provide either 3.5° or 5° degree anti-pronatory wedge, using high density EVA. The supplied wedge will aim to reduce excessive STJ pronation. The wedge will be applied underneath the surface of the FOs extended corresponding to the sustentaculum tali covering whole plantar surface of calcaneus.	If significant discrepancy exists (>5mm difference), the CI will apply a heel lift to the shorter limb, using high density EVA. The height of the heel raise supplied will be half of the overall amount recorded during the assessment. For example a 14mm LLD difference, the CI will apply a 7mm heel lift. The heel lift will be positioned underneath the FOs and it will be extended and bevelled till the proximal portion of the medial longitudinal arch.

178x227mm (96 x 96 DPI)

BMJ Paediatrics Open

Effectiveness of pre-formed foot orthoses in reducing lower limb pain, swollen and tender joints, and in improving quality of life and gait parameters in children with Juvenile Idiopathic Arthritis: a randomised control trial (Protocol)

Journal:	*BMJ Paediatrics Open*
Manuscript ID	bmjpo-2017-000121.R3
Article Type:	Protocol
Date Submitted by the Author:	31-Oct-2017
Complete List of Authors:	Fellas, Antoni; University of Newcastle, Faculty of Health and Medicine Singh-Grewal, Davinder; University of Sydney, Clinical A/Prof- Paediatric Rheumatologists & Paediatrician Consultant, Sydney Children Hospitals Network Chaitow, Jeffrey; Sydney Children's Hospitals Network Randwick and Westmead, Rheumatology Santos, Derek; Queen Margaret University, Edinburgh, Podiatry Coda, Andrea; Newcastle University - Australia , Podiatry
Keywords:	Rheumatology

Effectiveness of pre-formed foot orthoses in reducing lower limb pain, swollen and tender joints, and in improving quality of life and gait parameters in children with juvenile idiopathic arthritis: a randomised control trial (Protocol)

Antoni Fellas[A*]
*Corresponding Author
Email: Antoni.Fellas@uon.edu.au

Davinder Singh-Grewal[B, C, E, F]

Jeffrey Chaitow[B]

Derek Santos[D]

Andrea Coda[A]

[A] School of Health Sciences, Faculty of Health and Medicine, University of Newcastle, Australia

[B] The Sydney Children's Hospital Network Randwick, and Westmead

[C] University of Sydney Discipline of Paediatrics and Child Health, Sydney, Australia

[D] School of Health Sciences, Queen Margaret University, Edinburgh, UK, EH21 6UU.

[E] University of New South Wales, School of Women's and Children's Health

[F] University of Western Sydney, Discipline of Paediatrics

Abstract

Background: Many children and adolescents with juvenile idiopathic arthritis experience lower limb problems which may lead to physical disabilities significantly impacting on their quality of life and symptoms. Emerging evidence has identified the effective role of podiatry in the management of juvenile idiopathic arthritis, suggesting the clinical benefit of different orthotic therapies.

Methods: This study will be a parallel group designed, multi-centre, randomised control trial, aiming to recruit 60 children and adolescents with juvenile idiopathic arthritis aged between 5 and 18. Those recruited will need to be diagnosed according to the ILAR criteria, and present with lower limb joint pain, swelling and/or tenderness. Participants will be recruited from three outpatient hospital clinics in New South Wales, Australia. Participants will be randomly allocated to receive a trial or control intervention. The trial group will be prescribed a customised pre-formed foot orthoses; instead the control group will receive a flat 1mm insole with no corrective modifications. Primary outcome measure recorded will be pain. Secondary outcomes will be quality of life, foot disability, swollen and tender joint count, and gait parameters (such as plantar pressures, walking speed, stance and swing time). The allocated foot orthoses will be worn for 12 months, with data collected at baseline, 4 weeks, 3, 6 and 12 months' intervals. Group allocation will be concealed and all analyses will be carried out on an intention-to-treat.

Discussion: The purpose of this trial is to explore the efficacy of a cost-effective, non-invasive podiatric intervention that will be prescribed at the initial biomechanical consultation. This approach will promote early clinical intervention, which is the gold standard in paediatric rheumatology. Furthermore, this study has the potential to provide new evidence for the effectiveness of a mechanical intervention alone to reduce swollen and tender joints in juvenile idiopathic arthritis.

This clinical trial has been registered with the Australian New Zealand Clinical Trials Registry: ACTRN12616001082493p.
Ethics for this randomised control trial has been approved (16/09/21/4.03).

What is already known about this subject?

Custom or customised foot orthoses may reduce lower limb pain and improve quality of life in children with juvenile idiopathic arthritis. No research has explored the effectiveness of a mechanical intervention alone for reducing swollen and tender lower limb joints in juvenile idiopathic arthritis.

How might it impact on clinical practice in the foreseeable future?

This study may inform clinical practice on the benefit of prescribing a customised pre-formed foot orthoses as part of a multidisciplinary approach, in the management of lower limb problems in juvenile idiopathic arthritis.

Keywords: Juvenile idiopathic arthritis, children, foot orthoses, lower limb, foot, ankle, pain, swelling, tenderness, gait parameters, protocol, podopaediatric

Introduction

Juvenile Idiopathic Arthritis (JIA) is the most common chronic rheumatic disease that affects children and adolescent and may cause short-term and long-term disability (1). Prevalence estimated in developed countries range from 16 to 400 per 100,000 (1, 2). The lower limb appears to be more commonly involved in JIA, particularly the oligoarticular subtype (1, 3). The manifestation of JIA includes joint swelling, effusion, tenderness, and painful limitation with joint movement, discrepancies in limb development and fatigue (1, 4). Lower limb impairments may reduce physical activities compared to healthy children (5-7). As a result; this may account, for the lower aerobic capacity among children with JIA (8). Initially the main aim for the multidisciplinary team should be to relieve pain and discomfort, to reduce joint inflammation, promote function and prevent deformities. However; the provision of health care to children with JIA has been reported to be particularly challenging (9-12), with podiatric care currently very limited within paediatric rheumatology in Australian hospitals.

Few studies have evaluated the effectiveness of a custom or customised pre-formed foot orthoses (FOs) in children with JIA (13, 14). A meta-analysis of the effectiveness of a custom or customised FOs in children with JIA indicated that FOs may hold clinical importance in outcomes such as pain and quality of life; however, between-group differences in means were predominately insignificant with imprecise and broad confidence intervals (15). Moreover, a randomised control trial investigating the effectiveness of a multidisciplinary foot care programme found no statistical significant difference between groups (16). The programme included a multifaceted approach to foot care in JIA; including ultrasound guided intra-corticosteroid injections, paediatric rheumatology, podiatry and physiotherapy (16). The authors reported challenges in participant recruitment and retention; leading to an underpowered study which may have been vulnerable to type II error (16). Until more research is conducted, the effectiveness of FOs in children with JIA remains to be further explored (15). A recent study in patients with early rheumatoid arthritis suggests that by correcting biomechanical misalignments and reducing mechanical trauma of foot and ankle joints using a customised pre-formed FOs, it may result in a reduction of swelling and joint tenderness (17). The effectiveness of a customised pre-formed FOs alone for the reduction of lower limb swollen and tender joints in JIA, has never been investigated. This randomised control trial aims to provide new evidence on the effectiveness of a non-invasive, mechanical therapy for the reduction of swollen and tender joint counts in children with JIA. It will also further explore the effectiveness of customised pre-formed FOs in reducing lower limb pain, improving quality of life and gait parameters in children and adolescents affected by this rheumatic disease.

Objectives

The objective of this study is to investigate the effectiveness of a customised pre-formed FOs in reducing lower limb pain, swollen and tender joints, and in improving quality of life and gait in children with JIA.

Hypotheses:

Primary Outcomes

1. Pre-formed FOs will reduce lower limb pain using visual analogue scale (VAS) in children with JIA

Secondary Outcomes

1. Pre-formed FOs will improve quality of life in children with JIA using the Pediatric Quality of Life Questionnaire™ (PedsQL) Rheumatology Module – version 3.0 for children and parents.
2. Pre-formed FOs will improve foot disability in children with JIA using the Juvenile Arthritis Foot Disability Index (JAFI).
3. Pre-formed FOs will reduce localised swelling and tenderness of lower limb joints in children with JIA by visual inspection and palpation.
4. Pre-formed FOs will have an effect on quantitative kinematic and kinetic parameters of gait in children with JIA when barefoot, with shoes alone, and with shoes and FOs.

Trial Design

To test the hypothesis, this study will be a parallel group designed, multi-centre, randomised control trial. The allocation ratio of participants to their groups will be 1:1.

Methodology

Study Setting

This randomised control trial will be conducted across three outpatient paediatric rheumatology clinics in New South Wales, Australia: John Hunter Children's Hospital (Newcastle); Sydney Children's Hospital Network (Randwick and Westmead).

Eligibility Criteria

The inclusion and exclusion criteria are as follows:

Inclusion Criteria:

- Diagnosed with JIA according to ILAR (International League of Associations for Rheumatology) criteria.
- Age 5 to 18 years old.
- Active involvement of the lower limb (including foot/ankle and/or hip and knee involvement)
- No previous use of FOs, or previous failure of foot orthotic management, where the patient has not worn any FOs for a period of at least 3 months.
- If disease modifying anti-rheumatic drugs and/or biological therapy are used, not having started these drug therapies within 6 months of enrolling in the trial.

Exclusion Criteria:

- Inability to walk barefoot or shod for 15 meters without assistive devices.
- Concomitant musculoskeletal disease, central or peripheral nerve disease and endocrine disorders, including Diabetes Mellitus.
- History of lower limb surgery that required general anesthetic.
- Currently using FOs.
- Where prescription of FOs is contraindicated: for example, significant osseous abnormalities noted in the lower limbs and/or vertebrae during the physical evaluation. Unwillingness to wear appropriate footwear for fitting orthoses.

Control Group

Participants in the control group will receive a flat insole without any corrective modifications. The control insole will be made with 1mm thick leather board, top covered by a 'Dual Opulex Performance' 1.5mm thick material made from a neoprene base and a stretch nylon top. The top cover is representative of standard insole appearance regularly supplied by podiatrists.

Trial Group

The trial group will receive a customised, pre-formed FOs with the same 'Dual Opulex Performance' top cover. The prescription of the FOs (SlimFlex Simple, Algeos PTY LTD) will be customised at chair side according to each individual biomechanical need, and supplied on the same day of the initial assessment. Supplying the FOs on the same day of the initial assessment promotes early clinical intervention which is the gold standard approach in JIA (1, 18). Chief investigator (AF) will issue the trial and control orthoses to participants.

Footwear

Participants in both the control and trial group will receive footwear education and recommendations. Footwear advice will focus on suitable cushioning properties and supportive features of a shoe, appropriate sizes, and details related to orthoses fitting. Information will be conveyed in a manner that is easy to understand for both participants and their parents.

Usual Care

Throughout the duration of the trial, participants in both the control and trial groups will continue their usual outpatient care at the John Hunter Children's Hospital and Sydney Children's Hospital Network. Outpatient care may include but not limited to: a paediatric rheumatologist, specialist nurse, physiotherapist, occupational therapist, psychologist etc.

Compliance/Adherence

Adherence to the control and trial intervention will be monitored with visual inspection of FOs at follow-up consultations. Participants will be asked to fill a self-reported diary that will have to be completed for the duration of the trial in order to record the overall number of days per week they have worn their FOs. Participants will be required to bring their diary to their next follow-up consultation and will be given a new one to complete and return. Chief investigator (AF) will provide verbal and written instructions to both participants and parent on how to correctly wear the FOs, as well as clinical support if any problems arise. In case patient's foot size will increase during the data collection period and become unsuitable, the exact same prescription will be replicated in a new longer device and supplied to the participant.

Pharmaceutical changes will be recorded over the 12-month period. If changes occur to participant's medications, it will be noted and patients will be classified as "Medication-Changed". This approach is fundamental to account for any positive effect to be solely attributed to the FOs intervention and not to the medication changes.

Outcomes

Primary outcomes

1. Pain

Participants in both groups will be asked to rate their lower limb pain on a 100mm VAS. Pain will be self-reported by participants and their parents/carer. A clinical important difference is considered when there is an 8mm difference between time intervals (19). When measuring pain with the 100mm VAS, a lower score indicates less pain and therefore is a better outcome. Pain scores will be collected

at baseline, 4 weeks, 3, 6 and 12 month follow-up consultations, with 12 month representing the end-point for primary outcome assessment.

Secondary outcomes

1. Quality of life

Quality of life will be measured using the PedsQL. The PedsQL (module 3) is a self-reported questionnaire which will be independently supplied to both the participants and parents/carer (20). The PedsQL 3.0 Rheumatology Module is specific for children with JIA by measuring different outcome subheadings such as: 'pain and hurt', 'daily activities', 'treatment', 'worry', and 'communication' (20). A clinical important difference is considered when there is a 5 point difference between time intervals (20). The PedsQL questionnaire is scored out of 100 points, and a higher score is indicative of a better quality of life. The PedsQL is available in different age ranges: 5-7; 8-12; and 13-18. Quality of life is self-assessed and will be measured at baseline and 3, 6 and 12 months' time point.

2. Foot disability

Foot disability will be measured using the JAFI which comprises of 3 components (27 responses in total): foot and ankle impairment, activity limitation and participation restriction (21). The JAFI has shown to be a reliable and valid measure of foot-related disability in children with JIA (21). Foot disability using the JAFI will be measured at baseline and 3, 6 and 12 months' time.

3. Swollen and tender joint

Helliwell et al (2007) developed a tool to record swollen and tender foot and ankle joints specifically for adult rheumatoid arthritis (22). This tool was used in an earlier podiatric based study in rheumatoid arthritis (17); and with some further modifications (adding hip, knee, distal and proximal interphalangeal joints), will be used to assess lower limb joint swelling and tenderness count for this randomised control trial. Joint count for swelling and tenderness will be recorded at baseline, 3 and 6 month follow-up assessments. The assessment tools for swelling and tenderness are depicted in Figures 1 and 2 respectively.

4. Gait parameters

Gait analysis will be completed at baseline, 3 and 6 months. In-shoe and plantar pressure analysis will be carried out by using the latest Wireless F-Scan and HR Mat (Tekscan™, Boston, USA) respectively. Both systems are equipped with the same sensors resolution allowing for calibration and data analysis comparison. Barefoot, shod, and shoes with the FOs recordings sequence will be

randomised to account for fatigue potentially exhibited by symptomatic JIA children during acquisition of gait data. Outcome measures for gait parameters include:

a) Peak pressure and pressure time integral data will be extrapolated from the following anatomical areas: total contact; heel; midfoot; rearfoot; 1st metatarsal head; 2nd metatarsal head; 3rd/4th metatarsal head; 5th metatarsal head; lesser digits; distal phalanx of hallux.
b) walking speed (m/sec)
c) Stance time (sec)
d) Swing time (sec)
e) Double limb support (sec)
f) Stride length (cm)

Biomechanical Assessment:

Standardised assessments such as the Foot Posture Index will be conducted to clinically assess the lower limb, and inform the prescription and modifications of foot orthoses. Muscle bulk and limb length discrepancies will be observed and recorded as part of the pGALS Legs assessment. The following additional biomechanical and anatomical test will be carried out: range of motion of lower limb joints; gait analysis; presence of enthesitis (Achilles and plantar fascia); and presence of tendonitis (e.g. tibialis posterior, peroneal and Achilles tendons).

Timeline of Participants

Participants will only be required to attend 3 data collection sessions; baseline, 3 and 6 months (12 month outcomes are self-assessed); and it is expected that each meeting will last no more than 1 hour. Participants, in both groups, will be supplied their allocated FOs at the same day of baseline assessment and will be required to wear their FOs for 12 months. Figure 3 depicts a schematic diagram of the participant timeline.

Sample Size

Currently, there are insufficient data to conduct power calculations for each outcome. However, sufficient data are available with regards to pain outcome. Power calculations are therefore based on the outcome of pain measured on a 100mm VAS, with a minimal clinical significance of 8mm (19). For a 2-sided t-test with α=0.05 and power 80% for a randomised control trial design with baseline and primary outcome of difference between the groups at 12 months, and a moderate effect size of 0.6, it was estimated that a total of 90 participants would be required (45 controls and 45 trial) on a ratio of 1:1 allocation (23, 24). This was adjusted with an ANCOVA using an assumed correlation of 0.6 giving an adjusted total number of participants required of 60 (30 controls and 30 trial). The study

will be overpowered to an estimated 66 (that is, 33 participants per group) to allow for 10% dropouts during the 12 months' data collection period.

Recruitment

Participants will be recruited from the outpatient paediatric rheumatology clinics listed in the study setting section. Parents and patient will be asked if they would like to be part of the study when attending their scheduled consultation with the paediatric rheumatologist. If the patients are eligible and their parents/carers are interested in being involved they will then be referred to the chief investigator (AF).

Allocation

Sequence generation

Immediately after consent is obtained; participants will be randomly allocated in blocks of 10, to either a control or trial group. Their allocation to each group will be achieved with a pre-determined generated list. This will be achieved using a computer random number generator (https://www.random.org/sequences/).

Allocation concealment

Allocation concealment will be achieved by using sequentially numbered, opaque and sealed envelopes. Both sequence generation and allocation concealment will be conducted by research team member. During this independent allocation process, the research team member will not be involved at any stage as part of the recruitment process, orthotic prescription of the control or trial intervention; data collection and will not have any prior or ongoing contact with enrolled participants.

Blinding

Participants and their carer's in both groups will be blinded to what intervention they receive. The external aesthetic appearance of both the control and trial FOs will be the same by using the 'Dual Opulex Performance' top cover. To reduce bias during the data analysis stage; once data collection is complete, the participant's and parents/carers identity and their intervention will be coded and de-identified. Outcome assessors will be blinded to all self-reported outcomes such as pain (VAS), quality of life (PedsQL) and foot disability (JAFI).

Data Analysis

All data collected during the study from baseline, 3, 6 and 12 months will be represented graphically using the histograms and/or box-plots. Normality will be checked using the Shapiro Wilks test. Where the variable presents ordinal data, the appropriate non-parametric test will be used. A series of

between and within group analyses will be carried out. Analyses will be conducted with intention to treat.

Comparison between control and trial Group

To test the hypothesis, the control group will be compared with the trial group. Pair wise statistical analysis will be carried out using an unpaired t-test or Mann Whitney U test, depending on the distribution of the data.

Within each individual Group Analysis

To investigate the relationships between the groups at baseline, 3, 6 and 12 months, a repeated measures ANOVA will be carried out for parametric data where sphericity exist; or a Friedman test where non-parametric and/or no-sphericity exists.

Limitations

Few limitations should be noted as part of in this protocol. The swelling and tenderness outcome may be vulnerable to ascertainment bias, as the outcome assessor will not be blinded against interventions. Due to limited funding available as part of this PhD scholarship and logistical travelling restrictions no blinded assessor for this outcome will not be available. Moreover, joint disease in JIA may be subclinical and therefore may not be detected using physical examination alone. The use of a standardised lower limb physical examination tool may improve the validity of findings in the swollen and tender joint outcome. Lastly, the orthoses intervention will vary based on the individual biomechanical needs of each participants and therefore may differ. In order too enhance the reproducibility of the trial intervention, each FOs modifications will be standardised using a clinical decision pathway (figure 4).

Data Management

All electronic data will be kept on a University approved and prescribed laptop that will be password protected. The data will also be stored on a backup external hard drive that will be under lock and key in a metal cabinet on the University premises. The information from the research project will be stored for a period of 5 years after the completion of the research project, in accordance with the University of Newcastle's "stored data policy S000922".

Consent

Written and verbal consent will be obtained prior to the participant's involvement in the study. Parents/guardians of the child will sign consent forms on their behalf. This will be processed and obtained by the chief investigator (AF).

Ethics

Ethics has been approved by the Hunter New England Human Research Ethics Committee (16/09/21/4.03). Site authorisation has also been approved for all data collection sites by the relevant research governance committees.

Ethical considerations:

- Participants can withdraw from the trial at any stage without providing any reason.
- If participants in the trial group benefited from the FOs and their symptoms improved, they will be informed to keep them and given referral information to seek out further podiatric care if needed.
- If the trial intervention is found to be beneficial and data analysis confirms this; participants in the control group will be given the option of a free consultation and prescription of the trial FOs used in the study.

Privacy and confidentiality

To protect the confidentiality of participants involved, once the data collection process has been completed all identifying information will be removed and non-identifiable. All data presented on the final published paper will not contain any participant identifying information.

Contribution of Authors

AF, DSG, DS, JC and AC were actively involved in the conception and design of the study. AF and AC drafted the protocol, and DSG, DS and JC revised the draft and critically appraised for intellectual content. Finally, all authors read and approved the final manuscript prior to submitting for publication.

Competing Interest

All authors declare they have no competing interests

Funding Statement

Funding: University of Newcastle – (part of a PhD scholarship).

Registration

This clinical trial has been registered with the Australian New Zealand Clinical Trials Registry: ACTRN12616001082493p.

Abbreviations

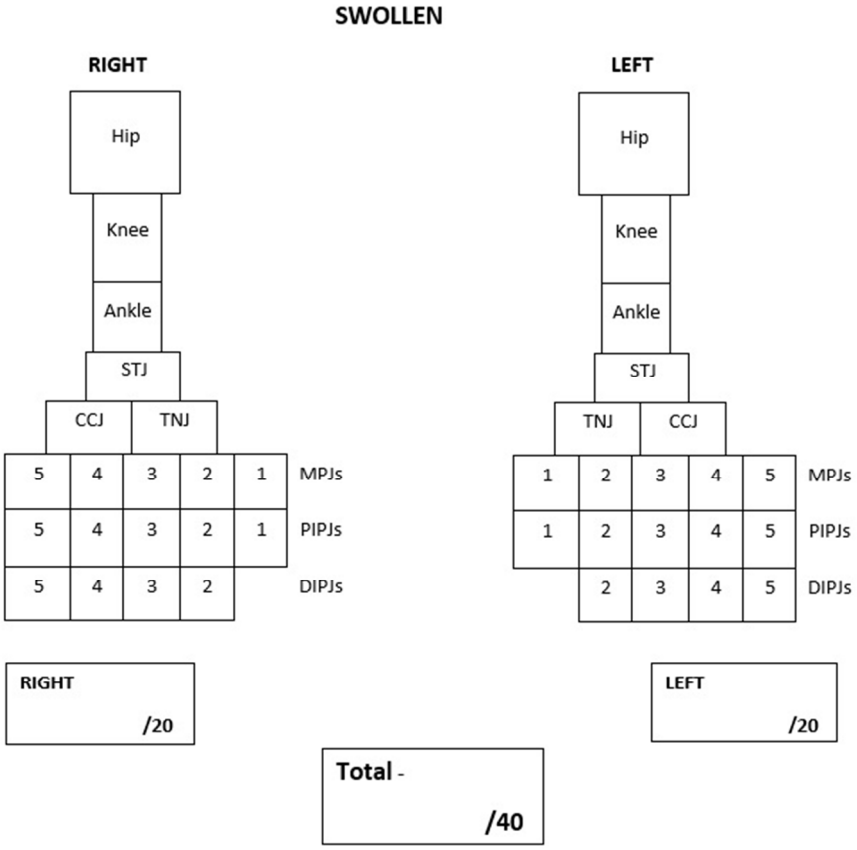
JIA: Juvenile idiopathic arthritis; FOs: foot orthoses; VAS: visual analogue scale; PedsQL: Pediatric Quality of Life Questionnaire; JAFI: Juvenile Arthritis Foot Disability Index; ILAR: International League of Associations for Rheumatology

References

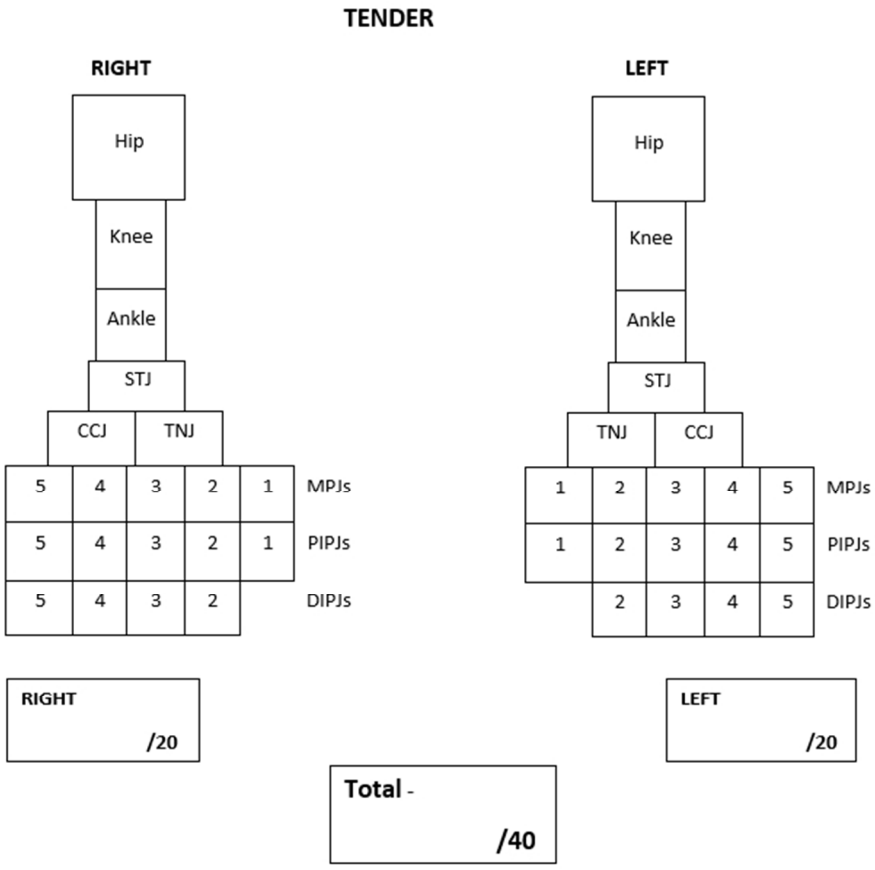
1. Ravelli A, Martini A. Juvenile idiopathic arthritis. The Lancet. 2007;369(9563):767-78.
2. Manners PJ, Diepeveen DA. Prevalence of juvenile chronic arthritis in a population of 12-year-old children in urban Australia. Pediatrics. 1996;98(1):84-90.
3. Szer IS, Kimura Y, Malleson PN, Southwood TR. Arthritis in children and adolescents: juvenile idiopathic arthritis: Oxford university press USA; 2006.
4. Prakken B, Albani S, Martini A. Juvenile idiopathic arthritis. The Lancet. 2011;377(9783):2138-49.
5. Takken T, van der Net J, Kuis W, Helders PJ. Physical activity and health related physical fitness in children with juvenile idiopathic arthritis. Annals of the rheumatic diseases. 2003;62(9):885-9.
6. Tarakci E, Yeldan I, Kaya Mutlu E, Baydogan SN, Kasapcopur O. The relationship between physical activity level, anxiety, depression, and functional ability in children and adolescents with juvenile idiopathic arthritis. Clinical Rheumatology. 2011;30(11):1415-20.
7. Lelieveld OTHM, Armbrust W, van Leeuwen MA, Duppen N, Geertzen JHB, Sauer PJJ, et al. Physical activity in adolescents with juvenile idiopathic arthritis. Arthritis & Rheumatism. 2008;59(10):1379-84.
8. Brostrom E, Haglund-Akerlind Y, Hagelberg S, Cresswell AG. Gait in children with juvenile chronic arthritis. Timing and force parameters. Scandinavian Journal of Rheumatology. 2002;31(6):317-23.
9. Foster H, Rapley T. Access to pediatric rheumatology care—a major challenge to improving outcome in juvenile idiopathic arthritis. The Journal of rheumatology. 2010;37(11):2199-202.
10. Foster HE, Eltringham MS, Kay LJ, Friswell M, Abinun M, Myers A. Delay in access to appropriate care for children presenting with musculoskeletal symptoms and ultimately diagnosed with juvenile idiopathic arthritis. Arthritis Care & Research. 2007;57(6):921-7.
11. Coda A, Jones J, Grech D, Grewal DS. A Survey of Parent and Carer experiences and expectations of paediatric rheumatology care in New South Wales. Australian Health Review. 2016.
12. Amine B, Rostom S, Benbouazza K, Abouqal R, Hajjaj-Hassouni N. Health related quality of life survey about children and adolescents with juvenile idiopathic arthritis. Rheumatology International. 2009;29(3):275-9.
13. Powell M, Seid M, Szer IS. Efficacy of custom foot orthotics in improving pain and functional status in children with juvenile idiopathic arthritis: a randomized trial. Journal of Rheumatology. 2005;32(5):943-50.
14. Coda A, Fowlie PW, Davidson JE, Walsh J, Carline T, Santos D. Foot orthoses in children with juvenile idiopathic arthritis: a randomised controlled trial. Archives of Disease in Childhood. 2014;99(7):649-51.
15. Fellas A, Coda A, Hawke F. Physical and mechanical therapies for lower limb problems in juvenile idiopathic arthritis: a systematic review with meta- analysis Journal of the American Podiatric Medical Association. 2017; http://dx.doi.org/10.7547/15-213 (In Press).
16. Hendry GJ, Watt GF, Brandon M, Friel L, Turner DE, Lorgelly PK, et al. The effectiveness of a multidisciplinary foot care program for children and adolescents with juvenile idiopathic arthritis: an exploratory trial. Journal of Rehabilitation Medicine. 2013;45(5):467-76.
17. Cameron-Fiddes V, Santos D. The use of 'off-the-shelf' foot orthoses in the reduction of foot symptoms in patients with early rheumatoid arthritis. The Foot. 2013;23(4):123-9.
18. Practitioners TRACoG. Clinical guideline for the diagnosis and management of juvenile idiopathic arthritis. 2009.
19. Dhanani S, Quenneville J, Perron M, Abdolell M, Feldman BM. Minimal difference in pain associated with change in quality of life in children with rheumatic disease. Arthritis Care & Research. 2002;47(5):501-5.
20. Varni JW, Seid M, Smith Knight T, Burwinkle T, Brown J, Szer IS. The PedsQL™ in pediatric rheumatology: reliability, validity, and responsiveness of the Pediatric Quality of Life Inventory™ Generic Core Scales and Rheumatology Module. Arthritis & Rheumatism. 2002;46(3):714-25.

21. Andre M, Hagelberg S, Stenstrom CH. The juvenile arthritis foot disability index: development and evaluation of measurement properties. Journal of Rheumatology. 2004;31(12):2488-93.
22. Helliwell P. The foot and ankle in rheumatoid arthritis: a comprehensive guide: Elsevier Health Sciences; 2007.
23. Noordzij M, Tripepi G, Dekker FW, Zoccali C, Tanck MW, Jager KJ. Sample size calculations: basic principles and common pitfalls. Nephrology dialysis transplantation. 2010:gfp732.
24. Cohen J. Statistical power analysis for the behavioural sciences. Hillside. NJ: Lawrence Earlbaum Associates. 1988.

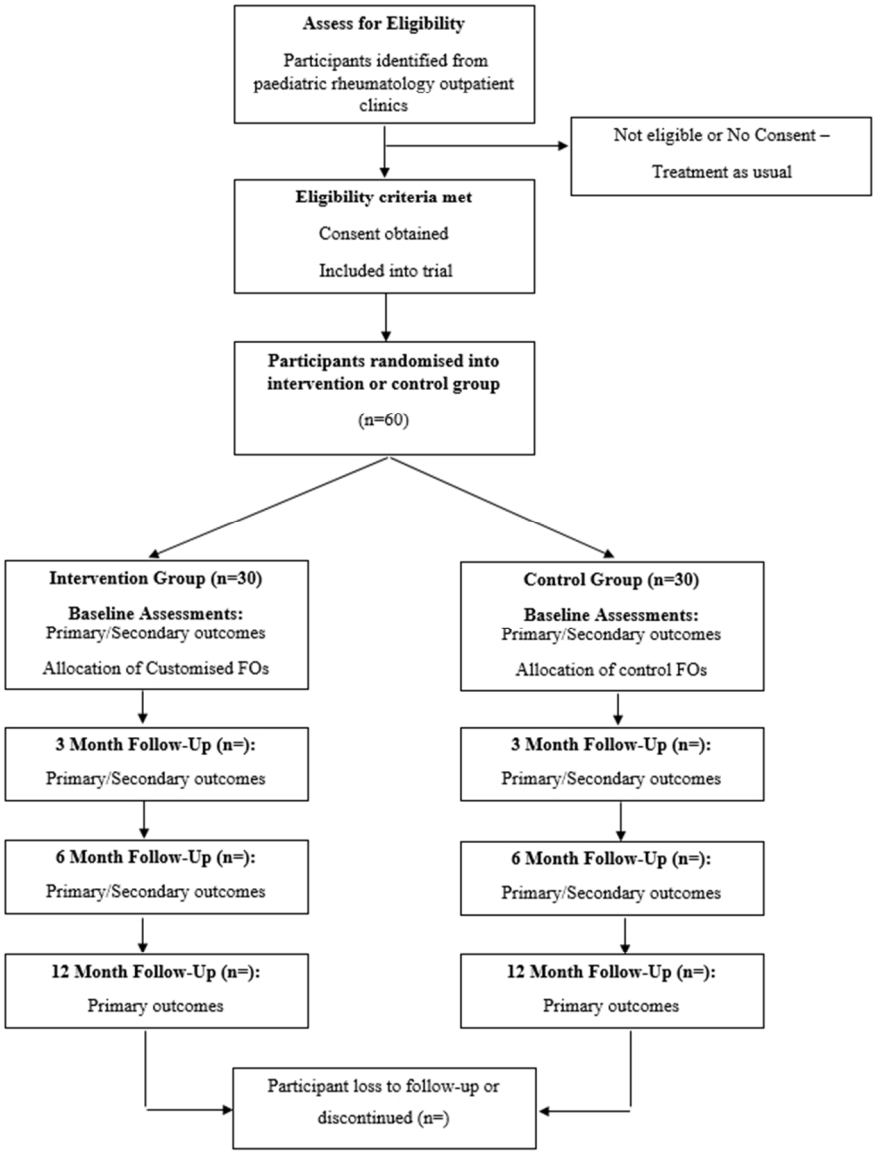
Figure List



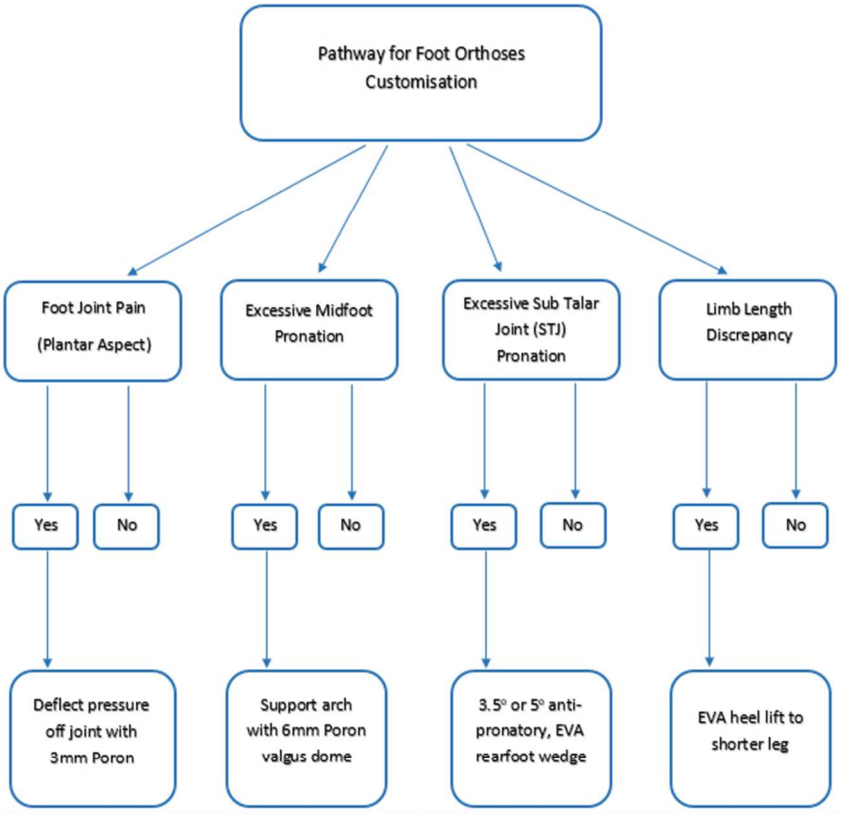
186x169mm (96 x 96 DPI)



182x168mm (96 x 96 DPI)



187x221mm (96 x 96 DPI)



Joint pain	Excessive midfoot pronation	Excessive Sub Talar Joint (STJ) pronation	Limb length discrepancy (LLD)
The physical examination carried out by the CI, will enable to determine the pathological joints on the plantar surface of foot. If symptomatic, the CI will deflect pressure by offloading the joint using 3mm Poron. The deflection will be glued on top of the FOs in correspondence of the painful joint.	In order to reduce excessive midfoot pronation, the CI will prescribe 6mm Poron valgus dome on the top surface of FOs. The valgus dome (semi-circular shape) will be bevelled to promote comfort. The valgus dome will be applied from the distal aspect of the sustentaculum tali extending to the proximal aspect of the 1st met phalangeal joint.	The CI will record the Resting Calcaneal Stance Position and the Neutral Calcaneal Stance Position from each patient. Based on the results obtained, the CI will provide either 3.5° or 5° degree anti-pronatory wedge, using high density EVA. The supplied wedge will aim to reduce excessive STJ pronation. The wedge will be applied underneath the surface of the FOs extended corresponding to the sustentaculum tali covering whole plantar surface of calcaneus.	If significant discrepancy exists (>5mm difference), the CI will apply a heel lift to the shorter limb, using high density EVA. The height of the heel raise supplied will be half of the overall amount recorded during the assessment. For example a 14mm LLD difference, the CI will apply a 7mm heel lift. The heel lift will be positioned underneath the FOs and it will be extended and bevelled till the proximal portion of the medial longitudinal arch.

178x227mm (96 x 96 DPI)