

Comparing digitally-planned personalised surgery with conventional surgery for realignment of the knee joint in knee osteoarthritis patients

Submission date 21/09/2020	Recruitment status No longer recruiting	☒ Prospectively registered ☒ Protocol
Registration date 18/03/2021	Overall study status Completed	☒ Statistical analysis plan ☐ Results
Last Edited 07/04/2026	Condition category Musculoskeletal Diseases	☐ Individual participant data ☒ Record updated in last year

Plain English summary of protocol

Background and study aims

This trial is for patients having a type of knee surgery called a high tibial osteotomy. The current standard surgery involves putting a standard “one size fits all” plate into the knee. This study plans to investigate if a plate personalised to the knee, is better than the standard plate.

Arthritis of the knee is a common condition. In the UK, 14% of the population over 40 suffer from knee arthritis (4.5 million people). It is a cause of significant disability and pain as well as being a financial burden and treatment options for relatively young sufferers are limited.

High Tibial Osteotomy (HTO) is a surgical procedure to straighten the leg and reduce knee pain. Patients suitable for HTO usually have been diagnosed with arthritis affecting one side of the knee joint. During HTO surgery, the knee joint is straightened to off-load the worn areas of the knee.

A new, patient-specific procedure has been developed called Tailored Osteotomy Knee Alignment (TOKA). This involves the patient having a CT scan of the leg before the operation, which is then used to make a plate specifically to fit each patient. The pain and discomfort around the knee may be reduced as the plate is personalised to the patient.

Who can participate?

Patients at participating hospitals who have been offered the HTO operation to try and improve their knee symptoms will be assessed to see whether they are suitable to participate in the trial.

What does the study involve?

Participants are randomly allocated to one of two groups and will not know which procedure they have received. One group will receive the standard HTO procedure (Tomofix or

ActivMotion) which is the plate the patient would have received had they not agreed to participate in this trial. The other group will receive the Personalised HTO procedure (TOKA) which is a personalised 3D printed plate, tailored to the patient's knee.

As part of routine care, participants will receive the usual NHS treatment and aftercare at their hospital.

At the start of the study, participants will be asked to fill in a questionnaire which includes some questions about them, their knee, and their general health and should take about 15-20 min. Participants will be asked to repeat these questionnaires at approximately 6 months and 12 months after their operation.

At the start of the study, before surgery, and 6 months after the surgery participants will also be asked to attend the hospital for assessment using Video Vector Analysis (VVA). This typically lasts 20 mins and involves videos being taken of the participant walking. VVA will be used to measure if the desired change in the knee joint has been achieved.

At the start of the study, before surgery, and 6 months after the surgery participants will also be asked to have hospital scans, both X-Ray and CT scan. X-Ray imaging will help to accurately measure if the desired change in the knee joint has been achieved. Both of the X-rays are part of routine care, which means participants would have them even if they do not agree to take part in this study. The CT scan of the leg, is used to make the personalised TOKA plate. The imaging information will also be used to further improve the design of surgical plates used in HTO in the future. This would not be part of usual care. For participants who are not randomly allocated to receive the TOKA plate, the CT scan will not be sent to the device manufacturer to make the plate, but the imaging information will still be used to further improve the design of surgical plates used in HTO in the future.

What are the possible benefits and risks of participating?

We cannot guarantee any benefit to patients who take part in this study. The results of the study are likely to benefit future patients with knee arthritis.

The HTO operation is already well established throughout the world as a treatment for arthritis of the knee. The risks of HTO surgery will be explained to participants by their surgeon at the time of listing you for the operation. No problems are anticipated as a result of being involved in this study.

This study uses a new design of personalised plate that has been approved for use by the appropriate regulators, including the Medicines and Healthcare Products Regulatory Agency (MHRA).

X-rays and CT scans are a form of ionising radiation, which can cause cell damage that may, after many years or decades, turn cancerous. We are all at risk of developing cancer during our lifetime. The normal risk is that this will happen to about 50% of people at some point in their life. Taking part in this study will add only a very small chance of this.

Any safety events will be reviewed periodically by an independent Data Monitoring Committee who will advise if there are any concerns during the study.

Where is the study run from?

Sponsored by The University of Bath (UK) and managed by the Surgical Intervention Trials Unit, part of the Oxford Clinical Trials and Research Unit at the University of Oxford (UK)

When is the study starting and how long is it expected to run for?

From January 2020 to July 2025

Who is funding the study?

Versus Arthritis (UK)

Who is the main contact?

Dr David Smith, pashion@ndorms.ox.ac.uk

Contact information

Type(s)

Public

Contact name

None SITU-NDORMS Team

Contact details

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OX3 7LD

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pashion@ndorms.ox.ac.uk

Additional identifiers

ClinicalTrials.gov (NCT)

NCT04666571

Integrated Research Application System (IRAS)

280261

Central Portfolio Management System (CPMS)

46724

Study information

Scientific Title

PASHiOn: Personalised Against Standard High tibial Osteotomy, a prospective multi-centre randomised controlled trial

Acronym

PASHiOn

Study objectives

In patients with medial compartment knee osteoarthritis, a digitally planned personalised high tibial osteotomy (HTO) procedure using a custom 3D printed surgical guide and plate (ToKa HTO) compared to a conventional generic HTO procedure increases the number of patients with accurate bony correction (as measured by the reduction in error [in degrees] between planned and achieved alignment correction).

Ethics approval required

Old ethics approval format

Ethics approval(s)

Approved 16/11/2020, London - Stanmore Research Ethics Committee (Health Research Authority, Skipton House, 80 London Road, London, SE1 6LH; +44 (0)20 7104 80641; stanmore.rec@hra.nhs.uk), ref: 20/LO/1082

Primary study design

Interventional

Study design

Multi-centre blinded superiority two-arm parallel-group design randomized controlled trial with an embedded non-randomized pre-trial technology check and safety assessment

Study type(s)

Treatment

Health condition(s) or problem(s) studied

High tibial Osteotomy for osteoarthritis of the knee

Interventions

Current interventions as of 29/03/2023:

Embedded within the trial is a non-randomised pre-trial technology check and safety assessment, this is termed the Initial Safety Phase (Phase 1). During this stage of the clinical investigation, 5 patients fulfilling the inclusion criteria will be recruited and assessed in an identical way to the patients recruited in the main trial, but without randomisation. The 5 participants will receive the interventional device – Tailored Osteotomy Knee Alignment (TOKA). In Phase 2, the main randomised control trial, patients will be randomised in a 1:1 ratio to receive either personalised (TOKA) or conventional HTO (Tomofix or ActivMotion) surgery. Recruitment of the remaining patients to Phase 2 will take place after the six-week assessment on the fifth patient in Phase 1 is complete, and the oversight committee supports progression to Phase 2. Patients and primary outcome assessors will be blinded to the allocation.

All patients will receive a high tibial osteotomy (HTO) as a single surgical intervention. A high tibial osteotomy is a surgical procedure to realign the leg. A cut is made in the tibia and the alignment of the tibia is carefully adjusted by levering open this cut in the bone until the desired alignment is reached. The bone is then fixed with a plate that is held in place with screws. This is called an 'opening wedge osteotomy'. The osteotomy gap in the bone will fill in with new bone over the next few months post-surgery. During surgery, patients will either receive the standard HTO procedure (the Tomofix or ActivMotion plate) or the personalised 3D printed HTO procedure (TOKA). As part of routine care, patients will receive the usual NHS treatment and aftercare.

The Baseline assessment will be undertaken once the patients' eligibility and willingness to participate has been confirmed and the patient has provided Informed Consent. No study specific activities will take place prior to receiving Informed Consent.

Baseline assessment includes:

- X-ray (routine imaging to confirm initial diagnosis can be used). In some cases, as per routine practice, this may require a second X-ray to review clinical status of the knee joint if the period from initial X-Ray is more than 6 months.
- CT scan (approximately 3 months prior to surgery). Dependent on unexpected delays to surgery, a repeat CT scan may need to be undertaken. The need for a repeat scan will be a clinical decision, but with a maximum window of 6 months between the scan and surgery.
- Video Vector Analysis
- Range of Motion (standard clinical measurement)
- Pregnancy test (standard of care)

The baseline assessment includes a questionnaire to be completed by the patient which will take approximately 20 minutes. These include:

- KOOS
- EQ-5D-5L
- Pain VAS
- UCLA Activity Score

The baseline questionnaire will be completed at recruitment, in the months prior to surgery.

Randomisation to Phase 2 will be undertaken using a centralised web-based randomisation service (RRAMP) run through the Oxford Clinical Trials Research Unit (OCTRU). Randomisation will take place once the CT imaging is available, approximately 3 months prior to the HTO operation when the planned date of surgery is confirmed. This will allow sufficient time for the plates and surgical guides to be manufactured, delivered to the appropriate study site and sterilised. Once a patient has been randomised, the CT scan, X-ray imaging and planned correction angle for participants allocated the intervention arm (TOKA), will be securely sent to the device manufacturer. The local site clinician will need to be available to assist with the design of the device, to ensure that there are no delays with manufacture.

Consenting participants for Phase 2 will be randomised at clinic on a 1:1 basis to either personalised or standard HTO. Random allocation will be implemented using a minimisation algorithm stratified by trial centre participant sex, age and BMI. The minimisation algorithm will include a random element to prevent predictability of the treatment allocation. A small number of participants will be randomised using a simple randomisation schedule, generated in advance by the trial statistician, the seed the minimisation algorithm. Stratification by centre, sex, age and BMI will help ensure that any related effects will be equally distributed in the trial arms. We have chosen to separate patients younger than 50 years and 50 years and older, and patients with a BMI lower than 30 and those with a BMI of 30 or greater, as stratification cut-off points for this trial.

Following surgery, participants will return to hospital as part of routine clinical care at 6 weeks, 3 months and 6 months post-surgery. No data will be collected for the study at the 6 week and 3 month visits but recruiting centres will be expected to routinely monitor patient records at each post-operative time point, for unreported safety events that may have occurred.

A full leg weight bearing X-Ray will be taken as part of routine care at the 6 month post surgery follow up appointment (9 months from randomisation). Images and reports from this routine scan will be securely sent to the central study team at Oxford, who will ensure that the images

are anonymised and masked, before sending to the blinded independent assessors to measure and assess the primary outcome.

A repeat Video Vector Analysis (VVA) will be arranged for 6 months post surgery (9 months post-randomisation). VVA simultaneously records ground reaction force data from a force plate and video data from a video camera focussed on the lower limb of a participant. This enables the magnitude, orientation, and location of the ground reaction force to be determined relative to the limb under investigation.

The follow up questionnaires will be sent at 9 and 15 months post randomisation. Participants will have a choice whether they would like to complete these electronically (via a link sent in an email) or completed on paper form sent out via post and the questionnaires will take between 20 and 30 minutes to complete.

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A full leg weight bearing X-Ray will be taken as part of routine care at the 6 month post surgery follow up appointment (9 months from randomisation). Images and reports from this routine scan will be securely sent to the central study team at Oxford, who will ensure that the images are anonymised and masked, before sending to the blinded independent assessors to measure and assess the primary outcome.

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Intervention Type

Device

Phase

Not Applicable

Drug/device/biological/vaccine name(s)

Tailored Osteotomy Knee Alignment (TOKA)

Primary outcome(s)

Phase 1

1. Safety of the TOKA device assessed by incidence/rate of safety events Adverse Effects (AEs), Adverse Device Effects (ADEs), Serious Adverse Effects (SAEs), Serious Adverse Device Effects (SADEs) Unanticipated Serious Adverse Device Effects (USADEs), and complications at 6 weeks post-surgery

Phase 2

1. Accuracy of bone correction assessed by the absolute difference between achieved and planned correction as measured by full length weight-bearing X-rays at 9 months post-randomisation

Key secondary outcome(s)

Phase 2

1. Number of patients (%) achieving a pre-specified difference between planned and achieved coronal plane correction assessed using by full length weight-bearing X-rays at 9 months post-randomisation
2. Change in coronal plane location of peak loading during gait measured by Video Vector Analysis (VVA) at baseline and 9 months post-randomisation
3. Operative time in minutes measured on day of surgery
4. Range of motion measured using ROM flexion and extension will be measured (in degrees) at baseline and nine months post randomisation
5. Patient-reported pain measured using Knee Injury and Osteoarthritis Outcome Score (KOOS) score, visual analogue scale (VAS) pain score, and UCLA Activity Score at baseline and 9 months post-randomisation
6. Patient-reported quality of life measured using generic health-related quality of life (EQ-5D-5L) at baseline and 9 months post-randomisation
7. Patient-reported satisfaction measured using satisfaction and transition questionnaire at baseline and 9 months post-randomisation
8. Patient-reported health resource use measured using health resource use questionnaire at baseline and 9 months post-randomisation
9. Relationship between correction angle, change in loading calculated by computer modelling and outcome at baseline and 9 months post-randomisation

Completion date

10/07/2025

Eligibility

Key inclusion criteria

Current participant inclusion criteria as of 29/03/2023:

1. Undergoing High Tibial Osteotomy
2. Male or female, aged between 18 and 65 years
3. Primary diagnosis of Non-Inflammatory Degenerative Joint Disease (NIDJD)
4. Predominately diagnosed with unicompartmental medial osteoarthritis of the knee with the

normal clinically acceptable level of other compartmental involvement

5. Varus deformity

6. BMI ≤ 35 . An exemption to this may be made if the participant (in the investigator's opinion) is suitable for surgery.

7. Willing and able to give informed consent for participation in the study

8. Able (in the Investigators opinion) and willing to comply with all study requirements

9. Willing to allow their General Practitioner and consultant, if appropriate, to be notified of participation in the study

Previous participant inclusion criteria:

1. Undergoing High Tibial Osteotomy

2. Male or female, aged between 18 and 65 years

3. Primary diagnosis of Non-Inflammatory Degenerative Joint Disease (NIDJD)

4. Predominately diagnosed with unicompartamental medial osteoarthritis of the knee with the normal clinically acceptable level of other compartmental involvement

5. Varus deformity $< 20^\circ$

6. BMI ≤ 35

7. Willing and able to give informed consent for participation in the study

8. Able (in the Investigators opinion) and willing to comply with all study requirements

9. Willing to allow their General Practitioner and consultant, if appropriate, to be notified of participation in the study

Participant type(s)

Patient

Healthy volunteers allowed

No

Age group

Mixed

Lower age limit

18 Years

Upper age limit

65 Years

Sex

All

Total final enrolment

56

Key exclusion criteria

Current participant exclusion criteria as of 29/03/2022:

1. Female participants who are pregnant, lactating or planning pregnancy during the course of the study.

2. Prisoners

3. Participants with a known deep tissue sensitivity to device materials

4. Participants with an active or suspected latent infection in or about the affected knee joint

5. Participants who have received any orthopaedic surgical intervention to the lower extremities

(excluding investigative surgery) within the past 12 months, or is expected to require any orthopaedic surgical intervention to the lower extremities, other than the HTO to be enrolled in this study, within the next 12 months (including intra-articular procedures).

6. Participants who require bilateral HTO with surgery planned on their second knee within 6 months of their first operation (bilateral HTO patients are otherwise included).

7. Participants who require bilateral HTO who have a previous unsuccessful contralateral partial replacement or HTO.

8. Chronic heart failure (NYHA Stage ≥ 2)

9. Neuromuscular or neurosensory deficiency, which limits the ability to evaluate the safety and efficacy of the device

10. Systemic disease diagnosis (e.g. Lupus Erythematosus) or a metabolic disorder (e.g. Paget's disease) leading to progressive bone deterioration.

11. Participant is immunologically suppressed or receiving steroids in excess of normal physiological requirements (e.g. > 30 days).

12. Participant is a smoker.

13. Any other significant disease or disorder which, in the opinion of the Investigator, may either put the participants at risk because of participation in the study, or may influence the result of the study, or the participant's ability to participate in the study

Previous participant exclusion criteria:

1. Pregnant, lactating, or planning a pregnancy during the course of the study

2. Prisoners

3. Known deep tissue sensitivity to device materials

4. Active or suspended latent infection in or about the affected knee joint

5. Received any orthopaedic surgical intervention to the lower extremities (excluding investigative surgery) within the past 12 months, or is expected to require any orthopaedic surgical intervention to the lower extremities, other than the HTO to be enrolled in this study, within the next 12 months

6. Requiring bilateral HTO, or have a history of unsuccessful contralateral partial replacement or HTO

7. Chronic heart failure, New York Heart Association (NYHA) stage ≥ 2

8. Neuromuscular or neurosensory deficiency, which limits the ability to evaluate the safety and efficacy of the device

9. Systemic disease diagnosis (e.g. Lupus Erythematosus) or a metabolic disorder (e.g. Paget's disease) leading to progressive bone deterioration.

10. Immunologically suppressed or receiving steroids in excess of normal physiological requirements (e.g. >30 days).

11. Current smoker

12. Any other significant disease or disorder which, in the opinion of the Investigator, may either put the participants at risk because of participation in the study, or may influence the result of the study, or the participant's ability to participate in the study.

Date of first enrolment

08/09/2021

Date of final enrolment

24/11/2023

Locations

Countries of recruitment

United Kingdom

England

Study participating centre

Royal Devon and Exeter Hospital

Barrack Road

Exeter

England

EX2 5DW

Study participating centre

Cardiff and Vale University Health Board

University Hospital of Wales

Heath Park

Cardiff

Wales

CF14 4XW

Study participating centre

Royal United Hospital

Combe Park

Bath

England

BA1 3NG

Study participating centre

Nuffield Orthopaedic Centre

Oxford University Hospitals NHS Trust

Windmill Road

Headington

Oxford

England

OX3 7HE

Study participating centre

Great Western Hospitals NHS Foundation Trust

Great Western Hospital

Marlborough Road

Swindon
England
SN3 6BB

Study participating centre

Walsall Manor Hospital

Moat Road
Walsall
England
WS2 9PS

Study participating centre

The Royal Orthopaedic Hospital

Bristol Road South
Northfield
Birmingham
England
B31 2AP

Sponsor information

Organisation

University of Bath

Funder(s)

Funder type

Charity

Funder Name

Versus Arthritis

Alternative Name(s)

Arthritis UK

Funding Body Type

Private sector organisation

Funding Body Subtype

Other non-profit organizations

Location
United Kingdom

Results and Publications

Individual participant data (IPD) sharing plan

IPD sharing plan summary
Data sharing statement to be made available at a later date

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
HRA research summary			26/07/2023	No	No
Protocol file	version 6.0	04/09/2024	07/04/2026	No	No
Statistical Analysis Plan	version 1.0	23/04/2025	07/04/2026	No	No
Study website		11/11/2025	11/11/2025	No	Yes