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#### Biomechanical changes of the trunk and lower limb during walking in patients after total hip arthroplasty for osteoarthritis: a systematic review and meta-analysis

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### Review question

1. What are the differences in trunk, pelvis, hip, knee and ankle joint kinematics and kinetics during walking between individuals with total hip arthroplasty (THA) for osteoarthritis (OA) and controls?

Aim: To investigate whether gait biomechanics after THA recover to match those of typical healthy individuals or those with OA who have not undergone THA

2. What are the changes in trunk, pelvis, hip, knee and ankle joint kinematics and kinetics during walking pre to post THA for OA?

Aim: To establish if the changes in gait biomechanics after THA and the time frame for these changes

### Searches

We will search the following electronic databases:

Cochrane Central Register of Controlled Trials (CENTRAL; current issue) and the Cochrane Database of Systematic Reviews (CDSR)

PubMed Ovid

CINAHL EBSCO (Cumulative Index to Nursing and Allied Health Literature; 1982 to present)

Web of Science (WoS)

Physiotherapy Evidence Database (PedRO)

Sport discuss

EMBASE

ETHOS

MEDLINE Ovid

Reference lists of all included studies and relevant systematic reviews will be scanned for any further studies which meet the inclusion criteria for the review.

The PECOS framework will be used to define the search strategy (full search strategy can be found in the supporting document). Eligible languages for inclusion will be restricted to English.

### Search strategy

[https://www.crd.york.ac.uk/PROSPEROFILES/105048\\_STRATEGY\\_20180727.pdf](https://www.crd.york.ac.uk/PROSPEROFILES/105048_STRATEGY_20180727.pdf)

### Types of study to be included

All experimental and interventional study designs will be included within the review. Specifically, cohort, case-control and single group pre-post intervention studies will be included. Randomised control trials (RCTs) will be included within the review, however data from the single arm cohorts included within the RCT that meet the inclusion criteria for the review will be included; these studies will then be appraised as though they were cohort studies.

Where only partial biomechanical data sets are available these will be extracted and included within the relevant sections of the review (for instance if a study only reports on hip joint kinematics the study will only

be included in this component of the review).

### Condition or domain being studied

Total hip arthroplasty for osteoarthritis. Changes in biomechanical parameters of the trunk and lower limb during walking.

### Participants/population

Q1. Adults over 18 years old

Exposed group: those who have undergone a unilateral THA for osteoarthritis

Comparison groups: healthy or OA control groups (no total hip arthroplasty)

Q2 & 3. Adults over 18 years old requiring a unilateral THA for osteoarthritis

Exposed group: before THA

Comparison group: after THA

Studies will be excluded if they include patients with bilateral THA, THA for any other reason than osteoarthritis, other major medical conditions affecting gait (i.e. stroke, multiple sclerosis, cancer, etc.) or previous surgery (e.g. revision THA, knee or ankle arthroplasty, THA at the other side). Studies that compared the non-operated leg to the operated leg and studies assessing outcomes of 2D movement analysis will be excluded.

### Intervention(s), exposure(s)

Intervention: primary unilateral THA for osteoarthritis

Exposures: pre, 6 weeks post, 6 months post, 1 year post and 2+ years post THA

### Comparator(s)/control

Q1. Comparator = total hip arthroplasty; Control = matched controls (OA or healthy)

Q2. Comparator = post-THA (at the following time frames; 6 weeks post, 6 months post, 1 year post and 2+ years post operation); Control = pre-THA

### Context

Not applicable

### Primary outcome(s)

The primary outcomes will be trunk, pelvis, hip, knee, and ankle kinematics and kinetics measured during walking trials using 3D motion analysis. The biomechanical measures will be analysed before and after THA and compared between individuals with and without THA.

### Secondary outcome(s)

Recovery of the primary outcome measures post-surgery will be assessed at different time points, the time points to be explored are; 6 weeks, 6 months, 1 year and 2 years +. Patient reported measures of hip pain, function, quality of life, and participation at the time of the walking trials. Spatial-temporal parameters will be extracted as secondary outcome measures. Furthermore, walking speed and surgical approach will be reported. These secondary outcomes will be used to investigate further differences that are not reflected in lower limb biomechanics and will be used for the meta-regression analysis, if required.

### Data extraction (selection and coding)

The review process will be performed in two-stages. Firstly, all titles and abstracts retrieved by electronic searching will be imported into a cloud based password protected folder with author, year, title and journal of publication input into Microsoft Excel. Using the descriptive information in the Excel workbook duplicates will be removed. Two reviewers will screen titles and abstracts of all identified citations to identify potential studies and all potentially eligible studies will be categorised as either 'retrieve' (eligible, potentially eligible, unclear) or 'do not retrieve'. The full text of study reports and publications coded as 'retrieve' will be obtained. Then, the full text will be screened to identify studies for inclusion. If a study is excluded, the reason(s) for exclusion of the ineligible studies will be recorded in a 'Characteristics of excluded studies'

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table. If the two authors disagree over the eligibility of a particular article, a third reviewer will be consulted. The selection process will be documented using Covidence and the details of the search will be presented in a PRISMA checklist. We will use a modified EPOC data collection form to capture study characteristics and outcome data. Two review authors will independently extract the following study characteristics from included studies, if available:

1. Methods: study design, follow-up period, biomechanical model
2. Participants: number, mean age, age range, gender, diagnostic criteria, inclusion and exclusion criteria, other relevant characteristics (e.g. surgical approach, type of THA [(un)cemented component])
3. Outcomes: main and other outcomes specified and collected, time points reported;
4. Notes: funding for trial, notable conflicts of interest of trial authors, and ethical approval.
5. Outcome data that is not adequately reported in the studies a usable way will be highlighted.

The extracted data will be presented in a table of characteristics of included studies. For studies where only a subset of the participants is eligible for inclusion, the data for the subgroup will be reported separately

### Risk of bias (quality) assessment

Owing to the potential risk of bias arising from both different study designs as well as outcome (kinematics and kinetics) assessments, the methodological risk of bias (within studies) will be assessed using; a) a critical appraisal tool (CAT) or b) the Downs and Black (1998) checklist for observational studies, as appropriate. There may be an opportunity and potential to merge several established checklists specific to THA analysis studies but a decision to do this will be guided and justified by revelations of the initial scoping exercise in terms of each tool's relevance vis a vis our research questions, ease of use and sufficient numbers of particular types of study designs. The scoring of individual studies will be independently carried out by two reviewers, with any disagreements resolved with the opinion (consensus) of a third reviewer if required.

The above within study risk of bias assessment can be viewed as a prerequisite to assessing bias across studies to check quality of evidence or effect estimate accuracy. If it is seen that studies (or a considerable number of adequately powered studies) have been appropriately conducted and are relatively resistant to bias, a well thought out meta-analysis will be attempted along with a suitable global standard for rating evidence quality. The inclusion of bias scores in a meta-regression will investigate whether any identified study bias contributed significantly to heterogeneity. This will be supported by contour-enhanced funnel plots and complemented by performing either the Begg's or Egger's regression test as appropriate depending on quality and size of studies to assess funnel plot asymmetry. Aside from somewhat enabling the classification of the strength of evidence as strong, moderate or limited, these findings will advise the suitability of reporting of adjusted effect estimates with respect to either specific study designs, relative benefits or risk factors of THA and type as well as timings of THA assessment outcomes. Any quantitative results not included in the meta-analysis due to a different manner of reporting will be checked for their consistency with meta-analysis results by the reviewers. A well-established standardised guide for carrying out a systematic review such as PRISMA or STROBE, as appropriate, will be used to assess the quality of this review process.

### Strategy for data synthesis

It is anticipated that there will be numerous THA outcome variables reported that are also measured across variable time points that will in turn be summarised differently. Therefore, we will employ the 'best' structured synthesis of data to meet our research objectives. In as much as this is a challenge potentially also compounded by different patient characteristics, the speed and type of functionality assessed and surgical (intervention) approaches, it is a finding in itself which we will endeavour to adequately report. Specifically data synthesis may be frustrated by the fact that different a) studies even if of similar design will report summary follow up time or pre and post-operative comparisons at different time points b) studies may report different summary follow up statistical measures e.g. means while others use medians and inter quartile ranges (IQR) or two studies report medians that are computed differently.

A decision on the most appropriate method to standardize, pool or amalgamate differently reported variable estimates will be driven by any detail that can be gleaned to the type of their distributions, specific study sample sizes and time between follow-up time or pre and post-operative periods. In instances where

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variation (or standard deviation) of biomechanical THA parameters is not available we will pursue the possibility of either a) using a p value's equivalent T-statistic of the mean difference between pre and post-operative estimates to compute the standard error of the mean difference b) using a suitable standard error of a mean difference from appropriate comparable literature to the study in question advised by a 'sensitivity analysis' c) as appropriate we will attempt reaching out to authors to get additional unreported information in line with our planned analysis. In the likely event that this is not forthcoming, the reported estimate will be appropriately transformed to meet our analysis obligations.

A typical spread sheet such as Excel will be used to extract data and facilitate efficient sharing of responsibilities of several reviewers which can be easily exported to suitable analysis software. A meta-analysis (where possible) will be applied to compute 95% confidence intervals (CIs) for pooled standardised mean differences (SMD) effects using the inverse variance method in RevMan software (v5.2). These will be reported depending on the extent of heterogeneity that will likely be driven by the variability of study designs and consistency of outcome measures used in the studies included. By conservatively setting the statistical significance at  $p < 0.10$ , the observed heterogeneity will be assessed where possible using the  $I^2$  test, Cochrane's Q statistic and  $I^2$  statistic. The interpretation of heterogeneity will follow Cochrane guidelines, where 25, 50 and 75% represent low, moderate and high heterogeneity, respectively.

### Analysis of subgroups or subsets

Sub-group analysis and meta-regression, where appropriate, will be conducted to explore any potential effect of surgical approach, walking speed, pain, function, quality of life, participation and hip function upon trunk and lower limb kinematic/kinetic parameters during walking gait.

### Contact details for further information

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None.

**PROSPERO**  
International prospective register of systematic reviews**Conflicts of interest**

TB has received financial support from DePuy Synthes for consultancy, education, research and design services related to hip arthroplasty

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**Stage of review**

Review\_Ongoing

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Subject indexing assigned by CRD

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**Details of any existing review of the same topic by the same authors****Stage of review at time of this submission**

<b>Stage</b>	<b>Started</b>	<b>Completed</b>
Preliminary searches	Yes	No
Piloting of the study selection process	No	No
Formal screening of search results against eligibility criteria	No	No
Data extraction	No	No
Risk of bias (quality) assessment	No	No
Data analysis	No	No

**Versions**

31 July 2018

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