1. ABOUT THE DATASET

Title: Dataset for ‘Hip contact forces can be directed outside of a well-oriented cup during common activities; implications for implant testing.’

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Description:

This study was a collaborative project between the University of Leeds, UK and the University of Denver, USA.

The purpose of this study was to identify hip motion and force scenario with the potential for hip replacement device ‘edge loading’. This is the separation or subluxation of the femoral head from the acetabular cup, resulting in the contact between the two being located at the rim of the acetabular cup. This contact position, and associated reduced contact area, can lead to accelerated failure of hip replacement devices.

Input data from the University of Denver consisted of motion capture data for three activities and for five participants with implanted total hip replacement devices. For each participant and activity, the output force data from a musculoskeletal model (software: Opensim) was provided, based on the motion capture data and force plate measurements. Hip joint contact force output data was also provided for cases where an adjustment had been made to the alignment of either the acetabular cup or femoral stem of the device. These adjustments had been represented in the model through modifications to the joint locations and tissue attachment sites.

At the University of Leeds, this data was processed to associate virtual acetabular cup implantations to the dynamic pelvic location and track the orientation of this cup relative to the hip joint contact force throughout the activity cycles. Reference locations on the cup rim were created and tracked. The direction of the load vector relative to the cup was determined. When the load vector was >90° from the cup pole this was deemed as the load vector passing outside of the cup rim. Locations where the load vector left the cup rim and returned into it were identified and recorded relative to the reference locations. The maximum angle around the cup circumference between these exit and entry locations was recorded; termed ‘sweep distance’. The resultant hip contact force was recorded whenever it was past the rim.

For ease of use and clarity, a most-relevant subset of the complete data has been collected to be shared within this data set.

Cite as:

Lee Etchels, Casey Myers, Chadd Clary, Paul Rullkoetter, Ruth Wilcox and Alison Jones (2025) Dataset for ‘Hip contact forces can be directed outside of a well-oriented cup during common activities; implications for implant testing’. University of Leeds. [Dataset] https://doi.org/10.5518/1605.

Related publication(s):

[1] Lee Etchels, Casey Myers, Chadd Clary, Paul Rullkoetter, Ruth Wilcox and Alison Jones, 2025. ‘Hip contact forces can be directed outside of a well-oriented cup during common activities; implications for implant testing.’ Clinical Biomechanics.

[2] Myers, C.A., Laz, P.J., Shelburne, K.B., Judd, D.L., Huff, D.N., Winters, J.D., Stevens-Lapsley, J.E., Rullkoetter, P.J., 2018. The impact of hip implant alignment on muscle and joint loading during dynamic activities. Clinical Biomechanics 53, 93–100. https://doi.org/10.1016/j.clinbiomech.2018.02.010

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2. TERMS OF USE

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3. PROJECT AND FUNDING INFORMATION

Title: Enabling Individualised Surgical Treatment of Osteoarthritis
Dates: 1 January 2022 to 31 December 2025
Funding organisation: EPSRC, Centre-to-Centre Internation Collaboration Call
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4. CONTENTS

All data files are in text format. The factors varied in the study are listed in **Table 1**, along with codes used to identify those. Then folder names and file name structures, are given in **Table 2**. The data for the two cases, selected as of most interest in the paper, are detailed in **Table 3** with file details.

Table 1: Study factors, numbers of variants and meaning of codes used in the filenames in the dataset.

Factors in the study	**#**	**Details; codes used in file names**
Activities	3	**Walk** – Walking gait **StepD** – Step Down **Stand** – Sit to stand
Human subjects	5	Subjects are anonymised using codes: **pt1**, **pt2**, **pt3**, **pt4**, and **pt5**.
Directions of hip joint alignment variation	8	**CupAP** – anterior (+) or posterior (-) translation of the cup **CupML** – medial or lateral translation of the cup [right (+), left (-)] **CupSI** – superior (+) or inferior (-) translation of the cup **StemABD** – adduction (+) or abduction (-) of the stem **StemANT** – anteversion (-) or retroversion (+) of the stem **StemAP** – anterior (+) or posterior (-) translation of the stem **StemML** – medial or lateral translation of the stem [right (+), left (-)] **StemSI** – superior (+) or inferior (-) translation of the stem
Positions along each alignment direction	5	**-2sd** – two standard deviations from native position **-1sd** – one standard deviation from native position **native** – the patient joint alignment reconstructed for original musculoskeletal modelling **+1sd** – one standard deviation from native position **+2sd** – two standard deviations from native position [Positive and negative defined above.]
Acetabular cup orientations	9	**3012** – Inclination 30 degrees, version 12 degrees **3022** – Inclination 30 degrees, version 22 degrees **3032** – Inclination 30 degrees, version 32 degrees **4012** – Inclination 40 degrees, version 12 degrees **4022** – Inclination 40 degrees, version 22 degrees **4032** – Inclination 40 degrees, version 32 degrees **5012** – Inclination 50 degrees, version 12 degrees **5022** – Inclination 50 degrees, version 22 degrees **5032** – Inclination 50 degrees, version 32 degrees [Radiographic inclination, radiographic version]
Hips per subject	2	Right and left hips for each person. One hip is operated and the other is the native joint. **Op** – operated **Nonop** – non operated

Table 2: Folder name and file name structures for each type of data and the number of files in each folder.

Data type	Folder / ZIP	Filename (example)	# files
Cup outward normal (CN)	Cup_normals	CN_pt1_Walk_Op_4032	270
Force vectors (FV)	Force_vectors	FV_pt2_Stand_Nonop_CupAP_+1sd	1,200
Angle between force and cup pole (A2P)	15 folders ptX_Stand ptX_StepD ptX_Walk (X = 1-5)	A2P_pt16_Walk_Nonop_3012_CupAP_-2sd	720 each
Locations* where force left and re-entered the cup rim	Locations	locations_on_and_off_the_cup	1

* Positions where force off and back on the rim: data for all cases, blank [] where no external forces, value defined as angle around rim clockface from superior reference point to position of interest. (Direction: clockwise if anterior is on the right.)

Table 3: Details of the two characteristic cases with most substantial force external to the cup [2]; features of the cases selected and folders, files.

Case	Factors	Folder / ZIP	Filename (example)	# file
1	Patient 4, operated hip, walking gait, 30 degree cup inclination, 32 degree cup version, Negative translation, In stem anterior-posterior.	Case1	A2P_pt4_Walk_Op_3032_StemAP_-1sd A2P_pt4_Walk_Op_3032_StemAP_-2sd Case1_locations_on_and_off_the_cup CN_pt4_Walk_op_3032 A2P_pt4_Walk_Op_3032_StemAP_-1sd A2P_pt4_Walk_Op_3032_StemAP_-2sd	6
2	Patient 5, operated hip, walking gait, 30 degree cup inclination, 32 degree cup version, Negative rotation, In stem adduction-abduction.	Case2	A2P_pt5_Walk_Op_3032_StemABD_-1sd A2P_pt5_Walk_Op_3032_StemABD_-2sd Case1_locations_on_and_off_the_cup CN_pt5_Walk_op_3032 A2P_pt5_Walk_Op_3032_StemABD_-1sd A2P_pt5_Walk_Op_3032_StemABD_-2sd	6

5. METHODS

The data processing methods are described in the associated publication **[1]** and those of the underlying data in a previous publication **[2]**.

The data processing was performed using code written in **Python 3.11** (library details below). The key functions used have been collected into a single file and are provided in this dataset (**key_functions.py**).

Software used:

Python 3.11
Libraries used across data read, data processing, data export, and data visualisation:
math, pathlib, os, winsound, pandas, plotly, numpy, pyquaternion, csv, json, re, datetime, scipy, itertools, ctypes, time.