Dataset: Dynamic acetabular cup orientation in fast and slow walking total hip replacement patients: raw motion data, processed cup angles and statistical analyses.

Study document: Statistical comparisons of fast and slow groups and correlations between pelvic and cup angles

Statistical comparison of the fast and slow groups – averaged over the gait cycle

The range and mean between two patient groups were compared using a two-tailed t-test (α=0.05) and showed no significant difference.

Statistical comparison of the fast and slow groups – throughout the gait cycle

The comparison of two patient groups for the whole gait cycle was performed using Statistical Parametric Map (SPM) methodology. This method was chosen as it allows statistical analysis of the whole gait cycle as a continuous process rather than analysing discrete gait cycle points.

The SPM method included calculating t-values for each cycle point and assembling them into one matrix, also called statistical 'map', SPM{t}. For this study, a two-sample t-test (α = 0.05) was used to calculate SPM{t}. Then, a corresponding critical threshold (t*) was computed based on the temporal smoothness of the input data through Random Field Theory (RTF). This threshold was used to cut-off regions of interest from SPM{t}, where difference between two groups was potentially significant, hence referred to as supra-threshold clusters. Finally, RTF expectations regarding supra-threshold cluster size were used to calculate cluster specific p-values. These indicated the probability with which supra-threshold clusters could have been produced by a random field process with the same temporal smoothness. Hence, if cluster would be present but p-value would be above 0.05 then two speed groups would not be statistically different. All SPM analyses were implemented using the open-source spm1d code (v.M0.1, www.spm1d.org) in Python 3.7 (python.org).

It was found that there was no significant difference in inclination angle between two groups during the whole gait cycle (Figure 1a, 1c). However, statistical difference was found for version angle around toe-off, 38-50% of a gait cycle (Figure 1b, 1d).

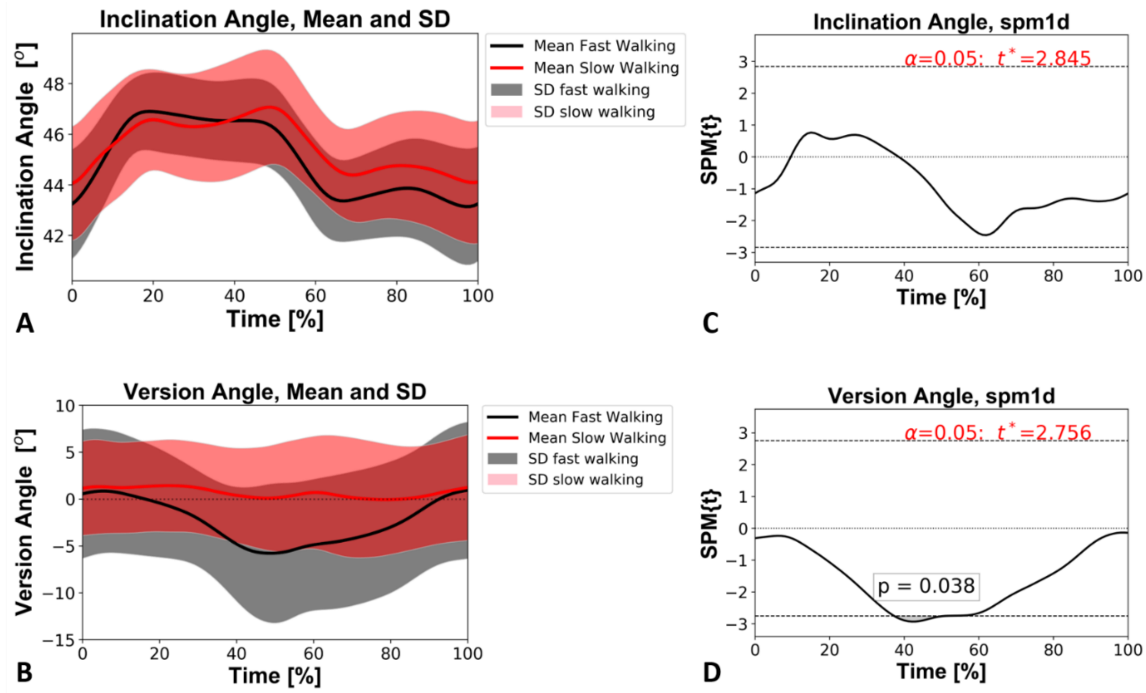

Figure 1: (Left) Angle profiles recorded over the gait cycle for fast and slow groups; (A) inclination angles, (B) version angles. The solid curves represent group mean and transparent bands represent one standard deviation (SD). (Right) Statistical parametric mapping (SPM) scalar trajectory t-test outputs; (C) for inclination angle, (D) for version angle. SPM{t} represent t-test statistics continuum, when it exceeds threshold (t*, dashed lines top/bottom) the significance P-value was recorded (α = 0.05).

A sensitivity test was performed to evaluate the influence of cup orientation at implantation on the difference between patient groups. Four cup orientations were chosen for the test. The selected orientations were combinations of 30° or 50° inclination and 5° or 25° version.

The identical SPM analysis, performed for the four alternative cup implantation positions, produced similar results. The difference in inclination angle remained not significant; and for version angle significance was recorded around toe-off, but with slight deviation in the gait region (Table 1).

Table 1: Sensitivity SPM t-test (α = 0.05) results for five cup implantation scenarios. (NS = not significant.)

Scenario: inclination(°), version (°)		45°, 7°	30°, 5°	30°, 25°	50°, 5°	50°, 25°
P-value [gait cycle point]	Inclination	NS	NS	NS	NS	NS
	Version	0.038 [38-50]	0.034 [39-59]	0.042 [39-52]	0.043 [38-46]	0.047 [39-44]

Correlation between pelvic angles and cup angles

A Spearman's rank correlation coefficient was calculated to establish any relationships between each pelvic angle (tilt, obliquity and internal-external rotation) and each cup orientation measure (inclination and version). This comparison was performed separately for each patient group, resulting in a total of 12 comparisons. For a given correlation calculation (e.g. pelvic tilt against cup inclination) the two sets compared were composed of the mean values of that angular measure over the patient group at each a data point in the gait cycle. The significance level of Spearman's rank coefficient was checked using Student's t-test distribution, and only results where the correlation coefficient was significantly different from zero (α=0.05) were reported.

For both fast and slow groups, the inclination angle was strongly correlated with obliquity (Table 2). However, for version, the results differed between the fast and slow walking groups. For the fast group both tilt and internal-external rotation were strongly correlated with version angle, but for the slow group only internal-external rotation was strongly correlated with version angle.

Table 2: Spearman's rank correlation coefficient between dynamic cup orientations and pelvic movement components. The closer coefficient is to +1 or -1 the stronger the correlation. Only results where the correlation coefficient was significantly different from zero (α=0.05) were reported.

	Tilt	Obliquity	Rotation
Inclination	Fast: -0.4 Slow: -	Fast: -1 Slow: -1	Fast: - Slow: -
Version	Fast: +0.8 Slow: -	Fast: - Slow: -	Fast: +1 Slow: +0.8

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