

## Supplementary article data

# No functional benefit of larger femoral heads and alternative bearings at 6 months following primary hip replacement

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## Supplementary material

The reliability of the multivariable statistical models was explored in a number of ways: covariates found not to be statistically significant were excluded from the model, based on statistical entry ( $p < 0.05$ ) criteria; the same covariates were fitted forward and reverse stepwise manually to ensure findings were not qualitatively affected in the final model, with any inconsistency reported. The final models were then re-evaluated as a directly entered model (non-stepwise), and were assessed by exploring 2-way interactions between covariates.

The purpose of the analysis was hypothesis generating rather than hypothesis testing, consequently there is no adjustment for multiple testing and the choice of level of statistical significance is somewhat arbitrary.

Tests for interaction (multiplicative) between covariates were not statistically significant. Forward and reverse stepwise model construction and varying significance thresholds led to the same final models. BMI data was available for 2,726 procedures (59%). BMI had a significant influence on the OHS change models and the wound complications models; thus, these models analysed fewer procedures than were available from the entire cohort. Despite this, testing with BMI excluded from the model did not qualitatively affect the change scores or significance levels, and so the final models retained the BMI variable. Variables included in the statistical models, and their significance levels within the final models, are shown in Table x and Table y.

Table x. Variables included in the change score analysis of covariance models

|                                                     | Oxford hip score change |               | EQ5D index change |               |
|-----------------------------------------------------|-------------------------|---------------|-------------------|---------------|
|                                                     | Head size model         | Bearing model | Head size model   | Bearing model |
| Head size                                           | 0.930                   | –             | 0.976             | –             |
| Bearing                                             | –                       | 0.895         | –                 | 0.320         |
| Approach                                            | <0.001                  | 0.008         | 0.003             | 0.003         |
| Preop. Oxford hip score                             | <0.001                  | <0.001        | 0.002             | –             |
| Preop. EQ5D index                                   | –                       | –             | <0.001            | <0.001        |
| Preop. general health                               | <0.001                  | <0.001        | <0.001            | <0.001        |
| Preop. disability                                   | 0.003                   | 0.001         | <0.001            | <0.001        |
| Circulatory problems                                | <0.001                  | <0.001        | <0.001            | 0.002         |
| History of depression                               | –                       | 0.001         | <0.001            | <0.001        |
| BMI <sup>a</sup>                                    | <0.001                  | 0.040         | –                 | 0.001         |
| Sex                                                 | <0.001                  | –             | –                 | –             |
| Goodness of fit of model (adjusted R <sup>2</sup> ) | 36%                     | 41%           | 58%               | 60%           |

<sup>a</sup> BMI data available for 2,726 implants (59%) therefore final change models analyse fewer procedures than entire cohort. Despite this, testing with BMI excluded from the model did not qualitatively effect the change scores or significance levels. Goodness of fit of a model provides a measure of how well observed outcomes are replicated by the model, as a proportion of total variation of outcomes explained by the model.

Table y. Variables included in the complications multivariable logistic regression models

|                                    | Bleeding        |               | Wound           |               | Readmitted      |               | Reoperation     |               |
|------------------------------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|
|                                    | Head size model | Bearing model | Head size model | Bearing model | Head size model | Bearing model | Head size model | Bearing model |
| Head size                          | 0.334           | –             | 0.001           | 0.014         | 0.191           | –             | 0.885           | –             |
| Bearing                            | –               | 0.967         | –               | 0.671         | –               | 0.936         | –               | 0.472         |
| Approach                           | –               | –             | 0.028           | 0.033         | –               | –             | –               | –             |
| Preoperative Oxford hip score      | –               | –             | –               | –             | –               | –             | 0.025           | 0.024         |
| Preoperative general health        | –               | –             | 0.009           | 0.009         | 0.028           | 0.027         | –               | –             |
| History of depression              | –               | –             | –               | –             | 0.024           | 0.028         | –               | –             |
| BMI <sup>a</sup>                   | –               | –             | 0.001           | 0.001         | –               | –             | –               | –             |
| Sex                                | –               | 0.067         | 0.002           | 0.003         | –               | –             | –               | –             |
| Age                                | –               | –             | –               | –             | 0.006           | 0.026         | –               | –             |
| Type of mechanical VTE prophylaxis | 0.013           | 0.017         | –               | –             | –               | –             | 0.076           | 0.083         |

VTE – venous thromboembolic

<sup>a</sup> BMI data available for 2,726 implants (59%) therefore final change models analyse fewer procedures than entire cohort. Despite this, testing with BMI excluded from the model did not qualitatively effect the change scores or significance levels.

Table 1. Summary of the demographic and surgical variables available for analysis

|                                                       | Source    | Description                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Patient factors</b>                                |           |                                                                                                                                                                                                                                                                               |
| Age (years)                                           | NJR/PROMs |                                                                                                                                                                                                                                                                               |
| Sex                                                   | NJR/PROMs |                                                                                                                                                                                                                                                                               |
| American Society of Anaesthesiology (ASA) grade       | NJR       | Grades 1 to 4                                                                                                                                                                                                                                                                 |
| Body mass index (BMI) (kg/m <sup>2</sup> )            | NJR       | Only BMI within 15 kg/m <sup>2</sup> to 60 kg/m <sup>2</sup> included                                                                                                                                                                                                         |
| Comorbidities                                         | PROMs     | Recorded by patients as part of the preoperative PROMs questionnaire. Nine comorbidities: i) ischaemic heart disease, ii) respiratory disease, iii) diabetes, iv) hypertension, v) kidney disease, vi) liver disease, vii) circulatory problems, viii) cancer, ix) depression |
| Preoperative general health                           | PROMs     | Indicates the patient's perception of their own general health with 5 options: i) excellent, ii) very good, iii) good, iv) fair, v) poor                                                                                                                                      |
| Preoperative disability                               | PROMs     | Indicates whether the patient considers themselves to have a disability                                                                                                                                                                                                       |
| Preoperative Oxford hip score (OHS)                   | PROMs     | Derived from adding the points (0 to 4) together from the response to hip symptom-specific questions on a scale of 0 to 48 (0 worst, 48 best)                                                                                                                                 |
| Preoperative EQ5D Visual Analogue Score               | PROMs     | Indicates how well the patient feels on the day of completing the questionnaire on a scale of 0–100 (0 worst, 100 best)                                                                                                                                                       |
| Preoperative EQ5D index                               | PROMs     | Single summary score derived from EQ5D profile (based on response to 5 questions) by applying a formula with appropriate operation specific weightings                                                                                                                        |
| <b>Surgical factors</b>                               |           |                                                                                                                                                                                                                                                                               |
| Lead surgeon grade                                    | NJR       | Consultant or other                                                                                                                                                                                                                                                           |
| Surgeon volume                                        | NJR       | i) Low, ii) medium, iii) high                                                                                                                                                                                                                                                 |
| Approach                                              | NJR       | i) Posterior, ii) direct lateral, ii) other                                                                                                                                                                                                                                   |
| Patient position                                      | NJR       | i) Lateral, ii) supine, iii) not recorded                                                                                                                                                                                                                                     |
| Type of replacement                                   | NJR       | i) Best cemented, ii) Other cemented, iii) Best hybrid, iv) Other hybrid, v) Best cementless, vi) Other cementless, vii) Best resurfacing, viii) Other resurfacing                                                                                                            |
| Anaesthesia                                           | NJR       | i) Regional only, ii) general only, iii) general and regional                                                                                                                                                                                                                 |
| Chemical venous thromboembolism prophylaxis           | NJR       | Intended prophylaxis as recorded at time of operation: i) aspirin only, ii) LMWH only, iii) other, iv) none, v) not recorded                                                                                                                                                  |
| Mechanical venous thromboembolism prophylaxis         | NJR       | Intended prophylaxis as recorded at time of operation: i) Compression stockings (CS) only, ii) combination CS/mechanical pump, iii) foot pump only, iv) intermittent calf pump only, v) other, vi) none, vii) not recorded                                                    |
| Time from operation to postoperative PROMs completion | PROMs     | Calculated from the date of operation as recorded on the NJR database to the date of postoperative PROMs as recorded on the questionnaire                                                                                                                                     |

NJR – National Joint Registry, PROMs – patient-reported outcome measures, LMWH – low molecular weight heparin

Table 6. Patient-reported outcome scores following primary hip replacement, by bearing (simple and multi-variable analyses)

|                            | Value | Simple<br>99% CI | p-value   | Value | Multivariable<br>99% CI | p-value   |
|----------------------------|-------|------------------|-----------|-------|-------------------------|-----------|
| Change in Oxford hip score |       |                  |           |       |                         |           |
| Metal-on-polyethylene      | 21.3  | 20.8–21.9        | Reference | 21.2  | 20.6–21.8               | Reference |
| Ceramic-on-polyethylene    | 19.7  | 18.4–21.0        | 0.003     | 20.5  | 19.1–21.8               | 0.2       |
| Ceramic-on-ceramic         | 20.9  | 20.3–21.4        | 0.14      | 21.2  | 20.6–21.8               | 1.0       |
| Change EQ5D index          |       |                  |           |       |                         |           |
| Metal-on-polyethylene      | 0.428 | 0.409–0.448      | Reference | 0.419 | 0.402–0.436             | Reference |
| Ceramic-on-polyethylene    | 0.385 | 0.337–0.433      | 0.03      | 0.404 | 0.365–0.444             | 0.4       |
| Ceramic-on-ceramic         | 0.406 | 0.386–0.426      | 0.04      | 0.411 | 0.393–0.428             | 0.4       |

See Table x in Supplementary data for variables included in models.

Table 7. Patient-reported outcome scores following primary hip replacement, by head size (simple and multi-variable analyses)

|                            | Value | Simple<br>99% CI | p-value   | Value | Multivariable<br>99% CI | p-value   |
|----------------------------|-------|------------------|-----------|-------|-------------------------|-----------|
| Change in Oxford hip score |       |                  |           |       |                         |           |
| 28 mm                      | 21.6  | 20.0–22.2        | Reference | 21.5  | 20.9–22.1               | Reference |
| 32 mm                      | 20.3  | 19.4–21.2        | 0.001     | 20.1  | 19.2–21.1               | 0.002     |
| 36 mm                      | 20.8  | 20.3–21.3        | 0.004     | 21.3  | 20.7–21.8               | 0.5       |
| Change EQ5D index          |       |                  |           |       |                         |           |
| 28 mm                      | 0.429 | 0.408–0.450      | Reference | 0.426 | 0.408–0.444             | Reference |
| 32 mm                      | 0.408 | 0.377–0.440      | 0.2       | 0.388 | 0.361–0.416             | 0.004     |
| 36 mm                      | 0.407 | 0.389–0.425      | 0.05      | 0.417 | 0.401–0.433             | 0.3       |

See Table x in Supplementary data for variables included in models.

Table 8. Patient-reported complications following primary hip replacement, by bearing (simple and multi-variable analyses)

|                         | %   | n   | OR   | Simple<br>99% CI | p-value | OR   | Multivariable<br>99% CI | p-value |
|-------------------------|-----|-----|------|------------------|---------|------|-------------------------|---------|
| Bleeding complications  |     |     |      |                  |         |      |                         |         |
| Metal-on-polyethylene   | 5.8 | 125 | 1    |                  |         | 1    |                         |         |
| Ceramic-on-polyethylene | 4.2 | 15  | 0.71 | 0.34–1.49        | 0.2     | 0.70 | 0.34–1.44               | 0.2     |
| Ceramic-on-ceramic      | 5.9 | 122 | 1.02 | 0.73–1.43        | 0.9     | 1.00 | 0.71–1.41               | 1.0     |
| Wound complications     |     |     |      |                  |         |      |                         |         |
| Metal-on-polyethylene   | 7.3 | 158 | 1    |                  |         | 1    |                         |         |
| Ceramic-on-polyethylene | 8.6 | 31  | 1.20 | 0.71–2.04        | 0.4     | 1.33 | 0.67–2.62               | 0.2     |
| Ceramic-on-ceramic      | 9.9 | 204 | 1.40 | 1.05–1.86        | 0.002   | 1.25 | 0.75–2.08               | 0.2     |
| Re-admission            |     |     |      |                  |         |      |                         |         |
| Metal-on-polyethylene   | 7.2 | 157 | 1    |                  |         | 1    |                         |         |
| Ceramic-on-polyethylene | 7.2 | 26  | 0.99 | 0.57–1.76        | 1.0     | 1.10 | 0.61–2.00               | 0.7     |
| Ceramic-on-ceramic      | 5.6 | 115 | 0.76 | 0.55–1.05        | 0.03    | 0.85 | 0.58–1.25               | 0.2     |
| Reoperation             |     |     |      |                  |         |      |                         |         |
| Metal-on-polyethylene   | 1.8 | 40  | 1    |                  |         | 1    |                         |         |
| Ceramic-on-polyethylene | 1.4 | 5   | 0.75 | 0.22–2.57        | 0.5     | 0.75 | 0.22–2.59               | 0.5     |
| Ceramic-on-ceramic      | 2.0 | 41  | 1.08 | 0.61–1.93        | 0.7     | 1.12 | 0.62–2.01               | 0.6     |

OR: odds ratio.  
See Table y in Supplementary data for variables included in models.

Table 9. Patient-reported complications following primary hip replacement, by head size (simple and multi-variable analyses)

|                        | %   | n   | OR   | Simple<br>99% CI | p-value | OR   | Multivariable<br>99% CI | p-value |
|------------------------|-----|-----|------|------------------|---------|------|-------------------------|---------|
| Bleeding complications |     |     |      |                  |         |      |                         |         |
| 28 mm                  | 4.5 | 84  | 1    |                  |         | 1    |                         |         |
| 32 mm                  | 7.9 | 69  | 1.83 | 1.19–2.82        | <0.001  | 1.83 | 1.19–2.82               | < 0.001 |
| 36 mm                  | 5.6 | 109 | 1.31 | 0.92–1.89        | 0.05    | 1.32 | 0.90–1.95               | 0.06    |
| Wound complications    |     |     |      |                  |         |      |                         |         |
| 28 mm                  | 7.7 | 144 | 1    |                  |         | 1    |                         |         |
| 32 mm                  | 7.6 | 66  | 0.98 | 0.66–1.46        | 0.9     | 1.12 | 0.65–1.93               | 0.6     |
| 36 mm                  | 9.8 | 183 | 1.27 | 0.96–1.68        | 0.03    | 1.68 | 1.10–2.59               | 0.002   |
| Re-admission           |     |     |      |                  |         |      |                         |         |
| 28 mm                  | 6.3 | 117 | 1    |                  |         | 1    |                         |         |
| 32 mm                  | 7.6 | 66  | 1.22 | 0.81–1.84        | 0.2     | 1.26 | 0.83–1.93               | 0.16    |
| 36 mm                  | 6.2 | 115 | 1.00 | 0.73–1.37        | 1.0     | 1.10 | 0.76–1.60               | 0.500   |
| Reoperation            |     |     |      |                  |         |      |                         |         |
| 28 mm                  | 2.3 | 42  | 1    |                  |         | 1    |                         |         |
| 32 mm                  | 1.3 | 11  | 0.55 | 0.23–1.31        | 0.08    | 0.55 | 0.23–1.32               | 0.08    |
| 36 mm                  | 1.8 | 33  | 0.71 | 0.41–1.26        | 0.1     | 0.85 | 0.46–1.57               | 0.5     |

OR: odds ratio.

See Table y in Supplementary data for variables included in models.