The Effect of Computer Guided and Robotic Total Hip Replacement on Risk of Revision and Patient-Reported Outcome Measures: An Analysis of National Joint Registry Data

Muhamed Farhan-Alanie, Daniel Gallacher, Peter Craig, James Martin Griffin, Jakub Kozdryk, James Mason[1], Peter David Henry Wall, J Mark Wilkinson, Andrew John Metcalfe, Pedro Foguet
[1]Warwick Medical School

INTRODUCTION: Component malpositioning in total hip replacement (THR) can increase the risk of revision for various reasons. Compared to conventional surgery, relatively improved accuracy of implant positioning can be achieved when computer-guided and robotic systems are used. However, it is not known whether application of these technologies has improved prosthesis survival in the real-world. This study aimed to compare risk of revision for all-causes and dislocation following primary THR performed using computer guidance and robotic assistance compared to conventional technique.

METHODS: We performed an observational study using data from the National Joint Registry (NJR) of England, Wales, Northern Ireland, the Isle of Man, and the States of Guernsey. All adult patients undergoing primary THR for osteoarthritis only between 1st April 2003 to 31st December 2020 were identified. Patients who received metal-on-metal THR were then excluded. Exposures were THR performed using computer guidance and robotic system assistance. Comparison was conventional THR. We generated propensity score weights (PSW), using Sturmer weight trimming, based on the following variables: age (continuous), gender, American Society of Anesthesiologists grade, side, operation funding, year of surgery, position, approach, bearing, fixation. Outcomes were revision for all-causes and dislocation and were assessed using Kaplan-Meier analysis and expressed using hazard ratios (HR) along with 95% confidence intervals (CI). Further adjustment using Cox Proportional-Hazards covariate adjustment was not required as propensity score weights were stable. For the main analyses, effective sample sizes were 9,379 and 10,600 procedures for computer-guided versus conventional and robotic system assisted versus conventional analyses, respectively. Statistical significance was defined as $p < 0.05$.

RESULTS:

For the computer-guided versus conventional analysis, trimmed unadjusted HR for revision for all-causes and dislocation was 0.771 (95% CI 0.573 to 1.036) p = 0.085 (Figure 1), and 0.594 (95% CI 0.297 to 1.190) p = 0.142 (Figure 2), respectively. Sensitivity analysis which included PSW variable adjustment for Body Mass Index (BMI) resulted in trimmed unadjusted HR of 0.620 (95% CI 0.399 to 0.962) p = 0.033 (Figure 3). Sensitivity analysis for patients aged under and over 60 years showed trimmed unadjusted hazard ratio of 0.938 (95% CI 0.532 to 1.656) p= 0.826, and 0.732 (95% CI 0.517 to 1.036) p = 0.078, respectively. Sensitivity analysis for indications other than osteoarthritis revealed trimmed unadjusted HR of 0.913 (95% CI 0.378 to 2.207) p = 0.84. Duration of follow up extended to 17 years and 9 months.

When comparing robotic system assisted versus conventional THR, trimmed unadjusted HR for revision for all-causes was 0.480 (95% CI 0.067 to 3.452) p = 0.466 (Figure 4). Duration of follow up extended to 3 years and 6 months.

DISCUSSION AND CONCLUSION:

This is the largest study investigating this topic utilizing propensity score analysis methods. We did not find a statistically significant difference in revision for all-causes and dislocation between conventional versus computer guided and robotic assisted THR. However, these analyses are underpowered to detect smaller differences in effect size between groups. Although a statistically significant finding was demonstrated in the sensitivity analysis exploring the effect of including BMI data, this result should be interpreted with caution. This is due to the combination of a relatively larger observed effect size despite reduced power owing to approximately 33% of all procedures lacking BMI data, suggesting the signal may be inaccurate. Additional comparison for revision for dislocation between robotic-assisted versus conventional technique was not performed as this is a subset of revision for all-causes and wide confidence intervals were already observed for that analysis. It is also important to mention this NJR analysis study is of an observational study design which has inherent limitations. Nonetheless, this is the most feasible study design to answer this research question requiring use of a large data set due to revision being a rare outcome.