The Effect of Computer Assisted Technologies on Risk of Revision, Patient-Reported Outcome Measures, and Mortality following Primary Total Knee Replacement: An Analysis of National Joint Registry Data

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

[1]Warwick Medical School

INTRODUCTION: Compared to conventional surgery, relatively improved accuracy of prosthetic component positioning can be achieved in knee replacement using computer-assisted technologies. 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 following primary total knee replacement (TKR) performed using computer guidance, patient-specific jigs, 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 TKR for osteoarthritis between 01/04/2003 to 31/12/2020 were eligible. Exposures were TKR performed using computer guidance, patient-specific jigs, and robotic system assistance. Comparison was conventional TKR. We generated propensity score weights, using Sturmer weight trimming, based on: age, gender, ASA grade, side, operation funding, year of surgery, approach, fixation, and patellar resurfacing. Outcome was revision for all-cause 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. Effective sample sizes and durations of follow up for conventional versus computer-guided, patient specific jigs, and robotic assistance groups were 92,579 procedures over 18 years, 11,665 procedures over 8 years, and 644 over 3 years, respectively. Statistical significance was defined as $p < 0.05$.

RESULTS:

For the computer-guided versus conventional analysis, trimmed unadjusted HR was 0.967 (95% CI 0.888-1.052) p=0.430 (Figure 1). When comparing patient specific jigs versus conventional technique, trimmed unadjusted HR was 0.937 (95% CI 0.708-1.241) p=0.65 (Figure 2). For robotic system assisted versus conventional TKR, trimmed unadjusted HR was 2.094 (95% CI 0.2423 - 18.0995) p= 0.50 (Figure 3).

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 for TKR although these analyses are underpowered to detect smaller differences in effect size between groups. 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.

Figure 1 — Kaplan-Meier survival estimates (Conventional vs Navigation)

Figure 2 — Kaplan-Meier survival estimates (Computer Printed Jig vs Conventional)

Figure 3 — Kaplan-Meier survival estimates (Conventional vs Robotic)