

Prediction of Periprosthetic Femoral Fracture Incidence around Commonly Used Femoral Implant Designs in Primary Total Hip Replacement: A Study Using National Health Data Linked to The National Joint Registry

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INTRODUCTION:

Postoperative periprosthetic femoral fracture (POPFF) after total hip replacement (THR) is associated with a significant burden of morbidity and mortality (1-3). The incidence of POPFF is projected to increase further in the future (5).

Registry studies are typically limited to observation of POPFF treated with revision, which increases bias due to missing data.

Changing femoral implants for primary THR may be a useful way to reduce the incidence of POPFF. Current evidence suggests that the risk of POPFF is greatest following collarless cementless stem usage (10, 11) and polished taper slip (PTS) stems versus composite beam (CB) stem designs (12-14). This evidence is generally limited to revision only registry datasets or smaller studies which lack the power to make accurate generalizations about the performance of stem designs.

The aim of this study is to estimate the incidence of all surgically treated POPFF associated with commonly used stem designs in a large national data set.

METHODS:

This observational cohort study used routinely collected data from the National Health Service (NHS) and the UK National Joint Registry (NJR). All patients undergoing primary THR between 01/01/2004 to 31/12/2020 were included in the study. NJR data was matched to all available hospital admissions by a unique national identifier. Revision or fixation of POPFF were identified using a combination of procedure codes, diagnosis codes.

Where multiple designs existed under the same stem brand, stem brands were further subdivided into unique design categories.

Incidence (PTIR) was estimated using number of POPFF occurring per 1,000 patients. PTIR associated with stem designs was estimated for all commonly used stems. POPFF survival was estimated using a multivariable Cox survival model, built using a step wise ten-fold cross-validation method. PTIR was predicted for a randomly selected representative cohort, as if all patients had undergone primary THR with the stem of interest. The analysis was completed for all patients and subgroups including patients over 70 years, patients with a non-hip osteoarthritis indication, and patients with a neck of femur fracture.

RESULTS:

A total of 864,793 of 1,128,684 (70.3%) patients who had undergone primary THR between 01/01/2004 and 31/12/2020, were matched to national hospital records. In total, 54,961 patients were excluded because of event time coding error (n=2), bearing unknown or not metal on polyethylene or ceramic on polyethylene (n=38,703), unknown stem fixation (n=10,617), unknown cup fixation (3,313), unknown stem design (n=2,326). The final cohort was well matched to all available patients in the NJR.

Median age (Interquartile range [IQR]) of the final cohort was 71 (63 to 77) years and 61.3% (496,576 of 809,832) patients were women. Some 2.8% (22,647/809,832) of patients underwent surgery for revision or POPFF fixation, with a PTIR of 4.09. Another 0.6 % (5,100/809,832) of patients underwent surgery for POPFF, with a PTIR of 0.92. The lowest predicted PTIR for POPFF was observed following THR with CB stems and highest after THR with cementless stems. PTS stems constructed from stainless steel alloys performed better than those made from cobalt chrome alloys. Collared cementless stems performed better than collarless versions.

For patients over 70, PTIR for any revision or POPFF fixation was 4.09, and for POPFF was 1.31. The lowest adjusted PTIR for POPFF was observed following THR with CB stems and highest after THR with cementless stems.

For patients who underwent THR for any reason other than osteoarthritis, PTIR for any revision, or POPFF fixation was 6.34, and PTIR for POPFF was 1.39. The lowest adjusted PTIR for POPFF was observed following THR with CB stems and highest after THR with cementless stems.

For patients with neck of femur fracture, PTIR for any revision or POPFF fixation was 7.39, and for POPFF was 2.19 per 1,000 patient years. The lowest adjusted PTIR for POPFF was observed following THR with collared cementless stems and highest after THR with PTS stems.

DISCUSSION AND CONCLUSION:

POPFF was the largest single cause of major reoperation following THR in the UK, which demonstrates that registry estimates alone under report the true incidence of POPFF. Future work must consider both revision and fixation events when estimating implant performance.

Most POPFF ORIF occurred after cemented PTS stem insertion. It is likely that if ORIF events are included in overall stem performance assessment that this design of stem may fair worse than previously expected.

The predicted incidence varied among the cementless group and collared cementless performed better than the collarless versions in all groups, which confirms previous findings (9, 18). In patients with neck of femur fracture and non-osteoarthritis hip disease, collared cementless stems were among the best performing, which challenges the traditional dogma of the cementless versus cemented stem debate.

PTS stems constructed from stainless steel alloys performed better than those made from cobalt chrome alloys, which is similar to previous evidence (19) (20). CB stems were associated with a low incidence of POPFF, which adds to the weight of evidence which suggests that CB stems may be a suitable stem choice in patients most at risk of POPFF.

This study is limited to hypothesis generation rather than establishing causation, but will set firm foundations for ongoing investigations into implant performance. This study used novel modelling and prediction techniques to overcome bias and confounding which occurs in registry data; further study is required to corroborate these results.

This study has identified POPFF as the leading single cause of major reoperation following THR. The risk of POPFF was dependent on the design features of the femoral implant and in general the predicted incidence was lowest with cemented CB and collared cementless implants.