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ORIGINAL ARTICLE

Primary total hip arthroplasty: registry data for fixation methods and bearing options at a minimum of 10 years

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Abstract

Background Registry data for total hip arthroplasty (THA) has allowed optimal fixation methods, bearing surfaces and many other factors to be assessed. We describe 10-year THA outcomes from an Irish perspective using regional THA registry data for the first time.

Aims We assess the main predictors of revision in primary total hip arthroplasty (THA) using regional registry data.

Methods This was a prospective study of registry data from a National Orthopaedic Hospital for all THAs with 10-year follow-up data. All metal-on-metal THAs and resurfacings were excluded from the analysis. All-cause revision was the primary outcome. Univariate and multivariate analyses controlling for confounding variables were performed to assess predictor impact on primary and secondary outcomes.

Results A total of 1697 THAs were performed in 1553 patients. The three significant predictors for all-cause revision were fixation type ($p < 0.01$), surface bearing type ($p < 0.01$) and femoral head size ($p < 0.05$). The lowest 10-year all-cause revision rates were seen in cemented THRs at 1.2%. Ceramic-on-poly bearings had the lowest revision rate at 0.9%. The 22.225-mm head sizes had a significantly lower revision rate than other head sizes ($p < 0.05$). The causes for revision in order of decreasing frequency were infection (0.7%), dislocation (0.4%), periprosthetic fracture (0.2%) and aseptic loosening (0.1%). There were two re-revisions at 10 years in total.

Conclusions Based on this registry and other emerging registry data, the shift towards uncemented THAs may not be fully supported. We also acknowledge that ceramic-on-polyethylene bearings afford the lowest revision rates in this registry.

Keywords Arthroplasty · Cemented · Ceramic · Hip · Revision

Introduction

In recent literature, a trend has emerged indicating that primary hip arthroplasty surgeons are performing more uncemented THAs and less cemented THAs [1, 2]. There is controversy over this trend however, as there is evidence to suggest that an increased use of uncemented THAs leads to increasing rates of periprosthetic fracture [3, 4]. Regarding surface bearings, many registries have recommended their ideal combination of surface bearings for maximal THA survivorship. These recommendations can vary between registries occasionally. There are many questions to be asked of THA and the experience of different countries as demonstrated through their various registries is invaluable.

Arthroplasty registries in Ireland are in their infancy compared to countries such as Sweden, but they are now becoming meaningful sources of THA data as we surpass the 10-year mark after their initiation. We describe here, the first results from a regional Irish hip arthroplasty registry and we assess current trends, such as those described above, from an Irish perspective.

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Methods

This was a prospective study performed at the National Orthopaedic Hospital (NOH) in Ireland. The NOH joint registry was established in February 2005. It is a comprehensive electronic record maintained by the arthroplasty clinical nurse specialist. Patients undergoing primary THA were identified and enrolled in the registry. For this study, all patients underwent primary THA between the dates of the 1st February 2005 to 31st October 2007. These patients were then prospectively reviewed at postoperative intervals of 6 months, 2 years, 5 years and 10 years. During their review, plain radiographs and functional assessments were carried out by the orthopaedic team until 6 months. After 6 months, the arthroplasty clinical nurse specialist performed the review. Patients with any clinical or radiographic concern were then referred for orthopaedic review and further management. Any revision in the NOH for these patients was automatically documented in the registry. Patients who underwent revision procedures in alternative institutions were identified as 'opt-out' cases. All of these patients were contacted regarding details of their external follow-up and intervention to ensure a complete data set was attained. On review, 48 patients had decided to be managed outside of our institution. Only 17 of these patients were contactable, meaning that 31 patients (1.8%) were lost to follow-up. One hundred and thirteen patients were deceased at the time of review. We therefore had complete 10-year all-cause revision data for 1405 patients, excluding patients who were either deceased or lost to follow-up.

Inclusion criteria included all patients undergoing primary THA with at least 10 years of follow-up. Exclusion criteria included any patient who had their primary procedure performed outside of the NOH. All metal-on-metal implants were excluded from this analysis due to the known rates of increased revision with this bearing type.

Independent variables collected included 'fixation type', 'approach used', 'bearing surface', 'femoral head size', 'operative time', 'BMI' and 'ASA grade'. The primary outcome measure was 10-year all-cause revision. Other secondary outcomes included 're-revision', 'length of stay' (LOS), 'mortality' and functional 'Western Ontario and McMaster Universities Osteoarthritis Index' (WOMAC) scores.

Statistical analysis was performed using STATA©(Stata/IC 13.1 for Mac (64-bit Intel)) software. Firstly, descriptive statistics were performed. Univariate analysis between the listed independent and dependent variables was performed. The statistical test used depended on the variables being analysed. When analysing the predictors for revision, if the independent variable was categorical, the chi-square test was used provided the number of observations exceeded five in each group. If there were less than five observations per group, Fisher's exact test was used. When the independent variables were interval, simple logistic regression was performed. In order to assess the effect of categorical independent variables on WOMAC scores, the Kruskal-Wallis equality-of-populations rank test was used.

Once the univariate analyses were complete, we performed a multivariate analysis assessing the predictors of revision, controlling for the confounding predictor variables identified in our original analysis. Multiple logistic regression was used in this circumstance. A p value of < 0.05 was taken to be significant. Ethical approval was granted by the local ethics committee.

Results

Descriptive

In total, 1696 THAs were performed in 1549 patients between February 2005 and October 2007. The mean patient age was 65 (15–92). There was a 55% female majority. The mean BMI per patient was 28.8 (18–51, $\sigma = 5.4$).

In order of decreasing frequency, the commonest form of fixation used was fully cemented (73%), uncemented (16%), hybrid (10%) and reverse hybrid (1%). The majority of procedures were performed through the anterolateral approach (61%). The posterior approach accounted for 26%, direct lateral for 12% and direct anterior for the remainder. Metal-on-polyethylene (MOP) accounted for 68% of the bearing surfaces used. Ceramic-on-ceramic (COC) accounted for 20% while ceramic-on-poly (COP) accounted for the remainder. Regarding WOMAC scores, the mean preoperative score was 59.3 ($\sigma = 18$). At 10 years, the mean WOMAC was 20.9 ($\sigma = 19.8$), indicating an improvement of 38.3.

Univariate analysis

The primary outcome measure was all-cause revision rate at 10 years. There were 32 revision THA procedures performed in the entire cohort at 10 years giving a revision rate of 1.9%. Infection was the commonest cause for revision, followed by dislocation, aseptic loosening then periprosthetic fracture. Our infection rates were 0.8% at 10 years. The rate of revision for dislocation was 0.4%, aseptic loosening was 0.2% and periprosthetic fracture was 0.2% also.

Methods of fixation were analysed and cemented THAs had a significantly lower revision rate at 1.2% ($p < 0.05$). Uncemented revision rates were 3.2%, hybrid was 3.4% and there was an 8.3% reverse hybrid revision rate. Only 12 reverse hybrid procedures were performed and 1 of these was revised by 10 years. Figure 1 demonstrates the survivorship of THA by fixation method, using revision as failure. COP THAs had a significantly lower revision rate of 0.9% compared to MOP (1.3%) and COC (3.5%) ($p < 0.05$). Figure 2 illustrates the survivorship of THA by bearing surface, again using revision as failure. The third predictor of revision in univariate analysis was femoral head size. Interestingly, the 22.225-mm heads had the lowest revision rate on univariate analysis at 0.9%. Increasing head size equated to increasing revision rates (28 mm = 2.7% revision rate, 32 mm = 3%

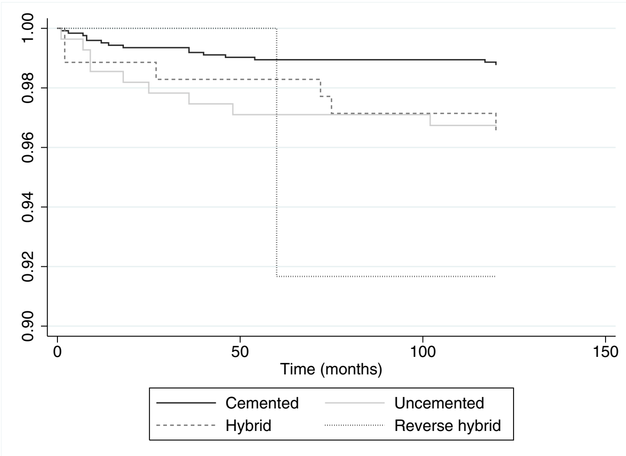

Fig. 1 Kaplan-Meier survival estimates by method of fixation

revision rate, 36 mm = 4.3% revision rate). Only eight THAs were performed with a head size of 44 mm or larger. None of these were revised. Eight hundred thirty-three THAs were performed with a head size of 22.225 mm. Only two of these were revised for dislocation. Two out of 32 28-mm THAs were revised for dislocation. Two of 193 32-mm THAs and 1 of 111 36-mm THAs were revised for dislocation also. Of note, the approach used, patient gender and BMI had no impact on revision rates.

One case was re-revised within 10 years and one case was revised three times. The first case was a 77-year-old male with a cemented Charnley® Modular THA with a 28-mm head. At 3 years, due to recurrent dislocation, the patient underwent a single stage revision. At 5 years, there was evidence of aseptic loosening.

A hybrid Trident/Exeter® THA was inserted and the patient has had an uneventful course since then. The second patient undergoing three revisions was a 69-year-old male who had a Trident/Exeter® inserted through a posterior approach with a 40-mm head size. At 8 years, the patient developed a prosthetic infection which was treated with a 2-stage revision. Within the next 2 years, the patient was revised a second time for recurrent dislocation and a third time for a recurrent prosthetic infection. On latest follow-up at 10 years, he was asymptomatic.

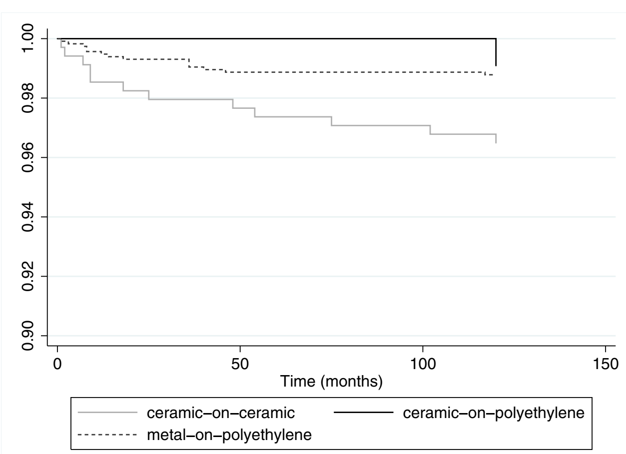

Fig. 2 Kaplan-Meier survival estimates by bearing surface

Regarding secondary outcomes, blood loss was found to be higher with increasing operative time, female gender and raised BMI ($p < 0.05$). Fixation type had a significant effect on the LOS. Cemented prostheses had the longest LOS while hybrid prostheses had the shortest LOS. Direct anterior and posterior approaches had the shortest LOS followed by the anterolateral approach. Patients who underwent the direct lateral approach, especially with a trochanteric osteotomy, had a significantly increased LOS compared to other approaches ($p < 0.05$).

At 10 years, the mean WOMAC scores had improved compared to the preoperative baseline scores. At 10 years, using the Kruskal-Wallis statistical method, it was found that uncemented THAs had the lowest WOMAC scores (mean = 17.6), followed by hybrid then cemented THAs ($p < 0.05$). Ceramic-on-ceramic bearings had significantly lower WOMAC scores (mean = 16.6) compared to COP and MOP bearings ($p < 0.05$). Men had significantly lower scores than women (mean = 19.0) ($p < 0.05$). The approach used had no effect on the WOMAC score at 10 years.

Multivariate analysis

The three significant predictors of revision were method of fixation, bearing surface type and head size. Multivariate analysis controlling for these confounding variables was performed using multiple logistic regression. There was a significant relationship noted in the overall model ($p < 0.05$). However, when the individual independent predictor variables were analysed, there was no significant predictor of revision when controlling for confounding variables in this cohort ($p > 0.05$).

Limitations

Study limitations include a number of factors. This is a heterogeneous cohort of patients who were treated by 1 of a total group of 25 consultant orthopaedic surgeons. Surgical techniques are therefore varied across the group. A benefit of a multi-surgeon analysis however, is that the findings are likely to be more representative of the orthopaedic community at large. Loss to follow-up occurred in 31 cases and 113 patients were deceased on review at 10 years. The specific cause of death was not recorded for the deceased patients as these deaths occurred external to and independent of our institution. No patients were known to have died during their inpatient stay at our institution. Patients that were lost to follow-up elected to be treated elsewhere through their own volition. This will affect the true figures for all-cause 10-year revision rates but likely only minimally. The small number of revisions poses a problem when interpreting the comparative revision rates between groups. When the number of cases revised is so low, a single case can apparently have a major effect on the overall revision rates. This is not due to an insufficient study power as 1696 THAs is a significant number. This is more attributable to the low number of revisions seen overall in this registry, which is desirable from a surgeon's perspective in general.

Discussion

Internationally, over recent years, there has been a trend towards an increasing number of uncemented THAs with a subsequent decline in the overall use of cemented THAs for primary THA [1]. Uncemented implants are often used in the younger population [2]. Evidence suggests that the increasing usage of uncemented stems may be associated with a higher rate of periprosthetic fracture rates when compared to cemented stems [3, 4]. A known disadvantage of cemented prostheses however, is the risk of aseptic loosening. Cemented THAs have a significantly higher rate of aseptic loosening when compared to uncemented prostheses [5].

Arguments can be made for the use of cemented and uncemented prostheses based on these considerations. The rate of all-cause revision, however, has been repeatedly demonstrated as equivocal between these two forms of fixation [6]. In fact, some studies have confirmed improved all-cause revision rates for cemented stems [7, 8]. In 2017, Hughes et al. reviewed results from the Australian, Finnish, Italian and Danish registries. All data had at least 10-year outcomes. Their findings showed that certain cemented THAs performed better than even the best performing uncemented THAs [7]. These findings beg the question as to why there is such an international shift among orthopaedic surgeons to the use uncemented prostheses for primary THA. In this regional Irish arthroplasty registry, we confirm that cemented THAs had the lowest revision rate at 1.2%. This was 2% lower than the uncemented cohort and 2.2% lower than the hybrid cohort. This was a statistically significant finding.

In 2017, 106,139 THAs were analysed from the New Zealand arthroplasty registry. Sharplin et al. confirmed that a ceramic-on-highly cross-linked polyethylene bearing afforded the lowest all-cause revision rate [9]. Similar to this study, we report the lowest revision rates in COP bearings. We observed a 0.9% all-cause revision rate at 10 years in the COP cohort. MOP had a 1.3% revision rate and COC bearings had a 3.5% revision rate. Two revisions in the COC cohort were performed for prosthetic 'squeak' and ceramic head fracture. Ceramic head fracture is a rare complication specific to ceramic head usage [10]. Recent literature describes the issues of liner fracture, audible noises, clicking and squeak with COC bearings [11]. These complications may be avoided with the use of alternative bearings.

Increasing femoral head size affords a lower risk of THA dislocation [12]. Larger femoral head sizes, however, have been associated with increased rates of volumetric wear [13]. Interestingly, we found that the original Charnley® 22.225-mm femoral head had the lowest rates of revision on univariate analysis. Only 2 of the 833 22.225-mm femoral heads were revised for dislocation. Compared to the larger femoral heads, 2/321 28-mm heads were revised for dislocation. 2/192 32-mm heads were revised for dislocation and 1/110 36-mm femoral heads were revised for dislocation. The rates of revision for aseptic loosening were very low. Only 2 of the 22.225-mm heads were revised for this indication. Only 1 28-mm, 32-mm and 36-mm head were revised for aseptic loosening also. It is not clear why a smaller femoral head is protective against revision here. Perhaps, the inherently low rates of aseptic loosening with smaller femoral heads coupled with the very low rates of dislocation for all head sizes seen in this particular regional registry can account for the findings observed. This may also be due to surgeon-specific closure-techniques. Another hypothesis is that the 22.225-mm head sizes tended to be used by the more senior experienced surgeons in the unit. Naturally, this group of surgeons would be expected to have lower revision rates as they are further on in their practice. It is difficult to assess this relationship due to the large volume of consultant surgeons enlisted in this registry. On multivariate analysis, when controlling for other predictor variables, the femoral head size was found to be a statistically insignificant predictor of revision ($p = 0.095$).

Conclusion

Based on this regional registry, we observe that the three main predictors of revision are fixation method, bearing surface and femoral head size. Cemented THAs have the best 10-year all-cause revision rate at 1.2%. Ceramic-on-polyethylene bearing surfaces had the lowest 10-year all-cause revision rates at 0.9%. We found that smaller femoral head sizes actually have lower 10-year all-cause revision rates when compared to larger head sizes. We postulate that this may be due to surgeon-specific techniques or the low total number of revisions for dislocation seen in this particular registry. We therefore conclude that the international increase in the use of uncemented THA with a concurrent decline in cemented THA may not be fully supported by emerging registry data. We can fully support the regular use of COP bearings. We note the poor performance of reverse hybrid fixation methods and COC bearing surfaces and advise surgeons to consider their continued role in standard future clinical practice.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Full ethical approval was granted by the local research ethics committee.

For this type of study formal consent is not required.

This article does not contain any studies with animals performed by any of the authors.

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