Medical Research Archives

European Society of Medicine

Published: May 31, 2024

Citation: Williams P, Hannah A., et al., 2024. Trends in revision hip replacement surgery - a 21-year review of the New Zealand Joint Registry. Medical Research Archives, [online] 12(5). https://doi.org/10.18103/mra.v12i5.5253

DOI:
https://doi.org/10.18103/mra.v12i5.5253

ISSN: 2375-1924

RESEARCH ARTICLE

Trends in revision hip replacement surgery - a 21-year review of the New Zealand Joint Registry

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ABSTRACT

Introduction: This study aimed to examine the changing trends in the reasons for total hip replacement (THR) revision surgery, in one country over a twenty-one-year period, in order to assess whether changes in arthroplasty practices have impacted revision patterns and whether an awareness of these changes can be used to guide clinical practice and reduce future revision rates.

Methods: The reason for revision THR performed between January 1999 and December 2019 was extracted from the New Zealand Joint Registry (NZJR). The results were then grouped into seven 3-year periods to allow for clearer visualization of trends. The reasons were compared across the seven time periods and trends in prosthesis use, patient age, gender, body mass index (BMI) and American Society of Anesthesiologist (ASA) grade were also reviewed. We compared the reasons for early revision, within one year, with the overall revision rates.

Results: There were 20,740 revision THR registered of which 7665 were revisions of hips with the index procedure registered during the 21-year period. There has been a statistically significant increase in both femoral fracture (4.1 - 14.9%, $p<0.001$) and pain (8.1 - 14.9%, $p<0.001$) as a reason for hip revision. While dislocation has significantly decreased from 57.6% to 17.1% ($p<0.001$). Deep infection decreased over the first 15 years but has subsequently seen further increases over the last 6 years. Conversely both femoral and acetabular loosening increased over the first 12 years but have subsequently decreased over the last 9 years. The rate of early revisions rose from 0.86% to 1.30% with a significant rise in revision for deep infection (13-33% of all causes, $p<0.001$) and femoral fracture (4-18%, $p<0.001$), whereas revision for dislocation decreased (59-30%, $p<0.001$). Adjusting for age and gender femoral fracture and deep infection rates remained significant for both ($p<0.05$). Adjusting for age, gender and ASA was only significant for infection.

Conclusions: The most troubling finding was the increased rate of deep infection in revision THR, with no obvious linked pattern, whereas the reduction in revision for dislocation, aseptic femoral and acetabular loosening can be linked to the changing patterns of the use of larger femoral heads and improved bearing surfaces.

Introduction

Total hip replacement (THR) is a proven, successful operation for reducing pain and improving quality of life[1,2]. Ongoing, increasing worldwide requirements for THR is well documented[3–6] and numerous studies project future demand to be significantly increased[7–9]. This is directly associated with a steadily, constantly increasing number and burden of revision total hip replacements (rTHR)[9,10] which is expected to place significant pressures on future healthcare funding[5,7,8]. While it is postulated that this increase in the number of rTHR is largely linked to increasing life expectancy and an aging population, undoubtedly the increasing prevalence of obesity[11] and success of the procedure, with extending the surgical indications to younger patients[12], also has a significant effect.

Since the introduction of THR in the 1960s many changes have occurred in both the design of implants and our understanding of failure mechanisms but there has been minimal research into how these changing trends of practise, over many decades, has impacted on the rate of revision surgery. Reliable information on the patterns of THR failure is required to help guide changes in clinical practice and reduce future revision rates.

The New Zealand Joint Registry (NZJR) is a national registry which has recorded all index and revision hip replacements since 1999 with >95% capture rate. By examining the 21-year results of the NZJR we aimed to determine if there were any changing patterns in the reason for revision of hip replacements. In particular, we were interested in observing the trends in the six commonest reasons for early hip revision and comparing these changes with implant usage patterns across the same period. We also aimed to review whether there was any correlation between alterations in early revision patterns and changing patient demographics, in particular age, gender and associated co-morbidities.

Methods

Data on all primary and revision THR's was extracted from the NZJR between January 1999 and December 2019. Metal-on-Metal hip replacements were excluded as they are infrequently performed, accounting for approximately 1% of the registry database and the complications with these implants are well documented[13].

Revision was defined as any new operation in a previously replaced hip joint during which one of the components is exchanged, removed, manipulated or added. Early revision was defined as a replacement that was revised within one year, which enabled all index procedures recorded on the registry to be followed for a minimum of 12 months. The overall revision rates were calculated by dividing the number of revisions per year by the total number of primary procedures for that year, expressed as a percentage. The reason for revision was expressed as a percentage of the number of revision procedures performed in that year.

To allow for visually clearer trends in revision patterns over the 21-year period, the results were then grouped into seven 3-year time periods. The results for each period were summated and a percentage for the six commonest reasons for revision were calculated for each 3-year time period. This data was then compared to the changing patterns of implant use, age, gender, Body Mass Index (BMI) and comorbidities as represented by the American Society of Anaesthesiology (ASA) score, over the 21-year period. Age was divided into four categories: under 55 years-of-age, 55 to 64, 65 to 74 and 75 and over. The ASA score was limited to classes 1-4 as ASA 5 represents those patients who are moribund and not applicable to elective hip surgery.

The reasons for all revisions and early revisions were compared between the 3-year epochs using chi-squared tests and a two-tailed p-value <0.05 was taken to indicate statistical significance.

Results

Procedures

Between January 1999 and December 2019, 144,786 primary THRs were registered on the NZJR. Over the same period 20,740 revisions were recorded. Of these 7,665 had their primary surgery recorded on the NZJR, the remaining revisions had their primary surgery carried out prior to the formation of the NZJR and, therefore, are not included in the early revision analysis. However, they are included in the overall revision data analysis as the primary surgery data is not needed for this. The mean time from primary surgery to revision was 6.1 years (0 – 20.6 years).

Patient demographics

Over the 21 years of the observed period the mean age of patients undergoing primary THR has remained static at 67 (range 13-101). However, there has been a slight decrease in the mean age of those patients requiring revision surgery from 64 to 62 years. Conversely, the age of patients having an early revision (within 12 months of primary surgery) has increased from 64 to 66 years.

Patients undergoing primary THR were predominantly female (53.5%) which did not significantly vary over the study period. Both early and late revisions showed a slight predominance towards male patients (51% early, 51.9% late) but this fluctuated year on year.

Body mass index data was only recorded on the NZJR from 2008 with relatively little increase in the mean BMI of those undergoing primary THR (29.7 to 31.3), with a similar small increase in the mean BMI of patients undergoing early revision surgery (29.7 to 31.26).

American Society of Anaesthesiologists data was only collected from 2005 onward with no significant change in the ASA grades of patients undergoing primary THR (ASA 1 – 16%, 2 – 59%, 3 – 24%, 4 – 1%) and this ratio is mirrored in the overall revision population. However, it is worth noting that the early revision group has shown a consistent decrease in ASA 1 patients (15.2 – 9.4%) with a corresponding increase in ASA 2 patients (54.3 – 62.2%). In the final 3-year period of the study data the ASA 3 group showed a spike in early revision (39.1%) but this does not reach statistical significance. Despite this it is clear to see that ASA 1 patients undergo fewer early revisions and ASA 3 patients more (30%) than the overall revision cohort.

Techniques

Over the 21 years of the study period predominant surgical approach has been posterior, with little change between other approaches, although the direct anterior approach has increased in popularity over the last 5 years. The overall surgical time has remained similar over the years. The use of designated laminar flow operating rooms and protective "space suits" is also unchanged.

Total hip replacement components can either be cemented or uncemented. A hybrid THR normally involves a cemented femoral component and an uncemented acetabular component. The study period has seen a steady decline in the use of fully cemented implants (35% to 7%) with both hybrid (36% to 43%) and fully uncemented (28% to 50%) constructs taking over.

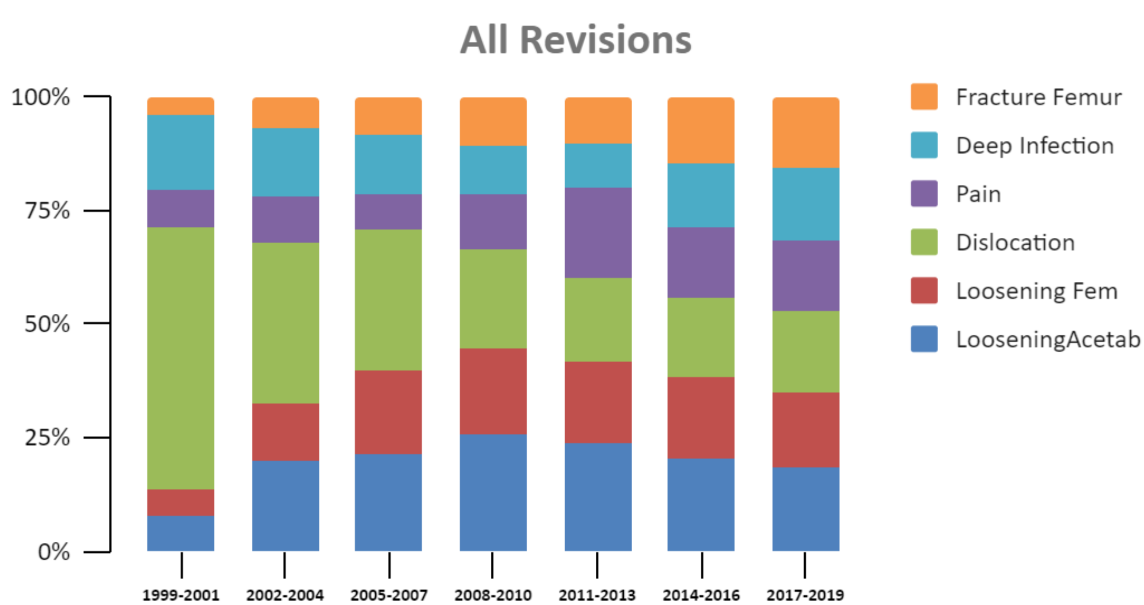
The bearing surface of a THR is the mobile junction between the femoral head and the acetabular component. The NZJR shows that metal on polyethylene bearing surfaces have steadily declined from 71% to 40% of primary THRs. Conversely, ceramic on polyethylene bearings have increased from 16% to 51% of primary THRs, with the use of highly cross-linked polyethylene steadily increasing from 2000 to now being the commonest polyethylene inserted in well over 95% of cases. Ceramic on ceramic bearings saw an initial increase from 4% to 18% before declining to 7% by the end of the study period.

As well as having options for the material the femoral head is made of, surgeons can choose how big a femoral head they wish to use. A steady move towards larger femoral heads has been shown in the data. The earliest cohort show that 84% of patients got a femoral head of 28mm or less. However, by the final cohort only 12% received a head measuring 28mm or less. There was an early move to 32mm heads and latterly a move towards 36mm heads.

Revisions

Figure 1 shows the trend in revision cause over the study period. This includes all revisions and includes patients who had their primary surgery prior to the NZJR being formed.

Figure 1: The cause of revision hip replacement per three-year period



Over the 21-year period there has been a statistically significant increase in both femoral fracture (4.1 – 14.9%, P<0.001) and pain (8.1 – 14.9%, P<0.001) as a reason for hip revision. While dislocation has significantly decreased from 57.6% to 17.1% (P<0.001), although after the dramatic decrease seen in the early years numbers have remained relatively static since 2011.

Deep infection as a reason for revision consistently decreased over the first 15 years but has subsequently increased over the last 6 years back to similar preliminary levels of approximately 16%. Conversely both femoral and acetabular loosening increased over the first 12 years but have subsequently decreased over the last 9 years, suggesting a possible implant or fixation problem which may now have been improved.

While the 6 commonest reasons for revision started out with very different percentage contributions, these have all now balanced out so that each reason for revision contributes to approximately 1/6th of the overall number of rTHR (15-18%).

Figure 2: The cause of early revision total hip replacement per 3-year period

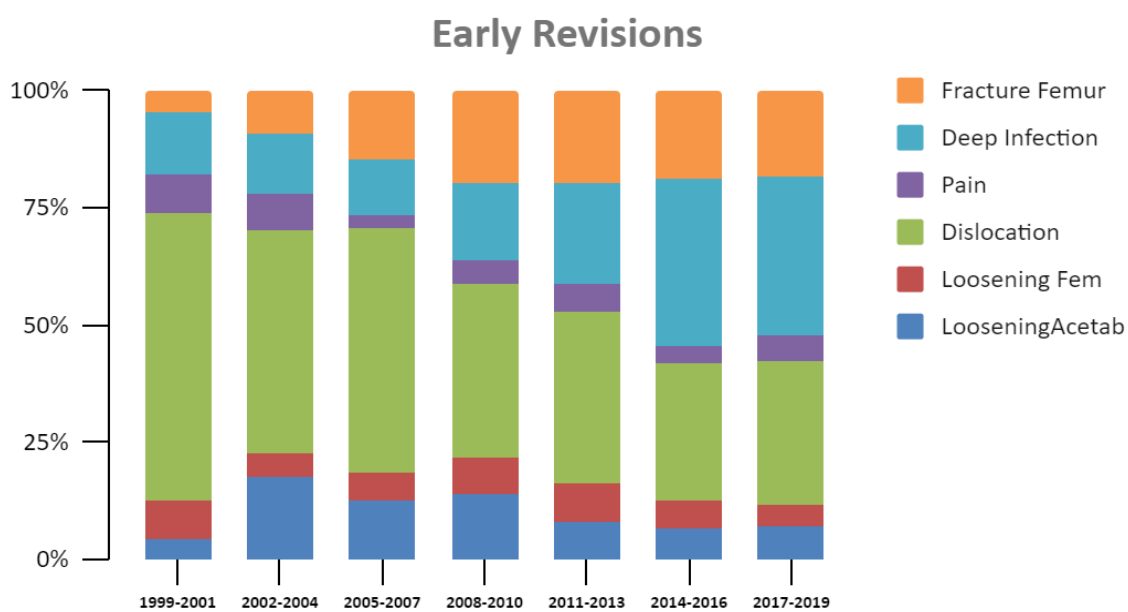


Figure 2 depicts the reasons for early revision hip replacement expressed as a percentage, per three-year period. Early revisions, within one year of implantation, increased from 0.86% to 1.30% of all hip arthroplasty per year during the study period (P<0.001).

Over the 21-year period dislocation has significantly decreased as a reason for early hip revision (59.1 – 30% P<0.001) but remains the second commonest cause for early revision. While both deep infection (13 – 32.7% P<0.001) and femoral fracture (4.3 – 17.8% P<0.001) have statistically significantly increased. Although femoral fracture has slightly decreased over the last 12 years (19.5 – 17.8%).

Acetabular loosening demonstrates a similar pattern to the overall revision group, in that percentages initially increased but have since decreased and remained relatively static at around 7% over the last 9 years. Both femoral loosening (P=0.474) and pain (P=0.140) have not demonstrated any significant change, remaining relatively static throughout. These 3 revision causes make up a small percentage of the early revisions which fits with the expected timeline of these pathologies.

Discussion

The purpose of this study was to analyse the patterns of revision hip replacement over a twenty-one-year period using a national joint registry which has greater than 95% capture rate of all index and revision procedures performed in New Zealand. We were particularly interested to see whether changing patterns of surgical behaviour, specifically prosthesis choice, could be associated with these trends in revision practice.

The single biggest change seen is in the rate of revision secondary to dislocation. This is true for both early and late revisions. We propose that the reduction in early revision for dislocation is likely due to the rise in the use of larger femoral head sizes. Moving to larger femoral heads is strongly suggested by the global literature[14–17] to reduce mechanical instability of the hip. This has probably contributed to the reduction in overall dislocation rate. However, it is also important to consider the rise of modern bearing surfaces with lower wear rates. As older polyethylene bearing surfaces wear out the hip becomes less stable and predisposed to dislocation. Therefore, these patients are likely to undergo late dislocation and only appear in the overall dislocation rate data. Modern bearing surfaces, particularly highly crosslinked ultra-high molecular weight polyethylene (XLPE), demonstrate significantly lower wear rates[18–20] and it is hoped that the rate of late dislocation will fall as older hip replacements are phased out of the data. The use of XLPE has enabled thinner polyethylene liners which in turn has allowed the use of larger femoral heads.

There were some concerns raised about the possibility of larger head sizes leading to higher wear rates[21] and the possibility of acetabular liner fractures[22–24]. These concerns are likely responsible for a move towards 32 mm heads in the middle of our study period but have since been shown not to be an issue and there has been a further move towards 36mm heads. It is hoped that this will reverse the recent trend showing increased early dislocation rate.

As mentioned above, the wear rate of modern XLPE is significantly lower than previous iterations[25–27]. The move to XLPE is likely to be responsible for the gradual reduction in femoral and acetabular loosening seen in the overall revision data. This data is likely to lag behind the widescale adoption of XLPE, from 2000 onwards, as loosening typically takes years to develop. This is demonstrated by the very low rates of early revision for loosening. As most of the acetabular cups implanted are now uncemented, this reassures surgeons that this implant-bone interface is reliable. There is also some evidence to suggest that the increased use of uncemented femoral stems may lead to lower risk of femoral loosening as we see in our data[28].

Overall revision for infection has shown an initial fall and more recent increase but this has never reached statistical significance. Infections occurring beyond one year post surgery are often caused by haematogenous spread from elsewhere in the body, making it a revision cause that is challenging to directly influence. It may be expected to see an increase in late revision for infection as the overall populations ages and tends towards higher ASA categories, but this does not seem to match with our data.

In contrast to revision for late infection, early revision for infection has shown a significant increase over recent years. This is in keeping with data from elsewhere in the world[29–31]. When each year was reviewed there was a gradual increase in revision rates for infection without one year dominating each group. This rate was significantly higher ($p<0.001$) in patients with increased ASA score and although the overall ASA score for patients undergoing primary THR on the registry has not changed, those requiring revision have, with a 2.5 (11.65% to 28.70%) increase across the time period in those with ASA 3 or 4. We have used ASA rating as a surrogate for patient co-morbidities and as such this is a relatively blunt tool despite being validated for this use.

It is likely that the increase in early revision for deep infection is multimodal and it is important to consider factors beyond the ageing and increasingly co-morbid population. Other factors such as surgical time, prophylactic antibiotics, the use of laminar flow theatres and 'space suits' have all been implicated[29,32] but we have not seen any variation in these over the study period. It is also possible that with increased awareness of the devastating effects of periprosthetic infection, and the importance of early treatment, that more patients are being identified early. This goes hand in hand with the improved techniques we now have to detect these infections.

There has been an increase in both early and overall revision rate for femoral fracture over the period of this study. This seems to coincide with the increased use of uncemented femoral stems. This is in accordance with the wider literature[33,34]. The rate of delayed femoral fracture has also increased in recent years. This may be related to the increased use of uncemented stems, but it is also likely to be a marker of an ageing population with greater falls risk.

It is important to note that this study is limited by the nature of the data we are looking at. In depth analysis and statistical attempts to attribute causality are beyond the scope of this paper. Instead, we have tried to give an overview of the trends we are seeing and correlate these with existing evidence from the global literature. We feel this analysis is worthwhile as it allows identification of areas for further work and gives the non-specialist an up-to-date picture of current revision causes.

Conclusion

This paper lays out the major trends in the causes of total hip revision surgery using data from the New Zealand Joint Registry. The data suggests that, when looking at all time points, the 6 major causes of revision have equalized over the study period. This has predominantly been driven by a fall in the rate of revision for dislocation, likely associated with the move towards larger femoral heads and better wearing materials. Analysis of early revisions has shown a concerning trend with increasing rates of revision for infection. This is difficult to explain and is likely to be multimodal in nature. There has also been an increase in the percentage of early revisions carried out for femoral fracture, which may be associated with the increased use of uncemented stems.

Conflict of Interest Statement:

None

Funding Statement:

None

Acknowledgement Statement:

None

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