



# Total hip replacement—the cause of failure in patients under 50 years old?

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## Abstract

**Aim** To establish the mode of failure of primary total hip replacement in patients under 50 years old.

**Methods** A total of 1062 revision total hip arthroplasties were performed over a 5-year period, with 146 on patients under 50 years old. These were subdivided into early (< 5 years) and late (> 5 years) failures from the index procedure.

**Results** The commonest mechanism of failure was aseptic loosening (42.3%) followed by metal-on-metal failure (15.8%), infection (14.4%) and instability (9.6%). The commonest cause of early revision surgery was due to metal-on-metal failure (27.8%) followed by aseptic loosening (19.7%) and infection (18.4%). In the late revision group, the main cause of failure was aseptic loosening (64%) and infection (10.7%).

**Conclusion** The changing trend of early revision due to metal-on-metal failure is important to recognise. Continuous review of the mechanism of primary total hip replacement failure is necessary to ensure the best patient outcome and maximise implant survivorship.

**Keywords** Mode of failure · Revision total hip replacement · Total hip replacement

## Introduction

Total hip arthroplasty is a successful procedure with over 90% of patients experiencing improvement in pain and function [1]. In the National Joint Registry of England, Wales Northern Ireland and the Isle of Man (NJR), over 83,000 primary total hip replacements (THR) were performed in 2015. The cumulative revision rate of all fixed bearing THR at 3 and 5 years was 1.59% and 2.51% respectively [2]. The impact of revision surgery on a patient is significant, with an increased risk of mortality and major complications compared with primary arthroplasty [3, 4]. Revision surgery is complex and associated with increased costs and resource utilisation. The number of revision THR cases is predicted to increase exponentially over the next 20 years [5], as patients undergoing the procedure are younger and more active, and have an increased life expectancy.

The goal of THR surgery is to provide a pain-free, stable and functional prosthetic hip joint, but maximising the

longevity of the implant is also of paramount importance especially in the younger patient. Knowledge of the mechanism of failure of THR in the younger patient is fundamental to providing better care. Total hip revision surgery can be attributed to patient/host-specific risk factors, implant-related factors and poor surgical technique. Aseptic loosening, instability and infection are the common reasons for failure in several national joint registers [2, 6, 7]. Larger head diameter, porous metals to improve fixation, alternative bearing surfaces to decrease wear and an appreciation of the soft tissue repair have all been introduced to reduce failure rates with varying success and controversy [8–10].

The aim of this study is to evaluate the modes of failure of primary THR in a tertiary referral centre in patients under the age of 50 at the time of their revision procedure. This knowledge is essential to improve patient care and establish strategies to mitigate against early and late failures in this younger population group.

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## Patients and methods

Institutional review board approval was granted for this study. A systematic retrospective review of all revision THRs was

performed at our tertiary referral centre between 2008 and 2013. A total of 1062 revision hip arthroplasty procedures were performed during this period, with 146 on patients under 50 years old. An institutional prospective hip arthroplasty register was used to determine the failure mechanism and corroborated by review of the operative note. Demographic data for each patient was collected including age at date of revision hip surgery, gender, date of primary procedure, and date of revision surgery. The data resources reviewed included the patient chart, operative notes, discharge summaries and relevant radiographs. Inclusion criteria included minimum 2-year follow-up post revision THR. Hemiarthroplasty and dynamic hip screw failures were excluded.

All revision THR patients were subdivided into early (< 5 years) and late (> 5 years) failures depending on the timing of the primary procedure. This stratification for time to failure for primary arthroplasty procedures has been previously used in other studies [11, 12]. The mode of failure was classified as aseptic loosening, instability, infection, metal-on-metal-related failure, periprosthetic fracture and miscellaneous, which included iliopsoas impingement, 'squeaky' ceramic THR, fracture of ceramic femoral head and leg length discrepancy. In order to be classified as a metal-on-metal failure, the patient must have one or more of the following: pain, elevated serum ion levels, or the confirmed presence of adverse local tissue reaction. The metal-on-metal prosthesis components also had to be well fixed; otherwise, the procedure would be reclassified into another of the groups.

Descriptive statistics are reported as number (percentage) of people for categorical variables and mean (SD) for continuous variables. The chi-squared test was used to determine whether early or late failure was related to gender. Variables were statistically significant if they had a *p* value less than 0.05.

## Results

One hundred forty-six revision THR procedures were performed in our institution in patients aged less than 50 years at the time of surgery. The mean age at time of the primary surgery was 43.4 years (range 18–49). Seventy-nine patients were female and 67 were male. The overall mean time from index procedure to revision was 7.36 years ( $\sigma = 6.7$ ).

In the early group (< 5 years of primary THR), there were 71 patients, with a mean time before revision THR of 2.15 years (range 3 days–4.97 years,  $\sigma = 1.45$ ). The mean age for revision was 42.9 years. There were 60.5% male (43 males and 28 females).

In the late group (> 5 years), there were 75 patients, with a mean time to revision of 12.3 years (range 5.1–29.1 years,  $\sigma = 5.9$ ). The average age was 44.0 years ( $\sigma = 6.42$ ). There was 30.1% male (51 females and 24 males). Table 1 shows the overall mode of failure in the under 50 patient population in our study.

**Table 1** Overall mode of failure of the patient cohort

Mode of failure	No. of patients ( <i>n</i> = 146)
Aseptic loosening	62 (42.3%)
Metal-on-metal failure	23 (15.8%)
Infection	21 (14.4%)
Dislocation	14 (9.6%)
Periprosthetic fracture	10 (6.8%)
Miscellaneous	14 (9.6%)
Polyethylene wear	2 (1.4%)

Figure 1 displays the mechanism of failure and the percentage of patients with each mode of failure in the early, late and overall subgroups. In our cohort of patients under 50 years of age, 48.6% underwent early revision THR and 51.4% of the revisions were performed more than 5 years after the primary surgery.

Overall, the most common aetiology of failure was aseptic loosening of the implants (42.4%). In 36 patients (58%), both the femoral and acetabular components were loose. In 20 (32.3%) cases, only the acetabular cup needed revision, and in 6 patients (9.7%), only the femoral stem required revision. Aseptic loosening was more common in the late group, accounting for 64% of patients undergoing revision THR more than 5 years after the primary procedure. In the early revision group, aseptic loosening only accounted for 19.7%. Figure 2 shows the percentage of patients with each mechanism of failure.

Metal-on-metal-related failure was the main cause of revision THR in the early group accounting for 26.8%, compared to 5.3% in the late revision surgeries. Periprosthetic fracture accounted for 10 patients (6.3%) in the early group, with four of these patients sustaining a fractured neck of femur involving a metal-on-metal hip resurfacing.

Infection was responsible for 18.3% of revisions performed within 5 years of the primary THR. In the late failure group, infection accounted for 10.7% of revision arthroplasty procedures, and overall in both groups, infection accounted for 14.4% of revision THR in patients under 50 years old at our institution. Instability was observed in 15.5% of early and 4% of late revision surgeries. Polyethylene wear was a cause of failure only in the late revision hip surgery group.

Regarding gender in the two categories of early and late failure, there was a significantly larger proportion of males in the early group ( $p < 0.005$ ). In the late group, a significant number of the patients were female ( $p < 0.05$ ).

## Discussion

Revision THR in the younger patient can be complex, challenging and resource intensive. It has been shown there is a two to fivefold increase in the rate of an adverse event following revision THR with respect to mortality (2.6%), deep infection (1%)

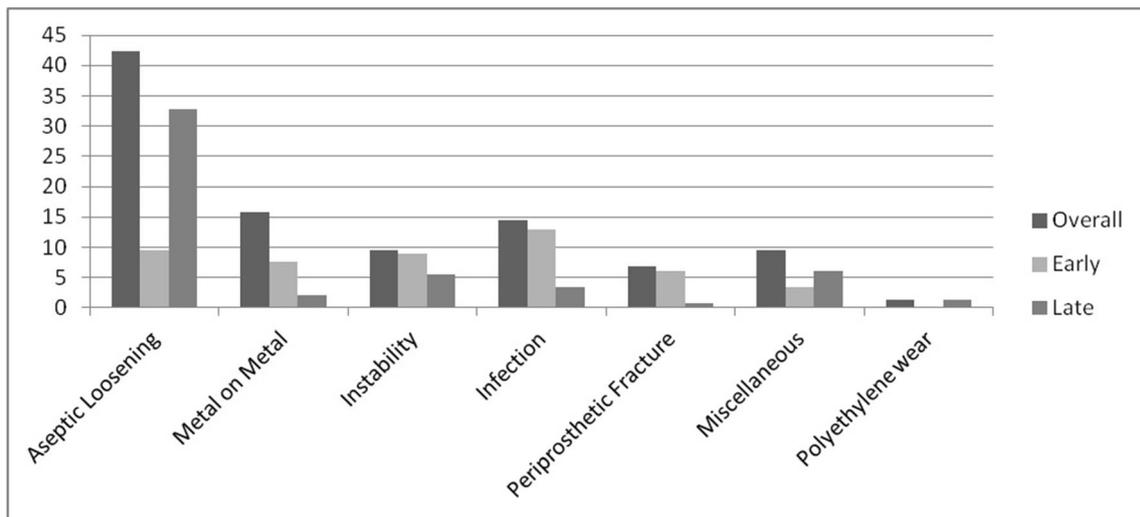


Fig. 1 Percentage of patients with each failure mechanism comparing the overall, early and late groups

and dislocation (8.3%) within 90 days of surgery, when compared to the primary procedure [4]. Pain relief and functional outcome are also not as favourable following revision surgery [13]. In young, active patients, this diminished function is not well tolerated [14], and so it is imperative that the surgeon undertakes all available measures to avoid revision surgery in the future in order to maximise patient outcomes and implant durability. An understanding of the cause of failure in primary THR is paramount. This has been previously analysed in all age groups [11, 15, 16], but the purpose of this study was to determine the mode of failure in the under 50 years of age population at the time of revision surgery and further delineate the cause of early and late revision.

The National Joint Registry of England, Wales and Northern Ireland showed that patients younger than 55 years old have a higher failure rate, with an overall inverse relationship between the probability of revision and the age of the patient [2]. This high failure rate in younger patients has also been shown in other national joint registries [17]. Fevang et al. [18] in a review of the Norwegian Joint Registry showed there was a decrease in the overall revision THR rate, but a shift towards early revision due to infection and dislocation.

Early failure of primary THR within 5 years of the index procedure was also analysed by Melvin et al. [15]. In their study, 24.1% of primary THR underwent revision within 5 years. Aseptic loosening, infection, instability, metallosis

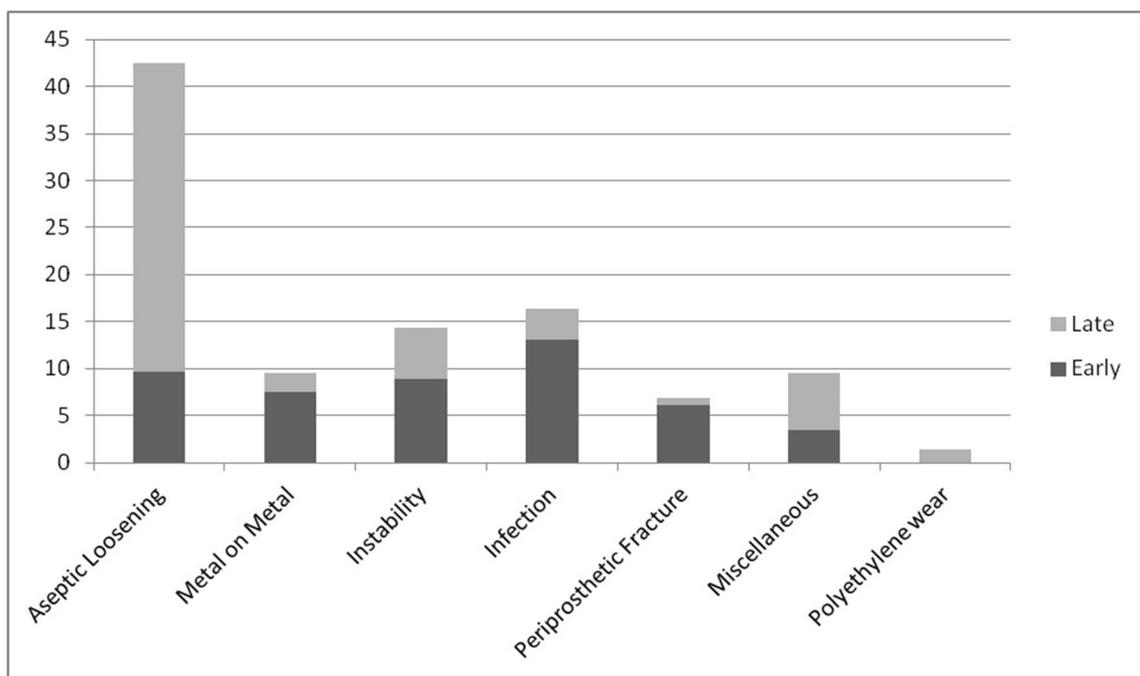


Fig. 2 Percentage of patients for each mechanism of failure

and periprosthetic fracture were the common modes of failure, in descending order. In our study, the main cause of early revision within 5 years was metal-on-metal-related failure (26.8%). Melvin et al. reported aseptic loosening as the most common cause of failure with metal-on-metal failure only accounting for 13.8% of revisions. The increasing number of early revision of metal-on-metal implants has been reported previously [2, 6, 7]. The results of this study further corroborate that this type of articulation remains a major cause of failure and leads to early revision surgery. Fracture of the femoral neck with a metal-on-metal hip resurfacing implant in situ also contributed to 40% of the early periprosthetic fracture revision cases in this study.

Ulrich et al. [11] reported that 50% of their 237 revisions occurred within 5 years of the primary procedure. The mean time to failure was 5.25 years, and overall there was an increase in the mean time to failure as the patient age increased. In their study, the main modes of early failure were instability (30.5%), aseptic loosening (27.1%) and infection (19.6%). The late failures were predominantly due to aseptic loosening (80.7%) followed by infection (9.2%). The mean time to failure was 7.36 years in patients undergoing revision THR under the age 50 years old in our study. In our patient cohort, the early mode of failure was different with the metal-on-metal failure followed by aseptic loosening, then infection and instability. The changing paradigm of early THR revision surgery due to metal-on-metal-related failure is highlighted by this study.

Aseptic loosening was the main cause of failure in patients under 50 years old undergoing revision THR in our study (42%). This is also supported by the NJR, New Zealand, and Australian hip arthroplasty registries (30–45%) [2, 6, 7]. Dislocation (15–31%), infection (13–17%) and periprosthetic fracture (9%–15%) in these registries were also common modes of failure. Bozic et al. [5] in a multicentre epidemiological study found instability (22%) was the most common cause of revision followed by mechanical loosening (20%) and infection (15%), but notably this study included all revision hip procedures and included all age groups. In our study, instability in both groups accounted for 9.59% of revision THR failures and this was similar to that reported by Delaunay et al. [16], and slightly less than the dislocation rate reported in the above three registries.

Infection is a common mode of early and late failure in primary THR. In this study of patients under 50 years old, it was responsible for 18.3% of early THR revisions and 10.7% in the late group. Our results were again consistent with those reported in the British, Australian and New Zealand hip registries [2, 6, 7]. Two-stage revision surgery remains the gold standard for the treatment of infected primary THR, but also single-stage revision procedures have been advocated in certain European centres [19, 20]. Various infection prevention modalities have been implemented to reduce the risk of infection risk, but it still

remains a significant cause of primary THR failure in all age groups, as well as those requiring revision THR surgery under 50 years of age as this study demonstrates.

The NJR shows that in women less than 55 years of age, the revision rate was slightly higher than their male counterparts [2]. It reports a cumulative percentage probability of revision THR of 4.97% in females and 4.11% in males at 5-year post primary procedure. Interestingly in this study, the group of early revision procedures was performed mainly in males (60.5%) and this is likely linked to the early metal-on-metal failure. In the late group with a large proportion of females (73.3%) undergoing revision after 5 years from their index surgery, the NJR showed females less than 55 years old had a higher revision THR rate than males at more than 5 years following the primary procedure. Further studies would need to be performed to investigate factors such as body mass index, primary diagnosis of hip pathology, type of prosthesis used or activity levels to appreciate the relevance of these findings.

This study has several limitations. As a tertiary referral centre for revision hip arthroplasty, many of the primary procedures were not performed in our institution, especially in this younger age group (<50 years old). The aim of this paper was to analyse the causes of revision THR in younger patient cohort; however, we must acknowledge that we did not provide a similar analysis of the older cohort of patients to provide a comparison of causes of failure as we did not expect this to vary from the overwhelming number of studies that provide this data which is largely similar throughout international publications. The difficult and complex cases may only be referred by other hospitals and so creating a selection bias. Another limitation is this is only a single-centre study and is not data from a national joint registry. However, our institute is one of the main hip arthroplasty revision centres in Ireland, and this accurate prospective database has provided data on a large cohort of patients of less than 50 years of age undergoing revision hip surgery and the mode of failure.

## Conclusion

The main cause of early THR revision in the younger patient is metal-on-metal failure and predominately aseptic loosening for late failure in this study. The changing trends of THR failure should be continuously reviewed to ensure both the surgeon and the patient are aware of the common modes of early and late failure. An evidence-based practice approach when deciding which the hip prosthesis/bearing to use to ensure the optimal survivorship of the implant is essential. Surgeons should also continue to maintain high standards to minimise instability and infection risk.

## Compliance with ethical standards

All procedures performed in studies involving human participant were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Prior to undertaking the study, the local institutional review board was consulted. As it is a retrospective study, the decision was made that formal consent was not required.

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

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## References

- Harris WH, Sledge CB (1990) Total hip and total knee replacement. *N Engl J Med* 323:725–731. <https://doi.org/10.1056/NEJM199009133231106>
- Natl Jt Regist England, Wales, North Irel Isle Man, 13th Annu Rep 2016. <http://www.njrreports.org.uk/>. Accessed 8 March 2017
- Katz JN, Losina E, Barrett J, Phillips CB, Mahomed NN, Lew RA et al (2001) Association between hospital and surgeon procedure volume and outcomes of total hip replacement in the United States medicare population. *J Bone Joint Surg Am* 83–A:1622–1629
- Mahomed NN, Barrett JA, Katz JN, Phillips CB, Losina E, Lew RA et al (2003) Rates and outcomes of primary and revision total hip replacement in the United States medicare population. *J Bone Joint Surg Am* 85–A:27–32
- Bozic KJ, Kurtz SM, Lau E, Ong K, Vail TP, Berry DJ (2009) The epidemiology of revision total hip arthroplasty in the United States. *J Bone Joint Surg Am* 91:128–133. <https://doi.org/10.2106/JBJS.H.00155>
- Aust Orthop Assoc Natl Jt Repalcement Rep 2016 (n.d.) <https://aoanjrr.dmac.adelaide.edu.au/annual-reports-2014>. Accessed 8 March 2017
- Association NZO (n.d.) New Zeal Jt Regist Fifteen Year Rep. <http://www.nzoa.org.nz/nz-joint-registryb.govt.nz/njr/>. Accessed 8 March 2017
- Yoo JJ, Kim Y-M, Yoon KS, Koo K-H, Song WS, Kim HJ (2005) Alumina-on-alumina total hip arthroplasty. A five-year minimum follow-up study. *J Bone Joint Surg Am* 87:530–535. <https://doi.org/10.2106/JBJS.D.01753>
- Moen TC, Ghate R, Salaz N, Ghodasra J, Stulberg SD (2010) A monoblock porous tantalum acetabular cup has no osteolysis on CT at 10 years. *Clin Orthop Relat Res* 469:382–386. <https://doi.org/10.1007/s11999-010-1500-8>
- Cuckler JM, Moore KD, Lombardi AV, McPherson E, Emerson R (2004) Large versus small femoral heads in metal-on-metal total hip arthroplasty. *J Arthroplast* 19:41–44
- Ulrich SD, Seyler TM, Bennett D, Delanois RE, Saleh KJ, Thongtrangan I, Kuskowski M, Cheng EY, Sharkey PF, Parvizi J, Stiehl JB, Mont MA (2007) Total hip arthroplasties: what are the reasons for revision? *Int Orthop* 32:597–604. <https://doi.org/10.1007/s00264-007-0364-3>
- Sharkey PF, Lichstein PM, Shen C, Tokarski AT, Parvizi J (2014) Why are total knee arthroplasties failing today—has anything changed after 10 years? *J Arthroplast* 29:1774–1778. <https://doi.org/10.1016/j.arth.2013.07.024>
- Katz JN, Phillips CB, Baron JA, Fossel AH, Mahomed NN, Barrett J, Lingard EA, Harris WH, Poss R, Lew RA, Guadagnoli E, Wright EA, Losina E (2003) Association of hospital and surgeon volume of total hip replacement with functional status and satisfaction three years following surgery. *Arthritis Rheum* 48:560–568. <https://doi.org/10.1002/art.10754>
- Eskelinen A, Remes V, Helenius I, Pulkkinen P, Nevalainen J, Paavola P (2005) Total hip arthroplasty for primary osteoarthritis in younger patients in the Finnish arthroplasty register. 4,661 primary replacements followed for 0–22 years. *Acta Orthop* 76:28–41. <https://doi.org/10.1080/00016470510030292>
- Melvin JS, Karthikeyan T, Cope R, Fehring TK (2014) Early failures in total hip arthroplasty – a changing paradigm. *J Arthroplast* 29:1285–1288. <https://doi.org/10.1016/j.arth.2013.12.024>
- Delaunay C, Hamadouche M, Girard J, Duhamel A (2013) What are the causes for failures of primary hip arthroplasties in France? *Clin Orthop Relat Res* 471:3863–3869. <https://doi.org/10.1007/s11999-013-2935-5>
- Malchau H, Herberts P, Eisler T, Garellick G, Söderman P (2002) The Swedish Total Hip Replacement Register. *J Bone Joint Surg Am* 84–A(Suppl):2–20
- Fevang B-TS, Lie SA, Havelin LI, Engesaeter LB, Furnes O (2010) Improved results of primary total hip replacement. *Acta Orthop* 81: 649–659. <https://doi.org/10.3109/17453674.2010.537807>
- Winkler H, Stoiber A, Kaudela K, Winter F, Menschik F (2008) One stage uncemented revision of infected total hip replacement using cancellous allograft bone impregnated with antibiotics. *J Bone Jt Surg Br* 90–B:1580–1584. <https://doi.org/10.1302/0301-620X.90B12.20742>
- Lange J, Troelsen A, Thomsen RW, Søballe K (2012) Chronic infections in hip arthroplasties: comparing risk of reinfection following one-stage and two-stage revision: a systematic review and meta-analysis. *Clin Epidemiol* 4:57–73. <https://doi.org/10.2147/CLEP.S29025>