ARTHROPLASTY

The short-term outcome of hip revision arthroplasty with Trabecular Metal™ components and augments

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Abstract

Background: Highly porous Trabecular Metal™ acetabular components are increasingly being used in revision hip arthroplasty as they facilitate ingrowth, provide a useful mechanism to deal with bone loss and may decrease the risk of infection. The purpose of this audit was to describe: 1) the total number of hip arthroplasty surgeries over five years, the ratio of revision to primary hip arthroplasty and indications for revision; 2) the short-term outcomes of revision hip arthroplasty with Trabecular Metal™ components and augments.

Methods: A retrospective folder and radiograph review of all patients who had revision total hip arthroplasty (THA) at a tertiary level hospital from February 2012 to February 2017 was done.

Results: There were 979 THAs performed over the period – 863 (87%) primary THAs, and 116 (12%) hip revision cases performed in 107 patients. Of the 116 (107 patients) hip revisions, there were seven (6%) re-revisions in five patients. The indications for revision were aseptic loosening 67 (59%), septic loosening 11 (10%), liner wear 18 (16%), periprosthetic fracture five (4%), other 15 (13%). Trabecular Metal™ was used for revision in 16 hips (14 patients), which is 14% of the total 116 revisions. There were ten females and four males with an average age of 61 years. The average duration of follow-up in this group was 18.5 months (1.5–39.2). In these 16 Trabecular Metal™ hips, there were three (19%) early failures of fixation due to technical errors.

Conclusion: In our institution, 12% of the arthroplasty is revision surgery. The indications for revision are similar to published literature. Trabecular Metal™ revisions had a 19% early failure rate due to technical error.

Level of evidence: Level 4

Keywords: Trabecular Metal™, augments, total hip arthroplasty, revision hip arthroplasty

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Introduction

Total hip arthroplasty (THA) is reported as one of the most successful procedures to relieve pain and restore function. It has evolved from a salvage procedure with poor long-term outcomes reserved for the most infirm patients, to one of the most successful and frequently undertaken elective surgical procedures.[1]

Indications for revision in a Swedish registry were aseptic loosening 75%, deep joint infection 8%, dislocation 6%, fracture 5%, technical errors 3% and implant fracture 1%.[2] Aseptic loosening is a leading cause of failure in the intermediate and long-term post-operative period. It is hypothesised to be the result of a harmful combination of mechanical and biological events destroying the bond between the implant and the bone bed. To date, a variety of host, implant and surgery-related factors have been delineated to explain the development of aseptic loosening and osteolysis.[3]

Periprosthetic joint infection (PJI) is a devastating and costly complication of total joint arthroplasty. Diagnosis is challenging and a mixture of multiple tests can reasonably increase the diagnostic accuracy. Some criteria from the Musculoskeletal Infection Society (MSIS), European Bone and Joint Infection Society (EBJIS), and Infection Disease Society of America (IDSA) have been published.[4] In our institution we prefer to use the MSIS criteria.

Dislocation is a complication occurring in approximately 0.3% to 10% of all primary procedures and up to 28% in revision surgery. It is a multifactorial problem caused by patient, implant and surgeon factors and can be reduced by thoughtful pre-operative planning and a careful surgical technique.[5]

Periprosthetic fractures in hip arthroplasty can occur intra- or post-operatively. Intra-operative fractures are estimated to occur in 1% of cemented and in 5.4% of uncemented primary THA. In revision surgery, incidence is higher, reaching 3.6% in cemented and 20.9% during uncemented procedures. Post-operatively, the incidence has been estimated to be less than 1% after THA and up to 4% following revision THA.[6]

Technical errors are of greater concern. Poor exposure, undersizing, malposition, intra-operative fractures and failure to achieve correct soft tissue tension can cause any implant to fail despite optimal design characteristics. Lastly, implant fracture after THA is a relevant complication leading to technically demanding revision surgery, with an incidence of 304 fractures per 100 000 implants from a pooled worldwide arthroplasty registry dataset.[7]

Osteolysis can lead to problematic bone loss. Several classifications exist for acetabular bone loss in THA. The most commonly cited classification is that by Paprosky.[8]

The porous metal tantalum (Trabecular Metal™ Zimmer/Implex, Warsaw, IN) has been in use since 1997. A rough surface microtexture provides a high coefficient of friction for increased initial stability. It has a lower modulus of elasticity than that of titanium which creates a potential for improved transfer of forces to the pelvis and reduced stress shielding. Interestingly, equivalent or lower bacterial adherence to porous tantalum has been demonstrated when compared with traditional surfaces.[9] In our study all Trabecular Metal™ (or TM) cups were TM revision cups and if augments were used with the TM cup, they were Zimmer Biomet Trabecular Metal™ augments.

The purpose of this audit was to describe:

1. The total number of hip arthroplasty surgeries over five years, the ratio of revision to primary hip arthroplasty and the indications for revision.
2. The short-term outcome of revision hip arthroplasty with Trabecular Metal™ components and augments.

Materials and methods

After receiving approval from the institutional ethics board, we performed a retrospective audit on the use of TM acetabular components and augments in revision hip arthroplasty at Groote Schuur Hospital from February 2012 to February 2017. Eligible patients were identified from a prospectively collected orthopaedic surgery database. Clinical data including patient demographics, date of surgery, type of implant, indication for revision, complications and surgeon were recorded from patient folders. The pictorial archive communicating system (PACS) was used to access digital radiographic images. Pre-operative pelvic anteroposterior and lateral X-rays were reviewed, and defects classified as per Paprosky.[8]

Initial post-operative and last follow-up X-rays were evaluated for signs of osseous integration using the method of Moore *et al.*[10] All radiographs were reviewed by the investigator (registrar) and supervisor (senior consultant); a CT scan was not routinely performed. Patients with incomplete clinical and radiographic information, internal fixation revision to THA and revision for tumours were excluded from the study. Descriptive statistical analysis was used to analyse the data.

Results

There were 979 THAs performed over the period: 863 (87%) primary THAs, and 116 (12%) hip revision cases performed in 107 patients. *Figure 1* shows a breakdown of primary and revision THA procedures done per year. In the revision group there were 43 (40%) males and 64 (60%) females with an average age of 60.8 years (range 50–71). The average follow-up of the revisions was 15.9 months (4.7–25.8)

The indications for revision were aseptic loosening 67 (59%), septic loosening 11 (10%), liner wear 18 (16%), periprosthetic fracture five (4%), cortical perforation four (3%), recurrent dislocation four (3%), early failure of fixation four (3%), broken stem two (2%) and ankylosis one (1%).

The Paprosky classification of the revision cases is shown in *Table I.*

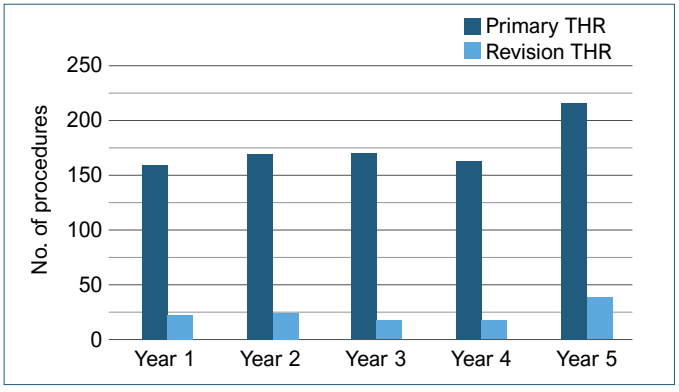

Figure 1. Summary of primary and revision THR procedures done during the five-year period

Table I: Paprosky[8] classification of the revision cases

Type	Non-TM revisions (n=100)	Trabecular Metal™ revisions (n=16)
1	42	1
2A	13	3
2B	29	1
2C	8	3
3A	2	6
3B	6	2

Table II: The indications for re-revision and procedure

Patient	Primary procedure	Revision 1	Revision 2	Revision 3
1	1980s Uncemented stem and cemented cup	2012 Aseptic loosening of cup Paprosky 3B Cemented cup to uncemented spiked cup	2013 Failure of fixation of cup Spiked cup to multi-hole cup with screws	
2	2014 Cemented stem and uncemented cup	2016 Aseptic loosening of cup Paprosky 3A Uncemented cup to TM revision cup and augment	2017 Failure of fixation of the cup Excision arthroplasty	
3	1990 Cemented stem and cup 2004 Long stem for periprosthetic fracture Uncemented cup stable	2014 Aseptic loosening and liner wear Loose long stem exchanged and new liner, cup stable	2017 Aseptic loosening cup Paprosky 3B Uncemented cup to custom acetabular component	
4	1990s Cemented stem and cup	2015 Long stem for aseptic loosening of the femur Cemented cup stable	2015 Recurrent dislocations Cemented cup to uncemented cup with screws	
5	2001 Uncemented stem and cup	2016 Aseptic loosening of uncemented cup to TM cup and two screws	2017 Failure of fixation Paprosksy 3A TM cup to TM cup and augment	2018 Failure of fixation TM cup and augment to TM cup cage construct

Of the 116 (107 patients) hip revisions, there were seven (6%) re-revisions. One of these seven re-revisions have not yet been performed due to medical reasons; the patient remains dislocated but is included in the numbers as a revision is indicated. The indications for re-revision and procedure summary for the remaining six re-revisions in five patients are shown in *Table II*. There were three females and two males, with an average age of 60.2 years (47–71).

Trabecular Metal™ was used for revision in 16 hips (14 patients), which is 14% of the total 116 revisions. There were ten females and four males, with an average age of 61 years (38–86). The average duration of follow-up in this TM group was 18.5 months (1.8–39.2). Three hips (19%) that were revised with TM failed to remain stable and were classified as early failure of fixation. Patient number 2 in *Table II* was revised with a cup and augment for a Paprosky 3A defect and had an excision arthroplasty when it failed. Patient number 5 in *Table II* was revised with a TM cup and screws which failed and was re-revised with a cup and augment, which failed and then re-revised with a cup cage construct. This accounts for the 16 hips and 14 patients in the TM group during the five-year study period.

For the purposes of the study, excision arthroplasty and implantation of an antibiotic-impregnated cement spacer followed by re-implantation of components in the same joint were considered as a single two-stage revision procedure.

Discussion

Total hip replacement is one of the most cost-effective procedures to relieve pain and improve function.[1] The annual reports of the national arthroplasty registry of Sweden, Norway, Finland, Denmark, Australia and New Zealand show a mean of 1.29 revisions per 100 observed component years. This corresponds to a revision rate of 6.45% after five years and 12.9% after ten years.[11] In our study 12% of the procedures were revisions, not necessarily from our unit as we are a tertiary referral centre.

We found similar indications for revision to the published literature. Aseptic loosening was the most common cause of revision surgery in our study. Ulrich *et al.* evaluated the indications for revision hip arthroplasty and showed that 51% were revised for aseptic loosening.[12] It is probably a combination of several events and there is growing evidence indicating that cyclic mechanical loading, production of prosthetic wear particles and ensuing adverse tissue response are important contributors to local osteolysis and bone resorption at the bone–prosthesis interface.[13]

In our study, liner wear was the second most common indication for revision. There are three fundamental mechanisms of wear: abrasive, adhesive and fatigue. Abrasive wear constitutes the main wear type in hip arthroplasty. The criteria for revision surgery due to a worn polyethylene hip cup or liner have long been controversial. Often there is a dilemma in choosing polyethylene exchange alone or revising the acetabular components. Grobbelaar *et al.* reported a correlation between cup wear on the one hand, and pain, interface widening and osteolytic failure on the other.[14] In our institution, if a cup is radiologically aligned and well fixed, we prefer to do polyethylene exchange alone.

Periprosthetic joint infection is a devastating complication for both patient and surgeon. Sepsis was the cause of 10% of our revisions. This figure is higher than that reported by Ulrich *et al.*,[12] probably because our institution is a tertiary referral centre. We did not analyse reasons for infection.

A periprosthetic fracture of the femur in association with THA is increasingly common and often difficult to treat. Similar to our study, Marsland *et al.* reported an overall incidence of 4% of periprosthetic femur fractures with higher rates for uncemented and revision THA.[15]

We started using Trabecular Metal™ after promising findings in a retrospective study of 966 patients (421 men, 545 women and 990 hips) on the use of tantalum (Ta) acetabular components in revision of THA. Tokarski *et al.* believe that the reason tantalum is more protective against infection is the higher potential of tantalum for osteointegration, thereby obliterating any dead space.[16] The ability of osteoblasts to proliferate and integrate onto the surface of the uncemented component may then deprive infecting organisms' access to the surface. The second reason may relate to the topographical three-dimensional structure of the surface of tantalum that may be difficult for organisms to access and colonise. Furthermore, tantalum as an element may carry specific charge or have surface characteristics that are hostile to infecting organisms. Finally, they showed encouraging findings in the use of tantalum components which may be protective against failure due to infection at least in patients who had undergone revision surgery for infection. A case series by Malkani *et al.* showed that

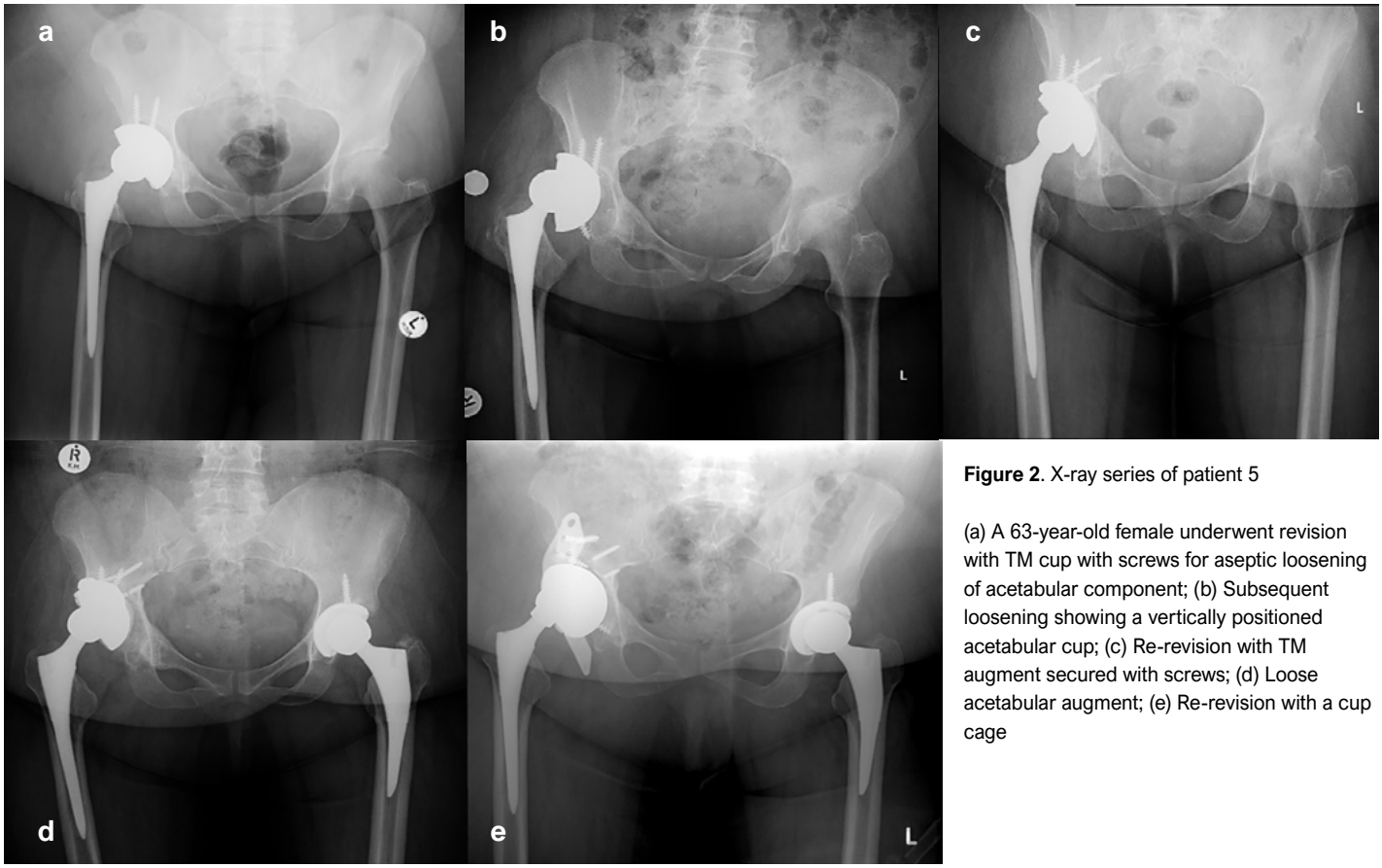

Figure 2. X-ray series of patient 5

(a) A 63-year-old female underwent revision with TM cup with screws for aseptic loosening of acetabular component; (b) Subsequent loosening showing a vertically positioned acetabular cup; (c) Re-revision with TM augment secured with screws; (d) Loose acetabular augment; (e) Re-revision with a cup cage

all 21 patients developed ingrowth along the tantalum surface despite compromised bone loss, and he concluded that porous tantalum appears to be a promising material to use in revision hip arthroplasty to facilitate biological ingrowth in patients with acetabular bone loss.[17]

In most cases of acetabular component revision, there will be some degree of bone loss.[18] Our usual management of Paprosky type 3A and 3B includes the use of augments. Our approach is similar to that described by Abolghasemian *et al.* which suggests that type 1 and type 2 defects do not usually require the use of acetabular augments. In type 1, conventional cemented or cementless components can be used. Type 2 defects are usually managed with morselised bone graft and normal uncemented acetabular cups. If there is less than 50% contact of the cup with viable host bone, the use of an ultra-porous acetabular component is recommended to ensure sufficient initial stability and potential for subsequent bone ingrowth. Type 3 defects are mostly associated with the use of augments.[19] Porous acetabular components are manufactured by numerous implant companies; we have used different manufacturers in our series but are focusing on the tantalum TM Revision™ components from Zimmer Biomet.

In *Table II*, patient 1 had failure of an uncemented 62 mm spiked cup in a 3B defect and was revised successfully to a 64 mm multi-hole uncemented cup with screws. In the first case, augments were incorrectly not ordered, probably causing the early failure of fixation and in the second, the cup screw construct was deemed stable and therefore augments not used.

Patient 2 was revised to a Trabecular Metal™ cup and augment and the augment grew in, but the cup failed due to cement extravasation during liner insertion that prevented osseous integration, evident at excision arthroplasty a year later. The patient had comorbidities precluding further major surgery.

Patient 5 had posterior superior acetabular bone loss which occurred with acetabular preparation at the first revision (*Figure 2a*). No augments had been ordered and the cup screw fixation failed in 3 months (*Figure 2b*). The second revision included an augment (*Figure 2c*) and the cup failed a year later (*Figure 2d*). This was converted to a cup cage construct (*Figure 2e*) and at revision the cup and augment were found to have no osseous integration. There was no sign of infection at any stage and the reason for early failure of fixation was thought to be instability of the construct. This patient continues to be monitored and there is no sign of loosening of the cup cage construct at final follow-up. The series of X-rays is shown in *Figure 2*.

Our study is limited by short follow-up. This is due to only recently starting to use Trabecular Metal™ and the fact that patients are lost to follow-up due to social factors and geographic movement. This audit needs to be repeated with longer follow-up. Our small numbers make statistical analysis difficult.

Conclusion

In our institution, 12% of the arthroplasty performed is revision surgery. The indications for revision are similar to the published literature. Trabecular Metal™ was used in 13% of revisions. Three hips (19%) failed to remain stable and were classified as early failure of fixation due to technical error.

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Ethics statement

This submission is in accordance with the principles laid down by the responsible research publication position statements as developed at the 2nd World Conference on Research Integrity in Singapore. For this study, formal consent was not required and approval was given by our institutional Human Research Ethics Committee (HREC REF:149/2017).

Declaration

The authors declare authorship of this article and that they have followed sound scientific research practice. This research is original and does not transgress plagiarism policies.

Author contributions

LN: Primary author, responsible for study design, data collection, data analysis and manuscript preparation
MN: Conceptualisation, study design, manuscript preparation, supervision of the study

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