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Midterm Outcomes of Revision Total Hip Arthroplasty Using a Modular Revision Hip System

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A B S T R A C T

Background: The growth in hip arthroplasty surgery has meant a corresponding escalating revision burden with increasing challenges for the orthopaedic surgeon. The purpose of this study was to review clinical outcomes of a modular revision hip system within a single institution.
Methods: We retrospectively reviewed a cohort of modular revision hip system stems performed in our institution between January 2005 and October 2012 giving a potential minimum follow-up of 2 years. Clinical outcomes data on complications, Oxford Hip Score (OHS, 0-48) and patient satisfaction were collected. Radiographic outcomes including subsidence were assessed. Implant survival was estimated using Kaplan Meier analysis.
Results: 115 stems in 106 patients were identified. All cause survival was 82% (95%CIs: 73%-89%) at 6.1 years; survival excluding infection being 99% (95%CIs: 93%-100%). There was a low incidence of subsidence (seven stems) and no peri-prosthetic fractures. Primary cause of re-revision in this series was re-infection with only one re-revision for mechanical failure. Median Oxford Hip Score at mean follow up 4.1 years (2-9) was 40 (14-48) and 93% of patients reported being satisfied with their revision surgery.
Conclusion: This study showed good clinical outcomes and survival using a modular revision stem with low mechanical failure and subsidence. Recurrence of infection remains a challenge in revision surgery.

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Total hip arthroplasty (THA) is a successful and cost-effective treatment with more than 80,000 THA surgery performed annually in the UK, with this number increasing by around 6000 surgeries per year [1]. This growth in THA surgery has led to a revision burden which presents increasing challenges for the orthopedic surgeon [2,3]. One challenge in performing revision surgery is achieving fixation of the femoral implant in compromised proximal bone stock, with aseptic loosening being the most common cause of failure in revision hip surgery and subsidence frequently reported in revision series [3-5]. Modular revision stems may provide 1 solution for bridging of gaps in defective bone to achieve good distal fixation to reduce the risk of subsidence, while the modular design allows some flexibility intraoperatively to address leg length discrepancy and anteversion [6]. A recent North American series reported successful results with this type of implant, both with patient-reported outcome measures (PROMs) and clinical outcomes [5]. However, concerns remain over the risk of fracture using modular stems where there is severe bone loss [7]. The purpose of this study was to review the survival and clinical outcomes of a modular revision hip system within a single UK institution with a minimum of 2-year follow-up. The aim was to add to the available evidence on this type of implant and, therefore, to further assist in implant selection.

Materials and Methods

This was a retrospective cohort study. Our institutional database was reviewed to identify revision hip arthroplasty using the Restoration Modular Stem system (Stryker, Newbury, United Kingdom) from July 2005 to November 2012. The restoration stem is the only modular stem in use in our institution and is our stem of choice for revision for proximal femoral bone loss that requires distal fixation. It is used in revision and occasionally in complex primary surgeries. Although most modern stems have some element of modularity in their design, the restoration modular stem system combines a proximal body with an independently selected distal portion which provides rotationally and axially stable distal fixation. It provides good proximal fill, leg length, and offset. It allows fine tuning of version and minimizes proximal-distal mismatch, which can occur with monoblock designs. The cone conical design is primarily used in this institution as this is a familiar design with evidence of successful outcomes with full weight bearing after surgery. Follow-up data up until November 2014 were used to give a minimum potential follow-up of 2 years. Departmental and institutional

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databases were interrogated to establish cohort demographics (sex, age, and body mass index [BMI]), date and indication for revision surgery, intraoperative details, Paprosky classification of femoral bone loss, and date of last known follow-up [8]. A telephone audit was carried out for those patients who did not have a recent (within 6 months) follow-up appointment to ascertain the prosthesis was still in place and collect PROMs. National PACS (Picture Archiving and Communications System, Carestream, Eastman Kodak, Rochester, NY) was also used to assess radiographs to give the last known date when the prosthesis was still in place as this database allows access to any x-ray taken within NHS Scotland. Clinical records were examined to identify patients who presented with complications related to surgery or who needed further surgical intervention. Patients who had further revision surgery were identified and reasons for re-revision determined. In addition, as patients are referred to this institution from across Scotland, data held by the National Health Service Information Services Division that links national data to allow analysis and follow-up of clinical outcomes were cross-checked to identify any patient who presented with complications of surgery or were revised at any other institution in Scotland [9]. The senior authors assessed preoperative x-rays to confirm Paprosky classification and postoperative x-rays for subsidence. Oxford hip scores (OHS) and satisfaction scores collected at most recent follow-up (over 2 years) were used.

Statistical Analysis

Survival probability of the cohort was estimated using the Kaplan-Meier survivorship analysis method giving survival probability with 95% confidence intervals. All patients in the series were included and censored at either last known follow-up or date of death. Survival was calculated for revision for any reason and for revision excluding infection. The survival analysis was presented up until there were only 10 patients still at risk as, when there are few patients at risk, survival curves can be misleading. In addition to survival analysis, descriptive statistics were reported for complication data and routinely collected PROM data (OHS [0-48] and patient satisfaction score). Where analysis showed a skewed distribution, median scores were used to give a measure of central tendency.

Results

There were 115 restoration stems in 106 patients with potential follow-up of 2 years or more. Fig. 1 shows a successful restoration stem up to 2 years postoperation. All surgeries were performed using a posterior approach, 61% with an extended trochanteric osteotomy (ETO). Eight surgeons performed revision surgery using the restoration system over 9 years; however, 55% were performed by 1 surgeon (JB), 17% were performed by another surgeon, and 7 surgeons performed the other 28% of surgeries, performing roughly the same number each. Mean age was 70 years (SD, 8.0; range, 43-85), and mean BMI was 30.2 kg/m^2 (SD, 5.1; range, 19-46). Median preoperative OHS was 21 (range, 1-47); 56% were female. Indications for surgery were 43% aseptic loosening, 32% infection, 13% fracture, and 12% other. Seventy-six percent were first revision linked to primaries, and 27% were subsequent revisions (Table). Postoperatively, 55% of patients were advised that they could mobilize fully weight bearing, 44% partial weight bearing, and 1% non–weight bearing.

Ninety patients had follow-up of at least 2 years (Fig. 2). Seven of the 90 patients who were known to have the restoration stem in situ at 2 years

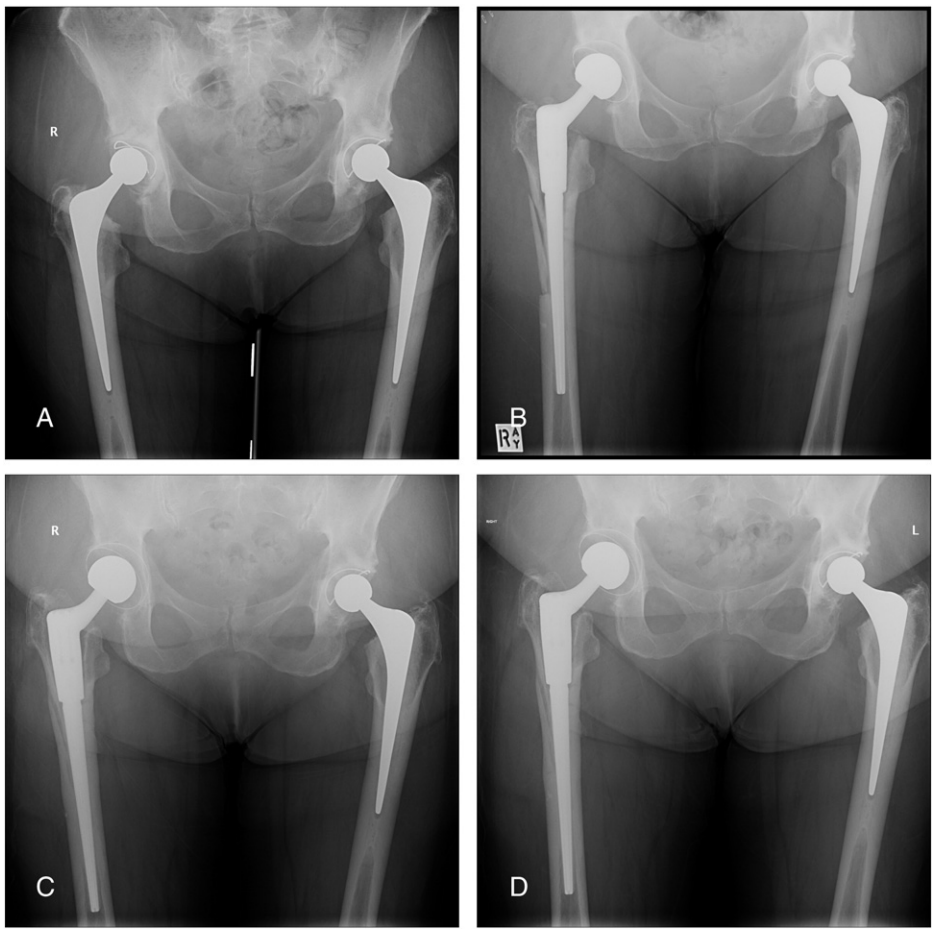

Fig. 1. Radiographs of a successful restoration stem preoperatively (A), immediate postoperatively (B), 1-year postoperatively (C), and 2-year postoperatively (D).

Table
Revision Surgeries by Bone Loss and Revision Number.

	Paprosky Classification				
	0	I-II	III-IV	B2 Fracture	Total
First revision	16	32	33	2	83
Second revision	1	10	15	1	27
Third revision	0	3	1	0	4
Fourth revision	0	0	1	0	1
Total	17	45	50	3	115

did not have PROM data. Three of these patients were subsequently revised, and 4 patients were followed up locally and had a local x-ray (Fig. 2).

The demographics of the remaining 83 patients were similar to the potential cohort of 115 stems and, therefore, appear to be representative of the population. Mean age was 69.6 years (SD, 8.2; range, 43-85), mean BMI was 30.0 (SD, 5.2; range, 20-46), and mean follow-up was 4.2 years (range, 2-9). Median preoperative OHS was 20 (range, 1-47); 59% were female.

Sixty-one percent of patients in this cohort had an ETO performed, 1 ETO broke into 2 pieces and 1 was partially dislodged. In addition, there were 6 known intraoperative fractures, 4 had ETO performed, and all were stabilized with cerclage cables. In the cohort (115 stems), there were a total of 17 stems re-revised. Median time to re-revision was 14 months (range, 2-62 months). Sixteen of these re-revisions were for infection; and 1, for loosening. The single stem re-revised for loosening was a second revision with Paprosky type II bone loss which was revised after 14 months. Of the 16 stems re-revised for infection, 12 had been implanted in patients being revised for confirmed infection and 1 in a patient being revised for pain with suspected infection; the remaining 3 consisted of 2 patients who had been revised for aseptic loosening and 1 for a periprosthetic fracture. There were no re-revisions for periprosthetic fracture around the modular revision stem. Mean follow-up for the survival analysis was 3.5 years (5 days to 9.2 years). Estimated mean survival for the cohort was 7.9 years (95% confidence interval [CI], 7.3-8.4). All-cause survival was 82% (95% CIs, 73%-89%) at 6.1 years (10 patients still at risk) (Fig. 3), with survival excluding infection being 99% (95% CIs, 93%-100%) (Fig. 4).

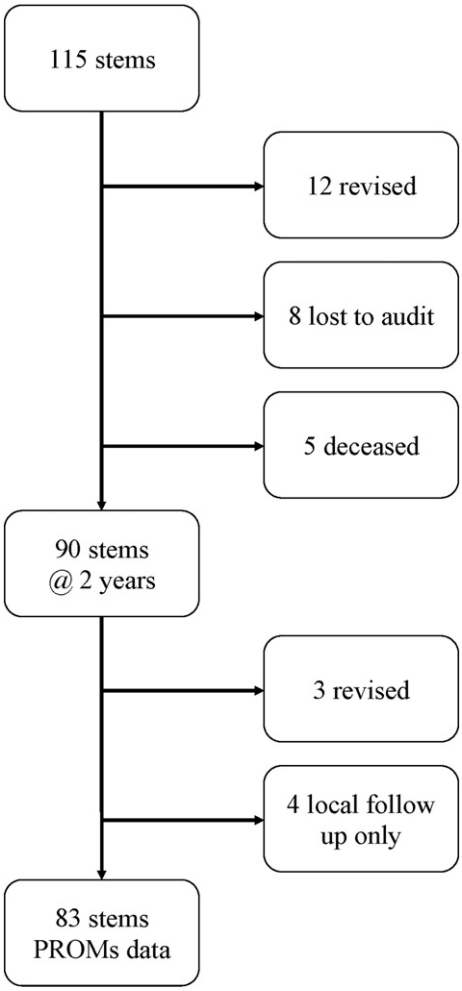

Fig. 2. Flow diagram of study cohort from operation to last follow-up.

There were 7 incidences of subsidence; however, no patients were revised purely based on subsidence: 2 were revised for infection and 1 was revised for loosening, a further patient had a femoral head exchange and the remaining 3 were treated conservatively. The 3 patients who were revised had subsidence of between 15 and 35 mm. The patient who had a femoral head exchange had subsidence of 20 mm, was seen at standard follow-up at 5 years, and had no further issues. Of the 3 patients who had no surgical intervention: 1 patient had initial subsidence of 3 to 5 mm which was noted at 6 weeks and which had stabilized by 3 months; 1 patient had initial subsidence of 5 to 10 mm noted at 6 weeks after surgery, the stem subsequently stabilized at 3 months after a period of partial weight bearing; the third patient also had initial subsidence of 5 to 10 mm, with no symptoms and no further action necessary. All 3 stems remained stable at last follow-up. The incidences of subsidence were in patients with Paprosky type IIa to IIIb bone loss.

There were 11 other complications reported; 1 single nonrecurrent dislocation within the first 6 months which required no surgery; 1 deep vein thrombosis which occurred at 6 months; 2 reoperations at 2 and 5 years for removal of a trochanteric grip; a sinus related to infection causing chronic wound leakage 3 years after surgery for which the patient refused further surgery and 7 patients who continued to report pain issues after 2 years. Of the 7 patients who continued to report pain issues, 6 described the location of this pain as around the hip and pelvic area, and 1 reported thigh pain. Six of these patients were managed with analgesia, and 1 patient was referred for revision surgery but was then lost to audit.

For the 83 patients with PROM data at a minimum of 2 years, this showed that median postoperative OHS at last follow-up point was 40 (14-48) and median improvement in OHS was 20 (3-point decrease to 33-point increase). Those patients who reported only small changes between the preoperative OHS and postoperative assessment reported being very satisfied with their surgery. At last follow-up, 81% of patients reported being very satisfied with their surgery, 12% were satisfied, 4%

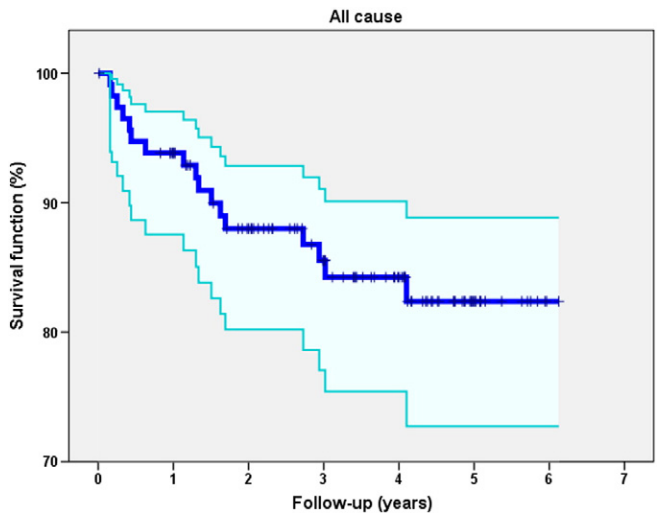

Fig. 3. Kaplan-Meier survival curve with 95% CI for revision for all causes. Curve truncated when less than 10 patients left at risk.

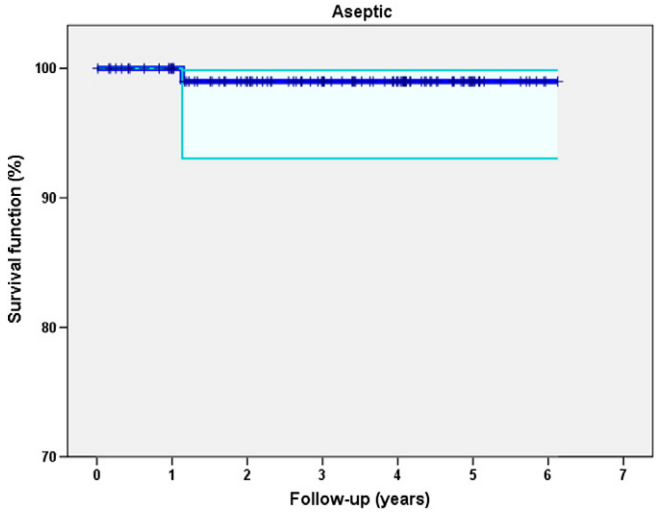

Fig. 4. Kaplan-Meier survival curve with 95% CI for revision excluding infection. Curve truncated when less than 10 patients left at risk.

were unsure, and 3% were dissatisfied with their surgery. Overall, patients who were not satisfied with surgery consisted of 2 patients who were dissatisfied and 3 who were unsure. The 2 patients who were dissatisfied and 1 of the patients who was unsure were among those patients who continued to report ongoing pain issues, 2 of which had preexisting back pain which continued to affect them. The position and radiographic appearance of the implants for these patients were satisfactory, and infection had been ruled out. One patient who was dissatisfied received a second surgical opinion at this institution, and the other was referred for further physiotherapy. The unsure patient who had continuing pain had a slow-to-heal ETO and pain mostly on weight bearing. The second unsure patient had difficulties with the combination of a leg length discrepancy and impaired vision, which inhibited daily activities of living, and the remaining unsure patient had no obvious issues to indicate why they were unsure of their satisfaction with surgery.

Discussion

This retrospective cohort study has shown acceptable short-term to midterm results of the Restoration modular revision stem for both survival and clinical outcomes and adds to the current evidence base for use of this implant in revision surgery. This series is one of the largest single center cohorts of modular hip revisions in the UK to date and includes 50 hip revisions classified as Paprosky type III to IV.

The main limitation of this study was its retrospective nature meaning that not all data were available and patients were at various stages of follow-up, ranging from 2 to 9 years, after their revision surgery. A further limitation was the number of patients who did not return for follow-up at this institution and who did not, therefore, report any PROM data. To reduce the impact of this, a telephone audit was used to ascertain the current status of implants where recent follow-up was not available; however, there remained a further 12 patients lost to audit for whom no PROM data are known. If satisfaction with outcome correlates to engagement with follow-up, then those patients lost to audit may skew our results; however, anecdotal evidence at this institution suggests that patients with problems seem to return to have these issues followed up [10]. Furthermore, those patients who were contacted via telephone audit, who had not attended their last follow-up, did not report dissatisfaction with surgery, or have poorer outcomes. The cohort was a nonhomogenous group, so meaningful statistical analysis of the differences in outcomes between subgroups, for example, sex, could not be carried out. Lastly, this study only looked at 1 revision implant and did not have a comparison group. As this was not a single-surgeon series, there may be small differences in the way each surgeon fine-tuned the implants; however, all surgeons worked with a Stryker representative and followed the standard operating procedure for this implant. Furthermore, since 2007, introduction of an enhanced recovery protocol has further reduced variation in perioperative protocols in both primary and revision total hip surgery. Despite these limitations, the results of this study are based on analysis of high-quality data, representative of a complex and heterogeneous group of patients. The nature of the etiology of this group of patients makes a prospective study of this size implausible; a retrospective study is, therefore, appropriate and decreases the possibility of inclusion bias.

Revision THA can be complex and challenging with varying levels of bone loss which can require flexible solutions [2,3,11,12]. Re-revision and complications related to surgery have negative consequences for both patient in terms of quality of life and the health provider in terms of health economics; therefore, selection of appropriate implant is paramount [13]. Although monoblock stems have been shown to provide successful long-term fixation in femoral revisions, stable fixation may be more difficult to obtain in complex situations with moderate to severe bone loss where modularity can be an advantage [11]. The restoration system is designed for use in revision hip arthroplasty situations where long stems can bypass proximal bone loss and achieve good distal fixation [5,7]. Although monobloc long stem hip revision systems can be a viable option, they may be unable to fill proximal bony defects due to the proximal-distal mismatch in femoral canal diameter [14,15]. In addition, with monobloc stems the surgeon may have less control of version and final leg length; this may lead to an increased risk of fracture of the femur during insertion. Intraoperative fracture reported in this cohort was comparable to other series at 5% [16-18]. Modularity with the restoration system gives immediately stable (rotationally and axially) distal fixation. The proximal body can then be chosen independently to give best proximal fill, leg length, and offset and allows the fine tuning of version [5,11].

Previous studies of revision surgery using modular systems have shown positive functional outcomes across Paprosky classifications I to IV, with low midterm mechanical failure rate, instability, and periprosthetic fracture [5,7,11,19–25], and this was also true of our study. The primary cause of re-revision in this series was reinfection. Chronic infection is among the most challenging complications of hip arthroplasty, causing pain and implant instability. Current orthopedic literature indicates that when an index revision for infection fails, one of the most common reasons is recurrence of infection [11,26]. Treatment options for persistent, deep infection after revision surgery are limited; therefore, it is unsurprising to find recurrence of infection to be the primary cause of failure within this series. Rate of occurrence of new infection after revision surgery in this cohort was less than 4% which is consistent with other series [24].

Re-revision for aseptic loosening accounted for less than 1% of re-revisions in this series, whereas there were no re-revisions for subsidence or fracture. There was also a low incidence of subsidence in this cohort, and of those even fewer needed surgical intervention, most incidences of subsidence were in patients with severely compromised femoral bone (5/7), whereas the remaining 2 incidences were in a patient with a complex etiology and surgical history and 1 patient with a previous periprosthetic fracture. A low rate of mechanical failure is consistent with other studies which reviewed the results of a modular stem in both moderate and severe bone loss and showed that the restoration modular stem can be used successfully in revision hip arthroplasty in patients with varying quality of host bone [5,19-25]. The main difference between this and other published series is the absence of re-revision due to fracture. Other authors have reported between 1% and 3% of postoperative periprosthetic fractures, whereas there were none in this study. Fractures reported in other series appeared to occur secondary to falls or traumatic events [3,5,24]. It is, therefore, difficult to ascertain exactly why our cohort did not experience any fractures postoperatively.

Patient-reported outcomes are increasingly considered an important measure of clinical outcome in arthroplasty surgery. Most patients

in this cohort showed a marked improvement in preoperative to postoperative OHS regardless of the length of time since revision surgery, whereas most patients also reported being satisfied with their surgery. Overall patient's perceptions of the outcomes of their revision surgery at a minimum of 2 years were primarily good, despite many patients having an extensive surgical history. Functional outcomes as recorded using the OHS were similar to that reported for the primary hip arthroplasty in England and Wales and Northern Ireland with a median of 40 as compared to median of 41 given by the UK National joint registry for primary hips [1].

Conclusions

This modular hip system can be used successfully in revision THA even with compromised bone and previous revision surgeries. Re-revision for aseptic loosening in this series was low, with no re-revisions for subsidence or fracture and good patient-reported outcomes. Re-revision for infection was the main cause of failure indicating that eradication of deep infection remains a major challenge.

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