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Clinical and Functional Outcomes of the Exeter V40 Short Stem in Primary and Revision Arthroplasty: Does the Indication Affect Outcomes in the Short Term?

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Purpose: A variety of short Exeter stems designed specifically for use in performance of total hip arthroplasty (THA) in primary and revision settings have recently been introduced. Some have been used 'off label' for hip reconstruction. The aim of this study is to report clinical and radiological results from the Exeter V40 125 mm stem in performance of primary THA and revision THA.

Materials and Methods: This study had a retrospective design. Insertion of 58 (24 primary, 34 revision) Exeter V40 125 mm stems was performed between 2015 and 2017. The minimum follow-up period was two years. Assessment of the Oxford hip score (OHS), EuroQol-5 Dimension (EQ-5D), and radiological follow-up was performed at one and two years.

Results: In the primary group, the preoperative, mean OHS was 13.29. The mean OHS was 32.86 and 23.39 at one-year and two-year post-surgery, respectively. The mean EQ-5D-3L scores were at 0.14, 0.59, and 0.35, preoperatively, at one-year follow-up and two-year follow-up, respectively. In the revision group, the mean preoperative OHS was 19.41. The mean OHS was 30.55 and 26.05 at one-year and two-year post-surgery, respectively. The mean EQ-5D-3L scores were 0.33, 0.61, and 0.48 preoperatively, at one-year follow-up and two-year follow-up, respectively. No progressive or new radiolucent lines were observed around any stem at the time of the final follow-up in all patients in both groups.

Conclusion: Encouraging results regarding use of Exeter V40 125 mm stems have been reported up to two years following surgery in primary and revision THA settings.

Key Words: Total hip arthroplasty, Hip prosthesis, Hip replacement arthroplasty, Prosthesis failure

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INTRODUCTION

The Exeter V40 stem is a modern version of the original Exeter total hip arthroplasty (THA) prosthesis, which was first introduced in 1970[1]. Although few changes have been made to the key aspects of the original design, including the double tapered stem, there have been modifications in the metallurgy, finish, and neck geometry. The most recent advancement was the introduction of short stems with a length of 125 millimeters (mm)[2]. The length of the standard stem is 150 mm; however, introduction of Exeter V40 stems with lengths of 95 mm, 115 mm, and 126 mm, with offsets of 30 mm, 33 mm, and 35.5 mm, respectively, has been reported[3]. A specific 'cement in cement' revision stem-the 44 00 - with a smaller proximal geometry compared to the standard 44 mm offset prostheses but with a 44 mm offset was introduced. Some studies have demonstrated that the longevity of these "shorter" stems is comparable to that of the standard Exeter V40[1,4,5]. These conclusions are based on comparison of the revision rate, often due to aseptic loosening, with historical results[6-9].

According to some reports, achieving optimal fit in patients with abnormal anatomy or those with Dorr type A proximal femoral morphology[10] can result in relative oversizing of components, which could potentially have a negative impact on survivorship[2]. The tendency toward oversizing of the stem when using a standard stem might be explained by a narrower isthmus and increased bowing in the femora of these patients[2,11]. The 44 00 stem has been used 'off label' in patients with Dorr type A femurs[10]; however, there is a concern regarding stem fractures in this setting. Consequently, a 'short stem' was included in the well-established Exeter series in 2014. The shorter stems, which are available in size 1 iterations of the 37.5 mm, 44 mm, and 50 mm offset designs, have the same proximal geometry as those stems but with a reduction in length from 150 to 125 mm. These stems were developed for management of patients with Dorr Type A femurs and femurs with an excessive bow or abnormality of proximal geometry[12] in an effort to minimize the potential risk of stem fractures associated with use of standard size stems and broaches in patients with this anatomy. Data examining the clinical and functional results from use of this new design are limited. To the best of the author's knowledge, the literature includes no published data comparing the results from use of the short Exeter stem in primary and revision settings.

The aim of this study is to report the clinical, radiological, and functional results from use of the Exeter short stem using validated patient reported outcome measures (PROMs) and patient satisfaction levels at two years after surgery and to compare the results from use of the cement in cement revision stem and the contemporary short stem design. We also report radiological results from use of this prosthesis in performance of both primary THA and revision THA.

MATERIALS AND METHODS

This study was conducted as a retrospective review of a prospectively collected database. All patients who underwent treatment using an Exeter stem (Stryker, Kalamazoo, MI, USA) measuring 125 mm in length (excluding the 35.5 mm offset [dysplasia] stem) from January 2015 to December 2017 with a minimum follow-up period of two years were identified from our institutional database. A total of 58 patients were included. Of these, 24 patients underwent primary THA procedures (Fig. 1A, B). The indication for use of the short stem in performance of primary THA procedures was Dorr type A femoral morphology[12] detected during the preoperative planning stage. Thirty-four patients underwent cement in cement revision. The technique for cement in cement revision included removal of the in-situ stem, re-cut of the femoral neck, assessment of the bone cement interface, reaming and drying the medullary surface of the cement mantle, introduction of cement, pressurization, and early insertion of the new stem (Fig. 1C, D). This technique was previously described[13]. All procedures were performed using a posterior approach. In primary cases, careful preoperative templating and component sizing, along with optimal visualization and accurate rasping, paying specific attention to careful insertion of the stem in order to avoid placement of the femoral stem in varus alignment, were performed in order to minimize the risk of placing the stems in a varus position. The cement in cement revision technique was previously described[13,14].

Patients underwent examination preoperatively, at six weeks, 12 weeks, and one-year post-surgery and then annually. Demographic data including age, sex, and body mass index (BMI), the type of procedure, implant used, and indication for surgery were collected. Functional and radiologic assessments were performed at each follow-up visit. Assessment of functional outcome was performed using validated PROMs, including the Oxford hip score (OHS)[15] and the EuroQol-5 Dimension (EQ-5D) questionnaire[16]. A visual analogue scale ranging from 0-100 was used for reporting patient satisfaction. All complications were documented. No patients were lost to follow-up.

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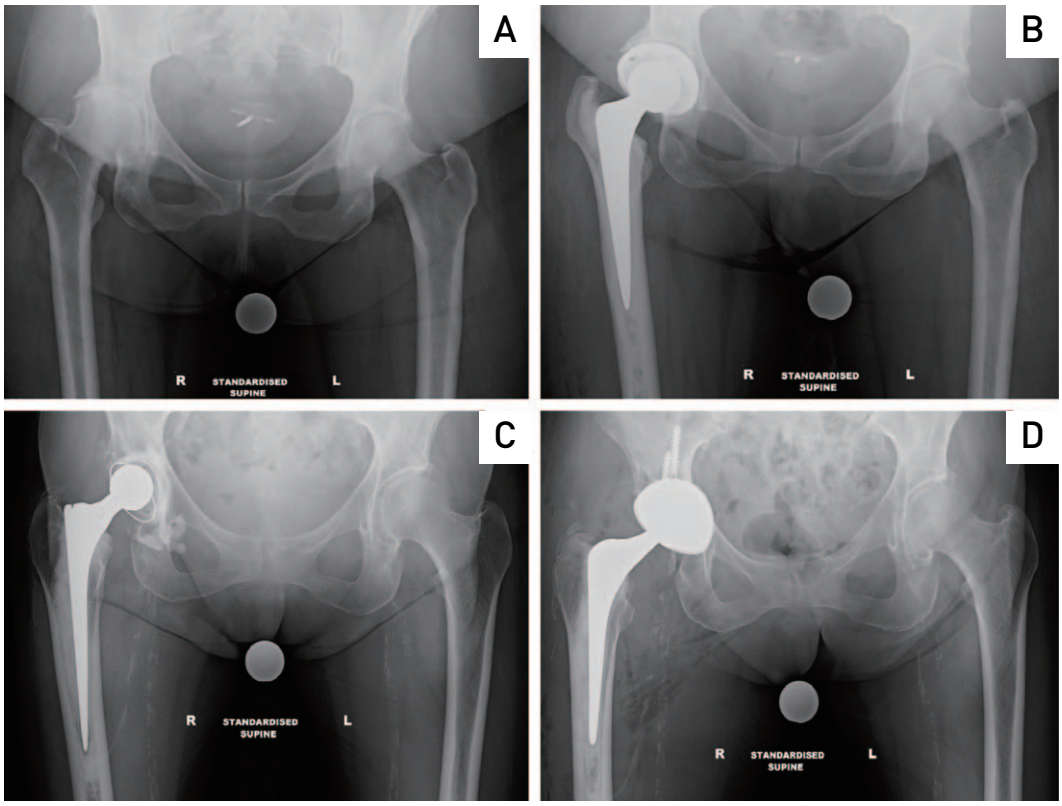

Fig. 1. Preoperative (**A**) and postoperative (**B**) radiographs of a primary total hip arthroplasty using a primary cemented short femoral stem and an uncemented acetabular component. Preoperative (**C**) and postoperative (**D**) radiographs of a revision total hip arthroplasty indicated for loosening of the acetabular component, where the femoral stem was removed in order to optimize visualization of the acetabulum. Revision of the femoral stem was performed using the cement in cement revision technique, including removal of the in-situ stem, re-cut of the femoral neck, assessment of the bone cement interface, and insertion of a cemented short femoral stem.

Standardized anteroposterior pelvic and lateral radiographs of the hip on which surgery was performed were taken at each visit. Assessment of radiographs for the component position, alignment, and observation of progressive radiolucent lines at the interfaces of the bone cement and cement prosthesis was performed by the senior authors (N.A.S. and S.R.). Classification was based on the system proposed by Gruen et al.[17]. Any areas of uncertainty were addressed by discussion and consensus.

Tabulation of data was performed using Microsoft Excel 2019 (Microsoft, Redmond, WA, USA). Due to the small sample size, the Shapiro–Wilks was performed, followed by either a Student's *t*-test (parametric) or Mann–Whitney U test (non-parametric) in order to test the normality of continuous data. The level of significance was set at alpha=0.05.

Routine collection of data reported in this study is performed as part of routine assessment and follow-up for all patients undergoing surgery in the South West London Elective Orthopaedic Centre. Consent was obtained from each patient, enabling collection and use of data for research purposes. Ethical approval for conduct of this study was obtained by the Institutional Review Board of South West London Elective Orthopaedic Centre from which data was collected.

RESULTS

Demographic data for all patients included in our cohort is shown in Table 1. Fourteen males and 44 females were included. The mean age of patients included in our primary and revision THA cohorts was 65.6 years (range, 41-84 years) and 75.8 years (range, 66-93 years) (P=0.83), respectively. The mean BMI for patients in the primary THA cohort was 28.6 kg/m^2 (range, 20-45 kg/m^2). The mean BMI for patients in the group undergoing revision THA was 25.9 kg/m^2 (range, 17-37 kg/m^2) (P=0.76).

The indication for primary THA was osteoarthritis in all cases. The indications for revision THA included aseptic

loosening of the acetabular component (n=27), revision of a hemiarthroplasty to a total hip replacement (n=4), and revision for instability (n=2), and ceramic fracture (n=1). In the group of patients who underwent revision for aseptic loosening, revision of the original in-situ stem was performed, with insertion of a short Exeter stem into the existing cement mantle after standard preparation. Optimized visualization for acetabular reconstruction was attained by removal of the stem. The stems used are shown in Table 2. Optimized visualization during performance of the revision procedure was the indication for removal of the stem in cases of loosening of the acetabular component. A description of this indication was previously reported[13].

1. OHS

No significant difference in the mean preoperative OHS was observed between the primary and revision cohorts (P=0.08). The mean preoperative OHS was 13.29±11.93 in the cohort of patients undergoing primary THA. The mean OHS was 32.86±17.23 at one year after surgery (P<0.0001) and 23.29±22.83 at two years after surgery (P=0.05) (Table 3) compared with preoperative scores.

In the cohort of patients who underwent revision THA, the mean preoperative OHS prior to undergoing a revision procedure was 19.41±13.66. The OHS was 30.55±15.14 (P=0.01) at one year after surgery. The OHS was 26.05 ±19.79 (P=0.16) at two years after surgery. This trend was similar to that observed in the primary THA cohort but without statistical significance.

No significant difference in the change in OHS from the preoperative scores and the scores at the final follow-up was observed between the two cohorts (P=0.32).

2. EQ-5D

No significant difference in the mean preoperative EQ-5D was observed between the primary and revision cohorts (P=0.06). A significant improvement in the EQ-5D score was observed in the first year after surgery in both the primary and revision THA cohorts (P<0.0001 and P=0.01, respectively). A trend toward improvement between one-year and two-year post-surgery was observed in the primary group, although the difference was not significant (P=0.06). However, no significant improvement in this score was observed during the same time period in the revision cohort (P=0.15) (Table 3).

Table 1. Patient Demographics

Variable	Primary THA	Revision THA
Patient demographics		
No. of patients	24	34
Sex		
Male	3	11
Female	21	23
Mean age (yr)	65.6 (41-84)	75.8 (66-93)
Body mass index (kg/m^2)	28.6 (20-45)	25.9 (17-37)
Indication for surgery		
Osteoarthritis	24	-
Acetabular loosening	-	27
Conversion of hemiarthroplasty to THA	-	4
Instability (change of stem version)	-	2
Ceramic fracture	-	1

Values are presented as number only or mean (range).
THA: total hip arthroplasty.

Table 2. Stem Use in the Cohort of Primary and Revision Total Hip Arthroplasty (THA)

Stem (offset and size)	37.5#1	44 00	44#1	50#1
Primary THA (n)	10	5	7	2
Revision THA (n)	1	32	1	-

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Table 3. Patient Reported Outcome Measures (PROMs) of the Study Cohort at One-Year and Two-Year Following Surgery

	All patient	Primary THA	Revision THA
OHS			
Preoperative OHS	17.29±12.99	13.29±11.93	19.41±13.66
1-year OHS	31.50±14.96	32.86±17.23	30.55±15.14
P-value		<0.0001	0.01
2-year OHS	25.36±25.36	23.29±22.83	26.05±19.79
P-value		0.05	0.16
⊿OHS 1 to 2 years	−6.14±16.26	−9.57±23.60	−4.50±13.57
EQ-5D			
Preoperative EQ-5D	0.28±0.38	0.14±0.31	0.33±0.40
1-year EQ-5D	0.59±0.37	0.59±0.37	0.61±0.38
P-value		<0.0001	0.01
2-year EQ-5D	0.43±0.43	0.35±0.43	0.48±0.45
P-value		0.06	0.15
⊿EQ-5D 1 to 2 years	−0.16±0.37	−0.24±0.34	−0.14±0.39

Values are presented as mean±standard deviation.
THA: total hip arthroplasty.

3. Patient Satisfaction

Postoperative scores for satisfaction at one and two years were 80.0% and 50.0% for primary procedures and 78.5% and 61.4% for revision procedures, respectively. Overall, 79.6% of patients were satisfied with their outcome at one year, and 60.7% were satisfied with their outcome at two years postoperatively.

4. Radiological Results

Review of radiographs was performed by the senior authors (N.A.S. and S.R.). In all patients, no progressive or new radiolucent lines were observed around any of the stems at the time of the final follow-up. Similarly, the most recent X-ray images showed no change in stem position.

5. Complications

None of the patients experienced wound-related issues, infections, dislocations, or periprosthetic fractures up to the time of the final follow-up. There were no cases involving revisions or pending revisions up to the time of the final follow-up.

DISCUSSION

THA is a clinically proven and cost-effective surgical option for treatment of patients suffering from symptomatic osteoarthritis of the hip. This procedure has been described as the operation of the century[18]. Encouraging outcomes following THA using cemented and uncemented femoral components have been reported[19]. Some of the most encouraging long-term results have been obtained from use of the Exeter stem in both primary and revision settings[20]. One modification of this stem was the introduction of short stems. This series includes 37.5#1, 44#1, and 50#1-sized stems, which measured 125 mm in length but had normal proximal geometry. This design was developed for optimal fitting of the metaphyseal and diaphyseal femoral anatomy of patients with Dorr type A femora, as well as those with altered proximal or diaphyseal femoral morphology. The 44 00 cement in cement revision stem also measures 125 mm in length but has an overall smaller geometry. Short stems have been used in the primary setting in our institution. Because they fit the existing cement mantle with little extra preparation, they have also been used (along with the 44 00 cement in cement revision stem) in performance of cement in cement revision.

These changes in design are significant, and the clinical results cannot be extrapolated from results on use of the well-established Exeter stem[21]. In addition, the results on use of short stems in the setting of cement in cement revision also cannot be determined. Attaining an understanding of the short and long-term clinical results regarding use of these stems would be helpful to practicing hip surgeons and contribute to the current orthopaedic literature. In addition, this is also a reliable method for introducing new technology. To the best of the author's knowledge, no study comparing the results on use of these stems in prima-

ry and revision settings from a single center has been reported. Choy et al.[5] reported that survivorship was comparable between the standard Exeter stem and short stems at up to seven years; however, their study included a heterogeneous group of prostheses, and no data on patient-reported outcome measures was reported. Evans et al.[22] recently reported a higher 10-year revision rate with use of the 44 00 stem compared with the other stems included in the Exeter V40 range. However, the estimate regarding revision was still within the National Institute for Health and Care Excellence (NICE) 10-year benchmark. In the current study, patients in both cohorts showed improvements in the OHS and EQ-5D scores at one year follow-up. This finding is in agreement with those of studies reported from other institutions[23-25].

In the revision cohort, a numerically higher score was observed for both OHS and EQ-5D compared with primary cases at two years after surgery. This difference is particularly apparent in the two-year EQ-5D scores, which were 0.35 and 0.48 for patients who underwent primary and revision THA, respectively. A higher preoperative score was also observed for patients undergoing revision THA. This finding could potentially be due to the clinical effect of the initial THA procedure and might also explain why a greater improvement in scores was observed for patients undergoing primary THA compared to those undergoing revisions at two years after surgery. The overall score for satisfaction at two years also reflected this result; the revision group included a higher proportion of satisfied patients compared to the primary group. The results obtained in both the primary and revision THA groups are similar to those reported in the literature for use of the standard Exeter stem and other short stem variants[1] as well as results on use of the cement in cement revision technique in other centers[13].

A reduction of both mean OHS and mean EQ-5D scores was also observed between the one-year and two-year follow-up points. Both scores showed a greater reduction in the primary THA group compared with the revision THA group (–9.57 vs. –4.50 for OHS, –0.24 vs. –0.14 for EQ-5D). This finding is in agreement with those reported in previous studies on the outcome of primary THA[26]. The reasons for the changes observed in the revision THA cohort are less clear. Our findings might reflect a relatively longer period of symptomatology and disability experienced by patients in this group prior to undergoing revision surgery as well as a relatively longer period of recovery for patients undergoing revision surgery compared to those undergoing primary THA. These results are consistent with those reported by the authors of previously reported studies which demonstrated that an improvement of 11-14 points in the OHS can be regarded as meaningful, showing correlation with clinical improvement in hip arthroplasty[23-25]. However, because this cohort included a relatively small number of patients, caution is required when interpreting this data.

Sivananthan et al.[1] first reported improvements in the OHS in a cohort of patients who underwent primary and revision THA utilizing the Exeter short stem. Chiu et al.[4] reported that a cohort of patients who underwent primary THA showed improvements in the Harris hip score. Both studies included a heterogeneous group of implant designs, including stem lengths of 95 mm, 115 mm, or 125 mm with offsets of 30 mm, 33 mm, and 35.5 mm, respectively. Therefore, direct comparison of their results with those of this study is not possible. In addition, our patient population and the indications for use of this 125 mm short stem differ from those of previous studies. In our study a 125 mm stem length was only used in two common surgical situations.

This study has several limitations. It has a single center design, it included a small number of patients, and the duration of postoperative follow-up was only up to two years. However, this study does report the first clinical results from use of a novel and increasingly utilized femoral component in the primary and revision setting.

CONCLUSION

In this study, the results of hip reconstruction suggest that the Exeter short stem can be regarded as a feasible option for use in performance of primary THA and for performance of femoral component revision using the cement in cement technique. Satisfactory PROMs and levels of patient satisfaction at up to two years after surgery have been reported in association with use of this prosthesis. Further conduct of large multicenter studies will be required for evaluation of medium and long-term results.

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CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

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