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Evaluation of the JRI Cemented Hip Hemiarthroplasty: Mid-Term Results Including Patient-Reported Outcomes

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Abstract

Background: Hemiarthroplasty is the primary treatment for displaced intracapsular hip fractures in frail patients. Implant selection is crucial to reduce reoperations, which carry a high complication risk. This study reports on re-operations, mortality, revisions, and patient-reported outcome measures (PROMs) following the use of the JRI (Joint Replacement Instrumentation Limited) Furlong Cemented Hemiarthroplasty prosthesis.

Methods: We undertook a retrospective cohort study at a major trauma centre in the United Kingdom. All intracapsular neck of femur patients aged over 60 who underwent cemented hip hemiarthroplasty with the JRI Furlong femoral stem over a 5 year period from January 2018 to December 2022 were included. The primary outcome measure was reoperation, including closed reduction of dislocation. Secondary outcome measures were dislocation specifically, revision, mortality and PROMs.

Results: 1183 patients in the study period (793 female, 390 male) with an average age of 84.3 were followed up to 6 years. For a subset of patients, PROMs were recorded at 4 months (n = 237) and 3 years (n = 215). The reoperation rate at 1 year was 1.13% (95% CI 0.64% to 1.99%), increasing to 1.62% (95% CI 0.95% to 2.75%) at 5 years. The 5-year revision rate was 0.68% (95% CI 0.39% to 1.55%); 5-year dislocation rate was 0.87% (95% CI 0.45% to 1.67%). Mean EQ5D utility score was 0.621 at 4 months and 0.603 at 3 years for those alive.

Conclusions: Our cohort shows low re-operation, revision and dislocation rates in the mid-term. We describe acceptable PROMS in the context of a frail population.

Keywords

hip, hemiarthroplasty, outcome, medium, mid, revision, re-operation, PROM, patient-reported

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Introduction

Neck of femur fractures represent a significant burden on the UK population and its health service. Approximately 76 000 neck of femur fractures are sustained in the UK each year with high associated morbidity and mortality.[1-3] Hemiarthroplasty remains the mainstay of treatment for elderly, frail patients with displaced neck of femur fractures without significant osteoarthritis, to restore mobility

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and relieve pain.[4] Implant selection is critical to minimise reoperations for patients undergoing hemiarthroplasty, which come with high risk of complications such as fracture, dislocation, and infection.[5]

Whilst the National Institute for Health and Care Excellence (NICE) sets a benchmark of 5% revision rate or less at 10 years for elective total hip replacement prostheses,[6] there is no set standard for hemiarthroplasty. Only recently have NICE guidelines been updated to recommend data collection into the National Joint Registry for hip hemiarthroplasties in order to prospectively monitor implant survivorship. These data will take years to gather; in the meantime there is ongoing need to monitor the real-world performance of these devices.

Our institution uses the JRI Furlong Cemented Hemiarthroplasty Femoral Stem (Joint Replacement Instrumentation Limited, Sheffield, UK), a collarless, modular, double tapered, polished stainless-steel prosthesis (Figure 1). Previous smaller series have shown good early outcomes for the prosthesis,[7] but the literature is sparse and does not include patient-reported outcome measures (PROMs). Evaluation of PROMs is an important metric in frail patients[8] because their use can identify poorly functioning but unrevised implants, as revision surgery in this population is a relatively rare event.

This study aimed to fill this evidence gap, reporting on reoperations, mortality, revisions, and PROMs with up to 6-year follow-up using this device.

Methods

This was a retrospective cohort study of consecutive patients undergoing hemiarthroplasty for intracapsular neck of femur fracture at a tertiary National Health Service (public-sector) hospital in the United Kingdom from January 2018 to December 2022. Institutional approval was granted (CAE-193). Our inclusion criteria were any patient who underwent hip hemiarthroplasty with the JRI hip hemiarthroplasty stem at our centre during the study. Exclusion criteria were those under the age of 60, and operations done for pathological fractures.

Cases were identified through review of prospectively logged local National Hip Fracture Database (NHFD) records. Electronic medical records, theatre logs, radiographs, outpatient clinic letters, and NHS Spine records were reviewed for each. Data were collected: age, sex, American Society of Anaesthesiologists (ASA) grade, preoperative Abbreviated Mental Test Score (AMTS), mobility, residential status, hours to surgery from admission, indication, fracture pattern, operating side, implant details, length of hospital stay (LOS).

Figure 1. JRI Furlong Hemiarthroplasty Stem.

Outcome Measures

The primary outcome of reoperation was defined as any subsequent hip procedure, including closed reductions of dislocations. Dislocation was also reported specifically as a secondary outcome measure as the risk of it is directly impacted by prosthesis design.[9] The unit is the revision arthroplasty centre for the region and all revisions were likely to have been undertaken in this centre. Indication for and details of surgery were recorded. Revision was defined in accordance with the National Joint Registry (NJR) as any operation performed to add, remove or modify one or more components of a joint replacement or to perform a debridement and implant retention (DAIR) of a joint replacement, with or without modular exchange.[10] Mortality data were obtained through hospital records which are linked to the centralised NHS Personal Demographics Service (PDS).

PROMs data were obtained in a subset of 292 patients in the form of the EuroQol Group 5-Dimension (EQ-5D) score at the 4-month and 3-year marks following surgery via telephone. The EQ-5D questionnaire is a validated instrument comprising a visual analogue scale (EQ-VAS) that measures health from 0 (worst imaginable state of health) to 100 (best imaginable state of health) and a health-status instrument that consists of a five-level response (EQ-5D-5L) from "no problems" to "unable" for five domains related to daily activities: mobility, self-care, usual activities, pain or discomfort, and anxiety or depression (Appendix 1).[11] Detailed implant manufacturer characteristics were also obtained for this patient subgroup.

Operative Technique

All patients are admitted under joint care of trauma & orthopaedic surgeons and care of the elderly physicians. Surgical technique is standardised and involves implantation of a JRI Furlong Cemented Hemiarthroplasty Femoral Stem (Joint Replacement Instrumentation Limited, Sheffield, UK) with modular monopolar head through a trans-gluteal anterolateral approach to the hip joint. A double-mix of Palacos G cement is used (Heraeus Medical UK, Berkshire, UK). The definitive stem size selected is one smaller than the largest rasp with good fit due to previous findings from our institution of a relatively high intra-operative fracture rate.[7] All patients fully weightbear postoperatively.

Statistical Analysis

The outcomes of reoperation, revision, and mortality were analysed as time-to-event data using Kaplan-Meier (KM) failure estimates for each respective endpoint. Estimates were expressed with 95% confidence intervals (CI), and numbers at risk at relevant timepoints included in figures. EQ-5D-5L responses were converted into a single utility score with the use of the Crosswalk Index Value Calculator of the 3-Level (3L) instrument and its established time trade-off utility algorithm for the U.K. population, and expressed as both non-death adjusted and death-adjusted (with death imputed as a score of 0).[11,12] Analysis was performed using Stata (MP 18.0; StataCorp).

Results

There were 1183 patients in the study period (793 female, 390 male) with an average age of 84.3 (Table 1) and a follow-up period up to 6 years. The majority of patients were ASA III or IV and only mobile indoors. All prostheses were JRI Furlong Cemented Hemiarthroplasties; detailed implant materials can be found in Appendix 2. A summary of Kaplan-Meier analyses is provided in Appendix 3-6.

Reoperation rate at 1 year was 1.13% (95% CI 0.64% to 1.99%), and 1.62% at 5 years (95% CI 0.95% to 2.75%; Figure 2). Table 2 outlines the absolute number and percentage of re-operations by cause from the cohort. Of the reoperations, eight were classed as revisions meaning the 5-year revision rate was 0.78% (95% CI 0.39% to 1.55%).

Table 1. Demographic Details.

Category	Summary (N = 1183)
Sex	
Female	793 (67.0%)
Male	390 (33.0%)
Age	84.25 (7.65)
ASA	
I	4 (0.3%)
II	137 (11.7%)
III	700 (59.7%)
IV	329 (28.1%)
V	2 (0.2%)
Pre-op AMTS	6.82 (3.62)
Operating side	
Left	647 (54.7%)
Right	536 (45.3%)
Mobility	
Freely mobile without aids	255 (21.6%)
Mobile outdoors with 1 aid	235 (19.9%)
Mobile outdoors with two aids	79 (6.7%)
Mobile indoors only	581 (49.1%)
No functional mobility	16 (1.4%)
Unknown	17 (1.4%)
Residence	
Nursing care	138 (11.7%)
Own home/sheltered housing	945 (79.9%)
Residential care	98 (8.3%)
Unknown	2 (0.2%)
Time to surgery (hours)	29.73 (46.96)
Length of hospital stay (days)	18.50 (13.19)

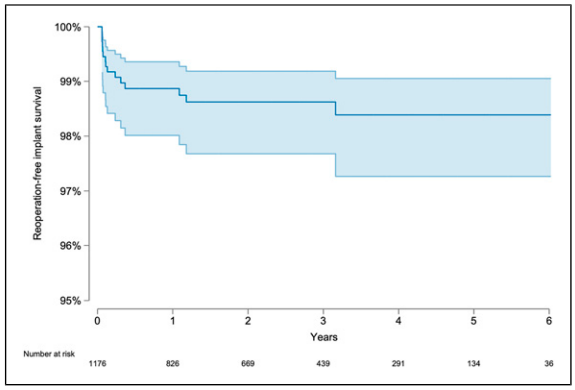

Figure 2. Kaplan-Meier Survival Estimates for Implant Survival Without Reoperation (%). Shaded Area Represents 95% Confidence Interval.

There were no revisions for implant loosening or acetabular wear.

The most common cause of re-operation was dislocation. Five-year dislocation rate was 0.87% (95% CI 0.45% to 1.67%). Management of dislocations included three patients who underwent successful closed reduction under anaesthesia, three where dislocation was recurrent who were managed with excision arthroplasty, two which occurred in fitter patients who were revised to a constrained THR, and one in a frail patient requiring open reduction where the joint was subsequently stable and therefore was not revised.

Intraoperatively there were three significant surgical complications comprising two stem perforations and one fracture of the greater trochanter. Neither stem perforation was noticed intra-operatively; one was successfully managed conservatively, the other required excision arthroplasty when the stem later migrated from the femur. The intra-operative fracture was managed with trochanteric plate fixation and cables.

Mortality was 29.7% (95% CI 27.16% to 32.36%) at 1 year, rising to 63% (95% CI 60.6% to 67.3%) by 5 years postoperatively (supplementary). For patients who underwent reoperation, the 30-day mortality following it was 40% (95% CI 20.4 to 68.2).

PROMs (Table 3) at 4 months comprised a mean death-adjusted EQ5D utility score of 0.495, and 0.621 for those alive, with a mean EQ-VAS of 70.6. At 3 years, mean death-adjusted EQ5D utility score was 0.157, 0.603 for those alive, with a mean EQ-VAS of 65. PROMs were missing in 18.8% and 26.4% of patients at 4 months and 3 years respectively.

Discussion

These data show good mid-term survivorship of the JRI Furlong cemented hemiarthroplasty prosthesis in a cohort of 1183 consecutive patients. The primary outcome showed a low reoperation rate of 1.13% at 1 year and 1.62% at 5 years. The 5-year revision rate was 0.68%, with no revisions for implant loosening or acetabular wear. Dislocation rates were low, occurring in only 0.87% of patients over 5 years. Mortality was high, reflecting the frailty of this cohort; 29.7% at 1 year, reaching 63% at 5 years, somewhat limiting longer-term interpretation of prosthesis performance. Notably, reoperation was associated with a significant impact, with a 30-day mortality rate of 40%. Postoperative PROMs showed reasonable results, with interpretation also limited by the high mortality rate.

This represents to our knowledge the largest study on this implant in the literature, with the longest follow-up period, and the only to include PROMs. The implant survival reported here compares favourably to the existing literature for other designs.[13-16] A recent systematic review and meta-analysis including 23 436 cemented hemiarthroplasties gave a pooled re-operation rate of 3.66%.[13] Previously reported Norwegian Registry data represented the largest study included in this analysis with median follow-up of two years and an interquartile range of 0.5-4.2 years.[14] The only RCT within the analysis of re-operation rate included 116 cemented hemiarthroplasties with a re-operation rate of 6.25% and dislocation rate of

Table 2. Summary of Reoperations.

	Frequency	Percent
Reoperations	15	1.27%
(Of which were revisions)	8	0.68%
Details		
Closed reduction of dislocation	3	0.25%
Open reduction of dislocation with soft tissue repair	1	0.08%
Girdlestone excision arthroplasty	4	0.34%
Periprosthetic fracture fixation (Vancouver B)	3	0.25%
DAIR	1	0.08%
Washout without component exchange	1	0.08%
Revision to THR (constrained)	2	0.17%

Table 3. Patient-Reported Outcome Measures (PROM).

	Mean	SD	N=
EQ-5D utility score, 4 months	.621	.299	189
EQ-5D death-adjusted utility score, 4 months	.495	.365	237
EQ-VAS at 4 months	70.6	17.4	179
Missing[a]			55
EQ-5D utility score, 3 years	.603	.355	56
EQ-5D death-adjusted utility score, 3 years	.157	.321	215
EQ-VAS at 3 years	65	19.3	56
Missing[a]			77

SD, standard deviation; EQ-5D, EuroQol- 5 dimension; VAS, visual analogue score.
[a]Unable to comply with questions, uncontactable, or declined.

4.46% with a median follow-up of 5 years.[15] A 5 year review of 1670 cemented Thompson's hemiarthroplasties gave survival rates of 95.4%, with a revision rate of 2.16% and a dislocation rate of 1.1%.[16] The 10-year follow-up for this cohort has been reported recently.[17]

One explanation for the relatively lower dislocation result within our cohort could be the relatively capacitious JRI stem which permits minimal alteration of femoral neck anteversion and length. The system is modular which also facilitates ease of implant positioning. Offset increases in a fixed manner with stem size. At our centre it is routine practice to downsize the stem by one size compared to the largest rasp fitting due to previous findings of a high rate of intra-operative fracture.[7] Perhaps as a result, in the present cohort intraoperative femoral fracture or perforation rates were lower, with three events identified.

Our 1- and 5- year mortality rates of 29% and 63% respectively are similar to previous studies focusing specifically on elderly hip fracture patients treated with hemiarthroplasty.[18] These are slightly higher than the figures quotes for all hip fractures which typically range between 20-28% at 1 year.[19,20] This is likely due to selection bias where hemiarthroplasty patients represent a frailer subset of patients within the full spectrum of hip fracture patients which includes those undergoing total hip replacement or fixation. The higher mortality rate does somewhat limit the interpretation of prosthesis performance in the long term due to the steady reduction in numbers at risk when the time period in question becomes years. However, when specifically evaluating implant failure Kaplan-Meier estimates remain the most appropriate to assess longevity.[21] Notably reoperation carried a 30-day mortality of 40%; these included non-revision procedures such as closed reduction of dislocation, which would not necessarily be captured by the NJR, demonstrating the importance of observational data of this nature.

The reported PROMs were comparable to previous studies. Mean death-adjusted ED-5D-5L utility score for the WHiTE 5 trial was 0.371 at 4 months (n = 441) and 0.329 (n = 438) at 1 year respectively.[22] For our study, on a frailer cohort of patients, mean death-adjusted ED-5D-5L utility scores taken at 4 months and 3 years were 0.495 (n = 237) and 0.157 (n = 215). A notable difference in our methodology is that we did not include carer or relative responses for cognitively impaired patients who were unable to provide answers themselves. As a result, our findings are likely biased upwards, as these patients, along with those who could not be contacted, are expected to have lower scores. This represents an inherent limitation in studying this patient cohort in a real-world, non-selective setting. However, we believe the results remain valuable when interpreted within this context. Additional limitations include the challenge of follow-up in this cohort, where reoperations that may have occurred in other centers or regions might have been missed. Since our hospital serves as the regional tertiary center for revision arthroplasty, we expect this number to be low.

Conclusions

We report low reoperation, revision and dislocation rates associated with the JRI Furlong cemented hemiarthroplasty stem in the mid-term, with acceptable PROMs when interpreted in the context of a frail population. These data support the ongoing use of the device and will facilitate further comparison with existing femoral stems to ensure effective implant selection and optimisation of patient outcomes.

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Statements and Declarations

Ethical Approval

Institutional ethical approval was granted - reference CAE-193.

Author Contributions

Felix Morriss: Conceptualisation, Writing - original draft, Writing - reviewing & editing. Joseph M. Battle: Investigation, Data curation, Writing - reviewing & editing. Jonny Varma:

Investigation, Data curation, Writing – reviewing & editing. Ahmed M. M. Shaheen: Investigation, Data curation, Writing - reviewing & editing. Steven Barnfield: Investigation, Data curation, Formal analysis. Jonathan M. R. French: Conceptualisation, Writing - original draft, Writing - reviewing & editing, Formal analysis, Project administration. Michael Kelly: Conceptualisation, Supervision, Writing - reviewing & editing.

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Conflicting Interests

Mr Michael Kelly has consultancies with Stryker and J&J MedTech. None are relevant to this paper.

Data Availability Statement

Anonymised data is available for appropriate requests subject to local institutional approval.

Supplemental Material

Supplemental material for this article is available online.

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