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A multicentre comparative analysis of fixation versus revision surgery for periprosthetic femoral fractures following total hip arthroplasty with a cemented polished taper-slip stem

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Abstract

Aims

This study compares open reduction and internal fixation (ORIF) to revision surgery for Unified Classification System (UCS) grade B periprosthetic femoral fractures (PFFs) around cemented polished taper-slip stems following primary total hip arthroplasty.

Methods

Data were collected for patients admitted to five UK centres. The primary outcome was the two-year reoperation rate. Secondary outcomes were time to surgery, transfusion requirements, critical care requirements, length of stay, two-year local complication rates, six-month systemic complication rates and mortality rates. Comparisons were made by treatment type (ORIF versus revision) and UCS grade (B1 versus B2/B3). Kaplan-Meier survival analysis was performed with two-year reoperation for any reason as the endpoint. Statistical significance was $p<0.05$.

Results

317 PFFs with median follow-up of 3.6 (IQR, 2.0-5.4) years were included. PPFs were B1 in 133 (42.0%) patients, B2 in 170 (53.6%) patients and B3 in 14 (4.4%) patients. ORIF was performed in 167 (52.7%) patients and revision in 150 (47.3%) patients. The two-year reoperation rate (15.3% versus 7.2%, p=0.021), time to surgery (4.0 [IQR, 2.0-7.0] versus 2.0 [IQR, 1.0-4.0] days, p<0.001), transfusion requirements (55 [36.7%] versus 42 [25.1%] patients, p=0.026), critical care requirements (54 [24.0%) versus seven [4.2%] patients, p<0.001) and two-year local complication rates (26.7% versus 9.0%, p<0.001) were significantly higher in the revision group. The two-year survival rate was significantly greater for ORIF (91.9% [SE, 0.023] versus 83.9% [SE, 0.031], p=0.032) versus revision. For B1 fractures, the two-year reoperation rate was significantly higher for revision compared to ORIF (29.4% versus 6.0%, p=0.002) but this was similar for B2/B3 fractures (9.8% versus 13.5%, p=0.341). The commonest cause for reoperation after revision was dislocation (8.0%).

Conclusion

Revision surgery has higher reoperation rates, longer surgical waiting times, higher transfusion requirements and higher critical care requirements than ORIF. ORIF is safe and resourceful providing anatomic reconstruction is achievable.

Introduction

Cemented total hip arthroplasty (THA) provides excellent long-term outcomes and is cost-effective.[1-4] Polished taper-slip (PTS) stems are the commonest cemented stem type in the UK having replaced traditional composite-beam (CB) stems. Due to their clinical and cost-effectiveness, a Best Practice Tariff was introduced to NHS providers to incentivise their use in patients aged over 70 years.[5,6]

Despite lower rates of aseptic loosening, PTS stems have a higher risk of postoperative periprosthetic femoral fracture (PFF) compared to CB stems.[7-13] PFF incidence is increasing by 13% each year and it is one of the commonest indications for revision THA.[5,14] PFF is a serious complication and typically requires surgical management which is associated with high complication rates and healthcare costs.[15,16] Surgical treatment is guided by the Unified Classification System (UCS) and, for grade B fractures occurring around the stem, this involves open reduction and internal fixation (ORIF) for fractures around well-fixed stems (B1) or revision (+/- ORIF) for fractures around loose stems (B2) or in the presence of severe bone loss (B3).[17] Whilst this is well-accepted for fractures around CB stems, there is considerable variation in practice when treating fractures around PTS stems.[18] This disparity is due to differences in their fixation methods and the subsequent effect on stem stability at the time of fracture. CB stems rely on a mechanical interlock at both the stem-cement and cement-bone interfaces. PTS stems allow controlled subsidence at the stem-cement interface but require a well interdigitated cement-bone interface. Many surgeons offer revision surgery for all grade B PFFs around PTS stems whereas some favour ORIF providing that the cement-bone interface is maintained and that anatomical reconstruction of the bone and cement mantle is achievable.

The clinical evidence for operatively managing grade B PFFs around PTS stems is sparse and there are only single-centre studies reporting clinical outcomes which limits the generalisability of their conclusions. Smitham et al. reported an 11.4% reoperation rate following ORIF surgery in a series of 44 PFFs.[19] Maggs et al. reviewed 87 PFFs treated with revision and described reoperations in 20.7% of patients.[20] Powell-Bowns et al. reviewed 152 PFFs and reported reoperation rates of 11% with ORIF and 55% with revision.[21] However, the optimal surgical treatment remains uncertain.

The aim of this study was to compare clinical outcomes of ORIF and revision in a multicentre series of grade B PFFs occurring around a PTS stem following primary THA.

Methods

NHS Health Research Authority ethical approval was obtained for this multicentre observational cohort study (REC 21/PR/0856). Patients with operatively treated UCS B PFFs around a primary THA with a PTS stem consecutively admitted to each of five UK centres between 8th March 2007 and 14th May 2020 were included. Exclusion criteria were intraoperative fractures, PFFs around a hemiarthroplasty or hip resurfacing, PFFs around revision THA or trauma implants and interprosthetic fractures.

Data were collected through electronic patient records and radiographs using local Picture Archiving and Communication System software. Anonymised data were recorded on patient demographics, primary THA implants, PFF details and management. Demographic data included gender, age at fracture, pre- and postoperative residential status (own home, supported living, residential home or nursing home), body mass index (BMI), ASA score and Charlson Comorbidity Index (CCI). Primary THA data included indication, cup fixation (cemented or cementless) and cup type (standard articulation, dual-mobility or constrained). PFF data included laterality, mechanism of injury (low energy or high energy), UCS grade (B1, B2 or B3), multifragmentary fracture pattern, associated cup wear or loosening, whether femoral cement was well-fixed to bone and if the stem was still potted in its centraliser. For consistency, a B1 PFF was defined by a well-fixed stem, a B2 PFF by radiolucency at either the stem-cement interface or the cement-bone interface and a B3 PFF by severe comminution and/or bone loss. Surgical treatment data included treatment (ORIF or revision), ORIF type (cerclage fixation only, plate only or combined plate and cerclage fixation), use of a PFF-specific locking plate, use of fluoroscopy, revision stem type (long cementless modular, long cementless non-modular, standard length cemented stem, short cemented stem, long cemented stem or proximal femur replacement), cup revision (standard articulation, dual-mobility, constrained or not revised), use of femoral bone graft and graft type. ORIF was defined by the use of any fixation device placed internally without THA implant removal, exchange or modification. Revision was defined by removal, exchange or modification of any component of the THA construct +/- an additional fixation device. Choice of surgery was determined by the operating surgeon but ORIF was only considered if stable anatomical reconstruction of the femur and cement mantle could be achieved or if the patient was too frail to undergo revision.

The primary outcome was the two-year reoperation rate. Secondary outcomes were time to surgery (days), 72-hour blood transfusion requirements, postoperative critical care (high dependency and intensive care units) requirements, length of stay (LOS, days), return to usual residence, 90-day reoperation rates, 30-day readmission rates, two-year local complication rates, six-month systemic

complication rates and 30-day and one-year mortality rates. Final follow-up was determined by the date of the latest clinical or radiographical review.

Statistical analysis

Statistical analyses were undertaken using SPSS version 27.0 (IBM, Armonk, New York, USA). Data were tested for normality using the Shapiro-Wilks test and compared between the ORIF and revision groups. Data were reported as mean values with 95% confidence intervals (CI) or median values with interquartile ranges (IQRs) for continuous variables and percentages for categorical variables. Descriptive statistics were used to report population characteristics at baseline. Comparisons between independent continuous variables were performed with the Mann Whitney U test. Comparison of independent categorical variables were performed with the Chi-squared test but where assumptions for this were not met, Fisher's exact test was used. A comparison of outcomes was performed for the whole cohort followed by a subgroup comparison of outcomes by UCS grade (well-fixed [B1] versus loose stems [B2 and B3]). Cumulative survival rates (%) with standard error (SE) were assessed using Kaplan-Meier methodology with the two-year reoperation for any reason as the endpoint. Patients who died before the end of the two-year period were censored. Log rank statistic was used to compare treatment methods. Statistical significance was set to $p<0.05$.

Results

Overall, 317 unilateral PFFs around PTS stems were included with a median follow-up time of 3.6 (IQR, 2.0-5.4) years. All patients were accountable for and therefore there was no loss to follow-up. Median age was 79.9 (IQR, 72.0-86.0) years and 143 (45.1%) patients were female. Median BMI was 26.4 (IQR, 23.2-30.6), median ASA score was 3.0 (IQR, 2.0-3.0) and median CCI was 5.0 (IQR, 3.0-6.0). There were 201 (63.4%) PFFs involving a fully cemented THA and 116 (36.6%) PFFs involving a hybrid THA with a cementless cup. There were 166 (52.4%) right sided PFFs and 16 (5.0%) PFFs occurred following high energy injury. PPFs were B1 in 133 (42.0%) patients, B2 in 170 (53.6%) patients and B3 in 14 (4.4%) patients. Five (1.6%) cups were loose or worn and femoral cement was well-fixed in 259 (81.7%) cases. The stem was still potted in its centraliser in 239 (75.4%) cases. ORIF was performed in 167 (52.7%) and revision in 150 (47.3%) patients.

The two-year reoperation rate for all B fractures was 11.0% (35 patients). Median time to surgery was 3.0 (IQR, 2.0-5.0) days, median LOS was 18.0 (IQR, 12.0-28.0) days and 250 (78.4%) patients returned to their usual residence. Postoperative blood transfusion was administered to 97 (30.6%) patients within 72-hours and 43 (13.6%) patients required critical care admission postoperatively. The 90-day reoperation rate was 5.4% (17 patients), the 30-day readmission rate was 3.8% (12 patients), the two-year local complication rate was 17.4% (55 patients), the six-month systemic complication

rate was 16.1% (51 patients), the 30-day mortality rate was 3.2% (10 patients) and the one-year mortality rate was 15.1% (48 patients). By two-years, 74 (23.3%) patients had died with a median time to death of 7.5 (IQR, 2.3-15.4) months.

Comparison of groups (open reduction and internal fixation versus revision)

A comparison of baseline patient, primary THA and PFF characteristics is presented in **Table 1**. Significantly more patients in the ORIF group had preoperative care home status (15.6% versus 6.0%, p=0.002), a fully cemented THA (78.4% versus 46.7%, p<0.001), well-fixed femoral cement (89.2% versus 73.3%, p<0.001) and stems still potted in their centraliser (84.4% versus 65.3%, p<0.001) compared to the revision group which had significantly more patients with high energy injuries (12.0% versus 4.3%, p=0.010) and multifragmentary fractures (42.7% versus 17.4%, p<0.001).

Open reduction and internal fixation versus revision (all B fractures)

Surgery performed for all B fractures is presented in **Table 2** and outcomes are presented in **Table 3**. The two-year reoperation rate was significantly higher in the revision compared to the ORIF group (15.3% [23 patients] versus 7.2% [12 patients], p=0.021). Two-year reoperation rates by ORIF subtype were 16.7% (one case), 9.5% (two cases) and 6.4% (nine cases) for the cerclage, plate only and plate and cerclage groups, respectively. There was no significant difference in either the two-year reoperation rate (8.1% [nine patients] versus 4.0% [two patients], p=0.339) or the two-year local complication rate (7.2% [eight patients] versus 12.0% [six patients], p=0.318) between conventional and PFF-specific locking plates, respectively. Median time to surgery (4.0 [IQR, 2.0-7.0] versus 2.0 [IQR, 1.0-4.0] days, p<0.001), 72-hour blood transfusion requirement (55 [36.7%] versus 42 [25.1%] patients, p=0.026), postoperative critical care requirement (54 should be 36 [24.0%) versus seven [4.2%] patients, p<0.001) and two-year local complication rates (26.7% [40 patients] versus 9.0% [15 patients], p<0.001) were also significantly higher in the revision group.

Reasons for reoperations, readmissions and complications following surgery are presented in **Table 4**. The commonest local complication (13 [9.3%] patients) and reason for reoperation (12 [8.0%] patients) in the revision group was dislocation. Only twenty-two (14.7%) patients in the revision group had revision of the acetabular component at PFF surgery. Of the 13 dislocation patients in the revision group, 10 (76.9%) did not have cup revision and the remaining three (23.1%) had revision with a standard articulation cup. None of the 12 patients who had cup revision at PFF surgery with either a dual-mobility (seven, 58.3%) or a constrained (five, 41.7%) cup had a dislocation. With two-year reoperation for any reason as the endpoint, Kaplan-Meier analysis demonstrated a significantly higher two-year survival rate for ORIF compared to revision (91.9% [SE, 0.023] versus 83.9% [SE, 0.031], p=0.032, **Figure 1**).

Open reduction and internal fixation versus revision (B1 fractures)

Outcomes of surgical treatment for B1 fractures are shown in **Table 5**. The two-year reoperation rate was significantly higher in the revision compared to the ORIF group (29.4% [five patients] versus 6.0% [seven patients], p=0.002). Median time to surgery (4.0 [IQR, 3.0-7.0] versus 2.0 [IQR, 1.0-4.0] days, p=0.003), postoperative critical care requirement (four [23.5%) versus seven [6.0%] patients, p=0.035), 90-day reoperation rates (23.5% [four patients] versus 2.6% [three patients], p<0.001) and two-year local complication rates (47.1% [eight patients] versus 8.6% [10 patients], p<0.001) were also significantly higher in the revision group. Significantly more patients returned to their usual residence in the revision group (17 [100.0%] versus 89 [76.7%] patients, p=0.026). Reasons for reoperations, readmissions and complications following surgery are presented in **Table 6**. The commonest local complication and reason for reoperation (four [23.5%] patients) in the revision group was postoperative dislocation. A significantly higher two-year survival rate was observed for ORIF compared to revision (93.1% [SE, 0.025] versus 70.6% [SE, 0.111], p=0.001, **Figure 2**).

Open reduction and internal fixation versus revision (B2 and B3 fractures)

Outcomes of surgical treatment for B2 and B3 fractures are shown in **Table 7**. The two-year reoperation rate was similar between the ORIF and revision groups (9.8% [five patients] versus 13.5% [eighteen patients], p=0.341). Median time to surgery (4.0 [IQR, 2.0-7.0] versus 3.0 [IQR, 1.0-6.0] days, p=0.039), postoperative critical care requirement (32 [24.0%) versus zero [0.0%] patients, p<0.001) and two-year local complication rates (24.1% [32 patients] versus 9.8% [five patients], p=0.031) were significantly higher in the revision group. Thirty-day readmission rates were significantly higher in the ORIF group (11.8% [six patients] versus 3.0% [four patients], p=0.029). Reasons for reoperations, readmissions and complications following surgery are presented in **Table 8**. The commonest local complication (nine [6.8%] patients) in the revision group was dislocation. Two-year survival rates were similar between the ORIF and revision groups (89.0% [SE, 0.047] versus 85.6% [SE, 0.032], respectively, p=0.640, **Figure 3).**

Discussion

This is the largest study investigating surgical outcomes for grade B PFFs around PTS stems. It confirms that for B1 fractures, revision has a significantly higher two-year reoperation rate than ORIF and that for B2 and B3 fractures, two-year reoperation rates are similar between the groups. Revision is also associated with longer times to surgery, higher blood transfusion requirements, higher critical care requirements and a higher two-year local complication rate. The commonest local complication and reason for reoperation following revision is postoperative dislocation. Where revision is performed, cup revision to either a dual-mobility or constrained cup should be considered. Due to lower reoperation rates and hospital resource requirements, this study supports ORIF over revision for

grade B fractures, providing anatomical reconstruction can be achieved. This challenges the practice of exclusively performing revision for PFFs around PTS stems based on the assumption that PTS stems are loose due to their taper-slip design.

Expected differences between the ORIF and revision groups' baseline characteristics were observed. The ORIF group had more care home residents reflecting increased frailty which may have influenced surgical decision making with a preference for ORIF over revision surgery in some patients. The ORIF group had more cases with well-fixed femoral cement and stems still potted in their centraliser. It is unclear why there were more cemented cups in the ORIF group, but this is unlikely to have influenced treatment choice. The revision group had more high energy injuries and multifragmentary fractures which are less likely to be treated with ORIF due to the risk of subsequent stem loosening.

The two-year reoperation rate for all B PFFs was 11.0% and this is consistent with a recent systematic review of PFFs around PTS stems which reported a reoperation rate of 11.4%.[22] In the present study, the two-year reoperation rate of the ORIF group was 7.2% which compares favourably to previous reports.[19,21,23] Like others, this study did not show any benefit of PFF-specific locking plates over conventional non-locking plates and this may have significant implications for cost-savings.[15,23] In effect, placing non-locked cortical screws into cement through a conventional plate creates a fixed-angled device where screws cannot loosen independently. This may explain the lack of advantage of PFF-specific locking plates. The higher reoperation rate of 15.3% in the revision group was predominantly due to dislocation as evidenced by the early drop-off in cumulative survival compared to the ORIF group. Dislocation can occur due to abductor dysfunction, incorrect offset restoration and limb length discrepancy. The overall dislocation rate following revision was 8.0% which is lower than previously reported.[20,21] If this complication could be avoided all together, outcomes may have been at least equivalent to ORIF. Only 14.7% patients in the revision group underwent concurrent cup revision and none of those with revision to either a dual mobility or constrained cup dislocated. Dislocation risk may therefore be mitigated by their use but this must be balanced against the increased risks of bleeding and infection associated with increased operating times.

Longer waiting times for revision compared to ORIF were consistently observed and these delays are likely related to the availability of arthroplasty teams with the appropriate revision expertise. Surgical waiting times are variable and there is some evidence that longer waiting times are associated with poorer outcomes such as higher mortality rates, higher transfusion rates and increased LOS.[24,25] Revision surgery is more complex than ORIF and this explains the higher blood transfusion and critical care requirements observed in this group. LOS was similar between the groups which was an unexpected finding as revision stems allow full postoperative weightbearing whereas some surgeons may restrict weightbearing following ORIF. However, LOS is recognised to be a complex and

multifaceted topic which encompasses many patient-related and social care issues. These issues are pertinent to upcoming regional NHS service reconfigurations for joint revision surgery networks in order to improve the outcomes of patients undergoing complex surgery.[26,27]

This study is strengthened by its multicentre, consecutive and large dataset which enhances the generalisability of its conclusions. Expected differences in baseline characteristics were observed between the ORIF and revision groups and we recognise this limitation. An attempt was made to match the groups but numbers became too small for meaningful comparison. There may also be some variation in the subclassification of fractures but this was managed by providing standardised definitions to all study centres.[28] Surgical success as measured by absence of reoperation alone does not reflect patient function or experience so any future prospective study should account for patient-reported outcome measures for a more holistic analysis.

In conclusion, revision for grade B PFFs around PTS stems is associated with higher reoperation rates, longer surgical waiting times, higher blood transfusion requirements, higher critical care requirements and higher local complication rates compared to ORIF. For these fractures, ORIF is a safe and resourceful option, providing anatomic reconstruction can be achieved. If revision is performed, the risk of postoperative dislocation should be mitigated with cup revision to a dual-mobility or constrained cup.

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Figure legends

Figure 1. Kaplan-Meier survival analysis of open reduction and internal fixation versus revision (all B fractures)

Figure 2. Kaplan-Meier survival analysis of open reduction and internal fixation versus revision (B1 fractures)

Figure 3. Kaplan-Meier survival analysis of open reduction and internal fixation versus revision (B2 and B3 fractures)

Table 1. Comparison of baseline characteristics between groups (all B fractures)

Variable	ORIF (n, %)	Revision (n, %)	p-value
Total (317)	167 (52.7)	150 (47.3)	
Female (patients)	81 (48.5)	62 (41.3)	0.200
Right sided PFF	80 (47.9)	86 (57.3)	0.093
Follow-up (years, median, IQR)	3.5 (1.5-6.1)	3.9 (2.7-4.9)	0.377
Age at PFF by group (years)			0.859
< 50 yrs	1 (0.6)	2 (1.3)	
50-59 yrs	8 (4.8)	9 (6.0)	
60-69 yrs	23 (13.8)	20 (13.3)	
70-79 yrs	48 (28.7)	48 (32.0)	
> 80 yrs	87 (52.1)	71 (47.3)	
Preoperative residential status			0.002*
Own home	123 (73.7)	135 (90.0)	
Supported living	18 (10.8)	6 (4.0)	
Residential home	12 (7.2)	6 (4.0)	
Nursing home	14 (8.4)	3 (2.0)	
Body mass index	26 (23-31)	27 (24-31)	0.423
ASA score			0.190
1	8 (4.8)	15 (10.0)	
2	43 (25.7)	52 (34.7)	
3	86 (51.5)	55 (36.7)	
4	15 (9.0)	8 (5.3)	
Unknown	15 (9.0)	20 (13.3)	
Charlson Comorbidity Index (median, IQR)	5 (4-7)	4 (3-6)	0.352
Indication for primary THA			0.925
Osteoarthritis	120 (71.9)	113 (75.3)	
Rheumatoid arthritis	3 (1.8)	2 (1.3)	
Avascular necrosis	2 (1.2)	1 (0.7)	
Hip fracture	11 (6.6)	11 (7.3)	
Failed trauma	5 (3.0)	3 (2.0)	
Tumour	0 (0.0)	1 (0.7)	
Childhood hip disease	2 (1.2)	1 (0.7)	
Unknown	24 (14.4)	18 (12.0)	
Primary cup fixation			<0.001*
Cemented	131 (78.4)	70 (46.7)	
Cementless	36 (21.6)	80 (53.3)	
Primary cup type			0.366
Standard	156 (93.4)	140 (93.3)	
Dual mobility	9 (5.4)	10 (6.7)	
Constrained	2 (1.2)	0 (0.0)	
Mechanism of injury			0.010*
Low energy	160 (95.8)	132 (88.0)	
High energy	7 (4.2)	18 (12.0)	

Multifragmentary			<0.001*
No	138 (82.6)	86 (57.3)	
Yes	29 (17.4)	64 (42.7)	
Associated cup wear/loosening			0.112
No	165 (98.8)	144 (96.0)	
Yes	2 (1.2)	6 (4.0)	
Femoral cement well fixed to bone			<0.001*
No	18 (10.8)	40 (26.7)	
Yes	149 (89.2)	110 (73.3)	
Stem still potted in centraliser			<0.001*
No	26 (15.6)	52 (34.7)	
Yes	141 (84.4)	98 (65.3)	

Note: ORIF = open reduction and internal fixation, PFF = periprosthetic femoral fracture, THA = total hip arthroplasty, ASA = American Society of Anaesthesiologists, IQR = interquartile range, *denotes a statistically significant difference

Table 2. Surgery performed for PFFs around PTS stem (all B fractures)

Variable	ORIF (n, %)	Revision (n, %)
Total (317)	167 (52.7)	150 (47.3)
ORIF type		
Cerclage fixation only	6 (3.6)	
Plate only	21 (12.6)	
Plate and cerclage fixation	140 (83.8)	
ORIF plate type		
Conventional plate	111 (68.9)	
PFF-specific locking plate	50 (31.1)	
Intraoperative fluoroscopy for ORIF	70 (41.9)	
Revision stem		
Long cementless modular		97 (64.7)
Long cementless non-modular		3 (2.0)
Cemented stem standard		13 (8.7)
Cemented stem short		2 (1.3)
Cemented stem long		23 (15.3)
Proximal femur replacement		12 (8.0)
Cup revision		
Standard		10 (6.7)
Dual mobility		7 (4.7)
Constrained		5 (3.3)
Not revised		128 (85.3)
Use of femoral bone graft	2 (1.2)	2 (1.3)
Graft type		
Impaction bone grafting	0 (0.0)	2 (1.3)
Cortical strut graft	2 (1.2)	0 (0.0)

Note: ORIF = open reduction and internal fixation, PFF = periprosthetic femoral fracture

Table 3. Comparison of outcomes (ORIF versus revision for all B fractures)

Variable	ORIF (n, %)	Revision (n, %)	p-value
Total (317)	167 (52.7)	150 (47.3)	
Time to surgery (days, median, IQR)	2.0 (1.0-4.0)	4.0 (2.0-7.0)	<0.001*
Blood transfusion needed in 72 hrs	42 (25.1)	55 (36.7)	0.026*
Units of blood transfused (median, IQR)	2 (2-2)	2 (1-2)	0.615
Postoperative destination Orthopaedic ward High dependency unit Intensive care unit	 160 (95.8) 4 (2.4) 3 (1.8)	 114 (76.0) 17 (11.3) 19 (12.7)	<0.001*
Length of stay (days, median, IQR)	17.0 (11.0-30.0)	19.0 (13.0-25.0)	0.991
Return to usual residence	128 (76.6)	122 (81.3)	0.308
Reoperation in 90 days	6 (3.6)	11 (7.3)	0.140
Reoperation in 2 years	12 (7.2)	23 (15.3)	0.021*
Time to first reoperation (days, median, IQR)	90.0 (23.0-475.0)	105.0 (47.0-195.0)	0.889
Total number of reoperations (median, IQR)	1 (1-2)	1 (1-2)	0.861
Readmissions in 30 days	7 (4.7)	5 (3.1)	0.561
Time to readmission (days, median, IQR)	11.0 (3.0-19.0)	7.0 (2.0-12.0)	0.413
Readmission LOS (days, median, IQR)	1.0 (1.0-7.0)	2.0 (2.0-21.0)	0.284
Local complications in 2 years	15 (9.0)	40 (26.7)	<0.001*
Time to local complication in 2 years (days, median, IQR)	68.0 (33.0-193.0)	78.0 (27.0-169.0)	0.720
Systemic complication in 6 months	27 (16.2)	24 (16.0)	0.968
Time to systemic complication in 6 months (days, median, IQR)	14.0 (2.0-22.0)	7.5 (6.0-24.0)	0.872
Mortality 30-day 1-year	 8 (4.8) 30 (18.0)	 2 (1.3) 18 (12.0)	 0.073 0.139
Time to death within 1 year (days, median, IQR)	97.0 (28.0-204.0)	185.0 (50.0-313.0)	0.163

Note: ORIF = open reduction and internal fixation, PFF = periprosthetic femoral fracture, THA = total hip arthroplasty, LOS = length of stay, IQR = interquartile range, *denotes a statistically significant difference

Table 4. Reasons for reoperations, readmissions and complications (all B fractures)

Variable	ORIF (n, %)	Revision (n, %)
Total (317)	167 (52.7)	150 (47.3)
First reoperation (indication)		
Fixation failure	4 (2.4)	0 (0.0)
Local infection	3 (1.8)	2 (1.3)
Dislocation	1 (0.6)	12 (8.0)
Further PFF	1 (0.6)	3 (2.0)
Stem loosening	3 (1.8)	3 (2.0)
Haematoma	0 (0.0)	2 (1.3)
Nonunion	0 (0.0)	1 (0.7)
Total	12 (7.2)	23 (15.3)
First reoperation (type)		
Debridement for infection	3 (1.8)	2 (1.3)
Evacuation of haematoma	0 (0.0)	2 (1.3)
Reduction of dislocated THA	1 (0.6)	8 (5.3)
Revision ORIF	4 (2.4)	0 (0.0)
ORIF of further PFF	1 (0.6)	2 (1.3)
Revision THA (both components)	1 (0.6)	4 (2.7)
Revision THA (stem only)	2 (1.2)	4 (2.7)
Revision THA (cup only)	0 (0.0)	1 (0.7)
Total	12 (7.2)	23 (15.3)
Readmissions in 30 days		
Sepsis	1 (0.6)	1 (0.7)
Dislocation	0 (0.0)	1 (0.7)
Chest infection	0 (0.0)	1 (0.7)
Further PFF	0 (0.0)	1 (0.7)
Fall	1 (0.6)	0 (0.0)
Loose stem	1 (0.6)	0 (0.0)
Local infection	1 (0.6)	0 (0.0)
Wound leak	1 (0.6)	0 (0.0)
Pain	2 (1.2)	0 (0.0)
Seizure	0 (0.0)	1 (0.7)
Total	7 (4.7)	5 (3.1)
Local complication in 2 years		
Chronic pain related to plate	1 (0.6)	1 (0.7)
Dislocation	1 (0.6)	13 (9.3)
Fixation failure	4 (2.4)	1 (0.7)
Further PFF	2 (1.2)	8 (5.3)
Haematoma	0 (0.0)	2 (1.3)
Heterotopic ossification	0 (0.0)	1 (0.7)
Stem loosening	4 (2.4)	5 (3.1)
Local infection	2 (1.2)	2 (1.3)
Intraoperative PFF	0 (0.0)	2 (1.3)
Symptomatic leg length difference	0 (0.0)	1 (0.7)
Nonunion	0 (0.0)	4 (2.7)
Sciatic nerve injury	1 (0.6)	0 (0.0)
Total	15 (9.0)	40 (26.7)

Systemic complication in 6 months		
Acute kidney injury	6 (3.6)	1 (0.7)
Stroke	1 (0.6)	0 (0.0)
Gastrointestinal bleed	1 (0.6)	1 (0.7)
Hospital acquired pneumonia	10 (5.9)	8 (5.3)
Hyponatraemia	0 (0.0)	1 (0.7)
Myocardial infarction	2 (1.2)	4 (2.7)
Pressure sore	1 (0.6)	0 (0.0)
Sepsis	1 (0.6)	2 (1.3)
Urinary tract infection	1 (0.6)	3 (2.0)
Venous thromboembolism	4 (2.4)	4 (2.7)
Total	27 (16.2)	24 (16.0)

Note: ORIF = open reduction and internal fixation, PFF = periprosthetic femoral fracture, THA = total hip arthroplasty

Table 5. Comparison of outcomes (ORIF versus revision for B1 fractures)

Variable	ORIF (n, %)	Revision (n, %)	p-value
Total (133)	116 (87.2)	17 (12.8)	
Time to surgery (days, median, IQR)	2.0 (1.0-4.0)	4.0 (3.0-7.0)	0.003*
Blood transfusion needed in 72 hrs	26 (22.4)	7 (41.2)	0.094
Units of blood transfused (median, IQR)	2 (1-2)	2 (2-3)	0.981
Post-op destination Orthopaedic ward High dependency unit Intensive care unit	 109 (94.0) 4 (3.4) 3 (2.6)	 13 (76.5) 3 (17.6) 1 (5.9)	0.035*
Length of stay (median, days, IQR)	17.0 (11.0-30.0)	19.0 (13.0-30.0)	0.708
Return to usual residence	89 (76.7)	17 (100.0)	0.026*
Reoperation in 90 days	3 (2.6)	4 (23.5)	<0.001*
Reoperation in 2 years	7 (6.0)	5 (29.4)	0.002*
Time to first reoperation (days, median, IQR)	150.0 (54.0-450.0)	59.0 (17.0-80.0)	0.290
Total number of reoperations (median, IQR)	1 (1-2)	1 (1-1)	0.428
Readmissions in 30 days	1 (0.9)	1 (5.9)	0.112
Time to readmission (days)	19.0	17.0	
Readmission LOS (days)	3.0	2.0	
Local complications in 2 years	10 (8.6)	8 (47.1)	<0.001*
Time to local complication in 2 years (days, median, IQR)	97.0 (48.0-345.0)	88.0 (42.0-260.0)	0.859
Systemic complication in 6 months	16 (13.8)	4 (23.5)	0.294
Time to systemic complication in 6 months (days, median, IQR)	15.0 (5.0-23.0)	20.0 (6.0-42.0)	0.392
Mortality 30-day 1-year	 4 (3.4) 21 (18.1)	 0 (0.0) 1 (5.9)	 0.437 0.205
Time to death within 1 year (days, median, IQR)	111.0 (46.0-202.0)	48.0	0.478

Note: ORIF = open reduction and internal fixation, PFF = periprosthetic femoral fracture, THA = total hip arthroplasty, LOS = length of stay, IQR = interquartile range, *denotes a statistically significant difference

Table 6. Reasons for reoperations, readmissions and complications (B1 fractures)

Variable	ORIF (n, %)	Revision (n, %)
Total (133)	116 (87.2)	17 (12.8)
First reoperation (indication)		
Fixation failure	3 (2.6)	0 (0.0)
Local infection	1 (0.9)	1 (5.9)
Dislocation	0 (0.0)	4 (23.5)
Further PFF	1 (0.9)	0 (0.0)
Stem loosening	2 (1.7)	0 (0.0)
Total	7 (6.0)	5 (29.4)
First reoperation (type)		
Debridement for infection	1 (0.9)	1 (5.9)
Reduction of dislocated THA	0 (0.0	2 (11.8)
Revision ORIF	3 (2.6)	0 (0.0)
ORIF of further PFF	1 (0.9)	0 (0.0)
Revision THA (both components)	0 (0.0)	1 (0.0)
Revision THA (stem only)	2 (1.7)	0 (0.0)
Revision THA (cup only)	0 (0.0)	1 (0.0)
Total	7 (6.0)	5 (29.4)
Readmissions in 30 days		
Loose stem	1 (0.9)	0 (0.0)
Seizure	0 (0.0)	1 (5.9)
Total	1 (0.9)	1 (5.9)
Local complication in 2 years		
Chronic pain related to plate	1 (0.9)	0 (0.0)
Dislocation	0 (0.0)	4 (23.5)
Fixation failure	3 (2.6)	0 (0.0)
Further PFF	1 (0.9)	2 (11.8)
Stem loosening	3 (2.6)	0 (0.0)
Local infection	1 (0.9)	0 (0.0)
Nonunion	0 (0.0)	2 (11.8)
Sciatic nerve injury	1 (0.9)	0 (0.0)
Total	10 (8.6)	8 (47.1)
Systemic complication in 6 months		
Acute kidney injury	5 (4.3)	0 (0.0)
Gastrointestinal bleed	1 (0.9)	0 (0.0)
Hospital acquired pneumonia	6 (5.2)	1 (5.9)
Myocardial infarction	1 (0.9)	1 (5.9)
Sepsis	1 (0.9)	0 (0.0)
Venous thromboembolism	2 (1.7)	2 (11.8)
Total	16 (13.8)	4 (23.5)

Note: ORIF = open reduction and internal fixation, PFF = periprosthetic femoral fracture, THA = total hip arthroplasty

Table 7. Comparison of outcomes (ORIF versus revision for B2 and B3 fractures)

Variable	ORIF (n, %)	Revision (n, %)	p-value
Total (184)	51	133	
Time to surgery (days, median, IQR)	3.0 (1.0-6.0)	4.0 (2.0-7.0)	0.039*
Blood transfusion needed in 72 hrs	16 (31.4)	48 (36.1)	0.548
Units of blood transfused (median, IQR)	2 (2-2.75)	2 (1-2)	0.301
Post-op destination Orthopaedic ward High dependency unit Intensive care unit	 51 (100.0) 0 (0.0) 0 (0.0)	 101 (75.9) 14 (10.5) 18 (13.5)	<0.001*
Length of stay (median, days, IQR)	20.0 (12.0-29.0)	19.0 (13.0-24.0)	0.414
Return to usual residence	39 (76.5)	105 (78.9)	0.715
Reoperation in 90 days	3 (5.9)	7 (5.3)	0.558
Reoperation in 2 years	5 (9.8)	18 (13.5)	0.341
Time to first reoperation (days, median, IQR)	40.0 (17.0-379.0)	149.0 (61.0-268.0)	0.233
Total number of reoperations (median, IQR)	1 (1-2)	1 (1-2)	0.629
Readmissions in 30 days	6 (11.8)	4 (3.0)	0.029*
Time to readmission (days, median, IQR)	8.0 (3.0-18.0)	5.0 (2.0-7.0)	0.389
Readmission LOS (days, median, IQR)	1.0 (1.0-14.0)	8.0 (2.0-24.0)	0.194
Local complications in 2 years	5 (9.8)	32 (24.1)	0.031*
Time to local complication in 2 years (days, median, IQR)	68.0 (27.0-161.0)	74.0 (27.0-156.0)	0.929
Systemic complication in 6 months	11 (21.6)	20 (15.0)	0.289
Time to systemic complication in 6 months (days, median, IQR)	13.0 (5.0-19.0)	8.0 (6.0-21.0)	0.605
Mortality 30-day 1-year	 4 (7.8) 9 (17.6)	 2 (1.5) 17 (12.8)	 0.051 0.396
Time to death within 1 year (days, median, IQR)	37.0 (22.0-162.0)	187.0 (54.0-324.0)	0.063

Note: ORIF = open reduction and internal fixation, PFF = periprosthetic femoral fracture, THA = total hip arthroplasty, LOS = length of stay, IQR = interquartile range, *denotes a statistically significant difference

Table 8. Reasons for reoperations, readmissions and complications (B2 and B3 fractures)

Variable	ORIF (n, %)	Revision (n, %)
Total (184)	51	133
First reoperation (indication)		
Fixation failure	1 (1.9)	0 (0.0)
Local infection	2 (3.9)	1 (0.8)
Dislocation	1 (1.9)	8 (6.0)
Further PFF	0 (0.0)	3 (2.3)
Stem loosening	1 (1.9)	3 (2.3)
Haematoma	0 (0.0)	2 (1.5)
Nonunion	0 (0.0)	1 (0.8)
Total	5 (9.8)	18 (13.5)
First reoperation (type)		
Debridement for infection	2 (3.9)	1 (0.8)
Evacuation of haematoma	0 (0.0)	2 (1.5)
Reduction of dislocated THA	1 (1.9)	6 (4.5)
Revision ORIF	1 (1.9)	0 (0.0)
ORIF of further PFF	0 (0.0)	2 (1.5)
Revision THA (both components)	1 (1.9)	3 (2.3)
Revision THA (stem only)	0 (0.0)	4 (3.0)
Revision THA (cup only)	0 (0.0)	0 (0.0)
Total	5 (9.8)	18 (13.5)
Readmissions in 30 days		
Sepsis	1 (1.9)	1 (0.8)
Dislocation	0 (0.0)	1 (0.8)
Chest infection	0 (0.0)	1 (0.8)
Further PFF	0 (0.0)	1 (0.8)
Fall	1 (1.9)	0 (0.0)
Local infection	1 (1.9)	0 (0.0)
Wound leak	1 (1.9)	0 (0.0)
Pain	1 (1.9)	0 (0.0)
Urinary tract infection	1 (1.9)	0 (0.0)
Total	6 (11.8)	4 (3.0)
Local complication in 2 years		
Chronic pain related to plate	0 (0.0)	1 (0.8)
Dislocation	1 (1.9)	9 (6.8)
Fixation failure	1 (1.9)	1 (0.8)
Further PFF	1 (1.9)	6 (4.5)
Haematoma	0 (0.0)	2 (1.5)
Heterotopic ossification	0 (0.0)	1 (0.8)
Stem loosening	1 (1.9)	5 (3.8)
Local infection	1 (1.9)	2 (1.5)
Intraoperative PFF	0 (0.0)	2 (1.5)
Symptomatic leg length difference	0 (0.0)	1 (0.8)
Nonunion	0 (0.0)	2 (1.5)
Total	5 (9.8)	32 (24.1)
Systemic complication in 6 months		
Acute kidney injury	1 (1.9)	1 (0.8)
Stroke	1 (1.9)	0 (0.0)
Gastrointestinal bleed	0 (0.0)	1 (0.8)
Hospital acquired pneumonia	4 (7.8)	7 (5.3)

Hyponatraemia	0 (0.0)	1 (0.8)
Myocardial infarction	1 (1.9)	3 (2.3)
Pressure sore	1 (1.9)	0 (0.0)
Sepsis	0 (0.0)	2 (1.5)
Urinary tract infection	1 (1.9)	3 (2.3)
Venous thromboembolism	2 (3.9)	2 (1.5)
Total	11 (21.6)	20 (15.0)

Note: ORIF = open reduction and internal fixation, PFF = periprosthetic femoral fracture, THA = total hip arthroplasty

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