■ HIP

More reoperations for periprosthetic fracture after cemented hemiarthroplasty with polished taper-slip stems than after anatomical and straight stems in the treatment of hip fractures

A STUDY FROM THE NORWEGIAN HIP FRACTURE REGISTER 2005 TO 2016

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Aims

The aim of this large registry-based study was to compare mid-term survival rates of cemented femoral stems of different designs used in hemiarthroplasty for a fracture of the femoral neck.

Patients and Methods

From the Norwegian Hip Fracture Register (NHFR), 20 532 primary cemented bipolar hemiarthroplasties, which were undertaken in patients aged > 70 years with a femoral neck fracture between 2005 and 2016, were included. Polished tapered stems (n = 12 065) (Exeter and CPT), straight stems (n = 5545) (Charnley, Charnley Modular, and Spectron EF), and anatomical stems (n = 2922) (Lubinus SP2) were included. The survival of the implant with any reoperation as the endpoint was calculated using the Kaplan–Meier method and hazard ratios (HRs), and the different indications for reoperation were calculated using Cox regression analysis.

Results

The one-year survival was 96.0% (95% confidence interval (CI) 95.6 to 96.4) for the Exeter stem, 97.0% (95% CI 96.4 to 97.6) for the Lubinus SP2 stem, 97.6% (95% CI 97.0 to 98.2) for the Charnley stem, 98.1% (95% CI 97.3 to 98.9) for the Spectron EF stem, and 96.4% (95% CI 95.6 to 97.2) for the Charnley Modular stem, respectively. The hazard ratio for reoperation after one year was lower for Lubinus SP2 (HR 0.77, 95% CI 0.60 to 0.97), Charnley (HR 0.64, 95% CI 0.48 to 0.86), and Spectron EF stems (HR 0.44, 95% CI 0.29 to 0.67) compared with the Exeter stem. Reoperation for periprosthetic fracture occurred almost exclusively after the use of polished tapered stems.

Conclusion

We were able to confirm that implant survival after cemented hemiarthroplasty for a hip fracture is high. Differences in rates of reoperation seem to favour anatomical and straight stems compared with polished tapered stems, which had a higher risk of periprosthetic fracture.

Cite this article: ***Bone Joint J*** **2018;100-B:1565–71.**

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doi:10.1302/0301-620X.100B12.BJJ-2018-0262.R1 $2.00

Bone Joint J
2018;100-B:1565–71.

Hemiarthroplasty is the most common surgical treatment for displaced fractures of the femoral neck in elderly patients in Western countries.[1] It is well known that fewer reoperations are required following cemented fixation of the stem compared with uncemented fixation in these patients.[2-5] Different designs of implant and two different principles of cementation are used in these operations. Polished taper-slip (TS) wedge-shaped implants have been designed to subside inside the cement mantle to achieve an even load bearing while anatomical and straight stems with matt

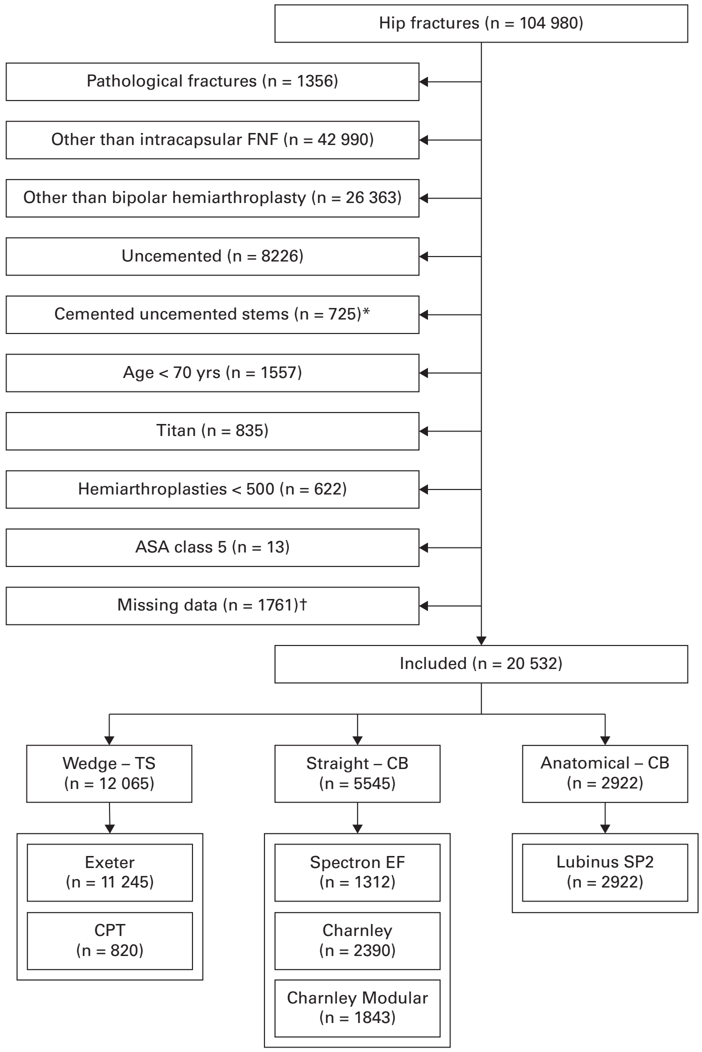

Fig. 1

Flowchart showing the inclusion of each type of stem. FNF, femoral neck fracture; ASA, the American Society of Anesthesiologists; TS, taper-slip; CB, composite-beam. *Hydroxyapatite-coated stems fixed with cement. †Missing data (incomplete information in the Norwegian Hip Fracture Register): Exeter, 5.6%; Lubinus SP2, 5.1%; Charnley, 4.6%; Charnley Modular, 4.6%; Spectron EF, 9.2%; CPT, 3.8%.

finish have been designed to be fixed in the cement mantle after the composite-beam (CB) principle.[6] Small observational studies including both hemiarthroplasties and total hip arthroplasties (THAs),[7-9] and one large registry study on THAs,[10] have reported a higher risk of periprosthetic fracture with a polished taper-slip stem compared with an anatomical stem.

Patients requiring hemiarthroplasty for femoral neck fracture are older with more comorbidities than those requiring THA.[11] No large registry study has so far investigated the survival of cemented hemiarthroplasties. We therefore studied a large group of patients with a femoral neck fracture in The Norwegian Hip Fracture Register (NHFR)[12] with the aim of investigating whether the design and brand of the stem influences the risk of reoperation and, in particular, whether the risk of periprosthetic fracture is higher with wedge polished TS stems compared with other designs.

Patients and Methods

The NHFR has prospectively registered fractures of the hip in Norway since 2005. After each primary operation and reoperation, the surgeons fill in a form for the registry, including detailed demographics of the patient such as age, gender, and comorbidity according to the American Society of Anesthesiologists (ASA) classification,[13] time between fracture and surgery, surgical approach, and the type of implant using catalogue numbers. For periprosthetic fractures, both reoperations that involve removal and exchange of the stem and reoperations with open reduction and internal fixation (ORIF) should be reported. Reoperations are linked to the primary operation using the unique 11-digit Norwegian personal identification number. The coverage of hospitals in the NHFR is 100% and the completeness of reporting of primary hemiarthroplasties is 93% compared with the compulsory administrative database of the Norwegian

Table I. Baseline demographics

	Exeter	Lubinus SP2	Charnley	Charnley Modular	Spectron EF	CPT	p-value
Total, n	11 245	2922	2390	1843	1312	820	
Mean age, yrs	83.8	83.9	83.6	84.1	84.0	84.1	0.03*
Female, %	*71.9*	*71.3*	*74.5*	*71.2*	*74.4*	*64.3*	< 0.005†
Median follow-up, yrs	2.1	1.9	3.3	2.9	3.0	0.4	
ASA class, %							< 0.005†
ASA 1	*1.7*	*2.4*	*4.7*	*1.6*	*4.6*	*1.2*	
ASA 2	*33.0*	*32.3*	*34.7*	*23.0*	*35.4*	*29.5*	
ASA 3	*59.1*	*58.4*	*54.7*	*64.3*	*53.4*	*62.7*	
ASA 4	*6.1*	*6.8*	*5.8*	*11.2*	*6.7*	*6.6*	
Cognitive impairment, %	*26.7*	*28.1*	*24.7*	*27.6*	*32.2*	*28.3*	< 0.005†
Approach, %							< 0.005†
Anterior	*5.0*	*11.6*	*8.0*	*9.5*	*20.4*	*1.5*	
Lateral	*86.4*	*81.5*	*90.1*	*81.9*	*64.7*	*81.1*	
Posterior	*8.6*	*6.9*	*1.8*	*8.6*	*14.9*	*17.4*	
Hospitals, n	30	10	22	6	15	15	
Stem design	Wedge	Anatomical	Straight	Straight	Straight	Wedge	
Stem finish	Polished	Matt	Matt	Matt	Matt, proximally rough	Polished	
Classification	Taper-slip	Composite-beam	Composite-beam	Composite-beam	Composite-beam	Taper-slip	

*Students' *t*-test
†Chi-squared test
ASA, the American Society of Anesthesiologists

Patient Registry.[11,14] We included patients who were entered in the NHFR between 2005 and 2016. As of 31 December 2016, there were 104 980 primary operations for a hip fracture. Pathological fractures (n = 1356), fractures other than intracapsular fractures (n = 42 990), operative methods other than bipolar hemiarthroplasty such as ORIF (n = 26 363), uncemented stems (n = 8226), uncemented stems that were cemented (n = 725), patients aged < 70 years (n = 1557), operations involving < 500 patients during the study period (n = 622), ASA class 5 patients (n = 13), and patients with incomplete information (n = 1761) were excluded (Fig. 1). Furthermore, operations using the Titan stem (n = 835) were excluded because this stem was not in use during the last years of the study period,[11] and because it has shown inferior outcome in an earlier study.[15]

A total of 20 532 cemented bipolar hemiarthroplasties remained for analyses. The Exeter V40 (n = 11 245) (Stryker, Mahwah, New Jersey) and the CPT stem (n = 820) (Zimmer Biomet, Warsaw, Indiana) have a wedge polished TS design. The Charnley (n = 2390) and Charnley Modular stem (n = 1843) (DePuy Synthes, Leeds, United Kingdom) and Spectron EF stem (n = 1312) (Smith & Nephew, Memphis, Tennessee) have a matt finish straight design with CB. The Lubinus SP2 stem (n = 2922) (Link, Hamburg, Germany) was the only matt finish anatomical designed CB stem. Bipolar heads from the same manufacturer as the stem were usually used; accordingly, we did not take the brand of the head into account when analyzing the results.

Statistical analysis. Pearson's chi-squared test was used for comparison of categorical variables and the independent-samples Student's *t*-test was used for continuous variables in independent groups. One- and five-year survival was calculated using the Kaplan–Meier (KM) method. The Cox regression model was used to calculate hazard ratios (HR) after one and five years for reoperation with adjustments for age, gender, comorbidity (ASA class), cognitive function, and surgical approach between the groups. Patients without reoperations were censored at the time of death, the time of emigration, or at 31 December 2016. Data on death and emigration was provided by the National Registry in Norway.[16] The Cox model was also used to construct adjusted survival curves and to compare the risk of reoperation due to all causes and due to periprosthetic fracture between the different stems. The proportional hazards assumption was not fulfilled when investigated visually using log-minus-log plots. The curves crossed each other at 40 days for implant survival. We therefore performed separate Cox regression analyses with the follow-up divided into two periods: the first period from surgery to 40 days postoperatively, and the second period from 40 days postoperatively until 31 December 2016. The proportional hazard assumption was fulfilled within these two periods. Since curves only crossed each other a short time after surgery, we chose to present HR after one and five years. Death is a competing risk and may influence the accumulated probability for revision. Therefore, regression analyses for competing risk were performed. The Fine and Gray regression model[17] for the sub-hazard was applied. These results were compared with the results from the Cox proportional hazards regression model. Additional analyses excluding patients who underwent bilateral procedures (n = 904) were performed. These analyses gave similar results. This is in line with the results of a previous study that showed that adjusting for bilaterality will not alter the conclusions.[18] The level of significance was set to $p < 0.05$. Analyses were performed using the package IBM SPSS statistics version 22 (IBM Corp., Armonk, New York) and the cmprsk library in the statistical package R (RC Team, Vienna, Austria). This study was undertaken using the Reporting of Studies Conducted Using Observational Routinely-Collected Data (RECORD) and Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.[19]

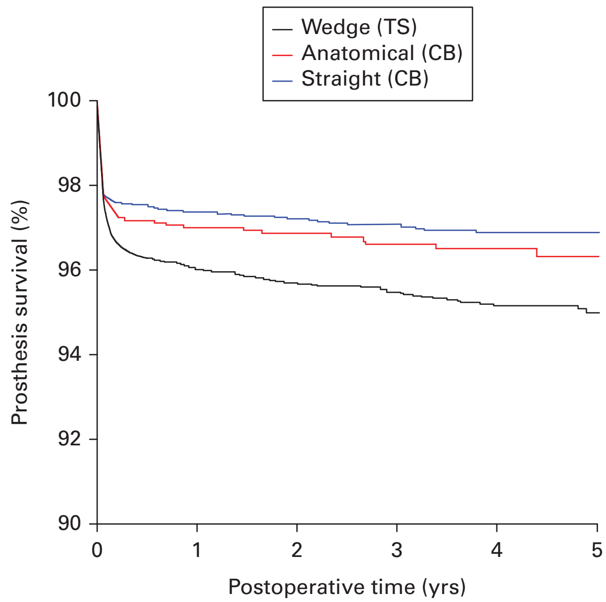

Fig. 2

Kaplan–Meier survival curve by design of stem. TS, taper-slip; CB, composite-beam.

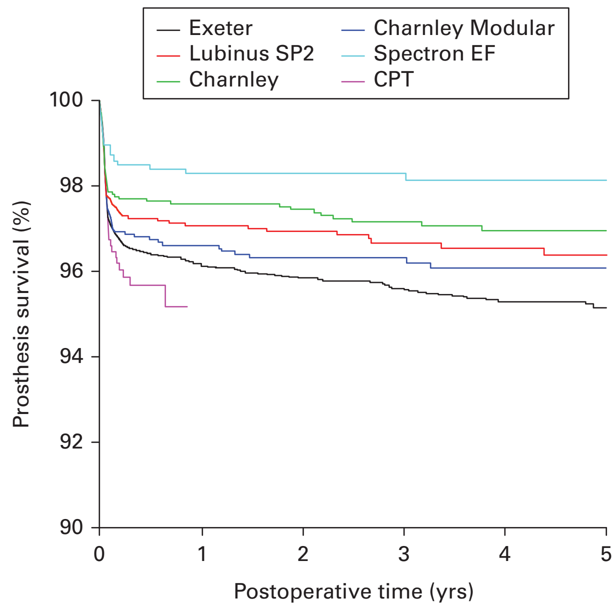

Fig. 3

Kaplan–Meier survival curve by brand of stem.

Table II. Survival analysis by Kaplan–Meier and Cox regression for reoperation after hemiarthroplasty

Stem	Total, n	Reoperation, n	1-yr survival (95% CI)	5-yr survival (95% CI)	1-yr HR (95% CI)	p-value*	5-yr HR (95% CI)	p-value*	Left at risk after 5 yrs, n
Exeter	11 245	461	96.0 (95.6 to 96.4)	95.0 (94.6 to 95.4)	1 (reference)		1 (reference)		1784
Lubinus SP2	2922	89	97.0 (96.4 to 97.6)	96.3 (95.5 to 97.1)	0.77 (0.60 to 0.97)	0.029	0.75 (0.60 to 0.95)	0.014	476
Charnley	2390	62	97.6 (97.0 to 98.2)	97.0 (96.2 to 97.8)	0.64 (0.48 to 0.86)	< 0.005	0.64 (0.49 to 0.84)	0.001	809
Charnley Modular	1843	70	96.4 (95.6 to 97.2)	95.9 (94.9 to 96.9)	0.88 (0.67 to 1.15)	0.35	0.86 (0.67 to 1.11)	0.253	410
Spectron EF	1312	25	98.1 (97.3 to 98.9)	98.0 (97.2 to 98.8)	0.44 (0.29 to 0.67)	< 0.005	0.41 (0.27 to 0.62)	< 0.005	404
CPT†	820	36	N/A	N/A	1.21 (0.86 to 1.70)	0.28	N/A	N/A	0

*Cox regression model adjusted for age, gender, comorbidity (American Society of Anesthesiologists class), cognitive function, surgical approach, and operating time
†Too few patients were left for one- and five-year calculations
CI, confidence interval; HR, hazard ratio; N/A, not available

Results

Overall, 72% of patients were women, and the mean age was 83 years (70 to 104). The median follow-up was 2.1 years (interquartile range (IQR) 0.61 to 4.29), but varied from 0.4 years (CPT stem) to 3.2 years (Charnley stem) when calculated by the reverse KM method of Schemper and Smith.[20] Fewer women were operated using the CPT stem. Patients whose operation involved the Charnley Modular stem had higher comorbidity. There were more patients with cognitive impairment in the Spectron EF group. There were variations between the surgical approach for all stems (Table I).

When dividing the stems by design, the survival of the straight (HR 0.66, 95% CI 0.55 to 0.79; $p < 0.001$) and anatomically designed stems (HR 0.74, 95% CI 0.59 to 0.93; $p = 0.010$) was better when compared with the wedge designed stems (Fig. 2). When analyzing the brands, the anatomical designed Lubinus SP2 stem, and the straight designed Charnley, Charnley Modular, and Spectron stems with CB cement fixation had better survival compared with the wedge designed Exeter and CPT stems with TS cement fixation (Fig. 3). One- and five-year survival of the Exeter, Lubinus SP2, Charnley, Charnley Modular stem, and the Spectron EF stem are shown in Table II. The CPT stem had only been used in the NHFR the last year of the study period and follow-up was too short to calculate survival. The HR for reoperation after one year was significantly lower for the Lubinus SP2, Charnley, and Spectron EF stems compared with the Exeter stem. The HR for reoperation after five years was 0.75 for the Lubinus SP2, 0.64 for the Charnley stem, and 0.41 for the Spectron EF stem compared with the Exeter stem (Table II). When performing competing risk analyses, similar results were found as in the Cox regression analyses. The three most common indications for reoperation were infection, dislocation, and periprosthetic fracture where infection was the most decisive (Table III). Overall, fractures were rare; they predominately followed the use of the wedge designed TS stems (n = 44). Only four periprosthetic fractures were reported as the indication for reoperation with the anatomical (n = 1) and the straight designed stems (n = 3). For the Exeter stem, periprosthetic fractures (n = 40) were evenly distributed between the different sizes.

Table III. Number and indication for reoperation for the different stems

	Total, n	Reoperations, n (%)	Infection, n (%)	Instability, n (%)	Fracture, n (%)	Aseptic loosening, n (%)	Other reasons, n (%)
Total	20 532	743 (*3.6*)	373 (*1.8*)	217 (*1.1*)	48 (*0.2*)	7 (*0.03*)	98 (*0.5*)
Exeter	11 245	461 (*4.1*)	230 (*2.0*)	123 (*1.1*)	40 (*0.4*)	4 (*0.04*)	64 (*0.6*)
Lubinus SP2	2922	89 (*3.0*)	42 (*1.4*)	36 (*1.2*)	1 (*0.03*)	0 (*0*)	10 (*0.3*)
Charnley	2390	62 (*2.6*)	34 (*1.4*)	15 (*0.6*)	1 (*0.04*)	2 (*0.08*)	10 (*0.4*)
Charnley Modular	1843	70 (*3.8*)	44 (*2.4*)	17 (*0.9*)	1 (*0.05*)	0 (*0*)	8 (*0.4*)
Spectron EF	1312	25 (*1.9*)	9 (*0.7*)	10 (*0.8*)	1 (*0.08*)	1 (*0.08*)	4 (*0.3*)
CPT	820	36 (*4.4*)	14 (*1.7*)	16 (*2.0*)	4 (*0.5*)	0 (*0*)	2 (*0.2*)
< 500*	622	28 (*4.5*)	16 (*2.5*)	6 (*1.0*)	3 (*0.5*)	0 (*0*)	3 (*0.5*)

*Cemented stems excluded from other analyses because of limited use (used < 500 times during the study period)

Table IV. Type and timing of reoperation, all causes

	Exeter	Lubinus SP2	Charnley	Charnley Modular	Spectron EF	CPT
Total, n	461	89	62	70	25	36
Type of reoperation, n						
New THA	105	27	7	20	7	11
New HA	36	3	3	0	2	6
ORIF	20	0	1	1	0	4
ORIF + HA/THA	6	0	0	0	0	0
Debridement for infection	193	38	28	35	8	10
Reduction of dislocation	50	17	13	9	5	2
Girdlestone	32	2	8	4	2	3
Other	19	2	2	1	1	0
Timing of reoperation, n (%)						
0 to 1 mths	263 (*57*)	49 (*55*)	37 (*60*)	44 (*63*)	14 (*56*)	26 (*72*)
1 to 12 mths	148 (*32*)	32 (*36*)	16 (*26*)	17 (*14*)	8 (*32*)	10 (*28*)
> 12 mths	50 (*11*)	8 (*9*)	9 (*15*)	9 (*13*)	3 (*12*)	0 (*0*)

THA, total hip arthroplasty; HA, hemiarthroplasty; ORIF, open reduction and internal fixation

Table V. Risk of reoperation due to periprosthetic fracture. Cox regression analysis with adjustments for gender, age group, American Society of Anesthesiologists (ASA) class, cognitive impairment, and surgical approach

Stem	n	Reoperation, n	HR (95% CI)	p-value
Exeter	11 245	40	1 (reference)	
Lubinus SP2	2922	1	0.10 (0.01 to 0.74)	0.024
Charnley	2390	1	0.09 (0.01 to 0.67)	0.019
Charnley Modular	1843	1	0.14 (0.02 to 0.99)	0.049
Spectron EF	1312	1	0.17 (0.02 to 1.25)	0.082
CPT	820	4	3.19 (1.06 to 9.56)	0.039

HR, hazard ratio; CI, confidence interval

Table VI. Type and timing of reoperation for periprosthetic fracture

	Exeter	Lubinus SP2	Charnley	Charnley Modular	Spectron EF	CPT
Total, n	40	1	1	1	1	4
Type of reoperation, n						
New HA	12	1	0	0	1	0
ORIF	19	0	1	1	0	4
ORIF+ HA/THA	6	0	0	0	0	0
Other	3	0	0	0	0	0
Timing of reoperation, n						
0 to 1 mths	3	0	0	0	0	1
1 to 12 mths	18	0	0	0	0	3
> 12 mths	19	1	1	1	1	0

HA, hemiarthroplasty; ORIF, open reduction and internal fixation; THA, total hip arthroplasty

Table IV shows the types of reoperations performed for each type of stem. For all types, most reoperations occurred during the first postoperative months. Few reoperations occurred later than 12 months postoperatively (Table IV).

Using the Exeter stem as reference, the risk of reoperation due to periprosthetic fracture was lower for Lubinus SP2, Charnley, and Charnley Modular stems (Table V). The CPT had a higher risk of periprosthetic fracture compared with the Exeter stem. Table VI shows the type of reoperations due to periprosthetic fracture performed for each type of stem. Most of the reoperations with the wedge designed TS stems occurred during the first 12 months postoperatively, whereas all reoperations for fracture occurred later than 12 months postoperatively for the straight and anatomical CB stems (Table VI).

As a comparator, we also counted reoperations for stems used < 500 times (Table III). The three periprosthetic fractures that were reported all had polished wedge design with TS principle (two MS30 (Zimmer Biomet) and one C-Stem (DePuy Synthes)).

Complications during surgery are also registered in the NHFR and the incidence of intraoperative fractures for different stems varied between 0.3% and 1.3% (Exeter, 1.0%; Lubinus SP2, 0.5%; Charnley, 0.3%; Charnley Modular, 0.5%; Spectron EF, 1.3%; and CPT, 1.3%).

Discussion

The design of the stem significantly influenced the outcome in this study. The wedge stems designed with the TS principle had a higher risk for reoperation compared with straight and anatomical stems designed with a CB principle. The most common indication for reoperation was infection followed by dislocation and periprosthetic fracture, which occurred almost exclusively with wedged polished stems.

The Exeter and CPT stems with a wedge polished TS design had an inferior outcome with higher risk of reoperation compared with the other stems. The Spectron EF stem with a straight design had a high implant survival rate. A RSA study by Kadar et al[21] showed good two-year results with this stem including more stability than the Charnley flanged 40 stem in THAs. These findings are in contrast to an earlier study by Espehaug et al[22] from the Norwegian Arthroplasty Register dealing with THAs undertaken for osteoarthritis, showing better results with the Exeter stem compared with the Spectron EF stem with aseptic loosening as the endpoint. In their study, Cox regression analyses showed that the inferior results of the Spectron EF stem were due to more reoperations after seven to ten years of follow-up, especially when it was combined with the non-crosslinked Reflection all-polyethylene acetabular component. Patients undergoing THA are usually more active with healthier bone than those with a hip fracture. Increased activity will release more microparticles, leading to osteolysis and aseptic loosening when using a proximally rough stem such as the Spectron EF. The mean age of the patients in the study by Espehaug et al[22] was 73 years. van den Bekerom et al[23] reported a five-year mortality of 63% in patients undergoing hemiarthroplasty for fracture. This could explain why the Spectron EF stem had a better outcome in our study, which included older patients with a higher mortality and without the combination with the non-crosslinked Reflection acetabular component.

In Norway, each hospital decides which implant to use during a tender process, as a consequence of which many hospitals started using the CPT stem during the final year in the study period. When introducing a new implant, there will be a learning curve with a higher initial reoperation rate and this could be an explanation for the higher reoperation rate found for this stem.

Periprosthetic fractures occurred rarely in our study. Most revision procedures for periprosthetic fracture followed the use of the Exeter and CPT stems. Other authors have also shown an association between wedged polished TS-designed stems and periprosthetic fracture. In our study, a periprosthetic fracture occurred after 0.2% of the operations. Other studies have reported an incidence of between 0% and 4%. Clinical observational studies[7,24,25] tend to report a higher incidence compared with registry studies. The incidence of 0.2% in our study is in line with other registry studies.[3,8,26] An observational study by Mukka et al[7] comparing the CPT and Lubinus SP2 stems used in both hemiarthroplasty and THA for hip fracture reported an increased risk of periprosthetic fracture when using the TS designed CPT stem and discussed the possible mechanisms for this rare complication. Our larger registry study supports these findings.

A large registry study by Palan et al[26] from the National Joint Registry in England investigated revision procedures for periprosthetic fracture after 257 202 primary THAs. They found a significantly higher risk of revision with the CPT stem and a lower risk with the Charnley stem compared with the Exeter stem. They reported that revisions for periprosthetic fracture occurred earlier postoperatively for wedge designed stems (C-Stem, CPT, and Exeter) than for the straight Charnley stem, in accord with our findings.

Carli et al,[27] in a review involving 596 studies dealing with periprosthetic fracture after THA, found four studies reporting a higher incidence of periprosthetic fracture with the Exeter stem and concluded with the need for registry studies.

Few studies have investigated the modes of biomechanical failure, none comparing TS and CB principles. Ginsel et al[28] compared TS-designed Exeter stems with identical length and offset with different cross-sectional area and found that large stems were more resistant to torque forces as a cause of fracture. The wedge TS design facilitates a thicker cement mantle around the tip of the stem than the straight and anatomical CB designed stems. Osteoporosis is a risk factor for periprosthetic fracture.[29-31] A thick cement mantle and more osteoporotic bone is an unfortunate combination in patients with a hip fracture. The CB principle with anatomical and straight stems may be more resistant to torque forces, which could be an explanation for there being fewer periprosthetic fractures when using this design. Further biomechanical studies comparing TS and CB principles are needed.

The study had limitations. Our primary endpoint was reoperations. Patients with pain may not undergo reoperation. Furthermore, low grade infection is difficult to diagnose and may present as aseptic loosening. Different bipolar heads used in combination with the stems might affect the rate of reoperation, especially in those undertaken for dislocation. The different stems were usually used with a bipolar head from the same manufacturer and therefore we could not adjust for the bipolar head in the Cox regression analyses. The stem and the bipolar head must thus be seen as one unit.

There is a risk of under-reporting reoperations to the NHFR. Reoperations due to periprosthetic fracture may be under-reported, particularly in patients in whom the prosthesis is retained and the fracture treated by fixation. However, all reoperations, including osteosyntheses, are registered in the NHFR. If there is under-reporting, a selective under-reporting of reoperations after the use of only one type of prosthesis is unlikely. The burden of periprosthetic fractures may be larger and make the findings of this study even more important.

There is no randomization for patients or surgeons in registry studies, leading to a risk of confounding variables. Adjustments were done for possible confounders such as ASA classification, age, gender, comorbidity, cognitive function, surgical approach, and duration of surgery. The results reflect those that are achieved on a national level. Each stem was used in several hospitals, which decreases the risk that local routines or environmental factors influenced the results significantly. Some stems were, however, used in fewer units than others and small differences in the rate of infection could be attributed to the environment of the unit.

The main strength of the study is the large number of patients and high external validity. In observational studies, with a large number of patients, even small differences may become statistically significant, but they are not necessarily of clinical importance. However, in Norway, where approximately 3000 hemiarthroplasties are performed annually in patients with a hip fracture, a small 1.0% difference in the risk of reoperation will lead to 30 extra procedures; and a 0.2% difference in the risk of reoperation due to periprosthetic fracture will lead to six extra procedures in these old and frail patients. We therefore believe that the differences that we found are of clinical importance. Randomized studies may fail to detect small differences due to a limited number of patients.

In conclusion, the survival of implants after surgery for a fracture of the femoral neck is high. Differences in the results for different designs of stem are important, however, because further surgery in old, frail patients could have a devastating outcome with increased morbidity and mortality. Our results seem to favour matt finished straight and anatomical hemiarthroplasty stems with CB fixation, compared with polished TS stems, which had higher risk of periprosthetic fracture.

Take home message

- High implant survival after cemented hemiarthroplasty for hip fracture.
- More reoperations for periprosthetic fracture after cemented hemiarthroplasty with polished taper-slip stems.
- More reoperations after cemented hemiarthroplasty with polished taper-slip stems than after anatomical and straight stems in the treatment of hip fracture.

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Author contributions:
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L. B. Engesæter: Planned and designed the study, Interpreted the results, Drafted and revised the manuscript.
J-E. Gjertsen: Planned and designed the study, Interpreted the results, Revised the manuscript.

Funding statement:
No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

This article was primary edited by J. Scott.