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Reduced risk of reoperation after treatment of femoral neck fractures with total hip arthroplasty

A matched pair analysis

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Background and purpose — Femoral neck fractures (FNFs) are commonly treated with some kind of arthroplasty, but evidence on whether to use hemiarthroplasty (HA) or total hip arthroplasty (THA) is lacking. HA reduces the risk of dislocation, but may lead to acetabular erosion. THA implies longer surgery and increased bleeding. THA may result in better function and health-related quality of life, but evidence is contradictory. We compared HA and THA and in terms of revision, reoperation and death.

Patients and methods — Data were extracted from the Swedish Hip Arthroplasty Register for 11,253 patients with acute FNF receiving cemented HA or THA during 2008–2012. 2,902 patients with THA were matched by propensity score matching with as many patients with HA based on age, sex, BMI, and ASA classification. We used competing risks survival regression with reoperation or death and revision or death as endpoints.

Results — THA patients had significantly reduced risk of revision (absolute risk reduction 0.51; 95% CI 0.39–0.67) and reoperation (0.58; 0.46–0.74). THA was associated with an almost 50% reduced mortality (risk ratio as competing risk for reoperation 0.51; 0.46–0.57).

Interpretation — In our national register study of femoral neck fractures, THA had a lower risk than HA for further surgical procedures related to the hip. The reasons for lower mortality after THA are not known. Despite matching, there might be a selection of more healthy patients for this procedure, and other factors unknown to us, with or without relation to the choice of implant. ■

Displaced femoral neck fractures are today most often treated with some kind of arthroplasty (Thorngren 2015) and there is good evidence to support this treatment (Keating et al. 2006, Frihagen et al. 2007, Gao et al. 2012) . Less is known concerning the optimum choice between hemiarthroplasty (HA) and total hip arthroplasty (THA). In Sweden, the use of THA as treatment for displaced femoral neck fractures differs between 1% and 78% in different hospitals (Garellick et al. 2013), which probably mirrors the uncertainty among orthopedic surgeons in this matter.

HA with its larger head has the potential benefit of a reduced risk of dislocation (Burgers et al. 2012), but since the head articulates directly against the cartilage of the acetabulum, there is a risk of developing painful acetabular erosion (Wang et al. 2015), a non-existing problem with the use of THA. Insertion of a THA usually takes longer and the blood loss is frequently higher (Blomfeldt et al. 2007). These circumstances may lead to higher mortality when choosing THA instead of HA, but at present there is no evidence to support this hypothesis.

Some studies show that THA results in better function and higher health-related quality-of-life (Baker et al. 2006, Keating et al. 2006, Macaulay et al. 2008) while other studies found no difference (Dorr et al. 1986, van den Bekerom et al. 2010). For particular patient groups, selecting the type of arthroplasty is rationally based. Very old, frail, and inactive patients benefit from treatment with HA rather than THA. Younger patients without physical limitations and with a long remaining lifespan will develop acetabular erosion if treated with HA. But for the majority of patients with a displaced femoral neck fracture, there are no clear recommendations on which type of arthroplasty to choose.

The aim of this study was to compare HA with THA as treatment for femoral neck fracture based on the outcomes reoperation, revision, and mortality, to be able to give clinical recommendations on which type of arthroplasty to use in patients with femoral neck fracture.

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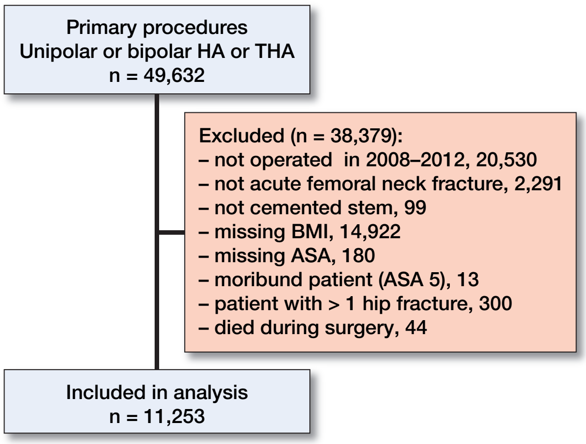

Figure 1. Flow chart of included procedures.

Patients and methods

We extracted data from the Swedish Hip Arthroplasty register (SHAR). SHAR covers all Swedish hospitals with a degree of coverage of approximately 97% for emergency procedures (Garellick et al. 2014). Patients are identified by their unique social security number given to all Swedish residents. In SHAR any reoperations—both revisions and other procedures—due to dislocation, infection, periprosthetic fractures, and other complications are recorded continuously. Revisions are defined as any further operations in which a part of or the whole prosthesis is replaced or extracted. Reoperations include all surgical interventions related to the inserted hip arthroplasty irrespective of whether the prosthesis or one of its parts has been exchanged, extracted, or left untouched. Hemiarthroplasties are recorded since 2005. Closed reduction of dislocation is not recorded. Patient characteristics such as age, sex, ASA classification, and BMI are recorded. ASA classification and BMI have been recorded routinely since 2008. Degree of dementia is recorded only for patients treated with hemiarthroplasty. We included all patients treated with cemented unipolar or bipolar HA or cemented THA for acute femoral neck fracture during 2008–2012. For patients suffering fracture of both hips during the study period, only the first surgery was included. Uncemented implants were excluded due to small numbers (Figure 1).

Statistics

Patient demographics and survival times were compared with t-test and chi-square test for continuous and categorical data respectively. We used competing risks survival regression with the endpoints reoperation or death, whichever came first, and revision or death, whichever came first. The coefficients of the model are interpreted as absolute risks and give the factor increase or decrease of the risk of the outcome. Model building and assumption testing is based on Gerds et al. (2012).

Patients treated with THA are generally younger and healthier than patients treated with HA (Garellick et al. 2013). To be able to compare the patients we conducted a subgroup analysis. We attempted to match all patients with THA with an equal number of patients with HA. We used propensity score matching with type of arthroplasty as outcome and age, sex, BMI, and ASA classification as independent variables. In the matching process, age and BMI were modeled as natural splines with 4 knots. We repeated the competing risks analysis on the propensity score matched data.

Ethics, funding and potential conflicts of interest

The study was approved by the Regional Ethical Review Board in Gothenburg 2015-03-12 (ref. 024-15) and was supported by grants from the Southern Health Care Region, Sweden. No competing interests declared.

Results

11,253 patients met the inclusion criteria (Figure 1). As expected, women outweighed men in both the HA group and in the THA group. The patients in the HA group were 10 years older than in the THA group and had higher ASA classifications. BMI was slightly higher for the THA group (Table 1).

After matching the 3,016 patients treated with THA with the cohort of patients with HA, 2 similar groups were created. The groups contained 2,902 patients each, after exclusion of 114 THA patients due to lack of proper matching partners. Comparison between the groups showed that a reasonably good balance was achieved for all demographic variables (Table 1).

When comparing the matched groups using Kaplan–Meier survival statistics, THA performed better than HA in terms of both revision and reoperation. Patients operated with THA had a lower mortality (Figures 2–4).

When comparing the unmatched data of the HA and the THA groups by using competing risks survival regression, we found that THA was associated with lower rates of both revision and reoperation. THA was also associated with lower mortality when death was a competing risk for both revision and reoperation. Age, sex, ASA classification, and BMI had no association with risk of reoperation or revision (Table 2).

The same results were found when we performed the analyses on the propensity score matched data. In the matched population, THA performed better than HA in terms of both revision and reoperation and was associated with a lower mortality (Table 3).

Discussion

Based on our analyses of a matched population with femoral neck fracture from a national Swedish register, we found that total hip arthroplasty had a reduced risk of both revision and

Table 1. Patient demographics and outcome

	Unmatched patients HA	Unmatched patients THA	p-value	Matched patients HA	Matched patients THA	p-value	Patients unable to match [a]
Sample size, n	8,237	3,016		2,902	2,902		114
Demographics							
Age, mean (SD), years	84 (6.8)	74 (8.1)	< 0.001	74 (8.2)	75 (7.8)	0.2	64 (5.4)
Female, n (%)	5,692 (69)	2,116 (70)	0.3	1,971 (68)	2,037 (70)	0.07	79 (69)
Male, n (%)	2,545 (31)	900 (30)		931 (32)	865 (30)		35 (31)
BMI, mean (SD)	23.6 (3.9)	24.4 (4.1)	< 0.001	24.4 (4.1)	24.4 (4.1)	1.0	25 (3.4)
ASA classification, n (%)			< 0.001			0.4	
1	219 (2.7)	337 (11)		232 (8.0)	255 (8.8)		82 (72)
2	3,068 (37)	1,620 (54)		1,554 (54)	1,588 (55)		32 (28)
3	4,401 (53)	1,012 (34)		1,067 (37)	1,012 (35)		0 0
4	549 (6.7)	47 (1.6)		49 (1.7)	47 (1.6)		0 0
Survival status							
Deceased, n (%)	3,867 (47)	589 (20)	< 0.001	1,054 (36)	578 (20)	< 0.001	11 (10)
Time to death, mean (SD), years	2.1 (1.5)	2.8 (1.5)	< 0.001	2.5 (1.6)	2.8 (1.5)	< 0.001	3.1 (1.6)
Revisions, n (%)	298 (3.6)	92 (3.1)	0.2	167 (5.8)	86 (3.0)	< 0.001	6 (5)
Time to revision, mean (SD), years	3.1 (1.5)	3.1 (1.5)	0.1	3.0 (1.5)	3.1 (1.5)	0.5	3.0 (1.6)
Reoperations, n (%)	369 (4.5)	124 (4.1)	0.4	192 (6.6)	117 (4.0)	< 0.001	7 (6)
Time to reoperation, mean (SD), years	3.0 (1.5)	3.1 (1.5)	0.2	3.1 (1.5)	3.1 (1.5)	0.6	3.3 (1.6)

[a] All patients treated with THA.

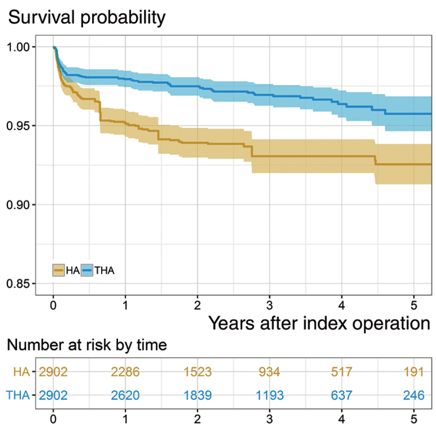

Figure 2. Kaplan–Meier survival curve (95% CI) with revision as end-point.

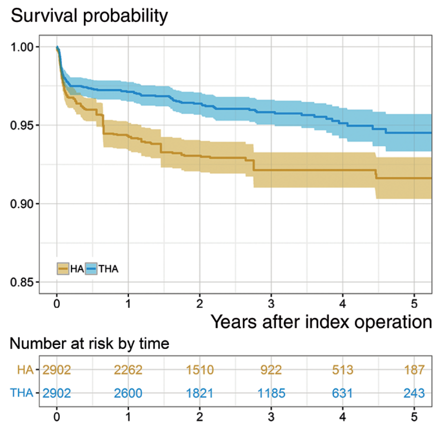

Figure 3. Kaplan–Meier survival curve (95% CI) with reoperation as end-point.

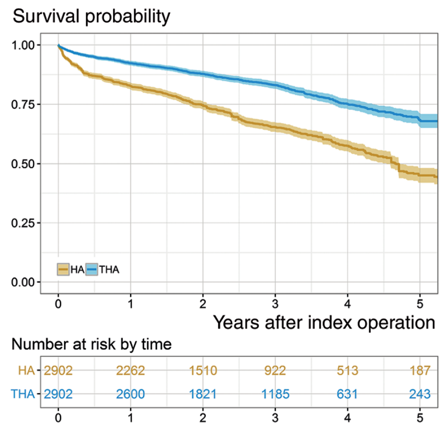

Figure 4. Kaplan–Meier survival curve (95% CI) with death as end-point.

reoperation compared with hemiarthroplasty. A similar comparison has been made by Jameson et al. (2013) using English registers. In that study, no difference was found in revision rates when comparing THA with HA in a matched population. The conflicting results may be due to different treatment traditions regarding both preferred implant designs and patient selection. There might also be variations in completeness in the two registers.

The best choice is vigorously debated. During recent years a number of randomized clinical trials and subsequent meta-analyses comparing THA and HA have been published (Baker et al. 2006, Keating et al. 2006, Macaulay et al. 2008, Mouzopoulos et al. 2008, van den Bekerom et al. 2010, Hedbeck et al. 2011, Burgers et al. 2012, Wang et al. 2015). Mostly they suggest no major differences, but Hopley et al. (2010) concluded that there is “some evidence” to suggest that THA may to lead to better outcome than HA.

THA can be assumed to lead to higher mortality than HA because of the longer surgery time and higher blood loss. We found, on the contrary, that THA was associated with a lower mortality than HA even in the matched population. We do not believe that the implant choice per se influences patient survival. As guidelines recommend THA for active and medically fit patients, one can assume that this group have fewer comorbidities than those given HA (National Clinical Guideline Centre 2011). By matching for age, sex, BMI, and ASA class, we aimed to overcome these differences. Nevertheless, several potential confounders still remain. Even more accurate matching might be made by including comorbidity as a variable, but this data is not available from the SHAR. Assumingly, the

Table 2. Risk of revision and reoperation with death as competing risk, unmatched patients. Absolute risk reduction (95% CI)

	Revision		Death	
THA	0.51	(0.37–0.71)	0.59	(0.54–0.65)
Age	0.97	(0.95–0.98)	1.03	(1.02–1.03)
Female	0.81	(0.65–1.0)	0.69	(0.66–0.72)
ASA 2	0.93	(0.54–1.6)	1.7	(1.3–2.2)
ASA 3	1.01	(0.58–1.8)	2.6	(2.0–3.3)
ASA 4	0.99	(0.50–2.0)	3.5	(2.7–4.5)
BMI	1.01	(0.98–1.04)	0.96	(0.95–0.96)
	Reoperation		Death	
THA	0.63	(0.48–0.84)	0.58	(0.53–0.64)
Age	0.97	(0.96–0.99)	1.03	(1.02–1.03)
Female	0.82	(0.67–1.01)	0.69	(0.66–0.73)
ASA 2	1.2	(0.73–2.0)	1.7	(1.3–2.2)
ASA 3	1.3	(0.79–2.2)	2.5	(2.0–3.2)
ASA 4	1.2	(0.66–2.3)	3.5	(2.7–4.5)
BMI	1.02	(1.0–1.05)	0.96	(0.95–0.96)

Table 3. Risk of revision and reoperation with death as competing risk, matched patients. Absolute risk reduction (95% CI)

	Revision		Death	
THA	0.51	(0.37–0.71)	0.59	(0.54–0.65)
	Reoperation		Death	
THA	0.63	(0.48–0.84)	0.58	(0.53–0.64)

constitution of the patient in terms of frailty will guide the surgeon in the choice between HA and THA. As this frailty is defined not only by health and age, but also capacity of independent life, socioeconomics, psychological well-being etc., the standardized set of variables within a national register will not be sufficient to address this selection bias. By including more variables in a register, more detailed information about the patients will be available. However, as more variables are included, the work of reporting data to the register increases and might lead to decreased coverage, which will lower the quality of data in the register.

If an increased risk of reoperation after HA truly exists, what will be the reasons for it? Acetabular erosion is possible only in HA and will occur in active "young old" patients (Baker et al. 2006), thus leading to revision. Second, the easier procedure of revising a HA to a THA by adding a cup, in case of pain or dislocation, might make surgeons more prone to do an HA revision. Revising an existing THA by implant exchange is assumingly more challenging in elderly patients. Finally, the aforementioned frailty of HA patients will not only explain the higher mortality in our study, but also a higher risk of infection and periprosthetic fractures. We plan a further study on the specific reasons for reoperation. To do so, co-processing with other national registers is necessary to add information on both patients' comorbidity and occurrence of any complication.

A higher risk of dislocation has been found for THA compared with HA (Carroll et al. 2011, Burgers et al. 2012, Yu et al. 2012, Jameson et al. 2013). Closed reduction of dislocation is no longer routinely recorded in the SHAR as previous attempts led to underreporting. The fact that only open procedures due to dislocation are included in our analysis is a limitation, although we consider the lower risk of revision and reoperation in total to suggest that most THAs are well-functioning.

Another limitation of our study is that we were not able to retrieve information on patient-reported outcome measures (PROMs). This is not recorded in SHAR for patients with hip fracture. Previous studies have shown varying results on post-fracture PROMs. 4 randomized studies showed that patients treated with THA score higher on health-related quality-of-life measures compared with the HA cases (Baker et al. 2006, Keating et al. 2006, Macaulay et al. 2008, Hedbeck et al. 2011), while others showed no difference (Dorr et al. 1986, van den Bekerom et al. 2010).

In the unmatched population, there was no association between age, sex, BMI, and ASA classification and increased risk of revision or reoperation. Previous studies have shown that high BMI increases the risk of complications, especially infections, after elective hip arthroplasty surgery (Lübbeke et al. 2007, Dowsey and Choong 2008) but obesity per se is not associated with increased mortality or morbidity after surgery (Huschak et al. 2013). Since older age and high ASA class is associated with higher mortality after hip fracture surgery (Smith et al. 2014), surgeons might be reluctant to perform secondary surgery on these patients, explaining why we could not find any influence of the variables on risk of revision or reoperation.

In summary, we found, based on national register data on femoral neck fractures, that THA has a lower risk of reoperation and revision compared with HA. The lower risk of mortality associated with THA may merely reflect factors other than those known by us, influencing the choice of arthroplasty design. Our data support THA as a good alternative for hip fracture patients, but the final decision on implant type should be made considering the complete status of the patient.

SH: principal author of the manuscript, general planning, interpretation of data. SN: general planning, calculation and interpretation of data. JK: scientific advice, interpretation of data. CR: general planning, scientific advice, interpretation of data.

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