The type of surgical approach influences the risk of revision in total hip arthroplasty

A study from the Swedish Hip Arthroplasty Register of 90,662 total hip replacements with 3 different cemented prostheses

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Background and purpose The most common surgical approaches in total hip arthroplasty in Sweden are the posterior and the anterolateral transgluteal approach. Currently, however, there is insufficient evidence to prefer one over the other regarding risk of subsequent surgery.

Patients and methods We searched the Swedish Hip Arthroplasty Register between the years 1992 and 2009 to compare the posterior and anterolateral transgluteal approach regarding risk of revision in the 3 most common all-cemented hip prosthesis designs in Sweden. 90,662 total hip replacements met the inclusion criteria. We used Cox regression analysis for estimation of prosthesis survival and relative risk of revision due to dislocation, infection, or aseptic loosening.

Results Our results show that for the Lubinus SPII prosthesis and the Spectron EF Primary prosthesis, the anterolateral transgluteal approach gave an increased risk of revision due to aseptic loosening (relative risk (RR) = 1.3, 95% CI: 1.0–1.6 and RR = 1.6, CI: 1.0–2.5) but a reduced risk of revision due to dislocation (RR = 0.7, CI: 0.5–0.8 and RR = 0.3, CI: 0.1–0.4). For the Exeter Polished prosthesis, the surgical approach did not affect the outcome for dislocation or aseptic loosening. The surgical approach had no influence on the risk of revision due to infection in any of these designs.

Interpretation This observational study shows that the surgical approach affected the risk of revision due to aseptic loosening and dislocation for 2 of the most commonly used cemented implants in Sweden. Further studies are needed to determine whether these results are generalizable to other implants and to uncemented fixation.

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The posterior approach and the anterolateral transgluteal (ALT) approach, also called the direct lateral approach, without trochanteric osteotomy are—with various variations—probably the 2 most common approaches used to insert a total hip arthroplasty (THA). The ALT incision offers good exposure of the acetabulum, which could facilitate cup positioning. Patients operated with an ALT approach run a higher risk of postoperative limp because of a risk of interference with the abductor muscles and the superior gluteal nerve (Baker and Bitounis 1989, Downing et al. 2001). The posterior incision may give better access to the femur and may facilitate stem positioning. This may reduce the risk of malalignment and in turn give a poor cement mantle, which could cause loosening (Garellick et al. 1999). However, the posterior approach has been associated with increased frequency of instability and dislocation (Woo and Morrey 1982, Masonis and Bourne 2002). A meta-analysis of clinical trials did not find any convincing evidence that either the posterior approach or the ALT approach was superior in THA for osteoarthritis (Jolles and Bogoch 2006).

Between 1999 and 2008, use of the ALT approach with the patients on their side (the Gammer approach (Gammer 1985)), increased in Sweden from 18% to 42%. This has mainly been done at the expense (i.e. decreasing frequency) of the posterior approach (Moore 1957), which changed in frequency of use from 63% to 52% during the same period (Garellick et al. 2008). One reason for this may have been reports of increasing dislocation rates due to hip fracture after THA performed with the posterior approach (Enocson et al. 2009). Another reason may have been that if the orthopedic surgeon operates without an assistant, which has become more common, for the nurse it is easier to hold the leg when the ALT approach is used. The possible effect of this development on the overall outcome regarding risk of revision is, however, unclear.

In this observational cohort study based on prospective collected data from the Swedish Hip Arthroplasty Register (SHAR), we therefore investigated the outcome of surgical

approach regarding risk of revision. We hypothesized that the influence of surgical approach on the risk of revision would vary depending on the reason for revision selected and that the outcomes would differ depending on the type of stem analyzed.

Patients and methods

The SHAR was started in 1979 in order to help improve the results of THA through the study of complications, and today all the units that perform total hip arthroplasty in Sweden participate (Karrholm 2010). The completeness of individual registration is about 98%. Until 1991, aggregated data were collected from each hospital. Since 1992, each operation has been identified through the personal identification number. The register includes information about patient age, sex, diagnosis, side, bilaterality, surgical approach, type of fixation, implant design, and type of hospital performing the procedure. Date of surgery and date of any subsequent revision are recorded. By matching the register to the Swedish death register, implant survival can be calculated. Until 1998, data on type of incision used were collected at the hospital level. Since then, this information has been recorded on an individual basis.

During the period 1992–2009 in Sweden, all-cemented THA was most common (87%)—especially during the early part of this period. We therefore limited our analysis to the most frequently used all-cemented designs, the Exeter Polished, the Lubinus SP II, and the Spectron EF Primary. In a previous study, it was shown that for these stem types the reason for revision varied depending on the type of stem used, and for some of them design-specific factors such as size and offset also had an influence (Thien and Karrholm 2010). To avoid bias caused by stem type, each design was studied separately. Head size has been reported to influence the risk of revision due to recurrent dislocation (Morrey 1992, Barrack 2003, Bystrom et al. 2003) and we therefore included only 28-mm head sizes in all prostheses analyzed.

Data from between 1992 and 2009 were extracted from the SHAR for the 3 most used stems still in use 2009: Lubinus SPII, Exeter Polished, and Spectron EF Primary. In order to reduce any possible influence of variations in the design of the cup, only combinations of these stems with their most frequently used cemented acetabular components were studied. Accordingly, the Lubinus SPII stem and FAL or Lubinus All-Poly cup (n = 66,405), the Exeter Polished with Contemporary Hooded Duration, Exeter Duration, or Exeter All-Poly cup (n = 18,711), and the Spectron EF Primary stem in combination with the Reflection cup (n = 5,546), were included. We included all diagnoses except insertion of THA due to tumors. In the analysis, diagnoses were classified as osteoarthritis, fracture (including both fresh fracture and sequelae after fracture), or other (inflammatory arthritis, sequelae after childhood hip disease, osteonecrosis, or other) (Table 1). Bilateral operations were included. Patients operated with any other

Table 1. Demographics of the 3 different prostheses

	Lubinus SPII n (%)	Exeter Polished n (%)	Spectron EF Primary n (%)
Total	66,405	18,711	5,546
Age, years			
< 50	922 (1)	468 (2)	
50–59	5,903 (9)	2,099 (11)	393 (7)
60–75	36,935 (56)	10,040 (54)	2,895 (52)
> 75	22,645 (34)	6,104 (33)	2,258 (41)
Mean	71	70	73
Sex			
Male	26,568 (40)	7,449 (40)	1,916 (34)
Female	39,837 (60)	11,262 (60)	3,630 (66)
Side			
Left	30,237 (46)	8,432 (45)	2,532 (46)
Right	36,168 (54)	10,279 (55)	3,014 (54)
Diagnosis			
Osteoarthritis	53,993 (81)	15,431 (83)	4,284 (77)
Fracture	8,126 (12)	1,689 (9)	857 (16)
Other	4,286 (7)	1,591 (8)	405 (7)
Head			
Co-Cr/metal	58,673 (88)	18,711 (100)	5,546 (100)
Ceramic	7,732 (12)		
Cup			
FAL	5,142 (8)		
All-Poly	61,263 (92)	4,430 (24)	
Duration		10,325 (55)	
Contemp HD		3,956 (21)	
Reflection			5,546 (100)
Approach			
ALT	16,493 (25)	3,291 (18)	4,174 (75)
Posterior	49,912 (75)	15,420 (82)	1,372 (25)
Order			
First hip	54,710 (82)	15,457 (83)	4,581 (83)
Second hip	11,695 (18)	3,254 (17)	965 (17)
Follow-up time, years			
Mean (SD)			
All	5.7 (3.8)	6.0 (3.7)	5.3 (2.5)
Revision due to			
Dislocation	2.1 (3.0)	2.6 (3.4)	2.4 (2.3)
Infection	1.8 (2.1)	2.5 (3.0)	1.6 (1.4)
Loosening	7.2 (3.7)	7.0 (3.8)	5.3 (2.3)

incision than the posterior one (Moore 1957) or the ALT with the patient in side position (Gammer 1985) were excluded.

More patients had been operated with the Lubinus SPII stem than with the other 2 designs. The Spectron EF Primary had been inserted through the ALT incision in 75% of the hips, whereas this approach had only been used in 18% of the cases operated with an Exeter stem and 25% of those operated with a Lubinus stem. Female sex was more common in the Spectron group (66%) than in the Lubinus group (60%) and the Exeter group (60%). Osteoarthritis was slightly more common in the Exeter group (83%) than in the Lubinus group (81%) and the Spectron group (77%) (Table 1).

The mean time to follow-up was 5.3 (0–11.0), 5.7 (0–18.0), and 6.0 (0–17.0) years for the Spectron EF Primary, Lubinus SP II, and Exeter stems, respectively. The mean time to revision due to infection was 1.6 years in the Spectron group and 1.8 and 2.5 years in the Lubinus and Exeter groups. Revision

Table 2. Numbers of revisions and crude revision rates due to dislocation, infection, or loosening using either the posterior approach or the ALT approach

	Lubinus SPII n (%)	Exeter Polished n (%)	Spectron EF Primary n (%)
Dislocation	449 (0.7)	163 (0.9)	44 (0.8)
Infection	297 (0.4)	88 (0.5)	42 (0.8)
Loosening	586 (0.9)	342 (1.8)	124 (2.2)
Total	1,332 (2.0)	593 (3.2)	210 (3.8)

because of dislocation occurred after a mean time of 2.4 years in the Spectron group, 2.1 years in the Lubinus group, and 2.6 years in the Exeter group. The corresponding mean time periods to revision because of loosening were 5.3, 7.2, and 7.0 years. Thus, revision due to infection and dislocation occurred earlier than revision due to aseptic loosening (Table 1).

The study was approved by the Regional Ethics Committee in Gothenburg, Sweden (ref. no. 1136-11)

Statistics

Follow-up started on the day of the primary THA operation and ended on the day of revision, death, emigration, or by December 31, 2009. Separate Cox proportional hazard models were used to analyze the 3 designs of implants. For each implant, 3 endpoints were used: revision because of infection, dislocation, or aseptic loosening. Adjustment for age, sex, diagnosis, side, nearly design of the acetabular cup, and number of operations (first or second in the same patient) was done. In the groups operated with Lubinus SP II and Exeter stems, age was divided into 4 groups (< 50, 50–59, 60–75, and > 75 years). In the Spectron EF Primary group, the classification was condensed into 3 groups because of a small number of cases (n < 100) in the youngest group. The adjusted relative risk (RR) of revision with 95% confidence interval (CI) for the different surgical approaches is presented. To investigate the assumption of proportionality, hazard function plots and log-minus-log plots of all covariates were inspected visually. For each of the analyses, there was no sign of insufficient proportionality, and log-minus-log plots ran parallel for all covariates. All statistical calculations were done with IBM SPSS Statistics version 19 for Windows.

Results

Lubinus SPII

Use of the ALT approach reduced the risk of subsequent revision due to dislocation by 34% (RR = 0.7, CI: 0.5–0.8) compared to the posterior approach. Increased risk was seen in males, patients with diagnoses other than osteoarthritis, and use of the FAL cup (Table 3). Usually the cup was exchanged (51%) with or without stem exchange (Table 4).

The choice of surgical approach had no influence on revision rate due to infection. Males and patients with fracture or sequelae after fracture had an increased risk of revision due to infection.

Hips that were operated using the ALT approach had a slightly higher probability of revision due to aseptic loosening (RR = 1.3, CI: 1.0–1.6). Young age and male sex also had a negative influence, whereas the FAL cup and ceramic head were associated with a reduced risk of revision due to loosening. Both components were most often revised (48%), followed by revision of the cup alone (30%) (Table 4).

Exeter Polished

With the Exeter prosthesis, the surgical approach had no influence on the risk of revision for dislocation, infection, or aseptic loosening. Male sex and diagnoses other than osteoarthritis had a negative effect on implant survival (Table 5) regarding revision due to infection or dislocation. Young age and use of the All-Poly cup were associated with an increased risk of revision due to loosening. Most commonly, the cup (59%) or the cup and stem (32%) were exchanged during revision for loosening (Table 6).

Spectron EF Primary

Use of the ALT approach reduced the risk of revision due to dislocation (RR = 0.3 CI: 0.1–0.4), whereas the diagnosis "fracture" increased this risk (Table 7). The cup was most often revised (with or without exchange of the stem) when this complication occurred (32 of 44 cases, 73%).

The choice of approach had no influence on the risk of revision due to infection. The only obvious risk factor for this complication was male sex (Table 7).

The ALT approach gave a higher risk of revision due to aseptic loosening (RR = 1.6 CI: 1.0–2.5), as did low age (Table 7). For this diagnosis, the cup (49%) or both components (33%) were most often revised (Table 8).

Discussion

Aseptic loosening of the implant is the most common reason for revision of a THA (Table 2). To our knowledge, only one study has addressed the question of the effect of surgical approach on prosthetic loosening. Arthursson et al. (2007) found that the Charnley prosthesis inserted with a lateral approach involving trochanteric osteotomy was associated with lower revision rates due to dislocation or aseptic loosening than those implanted using a posterior or lateral approach without trochanteric osteotomy. They also found that use of the posterior or lateral approach without trochanteric osteotomy had no influence on the risk of revision of the Exeter prosthesis, as also noted by us.

In light of the above-mentioned advantages and shortcomings of both approaches in terms of exposure, we believe that

Table 3. Relative risks (RR) of revision for the Lubinus SPII (Cox regression). Parameters with a value of 1 are reference

		RR	95% CI	p-value
Dislocation				
Age, years	< 50	0.5	0.2–1.3	0.2
	50–59	0.9	0.6–1.3	0.5
	60–75	0.9	0.7–1.1	0.3
	> 75	1		
Sex	Female	1		
	Male	1.2	1.0–1.5	0.03
Order	First hip	1.0	0.8–1.3	0.9
	Second hip	1		
Diagnosis	Osteoarthritis	1		
	Fracture	3.2	2.6–4.0	< 0.001
	Other	1.5	1.0–2.1	0.03
Cup	FAL	1.7	1.3–2.4	< 0.001
	Lubinus All-Poly	1		
Head	Ceramic	0.7	0.5–1.0	0.06
	Co-Cr	1		
Approach	ALT	0.7	0.5–0.8	0.001
	Posterior	1		
Side	Left	1		
	Right	1.0	0.8–1.2	0.8
Loosening				
Age, years	< 50	8.4	5.4–13.0	< 0.001
	50–59	6.0	4.3–8.3	< 0.001
	60–75	3.0	2.2–4.0	< 0.001
	> 75	1		
Sex	Female	1		
	Male	2.1	1.8–2.5	< 0.001
Order	First hip	1.0	0.8–1.3	1.0
	Second hip	1		
Diagnosis	Osteoarthritis	1		
	Fracture	1.3	0.9–1.8	0.1
	Other	1.2	0.9–1.6	0.2
Cup	FAL	0.5	0.3–1.0	0.05
	Lubinus All-Poly	1		
Head	Ceramic	0.5	0.3–0.7	< 0.001
	Co-Cr	1		
Approach	ALT	1.3	1.0–1.6	0.02
	Posterior	1		
Side	Left	1		
	Right	1.2	1.0–1.4	0.03
Infection				
Age, years	< 50	1.9	1.0–3.7	0.07
	50–59	1.1	0.7–1.7	0.7
	60–75	0.9	0.7–1.2	0.7
	> 75	1		
Sex	Female	1		
	Male	2.2	1.7–2.7	< 0.001
Order	First hip	0.7	0.6–1.0	0.04
	Second hip	1		
Diagnosis	Osteoarthritis	1		
	Fracture	1.8	1.3–2.6	< 0.001
	Other	1.6	1.1–2.4	0.03
Cup	FAL	0.7	0.4–1.1	0.1
	Lubinus All-Poly	1		
Head	Ceramic	0.7	0.5–1.1	0.1
	Co-Cr	1		
Approach	ALT	0.9	0.70–1.2	0.6
	Posterior	1		
Side	Left	1		
	Right	1.2	0.9–1.5	0.2

Table 4. Components exchanged or removed due to dislocation or loosening of the Lubinus SPII

	Dislocation				Loosening			
	ALT		Posterior		ALT		Posterior	
	n	%	n	%	n	%	n	%
Stem	2	3	13	4	28	24	93	20
Stem and cup	11	14	20	5	50	43	231	49
Cup	37	47	137	37	34	29	139	30
Extraction	1	1	14	4	3	3	6	1
Other	28	35	186	50	1	1	1	0
Total	79	100	370	100	116	100	470	100

acetabular cup of greater than 50 degrees has been found to be correlated with increased acetabular wear (Schmalzried et al. 1994, Kennedy et al. 1998), which is often associated with loosening of the implant. Callanan et al. (2011) found that the ALT approach led to a higher rate of malpostioned cups (defined as an inclination angle of greater than 50 degrees) (Callanan et al. 2011). If the ALT approach leads to a greater risk of malpositioning of the cup, this would explain the increased risk of revision due to loosening after this approach. The reason for only 2 of the stems having inferior results with the ALT approach is more difficult to explain, however. Perhaps the cups used with the Lubinus and Spectron designs are more prone to malpositioning than the cups used with the Exeter, at least when inserted using the ALT approach.

Regarding the differences found for stems, it may be that the 2 unpolished stems are more sensitive to malpositioning. This could occur if the femoral canal is entered too anteriorly, which may be more common with use of the ALT approach. An ALT approach with a straight stem design often results in a thin cement mantle, or even stem-cortex contact, in the proximal anterior and distal posterior parts of the femur (Macpherson et al. 2010), but this might not result in an osteolysis with loosening of the polished straight stem (Hook et al. 2006, Lewthwaite et al. 2008). The 2 unpolished stems are probably more sensitive to debonding and defects in the cement mantle, resulting in higher production of cement and metallic debris (Garellick et al. 1999). The relative distribution between cup and stem revisions, with higher frequency of the latter procedure with the non-polished designs, could support this theory (Tables 4, 6, and 8). Poor access to the femoral canal can also lead to the use of a smaller stem size than appropriate. The smallest stem sizes of the Spectron and Lubinus design are associated with greater risk of loosening, which could also contribute to the inferior results (Thien and Karrholm 2010).

As previously mentioned, the 2 surgical approaches are considered to have benefits and shortcomings concerning exposure and accessibility of the femur and acetabulum. With this in mind, it is interesting to see that the relationship between cup and stem revisions is similar in the 2 approaches for all 3 designs individually. It appears that the revision pattern (cup and/or stem revision) is constant for a certain prosthesis type

the higher revision rate for the Lubinus and Spectron groups might have to do with malpositioning of the components. In clinical and experimental studies, an inclination angle of the

Table 5. Relative risks (RR) of revision for the Exeter prosthesis (Cox regression). Parameters with a value of 1 are reference

		RR	95% CI	p-value
Dislocation				
Age, years	< 50	0.7	0.3–2.0	0.5
	50–59	0.9	0.5–1.6	0.8
	60–75	1.1	0.8–1.5	0.7
	> 75	1		
Sex	Female	1		
	Male	1.3	1.0–1.8	0.08
Order	First hip	0.9	0.6–1.3	0.6
	Second hip	1		
Diagnosis	Osteoarthritis	1		
	Fracture	3.4	2.2–5.1	< 0.001
	Other	2.0	1.2–3.3	0.01
Cup	Contemporary Hooded Duration	1		
	Exeter All-Poly	0.7	0.4–1.4	0.3
	Exeter Duration	0.9	0.5–1.5	0.6
Approach	ALT	0.6	0.3–1.1	0.1
	Posterior	1		
Side	Right	1.0	0.7–1.3	0.7
	Left	1		
Loosening				
Age, years	< 50	6.0	3.8–9.6	< 0.001
	50–59	3.8	2.5–5.6	< 0.001
	60–75	2.2	1.6–3.2	< 0.001
	> 75	1		
Sex	Female	1		
	Male	0.8	0.8–1.2	0.8
Order	First hip	1.0	0.7–1.3	0.9
	Second hip	1		
Diagnosis	Osteoarthritis	1		
	Fracture	0.6	0.4–1.1	0.1
	Other	1.2	0.9–1.7	0.2
Cup	Contemporary Hooded Duration	1		
	Exeter All-Poly	2.5	1.3–5.7	0.01
	Exeter Duration	0.9	0.5–1.8	0.9
Approach	ALT	0.9	0.5–1.5	0.6
	Posterior	1		
Side	Right	1.1	0.9–1.3	0.6
	Left	1		
Infection				
Age, years	< 50	1.5	0.4–5.0	0.6
	50–59	1.5	0.7–2.9	0.3
	60–75	1.3	0.8–2.1	0.4
	> 75	1		
Sex	Female	1		
	Male	2.2	1.4–3.4	< 0.001
Order	First hip	0.6	0.4–1.1	0.1
	Second hip	1		
Diagnosis	Osteoarthritis	1		
	Fracture	4.3	2.5–7.5	< 0.001
	Other	1.2	0.6–2.8	0.6
Cup	Contemporary Hooded Duration	1		
	Exeter All-Poly	0.6	0.3–1.5	0.3
	Exeter Duration	1.3	0.6–2.6	0.5
Approach	ALT	1.1	0.6–2.3	0.7
	Posterior	1		
Side	Right	1.1	0.8–1.7	0.6
	Left	1		

Table 6. Components exchanged or removed due to dislocation or loosening of the Exeter prosthesis

	Dislocation				Loosening			
	ALT		Posterior		ALT		Posterior	
	n	%	n	%	n	%	n	%
Stem	5	31	32	22	0	0	26	8
Stem and cup	0	0	27	18	9	45	102	32
Cup	8	50	56	38	11	55	190	59
Extraction	0	0	4	3	0	0	4	1
Other	3	19	28	19				
Total	16	100	147	100	20	100	322	100

Table 7. Relative risks (RR) of revision for the Spectron prosthesis (Cox regression). Parameters with a value of 1 are reference

		RR	95% CI	p-value
Dislocation				
Age, years	< 60	0.7	0.2–3.1	0.6
	60–75	1.2	0.6–2.1	0.7
	> 75	1		
Sex	Female	1		
	Male	1.0	0.5–1.9	1.0
Order	First hip	1.6	0.6–4.5	0.4
	Second hip	1		
Diagnosis	Osteoarthritis	1		
	Fracture	4.8	2.5–9.0	< 0.001
	Other	1.4	0.4–4.9	0.6
Approach	ALT	0.2	0.1–0.4	< 0.001
	Posterior	1		
Side	Right	1.0	0.5–1.8	1.0
	Left	1		
Loosening				
Age, years	< 60	7.1	3.8–13.2	< 0.001
	60–75	2.9	1.7–4.8	< 0.001
	> 75	1		
Sex	Female	1		
	Male	1.3	0.9–1.8	0.2
Order	First hip	0.7	0.5–1.1	0.2
	Second hip	1		
Diagnosis	Osteoarthritis	1		
	Fracture	0.8	0.5–1.6	0.6
	Other	1.1	0.6–2.1	0.7
Approach	ALT	1.6	1.0–2.5	0.04
	Posterior	1		
Side	Right	1.1	0.8–1.5	0.7
	Left	1		
Infection				
Age, years	< 60	1.9	0.7–5.1	0.2
	60–75	1.2	0.6–2.4	0.6
	> 75	1		
Sex	Female	1		
	Male	2.9	1.6–5.5	< 0.001
Order	First hip	0.8	0.4–1.6	0.4
	Second hip	1		
Diagnosis	Osteoarthritis	1		
	Fracture	1.5	0.6–3.6	0.4
	Other	2.5	1.1–6.0	0.04
Approach	ALT	0.9	0.5–1.8	0.8
	Posterior	1		
Side	Right	0.9	0.5–1.6	0.7
	Left	1		

and that the less favorable approach aggravates this pattern slightly for some types of prostheses, but not all of them, as one might have expected. If this observation is not biased by

Table 8. Components exchanged or removed due to dislocation or loosening of the Spectron EF Primary prosthesis

| | Dislocation | | | | Loosening | | | |
| | ALT | | Posterior | | ALT | | Posterior | |
	n	%	n	%	n	%	n	%
Stem	1	6	0	0	13	13	3	11
Stem and cup	4	22	1	4	32	33	9	33
Cup	9	50	18	69	48	50	13	48
Extraction	2	11	1	4	4	4	2	7
Other	2	11	6	23				
Total	18	100	26	100	97	100	27	99

factors beyond our control, it could explain why the influence of surgical approach on the risk of revision has not been noted in clinical practice. Separation of reason for revision is also important since one type of incision may reduce the risk of revision due to loosening and increase the risk of revision due to dislocation. If these outcomes are combined, the overall risk may become neutralized and may also become more dependent on time to follow-up—since revisions due to loosening tend to occur much later than those performed due to dislocation (Table 1).

The present study has confirmed the influence of young age and male sex as risk factors for revision due to aseptic loosening. Also, the overall revision rate due to dislocation was higher for the posterior approach, as has been shown earlier (Woo and Morrey 1982, Masonis and Bourne 2002). An unexpected finding was that the Exeter prosthesis did not have a higher revision rate due to dislocation when inserted with a posterior approach. The reason for this is difficult to explain. It is possibly an effect of its small CCD angle, the head-to-neck ratio, and/or the design of the cup rather than its straight tapered collarless stem, as stem revision after recurrent dislocation is more common for the Exeter prosthesis than for the Lubinus and the Spectron (Tables 4, 6, and 8), suggesting that correct stem placement is more difficult.

One concern with our study could be the skewed distribution in the 3 implant groups between the 2 types of approaches studied. Even so, the smallest group included more than 1,300 operations, which should be sufficient for a reliable analysis. Another source of error could be that some cases that were classified as aseptic loosening were low-grade infections. However, this would probably affect the different implant designs and surgical approaches evenly, especially when the study indicates that the revisions due to postoperative infection were equally dispersed among the different implants and surgical approaches.

From 1999, the SHAR has registered all information on an individual basis, which is a guarantee for a reliable database. However, before then some information was collected on a hospital basis—so that variation in some variables in one and the same hospital was not considered. Instead, the most com-

monly used variable was reported for all operations. Head size and surgical approach are examples of this kind of information. At that time in Sweden, each hospital had rather consistent use of a specific surgical approach and variations in head size of the prosthesis were rare. Nevertheless, this way of reporting means that there was an increased risk of incorrect data collection during the early period of the present study. We included this period to increase the observation time, which was of interest to obtain a better coverage of revisions due to loosening. Analysis based on the surgical approaches used and reported for individual operations performed during the year 2000 revealed that more than one type of approach was used on a regular basis in 12 of 55 departments that performed at least one of the implantation procedures in our study. If this finding is applicable to the period 1992–1998, this means that the relative share of misclassified cases would constitute 8.7% of the cases operated in 1992–1998 and 2.2% of the cases operated during the entire period of observation.

A few studies have investigated the influence of surgical approach on implant survival. Most of these found no convincing effect of the choice of surgical approach (Arthursson et al. 2007, Palan et al. 2009). The choice of incision is related to the surgeon's preference and experience, a factor that may make interpretation of a clinical trial difficult. Furthermore, large numbers are needed to obtain statistical power and especially to study burden of infection, dislocation, and aseptic loosening (Jolles and Bogoch 2006). When addressing these types of rare events and adverse effects, large prospective observational studies are preferable—especially when the time period between intervention and outcome (i.e. aseptic loosening) is long (von Elm et al. 2007)—and they have proven useful even in orthopedic surgery (Garellick et al. 2000). The strength of our study is therefore its large size, its long observational time, and its external validity due to the nationwide study population and the fact that the surgical approaches and the implants are still in use. Although we have shown a connection between surgical approach, implant, and complication registered, a study of this kind is mostly hypothesis-founding and we cannot explain this correlation with any degree of certainty.

In this nationwide prospective observational study involving 90,662 THAs, we can conclude that the ALT approach led to an elevated risk of revision due to aseptic loosening in 2 of the most frequently used cemented THAs in Sweden. For these implants, the risk of revision due to dislocation is increased when inserted using the posterior approach. For a polished tapered design, the surgical approach does not appear to influence the risk of revision for any reason. Thus, the type of failure is not only related to the surgical approach but also to the type of implant chosen. Further studies are needed to determine whether these results can be generalized to other cemented implants and implants used with uncemented fixation.

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