

Femoral head diameter affects the revision rate in total hip arthroplasty

An analysis of 1,720 hip replacements with 9–21 years of follow-up

Sarunas Tarasevicius¹, Uldis Kesteris², Otto Robertsson² and Hans Wingstrand²

Departments of Orthopaedics, ¹Kaunas Medical University, Kaunas, Lithuania, ²Lund University Hospital, Lund, Sweden

Correspondence ST: sarunas.tarasevicius@gmail.com

Submitted 05-12-03. Accepted 06-03-10

Background In a previous study concerning 1,660 ScanHip THAs that were followed for up to 12 years, the cumulative revision rate was not found to be dependent on whether a 22-mm or a 32-mm head size had been used. We have re-examined these patients to see whether a longer follow-up time (9–21 years) would disclose an effect of head size on the revision rate.

Patients and methods We analyzed the cumulative revision rate for 1,720 Scan Hip arthroplasties with either 22-mm or 32-mm femoral heads. The patients were followed for 9–21 years.

Results Arthroplasties with 32-mm head had 2.8-times higher cumulative revision rate than those with a 22-mm head. Older age reduced the risk of revision while male sex increased the risk.

Interpretation We found that head size affects revision risk, but that even in a reasonably large material a long follow-up time is required to disclose the effects of head size—and thus wear—on survival.

patients in the current series, Kesteris et al. (1996) measured polyethylene wear and found that a 32 mm head was more associated with increased volumetric and linear wear than a 22 mm head. One would expect that this difference would eventually result in different cumulative revision rates (CRR) for different head sizes. However, in following 1,660 patients for 2–12 years, Kesteris et al. (1998) found no significant difference between 22- and 32-mm heads. Similarly, Marston et al. (1996) followed 413 THA patients for 5–10 years and did not find that survival was affected by head size.

Our aim was to follow up and update information on the previously reported material, in order to investigate whether a longer follow-up would reveal differences in CRR related to head size.

Patients and methods

We analyzed the CRRs for 1,720 Scan Hip Classic I THAs implanted in 1,550 patients, with 22- and 32-mm heads, performed at Lund University Hospital from 1983 through 1995 (Table 1). The 2–12-year results for the larger part of this cohort (1,660 patients operated on until January 1994) have been reported previously by Kesteris et al. (1998). We added patients operated on from January 1994 to January 1995, at which point the use of this particular implant was discontinued. As previously, only patients with the 3 most common diagnoses were included in the analysis, i.e. osteoarthritis

Since the early days of total hip arthroplasty (THA), the choice of proper diameter of the femoral head has been under debate regarding its effect on wear. The most widely accepted theory to explain aseptic loosening of THAs is that of osteolysis induced by polyethylene particles (Murray et al. 1990, Schmalzried et al. 1992, Jasty et al. 1997). Increased head size has been found to be associated with increased volumetric wear (Livermore et al. 1990, Egli et al. 2002). In a study that included a subset of the

Table 1. Data on 1,720 THAs in 1550 patients

Implant type	n	THA components revised			No. of patients who died	Age mean (SD)	Sex Female/Male
		Cups	Stems	Both			
Classic I 22-mm	308	7	7	13	122	58 (16)	252/56
Classic I 32-mm	1,412	31	24	81	727	72 (10)	810/602

Table 2. Distribution data on preoperative diagnosis

Head size	Osteoarthritis	Rheumatoid arthritis	Femoral neck fractures
22 mm	154	114	40
32 mm	911	147	354

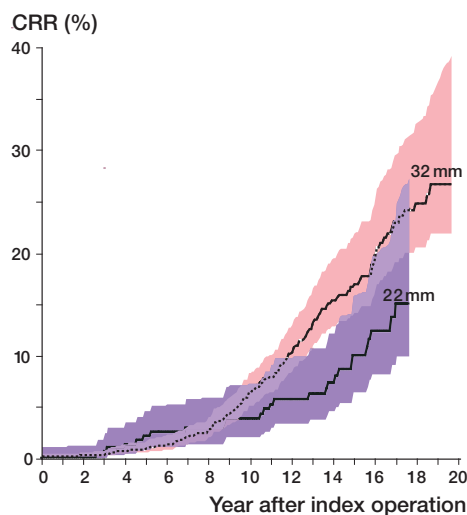
(OA), rheumatoid arthritis (RA) and femoral neck fracture (FR) (Table 2). The endpoint was defined as revision of any component for aseptic loosening before the end of 2004. This excluded 16 revisions for recurrent dislocation and 7 for infection. The choice of prosthetic head size was based only on the preferences of the surgeon.

The design of the Scan Hip Classic I MitAB stem (MitAB, Sjöbo, Sweden) and the standard all-polyethylene Scan Hip (MitAB) has been described previously (Kesteris et al. 1996). The range of thickness of polyethylene in the 22-mm head group was 9–13 mm, and it was 6–13 mm in the 32-mm group.

Almost all of the patients were operated on with a posterolateral skin incision and posterior arthroscopy in lateral decubitus position. The cementing technique consisted of cleaning the bone bed with pulsating lavage, plugging of the femoral canal, retrograde filling and pressurization of Palacos bone cement with gentamicin. All data were registered prospectively and no patients were lost to follow-up. All of the revisions were performed in Lund. According to the Swedish National Hip Register, none of the primary patients had been revised elsewhere.

Statistics

CRR curves were produced using the life table method at monthly intervals. The confidence intervals were calculated using the Wilson quadratic equation with Greenwood and Peto effective sample-size estimates (Dorey et al. 1993). Cut-offs



Cumulative revision rates for 22-mm and 32-mm diameter femoral heads (with 95% CIs) for THAs with 3 major diagnoses: osteoarthritis, rheumatoid arthritis, and femoral neck fracture.

were when 40 hips remained at risk. Cox regression was used to adjust for differences in age and sex. Patient's ages and standard deviations were calculated using one-sample t-test. A p-value of < 0.05 was considered significant. We used SPSS software.

Results

Using the same life table method as in the previous article, we determined CRRs for OA, FR and RA patients and found that the 32-mm head resulted in higher CRR ($p = 0.04$, Wilcoxon). Further analysis by Cox regression with adjustment for age and sex showed that the 32-mm head had 2.8 times greater risk of revision (CI (95% CI) 1.7–4.6, $p < 0.001$). For each annual increase in age, the risk of revision was reduced by 0.96 times (CI 0.95–0.97, $p < 0.001$) and males had 1.5 times greater risk of revision than females (CI 1.1–2.1, $p = 0.01$).

We also analyzed the patients operated for OA only, but exclusion of the FR and RA patients did not change the CRR ($p = 0.04$). Cox regression analysis for OA patients showed that the 32-mm head had 3.4 times greater risk of revision than the 22-mm head (CI 1.9–6.0, $p < 0.001$). For each annual increase in age, the risk of revision was reduced by 0.94 times (CI 0.93–0.96, $p < 0.001$) and men had 1.5 times greater risk of revision than women (1.1–2.2, $p = 0.02$).

Discussion

The mean age of patients in the 22-mm femoral head diameter group was 59 years, and 71 years in the 32-mm group ($p < 0.001$). It is well established that the risk of revision decreases with increasing age, possibly due to a lower activity level, and this was also the case in the Cox regression in our material. Thus, it would have been expected that the group of patients with 32-mm head and with a higher mean age would have had a lower incidence of revision for loosening. However, our results showed the opposite. One possible explanation for the association between large head size and high revision rate may be the amount of polyethylene (PE) particles. Kesteris et al. (1996) showed that in a subset of patients included in this study, the volumetric PE wear 7–9 years postoperatively was 3 times higher with the 32-mm head than with the 22-mm head. Thus, our findings support the theory that wear affects long-term survival. The reason that we did not find any significant difference in cumulative revision rates between head sizes in our previous study (Kesteris et al. 1998) may be the time it takes for wear particles to induce the chain of events that eventually leads to loosening. This discrepancy in the results between our previous study and this update is also in accordance with the results of Malchau and Herberts (1996) and Oparaugo et al. (2001) showing that changes in implant survival can be expected later than 10 years after surgery.

There were 7 isolated stem revisions in the 22-mm group and 24 in the 32-mm group. It could be argued that such revisions are not related to wear of the acetabular cup. However, it has been shown that PE particles can migrate down to the

femoral cavity via the bone-cement interface or the cement-stem interface, and they have been found distally in the femur (Pazzaglia et al. 1984). Thus, we believe that an increased amount of volumetric wear may cause isolated aseptic loosening of the stem although the cup is well fixed.

The initial thickness of polyethylene was greater in the 22-mm group. It has been repeatedly reported that the thickness of polyethylene is inversely correlated to wear (Bartel et al. 1986, Oonishi et al. 1998). However, selection of cup size is mostly based on the anatomical features of the patient; in a randomized group of patients, on balance a larger head size should have the effect of reducing the thickness of the polyethylene. Thus, it can be argued that the best way the surgeon can affect the thickness of polyethylene is by varying the head size. Our finding that head size affects results is therefore of importance, as it can be affected by the surgeon's choice.

Contributions of authors

ST collected, compiled and analyzed data, and wrote the manuscript. UK collected data and edited the manuscript. OR performed statistical analysis and edited the manuscript. HW organized the study and edited the manuscript.

This study was supported financially by a Pfizer EU Articulum Fellowship, by Lund Health District/Region Skåne, the Swedish Research Council (Project 73X-09509, the Swedish National Board of Health and Welfare, and by the Medical Faculty of Lund University, Sweden.

No competing interests declared.

Bartel D L, Bickneel V L, Wright T M. The effect of conformity, thickness, and material on stresses in ultra-high molecular weight components for total joint replacement. *J Bone Joint Surg (Am)* 1986; 68 (7): 1041-51.

Dorey F, Nasser S, Amstutz H. The need for confidence intervals in the presentation of orthopaedic data. *J Bone Joint Surg (Am)* 1993; 75 (12): 1844-52.

Eggl S, z' Brun S, Gerber D, Gantz R. Comparison of polyethylene wear with femoral heads of 22 mm and 32 mm. A prospective, randomized study. *J Bone Joint Surg (Br)* 2002; 84 (3): 447-51.

Jasty M, Goetz D D, Bragdon C R, Lee K R, Hanson A E, Elder J R, Harris W H. Wear of polyethylene acetabular components in total hip arthroplasty. An analysis of one hundred and twenty-eight components retrieved at autopsy or revision operations. *J Bone Joint Surg (Am)* 1997; 79 (3): 349-58.

- Kesteris U, Ilchmann T, Wingstrand H, Onnerfalt R. Polyethylene wear in Scanhip arthroplasty with a 22 or 32 mm head: 62 matched patients followed for 7-9 years. *Acta Orthop Scand* 1996; 67 (2): 125-7.
- Kesteris U, Robertsson O, Wingstrand H, Onnerfalt R. Survival rate with the Scan Hip Classic I total hip prosthesis. 1,660 cases followed for 2-12 years. *Acta Orthop Scand* 1998; 69 (2): 133-7.
- Livermore J, Ilstrup D, Morrey B. Effect of femoral head size on wear of the polyethylene acetabular component. *J Bone Joint Surg (Am)* 1990; 72 (4): 518-28.
- Malchau H, Herberts P. Prognosis in total hip replacement. Surgical and cementing technique in THA: a revision-risk unit. Department of Orthopaedics, University of Goteborg, Sweden 1996.
- Marston R A, Cobb A G, Bentley G. Stanmore compared with Charnley total hip replacement. A prospective study of 413 arthroplasties. *J Bone Joint Surg (Br)* 1996; 78 (2): 178-84.
- Murray D W, Rushton N. Macrophages stimulate bone resorption when they phagocytose particles. *J Bone Joint Surg (Br)* 1990; 72 (6): 988-92.
- Oonishi H, Iwaki H, Kin N, Kushitani S, Murata N, Wakitani S, Imoto K. The effects of polyethylene cup thickness on wear of total hip prostheses. *J Mater Sci Mater Med*. 1998; 9 (8): 475-8.
- Operaugo P C, Clarke I C, Malchau H, Herberts P. Correlation of wear debris-induced osteolysis and revision with volumetric wear-rates of polyethylene: a survey of 8 reports in the literature. *Acta Orthop Scand* 2001; 72 (1): 22-8.
- Pazzaglia U, Byers P D. Fractured femoral shaft through an osteolytic lesion resulting from the reaction to a prosthesis. A case report. *Bone Joint Surg (Br)* 1984; 66 (3): 337-9.
- Schmalzried T P, Jasty M, Harris W H. Periprosthetic bone loss in total hip arthroplasty. Polyethylene wear debris and the concept of the effective joint space. *J Bone Joint Surg (Am)* 1992; 74 (6): 849-63.