Polyethylene wear in Scanhip® arthroplasty with a 22 or 32 mm head

62 matched patients followed for 7–9 years

Uldis Kesteris, Thomas Ilchmann, Hans Wingstrand and Rolf Önnerfält

We measured radiographic polyethylene wear in patients with Scanhip® arthroplasty and no clinical or radiographic signs of loosening. The patients were divided into 2 groups according to head sizes. 32 patients (33 hips) had an implant with a 22 mm and 30 patients (34 hips) with a 32 mm head. They were followed for 7–9 years. The groups were matched for diagnosis, sex, weight, age, and time of follow-up. The mean linear wear with a 22 mm head was 1.1 mm and with a 32 mm head 1.5 mm (p 0.004), which corresponds to a yearly wear rate of 0.15 mm and 0.18 mm, respectively. The mean difference in volumetric wear was greater, 420 mm^3, as compared to 1239 mm^3.

Department of Orthopedics, Lund University Hospital, S-221 85 Lund, Sweden. Tel +46 46-171510. Fax -130732
Submitted 95-07-08. Accepted 95-12-03

One of the mechanical factors responsible for polyethylene wear and production of debris is the size of the prosthetic head. Radiographic polyethylene wear with 22 mm, 28 mm and 32 mm heads in different implants has been analyzed (Livermore et al. 1990, Callaghan et al. 1995), but there is no report about wear with the same femoral and acetabular component having different head sizes.

We studied the effect of the femoral head size on polyethylene wear in patients with the same type of cemented femoral stem.

Patients and methods

From December 1984 to March 1987, a total of 284 hips in 265 patients had a primary THR because of arthrosis using a cemented Scanhip®.

The Scanhip® (MitAB, Sweden) femoral component is a non-modular design made of CoCrMo alloy and available with two head diameters, 22 and 32 mm (Figure 1). The cup has no metal back and is made of machined UHWMP.

When our study started in September 1993, 70 patients had died. Among the remaining 214 hips in 195 patients (46 hips in 43 patients with the 22 mm femoral head) we selected 2 matched groups: group 22 with a femoral head diameter of 22 mm and group 32 with a 32 mm femoral head. The patients were matched for diagnosis, sex, weight, age, and time of follow-up, which was approximated to the nearest half-year (Table 1).

The same surgical approach and cementing technique were used in all cases: a posterolateral incision without trochanteric osteotomy, cleaning with pulsating lavage, plugging of the femoral canal, retrograde filling and pressurization of Palacos® bone cement with gentamicin. The size of the head was chosen according to the surgeon's own preference.

The clinical evaluation of the patients was performed by the standard system of terminology for reporting results recommended by AAOS, Hip Society and SICOT (Johnston et al. 1990). Included were only patients with no pain or slight, occasional pain

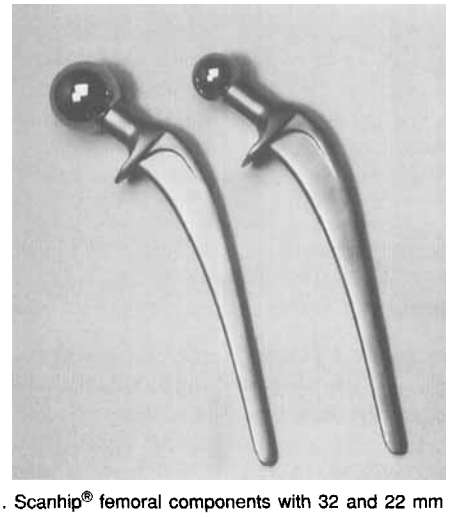

Figure 1. Scanhip® femoral components with 32 and 22 mm heads.

Table 1. Data on 62 patients operated on with a 22 or 32 mm prosthetic femoral head

Group	Pat n	Hips n	Age yr mean (range)	Sex F/M	Weight kg mean (range)	Follow-up yr mean (range)
22	32	33	59 (34–86)	23/9	70 (49–100)	7.5 (7–9)
32	30	34	61 (35–82)	20/10	73 (50–108)	8.0 (7–9)

Table 2. Linear and volumetric wear. Mean (range)

	22 mm head	32 mm head	P
Linear wear, mm	1.1 (0.1–2.1)	1.5 (0.4–3.4)	0.004
Linear wear rate, mm/yr	0.15 (0.01–0.31)	0.18 (0.05–0.37)	0.07
Volumetric wear, mm^3	420 (15–802)	1239 (329–2693)	0.0001
Volumetric wear rate, mm^3/yr	57 (2–117)	148 (41–299)	0.0001

but unaltered activity or work, normal walking ability and normal working capacity for their age. Radiographic criteria for inclusion included an absence of loosening of the components, according to Carlsson and Gentz (1984) and Harris et al. (1982). Migration of the cup was measured according to Nunn et al. (1989) and cases with significant migration—i.e., more than 3 mm—were excluded.

The wear of the polyethylene was measured according to Livermore et al. (1990). The most recent standard anteroposterior pelvic radiograph (taken on the same day as the clinical examination was performed) and the first postoperative radiograph were examined. All clinical examinations and radiographic measurements were made by one of the authors (UK). Each radiograph was measured twice to the nearest 0.05 mm, using a manual caliper. The measurements were corrected for magnification to obtain linear wear. Since acetabular wear is cylindrical (Charnley et al. 1969), the volume of wear can be calculated by the formula $v = \pi r^2 w$, in which v is volumetric wear, r is the radius of the femoral head and w is the linear wear. The angles of lateroversion and anteversion of the socket were also measured.

For statistical calculations, the Student's t-test was used.

Results

The mean linear wear in group 22 was lower (p 0.004) as also was the mean volumetric wear (p 0.0001). Moreover, the mean rate of linear wear was lower in group 22 (p 0.07) as also was the volumetric wear (p 0.0001) (Table 2).

The mean initial thickness of the cup was 11.5 (10–12) mm in group 22 and 7.8 (6–10)mm in group 32 (p 0.0001). The mean angle of lateroversion of the socket was 42° (22°–52°) in group 22 and 44° (25°–64°) in group 32; the mean angle of anteversion was 14° (1°–30°) and 12° (3°–30°), respectively.

Body weight, sex and age of the patients and position of the socket did not correlate with the amount of wear.

Discussion

Precise measurements are difficult to make on plain radiographs (Clarke et al. 1976). However, measurements according to Livermore et al. (1990) have a proven accuracy of 0.075–0.2 mm (Livermore et al. 1990, Bankston et al. 1994).

Our observations concerning the wear rate are in accordance with previously reported data of wear measured on radiographs (Table 3). There is, however, a difference between our study and that of Livermore et al. (1990); we used machined cups of the same fabrication and stems of the same design; Livermore et al. (1990) used compression molded cups and various stem designs. This makes the two studies not comparable and could explain why they found greater and we less linear wear with a 22 mm head. Theoretically one should expect greater linear wear with a 22 mm head, since the same load is carried by a smaller area. The factors which could be considered to affect wear of the polyethylene (body weight, age, sex, activity, time of observation, and position of the socket) were comparable in both our groups, except the initial thickness of the polyethylene which was greater in group 22. This could explain the lower linear wear in this group, since the thickness of the polyethylene implant correlates negatively with wear (Charnley et al. 1969, Bartel et al. 1986).

Table 3. Previously reported wear data and those in our series

	Head size (mm)	Linear wear rate (mm/yr)	Volumetric wear rate (mm^3/yr)
Charnley and Cupic 1973	22	0.12	–
Charnley and Halley 1975	22	0.15	–
Scheier and Sandel 1976	32	0.20	–
Griffith et al. 1978	22	0.07	–
Wroblewski 1985	22	0.21	–
Livermore et al. 1990	22	0.13	47.50
	32	0.10	84.10
Callaghan et al. 1995	22	0.12	48.36
Our series	22	0.15	57.00
	32	0.18	148.00

The volumetric wear in group 32 was approximately three times greater than in group 22 and twice as much as that reported by Livermore et al. (1990). The amount of wear debris is related to the volumetric wear. Polyethylene debris has been considered a cause of macrophage-induced resorption of bone at the cement-bone interface and consequently loosening of the implant (Howie 1990, Schmalzried et al. 1992, Maloney and Jasty 1993, Campbell 1995). If this is correct a greater incidence of loosening of prostheses with 32 mm heads than with 22 mm heads should be expected but there are only a few such reports (Ritter et al. 1983, Morrey and Ilstrup 1989).

The exact difference in volumetric wear and amount of wear particles cannot be calculated by simply measuring the thickness of the cup. Some reduction in the thickness is caused by plastic deformation of the polyethylene, and this deformation probably varies with the size of the head.

Acknowledgements

This study was supported by grants from Science and Technology Procordia AB, Lunds sjukvårdsdistrikt, Stiftelsen för bistånd åt vanföra i Skåne, Swedish Medical Research Council project 09509 and the Medical Faculty, Lund University.

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