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ORIGINAL PAPER

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Factors influencing the revision rate of Zweymueller acetabular cup

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Abstract Between January 1986 and December 1988, we implanted 220 conical-shaped Zweymueller threaded cups in 202 patients whose average age was 65 (33–83) years. The average thickness of the polyethylene (PE) insert was 8.0 (5.4–11.9) mm. In 142 cases, the corresponding femoral head was a 32 mm Al2O3 head. We followed 157 patients for a mean of 9.2 (1–16) years. Nine cups were revised and ten PE inserts replaced after an average of 11.9 (10–13.3) years. With cup revision alone considered as failure, the survival rate after 13 years was 89%. When both cup and insert revisions were considered failures, the survival rate decreased to 72% after 13 years. Patients younger than 60 years had a significantly higher rate of insert revision. Cup size 55 showed significantly more revisions in comparison to larger sizes. Using Cox regression model, neither gender, body mass index, nor material were risks factors leading to cup revision.

Résumé Entre janvier 1986 et décembre 1988 nous avons implanté 220 cupules acétabulaire coniques et filetées de Zweymueller chez 202 malades avec un âge moyen de 65 (33–83) années. L'épaisseur moyenne de l'insert de polyéthylène était 8.0 (5.4–11.9) mm. Dans 142 cas la tête fémorale correspondante était une tête de 32 mm en Al2O3. 157 malades ont été suivis pendant une moyenne de 9.2 (1–16) années. Neuf cupules ont été révisées et dix inserts de polyéthylène ont été remplacé après une moyenne de 11.9 (10–13.3) années. Avec la révision de la cupule seule considérée comme échec le taux de la survie après 13 années était 89% .Avec la révision de cupule et d'insert considérés comme échecs, le taux de la survie a diminué à 72% après 13 années. Les malades âgés de moins de 60 ans avaient un plus haut taux de révision de l'insert. Les cupule de 55 mm avaient plus de révisions que les cupules de plus grandes dimensions. En utilisant le modèle de Cox, ni le sexe, ni l'index de masse corporelle ni le matériau n'était des facteurs de risque menant à la révision de la cupule.

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Introduction

We studied a prospectively documented series of patients who had a Zweymueller threaded cup (AlloPro/Sulzer medica, Winterthur, Switzerland) implanted. The cup's

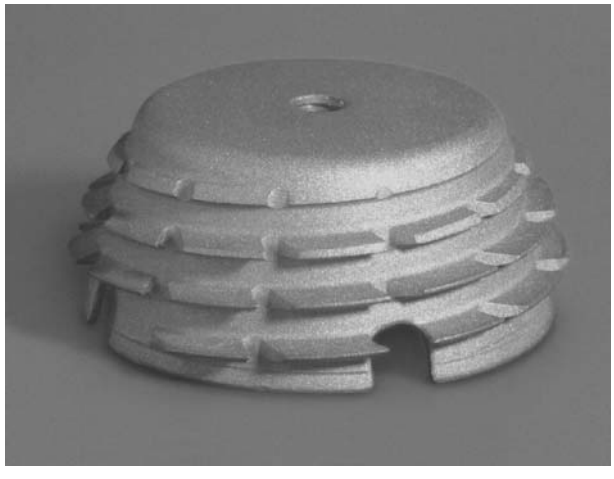

Fig. 1 Double threaded Zweymueller cup with corundum blasted surface

design is based on the Autophor cup, whereby material, thread design, surface structure and modularity were modified. Until 1988, the shell was made of pure titanium and had a conical shape with double V-cut threads. The cup has a small central bore hole at the pole. The surface is corundum-blasted with a roughness of 3–5 μm (Fig. 1).

The 1.6-mm thick titanium shell comes in seven sizes from 52 to 72 mm; the outer diameter is 9 mm smaller. The rim of cup has grooves to prevent polyethylene (PE) rotation. The PE insert (UHMWPE/Chirulen, Ruhrchemie, Oberhausen, Germany) is anchored by a snap lip near the equator.

Material and methods

From January 1986 to December 1988, we consecutively implanted 220 Zweymueller threaded cups in 202 patients. Average PE-insert thickness was 8.0 (5.4–11.9) mm. In 173 patients, primary osteoarthritis was the indication for arthroplasty. The femoral stem was uncemented in 184 patients. In 142 patients, ceramic femoral heads (Al2O3; Biolox, Ceramtec, formerly Feldmühle, Plochingen, Germany) were used; in 78 metal femoral heads were used (CoCrMo; Endocast, Krupp, Essen, Germany or Protasul, Sulzer, Winterthur, Switzerland). The outer diameter of all femoral heads was 32 mm.

All clinical and radiographic data was prospectively evaluated according to Harris [12] and DeLee and Charnley [4] and our own evaluation method [7]. Altogether, 157 patients with 172 hip replacements were clinically and radiologically followed-up for a mean of 9.2 (1–16) years. Two-dimensional linear wear was measured with the EBRA method [15] after an average of 7.3 (3.3–12.5) years.

Statistical analyses were based on the *t*-test and *U*-test for unpaired values, on Pearson (linear correlation), ANOVA, multiple linear regression, Kaplan and Meier [13], a Cox regression model, and on the chi-squared test and Fisher's exact test for nominal data. Results were significant at $p<0.05$.

Results

Deep-vein thrombosis occurred in four patients, hip dislocation in five, and in one patient heterotopic ossifications were removed surgically. Five uncemented femoral stems were replaced due to aseptic loosening. Nine cups were revised, and ten polyethylene inserts were replaced. Four cups showed symptoms of instability, and one suffered from severe polyethylene wear with osteolysis and fracture of the medial acetabular wall (Fig. 2). Two stable cups were replaced for technical reasons and two cups because of intraoperatively diagnosed polyethylene granuloma.

There were three cases of infection 1, 7, and 8 years after primary surgery. Up till now, ten polyethylene inserts were replaced after an average of 11.9 (10–13.3) years. The thickness of PE inserts did not influence the rate of revisions (chi-square test, $p=0.45$). There was no difference between inserts that were thicker or thinner than 6 mm ($p=0.63$). A Cox regression model showed that patient age at the time of surgery ($p<0.05$) was the only risk factor leading to insert revision.

Fig. 2 Osteolytic lesion superiorly on the cup and on the proximal femur 12 years postoperatively in zones I and VII caused by polyethylene (PE) wear, which also damaged the medial wall

The ratio of male to female patients in cases of total cup revision was 1:8. Age was not significant ($p=0.69$). Cup size 55 (outer diameter 46 mm) showed significantly more revisions in comparison to larger sizes ($p=0.029$). According to the Cox regression model, neither gender ($p=0.30$), body mass index ($p=0.67$), nor material ($p=0.16$) were risks factors leading to cup revision.

The average Harris score [14] was 74.9 (8–100) (SD: 19.3). This relatively low score was influenced by patient age and overall health. We found a significant decrease ($p<0.05$) in score values in comparison to age at follow-up, but no correlation between decreasing score values and the time span of follow-up examinations. Female patients had a slightly, but not significantly, lower score (73.6, SD: 19.5) than males (74.9, SD: 18.8; $p=0.31$). The score was 71.1 in patients over 80 years, (SD: 18.8, $n=46$) and 79.8 in patients less than 60 years (SD: 18.8; $n=14$).

The Kaplan and Meier analysis for survival [13] was limited to 13 years, at which point the number of cups "at risk" was less than 20 [6]. The survival rate after 10 years was 95% (95% confidence interval: 90.8–92.2%) and 89.7% after 13 years (CI: 81.3%–98.1%), whereby cup revision was defined as a failure. When both cup and insert revisions were considered failures, the survival rate decreased to 93.8% (88.9–98.5%) after 10 years and to 72.6% (59.2–84.8%) after 13 years (Fig. 3).

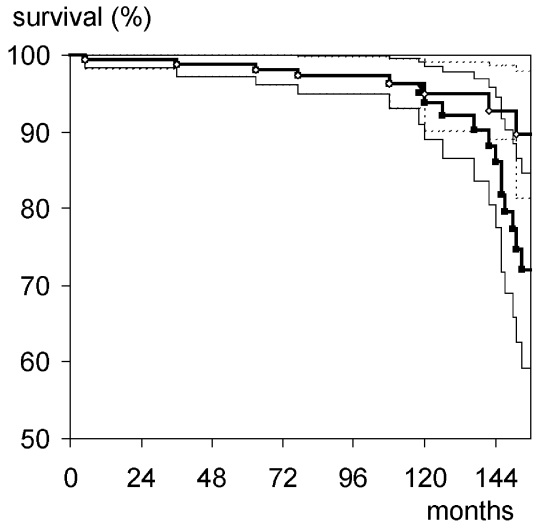

Fig. 3 Kaplan and Meier survivorship analysis. Survival rate was 89.7% (81.3–98.1%) after 13 years, whereby cup revision (n=9) was defined as a failure. Including insert revision (n=10), survival rate decreased to 72.6% (59.2–84.8%)

The linear wear in cases with ceramic femoral heads was 0.089 mm/year and with metallic heads 0.096 mm/year (p=0.58). There was no correlation between wear/year and patient age at the time of surgery (p>0.2 for each parameter).

According to variance analysis, wear/year was influenced significantly by gender (p<0.05) (men: 0.103 mm/year, women: 0.083 mm/year). Cup size, femoral head material, PE thickness, and the covariant's age, weight, and inclination, were not significant (p>0.20). According to EBRA [15], removed implants showed a highly significant (p<0.01) increase in wear (0.143 versus 0.084, p<0.01) in comparison to nonrevised implants. The longer in vivo periods were taken into account (92.9 versus 87.4 months).

The cups were implanted at an inclination angle of 44.8° on average (29–63°). There was partial acetabular contact in zones I and II in 89.1%. Larger atrophic gaps of up to 10 mm occurred in zone II. Free threads were observed in 14 cases with no clinical symptoms. Seven cups had stable superior osteophytic anchorage throughout the follow-up period. The very conical shape and height of the cup caused perforation of the medial wall in six cases. Osseointegration type 0 was observed in 91.4%, type 1 in 7.8%, and type 2 in 0.8% (Figs. 4a,b,c). PE wear led to femoral osteolysis in 5.9%.

Discussion

The first generation of threaded cups was not widely used because of poor performance. However, the second generation showed higher survival rates, as many publications report. Ten-year survival rates of 93.4% [11] and 99.4% [3] and 12-year survival rates of 97% [10] were found for Zweymueller threaded cups.

Garcia-Cimbrelo et al. [10] reported an average polyethylene wear rate of 0.08 mm/year for 28 mm femoral heads, whereby 0.2 mm polyethylene wear in 32 mm femoral heads was significantly higher. Grübel et al. [11] using 32 mm femoral heads found a total of 0.1 mm wear/year. Like Crowther and Lachiewicz [2], we found no significant correlation between body weight and wear.

Devane and Horne [5] claimed that thin PE inserts showed an increased polyethylene wear. However, Elfick et al. [8] found no such correlation between PE thickness and wear. This is consistent with that of Crowther and Lachiewicz [2] and with our own studies. Delaunay and Kapandji [3] found 2% osteolysis, and Epinette 4.6% [9]. Astion et al. [1] found higher rates of osteolysis with thin PE inserts and with 32 mm femoral heads.

The findings of Crowther and Lachiewicz [2] showed no correlation between wear rate and male gender, which is inconsistent with our results. Using variance analysis, we found a significantly (p<0.05) higher wear rate/year for men.

Kennedy et al. [14] reported a positive correlation between cup inclination angle and wear. In contrast, our data and those of Crowther and Lachiewicz [2] showed the cup inclination angle to be without influence on wear, cup migration, or insert revision. Our data showed an increase in cup loosening when smaller cups were used. However, this was not seen in cases where only the insert was replaced.

We found that revisions of the PE inserts were necessary after an average of 11.5 years. In older patients, however, revision may not be necessary either because of

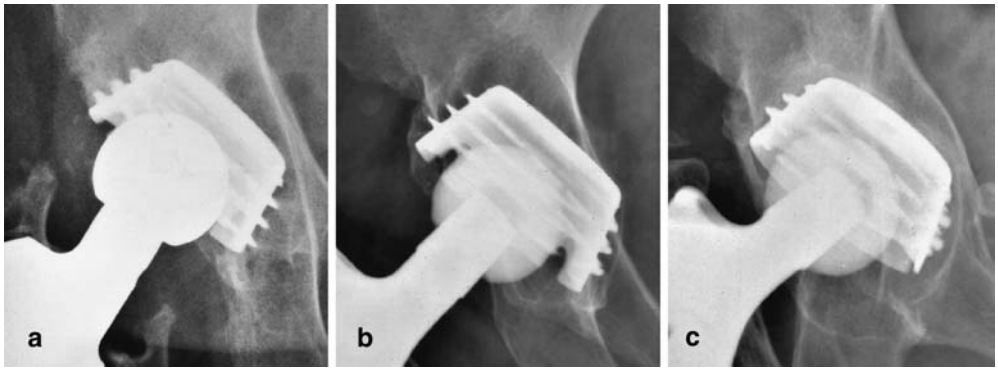

Fig. 4a–c Osseointegration type 0 without any radiolucency (**a**), type 1 with radiolucency in zone III—one zone (**b**), type 2 with radiolucency in zones I and III—two zones (**c**)

decreased physical activity or because the patients do not survive that long. We found that many of our patients with insert revisions were quite young. This may indicate that hard-hard pairings with either metal-metal or ceramic-ceramic and/or cross-linked PE inserts should be implanted in patients under age 60. In concurrence with other studies, patient age and small cup size appear to be risk factors for early insert revision.

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