Survival of Cementless and Cemented Porous-coated Anatomic Knee Replacements: Retrospective Cohort Study

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Aim. To evaluate the effect of cement use in porous-coated anatomic (PCA) total knee prosthesis on its survival.

Methods. The study was a retrospective analysis of 142 PCA total condylar arthroplasties performed in 124 patients from 1985 to 1991. Uncemented prosthesis was used in 87 knees, the prosthesis was cemented in 44 knees, and hybrid prosthesis components were used in 11 knees. The average follow-up time was 88 months (range 66-140). The survival of the prosthesis was assessed using the Kaplan-Meier's method. The Baltimore score was evaluated as a measure of clinical performance in 115 replacements.

Results. The overall cumulative survival rate of the PCA total knee prosthesis was 77% at an average follow-up time of 88 months. No significant differences in survival rates could be demonstrated among cementless, cemented, or hybrid fixations. The survival rate of the prosthesis in patients with rheumatoid arthritis (82.5%) was significantly higher than in patients with osteoarthritis (73.8%). Revision was necessary in 29 (20.4%) replacements.

Conclusion. The survival of PCA endoprosthesis, regardless of the components used for implantation, is not satisfactory.

Key words: arthritis, rheumatoid; arthroplasty, replacement, knee; knee prosthesis; knee replacement, total; osteoarthritis; prosthesis implantation

Implantation of porous-coated anatomic total knee prosthesis (PCA) without cement use was developed by Hungerford et al (1). It is a minimally constrained surface replacement, fixation of which depends on the ingrowth of bone into the porous coating. Fixation surfaces of PCA endoprosthesis components are covered with a double layer of sintered chrome cobalt beads, giving an average pore size of 425 μm, with 35% porosity (1). PCA prosthesis has been designed to simulate the anatomic form and kinematics of the normal knee (1). The same prosthesis was used as cemented replacement or as a hybrid model in which the tibial but not the femoral component was cemented (1). The early results of PCA prostheses without cement were comparable to those of cemented condylar knee prostheses (1,2).

The reported cumulative rate of survival of the uncemented PCA knee replacement is 84% at five years and 77% at six years (3). However, only a few studies compared the results of uncemented and cemented PCA implants (4,5). In one of them, 18 matched pairs of PCA knee prostheses were studied to compare clinical and functional performance of cemented versus uncemented fixation, with an average five-year follow-up period (4). No significant differences were found between knee prostheses with or without cement fixation. The other study also showed no significant difference between the quality of the clinical results in the group of 78 cemented and 48 cementless PCA prostheses (5). The aim of our study was to investigate clinical and survival characteristics of the PCA knee replacement inserted without cement compared to cemented prosthesis of the same type or to prostheses with hybrid fixation methods.

Patients and Methods

Between June 1985 and August 1991, porous coated anatomic knee prosthesis (PCA, Howmedica, Rutherford, NJ, USA) was used for 142 primary total knee arthroplasties in 124 patients at the Department of Orthopedic Surgery, Zagreb University School of Medicine. There were 27 men and 97 women with a median age of 61 years (range 20-81 years). Nineteen patients were under the age of fifty. The primary diagnosis was osteoarthritis in 97 knees (median age 65 years; range 41-80 years) and rheumatoid arthritis in 45 knees (median age 54 years; range 20-71 years). Uncemented prosthesis was implanted in 87 knees (median age 57 years; range 20-71

years), cemented prosthesis in 44 knees (median age 62 years; range 41-80 years) and hybrid components in 11 (median age 61 years; range 35-67 years). The choice of cementless, cemented, or hybrid endoprosthesis was made during the surgical procedure and was based on a number of factors, mostly on the quality of bone and possibility of obtaining ideal press-fit implantation of the prosthesis. There were no significant differences in age, sex, and primary diagnosis between the cemented and cementless groups (p=0.11; one way analysis of variance). On the basis of standardized preoperative and postoperative assessment, including radiographs in standing position, Baltimore knee score (6) was calculated for 115 replacements. Baltimore knee score is a clinical score with a maximum of 100 points: condition with no pain brings 50 points, full range of motion 20 points, normal stability 10 points, maximum power of quadriceps 10 points, and normal alignment also 10 points (6).

A standard surgical technique was employed, using Universal-II instrumentation (Howmedica). Three sizes of right and left tibial, patellar, and femoral implants were available. The femoral component was asymmetric, with divergent medial and lateral condyles and medial and lateral 16-mm fixation studs. The tibial component consisted of high-density polyethylene tibial plateau and metal back with two 16-mm studs for stability (1). We used a 6.5-mm cancellous bone screw for supplementary anterior fixation. The patellar component was also metal-backed with medial and lateral studs and polyethylene articulating surfaces. This was the only design available at the time of the study. The patella was not resurfaced in 13 knees. After the operation, the knee rested in a gutter splint for 48 hours, after which mobilization was initiated. Patients were allowed to put partial body weight on the operated leg using crutches. For a cemented prosthesis, full body weight load was allowed 8 weeks after the operation, and for an uncemented prosthesis 12 weeks after the operation.

The median duration of the follow-up was 88 months (range 66-140). Fourteen patients (18 knees), none with the evidence of implant failure, died during this period. Eight patients (9 knees) were lost to follow-up. Among the 115 knee prostheses assessed, 73 were implanted without cement, 34 with cement, and 8 hybrid. The survival was assessed by Kaplan-Meier analysis, with revision as the end point (7-9).

Results

Before surgery, the Baltimore knee score averaged 35 points (range 0-50). There was no significant difference between the mean score ($\pm$SD) for the patients with rheumatoid arthritis (33 ± 10) and those with osteoarthritis (36 ± 11). There was no significant difference between the average score for those who had a cemented prosthesis (35 ± 10) and those with an uncemented implant (34 ± 10, p=0.70; Kruskal-Wallis test). When prosthesis was implanted, the average Baltimore knee score was 69 ± 25 points for the entire group, 72 ± 26 with the uncemented knee replacement, 68 ± 24 for cementless prosthesis, and 69 ± 25 for the prostheses with hybrid fixation. There were no significant differences among the three groups (p=0.60, Kruskal-Wallis test). The average postoperative Baltimore knee score was 66 ± 25 points for the patients who had osteoarthritis and 75 ± 23 points for those with rheumatoid arthritis. The difference between the two groups was not statistically significant (p=0.06, Mann-Whitney U-test).

Survival analysis, with the time of revision as the end-point, revealed cumulative 88% survival for the whole group at five years, 77% at an average follow-up time of 88 (range 66-140) months, and 67% at ten years (Fig. 1). No significant difference in the survival rate could be demonstrated among cemented, uncemented, or hybrid prostheses (Fig. 2). At an average of 88 (range 66-140) months, the rate of prosthesis survival was 86% in patients with rheumatoid arthritis and 74% in patients with osteoarthritis (Fig. 3; p=0.038, Cox-Mantel test).

Revision was indicated in 29 knees (20.4%). The primary lesion was osteoarthritis in 23 and rheumatoid arthritis in 6 knees. Cementless prostheses were revised in 20 knees, cemented in 7, and hybrid in 2 knees. No significant differences could be demonstrated among the patients with different primary diagnosis (chi-square test; p=0.26) or method of fixation (chi-square test; p=0.77).

Five prostheses (3.5%) were revised because of late infection. On average, revision was carried out 46 months (range 10-99 months) after the first knee replacement. The primary diagnosis for all patients with infection was osteoarthritis; 3 prostheses were uncemented, 1 cemented, and 1 had a hybrid fixation. In 2 patients, a two-stage exchange procedure was carried out, and 3 knees were fused.
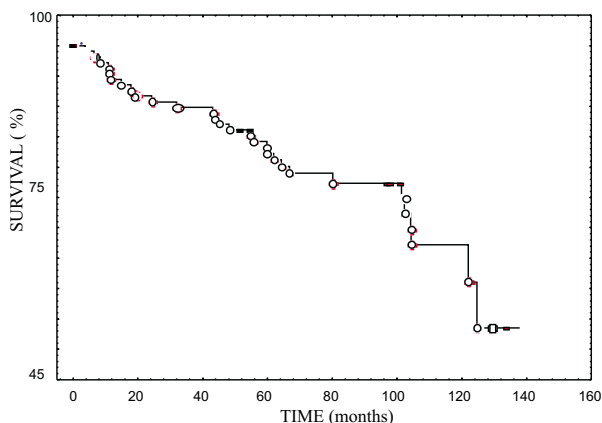
Figure 1. Total survival rate (%) of PCA knee prosthesis with revision as the end point.
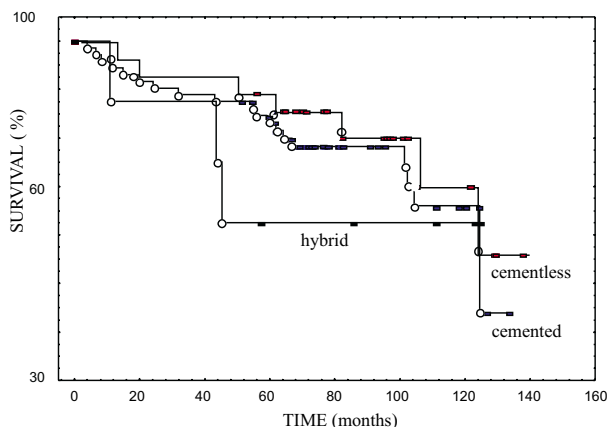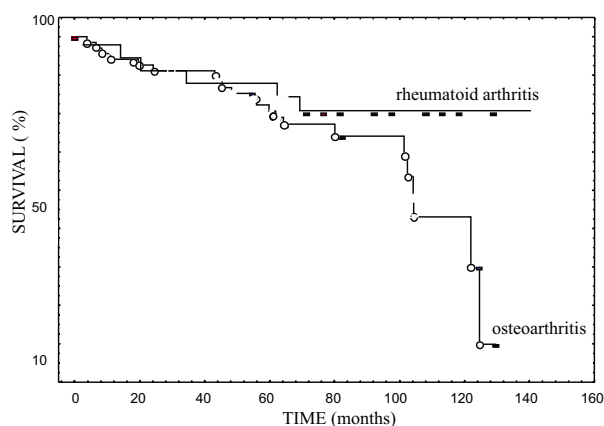

Figure 2. Survival rate (%) of PCA knee prosthesis with different fixation techniques.

Revision was required for aseptic failure of the tibial component in 13 knees (9.6%). In 2 cemented prostheses, the tibial component was stable but wear of the polyethylene had occurred in the anteromedial part of the implant. Exchange of this component was undertaken at 79 and 101 months after the primary procedure, respectively. In the other 11 knees, the revision was required because of the loosening of the tibial component; 8 of the prostheses were uncemented and 3 cemented, 9 with a primary diagnosis of osteoarthritis and 2 with a rheumatoid disease. In a single case, a fracture of the polyethylene component and the metal tibial tray occurred (Fig. 4). On average, the revision was carried out at 62 months (range 18-103 months) after the initial replacement. The most common mechanism of failure was the collapse of the anteromedial aspect of the tibial plateau, resulting in increasing varus deformity to an average of 13° in 10 knees and in valgus deformity of 10° in one knee. The tibial components were replaced with a cemented porous-coated implant with a central steam. In 5 knees (3.5%) there was a loosening of both tibial and femoral components. All were uncemented, 4 with rheumatoid arthritis and 1 with osteoarthritis. They were treated by revision arthroplasty procedure using a constrained prosthesis (Sant Georg model) in 3 cases and Lubinus model in 2 cases.

Patellar complications were the reason for revision in 5 patients. There were 2 dislocations, 1 subluxation, 1 fracture, and 1 loosening of a component. In a single patient, resection of the adhesions causing stiffness was needed three months after the primary procedure.

Discussion

In the beginning of PCA total knee joint arthroplasty, the major advantage of the procedure was proclaimed to be the possibility of various methods of fixation, including cementless fixation. The preliminary results of the PCA models were satisfactory, but five years after implantation, according to both the Newcastle study (3) and our own experience, the results were far from satisfactory. In the Newcastle study, survival rate was 84% for the first five years, 77% for the first six years, and less than 50% for the ten years (3). Our results are very similar and contrast the recent reports of 90% survival rate at ten years of cemented endoprostheses of the following types: Insall-Burstein type I and II (10), total knee arthroplasty with PFC system (11), and kinematic condylar total

Figure 3. Survival rate (%) of PCA knee prosthesis in patients with different primary diagnoses.

Figure 4. Fracture of the polyethylene component and metal tibial tray in a female patient, with a collapse of the anteromedial aspect of the tibial plateau and resulting increase in the varus deformity of the knee. A, anteroposterior x-ray; B, latero-lateral x-ray.

knee (12). It is difficult to explain why poor results are achieved with the PCA endoprosthesis, either cemented or cementless. The major cause of revision in our series, as well as in the Newcastle study, were complications involving the tibial component of the endoprosthesis instability and wear on the polyethylene plateau (6). Histological studies of revisioned PCA endoprostheses or autopsy material showed that in most cases there was a growth of the fibrous tissue but no ingrowth of bone into the porous tibial component (13-15). A possible explanation could be that the tibial component did not provide sufficient primary stability, an assumption which has been confirmed by laboratory experiments in which the primary stability of the tibial components of several types of cementless endoprostheses were compared (16). Clinical studies, assisted with radiological stereophotogrametric analysis, have shown that the distal and medial migration of the tibial component of the PCA endoprosthesis with lateral extension was more pronounced than in other models (17,18). Caudomedial migration of the tibial component, in combination with the wear on the medial polyethylene component, may lead to the development of the varus knee. In 11 of our endoprostheses that were subjected to revision because of the instability of the tibial component, with concomitant wear of the polyethylene plateau, varus of the knee was present in 10 cases. Howmedica has developed another model of PCA endoprosthesis with an intramedullary central tibial steam. Clinical results achieved with this model are far superior to those achieved with the model with lateral extension (19). Other factors include the use of too thin polyethylene tibial plateaus and inadequate size of tibial component.

A problem of fixation in knee replacement is not definitively solved. Several studies compared the use of endoprostheses of the knee joint with bone cement and cementless endoprostheses (20-24). In our study, there was no difference in the Baltimore score and survival among cementless, cemented, and hybrid PCA endoprostheses.

Also several studies analyzed the replacement of knee joint in patients with rheumatoid arthritis, with various results (25-28). In our series, patients with rheumatoid arthritis had a longer survival of the PCA endoprostheses and higher Baltimore score than patients with osteoarthritis, regardless of the type of components' fixation. The longer survival of the PCA endoprostheses in patients with rheumatoid arthritis can be attributed to their reduced physical activity.

In conclusion, our study shows that the success of the operation, as well as the usefulness of an endoprostheses, can be judged only after a long clinical follow-up period. Results achieved by using the PCA endoprosthesis, regardless of the way in which it was implanted and whether it was cemented, cementless or hybrid, are not satisfactory. We suggest that poor results with use of the PCA endoprosthesis are due to inadequate construction of the tibial component. It seems that the design of endoprosthesis is more important than the way of fixation.

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New Internet Database "Human P450 Metabolism" at http://genst.com

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"Human P450 Metabolism" is a free, web-searchable database which collects information on human cytochrome P450 metabolism. Information is organized by enzyme, therapeutic area, chemical substance, reaction, and type (substrate, inhibitor, activator, or inducer). The database was created by Professor Slobodan Rendić from the Zagreb University Faculty of Pharmacy and Biochemistry, Croatia. A related publication can be found in Drug Metabolism Reviews 1997;29(1,2):413-580 (Rendić S, Di Carlo F. Human cytochrome P450 enzymes: a status report summarizing their reactions, substrates, inducers, and inhibitors).

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