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Comparison of an Uncemented Tapered Stem Design in Cobalt-Chrome vs Titanium at 15-Year Follow-Up

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ABSTRACT

Background: Cobalt-chromium (Co-Cr) and titanium (Ti) have been the most popular materials employed for cementless implants. The purpose of this study was to compare clinical and radiological results of a single stem design with both alloys at long-term follow-up.
Methods: Two hundred consecutive uncemented stems implanted in 171 patients (100 Co-Cr and 100 Ti implants) between 1999 and 2002 were studied. Mean age of the patients was 60.9 years (range, 20-84). Clinical results were evaluated using the Harris hip score. The presence of thigh pain was also analyzed. Stem fixation was graded according to Engh criteria. Radiolucent lines, osteolysis, and stem subsidence were also analyzed.
Results: At 15-year follow-up, no stems had been revised. Both groups showed similar clinical results with mean Harris hip score of 93.4 (Co-Cr) vs 93.9 (Ti). There was no difference in the rate of thigh pain (11 vs 8.3, respectively, $P = .507$). Radiolucent lines were more frequent in the Co-Cr group (63.6% vs 35.6%, $P < .001$).
Conclusion: Ti stems showed better osteointegration than Co-Cr stems, with a significantly lower incidence of radiolucent lines. However, this did not affect the clinical results or the appearance of thigh pain.

Uncemented fixation became more widely used in an effort to improve implant survivorship following hip arthroplasty among younger patients [1,2]. Bone fixation is dependent upon stem design, surface texture, and the biomaterials used [3,4]. Early designs yielded a number of problems such as stress shielding, thigh pain, and the appearance of distal osteolysis that compromised clinical and radiological results [5–9].

Proximal circumferential porous-coated implants tried to avoid these phenomena [7–10]. Tapered designs with a more physiological load transfer presented less proximal femur osteopenia and reduced distal cortical hypertrophy [11–13].

The majority of uncemented stems are forged on cobalt-chromium (Co-Cr) or titanium (Ti) alloys. Ti presents a reduced modulus of elasticity and should provide a more favorable load transmission with better clinical and radiological results. However, to our knowledge, there are no previous studies comparing a single stem design manufactured with both alloys and long-term follow-up.

The purpose of our study was to compare the clinical and radiological results of a single stem design and 2 different alloys and to evaluate whether such differences might affect the long-term survivorship of these prostheses.

Patients and Methods

We prospectively studied 200 consecutive uncemented prostheses implanted in 171 patients (89 men and 82 women) between March 1999 and December 2002. The study was approved by the Ethics Committee of our institution. The mean age at the time of surgery was 60.9 years (range, 20-84), together with a mean body mass index of 27.3 (range, 17.3-44.4). Every patient received the same stem design (Meridian [Stryker, Rutherford, NJ]). The Meridian stem is a tapered design that includes a

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proximal circumferential porous coating (plasma spray without hydroxyapatite) with a neck angle of 132° and a pore size of 357 μm. The distal stem is polished and all stems over 12 mm have a distal split groove to reduce stiffness. Two different alloys were employed (Vitallium [Co-Cr-vanadium] and Ti). All stems supplied after March 2001 were of the Ti variety. This change was brought about for commercial reasons by the manufacturing company. Implantation of a Meridian stem in our hospital during the study period was an inclusion criterion. The underlying diagnosis was primary osteoarthritis in 161 hips (80.5%), avascular necrosis in 18 cases (9%), developmental dysplasia in 8 cases (4%), rheumatoid arthritis in 5 cases (2.5%), posttraumatic arthritis in 4 cases (2%), 2 cases of spondylitis (1%), 1 case of slipped capital femoral epiphysis, and a single case of psoriatic arthritis. Oral and written informed consent had been obtained from every patient before surgery. A minimum clinical and radiological follow-up of 10 years was required. Fifty-three patients were either lost to follow-up (26 hips [13%]) or died from causes unrelated to the operation (29 hips [14.5%]).

Two different acetabular components were used: Vitalock (Stryker, Rutherford, NJ) in 171 hips when a metal-on-polyethylene weight-bearing surface was used and Trident (Stryker, Rutherford, NJ) in 29 hips when the bearing surface was ceramic-on-ceramic. Screws were used in 121 (61.4%) hips.

Surgical Procedure

All the prostheses were carried out using a lateral Hardinge approach in lateral decubitus under spinal anesthesia [14]. Thromboprophylaxis with low-molecular-weight heparin was prescribed for 4 weeks. All patients received perioperative antibiotics with a second-generation cephalosporin (or vancomycin in the event of allergy) for 48 hours until the drains were removed. Partial weight-bearing on crutches was allowed, in all cases, the second day after surgery. Patients were discharged from hospital between the 7th and 12th postoperative day and continued with partial weight-bearing for 6-8 weeks after the index procedure.

Clinical and Radiological Analysis

Clinical evaluation using the Harris hip score was performed preoperatively, at 3 months, 6 months, and annually thereafter [15]. Extensive questioning about pain and its location was carried out with regard to thigh pain and its relation to the femoral component [16].

Standard anteroposterior and lateral radiographs of the pelvis and the operated femur were taken immediately after the operation and at 3, 6, and 12 months, and annually thereafter. All the radiographs were analyzed by a single observer (RFF). Variations in magnification were corrected using the known diameter of the femoral head as an internal reference. Canal fill index (CFI) was measured as the ratio of the stem and femoral width at the level and 20 mm below the lesser trochanter.

The femur was divided into the 7 Gruen zones in order to assess for the presence of radiolucent lines in the different zones [17]. Radiolucent lines affecting the porous or the polished part of the stem were categorized. For bone remodeling and stress shielding, we employed Engh's criteria [18]. Stem fixation was graded as bone ingrowth, stable fibrous or unstable, according to criteria described by Engh et al [19]. Migration was assessed by measuring the vertical subsidence of the femoral component according to the method of Callaghan et al [20]. We also assessed for the presence of osteolysis and the appearance of heterotopic ossification [21]. Intraoperative and postoperative complications were also recorded.

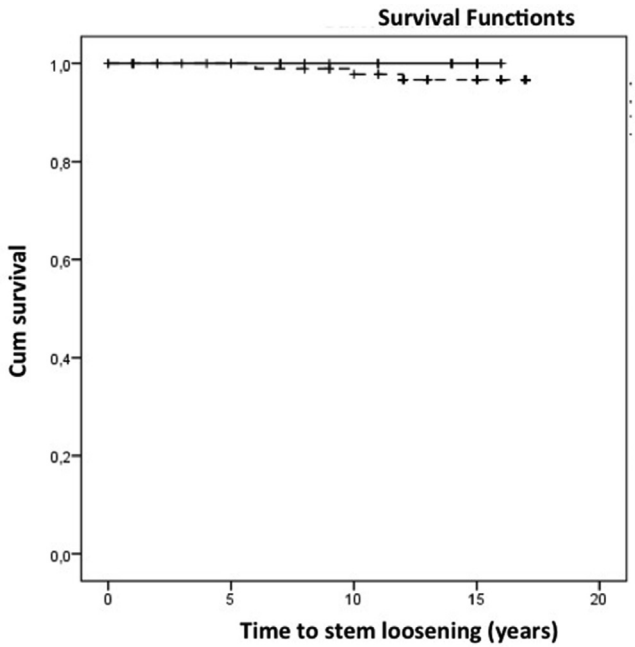

Fig. 1. Kaplan-Meier curves for aseptic loosening of the femoral component in the Co-Cr and Ti groups.

Survival Analysis

Time to failure was recorded with Kaplan-Meier survival analysis. This was performed using aseptic loosening of any component or revision of any component as end points and allowed for the calculation of asymmetrical 95% confidence intervals. Cases were censored at their last clinical and radiographical evaluation or date of death if the implant was doing well at that time. Kaplan-Meier curves for loosening or stem revision were also calculated. Statistical analysis was performed to compare patient demographics, as well as the preoperative and postoperative radiographic data of the Co-Cr and Ti stems. Differences in quantitative radiographic values between both groups were compared using the Student *t*-test. Categorical variables were analyzed using the chi-square test of independence or the Fisher exact test. All statistical analyses were performed using SPSS for Windows. Significance was set at $P < .05$.

Results

At 10-year follow-up, 174 hips in 148 patients were available for review (88 Co-Cr, 86 Ti). At 15 years, there were 145 hips (69 Co-Cr, 76 Ti). No femoral component had required revision for aseptic loosening. Three Co-Cr stems showed signs of aseptic loosening (1.6%), but had not been revised (Fig. 1). Ten acetabular components (5%) required revision, 9 for aseptic loosening and 1 for instability (0.5%).

Mean Harris hip scores improved from 26 points (range, 12-68) to 93.4 (range, 57-100) in the Co-Cr group and to 93.9 (range, 64-100) in the Ti group at last follow-up ($P < .005$). No pain was reported in 177 (90.3%) stems, slight occasional to mild pain was reported in 15 (7.7%) hips, and mild pain with activities was reported in 3 cases (1.5%), with a single case of marked disabling pain (one of the loose stems). Overall, there was a 9% incidence of thigh pain; 11% among Co-Cr stems and 8.3% in the Ti stems ($P = .507$) (Table 1).