Pre-coated femoral components in hybrid total hip arthroplasty
RESULTS AT 11 YEARS

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We present the medium-term results of hybrid total hip arthroplasties using pre-coated stems with a second-generation cementing technique. The 128 hips in 111 patients (18 men and 93 women) were followed up at a mean of 11 years after surgery. The mean age at the time of surgery was 61 years. Both components of one hip were removed at ten months after surgery for infection. None of the other 127 femoral components showed possible, probable, or definite loosening at the most recent follow-up. Five acetabular components were revised for aseptic loosening, recurrent dislocation, or displacement of the polyethylene liner from the metal shell. The mean Harris hip score at follow-up was 84 points. A pre-coated femoral component with a second-generation cementing technique provides good clinical function and survival in the medium term.

A variety of surface finishes to the femoral component is available for cemented total hip arthroplasty (THA). Debonding of the femoral component from the cement has been reported to be the most common early cause of aseptic loosening of a cemented stem.1-3 Pre-coating, or roughening, of the surface of a cemented stem has been shown to enhance the bonding of the cement to the prosthesis and decrease the prosthesis-cement interface stresses.1,4,5 Although laboratory studies and finite element analyses have confirmed these theories, many clinical reports have shown a high failure rate of pre-coated femoral components.6-11 Stem geometries, rasping and cementing techniques, cement mantles and patient populations might also be considered as contributory factors for this.1,5,7,12-17

There is still controversy as to whether the use of a pre-coated or matt-finished stem results in a higher risk of failure. We, therefore, investigated the medium-term results of a primary hybrid total THA with a collared, matt-finished, pre-coated femoral component, fixed with second-generation cementing technique.

Materials and Methods
Between March 1987 and October 1996, 163 consecutive primary hybrid THAs were performed in 145 patients. Twenty patients (21 hips) died with less than seven years of follow-up. Six patients (six hips) became bedridden and were too ill to return for their follow-up examination. Eight patients (eight hips) were lost to follow-up. Although each of these 35 arthroplasties was well-fixed at their last follow-up, these patients were excluded from the study. The remaining 128 hips in 111 patients were available for clinical and radiological review. The mean length of follow-up was 11.0 years (7.0 to 16.5), the mean age at surgery was 61 years (16 to 84) and the mean weight of patients was 58 kg (41 to 95). There were 18 men and 93 women and 62 right and 66 left hips. The pre-operative diagnoses were hip dysplasia (91 hips), primary osteoarthritis (three), rheumatoid arthritis (12), avascular necrosis of the femoral head (ten), acetabular or femoral neck fracture (six) and post-traumatic osteoarthritis (six). During the same period, we also undertook cementless THA in patients under the age of 55 years who had good femoral cortical bone quality.

All procedures were performed by the senior author (TM) through a posterolateral approach without trochanteric osteotomy. Capsulectomy was performed as part of the operation. A Harris Precoat, Precoat Plus, or CDH Precoat stem (Zimmer, Warsaw, Indiana) was used. A CDH stem was used in 8 hips, a small stem in 13, a small plus stem in 51, a medium stem in 45, a large stem in 9, a large plus stem in one, and an extra-large stem in one. A medium neck was used in 71 hips, a medium plus neck in 31, and a long neck in 26.

We used a so-called second-generation cementing technique with Simplex cement (Howmedica, Rutherford, New Jersey) which was
retrogradely inserted with a cement gun. We inserted a methylmethacrylate plug in all but ten hips. A plug was not used in the first four hips, and for six subsequent hips in which a CDH Precoat stem was inserted, as the femoral canal was too narrow. We did not use vacuum-mixing, centrifugation, proximal cement pressurisers, or stem centralisers.

A titanium, hemispherical, Harris-Galante porous-coated -1 or -2 (HGP) acetabular component (Zimmer, Warsaw, Indiana) was used for all hips. Structural bone grafting was performed in order to augment bone stock in 15 dysplastic hips. The acetabular bed was prepared with hemispherical reamers and a mean of 3.7 screws (2 to 6) was used for supplementary fixation. The mean outer diameter of the acetabular component was 51.5 mm (40 to 64) and the mean thickness of the polyethylene liner was 9.0 mm (3.3 to 15.3). The diameter of the prosthetic femoral head was 22 mm in all hips.

Clinical assessments were made with a Harris hip score.18 Anteroposterior and true lateral radiographs were taken pre-operatively and at each follow-up examination. Pre-operative, immediate post-operative and all intermediate radiographs, as well as those obtained at the latest follow-up visit were analysed by orthopaedic surgeons who had not participated in the primary procedure.

Cementation of the femoral stem was classified as grade A, B, C-1, C-2, or D according to the method described by Mulroy et al.15 Femoral osteolysis was defined as areas of endosteal, intracortical, or cancellous bone loss which were either scalloped or had the appearance of bone destruction rather than disuse osteopenia. A linear radiolucent zone more than 2 mm in width was considered to be osteolysis. The dimensions and location of radiolucent lines and osteolytic lesions at the bone-cement interface of the femoral component were recorded according to the zones of Gruen, McNeice and Amstutz.19 Loosening of the femoral component was defined with the use of criteria described by Harris, McCarthy and O’Neill.20 Definite loosening was defined as migration of the component or the cement mantle, bending or breakage of the stem, or cement fracture. Debonding of the cement-metal interface, as demonstrated by a radiolucent line of any width at this interface, was considered to indicate stem subsidence and classified as loose.

The acetabular interface on the anteroposterior radiograph was divided into three zones as described by DeLee and Charnley.21 The acetabular component was classified as migrated if there was a change of at least 4 mm in either the horizontal or vertical position of its centre when compared with the immediate post-operative anteroposterior radiographs.22 The linear penetration of the head into the polyethylene liner was measured using the technique described by Livermore, Ilstrup and Morrey.23

A Kaplan-Meier survivorship analysis was performed in order to calculate the probability of retention of the original prosthesis. StatView software was used for this analysis (StatView; SAS Institute Inc, Cary, North Carolina).

Results
At the time of the most recent follow-up, revision had been performed in six hips (six patients). The acetabular and femoral components of one hip with a post-operative infection were removed ten months after the index procedure. No femoral component was revised for aseptic loosening. Five other acetabular components were revised; one for aseptic loosening, two for recurrent dislocation, and two for displacement of the polyethylene liner from the metal shell. The Kaplan-Meier survivorship analysis, with failure defined as revision surgery, demonstrated that the probabil-
ity of retention of the femoral component 15 years after surgery was 99% (95% confidence interval (CI) 0.98 to 1.0) and that of the acetabular component 15 years after surgery was 95% (95% CI 0.93 to 0.97).

The Harris hip score increased from a pre-operative mean of 44 points (24 to 76) to 84 points (42 to 100) at the most recent follow-up.

One femoral component was revised because of infection. None of the other 127 femoral components showed possible, probable, or definite loosening at the most recent follow-up. The initial position of the femoral component was neutral in 77 hips, valgus in 46, and varus in five. The cementation of the femoral component was grade A in five hips, grade B in 32, grade C-1 in 44, grade C-2 in 45, and grade D in two (Fig. 1). Radiolucent lines, all of which were proximal (zones 1 to 7), were observed around 26 (20%) of 127 femoral components. Radiolucent lines were shown only in zone 1 in 20 hips. No femur showed radiolucent lines other than in zones 1 and/or 7. Four (3%) hips showed focal osteolysis in these zones.

Six acetabular components were revised and six of 15 structural grafts collapsed within five years of surgery. However, serial radiographs did not show any progression of collapse thereafter and there were no continuous radiolucent lines at the most recent follow-up. The mean post-operative acetabular angle of the 128 acetabular components was 45° (25 to 63) at the latest follow-up. For the 122 acetabular components which were not revised, radiolucent lines were observed around 19 (16%). These lines were all 1 mm wide or less, and in either zone 1 (nine hips), zone 2 (ten hips) or zone 3 (eight hips). No socket showed a continuous radiolucent line. Pelvic osteolytic lesions were seen immediately adjacent to the acetabular component in four (3%) hips. The mean rate of head penetration into the polyethylene liner was 0.09 mm (0 to 0.29) per year.

Fourteen hips dislocated posteriorly. Two underwent revision of the acetabular component for recurrent dislocation. One patient had a mild sciatic nerve palsy which had largely resolved within 18 months. There were no clinically-evident pulmonary emboli.

Discussion
The best surface finish for a cemented femoral component has been controversial. Clohisy and Harris24 reported that only one of 100 pre-coated femoral components had been revised because of aseptic loosening after a mean follow-up of 120 months. Similar results with pre-coated femoral components, albeit after shorter follow-ups, have been reported by Berger et al,25 Goldberg et al,26 and Oishi, Walker and Colwell.27 Lachiewicz and Messick12 reported that two of 75 pre-coated stems, secured with third-generation cementing techniques, were revised for aseptic loosening after a mean follow-up of ten years and that the prevalence of femoral osteolysis was 4%. Sanchez-Sotelo et al16 reported that the 15-year survival rate of 256 total hip arthroplasties, using a matt-finished stem and second-generation cementing techniques, was 92.2% for revision surgery and 90.1% for mechanical failure, after a mean follow-up of 15.4 years. They emphasised that the most significant factor associated with revision and mechanical failure was a patient aged 50 years or younger. Vail et al28 reported that there was no difference between polished (Ra = 0.1 µm) and grit-blasted (Ra = 2.8 µm) stems of the same geometry with use of third-generation cementing techniques after four to seven years of follow-up and that the five-year survival rate was 99.5% for both stems. Our results support these studies.

In contrast, several clinical studies have shown a high failure rate of the pre-coated femoral component. Mohler et al19 indicated that the surface finish and pre-coating on a cemented femoral stem may contribute to loosening. They emphasised that the rates of loosening and osteolysis were lower in an earlier study in which a smooth stem with a different design had been used. Similar work, which compared polished and matt-finished Exeter stems, indicated that surface roughening increased the failure rate.3,11 Ong et al16 also reported that the rate of failure of roughened, pre-coated, cemented femoral components was considerably higher and occurred earlier than for femoral components that were neither textured nor pre-coated with methylmethacrylate. These studies suggested that an enhanced cement-prosthesis bond may be deleterious rather than helpful because rougher surfaces generated more cement debris than smooth surfaces when loosening occurred.

Mulroy et al15 reported that there was a significant difference in the rate of aseptic femoral loosening between the grade C-2 hips and a combined group of grade A, B, and C-1 hips. Smith et al17 reported a significant association between grade C-2 and revision of a femoral component. In our study, 47 (37%) of 128 hips were grade C-2 or grade D and no femoral component was revised because of aseptic loosening. Several other studies indicated that the cement grade was not significant in aseptic loosening.12,13,16 Although it is clearly desirable to achieve the best cement mantle possible, the cause of aseptic loosening is multifactorial and other issues may also have an important part in the long-term survival of an implant.

One limitation of our study is that the patients were selected. Cementless total hip arthroplasty was performed for most of the younger, high-demand patients in the same period although these patients were excluded from our study. The results of using this pre-coated component in a younger, more active patient population might have given different findings.

We, thus, conclude that the use of a pre-coated femoral component in a hybrid THA is not detrimental to the medium-term results of the procedure at a mean follow-up of 11 years. Asymptomatic femoral and peri-acetabular osteolysis is also not a major problem. Earlier results of pre-coated femoral components should not be regarded as universal. There may be other factors which can influence the early and long-term survival of the femoral component. In
addition to surface finish, stem geometry and offset, operative technique and patient population, may all play important roles in the survival of a pre-coated femoral component.1,5,7,12-17,28

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References