We present the clinical and radiographic outcome of 68 consecutive primary total hip replacements performed in 54 patients under the age of 55 years using a hydroxyapatite-coated femoral component and threaded cup with a modular ceramic head (JRI-Furlong). We reviewed 62 (91%) hips at a median follow-up of 8.8 years (5 to 13.8) after implantation; six (9%) were lost to follow-up. At review there had been four (6%) revisions but only one for aseptic loosening (acetabulum). Radiographic review of the remaining hips did not identify any evidence of femoral or acetabular loosening. The median Harris and Merle d’Aubigné and Postel hip scores were 95.9 (42.7 to 100) and 17 (3 to 18) respectively. The JRI-Furlong hip gives promising functional and radiographic results in young patients in the medium term.

Total hip replacement (THR) in the younger patient presents a particular challenge. High physical demands and the need for long-term implant survival make good surgical technique and an appropriate choice of implant important. The revision rate of cemented implants may be high in this group of patients. The use of hydroxyapatite (HA)-coated cementless implants in THR has been well-established. However, there is a lack of papers which address their outcome in the younger patient. We present the clinical and radiographic outcomes of the HA-coated JRI-Furlong hip with a threaded acetabular cup (JRI Instrumentation Ltd, London, UK) in patients aged 55 years or less and with a minimum follow-up of five years.

Patients and Methods
We performed 68 consecutive primary THRs between September 1988 and June 1997 in 54 patients using the JRI-Furlong HA-coated femoral stem and a threaded acetabular component with an ultra-high-molecular-weight polyethylene insert and a modular ceramic head (Fig. 1). All patients were aged 55 years or less at the time of surgery with a median age of 48 years (21.3 to 55.4). All operations were performed by a single surgeon (PDA) through a posterior approach. Fourteen (26%) patients had bilateral procedures (ten sequential, four staged). The indication for THR was pain. The underlying pathology was primary osteoarthritis in 37 (54%) operations, avascular necrosis in 12 (18%), degeneration secondary to developmental dysplasia in ten (15%), ankylosing spondylitis in three (4%), degeneration secondary to slipped capital femoral epiphysis in two (3%), degeneration secondary to infection in two (3%), and hereditary epiphyseal dysplasia in two (3%) operations. Implant size was determined from pre-operative radiographs and intra-operative assessment. A total of 31 (46%) 28-mm and 37 (54%) 32-mm heads were used.

Immediate post-operative weight-bearing was encouraged and clinical follow-up was performed at six weeks and six months post-operatively, followed by annual clinical and radiographic review.

Our protocol involved the recall of all patients for outpatient review. Clinic notes were examined for evidence of complications or revision. The clinical outcome was documented using the Merle d’Aubigné and Postel score and the Harris hip score (HHS) and an analogue pain scale (0 to 100 mm). Two scores were used in view of previous concerns about the validity of a single score. Where a full clinical review was not possible the last clinic record was taken as the time when the patient was lost to follow-up.

Radiographs were examined for evidence of implant loosening and for component migration by a single observer (SM) who was blinded to the clinical outcome. Radiographic features sought to suggest implant loosening included the presence of divergent radiopaque lines, increased cortical thickening beneath the
collar and at the end of the stem of the femoral component and radioluencies around the acetabular component.

The radiographs were also assessed for signs of heterotopic ossification. Survival analysis was constructed by using the methods of Carr et al\textsuperscript{10} and Murray, Carr and Bulstrode.\textsuperscript{11}

**Results**

We reviewed 62 (91\%) hips in 48 (89\%) patients at a median follow-up of 8.8 years (5.0 to 13.8) after THR (Table I). Full clinical review was performed on 44 (81.8\%) patients (56 hips). Four (7\%) patients (six hips) who were unable to attend for review were contacted to establish whether a revision had been undertaken. Six (11\%) patients (six hips) were lost to follow-up. Those lost to follow-up included three patients who had died at 24 days, 1.9 years and 5.2 years after operation. All had been seen within the year before death and had shown no evidence of implant failure or loosening at that time. Three patients were lost after review at 4.2, 4.9 and 5.2 years post-operatively. No evidence of clinical or radiographic failure had been noted at their final review (Table II).

**Complications.** Minor complications were noted in ten (15\%) patients. Early complications (less than 30 days post-operatively) included one (1\%) sciatic nerve injury which went on to full recovery, three (4\%) dislocations, two (3\%) superficial infections, one (1\%) deep-vein thrombosis and one (1\%) cerebrovascular accident. Late complications (more than 30 days post-operatively) included two (3\%) dislocations, one (1\%) patient with heterotopic ossification which required excision and one (1\%) deep infection which required revision.

**Revision.** At the time of review there had been four (6\%) revisions (three femoral, one acetabular) (Table III). The acetabular revision was performed for aseptic loosening.

One femoral revision was undertaken after an anterior shaft fracture, which occurred at the time of insertion, and led to failure of primary mechanical fixation and subsequent failure of biological fixation. One femoral revision was performed after fracture of the implant related to technically poor insertion in a small patient with a narrow medullary canal. One femoral component was revised for a low-grade, deep infection. All revisions used a similar implant and all were functioning well, with no radiographic evidence of loosening by the time of review at 4.4, 4.7, 6.1 and 6.7 years after revision.

**Clinical and radiographic results.** The median functional scores were HHS 95.9 (42.7 to 100.0), Merle d’Aubigné and Postel 17 (3 to 18) and analogue pain 6 (0 to 90). The radiographs of 40 (74\%) patients (52 hips) were reviewed at the time of the clinical visit (four revisions were excluded). None showed any radiographic signs of failure.
The ten-year stem survivorship of 95.3% and cup survivorship of 98.0% reported in this study demonstrate that good results may be achieved in the medium term by using an uncemented implant in the younger patient. If the criterion taken for failure is revision for aseptic loosening, the stem survivorship was 100% and the cup survivorship was 98%. These results compare favourably with other reported series of cemented total hip replacement, both in non-age specific series and in those which looked at the younger patient.

Reports of the outcomes of cemented implants in the younger patient vary widely. Wroblewski, Siney and Fleming,12 in a large series of patients under the age of 51 years and with a mean follow-up of 15.1 years, reported an overall revision rate of 6.3% at ten years which increased to 15.3% at 15 years. Dorr et al1 found a revision rate of 33% in a series of 49 hips in patients under 45 years of age at a mean of 9.2 years of follow-up whilst Emery et al2 reported a revision rate of 39% at a mean of 12 years from implantation in a series of 57 patients with a mean age of 41 years. In non-age selected studies, excellent HA-coated femoral stem survival rates, both using the JRI-Furlong hip6 and other HA-coated implants, have been reported.13-17 The promising results produced by HA-coated femoral components have been repeated in the younger patient. Loupasis, Morris and Hyde,18 in a six-year follow-up study of 45 patients under the age of 51, reported promising results with the JRI-Furlong with no revision for aseptic loosening or evidence of stem loosening. Capello et al19 reported a low stem failure rate of 2% in patients under 45 years of age when using a proximally HA-coated implant with a minimum follow-up of ten years. This finding was supported by the groups subsequent paper which reported an aseptic loosening rate of 0.06% in a series of 274 patients (314 hips) with a mean age of 51 years and a minimum follow-up of ten years.20 Giannikas et al21 reported a predicted stem survival rate of 96.9% at seven years in a group of 66 patients (71 hips), also using a proximally HA-coated implant. Further long-term studies are required to see if these promising results are maintained.

No patient in our series showed signs of aseptic loosening of the femoral component. Both revisions which were performed for un-infected implants could be explained by technical difficulties which had been encountered at the time of operation. Fracture of the anterior cortex has previously been reported as a possible complication of the use of an uncemented femoral component and technical difficulties which had been encountered at the time of operation. Fracture of the anterior cortex has previously been reported as a possible complication of the use of an uncemented femoral component and technical difficulties which have been cited as the cause of many early failures.6,16 Despite this, previous reports have suggested generally good outcomes with or without further intervention.22-24

It is clearly important to bear in mind the usual ease of subsequent revision procedures. For our two patients in whom revision was performed for loosening because of failure of mechanical, and subsequent biological fixation, the implants were removed easily. Removal of the fractured femoral implant was challenging. The proximal part of the implant, which had not been properly seated at insertion, failed to achieve primary mechanical or subsequent biological fixation. At revision it was simple to remove. The
distal stem fragment which had been jammed into the medullary canal had achieved sound biological fixation and was removed only with great difficulty and after windowing the femur. The hip with suspected infection was also difficult to remove as the implant was clearly fixed soundly to the surrounding bone. There was no evidence of loosening at the time of review of the revised prostheses.

Recent reports have described concerns about the longevity of HA-coated uncemented acetabular components. However, threaded acetabular cups have demonstrated excellent results, both when compared with other methods of HA-coated fixation, or the Charnley cup, particularly when used with a ceramic head. We have not seen the high failure rate of threaded cups noted by Kronick, Barba and Paprosky who used porous-coated designs. Only one acetabular component in our series demonstrated aseptic loosening, despite adequate initial fixation. The combination of mechanical fixation produced by the threaded cup and biological fixation from the HA-coating may be important for stable, long-term fixation. Further studies are required in order to assess the relative contribution of HA-coating to the clinical outcome. There remain significant concerns about the potential difficulties of revising soundly fixed implants in the younger population which will need to be addressed in the long term.

The overall functional scores were good, with low pain scores in this series. Patients with coexisting pathology accounted for much of the variation seen. There was no relationship between the scores at the time of review and the length of time that the hip had been implanted. Baseline scores taken before implant insertion were not available for comparison.

Only one of our patients required excision of heterotopic ossification. The remaining patients showed little radiographic evidence of excessive bone formation. We thus agree with Kasetti, Shetty and Rand that heterotopic calcification does not appear to be a major problem in HA-coated implants. Additionally, although not specifically quantified, anterior thigh pain did not appear to be a significant complaint for our patients.

We thus conclude that the use of a fully HA-coated femoral stem in conjunction with a modular ceramic head and a threaded HA-coated acetabular cup appears to give promising results when compared with cemented implants in the younger patient. Further long-term assessment will be required in order to confirm that these results are maintained and that concerns about late osteolysis and implant failure from polyethylene wear are addressed.

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References