We evaluated the outcome of 104 consecutive primary cemented Exeter femoral components in 78 patients (34 men, 44 women) under the age of 40 years who underwent total hip replacement between October 1993 and May 2004. The mean age at operation was 31 years (16 to 39). No hip was lost to follow-up, but three patients (four hips) died. None of the deaths were related to the surgery. At a mean follow-up of 6.2 years (2 to 13), three femoral components had been revised for septic loosening. Using Kaplan-Meier survival analysis, the seven-year survival of the component with revision for any reason as the endpoint was 95.8% (95% confidence interval 86.67 to 98.7). The seven-year survival with aseptic femoral loosening as the endpoint was 100% (95% confidence interval 100).

The cemented Exeter femoral component in patients under the age of 40 shows promising medium-term results. As it is available in a wide range of sizes and offsets, we could address all types of anatomical variation in this series without the need for custom-made components.

The Exeter cemented femoral component developed in 1969 and was first implanted in November 1970. Since then there have been two minor changes in its design, two changes to the alloy and two to the surface finish, resulting, in 1988, in the production of the Exeter Universal femoral component. This retains its original double-tapered design and has a highly polished surface finish. Outcome studies of the Exeter prosthesis have been published for older patient populations, but the outcome in younger patients has not been published to date.

In this study we evaluated the clinical and radiological outcome of the Exeter Universal femoral component in 78 patients (104 hips) who were under the age of 40 years at the time of surgery.

Patients and Methods
Between October 1993 and May 2004 we inserted 104 primary cemented Exeter Universal femoral components (Stryker Howmedica, Newbury, United Kingdom) in 78 consecutive patients all of whom were under 40 years old at the time of surgery. All diagnoses were included and no patients were excluded. A cemented acetabular component was used in each case. Many patients in this age group have secondary osteoarthritis due to developmental dysplasia of the hip, inflammatory arthropathy, or avascular necrosis with loss of bone stock. We reconstructed the acetabulum with wire mesh, to contain sequential bone defects, and impaction bone grafting.

There were 34 men (44%) and 44 women (56%), of whom 26 underwent a bilateral procedure. In total, 50 femoral components were implanted on the left side and 54 on the right. The mean age at the time of surgery was 31 years (16 to 39).

All patients included in this retrospective review were followed up on a regular basis. During follow-up, three patients (four stems) died, at 4.4, 5.3, 6.9 and 8.5 post-operative years respectively, from causes unrelated to the surgery. None had required revision. All patients were followed for a minimum of two years, and no patient was lost to follow-up. The mean follow-up was 6.2 years (2 to 12.8).

The primary diagnosis was developmental dysplasia in 30 hips, rheumatoid arthritis in 13 and corticosteroid-induced avascular necrosis in 23. Five hips were replaced for idiopathic avascular necrosis, five for Perthes’ disease, five for post-traumatic arthritis. Four hips were replaced for slipped capital femoral epiphysis and four for Morquio’s disease. A further 15 hips were replaced for a variety of other diagnoses.

The majority of the operations (94 hips; 90%) were performed by or under the supervision of the two senior faculty surgeons.
were recorded in accordance with the 14 femoral zones described by Gruen, McNiece and Amstutz. A valgus or varus position of the femoral component was evaluated if it lay within 3° of the femoral axis. Loosening was analysed using the criteria described by Harris, McCarthy and O’Neill. In the event of such loosening, we categorised the mode of failure as described by Gruen et al. Subsidence of 2 mm or more was registered as abnormal, as described by Loudon and Older. Heterotopic ossification was defined according to the system of Brooker et al. We defined revision as the removal and/or replacement of the component for any reason. Kaplan-Meier survival analysis was performed for all hips to calculate the cumulative survival with 95% confidence intervals (CI). The survival analysis was performed for four different endpoints: revision of the femoral component for any reason, revision for any reason excluding infection, revision for aseptic loosening, and radiological signs of loosening.

Results
The mean operating time was 151 minutes (65 to 285). There were two intra-operative complications related to implantation of the femoral component. In one femur a hoop stem crack occurred during broaching. This was recognised intra-operatively and treated by cerclage wiring. A technical failure of the implantation technique was seen in one case. The component jammed during insertion, and its removal with some recementing was necessary for proper implantation. Post-operative rehabilitation was uneventful in both cases.

Functional outcome. The mean pre-operative HHS was 51 points (15 to 77) and improved to a mean of 89 points (55 to 100) at final follow-up. The mean OHS improved from 39 points (28 to 52) to 19 points (12 to 45), where the best available score is 12 and 60 the worst. The mean post-operative VAS for pain at rest was 7 points (0 to 75). The mean post-operative VAS score for pain during physical activity was 19 points (0 to 90). The mean VAS for overall satisfaction was 87 points (20 to 100).

One patient with secondary osteoarthritis after an acetabular fracture had persistent pain after THR. In the absence of evidence of failure of fixation or infection, this patient was referred for pain management.

Revisions. Three femoral components (3%) were revised, because of septic loosening at 2.2, 3.4 and 6.1 years. The infecting organisms were Pseudomonas aeruginosa in one hip and Staphylococcus epidermidis in two. In one infected hip, revised after 2.2 years the infection was related to the surgery. The indication for this THR was an infected non-union of a Sugioka osteotomy. The other two infected hips presented as an acute infection in patients with a previously well-functioning THR, one of whom was receiving steroids for systemic disease. No femoral component was revised for aseptic loosening.

Radiological outcome. Radiographs of all hips were available for analysis. The alignment of 83 femoral components was considered to be in a neutral position, but 21 had a deviation of > 3° from the neutral axis. Of these, 11 were in a varus and ten a valgus position. Most components had a stable radiological appearance during follow-up (Fig. 1). Subsidence of more than 2 mm within the cement mantle occurred in three hips, none of which required revision. All three were asymptomatic. Migration of the femoral component with distal migration of the cement mantle was not seen. Femoral radiolucent lines were seen in six hips and involved a total of 16 zones. Four radiolucent lines were seen in zone 1, two in zones 7 and 8, and one in zones 2, 6 and 9 to 14. Two components had radiolucent lines in several zones. One of these has been revised for septic loosening. The other had progressive lines in zones 1, 2, and
6 to 8 for five years, but the patient reported only mild pain and no loss of function. One other hip had a progressive radiolucent line in zone 1.

Three components had showed one osteolytic zone in zones 1, 6 and 7, respectively. Rounding of the calcar was visible in 15 hips, but this did not produce any loss of calcar height in these hips. Hypertrophy and atrophy of the femoral cortex were present in one hip each. There were no fractures of the cement mantle or zones with sclerosis.

Other complications and re-operations not related to the femoral component. In three patients a deep wound infection was suspected post-operatively. Treatment consisted of immediate surgical debridement combined with local and intravenous antibiotics. All three patients recovered, and none developed septic loosening. A superficial wound infection was seen in three hips, and in five hips there was a post-operative haematoma. One patient had an extensive haematoma four months after THR, due to excessive thromboprophylaxis. A transient femoral and/or sciatic nerve palsy occurred in five patients; in four, there was isolated sensory disturbance, and in one a combined motor and sensory palsy. All five had developmental dysplasia with high dislocation of the hip joint. In each case conservative treatment led to complete recovery.

A total of 12 patients (12 hips, 11.5%) had a dislocation. Nine were treated conservatively and stabilised. Three patients underwent re-operation. Two had a femoral head exchange at five and 28 days post-operatively and the third had a revision of the acetabular component after 3.5 years. All patients became stable after surgery.

Heterotopic ossification was seen in 24 hips (23%); Brooker class I in eight; Brooker class II in ten and Brooker class III in six. The presence of the heterotopic ossification did not restrict movement in any patient. There were five acetabular revisions (4.8%), four for aseptic loosening and one for pain because of an unknown cause. During surgery in this patient the acetabular component was stable, however, the patient was relieved of pain following revision.

Survival analysis. Using Kaplan-Meier survival analysis with revision of the femoral component for any reason as the endpoint, the survival rate was 97.8% (95% CI 91.6 to 99.5) at five years and 95.8% (95% CI 86.6 to 98.7) at seven years. With aseptic loosening of the femoral component as the endpoint, the survival rate was 100% (95% CI 100) at five and seven years, and with radiological loosening of the component as the endpoint, the survival was 99% (95% CI 93.2 to 99.9) at five years and 96.7% (95% CI 86.1 to 99.3) at seven years (Table I).

### Discussion

Although the Exeter Universal femoral component is widely-used, we believe this to be the first report of the medium-term results of its use in patients under 40 years of age. In this group of patients, it has an acceptable survival rate at seven years post-operatively. None of the femoral components failed due to aseptic loosening, and the three

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<th>Table I. Survival analysis for all Exeter femoral components</th>
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<td><strong>Revised for any reason excluding infection</strong> (95% CI)</td>
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<td><strong>Revision for aseptic loosening</strong> (95% CI)</td>
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<td><strong>Revision for radiographic loosening</strong> (95% CI)</td>
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<td>Five-year survival</td>
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<td>Seven-year survival</td>
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Bilateral Exeter prosthesis in a 36-year-old woman with developmental dysplasia of the hip treated with extended acetabular reconstruction with wire meshes and bone impaction grafting a) pre-operative anteroposterior pelvic radiograph, b) immediate post-operative view, c) 11 years post-operatively with a stable view of the prostheses.
that were revised were all infected. Despite a trend to use uncemented implants in young patients,\textsuperscript{15-15} this study confirms that good results can be obtained with a cemented femoral component.

The wide range of available sizes and offsets (from 30.5 mm to 50 mm) meant that no custom-made components were needed. All patients were followed, and none were lost to follow-up, which is the ideal.\textsuperscript{16}

One limitation of our study is the mean follow-up of 6.2 years, which means that the results are only medium-term. The number of hips with septic loosening was relatively high but this was associated with the surgery in only one patient, whereas the other two could be attributed to an acute haematogenous infection.

The dislocation rate of 11.5% was also relatively high. However, the reported incidence of dislocations in other series where a THR has been carried out in patients under 40 years varies between 0% and 18.2%.\textsuperscript{17-27} We do not think the dislocation rate is related to the type of femoral component but it could be related to the previous operations which had been undertaken in seven of the 12 patients. Fortunately, none of the 12 patients could be treated conservatively.

Reviewing the literature on patients under 40 years in general, femoral component survival is acceptable in all series, using both cemented and non-cemented components. A study on uncemented components of different designs by Duffy et al\textsuperscript{18} had a slightly lower survival rate than reported survival rates of cemented components of 86% at ten years, using revision due to aseptic loosening as the endpoint. However, McAuley et al\textsuperscript{28} had a survival rate of 98% of uncemented femoral components in their patient population under the age of 40 years at a mean follow-up of seven years. The most extensive data available relates to the Charnley femoral component. Joshi et al,\textsuperscript{29} reported a survival rate of the original Charnley component of 99% at five years and 97% at ten years, with revision due to aseptic loosening as the endpoint. Chmell et al\textsuperscript{17} described a survival rate of 95% at ten years with a variety of cemented femoral components in patients under the age of 30 years. The outcome of the Exeter femoral component at seven years in our series seems to be comparable to that of other cemented components in patients under the age of 40 years.

The best-reported long-term results of THR in patients under 40 years showed that the Charnley component had a survival rate of 75% after 20 years, with revision for any reason as the endpoint and a survival of 86% after 20 years with revision for aseptic loosening as the endpoint.\textsuperscript{30}

There are several studies which report the survival of the Exeter femoral component in older patients\textsuperscript{1,2,31-36} These give a survival rate for patients with a mean age between 61 and 71 years ranging from 93% to 100% after ten years when femoral revision for aseptic loosening is taken as the endpoint. In our study group, the mean age was 31 years and we had a survival of 100% after seven years, with revision for aseptic femoral loosening taken as the endpoint.

The Exeter universal femoral component survives well in the medium term in young patients, despite the assumption that this group is more active, and will have a higher rate of wear.\textsuperscript{37,38} Consequently, we will be keeping this cohort under review.

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