We reviewed the results at nine to 13 years of 125 total hip replacements in 113 patients using the monoblock uncemented Morscher press-fit acetabular component. The mean age at the time of operation was 56.9 years (36 to 74). The mean clinical follow-up was 11 years (9.7 to 13.5) and the mean radiological follow-up was 9.4 years (7.7 to 13.1). Three hips were revised, one immediately for instability, one for excessive wear and one for deep infection.

No revisions were required for aseptic loosening. A total of eight hips (7.0%) had osteolytic lesions greater than 1 cm, in four around the acetabular component (3.5%). One required bone grafting behind a well-fixed implant. The mean wear rate was 0.11 mm/year (0.06 to 0.78) and was significantly higher in components with a steeper abduction angle.

Kaplan-Meier survival curves at 13 years showed survival of 96.8% (95% confidence interval 90.2 to 99.0) for revision for any cause and of 95.7% (95% confidence interval 88.6 to 98.4) for any acetabular re-operation.

Cemented acetabular components in general have been recognised for their longevity and predictable performance.1-3 Cementless acetabular components may have variable medium and longer term results.4,6 Despite this, uncemented acetabular components are widely used during primary total hip replacement (THR), accounting for 89% of these procedures in Australia7 and 80% in New Zealand.8 Some of the designs have been susceptible to early loosening and failure.9,10 Metal-backed modular acetabular implants may be prone to this because of poor locking mechanisms for their inserts, increased rates of wear compared with all-polyethylene components, and backside wear at the interface between the polyethylene component and the metal shell.11

The Morscher acetabular component (Sulzer Orthopaedics Ltd, Baar, Switzerland), introduced in 1985, is a non-modular flexible press-fit design.12,13 The polyethylene is bonded directly to a titanium mesh shell to eliminate the potential for backside wear. There is no option for supplementary screw fixation. Berli et al14 recently reported the results at 15 years of 280 hips implanted by the original designer quoting a survival of 97.5% for aseptic loosening and of 95.3% overall. However, there has been little independent evidence as to whether these excellent results can be achieved in other centres. We describe our experience with the Morscher acetabular component, which we have used since 1993, and compare our results with those of the designer’s series.

Patients and Methods
Between January 1994 and December 1997 five orthopaedic surgeons implanted 125 Morscher acetabular components in 113 patients at either of the two hospitals in our city. The type of femoral component used, the material of the head and the approach were at the surgeon’s discretion.

There were 80 THRs (64%) in 71 men and 45 (36%) in 42 women. The mean age at operation was 56.9 years (36 to 74). The Charnley grades14 by patient were as follows: grade A 84 (74.3%), grade B 24 (21.3%) and grade C five (4.4%). The direct lateral approach was used in 65 hips (52%) and a posterior approach in 60 (48%). Osteoarthritis was the primary diagnosis in 106 hips (84.8%; Table I).

The acetabular component was inserted according to the manufacturer’s instructions. The acetabulum was reamed to the stated diameter with the implant oversized by 1.5 mm. A cemented femoral compo-
Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score normalised to 100,18 the short form (SF)-12 generic health score19 and the Oxford hip score (OHS)20 were calculated at review with the results given as the mean and SD. An anteroposterior (AP) pelvic radiograph showing the hip with the proximal femur was obtained unless one had been taken within the previous 12 months. Patients who declined to travel were sent questionnaires by post or interviewed by telephone. Radiographs were obtained at their local facility and sent to our institution for assessment. All the patients were cross-referenced to the National Joint Registry8 and to our local theatre and audit databases to ensure that no revisions had been registered.

At the time of review two patients had died at eight and nine years after surgery. Both had well functioning hips at the time of death. Three hips in three patients had been revised. Two patients (two hips) were lost to follow-up. Three patients (three hips) could not be contacted, but had radiological follow-up at a mean of 8.4 years (7.7 to 9.1). All hips had been functioning well at the last review. The National Joint Registry had no record of revision for any of these five hips. We obtained clinical and radiological review of 111 hips in 99 patients including the three (three hips) who had been revised. Seven patients were contacted by telephone and questionnaires were completed, but they declined to attend for radiological review (Table III). The mean age at review was 67.9 years (46.8 to 84.6) and the mean clinical follow-up was 11.2 years (9.7 to 13.5). Radiological follow-up was at a mean of 9.4 years (7.7 to 13.1).

Radiological evaluation. Radiological evaluation was performed using the zones described by DeLee and Charnley.21 The femoral component was assessed for evidence of migration, subsidence and the position of the stem. Radiolucent lines and areas of osteolysis were categorised in the seven zones described by Gruen, McNiece and Amstutz.22 We defined minor osteolysis as a lucency of less than 1 cm in diameter and major osteolysis as one greater than 1 cm. Heterotopic ossification (HO) was assessed using the classification of Brooker et al.23

Wear measurements. The Morscher acetabular component is a flattened hemisphere with a 20° bevel. The thickness of the polyethylene varies throughout the circumference. Therefore the standard techniques for measuring wear as described by Martell and Berdia24 could not be applied. A standard AP radiograph of the hip was taken and digitised using a digital camera of eight megapixels. The abduction angle and the superior polyethylene thickness were measured (Fig. 1) using E-ruler 1.1 freeware (MyCnKnow.com). The superior polyethylene thickness was calculated by counting the pixels to the edge of the titanium backing. The known head diameter of 28 mm was used as a reference. Wear was calculated as the difference in the superior thickness as seen on the post-operative radiograph compared with that on the latest follow-up radiograph. A total of 58 patients had suitable early and late radiographs to allow accurate measurement of the wear rate to be made. Of these, 20 randomly selected films were re-measured by the same observer on two occasions. The abduction angle was accurate to within 0.33° in all cases with a mean difference of 0.11°. The mean difference in measurement of the thickness of the polyethylene was

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**Table I. Pre-operative indications for total hip replacement**

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Number of hips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteoarthritis</td>
<td>106</td>
</tr>
<tr>
<td>Developmental dysplasia</td>
<td>9</td>
</tr>
<tr>
<td>Previous slipped upper femoral epiphysis</td>
<td>3</td>
</tr>
<tr>
<td>Avascular necrosis</td>
<td>3</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>2</td>
</tr>
<tr>
<td>Paget’s disease</td>
<td>1</td>
</tr>
<tr>
<td>Post-traumatic arthritis</td>
<td>1</td>
</tr>
</tbody>
</table>

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**Table II. Details of the femoral components used**

<table>
<thead>
<tr>
<th>Femoral component</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncemented femoral stems</td>
<td>58 (46.4)</td>
</tr>
<tr>
<td>CLS*</td>
<td>57 (45.6)</td>
</tr>
<tr>
<td>Wagner cone*</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td>Cemented femoral stems</td>
<td>67 (53.6)</td>
</tr>
<tr>
<td>SLS†</td>
<td>52 (41.6)</td>
</tr>
<tr>
<td>Exeter‡</td>
<td>11 (8.8)</td>
</tr>
<tr>
<td>MS-30†</td>
<td>4 (3.2)</td>
</tr>
<tr>
<td>Stainless-steel head (28 mm)</td>
<td>59 (47.2)</td>
</tr>
<tr>
<td>Ceramic head (28 mm)</td>
<td>66 (52.8)</td>
</tr>
</tbody>
</table>

* Zimmer, Warsaw, Indiana
† Sulzer Medica, Winterthur, Switzerland
‡ Stryker Europe, Montreaux, Switzerland

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**Table III. Details of the study group**

<table>
<thead>
<tr>
<th></th>
<th>Hips</th>
<th>Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>125</td>
<td>113</td>
</tr>
<tr>
<td>Died</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Follow-up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical and radiological</td>
<td>108</td>
<td>97</td>
</tr>
<tr>
<td>Clinical only</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Radiological only</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Lost to follow-up</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Revised*</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

* one hip revised in patient with bilateral THRs
0.14 mm. The coefficient of repeatability for wear measurements was 0.37 mm. With a mean follow-up of eight years between radiographs this gave an accuracy of 0.05 mm/year for the calculated wear rate.

**Statistical analysis.** Data were collected and recorded in a custom-made database. Statistical analysis was performed using Microsoft Excel (Microsoft, Redmond, Washington), SPSS (SPSS Inc., Chicago, Illinois) and Simple Interactive Statistical Analysis (SISA, Quantitative skills, Hilversum, Netherlands). An unpaired two-tailed Student \( t \)-test was used for comparison of normally distributed groups of data, and for continuous data correlation coefficients were calculated with \( p \)-values. Statistical significance was set at a \( p \)-value of \( \leq 0.05 \). Kaplan-Meier survival curves with the 95% confidence interval (CI) were calculated with the help of a biostatistician.

**Results**

Three hips were revised. One dislocated in the immediate post-operative period because the acetabular component had been inserted too steeply in a dysplastic acetabulum and required revision at two weeks. A 40-year-old woman with acetabular dysplasia had excessive wear of the polyethylene at seven years which was attributed to a steep abduction angle of 54° (Fig. 2). The hip was revised to a metal-on-metal bearing. A 60-year-old man required revision for deep infection and loosening of the femoral component at 9.3 years.

There were three other re-operations. An unrecognised intraoperative femoral fracture in a 67-year-old man was treated by cerclage wires around an uncemented CLS (Zimmer, Warsaw, Indiana) femoral component. The hip was still functioning well at 13.5 years. A 55-year-old man sustained a traumatic periprosthetic fracture at the tip of a CLS femoral component 11 years after operation. This was treated successfully by a cable plate. The implant was firmly fixed with no sign of osteolysis. One man, aged 64 years at the time of the primary THR, required re-operation at another centre for major pelvic osteolysis at nine years (Fig. 3). The acetabular component was firmly fixed. Therefore allografting was carried out with good results when seen at a follow-up of three years after grafting and 12 years after the original procedure. In addition to the early dislocation that was revised three other hips dislocated giving a dislocation rate of 3.2%. All three stabilised after a closed reduction with no further dislocation.

The Kaplan-Meier survival curves at both ten and 13 years showed survival of 96.8% for revision for any cause (95% CI 90.2 to 99.0) and of 95.7% for any acetabular re-operation (95% CI 88.6 to 98.4) (Fig. 4). No acetabular component required revision for aseptic loosening. If the two hips lost to follow-up had been classified as failures the revision rate would be 4% for any cause at 11 years. However, neither was recorded as having been revised in the New Zealand National Joint Registry which is comprehensive, requires the participation of all surgeons and enjoys 98% compliance.

The Merle d’Aubigné and Postel score improved from a mean pre-operative value of 9.0 (SD 3.2) (pain 2.0, mobility
2.9, function 4.1) to 16.7 (SD 1.7) (pain 5.5, mobility 5.4, function 5.8) (Student t-test, p < 0.001). At the time of review the mean OHS was 16.1 (SD 4.9), the mean HHS 94.0 (SD 8.5), the mean SF-12 score 75.7 (SD 17.2) and the mean normalised WOMAC score for pain 94 (SD 9.5) and function 90 (SD 11.6).

All the acetabular components appeared to have solid bony ingrowth radiologically. No radiolucent lines were seen and none of the components had migrated. The mean initial abduction angle was 38.0° (22.9° to 60.8°). The mean abduction angle at the time of final review was 37.8° (23.5° to 53.8°). No significant change was seen in inclination (paired Student t-test, p = 0.6) when comparing early and late post-operative radiographs.

Eight hips (7.0% of the 114 hips with radiological review) had osteolytic defects greater than 1 cm in diameter. One, as mentioned above, had major osteolysis around a well-fixed acetabular component and required bone grafting (Fig. 3). Three others had osteolysis ranging from 1 cm to 3 cm in diameter in zone I of the acetabulum. One further hip had an osteolytic area of less than 1 cm in diameter in zone I giving a rate of any acetabular osteolysis of 4.4% of those hips with radiological review. In four hips major osteolysis was observed around the femoral component. A 60-year-old woman had osteolysis in all zones around a cementless CLS femoral component but was asymptomatic and under regular review. Another patient had osteolysis in Gruen zones 5 and 6 around a cemented MS30 (Zimmer) femoral component but this was also asymptomatic. Two patients had osteolytic defects in zone 7 (1 cm, 1.5 cm × 3 cm as measured on the AP radiograph). Minor osteolysis (less than 1 cm) was seen in zones 1 or 7 in seven hips. Two cemented femoral components (SLS, Sulzer Medica, Winterthur, Switzerland) had subsided 2 mm and 4 mm, respectively, but were asymptomatic.

The overall rate of HO was 33% (38 of 114) (Brooker grade 1, 14, grade 2, 13, and grade 3, 11). All the patients were asymptomatic. There was a statistically significant association between a posterior approach and a higher mean score of HO (mean scores, posterior 0.81, lateral 0.43; p = 0.04). There was no association between the use of cemented or uncemented femoral components and the incidence of HO (p = 0.086).

The mean linear wear rate was 0.11 mm/year (0.06 to 0.78). The wear rate was significantly higher in patients with a steeper acetabular abduction angle (r = 0.3, p = 0.019). The one hip revised for excessive wear had an inclination of 54° and a wear rate of 0.78 mm/yr.

There was no statistically significant correlation between the wear rate and the type of material of the head (p = 0.6), gender (p = 0.98), Charnley grade (p = 0.45), approach (p = 0.99), the age at the time of operation (p = 0.36), the body mass index (p = 0.52) or the size of the acetabular component (p = 0.21).

No statistically significant correlation was found between the wear rate and osteolysis (p = 0.93), or a high abduction angle and osteolysis (p = 0.8). However, in the subgroup of seven patients with major osteolysis or reoperation, who had suitable radiographs for accurate measurements there was a mean wear rate of 0.26 mm/year (0.5 to 0.78). By contrast, the group with minor osteolysis or radiolucent lines showed a mean annual wear rate of 0.08 mm/year (0.05 to 0.16) and that with no radiological changes had a mean rate of 0.10 mm/year (0.0 to 0.46).

**Discussion**

The rationale of the design of the Morscher acetabular component includes the achievement of three-dimensional bony...
ingrowth to the titanium mesh, the production of an implant with relatively low stiffness to avoid stress shielding, the avoidance of the complications inherent in a modular system such as dissociation, the achievement of primary press-fit stability without supplementary screw fixation and the avoidance of impingement by the use of the inferior level.\textsuperscript{12-14} There have been a number of reports from the originator’s centre on the acetabular component alone or with a primary focus on the femoral components used with this implant.\textsuperscript{12,14,26} However, to our knowledge, there have been no published results on the performance of the Morscher implant from other centres.

In the original series, 280 hips in 261 patients underwent THR using the press-fit component. Only one revision for aseptic loosening was reported giving a survival rate with aseptic loosening as the endpoint of 99.6\% at a mean of 6.3 years.\textsuperscript{13} Berli et al\textsuperscript{14} reviewed the same series of patients ten years later and reported four acetabular revisions (1.4\%) at a mean of 9.8 years and 13 (4.6\%) at 15 years. The reasons for revision included aseptic loosening in seven, excessive polyethylene wear in three, osteolysis in one, late infection in one and malposition of the component in one. One acetabular component was radiologically loose and another had significant ischial osteolysis, but both were asymptomatic and unrevised. In addition, there were seven isolated femoral revisions giving a total revision rate of 7.1\% (20 of 280), at 15 years. No figures were reported for femoral osteolysis. The mean age of the original series was 71 years at operation and 123 of the 261 patients (47\%) had died at the time of the 15-year follow-up. By contrast, the mean age of our patients was 56.9 years at the time of surgery with 64\% being men. Only two (1.7\%) had died at the time of follow-up. Our total revision rate was 2.4\% at a mean of 11 years with none undertaken for aseptic loosening.

Berli et al\textsuperscript{26} also described a separate series of patients with a mean age of 67 years using the Morscher acetabular component with a matt finish MS30 femoral component. There was survival of 100\% of both components at ten years. No acetabular osteolysis was seen, but three acetabular components had radiolucent lines in zone I or zone II. In addition, 6.8\% of the femoral components showed osteolysis and 22\% had radiolucent lines.

Most cementless acetabular components are modular. The results with first-generation components such as the Harris-Galante acetabular component (Zimmer) have been reasonably good with revision rates ranging from 4\% to 6\% at 14.9 to 16 years.\textsuperscript{4,27,28} However, if all reasons for acetabular revision including dissociation and liner exchanges for wear are considered the re-operation rate increases to between 8.1\% and 19\%.\textsuperscript{4,28} Udomkiat et al\textsuperscript{5} reported survival rates at 12 years of 99.1\% for failure of fixation of the Anatomic Porous Replacement acetabular component implanted without screws, but this rose to 79\% when liner exchange was included. Recently, Uting et al\textsuperscript{29} recorded the 12- to 16-year results of the Harris-Galante acetabular component in patients under 50 years of age. There was a survival of 94\% for the shell, of 84\% for the shell and liner and of 55.3\% for impending revision at 16 years.

Osteolysis is often seen after THR and is thought to be initiated by wear particles. The literature records rates of osteolysis from 2.2\% to 31\% with various metal-backed acetabular components at follow-up of up to 18 years.\textsuperscript{4-6,27,28,30-34} Wear between the femoral head and polyethylene liner is inevitable but backside wear between the liner and shell may also occur in modular components. This latter problem is considered to be due to micromovement between the liner and the metal shell, poor conformity between the liner and the shell and the presence of screw holes.\textsuperscript{11,33} A non-modular acetabular component has the theoretical advantage of increased thickness of the liner, improved conformity and reduced micromovement, which may reduce wear and osteolysis. Young et al\textsuperscript{35} reported less wear and a rate of osteolysis of 2\% in non-modular acetabular components compared with 22\% in a matched group using a modular device after a mean follow-up of five years. Despite this there are few non-modular cementless acetabular components in current use. A recent report on the titanium coated RM acetabular component at 20 years described survival of 94\% with aseptic loosening of the acetabular component as the endpoint and 82.7\% for all acetabular revisions.\textsuperscript{36} Of the 14 revisions in 93 hips, five were for loosening and seven for osteolysis when the components were found to be well fixed. A further eight hips had acetabular osteolysis, but were not loose or awaiting revision. The authors concluded that the component gave reliable long-term fixation, but that the reduction of wear remained the challenge.\textsuperscript{36}

Despite improvement in the locking mechanisms newer designs of uncemented modular acetabular components have still been implicated in occasional liner dissociation, backside wear and osteolysis.\textsuperscript{37-40} For the Duraloc 100 acetabular component, osteolysis was found in 41\% of the hips at follow-up at seven years, but this may have been related to the use of Hylamer liners.\textsuperscript{41}

In our series all the acetabular components appeared to be solidly ingrown with no radiolucent lines, no migration and no revisions for aseptic loosening. Only eight patients had osteolytic defects greater than 1 cm in diameter in either the proximal femur or acetabulum with a rate of 4.6\% for any acetabular osteolysis. There have been no isolated femoral revisions.

The mean linear wear rate in our series was 0.11 mm/year which is comparable to those usually reported for stainless steel on cemented conventional ultra-high-molecular-weight polyethylene.\textsuperscript{42} The addition of a rigid metal backing to a cemented polyethylene component has previously been shown to increase wear rates by 37\% from 0.08 mm/year to 0.11 mm/year.\textsuperscript{43} Similar increases in wear have been described for uncemented acetabular components.\textsuperscript{44} Berli et al\textsuperscript{14} found polyethylene wear of 0.1 mm/year for a metal-polyethylene articulation and 0.05 mm/year for a ceramic-polyethylene articulation in Morscher acetabular
components with 32 mm heads. We found no difference in the wear rate between ceramic or metal in our series using a 28 mm head, but polyethylene wear in our study was significantly higher in patients with a steeper abduction angle of the component. Berli et al. also noted increased wear rates when the abduction angle was greater than 45° although quantitative results were not provided. The survival of the Morscher acetabular component in this series of young and predominantly male patients, was excellent and similar to those of the designer’s series.†

The revision rate for the Morscher acetabular component in both our series and those from the designer’s centre is lower than that of both first- and second-generation modular components at a comparable follow-up if exchange of the liner is included.†

We wish to thank Dr G. Coulter, Dr W. Leight and Mr A. Ballantyne for their work in the early stage of the project, Mr C. Fitzpatrick, Mr B. Hodgson, Mr J. Dunbar and Mr M. Chin for allowing us to review their patients and Dr S. Williams for help with the statistical analysis. Funding was provided by the Wishbone Trust. No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References