THE EFFECT OF IMPROVED CEMENTING TECHNIQUES ON COMPONENT LOOSENING IN TOTAL HIP REPLACEMENT

AN 11-YEAR RADIOGRAPHIC REVIEW

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Improved cementing techniques have been shown to decrease the rate of aseptic loosening of femoral components of cemented total hip replacements at five to seven years. We now report our results in 105 hips in 93 patients at 10 to 12.7 years (mean 11.2). The improved techniques included use of a medullary plug, a cement gun, a doughy mix of Simplex P and a collared stem of chrome cobalt.

Only three femoral components had definitely loosened, none were probably loose and 24 were graded as possibly loose. In contrast, the incidence of radiographic loosening on the acetabular side was 42%. Improved cementing techniques have produced a marked reduction in the rate of aseptic loosening of the femoral component, but the incidence of acetabular loosening is unchanged.

Aseptic loosening of the components is the most common long-term complication of cemented total hip arthroplasty. Radiographic evidence of femoral loosening in series using the cementing techniques of the late 1960s and early 1970s was found in about 20% at five years (Amstutz et al 1976; Beckenbaugh and Ilstrup 1978) and had increased to 30% to 40% by 10 years (Stauffer 1982; Sutherland et al 1982). Although others have reported lower rates, they often used different radiographic criteria.

For example, Salvati et al (1981) reported a femoral loosening rate of 9.3% at an average 10-year follow-up. However, their series also included 17 hips showing new cement-metal radiolucency at the superolateral border of the femoral prosthesis. Both Moreland et al (1980) and Stauffer (1982) felt that these 17 femoral components were definitely loose: adding these cases gives a loosening rate of 40.7% on the radiographic criteria used by other authors. Radiographic loosening of the acetabulum was found by Sutherland et al (1982) to be 29% at 10 years and by Charnley (1979) to be 25% at 12 to 15 years.

These poor results of component fixation led many surgeons to abandon cemented techniques, but there

were simultaneous improvements in component design and in cementing techniques which led to improved femoral results. In a series of 117 cemented total hip arthroplasties using an intramedullary plug of polymethylmethacrylate, a cement gun and stems of improved designs, we found radiographic signs of definite femoral component loosening at six years in only 1.7% (Harris and McGann 1986). In a similar series of 251 hips from the Mayo Clinic Russotti, Coventry and Stauffer (1988) found definite evidence of loosening in only 1.2%. None of these 251 hips had required revision.

The key questions are whether the improved results in cemented femoral components at six years still apply at 11 years, and whether there has been a corresponding improvement in acetabular fixation. We now report the findings at 11 years, in the hips we reported previously at an average follow-up of six years.

MATERIALS AND METHODS

Between January 1, 1976 and July 1, 1979, 234 cemented total hip replacements were performed in 206 patients with a polymethylmethacrylate intramedullary plug placed about 3 cm distal to the expected position of the tip of the femoral component (Oh et al 1978) using a medullary plug syringe (Johnson and Johnson Orthopaedic Products, New Brunswick, NJ). A doughy mix of Simplex P (Howmedica Inc, Rutherford, NJ) was used in a cement gun. Of the stems, 73 were CAD, 16 were HD-2, three were calcar replacement and 13 were CDH components (all Howmedica). Eight of the index operations had been revisions of failed THR.

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0301-620X/90/5170 \$2.00
J Bone Joint Surg [Br] 1990; 72-B:757-60.

At the acetabulum, subchondral bone was preserved if possible and three or four 12.5 mm diameter keyholes were made in the pubis, ischium and ilium. Cement was finger-packed and not pressurised. Femoral head grafting to the lateral wing of the ilium was used in 11 hips. Nineteen hips (17 patients) had metal-backed acetabular components, all others were of high density polyethylene.

Since our six-year follow-up, 11 patients (12 hips) have died. None of these had radiographic evidence of any loosening at latest follow-up except one which was revised at 9.8 years for aseptic loosening after an ipsilateral femur fracture. This hip and the only other one revised (at 2.9 years) for femoral loosening are recorded as definite loosening.

All other hips have at least a 10-year follow-up, and all the patients reported five years ago who are still alive have been reassessed (105 hips in 53 women and 41 men). Eighteen patients (19 hips) were examined by the authors and 75 patients (86 hips) replied to questionnaires. Current radiographs were obtained for all except two patients (2 hips).

Our radiological criteria for femoral loosening have previously been published (Harris, McCarthy and O'Neill 1982). Since Hodgkinson, Shelley and Wroblewski (1988) reported that acetabular components with any continuous radiolucent line had a 94% probability of being found loose at surgery, we considered that all sockets which showed a continuous radiolucent line were loose as well as all which showed migration.

The original diagnosis in the 105 hips followed for 10 years or more included congenital dislocation and/or dysplasia (18), pistol grip deformity causing osteoarthritis (19), osteoarthritis which was too far advanced to determine the original pathology (24), avascular necrosis (9), slipped capital femoral epiphysis (5), rheumatoid arthritis (4), post-traumatic osteoarthritis (4), failed osteotomies (4), failed total hip replacements (8), failed cup arthroplasties (4), failed endoprostheses (3), prior hip sepsis (2, including one with tuberculosis), and haemochromatosis in one.

We used the Kaplan-Meier survival analysis method (1958) to evaluate the failure of fixation of the femoral and acetabular components.

RESULTS

The average duration of follow-up was 11.2 years (10 to 12.7), the average age at surgery having been 57.4 years (20 to 84). The average pre-operative weight was 156 lb (102 to 225), 71 kg (46 to 102), and at follow-up was 157 lb (range 90 to 230). Five of the 105 hips had undergone acetabular revision, four for symptomatic loosening and one for recurrent dislocation. One hip had femoral revision for symptomatic aseptic loosening at 2.9 years and another was revised for loosening at the time of treatment of a femoral fracture at 9.8 years. The total revision rate was 7%. At 11 years, the average Harris hip

score (Harris 1969) for those hips that did not undergo revision surgery was 83 (range 34 to 100) with 42% rated excellent, 30% good, 14% fair and 14% poor.

Analysis of the 14 hips with a fair result showed that pain was not a major factor, but limited function, largely for other causes, had reduced the scores. Of the 14 poor results, pain was severe in only five hips, with none or mild pain in seven, and moderate pain in two. The low scores were largely attributable to a failed contralateral hip replacement in three cases, and to neurological disease in six (Parkinson's disease, CVA, cervical myelopathy, spinal stenosis (2) and sciatica). One patient had severe generalised arthritis and one had carcinoma of the lung.

Fig. 1

Kaplan-Meier survival analysis curves for cemented femoral and acetabular components reviewed at a mean of 11.2 years. The data are based on radiographic criteria and the findings at surgery in those cases having re-operation.

In the 103 current radiographs, only one femoral component was definitely loose, and none were probably loose. Seven hips showed localised osteolysis about the femoral component (6.8%) but no evidence of definite loosening (Jasty et al 1986). Twenty-four hips were graded as possibly loose, giving a total incidence of 23%.

Three additional patients had their femoral stems changed during acetabular revision; in each case the stems were not loose, but were removed to provide better operative exposure, to increase femoral offset, or because of massive bone resorption around the femoral component caused by a granuloma from the acetabulum. Two patients had removal of trochanteric wires.

Excluding the five hips that underwent acetabular re-operation and the two for which we did not have radiographic follow-up, we assessed acetabular fixation on 98 sets of current films. Evidence of acetabular

loosening was found in 39.8% (39 hips). Of special interest, only two of the 43 hips with definite loosening had shown clear evidence of radiographic loosening at our six-year review.

The nonmetal-backed components had a loosening rate of 39%, while the metal-backed components, used in 15 of 19 hips for younger, heavier male patients, had a loosening rate of 53%. This difference was not significant ($p = 0.133$).

Fig. 2

Kaplan-Meier survival analysis curves comparing metal-backed and nonmetal-backed acetabular components at an average follow-up of 11.2 years. The data are based on radiographic criteria and the findings at surgery in those cases having re-operation.

Figure 1 shows the Kaplan-Meier survival analysis curves for femoral and acetabular components; Figure 2 compares metal-backed and nonmetal-backed acetabular components.

DISCUSSION

The loosening rate of 3% for femoral components with a minimum follow-up of 10 years is a highly significant statistical reduction from the rates reported previously by other authors for comparable times and populations in which earlier cement techniques had been used (versus Stauffer $p < 0.0001$, versus Sutherland et al $p < 0.0001$).

We attribute this reduction, by an order of magnitude, to improved cementing techniques and stem design. The cement gun allows more complete filling of the canal and reduces the voids and laminations in the cement mantle. The use of a polymethylmethacrylate plug not only allows greater intrusion pressure of cement (Oh et al 1978), better filling and improved cement-interface strength, but in addition automatically extends the cement mantle for 2 to 4 cm beyond the tip of the

prosthesis. Beckenbaugh and Ilstrup (1978) have shown this to be an important factor for improved fixation of a cemented femoral prosthesis.

Our results have corroborated previous long-term studies which have shown that aseptic femoral loosening generally occurs within the first five years (Stauffer 1982; Sutherland et al 1982), and that after this the rate of femoral loosening reduces. Two femoral components became loose at 2.9 and 4.6 years; after this only one additional femoral component became loose.

It is important to note that, subsequent to the advances in femoral cementing reviewed in our study, further major improvements have been made in techniques. These include: pressurisation of the cement (Oh, Bourne and Harris 1983), reduction of cement porosity using centrifugation (Burke, Gates and Harris 1984) or vacuum mixing (Wixson, Lautenschlager and Novak 1985), pulsatile lavage, the use of an adrenalin-soaked sponge to reduce bleeding in the femoral canal, precoating (Ahmed, Raab and Miller 1984) and roughening of the surface of the femoral component. It is probable that these additions to cementing techniques will further improve the long-term fixation of cemented femoral components.

Cementless femoral components must match *these* results, not the results of primitive cementing techniques. The incidences of subsidence and revision in cementless femoral components which have been reported, to date, for shorter follow-up periods are greater than those we report for cemented femoral components at 11 years (Engh, Bobyn and Glassman 1987; Callaghan, Dysart and Savory 1988; Pierson et al 1989).

The incidence of acetabular loosening increased twentyfold between five and 11 years. Although we used metal-backed acetabular components for the younger, heavier, predominantly male, active patients, this did not appear to be an important advantage in the long-term.

Most stems in this study (84 hips) had an offset of less than 25 mm, which increases the resultant force acting on the hip (Charnley 1979; O'Connor et al 1989), and this may contribute to the early loosening of the acetabular components. O'Connor et al (1989) showed that increased offset did not increase the strain in the femoral cement. It therefore appears to be unlikely that femoral stems with an increased offset would have a higher rate of femoral loosening, and they would decrease the resultant force on the hip.

The excellent long-term femoral fixation we have found after cemented total hip replacement has led us to use cement for femoral fixation in most primary cases.

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