IMPROVED CEMENTING TECHNIQUES AND FEMORAL COMPONENT LOOSENING IN YOUNG PATIENTS WITH HIP ARTHROPLASTY

A 12-YEAR RADIOGRAPHIC REVIEW

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To assess the effect of improved methods of femoral cementing on the loosening rates in young patients, we reviewed 50 'second-generation' cemented hip arthroplasties in 44 patients aged 50 years or less. The femoral stems were all collared and rectangular in cross-section with rounded corners. The cement was delivered by a gun into a medullary canal occluded distally with a cement plug. A clinical and radiographic review was undertaken at an average of 12 years (10 to 14.8) and no patient was lost to follow-up.

No femoral component was revised for aseptic loosening, and only one stem was definitely loose by radiographic criteria. By contrast, 11 patients had undergone revision for symptomatic aseptic loosening of the acetabular component and 11 more had radiographic signs of acetabular loosening.

Aseptic loosening of the components is the most common long-term complication of cemented total hip arthroplasty. At five-year follow-up, radiographic loosening of the femoral component was reported in 20% to 24% of cases in which the cementing methods initially advocated by Charnley, which we call first-generation techniques, had been used (Amstutz et al 1976; Beckenbaugh and Ilstrup 1978). The figures increased to 30% to 40% at ten years (Stauffer 1982; Sutherland et al 1982). Improved cementing techniques can substantially reduce the incidence of femoral loosening (Harris and McGann 1986; Roberts, Poss and Kelley 1986; Russotti, Coventry and Stauffer 1988) to as little as 3% at 11 years (Mulroy and Harris 1990).

In young patients the incidence of failure of cemented hip replacements is reported to be even higher (Chandler et al 1981; Dorr, Takei and Conaty 1983; Dorr, Luckett and Conaty 1990) and for this reason many surgeons changed to cementless femoral stems. The question remained, however, whether the improved cementing technique which had reduced the incidence of loosening in the elderly would be effective in younger patients.

We now report the results of improved cementing techniques of 50 hips in 44 patients aged 50 years or younger at an average follow-up of 12 years (10 to 14.8).

PATIENTS AND METHODS

Between January 1, 1976 and January 1, 1979, 234 cemented total hip replacements were performed on 206 patients by the senior author (WHH), using 'second-generation' cementing techniques and stem design. The specific improvements included the use of a methylnethacrylate femoral medullary plug, delivery of a doughy mix of cement (Simplex P; Howmedica Inc, Rutherford, New Jersey) in retrograde fashion by a cement gun, and the use of a collared cobalt-chrome femoral stem with a rectangular cross-section and rounded corners. The medullary canal was irrigated and packed with sponges until immediately before cementing. Pulsatile lavage and adrenaline-soaked sponges were not used, nor was a cement pressuriser. A large stem was preferred and the largest rasp which could be comfortably inserted was used to prepare the socket in the upper femur. The rasp was usually about 3 mm oversized compared with the stem.
There were 50 hips in 44 patients (21 women, 23 men) with an average age of 40.9 years (18 to 50) at the time of surgery. The patients’ average weight was 69 kg (45.5 to 107).

The original diagnoses of the 50 hips were congenital dislocation and/or dysplasia (19), ‘pistol-grip deformity’ causing osteoarthritis (5), osteoarthritis which was too far advanced to determine the cause (4), avascular necrosis (5), slipped capital femoral epiphysis (5), post-traumatic osteoarthritis (2), rheumatoid arthritis (4), old sepsis (2, including 1 with tuberculosis), Perthes’ disease (2), mucopolysaccharidosis (1) and haemochromatosis (1).

Of the 50 femoral stems, 22 were CAD, 13 were HD-2, 13 were Harris CDH, and two were calcar replacements (Howmedica Inc, Rutherford, New Jersey). Five opera-

![Figure 1a](image1.png)  
*Figure 1a – A postoperative radiograph shows excellent cement distribution (‘white-out’) graded as ‘A’. 

![Figure 1b](image2.png)  
*Figure 1b – Thirteen years later fixation is secure despite adaptive remodelling of the femur.*

![Figure 2a](image3.png)  
*Figure 2a – A postoperative radiograph shows slight radiolucencies at the cement-bone interface, graded ‘B’. 

![Figure 2b](image4.png)  
*Figure 2b – Eleven years later the patient had an excellent clinical result and stable radiographic appearance.*
tions were for revision of failed cemented components, two for failed femoral osteotomies, one for a failed cup arthroplasty, and one for a failed double-cup arthroplasty.

All patients completed a questionnaire and 13 patients (15 hips) were examined by the authors. Current radiographs were obtained for all. These and the postoperative intermediate radiographs were reviewed for evidence of loosening.

'Definite' loosening was defined as migration, or a change in position of the stem or the cement (Harris, McCarthy and O’Neill 1982). This included fracture or bending of the stem, fracture of the cement, the appearance of a radiolucent line at the cement–stem interface not present on the immediate postoperative radiograph, and a shift in the position of the cement mantle relative to the femur. Radiographs that showed a continuous (100%) radiolucent line at the cement–bone interface without evidence of migration were graded as ‘probably’ loose. If a radiolucent zone was present that was not complete, but involved between 50% and 99% of the interface, the component was classified as ‘possibly’ loose.

The radiographic appearance of the initial cementing was graded on the immediate postoperative radiograph. Complete filling of the medullary cavity by cement, a so-called ‘white-out’ at the cement–bone interface was graded ‘A’ (Fig. 1). Slight radiolucency of the cement–bone interface was defined as ‘B’ (Fig. 2). Radiolucency involving 50% to 99% of the cement–bone interface or a defective or incomplete cement mantle was graded ‘C’. Radiolucency at the cement–bone interface of 100% in any projection, or a failure to fill the canal with cement such that the tip of the stem was not covered, was classified ‘D’.

Fixation of the acetabular component was also assessed. Any cemented acetabular component which had migrated or had a continuous radiolucent line regardless of its thickness, was diagnosed as definitely loose (Hodgkinson, Shelley and Wroblewski 1988).

RESULTS

The average duration of follow-up of the 50 hips was 12.0 years (10 to 14.8). No femoral component had been revised for loosening. By contrast, aseptic loosening was the reason for revision of 11 acetabular components. At 12 years, the average Harris hip score (Harris 1969) for the 39 hips that had not been revised was 88 points (41 to 100). 24 were rated excellent, six good, six fair, and three poor. Of the three hips with a poor result, one was due to unexplained pain with negative aspiration arthrogram, normal radiographs and a normal bone scan. In the other two the low score was caused by functional limitations. One patient had recently been operated on for severe spinal stenosis and the other was paraplegic from rheumatoid cervical myelopathy. Of the six hips rated fair, in three the low score was due to symptomatic aseptic loosening of their acetabular components with migration. One patient was being treated for osteomyelitis of the tibia, unrelated to his hip arthroplasty, with a resultant severe functional limitation which lowered his score.

In the 50 current radiographs only one stem was judged to be definitely loose (Fig. 3): a 0.5 mm radiolucent

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Figure 3a – The postoperative radiograph shows good cementing. Figure 3b – Twelve years later there is, however, a new radiolucent line at the cement–stem interface in zone one. This stem was classified radiographically as definitely loose.
line had developed in zone one between the stem and the cement mantle (Fig. 3b). No stem was classified as probably loose but nine hips were possibly loose. Six hips had a small region of focal osteolysis adjacent to the femoral component without evidence of loosening (Jasty et al 1986).

Femoral cementing was classified on the postoperative radiographs as grade A in 32 cases and grade B in 18. There were no cases in grades C or D.

In addition to the 11 acetabular components which had undergone revision for aseptic loosening, there were a further 11 acetabula classified as definitely loose radiographically. A total of 44% of the acetabular components had, therefore, loosened.

During the course of acetabular revision, three of the femoral stems were changed. In each case the stem was secure in the bone, but was removed to alter its position to improve access or, in one case, because of massive bone resorption caused by the granuloma from the loose acetabulum. All three stems had been in situ for more than ten years.

DISCUSSION

In this group of patients, aged 50 years or less undergoing cemented total hip replacement by second-generation femoral cementing techniques, there had been no femoral stem revisions by 12 years and only one femoral component was loose on radiographic criteria. This is a striking change from the results reported using first-generation cementing techniques, particularly as five of the 50 arthroplasties were revisions for failed cemented implants.

Chandler et al (1981) reported revised or radiographically loose components in 57% of 29 patients aged 30 years or less. The incidence of radiolucent lines was 94% on the acetabular side and 33% on the femoral side. The number of revisions for acetabular and femoral loosening, however, were equal (five of each in seven patients). Component migration or 'ominous' radiolucency (progressive and more than 2.5 mm thick), was seen in nine acetabula, one femur, and in one case involved both components (Chandler et al 1981).

Dorr et al (1983) described 81 patients aged 45 years or less and followed up for an average of 4.5 years. There was radiographic evidence of impending failure in 29% and most of the problems were on the acetabular side where progressive radiolucency was seen in 83% as against 42% in the femoral stem. Even in those hips in which the cementing technique was judged to be adequate (40%), there was progressive demarcation around 95% of the acetabula and 53% of the femoral stems. The cement technique was technically unsatisfactory in 60% of cases by the authors' criteria.

In a series of cemented total hip replacements in patients 49 years old or less using first-generation methods, Collis (1991) found at 14.9 years that 20% of the femoral stems had been revised and another 8% were loose radiographically.

Cornell and Ranawat (1986), in their series of cemented total hips in patients under 55 years of age, found that by 13 years, survivorship of prostheses had decreased to 70%, mainly due to acetabular component failure. The predicted rate of success for the femoral stems was 93%. No stem had been revised for aseptic loosening but two acetabular components had been revised. One other acetabular component and one femoral stem were radiographically loose. The results of our series are similar. We had 22% acetabular revisions and a further 22% were radiographically loose; on the femoral side the corresponding figures were 0% and 2%.

Based on the poor results of some early series, many authors have advised against the use of cemented stems in young patients (Aronson 1986; Dorr et al 1990) and many surgeons have changed to cementless femoral implants. Engh and Glassman (1990), however, found that there was a 2.6% failure rate at an average follow-up of only 4.75 years in 303 AML (DePuy Inc, Warsaw, Indiana) cementless femoral components in patients less than 50 years old.

The use of a PCA stem (Howmedica Inc, Rutherford, New Jersey) in patients aged 50 years or less, recently reported by Davies and Hedley (1991), resulted in 2% femoral revisions and 6% radiographically unstable femoral components in a series of 48 hips followed for only 38 months.

We attribute our reduced loosening rate to the introduction of improved cementing techniques and better stem design. The cement gun allows more complete filling of the medullary canal, and reduces the voids and laminations in the cement mantle. The use of a methylmethacrylate medullary plug not only allows greater intrusion pressure of cement (Oh et al 1978) with better filling and improved cement–bone interface strength, but also automatically extends the cement mantle 2 to 4 cm beyond the tip of the prosthesis. Beckenbaugh and Ilstrup (1978) noted that this was an important factor for improved fixation. The clear evidence for the improvement in technique is that we had no hips with grade C or D cementing. Wrobleski (1990) has recently reported a reduction of stem revision for loosening from 6% to 0.9% since he added an intramedullary bone plug to his cementing technique.

Advances in cementing technique have greatly improved the long-term survival of femoral stem implants in young patients. For cementless methods of fixation to compete they must now match these results, not those of first-generation cementing methods.

This study was supported by the William H. Harris Foundation.

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