REVISION FOR ASEPTIC STEM LOOSENING USING THE CEMENTED CHARNLEY PROSTHESIS

A REVIEW OF 351 HIPs

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We reviewed 351 cemented revisions of femoral stems performed for aseptic loosening.

At a mean of six years after the revision operation 72.1% of the patients were pain-free and 21.4% had only mild or occasional discomfort. The latest radiographs showed definite stem loosening in 10 (2.8%) and 20 hips (5.7%) had required rerevision, only nine (2.6%) of which were for mechanical failure of the stem. Survivorship analysis, taking the end point as rerevision of the stem, gave 97.0% survival at eight years and 91.6% at 11 years.

Excellent results both clinically and radiologically can be achieved by cemented revision of the femoral stem for aseptic loosening.

J Bone Joint Surg [Br] 1995;77-B:23-7.

Received 23 November 1993; Accepted after revision 6 June 1994

The Charnley low-friction arthroplasty has been accepted as the standard for assessment of the long-term results of primary hip arthroplasty (Wroblewski, Taylor and Siney 1992; Schulte et al 1993), but the early results of similar cemented revision arthroplasties were discouraging, with asymptomatic loosening reported to be 26% to 29% at 2.1 years and 8.1 years, respectively (Amstutz et al 1982; Pellicci et al 1985). These reports led to the increasing use of cementless techniques for revision surgery, but their medium-term success rates have also been unsatisfactory, with failure rates as high as 27% after 5 years (Lord et al 1988), femoral osteolysis rates of 69% at 20 months (Hedley, Gruen and Ruoff 1988) and minimal or absent bone ingrowth in 80% (Cook et al 1991). A stem loosening rate of 17.7% at 4.4 years was reported by Engh et al (1988), and Gustilo and Pasternak (1988) had a rerevision rate of 16% at 2.8 years. Other reports have also shown dis-

appointing results after revision with several types of cementless prosthesis (Owen, Moran and Pinder 1994; Sweetnam, Lavelle and Muirhead-Allwood 1994; Weir, Sher and Innes 1994).

Recent reports of stem revision using cement have been better (Rubash and Harris 1988; Marti et al 1990; Gie et al 1993; Izquierdo and Northmore-Ball 1994), and we have now reviewed our results of cemented stem revision for aseptic stem loosening at an average follow-up of six years. Revisions for fracture of the stem are the subject of a separate study.

PATIENTS AND METHODS

From 1974 to 1990, the senior author (BMW) revised 351 stems for aseptic loosening in 336 patients. This is a consecutive personal series with full records of all patients from before revision.

There were 193 men and 143 women. The average age at revision was 64 years (29 to 92), the average weight was 73 kg (32 to 118), and the underlying hip pathology is listed in Table I. Most of the hips, 265 (75.5%), were in

Table I. Primary diagnosis in 351 stem revisions

	Number	Percent
Primary osteoarthritis	248	70.7
Fractured neck of femur	24	6.8
Rheumatoid arthritis	15	4.3
Trauma	14	4.0
Congenital hip dysplasia	13	3.7
Quadrantic head necrosis	10	2.9
Paget's disease	6	1.7
Slipped upper femoral epiphysis	5	1.4
Old sepsis	3	0.9
Ankylosing spondylitis	3	0.9
Protrusio acetabuli	2	0.6
Perthes' disease	2	0.6
Other (unclassified)	6	1.7

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0301-620X/95/1898 \$2.00

patients referred from other hospitals; 86 hips (24.5%) had the primary arthroplasty at Wrightington Hospital. Over half the hips, 191 (54.4%), had Charnley stems at primary surgery; 242 hips (69.0%) had undergone only one previous operation (the primary arthroplasty) and 109 (31.0%) had had more than one previous operation.

Clinical assessment used the Merle d'Aubigné and Postel (1954) grading for hips as modified by Charnley (1979). The quality of femoral cementing was assessed from post-operative anteroposterior radiographs using the three grades suggested by Raut (1992): grade A showed total and complete filling of the medullary canal around the stem with cement; grade B showed some radiolucency at the cement-bone interface, but a continuous cement mantle around the stem; and in grade C there was at least one area around the stem where there was no cement between the stem and the femoral cortex. The presence of 'trapped air' or 'voids' in the cement mantle was also noted, as was stem orientation after revision.

Later radiographs of the pelvis were studied for the presence of the 'at risk' factors (Pacheco, Shelley and Wroblewski 1988), including stem migration, cement fracture and any radiolucency at the cement-prosthesis interface. Demarcation and cavitation around the cement were recorded for each of the zones of the cement-bone interface (Gruen, McNeice and Amstutz 1979). All review observations were based on a comparison between the latest radiograph and one taken immediately after revision. Aseptic stem loosening was classified as 'possible', 'probable' or 'definite' as suggested by Harris, McCarthy and O'Neill (1982). All the radiographic reviews were performed by one of the authors (VVR).

Revision technique. We used a transtrochanteric lateral approach in all cases, with technical details as described by Wroblewski (1990). In all cases, the socket was tested for

evidence of loosening and treated accordingly. After cement removal, the lesser trochanter was excavated where possible to provide a good cancellous bed in the proximal femur; in later cases the distal femoral canal was closed off with a cement block to enhance cement pressurisation during injection. Charnley components were used in all cases.

After operation, patients were allowed to start partial weight-bearing on crutches at two weeks and retained the crutches for three months. Hydroxychloroquine (Plaquenil; Winthrop, Guildford, UK), an antiplatelet agent, was given as antithrombotic treatment (Johnson and Charnley 1979).

RESULTS

The average hip score before revision was 3.3 for pain, 2.9 for function and 3.8 for movement. Fifteen (4.5%) of the patients were on long-term steroid therapy. There was some endosteal bone lysis before revision in 259 hips (73.8%). This involved four or more of the seven Gruen zones in only 132 hips (37.6%). There was a fracture of the femur in 29 hips (8.3%), and the stem of the femoral component was extruding from the femoral canal in 16 hips (4.6%).

Fifty-four hips (15.4%) required only a change of stem; 297 hips (84.6%) also required socket revision. The femoral canal was closed distally by a cement plug in 265 hips (75.5%), and the lesser trochanter was excavated in 201 hips (57.3%).

The type of prosthesis used is shown in Table II; it was placed in a neutral position in 193 hips (55.0%), in a valgus position in 126 (35.9%) and in a varus position in 32 (9.1%). The mean intraoperative blood loss was 456 ml (50 to 2500); the operating time averaged 112 minutes (60 to 195). Postoperative antibiotic treatment was given in 265

Table II. Type of Charnley femoral prosthesis used in 351 revision operations

	Number	Percent
Long neck	104	29.6
Standard	101	28.8
Long stem + long neck	42	12.0
Magnum	40	11.4
Modular prosthesis	23	6.6
Short stem + long neck	12	3.4
Long stem	10	2.9
Short stem	9	2.6
Short neck	5	1.4
Custom-made stem	4	1.1
Short stem + short neck	1	0.3

Table III. Postoperative complications (within one year) of 351 revision operations

	Number
Early	
Urinary infection	18
Pulmonary embolism (non-fatal)	13
Dislocation	12
Abdominal symptoms	11
Deep-vein thrombosis (clinical)	8
Cardiovascular	8
Delayed wound healing	6
Superficial infection	4
Other	68
Late	
Death (unrelated causes)	17
Trochanteric nonunion	22
Dislocation	14
Fractured femur	5

cases (75.5%), and antibiotic-loaded cement was used in 316 hips (90.03%). The average duration of hospital stay after operation was 25 days.

The postoperative femoral cementing (Raut 1992) was graded A in 126 hips (35.9%), B in 197 (56.1%) and C in 28 (8.0%). There were voids in the cement mantle around the stem in 145 hips (41.3%).

Complications. Intraoperative complications included fragmentation of the greater trochanter in seven hips, perforation of the femur in four and minor calcar fractures in three. The early and late postoperative complications are shown in Table III. There were no deaths in the first year, but 17 patients (5.1%) have died of unrelated causes during follow-up. There was nonunion of the trochanter in 22 hips (6.3%); three of these had ununited trochanters before the revision operation.

Clinical results. At an average follow-up of six years (1 year to 17 years 10 months) 253 hips (72.1%) were pain-free and 75 (21.4%) had only mild or occasional discomfort. The average hip scores were 5.4 for pain, 4.6 for function and 5.1 for movement.

Radiographic results. On the latest radiograph, 326 hips (92.9%) had a 'well-fixed' stem (Harris et al 1982). Twenty-five hips (7.1%) showed some at-risk factors for stem

loosening (Pacheco et al 1988); ten of these (2.8% of all hips) had 'definite' loosening, three (0.9%) 'probable' loosening and 12 (3.4%) showed 'possible' loosening (Harris et al 1982). One of the patients had evidence of late deep infection during follow-up and required a revision procedure.

Rerevision. Twenty hips (5.7%) required rerevision. Eight stems were revised for aseptic loosening and one for fracture of the revision prosthesis. Of the other 11 rerevi-

Fig. 1

Survivorship of 351 revised hips using rerevision of the stem, for any reason, as the definition of failure.

Table IV. Survivorship table of 351 revised hips using rerevision of the stem for any indication as the definition of failure

Year	Number at start	Withdrawn	Failure	Number at risk	Failure rate	Cumulative success rate	Standard error	Lower 95% confidence limit
0 to 1	351	0	0	351.0	0.00	100.00	0.00	100.00
1 to 2	351	23	0	339.5	0.00	100.00	0.00	100.00
2 to 3	328	55	3	300.5	1.00	99.00	0.01	97.77
3 to 4	270	43	0	248.5	0.00	99.00	0.01	97.65
4 to 5	227	44	0	205.0	0.00	99.00	0.01	97.49
5 to 6	183	38	2	164.0	1.22	97.78	0.01	95.24
6 to 7	143	34	1	126.0	0.79	96.99	0.02	93.56
7 to 8	108	31	0	92.5	0.00	96.99	0.02	93.00
8 to 9	77	17	2	68.5	2.92	94.07	0.03	87.81
9 to 10	58	13	0	51.5	0.00	94.07	0.04	87.01
10 to 11	45	9	1	40.5	2.47	91.60	0.05	81.85
11 to 12	35	13	1	28.5	3.51	88.09	0.07	74.60
12 to 13	21	3	1	19.5	5.13	82.96	0.09	65.02
13 to 14	17	6	0	14.0	0.00	82.96	0.11	61.74
14 to 15	11	2	1	10.0	10.00	72.96	0.15	42.61
15 to 16	8	4	0	6.0	0.00	72.96	0.22	30.03
16 to 17	4	2	0	3.0	0.00	72.96	0.38	-1.40
17 to 18	2	2	0	1.0	0.00	72.96		

sions (3.1%), five were for recurrent dislocation, four for aseptic socket loosening, one for deep infection and one for unexplained pain.

Survivorship analysis. Survivorship analysis (Kaplan and Meier 1958; McCoy et al 1988) using revision of the stem as the definition of failure showed a 97.0% survival of the femoral prosthesis at eight years and 91.6% at 11 years (Table IV, Fig. 1). Using 'definite' or 'probable' radio-

Fig. 2

Survivorship of 351 revised hips using definite or probable radiographic stem loosening as the definition of failure.

graphic stem loosening as the end point, survivorship was 96.4% at eight years and 89.6% at 11 years (Table V, Fig. 2). At 11 years, in both of these analyses, 40 or more prostheses were at risk (Letting, Ware and Morris 1991).

Factors influencing the result. We found that the incidence of stem loosening was significantly reduced by: a) a cement block in the distal femoral canal; b) excavation of the lesser trochanter as part of the preparation of the proximal femur; c) a neutral position of the stem after revision; and d) grade-A quality of femoral cementing. Other factors including the age and weight of the patient, the number of previous operations on the hip, the extent of endosteal cavitation before revision and the presence of voids in the cement mantle had little influence.

DISCUSSION

Reports of the results of revision surgery using cement have shown various but improving success rates. Early reports were disappointing (Hunter et al 1979; Amstutz et al 1982; Kavanagh, Ilstrup and Fitzgerald 1985; Pellicci et al 1985), but Callaghan et al (1985) achieved a success rate of 87.8% at a mean of 3.6 years, and Rubash and Harris

Table V. Survivorship table of 351 revised hips using definite or probable radiographic loosening of the stem as the definition of failure

Year	Start	Withdrawn	Failure	Number at risk	Failure rate	Cumulative success rate	Standard error	Lower 95% confidence limit
0 to 1	351	0	0	351.0	0.00	100.00	0.00	100.00
1 to 2	351	23	0	339.5	0.00	100.00	0.00	100.00
2 to 3	328	57	1	299.5	0.33	99.67	0.00	98.95
3 to 4	270	43	0	248.5	0.00	99.67	0.00	98.88
4 to 5	227	43	1	205.5	0.49	99.18	0.01	97.80
5 to 6	183	38	2	164.0	1.22	97.97	0.01	95.52
6 to 7	143	33	2	126.5	1.58	96.38	0.02	92.64
7 to 8	108	31	0	92.5	0.00	96.38	0.02	92.05
8 to 9	77	16	3	69.0	4.35	92.03	0.04	84.94
9 to 10	58	13	0	51.5	0.00	92.03	0.04	84.03
10 to 11	45	9	1	40.5	2.47	89.56	0.05	78.94
11 to 12	35	13	1	28.5	3.51	86.05	0.07	71.79
12 to 13	21	3	1	19.5	5.13	80.93	0.09	62.41
13 to 14	17	6	0	14.0	0.00	80.93	0.11	59.02
14 to 15	11	2	1	10.0	10.00	70.93	0.16	40.32
15 to 16	8	4	0	6.0	0.00	70.93	0.22	27.65
16 to 17	4	2	0	3.0	0.00	70.93	0.38	-4.03
17 to 18	2	2	0	1.0	0.00	70.93		

(1988) had a 7% rerevision rate with a 13% incidence of radiographic stem loosening at an average follow-up of six years. Marti et al (1990) reported a rerevision rate of 6.7% at an average follow-up of 8.9 years. The best results presented to date have been in the series of Izquierdo and Northmore-Ball (1994) who used Charnley cemented stems with a rerevision rate of 3.4% and a radiographic stem loosening rate of 8.9% at a mean of 6.5 years.

Hip revision using cementless techniques was no better. Engh et al (1988) reviewing 160 porous-surfaced implants at an average follow-up of 4.4 years, reported 17.7% loosening of the femoral component. Gustilo and Pasternak (1988), reporting 57 revisions using titanium-ingrowth femoral components, had a rerevision rate of 16% at a mean follow-up of only 2.8 years, and Hedley et al (1988), using uncemented porous-coated anatomic components, showed a 69% incidence of femoral lucencies and a 9.5% incidence of femoral component loosening at a mean follow-up of 20 months. Engh, Bobyn and Glassman (1987) reported significant stress shielding with fully porous-coated prostheses in 23% of cases and Lord et al (1988)

had unsatisfactory results after five years in 28% of their 64 cases.

Our rerevision rate for mechanical stem failure alone was 2.6%, while the overall rerevision rate for all reasons was 5.7%. On radiographic analysis, 2.8% of the stems showed definite loosening, 0.9% showed probable loosening and 3.4% showed possible loosening. These results are better than most of those discussed above perhaps because our cases were all operated on by one experienced surgeon.

Our analysis of the 25 stems which had some evidence of loosening showed that distal cement blocking, excavation of the lesser trochanter, a neutral stem position and grade-A cementing were important features of the surgical technique. A detailed analysis of all these variables and their statistical importance is the subject of a separate study.

Our results suggest that the cemented Charnley stem has again provided a standard for comparison of the outcome of revision surgery.

This study was supported by the Peter Kershaw 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.

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