MECHANICAL LOOSENING OF THE STEM IN CHARNLEY ARTHROPLASTIES

IDENTIFICATION OF THE "AT RISK" FACTORS

V. PACHECO, P. SHELLEY, B. M. WROBLEWSKI

From the Centre for Hip Surgery, Wrightington

A retrospective review of 72 cases of Charnley low friction arthroplasty revised for stem loosening, has identified a number of "at risk" factors. These were: previous hip surgery and, in radiographs taken at one year, demarcation of the distal cement and fracture of the cement near the tip of the stem. Separation of the back of the stem from the cement, as an isolated feature, was not considered significant. Endosteal cavitation of the femoral shaft, rare in the first year, indicated loosening of some duration. Patients whose radiographs show the "at risk" changes, should be followed-up indefinitely in order to plan timely revision and avoid gross loss of the femoral bone stock.

Loosening of the stem in cemented total hip arthroplasty is recognised as a major problem. It often causes symptoms and is relatively easily recognised on serial radiographs. However, the large number of operations performed makes it almost impossible to follow-up all patients indefinitely.

If radiographic signs indicating a high risk of stem loosening could be identified, then follow-up of a selected group of patients could be rationalised. To identify the radiographic signs of such "at risk" cases, as well as to study the changing pattern of revisions for stem loosening after Charnley low friction arthroplasty (LFA), a retrospective study has been undertaken of all cases revised for mechanical loosening of the stem. The one-year radiographs of the revised group were compared with those of the clinically successful cases with the longest follow-up (15–21 years, Wroblewski 1986). The time interval between the arthroplasty and the revision as well as the changing incidence of revisions for loosening were also noted.

MATERIALS AND METHODS

Between November 1962, when Charnley low friction arthroplasties became routine, and December 1984, 19,161 have been performed in our unit. During this 22-year period 1 085 are known to have been revised for

various reasons; this included 72 which were revised for mechanical loosening of the stem. The records and serial radiographs of these were studied. The radiographs taken about one year after operation were carefully compared with those taken soon after the operation. The following were recorded:

Appearance unchanged. Rounding off, or loss of cortical definition of the medial femoral neck was accepted as indicating no significant change.

Separation of the lateral side of the stem from the cement. This indicates a "slip" or tilting of the stem within the cement mantle (Fig. 1).

Demarcation of the tip of the cement. This is almost certainly due to lack of stem support and movement of the stem-cement complex within the medullary canal; it becomes more obvious if associated with condensation of cancellous bone around the distal cement (Fig. 2).

Fracture of the cement near the tip of the stem. When an end-weight bearing stem slips within the cement mantle, fracture of the distal end of the cement occurs. The proximal, curved portion of the stem is likely to break the continuity of the medial cement (Fig. 3).

Endosteal cavitation. Scalloping of the endosteal surface of the cortex is the result of alteration of pressure and volume within the cavity containing the implant (Fig. 3).

The position of the stem (varus, valgus or neutral), previous hip surgery, and the patients' weight were also recorded.

RESULTS

Of the 72 cases revised 47 were men and 25 women. Their average age at surgery was 58 years (range 22 to 75 years). The average time to revision was 7.7 years (range 1 to 17 years).

The original hip pathology is shown in Table I and

V. Pacheco, MA, Orthopaedic Registrar
P. Shelley, PhD, Research Fellow
B. M. Wroblewski, FRCS, Consultant Orthopaedic Surgeon
The Centre for Hip Surgery, Wrightington Hospital, Near Wigan,
Lancashire, England.

Correspondence should be sent to Dr V. Pacheco.

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Fig. 1

Figure 1 – Tilting of the stem with separation of its lateral aspect from the cement. Figure 2 – Demarcation at the tip of the cement. Figure 3 – To show fracture of the cement near the tip of the stem and endosteal cavitation.

Fig. 2

Fig. 3

Fig. 4

Incidence of revision for stem loosening in relation to postoperative follow-up.

Fig. 5

Yearly incidence of revision for stem loosening in relation to the evolution of the Charnley low friction arthroplasty from November 1962 to December 1986.

Table I. The original hip pathology

Diagnosis	Number
Osteoarthritis	
Primary	48
Secondary	18
Rheumatoid arthritis	2
Idiopathic protrusio	2
Ankylosing spondylitis	1
Avascular necrosis	1
Total	72

Table II. Previous operations

Operation	Number
Intertrochanteric osteotomy	11
Fracture fixation	3
Total hip arthroplasty	3
Femoral head replacement	3
Cup arthroplasty	1
Fusion	1
Total	22

Table III. The radiographic appearances at one year of 72 cases revised for stem loosening compared with those of 116 clinically successful cases followed up for 15–21 years

Radiographic appearances at one year	72 revisions for stem loosening		116 successful cases		Statistical significance of difference
	Number	Per cent	Number	Per cent	
Unchanged	12	16.7	70	60.3	p < 0.002
Separation of stem from cement	19	26.4	31	26.7	Not significant
Demarcation at tip of cement	43	59.7	21	18.1	p < 0.001
Fracture tip of cement	12	16.7	4	3.4	p < 0.001
Endosteal cavitation	1	1.4	0	0	
Stem position					
varus	7	9.7	16	13.8	Not significant
valgus	42	58.3	19	16.4	p < 0.001
neutral	23	31.9	81	69.8	p < 0.002
Previous surgery	22	30.6	5	4.3	p < 0.001
Weight (kg)	69		66		Not significant

Table IV. Radiographic appearances before revision for stem loosening

	Number	Per cent
Separation of stem from cement	33	45.8
Demarcation tip of cement	38	52.8
Fracture tip of cement	22	30.6
Fracture other part of cement	6	8.3
Endosteal cavitation	25	34.7
Fracture femur	2	0.3

any previous hip surgery in Table II. Table III shows the radiographic appearances at one year compared with those of clinically successful cases which had been followed up for 15 to 21 years; the statistical significance also is shown. Table IV lists the radiographic appearances immediately before the revision for stem loosening.

Figure 4 shows that the rate of revision for stem loosening was greatest in the ninth postoperative year and then, with one exception, gradually declined. Revision for stem loosening as part of the evolution of the Charnley LFA (Fig. 5) has shown that in the first six years (1962/63 to 1968) of the technique and during a time when some 2 500 LFAs were performed, there were no revisions for stem loosening. The numbers gradually increased to peak in 1985. Only now are the benefits of improved stem design and surgical technique becoming apparent.

DISCUSSION

This review has identified certain "at risk" factors. Careful assessment of the one-year radiograph will, in most cases, indicate the likelihood of future revision being needed. Apart from patients who have had previous hip surgery, the main "at risk" features are cement demarcation or fracture, and endosteal cavitation; once stem subsidence has occurred these changes may become progressive, with fractures of other parts of the cement and more endosteal cavitation (Fig. 4). These changes are rare in the first year but increase with time and are related to the duration of the loosening. This is clearly shown when Tables III and IV are compared; endosteal cavitation was present in only one case at one year, but increased to 25 cases by the time of revision. One important consequence of loosening of the stem or

stem-cement complex is that it acts as a stress riser and may lead to fracture of the femoral shaft.

A valgus position of the stem, often regarded as desirable, featured prominently in the group of revised cases and was associated with early demarcation of the distal femoral cement in 42% of them; the ideal position of the stem is neutral. The quality of cement fixation is improved by the use of an intramedullary bone block, which reduces the incidence of those radiological appearances indicating stem loosening (Wroblewski and Van der Rijt 1984).

This present study of stem loosening has not only identified the "at risk" factors, but has also highlighted the increasing incidence with longer follow-up. The peak incidence in the ninth postoperative year and the twenty-third year of the Charnley LFA technique warns against drawing conclusions from a short follow-up. It should be emphasised that the study was exclusively of Charnley's low friction arthroplasty, but there is no reason why the same criteria should not apply to other cemented total hip arthroplasties - provided, of course, that the cement is radio-opaque.

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