



## Correlation between thigh pain and radiological findings with a proximally porous-coated stem

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Thigh pain has been consistently reported with cementless hip arthroplasty. The correlation between thigh pain and radiological findings and the clinical significance of thigh pain have not been studied in any detail. We carried out a retrospective study to analyse the performance of a proximally porous-coated cementless femoral component. Ninety-eight total hip arthroplasties were followed up clinically and radiologically for an average of 33 months (range : 12 to 64) after operation. The clinical results were good or excellent in 85 cases (87%). Thirteen patients (13%) reported thigh pain at latest follow-up. Subsidence of the stem was recorded in 10 cases, cortical thickening occurred in 14 hips (14%), and 17 hips (17%) presented proximal osteopenia. Proximally, radiolucent lines were observed in 11 cases. Thigh pain correlated with radiolucent lines, femoral thickening, fibrous fixation and stem migration. Bone remodelling was noted to continue even five years after implantation.

Our observations demonstrated bone ingrowth in the majority of the cases and a low incidence of thigh pain. The correlation between radiological changes and thigh pain suggests implant micromotion and migration in some hips. Patients with thigh pain, changes in the proximal femur and progressive subsidence need further clinical and radiological follow-up.

**Keywords :** thigh pain ; hip arthroplasty ; remodelling ; short-term results.

## INTRODUCTION

Different designs and fixation techniques for the femoral component in cementless total hip arthroplasty (THA) have been developed in an attempt to minimise or eliminate loosening of the stem (1,3,5,18-20,22). Porous surfaces as adjunctive fixation have become increasingly popular (3,5,7). Femoral prostheses with two-third proximal porous coating were developed in an attempt to reduce stress shielding and thigh pain observed with stems designed for distal fixation. However, a characteristic pattern of thigh pain was also recorded with these cementless

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implants. It has been attributed to abnormal stress distribution and remodelling of the proximal femur, but instability has also been suggested as a possible cause (4).

Predicting long-term results on the basis of a relatively small number of hips followed for a shorter time period is an attractive alternative (13). The characteristics of migration and remodelling after implantation were found by various authors to be an accurate predictor of loosening and failure of the prosthesis (1,13,14,19,21). However, the clinical significance of thigh pain and the correlation between thigh pain and radiological findings are not well described in the literature.

The purpose of the current retrospective study was to evaluate thigh pain and the radiological performance of a proximally porous-coated cementless cobalt-chromium-molybdenum alloy femoral stem. This included assessment of radiological findings regarding bone remodelling and aseptic loosening of the stem and their relationship to factors related to both patients and prosthesis. Recognition of these factors will aid in understanding the osseous fixation of proximally coated femoral implants and provide criteria for evaluation of new stem designs.

## MATERIAL AND METHODS

Between April 1998 and October 2001, 132 total hip prostheses were implanted in 122 patients by six experienced orthopaedic surgeons. A two-third proximally porous-surfaced, collared, straight cobalt-chromium-molybdenum alloy femoral implant was used (Vision 2000 DePuy, Warsaw, USA) (fig 1). The stem was combined in all cases with a porous-coated Duraloc cup (DePuy, Warsaw, USA) and a 28mm prosthetic head (ceramic in 64, metal in 34).

During the follow-up period, four patients died of causes unrelated to the arthroplasty. Ten patients were lost to follow-up and 17 with clinically and radiological stable implants were excluded because of lack of regular follow-up. Two patients who underwent revision arthroplasty for periprosthetic fractures in the early postoperative period were also excluded.

One patient with an infected prosthesis died of sepsis three months postoperatively. These patients were however included in the survivorship analysis.



Fig. 1. — Photograph showing the Vision 2000 stem

The remaining 88 patients (98 hips, 51 women, 37 men) were evaluated clinically and radiographically preoperatively and postoperatively at 3 months, 6 months, 12 months, 2 years and then at two-year intervals. The average age of the patients at the time of the index arthroplasty was 63.9 years (range : 22 to 89). The mean duration of follow-up was 33 months (range : 12 to 64). The initial diagnosis was primary osteoarthritis in 64 hips (65.3%), avascular necrosis in 20 hips (20.4%), secondary osteoarthritis due to congenital dysplasia of the hip in eight (8.2%), and other conditions in six hips (6.1%).

The clinical evaluation was performed with the Harris hip score (HHS) preoperatively. Postoperatively, both the Harris hip score and Merle d'Aubigné and Postel scoring system (10, 16) were used for assessment. Charnley ABC groups were recorded (6).

Radiological evaluation was performed on standard anteroposterior and lateral radiographs by two orthopaedic surgeons (PK and RR) blinded to the patient's eventual clinical outcome. The postoperative radiographs were evaluated for radiolucencies, osteolysis,

periosteal cortical hypertrophy, cancellous condensation, atrophy of the calcar, subsidence and migration of the implant. If there was a bone pedestal and no reactive lines around the stem, this was defined as a pedestal associated with a stable distal stem (6). We graded resorption of the proximal part of the femoral neck as present or absent, but did not quantify it. Proximal osteopenia was recorded as "present" when compared with the appearance on the postoperative radiographs. Similar estimates were made of intramedullary stem-tip sclerosis and cortical hypertrophy as change in the thickness of the femoral cortex adjacent to the prosthesis. Femoral component fixation was graded as radiographic bone ingrowth, stable fibrous ingrowth, or unstable according to the criteria described by Engh *et al* (7, 8). Radiolucency was defined as a radiolucent line greater than 1 mm that encompasses at least 50 per cent of the length of the zone according to Gruen *et al* (9). Osteolysis was defined as a cystic change in the femoral cortex greater than 2 mm and 1/2 of the size of a zone (13). The position of the stem was defined as neutral, valgus ( $\geq 3$  mm of medial deviation), or varus ( $\geq 3$  mm of lateral deviation).

Measurements using ruled lines (21) were made with correction of radiographic magnification. Subsidence was defined as an increase of at least 3 mm in the distance between the top of the stem and the greater trochanter when the postoperative radiographs after initial weight-bearing were compared with those made at the follow-up evaluation (21). Subsidence of  $\geq 5$  mm was considered progressive. The latter four changes were measured with use of the zones described by Gruen *et al* (9). Progression or accompanying occurrences of the latter four postoperative radiological changes defined radiological fixation failure. Wear of the polyethylene was also measured (15).

Kaplan-Meier survivorship analysis was used to estimate the cumulative probability of not having radiological loosening. The "best-case" scenario curve for the 98 hips was compared with the "worst-case" scenario curve including all patients in the series and considering losses to follow-up as failures (17). Qualitative data were compared using the chi-square test or Fisher's exact test, and quantitative data were compared with use of the Mann-Whitney U test. Spearman's correlation coefficient rho was used to measure correlations between different parameters. Statistical analysis was performed with the SPSS statistical package Version 10.0 (SPSS, Chicago, Illinois, USA) and XLSTAT 2007 (Addinsoft, Paris, France). Significance was defined as a p value of  $< 0.05$ .



**Fig. 2.** — Radiographs of a 73-year-old woman with osteoarthritis postoperatively (a) and at 3 years (b), showing two-third proximally porous-coated stem. Good position of the stem and no signs of loosening. Slight resorption of the proximal part of the femoral neck is visible at three years. She has no pain with an excellent clinical result.

## RESULTS

### Clinical results

The mean HHS was 44 points (range : 13 to 78) preoperatively and 93 points at follow-up (range : 66 to 100) (fig 2). According to the clinical evaluation, 85 hips (87%) had excellent or good results, seven (7%) fair, and six (6%) poor. Of the six poor results, two were in Charnley category C, and their scores were reduced because of chronic conditions. Thirteen patients (13%) complained of thigh pain, severe in two cases. There was improvement in thigh pain after one year and throughout the whole period of observation (table I).

### Radiographic results

On postoperative radiographs, 96 (98%) of the 98 femoral stems were in neutral position, one (1%) was in varus and one (1%) in valgus. Bone ingrowth occurred in 87 (89%) of the cases, stable fibrous ingrowth was observed in 10 stems (10%) and radiological loosening was detected in one stem (1%). Fibrous fixation showed statistically significant correlation with thigh pain ( $p < 0.001$ ).

Table I. — Thigh pain according to Merle d'Aubigné and Postel in the 98 patients

Pain (Grade)	At 1 year (N, %)	At latest follow-up (N, %)
1	0	0
2	2 (2%)	0
3	4 (4%)	2 (2%)
4	6 (6%)	3 (3%)
5	7 (7%)	6 (6%)
6	3 (3%)	2 (2%)
Total	22 (22%)	13 (13%)

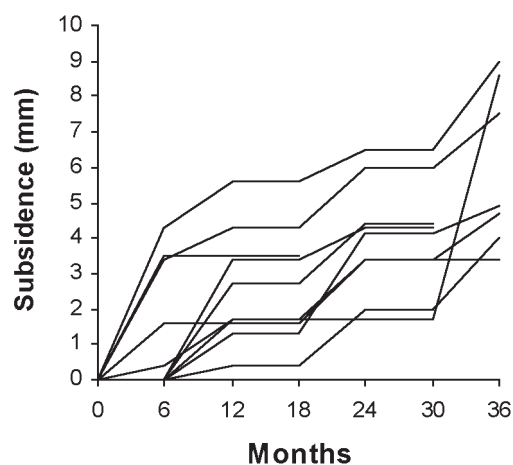


Fig. 3. — Migration pattern of the 10 hips with subsidence (> 3 mm).

Subsidence ( $\geq 3$  mm) occurred in 10 hips (10%) combined with varus migration in one stem implanted in varus position and three of these developed progressive subsidence ( $\geq 5$  mm) (fig 3). The mean subsidence in the 87 hips fixed by stable bone ingrowth was 1.1 mm (SD,  $\pm 1.4$  mm) versus 2.4 mm (SD,  $\pm 1.2$  mm) in the 10 hips fixed by stable fibrous ingrowth ( $p = 0.001$ ). Migration correlated with avascular necrosis as primary diagnosis ( $p < 0.011$ ), fibrous fixation ( $p < 0.001$ ) and thigh pain ( $p < 0.018$ ), and hips with migration showed greater linear wear of the polyethylene (0.15 mm/yr) although the difference did not reach statistical significance.

Cortical thickening was seen in 14 femora (14%), of which three had atypical thickening at the level of the middle of the stem on the lateral side and one had lateral thickening at the tip of the stem due to lateral migration of the tip of the stem. Cortical thickening was first seen 7 to 24 months (mean : 16 months) postoperatively and increased at the latest follow-up. Of these 14 femora with cortical hypertrophy, nine had concurrent evidence of slight resorption of the calcar. A correlation was found between the distal femoral bone thickening and thigh pain ( $p < 0.019$ ).

Radiolucent lines were observed in zone 1 in 11 cases and at the tip of the stem in one case. Radiolucency correlated with femoral thickening ( $p < 0.001$ ), thigh pain ( $p < 0.004$ ) and stem tip sclerosis ( $p < 0.001$ ). Femoral neck atrophy was observed in 15 hips (15%). Resorption typically involved only the proximal 2 to 4 mm of the neck. The incidence of proximal osteopenia was 17% (17 hips). Stem-tip sclerosis, with intramedullary new bone formation was seen in 18 hips (18%). It correlated with migration ( $p < 0.001$ ), thickening ( $p < 0.001$ ) and thigh pain ( $p < 0.02$ ). There was no statistically significant correlation between thigh pain and size of the femoral component used or canal filling, nor between thigh pain and gender, age or level of activity. Small focal lytic lesions were observed in four cases. Patients with lysis showed greater linear wear of the polyethylene (0.19 mm/yr, SD  $\pm 0.2$  mm/yr) although due to the small number of cases the difference lacked statistical significance ( $p < 0.193$ ).

### Reoperations

Four hips were revised (table II). One hip with progressive subsidence was revised for aseptic loosening 2.8 years after the index operation for avascular necrosis.

Using radiological loosening as the end-point, the Kaplan-Meier survivorship of the stem was 98.2% (95% confidence interval, 94.7% to 100%) at 4 years. When the patients who were lost or excluded from the follow-up were included in the analysis, the cumulative probability of not having radiological loosening was 91% (95% confidence

Table II. — Late postoperative complications in the 98 hips

Complication	N hips (%)	Stem exchange	PE liner exchange
Aseptic loosening	1 (1)	1	—
Dislocation	1 (1)	—	1
Unexplained groin pain	1 (1)	—	1
Fracture	1 (1)	1	—
Total (%)	4 (4)	2 (2)	2 (2)

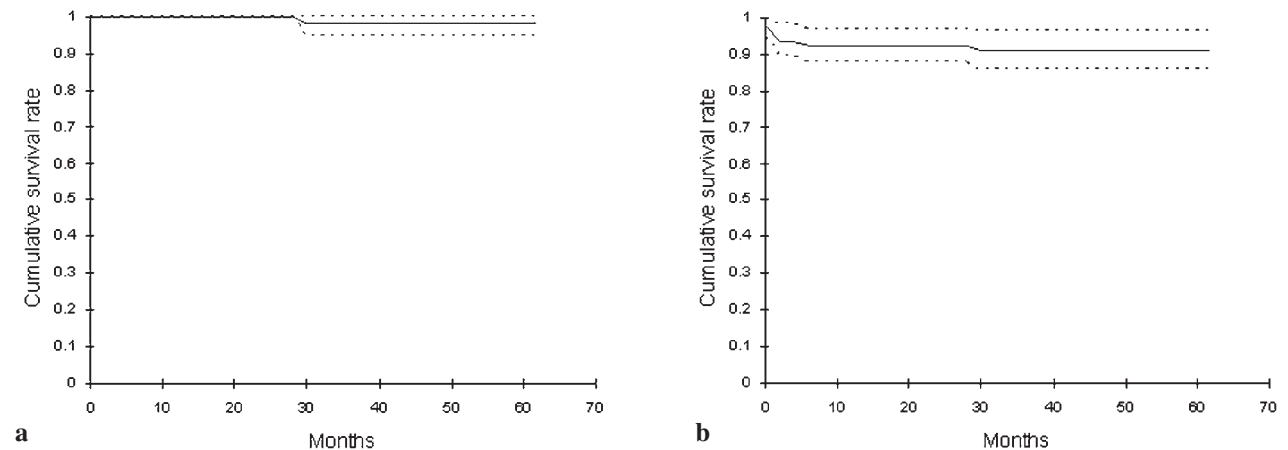


Fig. 4. — Survival curve using radiological loosening as the end point, with 95% confidence intervals : (a) “best-case” scenario, (b) “worst-case” scenario.

interval, 85.8% to 96.2%) in the “worst-case” scenario at 4 years (fig 4).

## DISCUSSION

The clinical outcome for the 98 hips in our series is comparable with that reported by others (4,5,7,12,14,18,22,23). Thirteen patients (13%) complained of thigh pain at latest follow-up. The incidence of thigh pain in patients with cementless stems is reported to be about 20%. Campbell *et al* found that 22% of PCA prostheses in their series had thigh pain (4). Similar figures for thigh pain (24%) have also been reported with cementless ingrowth implants by Wixson *et al* (23). The aetiology of thigh pain is often complex and is generally attributed to micromotion at the implant-bone interface, excessive stress transfer, prosthetic stem characteristics, host bone morphology, and endosteal/periosteal irritation (2). We suggest that

the main cause of thigh pain in our patients was implant micromotion. As cementless stems have a large cross-sectional area and are much stiffer than the surrounding bone, the contact stresses are higher than normal in certain areas and lower in others, so micromotion around part of the stem may occur. In support for this view, thigh pain correlates with radiolucent lines and stem tip sclerosis, and cortical thickening of the femur usually occurs in the middle of the stem and correlates with thigh pain and stem tip sclerosis. Moreover, fibrous fixation correlates with thigh pain and stems with fibrous fixation have greater subsidence. Thigh pain is also found to be related to instability of the stem (4) and failure to fill the medullary canal (12).

The aseptic loosening rate in our cases was one out of 98 (1%) with an average follow-up of 33 months and we demonstrated osseous fixation of the porous-coated stem in 89%. The findings of Kobayashi *et al* (13) and Walker *et al* (21) suggest

that early migration of the prosthesis predicts late loosening with clinically useful specificity and sensitivity. We therefore assessed the migration rate of the stem, in order to detect those hips which were destined to fail. We did not attach significance to early subsidence before the third month since most of these hips become stable by fibrous ingrowth and no further migration was observed. We feel that this subsidence stabilises the stem as the proximally porous-coated cementless prosthetic device has a collar and its tip is tapered. Subsidence occurred in 10 cases and progressive subsidence ( $\geq 5$  mm) was recorded in 3 cases (3%). Kobayashi *et al* (13) found that migration is linear for the implants that fail and we feel that the three cases with progressive subsidence are destined to revision.

Cortical hypertrophy was seen in 14% of hips. It occurred at the junction of zones II and III and V and VI rather than at the tip of the prosthesis. Remodelling progressed even at five years after implantation and shows association with difference in stiffness as revealed by radiolucent lines and stem tip sclerosis. This suggests that remodelling is influenced by mechanical stress and the elastic displacement of the bone relative to prosthesis. When a long and stiff stem is introduced into a more elastic femur there will be motion between prosthesis and bone in some areas, even though the component cannot be regarded as loose (8). Among hips with cortical hypertrophy at the middle of the stem, 90% had a good to excellent clinical result.

Radiolucent lines have been reported in as many as 79% of asymptomatic uncemented femoral components at two years postoperatively (11). Engh *et al* (7) have attributed these lines to micromotion and poor fixation by fibrous ingrowth. In our series, eleven stems (11%) had slight radiolucency along the proximolateral aspect of the implant. It appeared early but did not widen and is probably explained by micromotion between the implant and the greater trochanter due to contraction of the abductor muscles. Radiolucent lines correlate with cortical thickening, stem tip sclerosis and thigh pain.

Evaluation of early radiological findings with a particular prosthetic component is a good predictor for the successful long-term outcome of THA.

However, in a retrospective study such as this, when patients do not attend follow-up visits, data could be incomplete. The major limitation of this study is the absence of complete radiographic and clinical follow-up data on 31 patients, reflecting the proportion of elderly individuals in the study group. Calculating the "worst-case" scenario as advised by Murray *et al* (17) is a solution for this deficiency of information. Although the "worst-case" curve degrades our results substantially, we feel that the true survival curve is not that low, as the 10 cases lost to follow-up were predominantly elderly patients with low activity levels.

## CONCLUSION

We demonstrated a high percentage of osseointegration and low rate of radiologically detected loosening with proximally porous-coated stem prosthesis. The uncemented proximally porous coated stem shows a survival rate of 98.2% ("worst-case scenario" 91%) and satisfactory functional scores in 87%. A statistically significant correlation between thigh pain, migration, radiolucent lines, femoral thickening and stem tip sclerosis suggests greater implant micromotion in some cases. Bone remodelling continues even at five years after implantation. As radiological signs associated with instability seem to become pronounced with time (1,13,21) patients with thigh pain, changes in the proximal femur and progressive subsidence need a close clinical and radiological follow-up.

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