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Original article

MEDIUM-TERM RESULTS OF THE USE OF MODULAR, CEMENTLESS, PROXIMALLY PLASMA-COATED WITH DISPERSED TITANIUM POWDER AND HYDROXYAPATITE, ANATOMICAL FEMORAL STEM

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ABSTRACT

Objective: To report the medium-term outcome of a modular, cementless, proximal hydroxyapatite-coated, anatomical femoral stem in total hip arthroplasty (THA).

Methods: 160 consecutive patients aged 42 to 92 years (average 70) years underwent 185 cementless arthroplasties for primary osteoarthritis or femoral neck fractures. All procedures were performed by a single surgeon using the same modular, cementless, proximally plasma-coated with dispersed titanium powder and additionally superimposed hydroxyapatite, anatomical femoral stem, regardless of age and bone quality. The clinical assessment (pain, range of motion and walking ability) is based on the results of the Merle d'Aubigne and Postel scales. Stem failure is defined as revision or impending revision due to aseptic loosening or pain. Of the 160 patients, 21 died, and none were lost for follow-up. In 3 of the 21 patients, the femoral stems were revised for periprosthetic fractures after a fall at 6 weeks, 10 months, and 3.8 years. 138 patients (162 arthroplasties) completed a median follow-up of 7.8 (range, 5.5–10.4) years. Their overall average Merle d'Aubigne and Postel scores increased from 7.09 before surgery to 16.36 after surgery. There were 5 periprosthetic fractures of the femur, 2 deep infections, 3 dislocations, and 2 aseptic loosenings (one each for the femoral stem and acetabulum).

Conclusion: The MBA femoral stem provides predictably stable fixation with an excellent medium-term result.

Keywords: endoprosthesis, hip joint, short anatomical modular stem,

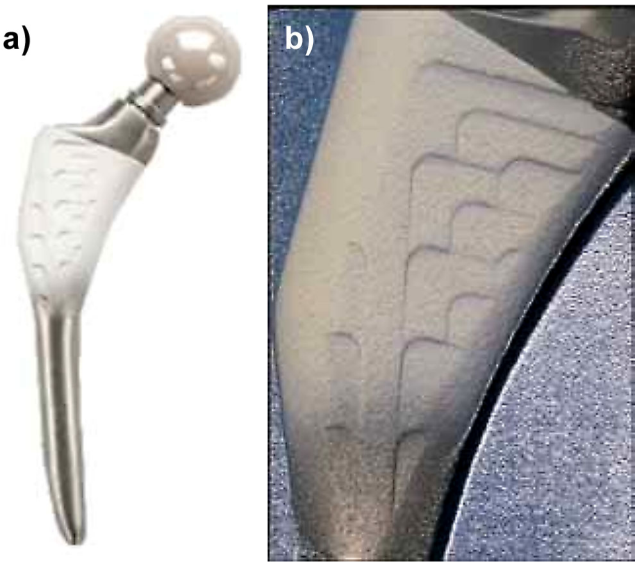
INTRODUCTION:

Cementless total hip arthroplasty (THA) has developed significantly since 1979 [1]. Currently, various femoral stems are used. The shape of the implant determines cortical contact and primary stability. Porous surfaces allow osseointegration. We report the medium-term result of the use of a modular, cementless, proximally hydroxyapatite-coated, anatomical femoral stem (MBA; Groupe Lepine - France) in primary hip arthroplasty.

MATERIAL AND METHODS:

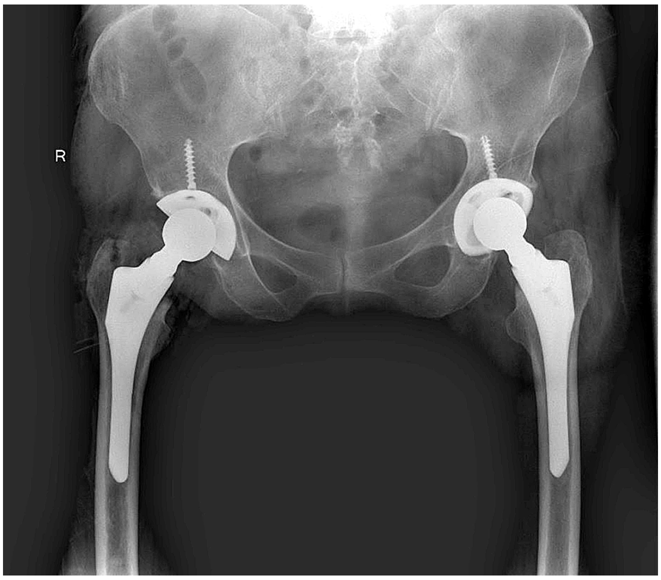
We examined 160 patients aged 42 to 92 years (mean 70) years who underwent 185 cementless arthroplasties between April 2009 and December 2013 for primary coxarthrosis (n=159), femoral neck fractures (n=22), avascular necrosis of the femoral head (n=2), pseudoarthrosis of femoral neck fractures (n=1) and secondary coxarthrosis after fracture (n=1). Fifteen of the patients underwent bilateral arthroplasty consecutively and not simultaneously with one anesthesia. Of the 96 left and 89 right hips (in 93 men and 92 women), 137 had unilateral and 48 had bilateral diseases, according to Charnley's functional categories [2]. All procedures were performed by a single surgeon using the same modular, cementless, proximal hydroxyapatite-coated, anatomical femoral stem (MBA Groupe Lepine), regardless of age and bone quality. There are 5 modular stem neck variants available for this endoprosthesis: standard neck with a 130° angle, varus neck, valgus neck, anteverted neck and retroverted neck with a 15° deviation from the standard cervical angle in the respective planes. The articulation of the neck and stem is through a hexagonal fit of the Morse cone. The proximal part of the femoral stem is biconical in shape and expands to fill the proximal femur and has a metaphyseal-diaphyseal curve of 4º. The distal end is asymmetrical and pointed anterolaterally to eliminate cortical stress (Fig. 1).

Fig. 1. a) MBA femoral stem and **b)** The proximal part of the MBA stem.



The femoral stem is made of titanium alloy. The proximal part has a two-layer porous coating. The bottom layer is made of pure titanium, which is deposited using plasma under vacuum at a very high temperature. It is 100 ìm thick and creates micro roughness without changing the surface of the alloy. The top layer is made of hydroxyapatite coating with a thickness of 50 to 100 ìm, which is deposited in powder form through a plasma torch under vacuum (Fig. 2).

Fig. 2. AP radiograph 9,9 years after endoprosthetic replacement of the right hip joint and 6,4 years after endoprosthetic replacement of the left hip joint.



There are 8 different sizes. The modular neck has a double Morse cone design and is made of cobalt chrome alloy. The hip heads used are 28 mm diameter stainless steel with a high nitrogen content. They were either metal on polyethylene or aluminum oxide on polyethylene. All acetabular components had a hydroxyapatite coating. The types of implanted acetabular cups are MBAs. Under the protection of prophylactic antibiotics, the operation was performed in a lateral position through a modified lateral Bauer-Hardinge approach. Both the femoral and acetabular parts were fixed without cement. The implanted femoral stems are 1 (n=1), 2 (n=24), 3 (n=33), 4 (n=54), 5 (n=52), 6 (n=13) and 7 (n=8). In 2 hip joints, the proximal femur was reinforced with a wire cerclage as a preventive measure against periprosthetic fractures due to severe osteoporosis. Additional screw fixation was used in 67 endoprostheses to further ensure the fixation of the acetabular cup. An acetabular deficiency was compensated in one patient with the help of autologous grafts. We usually allowed a full weight bearing 6 weeks after the operation.

We evaluated patients before and after surgery (at 6 weeks, 3 months, one year, 2 years, 5 years, 10 years). The clinical assessment (pain, range of motion and walking ability) is based on the results of Merle d'Aubigne and Postel [3]. Patients were asked specifically whether they had pain or discomfort in the hip, the type of pain (hesitation at starting or delayed onset of hip discomfort) and the activity causing the pain. AP and lateral radiographs were standardized using a magnification marker. The femoral stem was analyzed according to the 7 zones of Gruen et al. [4] with regard to the presence of radiolucent lines, osteolysis, annular condensation, cortical hypertrophy or atrophy, reactive lines and pedestal formation according to the criteria of Engh et al. [5]. Failure after stem implantation is defined as revision or impending revision due to aseptic loosening or pain. Due to the very small sample size, the Wilcoxon test was used to compare different categories of results before and after surgery. The Kaplan-Meyer survival curve was used to demonstrate the survival rate of the endoprosthesis.

RESULTS:

Of the 160 patients, 21 died from causes unrelated to surgery, and none were lost for follow-up. In 3 of 21 patients (22 arthroplasties), the femoral stems were revised for periprosthetic fractures after a fall at 6 weeks, 10 months, and 3.8 years. One patient with resection arthroplasty was excluded from the analysis due to infection after an abscess in the groin from coronary stenting 5.3 years after surgery. 138 patients (162 arthroplasties) completed a median follow-up of 7.8 (range, 5.5–10.4) years. Their overall average Merle d'Aubigne and Postel scores increased from 7.09 (standard deviation [SD], 3.02) before surgery to 16.36 (SD, 0.68) after surgery. The scores of all subcategories are also increasing ($p<0.001$), Wilcoxon signed rank test (Table 1).

Table 1. Mean Merle d'Aubigne and Postel clinical scores

Category (full score)	Standard deviation		p Value of the Wilcoxon test	
	Preoperative	Postoperative	Change	
Pain (6)	2.23 (0.92)	5.47 (0.51)	3.24 (0.56)	**<0.001**
Walking (6)	2.18 (0.90)	5.89 (0.31)	3.71 (0.87)	**<0.001**
Range of motion(6)	2.68 (1.25)	5 (0)	2.32 (0.87)	**<0.001**
Total (18)	**7.09 (3.02)**	**16.36 (0.68)**	**9.3 (2.54)**	**<0.001**

There are no cases of intraoperative proximal fractures of the femur or postoperative paralysis of the sciatic nerve. Two hips suffered periprosthetic fractures of the femur after a fall at 3.8 and 6.8 years, for which the femoral stems were replaced (Table 2).

Table 2. Postoperative complications

Complications	**No of Hips**
Aseptic loosening of the femoral stem	1
Aseptic loosening of the acetabular cup	1
Periprosthetic femoral fracture	5
Deep infection	2
Dislocation of the endoprosthesis	3

Two hip joints developed deep infections at 3.8 years and 3 weeks, respectively, as a result of infection of venous leg ulcers and skin colonization. Both patients were treated with early arthrotomy, washing, debridement, and intravenous antibiotic treatment. In both patients, the femoral stems and acetabular cups were preserved. One patient had recurrent anterior dislocation, in which the variant of the modular neck and head was altered 6 weeks after surgery. The latter had recurrent instability, for which the head and neck of the femur were replaced after 3.3 years. All three patients have a stable hip joint. All but one of the patients had stable and well-integrated femoral stems. Similarly, all but one of the patients had stable acetabular capsules.

There are no reactive lines at the bone-stem interfaces, and there is no subsidence or osteolysis in any of the X-rays (Fig. 2). Bone remodeling in the form of cortical atrophy in zones 1 and 7 due to stress shielding and mild cortical thickening of zones 2 and 6 have been noted, especially in patients with larger stem sizes. The average Engh score for fixation and stability was 24.9 out of 27. The average femoral stem fixation score is 10 out of 10 and 14.9 out of 17 for femoral stem stability.

Femoral stem survival after 10 years is 99% (95% confidence interval, 97%–100%), with revision secondary to aseptic femoral loosening being the endpoint. Endpoints were 96% (95% confidence interval, 92%–98%) for all-cause failures (infection, periprosthetic fracture and aseptic loosening).

DISCUSSION:

In our study, the survival rate was equal to or better than that of other series of hydroxyapatite-coated femoral components [6, 7, 8, 9, 10]. Cementless arthroplasty is becoming more and more popular. The high rate of osteolysis, aseptic loosening, and revision associated with earlier cementless femoral components has been significantly reduced with better-designed implants incorporating a peripheral porous coating to inhibit particle migration and osteolysis. In addition, the proximal femoral fixation prevents stress concentration, and the conical distal tip reduces hip pain.

In our series, 5 (3%) of the patients had periprosthetic fractures of the femur after a fall. The average age of these 5 patients at the time of fracture was 80 (range 73–83) years. During revision surgery, it was noted that the femoral stems were well fixed and difficult to extract, except for the one that underwent revision 6 weeks after the primary endoprosthetic replacement. The incidence of periprosthetic fractures has been reported to range from 0.1 to 2.1% for postoperative fractures and from 0.3 to 5.4% for intraoperative fractures [11]. These rates have increased due to the ageing of the patient population [12]. None of our patients complain of pain in the front of the thigh when asked specifically. This is comparable to other series involving femoral stems coated with hydroxyapatite [5, 9].

The modularity of the neck of this femoral component is useful in both primary and revision conditions. In primary procedures after stem implantation, leg length correction and dislocation can still be done. In revision procedures, cervical modularity facilitates adjustments to leg length, dislocation, and cervical version without the need to remove a well-fixed femoral component and also facilitates access to the acetabular component by removing the modular neck and head. In our study, in both types of dislocation, the change of the modular neck and head avoids a more extensive revision requiring the removal of a well-fixed femoral stem. Contrary to the increased frequency of revision of modular hip systems, based on some literature sources, the modular, cementless, metaphyseal-coated hydroxyapatite anatomical femoral stem provides predictably stable fixation with excellent medium-term outcome.

CONCLUSION:

The modular, cementless, proximally plasma-coated anatomical femoral stem with hydroxyapatite and titanium coating demonstrates excellent medium-term clinical and radiographic outcomes in total hip arthroplasty. With a 99% survival rate at 10 years for aseptic stem loosening and 96% for all-cause failures, this implant offers durable fixation and reliable performance across a broad patient population, regardless of age or bone quality[13]. Clinical improvements were significant, as evidenced by a substantial increase in Merle d'Aubigne and Postel scores, and complications were minimal and manageable. These results confirm that the MBA femoral stem is a reliable option in both primary and complex hip arthroplasty scenarios, combining anatomical design with modular adaptability to enhance stability, patient function, and long-term implant survival.

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