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Aseptic Loosening Rate of the Mayo Femoral Stem With Medium-Term Follow Up

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ABSTRACT

The aseptic loosening rate of the Mayo hip prosthesis femoral stem was determined in a 44 patient (52 hips) series, by comparing preoperative and postoperative clinical and radiographic parameters, over a minimal 5-year postoperative period. Loosening was obvious before five years in four hips (7.6%), while the stem was considered stable in the remaining 48 hips over a mean 6.1 year period, therefore accounting for a 92.3% Kaplan–Meier survival rate. We conclude that the aseptic loosening rate is too high for the Mayo hip prosthesis femoral stem, as compared to literature data concerning the non-conservative stems.

In order to further improve the survival of hip arthroplasties several modifications were conceived altering design, fixation and bearing surface [1]. These modifications have extended hip arthroplasty indications to young patients who demand more from the replaced joint and present greater aseptic loosening rates [2].

Conservative implants were designed with the purpose of preserving the proximal femoral bone stock [3]. One of the proposed modifications was the metaphyseal-fixation femoral stem with a shorter extension in the femoral canal such as the Mayo conservative hip (Zimmer, Warsaw, Indiana). Theoretically, this implant would have the advantage of preserving the distal femoral canal if revision surgery should become necessary. Preserving the distal bone envelope would be advantageous provided the stem remained well fixed in the metaphyseal area, with no evidence of aseptic loosening, for a longer period of time than the previously reported for the non-conservative implants [4,5]. The results reported by the designers of the Mayo were acceptable after implantation in a young and active population [6]. Morrey et al in 2000 [6] published 7.4% aseptic loosening rate, Falez et al in 2008 [4] published 1.1% aseptic loosening rate, Haegel et al in 2008 [7] published 1.8% aseptic loosening rate, Goelbel et al in 2009 [8] published 6.6% aseptic loosening rate, Gilbert et al in 2009 [9] published 10.2% aseptic loosening rate and the Australian National Replacement Registry Annual Report in 2011 [10] published 3% aseptic loosening rate.

Our objective was to determine aseptic loosening rate of the Mayo Femoral stem and compare to traditionally stemmed implants through clinical and radiographic evaluation.

Patients and Methods

Patients

Between June 2002 and December 2005, two surgeons from one institution performed a consecutive series of total hip arthroplasty procedures with the Mayo Hip Stem in 57 patients (65 hips). The inclusion criterion was patients with an indication for cementless primary hip arthroplasty. Thirteen patients (13 hips) were excluded due to lack of complete clinical and radiographic documentation. Forty one patients (48 hips) were evaluated with mean follow-up period of 6.1 years (5 to 7.5 years). Four patients (four hips) were added with aseptic loosening stem before five years (mean follow of 2.7 years; 2 to 3 years). One patient with bilateral arthroplasty presented a fixed stem in one side and loose in the other. Patient age ranged from 23 to 66 years (m = 48.54 years); body mass index (BMI) ranged from 17.63 to 39.21 (m = 26.90). There were 27 men and 17 women. Diagnoses were femoral head osteonecrosis (AVN) in 17 (38.6%), osteoarthritis (OA) in 16 (36.3%), non-union of a femoral neck fracture (FNF) in seven (15.9%) and other in four (8.8%). The other diagnoses were development dysplasia of the hip, renal osteodystrophy, epiphysiolysis and vilonodular synovits, none of them with aseptic loosening stem (Table 1).

Implants

The Trilogy acetabular system shell, Trilogy acetabular system liner and the Zimtron femoral head with Mayo hip corundumized stem (Zimmer, Warsaw, Indiana) were used for all procedures.

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Procedure

Preoperative planning was performed using the original stem template, keeping as close as possible the physiological center of rotation of the joint, correcting leg length discrepancy and selecting a stem size that would fill the femoral cavity as much as possible on both anteroposterior (AP) and lateral radiographs.

The Hardinge [11] approach with the patient in lateral decubitus was used in all cases. The stems were implanted using the technique described by Morrey et al [12,13].

All patients received 2 g of intravenous cefazolin one hour before surgery and 1 g every 8 h during the first 3 postoperative days. They received 5000 IU of subcutaneous sodium heparin every 12 h for four weeks for thromboprophylaxis.

Patients received standard postoperative care with analgesics and physical therapy. They were rehabilitated with toe touch weight bearing on the operated limb with the use of a walker during the first month, followed by partial weight bearing during the second month and total weight bearing thereafter.

Clinical Evaluation

The preoperative and postoperative clinical assessment was performed using the Harris Hip Score (HHS) [14].

Radiographic Evaluation

The evaluation was performed using the protocol of Johnston et al for non-cemented arthroplasties [15] at the zones of Gruen [16] (Fig. 1) for both the first postoperative radiographs and those taken in the last assessment, looking for stem loosening, stem–bone radiolucency line (SBL), increased medullary density, spot welds, uniform density loss and endosteal cavitation. The stems that presented an evident radiographic change in position were considered loose.

All patients were evaluated annually and radiographic aseptic loosening determined the final point of assessment. Of the 52 hips evaluated none presented acetabular loosening.

Statistical Analysis

The Fisher exact test was used to determine the difference in gender, SBL, periprostetic medulary density increase and spot welds between fixed and loose groups, with the level of significance set at $P < 0.05$.

The survival of the Mayo femoral stem at 5 and 7.5 years was determined by the Kaplan–Meier method using the aseptic loosening of the component as the end point.

The nonparametric Mann–Whitney test was used to determine the difference in age, BMI, Harris Hip Score and endosteal cavitation between the fixed and loose groups, with the level of significance set at $P < 0.05$.

Results

Radiological Assessment

The four loose stems (loose group) presented evident change in position to varus, higher incidence of radiolucent lines and medial reabsorption of the proximal lateral cortical of the femur. Aseptic loosening rate was 7.6%.

In the 48 fixed stems (fixed group) and in the four loose stems increased periprosthetic medullary density was observed. Spot weld was observed in the fixed group in 41 stems (85.4%); 68.7% in zone 6, 41.6% in zone 7, 22.9% in zone 2, 18.7% in zone 9 and 10.4% in zone 13. No spot welds were observed in stems of the loose group.

The incidence of SBL, the increase in periprosthetic medullary density and the spot welds in each zone of Gruen [16] are presented in Table 2 and their percentage and significance in Tables 3–5.

In the fixed group, 11 hips did not show bone uniform density loss. Density was uniformly lost only in zone 1 in nine hips, only in zone 2 in one hip and in zones 1 and 2 in 27 hips. Loose group showed bone uniform density loss in two hips, both in zones 1 and 2.

In the fixed group endosteal cavitation was observed in four hips (8.3%): three located in zone 1 measuring 6 mm^2, 24 mm^2 and 27 mm^2 and one in zone 14 measuring 10 mm^2. In the loose group, endosteal cavitation was observed in 2 hips (50%): one in zone 1 measuring 150 mm^2 and the other in zones 7 and 12 measuring 42 mm^2 and 7 mm^2, respectively. There was no difference in endosteal cavitation incidence between fixed and loose groups ($P = 0.06$).

Clinical and Survival Assessment

There was no difference in age ($P = 0.99$), BMI ($P = 0.19$) or gender ($P = 0.28$) between the fixed and loose groups (Table 1). Kaplan–Meier survival analysis showed a 92.3% rate of stem survival at 5 and 7.5 years (60 to 90 months) due to aseptic stem loosening as the end point (Fig. 2).

In the fixed group the mean HHS was 35.4 in the preoperative period and 96.2 in the final assessment ($P < 0.001$) and in 47 hips the HHS value exceeded 81 points. In the loose group the mean HHS was of 36 in the preoperative period and 77 in the final assessment ($P = 0.03$) and in three patients the HHS exceeds 81 points. The postoperative HHS between fixed and loose groups showed difference ($P = 0.005$) (Table 1).

Complications

There were one deep infection (1.92%), one sciatic nerve palsy (1.92%) and two incomplete metaphyseal fractures (3.8%) in the study group; all fractures healed without compromising the stability of the stem.

Discussion

Morrey et al [6] observed mechanical loosening of the stem in 3 cases (1.8%) after a follow-up within 6 months. Our mechanical

Table 1
Demography of Fixed and Loose Groups.

Group	Age (Mean)	Gender		BMI (Mean)	HHS Pre (Mean)	HHS Pos (Mean)	Diagnosis
		F	M				
Fixed	47	19	29	26	35	96	AVN: 17 OA: 14 FNF: 6 Other:4
Loose	48	0	4	30	36	77	OA: 2 AVN: 1 FNF:1
P	0.99	0.28		0.19	0.72	0.005	One patient with bilateral arthroplasty presented a fixed stem in one side and loose in the other.

F: Female, M: Male, BMI: Body Mass Index, HHS Pre: Pre-operative Harris Hip Score, HHS Pos: Post-operative Harris Hip Score, AVN: Avascular Necrosis of Femoral Head, OA: Osteoarthritis, FNF: Non-union of a femoral neck fracture, *P*: confidence interval.