Use of extensively porous femoral stems in hip revision

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Abstract

Introduction: In view of the difficult and increasingly frequent scenario of hip revision, there are different alternatives to get a stable and enduring fixation of the femoral component. The aim of this study is to assess medical and radiologic results in patients subject to revision of the femoral component with cylindrical extensively porous stem.

Materials and methods: We carried out a retrospective multi-centric study in 148 patients operated on from March 1997 to March 2010; they underwent femoral revision surgery with cylindrical extensively porous stem. Average age was 63.1 years old.

Results: Average follow-up was 7.7 years. In 134 (89.9%) patients, there was stable bone fixation; in 12 (8%), stable fibrous fixation and, in 3 (2%) unstable fibrous fixation. The Harris score changed from 41 before the surgery to 92 after the surgery. Complications were deep infection (2 cases, 1.3%), intra-operative femoral fracture (12.8%) and prosthetic dislocation (3 cases, 2%).

Conclusion: Cylindrical extensively porous stems have proved to be a cost-effective resort to solve most femoral revisions because they give the possibility of stable fixation in the short- and long- term.

Key words: Hip revision; femoral defect; cylindrical extensively porous stem
Level of evidence: IV

Utilización de tallos femorales porosos extendidos en revisiones de cadera

Resumen

Introducción: Ante el difícil y cada vez más frecuente escenario de una revisión de cadera, existen diferentes alternativas para conseguir una fijación estable y duradera del componente femoral. El objetivo de este estudio fue evaluar la evolución clínica y radiográfica de los pacientes sometidos a una revisión del componente femoral con tallo cilíndrico de superficie rugosa extendida.

Materiales y Métodos: Se llevó a cabo un estudio multicéntrico y retrospectivo de 148 pacientes, operados entre marzo de 1997 y marzo de 2010, a quienes se les realizó una cirugía de revisión femoral con un tallo cilíndrico con recubrimiento poroso. La edad promedio era de 63.1 años.

Resultados: El seguimiento promedio fue de 7.7 años. En 134 (89,9%) pacientes, se observó una fijación ósea estable; en 12 (8%), una fijación fibrosa estable y, en 3 (2%), una fijación fibrosa inestable. El puntaje de Harris se modificó de 41 en el preoperatorio a 92 después de la cirugía. Las complicaciones fueron infección profunda (2 casos, 1,3%), fractura de fémur intraoperatoria (12,8%) y luxación protésica (3 casos, 2%).

Conflict of interests: The authors have reported none.

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Conclusión: Los tallos cilíndricos con recubrimiento poroso han demostrado ser un eficaz recurso para solucionar la mayoría de las revisiones femorales por la posibilidad de obtener fijación estable a corto y largo plazo.

Palabras clave: Revisión de cadera; defecto femoral; tallo cilíndrico poroso.
Nivel de Evidencia: IV

Introduction

Due to the increase in the demand of hip total arthroplasties expected for the next 25 years, it is foreseen that revision rates will increase proportionately.[1] Data collected by Kurtz et al. between 1990 and 2002 report an increase of 60% in the total amount of revisions in the USA, and this tendency is expected to continue.[2]

While performing hip revision, the surgeon is challenged with the need of an enduring and stable fixation of the prosthetic components and that of restoring joint biomechanics, even though, sometimes, there are considerable bone deficits that are consecutive to osteolysis, septic loosening, fracture, and due to the removal of the prosthetic components previously inserted. In the case of bone deficit in the area of the proximal femur, the fixation of the prosthetic component will ask for different alternatives. Distal fixation by cementless cylindrical extensively porous stems (roughness in 2/3 or more of the implant length) comes as one of the options to solve this problem.[3-7]

Other suggested techniques are impaction of morselized bone allograft by cemented stems,[8-12] cementless striated tapered stems,[13] proximal fixation cementless stems [stems14] and tumor prosthesis.[15]

The aim of this study is to assess medical and radiologic results in patients subject to revision of the femoral component with cylindrical extensively porous stems.

Materials and methods

In a multi-centric study we evaluated retrospectively 148 patients who underwent hip revision surgery between March 1997 and March 2010; treatment was given by two orthopedists teams. Patients were 48 females (59.4%) and 60 males (40.6%), who were subject to revision of the femoral component with 150 extensively porous stems. The hip operated on was the right one in 77 patients (52%) and the left one in 71 patients (48%). It is worth mentioning that one patient underwent revision in both hips, and that another one was subject to a second revision surgery with an extensively porous stem. Average age in our population was 63.1 years old (ranging from 28 to 89). Average follow-up was 7.7, with a minimal follow-up of 3 years and a maximal follow-up of 17 years. Time elapsing between the last surgery and revision and insertion of the definite stem was, on average, 10.7 years. Revision surgery was performed in 88 cases (58.6%) due to aseptic loosening of the femoral component— 65 of them (73.8%) were cemented stems and 23 (26.2%), cementless stems. Forty-one patients (27.3%) suffered septic loosening of the femoral stem; therefore, revision was carried out in two surgical times, inserting a cement spacer with antibiotic in the first surgery so as to implant the definite prosthesis at a second time. Fourteen cases (9.3%) were due to peri-prosthetic fracture; four cases (2.6%) as rescue of failed osteosynthesis and three cases (2%) as a consequence of rupture of the primary femoral stem.

The stems that we used were Solution® (Depuy, Warsaw, Indiana, USA) in 107 patients (71.3%), modular ZMR® (Zimmer, Warsaw, Indiana, USA) in 17 cases (11.3%), Restoration® (Stryker, Mahwah, NJ, USA) in 13 (8.6%) and Versys® (Zimmer, Warsaw, Indiana, USA) in 13 (8.6%).

The lengths of the stems were: 254 mm (75 cases), 200 mm (55 cases), 220 mm (porous ZMR) (7 cases), 170 mm (porous ZMR) (7 cases), 150 mm (5 cases) and 305 mm (one case). We used 42 15 mm-diameter stems (28%), 37 16.5-diameter stems (24.6%), 30 18 mm-diameter stems (20%), 18 13.5 mm-diameter stems (12%), 17 19.5 mm-diameter stems (11.3%), four 12 mm-diameter stems (2.6%) and two 10.5 mm-diameter stems (1.3%). Eighty-nine stems (59.4%) were curve, whereas 61 (40.6%) were straight. We used the Paprosky's classification for femoral defects[4] and the Vancouver classification for peri-prosthetic fracture.[16]

Surgical technique

In all cases we performed pre-operative planning so as to determine the diameter and length of the prosthesis. We carried out a posterior-lateral approach in all cases. In 119 cases (79%) we performed extended femoral osteotomy because this facilitates the removal of the anterior stem, cement and membrane remains; and it also helps to avoid possible complications while inserting the new stem.[17,18] The objective is to achieve good quality contact, 4 to 6 cm, between the cement and the femoral cortex.[4] The femoral canal was prepared by progressive manual reaming with increasing 0-5 mm reamers until achieving enough contact for secure insertion of the nail. Later on, the osteotomized fragment was set and osteosynthesis was performed using two to three wire loops depending on the size of the fragment, with the option of inserting autograft when bone fragments do not show intimate contact (Figure 1). Prescriptions after surgery were: six weeks with partial weight bearing unloading on four spots (two crutches), and six weeks unloading on three spots (one crutch).

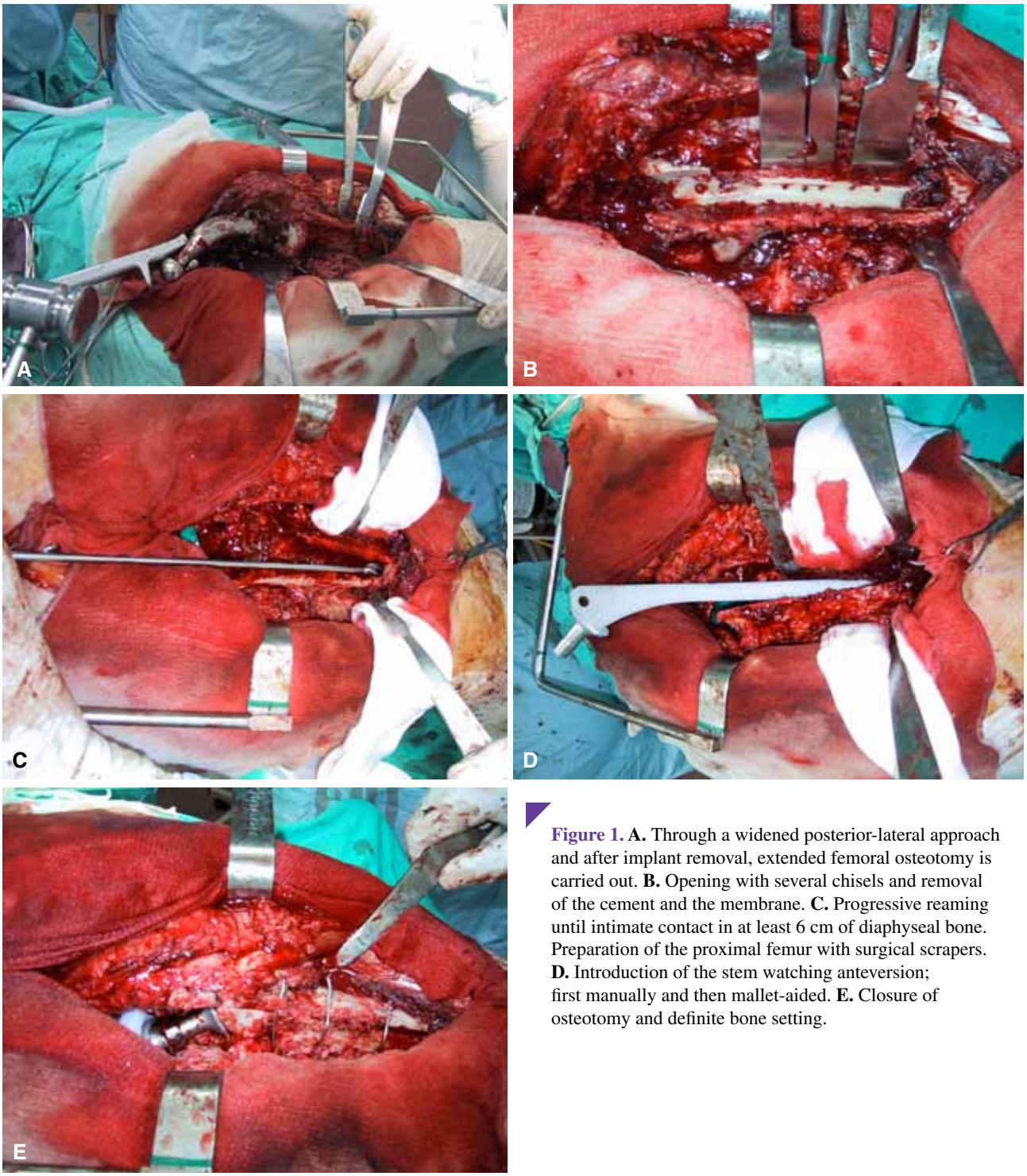

Figure 1. A. Through a widened posterior-lateral approach and after implant removal, extended femoral osteotomy is carried out. **B.** Opening with several chisels and removal of the cement and the membrane. **C.** Progressive reaming until intimate contact in at least 6 cm of diaphyseal bone. Preparation of the proximal femur with surgical scrapers. **D.** Introduction of the stem watching anteversion; first manually and then mallet-aided. **E.** Closure of osteotomy and definite bone setting.

Post-operative check-ups were carried out at weeks 3 and 6, at months 3, 6 and 12 and, then, on a yearly basis. On these occasions patients underwent medical and radiologic assessment as standardized on the basis of the time elapsed since revision surgery.

In 120 cases (80%), it was also necessary to revise the acetabular cup, whereas, in nine patients (6%) a new insert was cemented on the in-growth acetabular metallic component;[19] in four cases (2.6%) the insert was changed and, in 17 (11.3%), we performed no gesture on the acetabular component (Figure 2).

Figure 2. A and **B.** Seventy-year-old patient with loosening and considerable femoral osteolysis in hybrid hip replacement received 10 years before. **C** and **D.** Immediate post-operative check-up, and evaluation 14 years after revision with extensively porous stem, with stable bone fixation.

Results

Final follow-up was, on average, 7.7 years in 148 patients who received 150 extensively porous stems. Three patients passed away during follow-up due to diseases not associated with their hip condition.

As stated by the Paprosky's classification, 45 patients (33.3%) showed a type II femoral defect; 77 (57%), a type IIIA one and 13 (9.6%), a type IIIB one; among the 14 patients with peri-prosthetic fracture, 10 (71.4%) showed a type B2 fracture whereas four (28.6%) showed a type B3 one.

The stability of the femoral component was determined in X-rays in every case on the basis of the Engh criteria:[20] stable bone fixation (134 patients, 89.9%), stable fibrous fixation (12 patients, 8%) and unstable fibrous fixation (3 patients, 2%). In two of the latter three cases, fixation contact between the stem and the healthy femoral cortex was not achieved during the surgery; this is why, in the immediate post-operative period, there was stem subsidence of 8 and 15 mm and varus misalignment of 3º and 7º, which got stabilized when unloading was prescribed; results in the long term were favorable. Another one of these three stems had to be revised using one stem of the same characteristics as a consequence of an implant deep infection, and results were favorable in the medium term. On the other hand, it is worth making it clear that eight of the 15 patients stable bone fixation was not achieved in showed a greater pre-operative bone deficit (Paprosky IIIB)

In 15 patients' X-rays there was 2 mm-average subsidence (ranging from 1 to 3), which kept stable as from post-operative month 12 with final stable bone fixation.

The Harris score[21] changed, on average, from 41 (from 35 to 50) before the surgery to 92 (ranging from 85 to 99) after the surgery. No patient referred anterior thigh pain.

Complications in this series were two deep infections (1.3%); in one case, it was necessary to perform a two-time revision with insertion of a new extensively porous stem, and results in the medium term were good; in the other patient, revision was not necessary, because infection was not accompanied by prosthetic loosening; moreover, there were two superficial infections that did well with toilet plus antibiotics.

In nine cases there was incomplete longitudinal fracture of the femur, from the inferior limit of the osteotomy towards the knee, right at the moment of inserting the stem; fractures were solved using one or two wire loops depending on the fractures lengths. Moreover, there were three (2%) intra-operative peri-prosthetic fractures distal to the femoral stem; two of them were treated later on, whereas the other one was surgically solved right away. Results were favorable in the three cases.

Three patients (2%) in the series suffered a prosthetic dislocation event that was solved with closed setting under anesthesia, with no need of operating on the patient again. Three patients suffered deep venous thrombosis during rehabilitation at home; this condition receded without complications with proper treatment.

Finally, in the immediate post-operative period one patient (peripheral vascular disease) suffered acute arterial ischemia in the lower limb operated on; after failing at the revascularization attempt, it was necessary to perform amputation.

Discussion

Revision in a hip femoral component can be an extremely complex procedure, especially in patients with multiple surgeries and, therefore, greater bone loss. Bone deficit in the proximal femur hampers the use of not only cemented revision stems,[8,9] but also cementless stems of metaphyseal fixation, and the proximally porous ones.[14]

The technique of bone graft impaction plus insertion of cemented femoral stems gained popularity in the 1990s; some publications, however, pointed out the bad results achieved and the high rates of technical failures this kind of reconstruction is associated with.[10-12] With the progress of techniques and the use of long stems, these results were improving. Stroet et al.[12] got survival of 95% at 17-year follow-up; this kind of reconstruction, however, is difficult to reproduce and, with no exception, it is necessary to have xenograft and specific surgical instruments.

Cementless femoral components with metaphyseal fixation have been associated with high revision rates in the early follow-up when they are used in femurs with no metaphyseal support, something that makes them unpredictable.[14] This led a number of surgeons to disregard them and change them by stems that get stable primary distal fixation, like the extensively porous stems.[3-7]

The technique of cementless femoral revision with cylindrical extensively porous stems, provided that they have intimate contact of at least 4-6 cm with appropriate host bone, offers the advantage of immediate stable fixation that allows biological integration between the stem and the remaining bone, ensuring enduring fixation, with a technique which is simple and easy to reproduce for most surgeons.

In 1995, Moreland and Berstein reported survival of 96% in 175 femoral revisions with cementless extensively porous stems and an average follow-up of 5 years, 4% of second revisions, 2% of aseptic loosening and 83% of fixation by bone growth.[22] In 1997, Krishnamurthy et al. studied 297 hips revised with cementless extensively porous stems and a follow-up of 8.3 years; results were good in 94.3% of patients, with 1.7% of second revisions due to aseptic loosening and a rate of mechanic failure of 2.4%.[23] In 2001, Moreland and Moreno assessed 137 revisions with cementless extensively porous stems and an average follow-up of 9.3 years, and found 83% of fixation by bone growth and 4% of second revisions due to aseptic loosening.[24]

Despite the fact that distal fixation associated with considerable loss of proximal bone tends to increase tension at femoral stem level, what could lead to the femoral stem rupture, in the Hamilton et al.'s series, in which 905 extensively porous stems were used, this complication was found in only three patients with follow-up of 10 years; the three of them had 13.5 mm-diameter stems or stems of lesser diameter.[6] In our series, although we inserted 13.5 mm-diameter stems or stems of lesser diameter in 24 patients, there was not this kind of complications. Weeden and Paprosky reported 170 revisions with cementless extensively porous stems. Average follow-up was of 14.2 years, with a stem survival > 95%. Eighty-two percent of the stems showed radiologic evidence of fixation by bone growth; 13.9%, of fixation by stable fibrosis and 4%, of fixation by unstable fibrosis. Six stems were revised with greater-diameter components. Mechanical failure rates were, on average, of 4.1%.[4]

Although, historically, extensively porous stems have been used in almost every kind of femoral revision, Heng et al. reported a shorter survival in these stems among the patients with femoral cortex bone deficit which went beyond 10 cm down the lesser trochanter.[3] Other researchers have also reported high rates of failure among the femurs with type IIIB and type IV Paprosky's bone defects.[4,5,7]

Ninety percent of the cases in our series had not undergone revision seven years after the surgery. As reported by Paprosky in 2002,[4] we have found that type IIIB bone deficit as outlined by the Paprosky's classification is associated with lower rates of biological fixation when treated with extensively porous stems, since out of 13 patients in this sub-group, six had stable fibrous fixation and two, unstable fixation. We consider the technique of impaction of morselized bone graft plus cemented stemming as a good alternative in these cases, as cementless striated tapered stems are, or tumor prosthesis/alloprosthesis compounds as exceptions.

Chung et al. published a series of 96 femoral revisions in which, by extensively porous stems, they got stable bone fixation in 92 cases as outlined by the Engh criteria, with only 1.2 mm-average subsidence and a post-operative Harris score of 92.3.[25]

In our series, survival was similar to that found in other studies that used this kind of stems; we got stable bone fixation in 135 of the 150 stems that we inserted and a Harris score of 92. In 116 of the 122 femurs (95%) with type II and type IIIA bone defects, we got stem stable bone fixation; therefore, we believe that femoral revision with this type of implant is still a reproducible and predictable technique in this bone defects. Another scenario is that of Paprosky's type IIIB bone defects, because, nowadays, we prefer striated tapered stems for these kinds of revisions; however, in our series and many other ones, cylindrical extensively porous stems have proved to be a cost-effective resort to solve most femoral revisions because they make it possible to get stable fixation in the short and long term, due to the stability achieved by immediate fixation and the high probabilities of biological fixation they are associated with.

Conclusion

The use of cylindrical extensively porous stems in revision surgery of the hip is a reproducible and cost-effective technique to solve most femoral defects.

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