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ORIGINAL PAPER

Long-term survivorship of a monoblock long cementless stem in revision total hip arthroplasty

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Abstract

Purpose The purpose of this study was to assess the clinical outcomes, complications, and survival of a long cementless titanium femoral stem in revision total hip arthroplasty (THA) at a minimum five year follow-up.

Methods Between 2000 and 2010, 114 patients (116 hips), with a mean age of 68 ± 12 years, underwent revision THA using a KAR® stem (DePuy, Leeds, UK). The main reasons for revision were aseptic loosening (82%), periprosthetic joint infections (PJI) (11%), and periprosthetic fractures (6%). Mean follow-up was ten ± three years (range, 5–16). Harris Hip Score (HHS), Oxford Hip Score (OHS), and Postel-Merle d'Aubigné (PMA) score were recorded. Radiographic analysis assessed stem osseointegration and subsidence. Survival was analyzed using the Kaplan-Meier (KM) method and cumulative incidence function (CIF).

Results Post-operative HHS was 83 ± 15 (range, 35–99) and OHS was 37 ± 8 (range, 8–48). PMA score significantly increased from 12 ± 2 (range, 5–18) pre-operatively to 14.6 ± 2 (range, 9–18) post-operatively ($p = 0.0004$). The radiographic Engh score was 15 ± 8 (range, 7–22). Stem subsidence was observed in two cases (3%). At ten years, five stems had been revised, three for infections and two for periprosthetic fractures. Using the KM method, ten year survival free of stem revision for aseptic loosening was 100%, free of revision for any reason 95%, and free of any re-operation 81%.

Conclusions The present study reported satisfactory outcomes and survival of a long tapered unlocked cementless femoral stem in revision THA at a minimum follow-up of five years.

Keywords Revision · Total hip arthroplasty · Long tapered uncemented stem · Survival

Introduction

Revision total hip arthroplasty (THA) is expected to increase and represents nowadays 15% of all total hip replacements performed [1]. The main causes for revision THA are instability, aseptic loosening, infection, and periprosthetic fracture [1]. During revision THA, stems may be chosen among different designs: standard stems (as in primary THA), long stems, modular or distally locked stems, either cementless or cemented [2]. The choice of the stem depends mainly on the extent of femoral bone loss [3].

With the increased life expectancy and younger age of patients receiving primary THA, conservative femoral revision is of paramount importance. Several studies dealt with the use of cementless modular stems or cemented stems in revision THA with satisfactory outcomes [4, 5]. However, very few assessed the results and survival of long tapered cementless revision stem [6, 7].

The purpose of this study was therefore to assess clinical outcomes, complications, and survival of the KAR® stem at a minimum five year follow-up. Our hypothesis was that clinical outcomes and survival of the KAR® stem would be satisfactory and similar to those reported for other revision stems.

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Patients and methods

We retrospectively reviewed the clinical and radiographic records of a consecutive series of patients who underwent revision THA between 2000 and 2010. The inclusion criteria were the following: age over 18 years and the use of a KAR® femoral stem (DePuy, Leeds, UK). This study included 114 patients (116 hips). Demographics of the cohort are summarized in Table 1. The main reasons for revision were aseptic loosening (82%), periprosthetic joint infections (PJI) (11%), periprosthetic fractures (6%), and ceramic fractures (1%). Femoral bone defects were graded from 0 to 4 according to the Paprosky bone loss classification [8].

The KAR® stem is forged from titanium alloy, fully coated with hydroxylapatite (HA) (155 μm), with a collar and two distal slots. It is 25% longer than the standard CORAIL® stem (Fig. 1).

Surgical technique

In all cases, pre-operative planning and templating were performed to select the required stem length and offset. A posterolateral approach was used for 114 hips while a transtrochanteric approach was used for 2 hips. A two-stage procedure was performed for all hips with PJI. First, the previous stem and any cement were removed, which required an extended trochanteric osteotomy (ETO) in 28 hips (24%). Reamers were used to calibrate the femoral diaphysis, and then machined diamond-tooth broaches were used to calibrate the metaphysis in a size-to-size manner. A trial stem was inserted to verify adequate preparation and allow easy insertion of the final stem. Bone graft was used in 42 hips (36%). Weight-bearing was not allowed for 6 weeks in 66 patients (59%); full weight-bearing was allowed immediately in 30 patients (26%), and partially in 17 patients (15%).

Of these 114 patients (116 hips), 28 patients (28 hips) had died with their original stem in place, and five patients (5 hips) were lost to follow-up. This left a cohort of 81 patients (83 hips) who were clinically assessed, of which 63 patients (65 hips) were also radiologically evaluated. Mean follow-up was ten ± three years (range, 5–16).

Harris Hip Score (HHS), Oxford Hip Score (OHS), and Postel-Merle d'Aubigné (PMA) score were recorded. Radiographic analysis included the evaluation of stem osseointegration according to Engh score, the subsidence, and the stress shielding [9]. Femoral stem subsidence of at least 10 mm was considered significant.

Table 1 Demographics of the cohort

Gender, *n* (%)	
Male	53 (46%)
Female	61 (54%)
Age at surgery (years), mean ± SD (range)	68 ± 12 (36–92)
Side, *n* (%)	
Right	58 (50%)
Left	58 (50%)
Reasons for primary THA, *n* (%)	
Osteoarthritis	90 (78%)
Post-traumatic arthritis	17 (15%)
Osteonecrosis	9 (7%)
Number of previous surgeries, median (range)	1 (1–11)
Reasons for revision THA, *n* (%)	
Aseptic loosening	95 (82%)
PJI	13 (11%)
Periprosthetic fracture	7 (6%)
Ceramic fracture	1 (1%)
Paprosky femoral defect, *n* (%)	
Type 0	26 (23%)
Type 1	21 (18%)
Type 2	27 (23%)
Type 3A	25 (22%)
Type 3B	15 (12%)
Type 4	2 (2%)
Stems removed, *n* (%)	
Cemented	77 (66%)
Cementless	39 (34%)
Operative time, mean ± SD (range)	181 min ± 60 (60–360)

Fig. 1 KAR® stem (DePuy, J&J, Warsaw, IN): long tapered cementless stem

Statistical analysis

Descriptive statistics were used to summarize the data. Survival was assessed using the Kaplan-Meier (KM) method and Cumulative Incidence Function (CIF) [10]: free of stem revision for aseptic loosening, free of stem revision for any reason, and free of any reoperation. Multivariable Cox regression was performed to determine associations between re-operations and six independent variables (age, body mass index, Paprosky classification, reason for primary THA, reason for revision THA, and number of previous operations). *P* values < 0.05 were considered significant. Statistical analyses were performed using R, version 3.3.2 (R Foundation for Statistical Computing, Vienna, Austria).

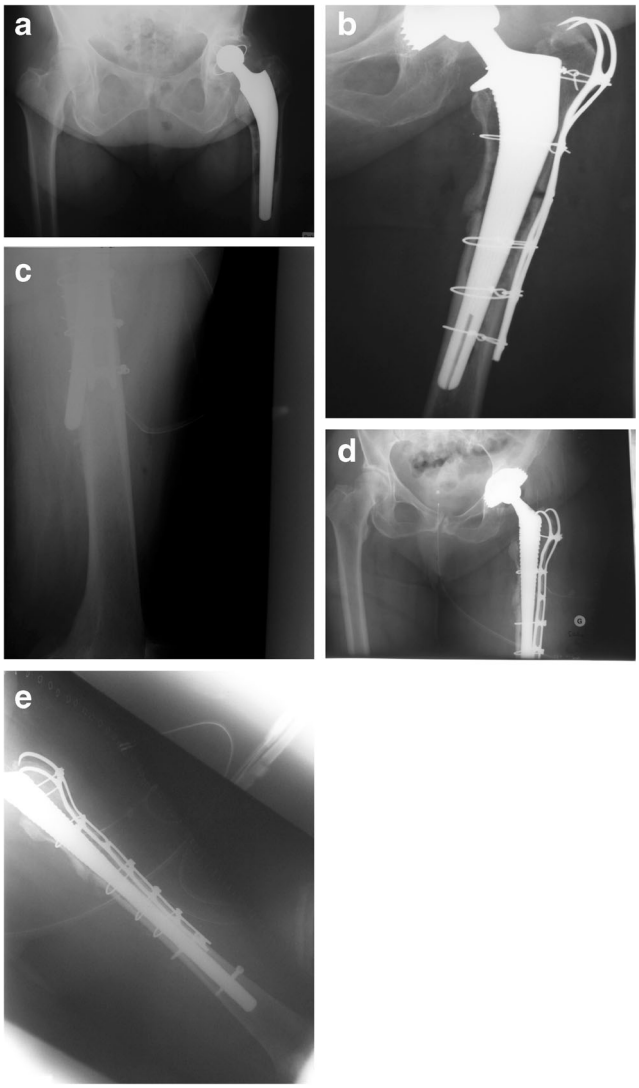

Fig. 2 **a** Pre-operative radiograph of a 75-year-old female with stem aseptic loosening. **b** Immediate post-operative AP radiograph of Kar implantation. **c** Immediate post-operative lateral radiograph of Kar implantation (cortex perforation). **d** Stem revision using a locked modular stem. **e** Distal radiograph of the long locked modular stem

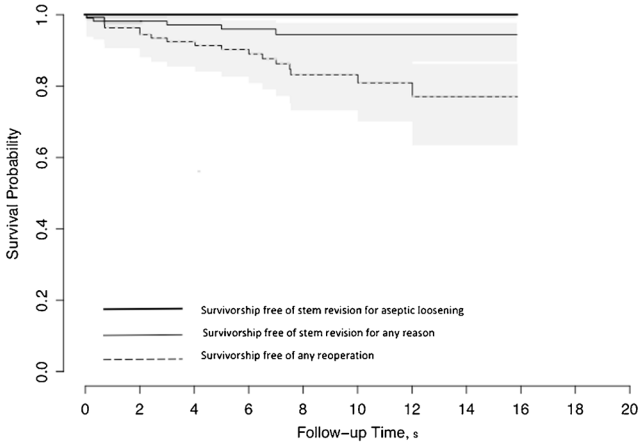

Fig. 3 Survivorship free of stem revision for any reason and survivorship free of any re-operation

Results

Clinical and radiographic assessments

Post-operative HHS was 83 ± 15 (range, 35–99) and OHS was 37 ± 8 (range, 8–48). PMA score significantly increased from 12 ± 2 (range, 5–18) pre-operatively to 14.6 ± 2 (range, 9–18) post-operatively ($p = 0.0004$). The radiographic Engh score was 15 ± 8 (range, 7–22). One hip (1%) had radiologic evidence of excessive stress shielding. Stem subsidence (equal or greater than 10 mm) was observed in two cases (3%) (10 mm and 15 mm) with no need of revision: respectively, pre-operative femoral bone defects were classified as Paprosky type IIIa and IIIb. Thigh pain was reported in these two cases of stem subsidence (3%) with resolution when the stem became stable. It was also seen in PJI. In the other cases, thigh pain was not recorded.

Complications

There were 11 intra-operative complications, including seven greater trochanter fractures (6%), three non-displaced calcar fractures (3%), and one periprosthetic fracture (1%) (requiring stem revision) (Fig. 2). There were four post-operative complications that required stem revision, including one periprosthetic fracture (1%) and three PJI (3%). There were nine post-operative complications which required a re-operation without

Table 2 Multivariate analysis using Cox model for revision or reoperation for any reason

Variables	*P*=
Age	0.4
BMI	0.8
Paprosky classification	0.9
Reason for Primary THA	0.8
Reason for revision THA	0.9
Number of previous surgeries	0.2

Table 3 Review of literature surrounding stems used in revision THAs

Authors et al.	Year	Number	Stem used	Paprosky stage (range)	Follow-up (years)	Clinical outcomes (HHS)	Complications (%): Fracture Dislocation Infection	Survival free of aseptic loosening (%)	Survival free of reoperation (%)
Our study	2018	116	Long HA	I–IV	10	83	10 2 5	100	84
Smith [4]	2016	115	Modular	I–IV	6	NC	0 NA 14	99	81
Kim [6]	2015	130	Long HA bone graft	IIIB–IV	16	86	3 3 5	91	83
Solomon [11]	2015	137	Long Cemented	III	14	38	3.6 1.5 1.5	95	90
Carrera [12]	2015	100	Locked	II–III	9	82	1 NA NA	97	NA
Imbuldeniya [13]	2014	393	Modular	I–IIIa	15	81	10 7 2	99	91
Thomsen [7]	2013	93	Long HA	I–IV	15	85	15 13 2	97	94
Mertl [14]	2011	725	Locked	I–IV	10	81	14 NA NA	93	NA
Pinaroli [2]	2009	41	Short HA	I–II	3	90	NA 5 2	100	93

NA not applicable

stem revision: three PJI (3%), cup aseptic loosening in four cases (3%), and two dislocations (2%).

Survival and cumulative incidences

Using the KM method, ten year survival free of stem revision for aseptic loosening was 100% (IC 95%, 100–100%), free of stem revision for any reason was 95% (IC 95%, 87–98%), and free of any re-operation was 81% (IC, 70–88%) (Fig. 3). Using the CIF method, the cumulative incidence at ten years of stem revision for aseptic loosening was 0% (IC, 0–0%), for any reason was 5% (IC, 0.5–9%), and for any re-operation was 17% (IC, 9–24%) (Fig. 4).

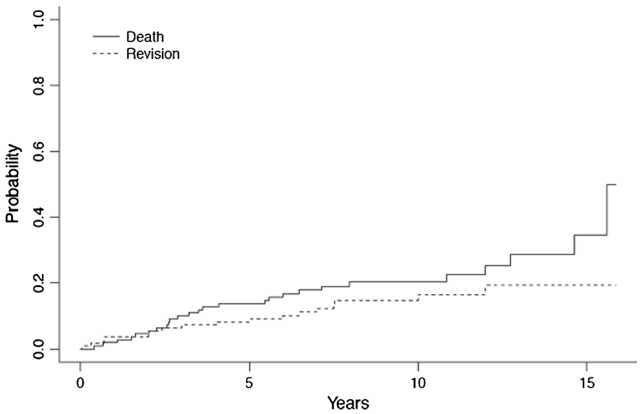

Fig. 4 Cumulative incidences with competing risk of death or revision for any reason

Risk factor

No factors were significantly associated with the risk of stem revision or reoperation (Table 2).

Discussion

During revision THA, stems may be chosen among different designs: standard stems (as in primary THA), long stems, modular or distally locked stems, either cementless or cemented [4, 6, 11–14]. The purpose of this study was to assess the clinical outcomes, complications, and survival of the KAR® stem at a minimum follow-up of five years. This study reported excellent clinical and radiological outcomes at

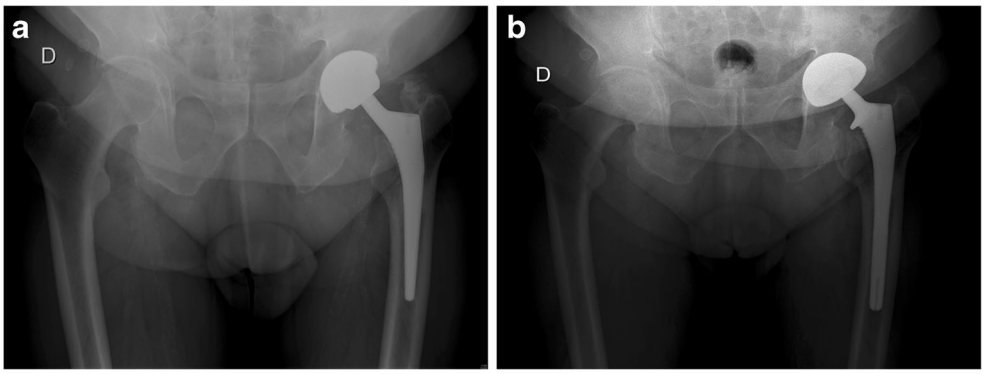

Fig. 5 **a** Pre-operative radiographs of a 55-year-old male with stem aseptic loosening. **b** 8 years after Kar implantation

ten years. Clinical results were satisfactory with a post-operative HHS and OHS comparable to other studies [2, 6, 7, 15, 16] (Table 3). Radiographic results showed adequate osseointegration [17, 18] (Figs. 5 and 6). Only one stress shielding has been reported in the present study, which is considerably lower than the 8% rate reported by Sanli et al. [19]. This difference may be explained by the protective role of the distal slots [19, 20]. In our study, subsidence was observed in two cases, but remained radiographically stable at the final follow-up. This low subsidence rate is comparable to those reported for modular stems or locked stems and may be explained by the role of the collar which has been found to increase immediate stem stability [16, 21].

Using the KM method, the ten year survivals were satisfactory. Our findings were similar to the mid- and long-term survival free of stem revision for aseptic loosening reported in the literature between 91 and 99% [4, 6, 7, 12, 13]. Our survival free of stem revision for any reason was slightly higher than that of other studies [4, 6]. Our survival free of any re-operation was comparable to literature with other long stems, either locked or modular [6, 22]. Reasons for failure were partially different than those reported in the literature [23] as we mainly reported periprosthetic infections and periprosthetic fractures, known to be a common complication of cementless THA [24]. It is worth noting that only two dislocations have been reported and can be explained by the protective role of the dual mobility [25, 26].

The use of standard stems is a reasonable solution for femoral revision in Paprosky type I or II bone defects [2]. These stems are easier to implant and spare femoral bone stock for future revisions [27], though their mid-term survival is 85% at seven years [28]. The long stem bypasses the damaged proximal femoral bone, thus relying on distal fixation in the diaphysis, and therefore can cause stress shielding [7, 15]. Even if locked stems provide primary axial and rotational stability, screws can be difficult to implant in some cases and could lead to thigh pain [12]. Modular implants provide diaphyseal fixation and metaphyseal filling which is adapted to massive bone loss; however, they are associated with high rates of subsidence (6%) and intra-operative fractures (9 to 28%) [4, 5]. Long-term studies demonstrated durable fixation of HA-coated stems beyond 20 years [29]. Our results suggested that a fully HA-coated stem in revision surgery could provide reliable results at ten years.

The limitations of this study were its retrospective design and limited cohort size. To our knowledge, however, it was the first study on revision THA using this specific stem design at a minimum follow-up of five years.

The present study reported satisfactory outcomes and survival of a long tapered unlocked cementless femoral stem in revision THA at a minimum follow-up of five years. The KM survival free of stem revision was 95%, similar to previous published studies. The full HA coating seemed to provide adequate fixation in revision THA.

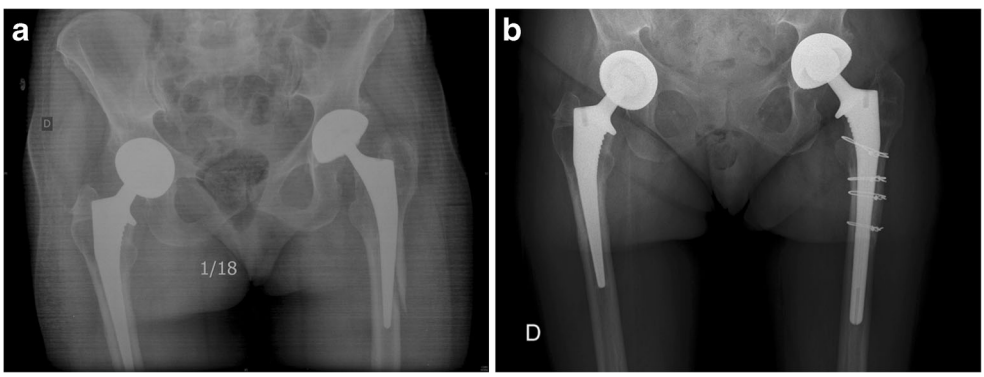

Fig. 6 **a** Femoral periprosthetic fracture Vancouver B2. **b** 7 years after Kar implantation

Compliance with ethical standards

Conflict of interest MHF perceives royalties from DePuy and Serf, not related to the current study. AV, HB, RD, and YH have no conflict of interest.

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