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Original article

Mid-term outcomes after distally locked-to-standard primary stem exchange in 29 hip-prosthesis patients

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ABSTRACT

Background: Cementless locked femoral stems are used for revision surgery in patients with bone loss to induce spontaneous bone reconstruction, allowing subsequent replacement by a standard primary stem. The small number of patients and short follow-ups available to date preclude a valid assessment of this strategy.
Hypothesis: After distally locked stem revision, replacement by a standard primary stem does not induce complications, and the quality of the bone reconstruction allows strong fixation of a regular primary stem.
Materials and methods: We retrospectively evaluated 29 patients in whom a distally locked femoral stem was replaced by a standard primary stem between 1998 and 2010 (cemented in 27, cementless in 2 cases). The reason for the procedure was stem breakage, stem migration, or thigh pain. Mean patient age was 63 years (range, 39–78 years). Outcomes were evaluated based on the Postel-Merle d'Aubigné [PMA] score and Harris Hip Score [HHS]. In addition, radiographs were obtained to assess prosthesis fixation and the Hofmann cortical index measured the bone reconstruction.
Results: The distally locked stem was removed via a postero-lateral approach without femoral osteotomy in all the 29 cases. In one patient, an intra-operative fracture occurred during femoral preparation. Mean follow-up after the exchange procedure was 75 months (range, 3–188 months). Postoperative ccomplications occurred in 9 (32%) patients and consisted of chronic infection in 2 patients (after 3 and 76 months), post-traumatic peri-prosthetic fractures treated with internal fixation in 3 patients (after 100, 138, and 182 months), aseptic loosening in 3 patients (after 13, 39, and 122 months), and recurrent instability in one patient (after 63 months). All cause revision stem survival after 75 months was 72% (95% confidence interval, 47%–87%). In the 19 patients who still had their revision stem at last follow-up, the mean PMA score was 16.7 (range, 13–18) and the mean HHS was 88.2 (range, 59–99). The Hofmann index remained unchanged [36.5% (range, 28%–58%) before the exchange and 32.9% (range, 20%–57%) after the exchange; $P = 0.129$].
Discussion: This study confirms the feasibility of substituting a distally locked stem with a standard primary stem. No specific complications occurred and no technical difficulties arose when extracting the long stems. However, the 32% complication rate and, more specifically, the occurrence of loosening in 10% (3/29) of patients mandates caution in the use of this technique, which should not be proposed routinely, and suggests a need for considering cementless fixation of the standard primary stem.
Level of evidence: Level IV, retrospective study.

1. Introduction

The increasing number of total hip arthroplasty (THA) revisions [1] and the high prevalence of bone loss found during these procedures prompted the development of cementless locked femoral stems, which were first introduced in 1987 [2]. Ultime™ (Wright Medical, Créteil, France) was a titanium alloy stem equipped with three to five locking screws and partially coated with hydroxyapatite at the metaphysis to induce secondary proximal fixation [3]. Early case-series studies showed that this stem was well tolerated and stable in older patients. In some patients, however, particularly those in the younger age groups, spontaneous femoral bone repair was followed by thigh pain or breakage of the stem or screws. These complications were ascribed to inadequate osteo-integration of the locked stem, whose replacement by a standard primary stem was therefore advocated [2–4]. This sequence, from a long-to-shorter stem, had been envisioned initially by the designers of the locked stem but rarely used in everyday practice, except in the event of

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failed locked stem fixation [2,3]. The only published data on long-to-short stem substitution comes from a 2011 study by Miletic et al. [4] in 15 patients, most of whom received a cementless standard primary stem. Highly satisfactory results were recorded after a mean follow-up of 55 months. We are unaware of any published studies reporting long-term outcomes of long-to-short stem substitution.

We hypothesised that long-to-short stem substitution was not associated with any specific complications and that bone reconstruction around the distally locked stem allowed stable fixation of the standard primary stem. The objectives of this study were to establish the technical feasibility of long-to-short stem substitution, particularly regarding locked stem extraction without femoral osteotomy, and to evaluate the mid-term outcomes of the standard primary stems.

2. Material and method

2.1. Patients

We retrospectively studied a single-centre series of patients who underwent exchange of a distally locked stem for a standard primary implant. Of 217 Ultime™ distally locked stems implanted between April 1995 and May 2008, 29 (in 29 patients) were replaced by a standard primary stem between March 1998 and November 2010.

Mean age at THA revision surgery with implantation of an Ultime™ distally locked femoral stem was 59 years (range, 38–79). There were 20 men and 9 women with a mean body mass index of 27.3 kg/m^2 (range, 19.7–36.3). The reasons for implantation of the distally locked stem were stem loosening in 20 patients, a Vancouver B3 [5] peri-prosthetic fracture in 5 patients, re-implantation of a total hip-prosthesis as part of the two-stage management of prosthetic infection in 3 patients, and an intra-operative fracture during implantation of a primary prosthesis in one patient. Bone loss was severe in 6 (20%) patients (SOFCOT stage III or IV) [6]; bone loss stages in the remaining patients were stage 0 ($n = 3$), stage I ($n = 9$), and stage II ($n = 10$). A trans-femoral approach was required in all the 29 patients to remove the stem and/or cement (Table 1), warranting the use of a distally locked cementless stem in the 22 patients with moderate bone loss (stages 0 to II).

Mean age at long-to-short stem substitution was 63 years (range, 39–82 years). The mean Postel-Merle d'Aubigné [PMA] score [7] was 11.4 (range, 8–14) and the mean Harris Hip Score [8] was 43.3 (range, 10–70). The reason for the substitution was stem breakage with no femoral fracture in 2 patients, screw breakage with stem migration in 2 patients, stem subsidence at a distance from unlocking in 4 patients, and thigh pain due to poor osteo-integration in 21 patients. In contradiction to the underlying principle of the distally locked stem design, none of the patients underwent routine conversion to a standard primary stem. At the time of de-escalation, the SOFCOT bone loss stage was 0 in 5 patients, I in 22 patients, and II in 2 patients. The standard stem was cemented in 27 patients and cementless in 2. One patient required implantation of a new distally locked stem after a femoral fracture, which occurred intra-operatively (Table 1) during the preparation for a cemented standard primary stem leaving 28 cases available.

2.2. Operative technique

All 29 procedures were performed via a postero-lateral approach with an additional lateral incision in the thigh for the removal of the locking screws. The stem contours were released first to allow extraction without a femoral osteotomy. The choice of the standard primary stem was at the discretion of the surgeon, who selected a cemented Contact™ stem (Wright Medical, Créteil, France) in 27 patients and a cementless Profemur-L™ stem (Wright Medical, Créteil, France) in 2 patients. In one patient, a femoral fracture occurred intra-operatively during the preparation of the femur and required implantation of a new distally locked stem. The cement was injected in the anterograde direction using a syringe with distal aspiration. Bone grafting was not used. A single patient underwent cup revision; a cemented polyethylene cup was replaced by a dual mobility cup cemented into the original reinforcement cage.

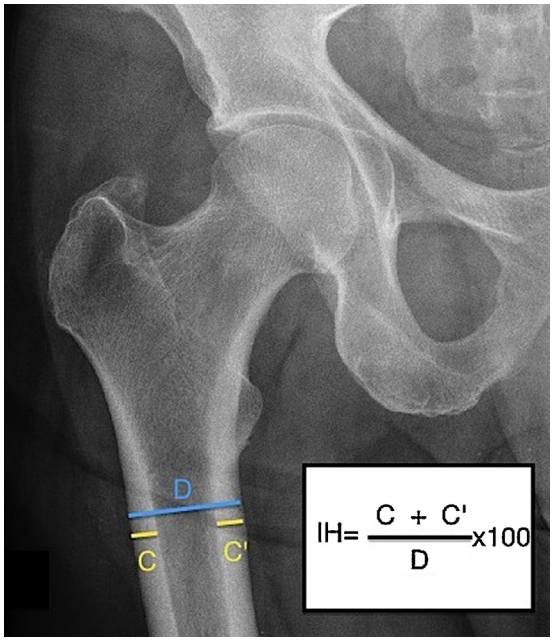

Fig. 1. Method used to determine the Hofmann index (HI): the sum of the thicknesses of the medial (C′) and lateral (C) cortices is divided by the femoral diameter (D) and the result is converted to a percentage.

2.3. Assessment methods

Clinical outcomes were evaluated at least follow-up based on the PMA score [7] and HHS [8]. An antero-posterior pelvic radiograph and lateral hip radiograph were obtained for the evaluation of implant position. In addition, peri-prosthetic lucencies were identified and classified according to Grüen et al. [9] in patients with cemented stems, and evidence of failed osteo-integration was sought in those with cementless stems. For both cemented and cementless stems, subsidence or migration over more than 5 mm or 5° was considered significant. Bone loss was evaluated using the SOFCOT staging system [6] and bone repair using the Hofmann cortical index [10] determined 1 cm and 10 cm distal to the lesser trochanter (Fig. 1); the values of these parameters at the time of the substitution procedure and at last follow-up were compared. Failure was defined as revision surgery for loosening, peri-prosthetic fracture, or infection.

2.4. Statistical methods

The data were described using the mean ± SD with the range. To compare the PMA score, HHS, and Hofmann index values obtained postoperatively and at last follow-up, we used the non-parametric Wilcoxon test for paired samples, with P values of 0.05 or less being considered significant. A Kaplan–Meier plot with the 95% confidence interval (95% CI) was established to assess the overall stem survival.

Table 1
Data obtained before the substitution procedure (preop) and at last follow-up after the substitution procedure (postop).

Patient[a]	BMI	Ind. for DLS	Age at subst. (years)	Ind. for subst.	Cemented stem	Preop SoFCOT bone loss	Preop Hofmann 1 cm	PreopHofmann 10 cm	Preop PMA	Preop HHS	FU after subst. (mo)	Failures	Postop SoFCOT bone loss	Postop Hofmann 1 cm	Postop Hofmann 10 cm	Postop PMA	Postop HHS
1	25.9	Loosng	69	Stem brk	Yes	1	28	41	10	32	84	–	1	35	58	17	99
2	19.7	Fracture	80	Pain	Yes	0	48	50	14	54	71	–	0	21	37	16	88
3	26	Loosng	79	Pain	Yes	0	31	44	11	49	100	Fracture	–	–	–	–	–
4	28.1	Loosng	77	Pain	Yes	1	33	44	12	51	114	–	1	20	51	17	87
5	26.2	Reimpl	70	Migr P	Yes	2	32	44	6	21	13	Loosng	–	–	–	–	–
6	27.9	Reimpl	52	Pain	Yes	1	39	56	9	27	76	Infection	–	–	–	–	–
7	27.6	Loosng	70	Migr P	Yes	1	32	49	10	38	109	–	0	21	49	14	59
8	32	Loosng	52	Pain	Yes	1	58	57	13	52	104	–	0	42	56	17	90
9	24	Loosng	59	Pain	Yes	0	36	39	14	64	67	–	0	57	48	18	99
10	36.3	Loosng	78	Pain	Yes	2	30	53	13	45	58	–	1	34	51	16	79
11	26.8	Loosng	36	Pain	Yes	1	35	52	12	50	54	–	1	32	44	18	95
12	25.5	Loosng	54	Pain	Yes	0	36	51	14	49	49	–	0	24	65	18	99
13	28.7	Loosng	42	Pain	Yes	1	36	58	15	66	55	–	1	38	63	18	96
14	17.9	Loosng	64	Pain	Yes	1	38	48	13	47	188	Fracture	–	–	–	–	–
15	29	Fracture	45	Migr P	No	1	38	37	13	45	3	Infection	–	–	–	–	–
16	21.3	Loosng	53	Pain	No	1	29	51	11	45	25	–	1	30	55	18	98
17	27.6	Fracture	73	Migr P	Yes	1	42	58	11	40	17	–	1	38	49	17	89
18	27.5	Fracture	75	Pain	Yes	1	35	55	10	40	13	–	1	36	51	17	88
19	28.8	Loosng	73	Pain	Yes	1	37	57	8	28	71	–	1	37	67	13	73
20	25.7	Loosng	48	Screw brk	Yes	1	38	52	10	29	39	Loosng	–	–	–	–	–
21	31.6	Loosng	82	Pain	Yes	1	38	57	8	30	29	–	1	38	54	14	66
22	33.9	Loosng	52	Pain	Yes	1	68	62	14	60	122	Loosng	–	–	–	–	–
23	32.4	Loosng	72	Screw brk	Yes	1	36	58	12	43	151	–	1	24	65	18	99
24	29.4	Intraop fracture	64	Pain	Yes	1	40	45	12	51	63	Instability	–	–	–	–	–
25	24.2	Reimpl	71	Pain	Yes	1	36	47	10	37	132	Fracture	–	–	–	–	–
26	23.5	Fracture	39	Pain	Yes	0	38	48	15	70	152	–	1	33	52	18	96
27	28.7	Loosng	50	Stem brk	Yes	1	38	53	9	10	36	–	1	36	52	16	89
28	30.4	Loosng	66	Pain	Yes	1	28	53	12	40	54	–	1	29	50	17	86

BMI: body mass index; DLS: distally locked stem; ind.: indication; subst.: substitution of a standard stem for the distally locked stem; PMA: Postel-Merle d'Aubigné score [7]; HHS: Harris Hip Score [8]; FU: follow-up; mo: months; Reimpl: second stage of a two-stage procedure in the treatment of infection; Preop, before the substitution procedure; postop., at last follow-up after the substitution procedure; Migr P: migration of the prosthesis; intraop: intra-operative; brk: breakage; SOFCOT stage: bone loss stage in the classification developed by the *Société française de Chirurgie orthopédique et traumatologique* [6]; Hofmann, Hofmann index (measured 1 cm and 10 cm distal to the lesser trochanter [10]; instability, recurrent instability.

[a] In addition to the 28 patients in the Table 1, patient experienced an intra-operative femoral fracture and therefore, received another distally locked stem instead of a standard stem.

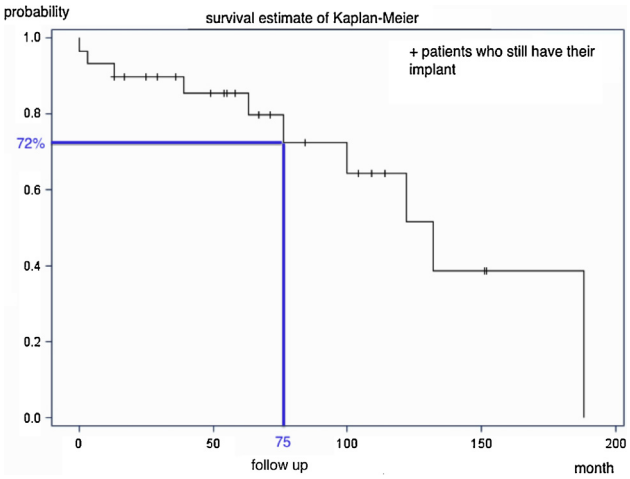

Fig. 2. Kaplan–Meier survival plot with censoring at stem replacement for any reason (75-month survival was 72%; 95% confidence interval, 47%–87%).

3. Results

All the distally locked stems were extracted via the posterolateral approach with no femoral osteotomy. A single patient experienced an intra-operative femoral fracture during preparation of the femur for implantation of a cemented standard primary stem; this event was managed by implantation of a new Ultime™ stem.

Mean follow-up was 75 months (range, 3–188 months). Stem survival at last follow-up was estimated at 72% (95% CI, 47%–87%) (Fig. 2). Postoperative complications requiring revision surgery occurred in 9 (32%) patients (Table 1):

- two prostheses were removed to treat chronic infection, after 76 months (in a patient with haematogeneous infection) and 3 months (in a patient with a peri-prosthetic fracture as the reason for distally locked stem implantation);
- three patients experienced Vancouver type C1 [5] peri-prosthetic fractures requiring revision surgery after a mean of 140 months (range, 100–188 months). All three fractures were located at a distance from the locking screw holes of the distally locked stem (Fig. 3). The fracture was caused by a mechanical fall in 2 patients and a motor vehicle accident in one patient. All 3 patients were managed by screw-plate fixation with no change in the standard primary stem;
- in 3 patients, stem loosening required revision surgery after a mean of 58 months (range, 13–122 months). In one of these patients, SOFCOT stage III bone loss required implantation of a distally locked screw after 39 months (Fig. 4), whereas a new cemented standard primary stem was used in the other 2 patients;
- recurrent instability with three dislocation episodes prompted revision surgery after 63 months in one patient. Femoral stem anteversion was satisfactory and, therefore, only the cup was changed to a dual mobility design.

Mean follow-up in the 19 patients who still had the standard primary stem was 69 months (range, 13–152 months). The stem substitution procedure was followed by significant improvements in the clinical scores: the PMA score increased from 11.7 (range, 8–14) before substitution to 16.7 (range, 13–18) at last follow-up ($P < 0.001$) and the HHS from 44.6 (range, 10–70) to 88.2 (range, 59–99) ($P < 0.001$), with 15 (79%) good or excellent results. The SOFCOT bone repair stage remained unchanged (Table 1). Similarly, the Hofmann index values 1 cm and 10 cm distal to the lesser trochanter were stable [(36.5% and 51.8% at the time of the substitution procedure, respectively, and 32.9% and 53.5% at last follow-up, respectively ($P = 0.129$ and $P = 0.349$)]. Peri-prosthetic lucencies were visible in 3 patients; their location, according to Gruen et al. [9] were zone 1; zone 3; and zones 1, 6, and 7; respectively. All 3 patients were free of symptoms.

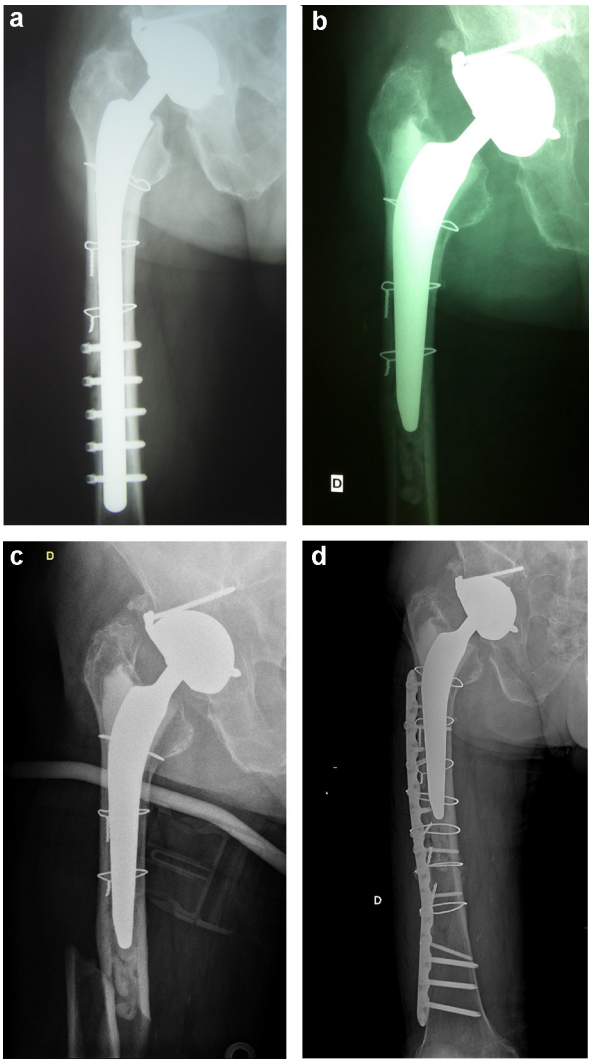

Fig. 3. Patient with thigh pain whose distally locked stem (A) was replaced by a cemented standard stem (B); a C1 peri-prosthetic fracture 132 months later (C) was managed by screw-plate fixation (D).

4. Discussion

Locked femoral stems are widely used in France for THA revision in patients with bone loss and/or peri-prosthetic fractures. The locking stem was initially designed to be replaced by a shorter stem after the occurrence of bone repair [2,3]. Little information is available, however, on long-to-short stem substitution. We are aware of a single study [4], which had a follow-up of only 4.5 years and only 15 patients. We retrospectively evaluated 29 patients to confirm the feasibility of long-to-short stem substitution and to assess the outcomes of the standard primary stems used for the procedure. The only case of intra-operative femoral fracture occurred during preparation of the femur for a cemented standard stem and not during extraction of the distally locked stem. Our findings confirm the feasibility of the substitution procedure: none of the patients

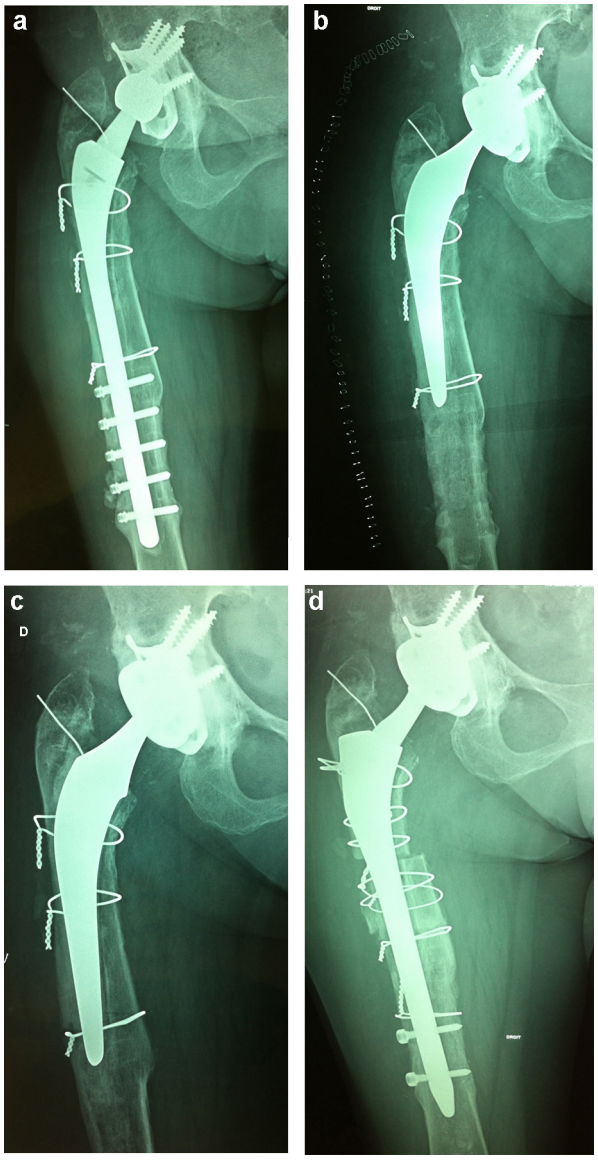

Fig. 4. Patient with fixation failure and thigh pain. The distally locked stem (A) was replaced by a cemented standard stem and the cup was changed to a dual mobility design cemented into the same reinforcement cage (B). Femoral loosening 39 months later (C) required implantation of a locked stem with femorotomy and proximal femoral adjustment osteotomy (D).

required specific bony procedures and none experienced complications related to locked stem extraction. However, the occurrence of standard stem loosening in 3 (10%) patients (all occurred in standard cemented stems) mandates caution when using the substitution technique and suggests that a cementless stem might be preferable.

The limitations of our study include the retrospective design and relatively small number of patients. However, we have nearly twice the number of patients in the only previously published study of the substitution procedure (29 vs 15) [4], and our mean follow-up is longer (75 vs 55 months). The patients were managed by several different surgeons, although this fact further supports the feasibility and reproducibility of the procedure. Although the mean follow-up in our study was only 75 months, follow-up was longer than 100 months in one-third, and longer than 10 years in one-fifth of the patients. Finally, none of our patients were lost to follow-up and no data were missing regarding the complications, particularly, those occurring early after the procedure.

Distally locked femoral stems were developed for patients with severe femoral bone loss (SOFCOT stages III and IV). The designers observed that spontaneous bone regeneration occurred around these implants, even in the absence of bone grafting [2–4]. In a multicentre study of 725 distal locking stem implantations for loosening, Mertl et al. [3] found that the bone reconstruction allowed the subsequent implantation of a standard stem when further revision surgery proved necessary. We assessed bone reconstruction based on the Hofmann cortical index, which remained unchanged over time after the substitution procedure.

Substitution of a cemented standard primary stem for the distally locked stem is indicated in patients with limited bone loss (SOFCOT stages I and II), such as those included in our study [6,11–13]. Improvements in cementing techniques have increased the survival of revision stems [11]. Nevertheless, our complication rate is higher than in first-revision case-series: for instance, Howie et al. [12] found an 8-year (range, 5–18 years) survival rate of 93%.

Miletic et al. [4] reported the only study of distally locked-to-standard stem substitution. None of the 15 patients experienced complications during the mean 55-month (range, 36–84 months) follow-up. In contrast, we observed a 32% complication rate. This discrepancy may be ascribable to the longer follow-up in our study, as half the complications occurred more than 55 months after the substitution procedure: all the peri-prostheticfractures occurred after more than 100 months (mean, 8.3 years), one of the infections was diagnosed after 76 months, and one of the revisions for loosening was performed after 122 months. Cemented standard stems were used in most of our patients and cementless stems in the earlier study [4], which may explain the survival difference, as Davies et al. [13] reported that replacing cemented stems by cemented stems was associated with poorer stem survival.

Our results in the patients who still had the substitution stem at last follow-up are in keeping with those obtained in earlier studies. Thus, Thorey et al. [14] obtained a mean HHS of 78.9 (range, 66.4–91.4) after a follow-up of 6.8 years. Substitution stem failures in our study fell into four categories, of which only one – peri-prosthetic fracture – can be viewed as specific for the substitution procedure. However, patient-related factors probably contributed to these fractures: all 3 patients were elderly (mean age of 82 years at the time of the fracture) and mean time to fracture was 140 months (11.5 years). Importantly, none of these fractures occurred along the trajectories of the previously implanted locking screws.

5. Conclusion

This case-series study confirms the feasibility of substituting a standard primary stem for a distally locked stem. This procedure carries no risk of specific complications and does not require an additional femoral osteotomy when performed via the postero-lateral approach. However, the occurrence of postoperative complications and more specifically, the revision rate for loosening suggests that the use of cementless stems may deserve consideration and that the substitution procedure should be reserved for failure of the distally locked stem in patients with good-quality bone reconstruction.

Disclosure of interest

Maxime-Louis Mencière, Nicolas Wissocq, ElieKrief, David Elkoun, andJérômeTaviauxdeclare no conflicts of interest related to this work. Patrice Mertlis a consultant for Zimmer, Stryker, De Puy, and B-Braun.

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