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Is isolated insert exchange a valuable choice for polyethylene wear in metal-backed unicompartmental knee arthroplasty?

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Abstract

Purpose The aim of this study was to evaluate the clinical outcome and survival rate after isolated liner exchange for polyethylene (PE) wear in well-fixed metal-backed fixed-bearing unicompartmental knee arthroplasty (UKA).

Methods Twenty medial UKAs in 19 patients [mean age 68.7 years ± 8.7 (range 48.5–81.5 years)] operated on for a direct PE liner exchange after isolated PE wear between 1996 and 2010 in two institutions were retrospectively reviewed. The mean delay between the index operation and revision was 8.2 years ± 2.6 (range 4.8–12.8 years). A four-level satisfaction questionnaire was used, and clinical outcomes were assessed using Knee Society scores (KSS) and range of motion (ROM) evaluation. Radiological evaluation analysed the position of the implants and progression of the disease. Survival rate of the implants was evaluated using Kaplan–Meier analysis with two different end-points.

Results At the last follow-up [mean 6.8 years ± 5.2 (range 1.1–15.9 years)], 15 patients (79 %) were enthusiastic or satisfied. KSS improved from 73.4 to 86.4 points (*p* = 0.01) and function from 58.9 to 89.2 points (*p* < 0.001). ROM at last FU was 126.5° ± 10.3°. The survival rate at 12 years considering "revision for any reason" as the end-point was 71.3 ± 15.3 %, and the survival rate at 12 years considering "revision of UKA to TKA" as the end-point was 93.3 ± 6.4 %.

Conclusion Isolated liner exchange for PE wear in well-fixed metal-backed fixed-bearing UKA represents a valuable treatment option in selective patients with durable improvement of clinical outcomes without compromising any future revision.

Level of evidence Retrospective therapeutic study, Level IV.

Keywords Unicompartmental knee arthroplasty · Polyethylene wear · Isolated replacement of polyethylene · Clinical outcome · Implant survival rate

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Introduction

Unicompartmental knee arthroplasty (UKA) is widely used for the treatment of osteoarthritis localized to one compartment of the knee. Several advantages of UKA over TKA have been described, including faster post-operative recovery, better range of motion, preservation of bone stock as well as cruciate ligaments that leads to a better kinematics of the knee [3, 6, 9, 15, 22, 26, 29]. As the number of UKA procedures is rising, revisions of UKA will also increase [28]. Loosening, progression of osteoarthritis, polyethylene (PE) wear and instability are the main reasons of UKA's failure, and the cumulative rate of revision reported in registries at 5 years is about 15 % [17, 34]. In young patients, UKA can represent a valuable solution for the treatment of bone-on-bone unicompartmental osteoarthritis; however, in this particular population, higher rate of PE wear have been reported [16]. Several factors influence PE wear:

thickness and quality of PE [5, 24, 27], femoral and tibial component alignment and positioning [13, 14], level of activity and BMI [16]. If revision is required, most UKAs are converted to a TKA and conflicting results regarding surgical complexity and outcomes of revision of UKA to TKA have been reported in recent publications [1, 8, 11, 12, 19, 25, 30–32]. Isolated liner exchange of UKAs for PE wear is, however, rarely reported [2, 16, 23]. Clinical outcomes and survival rate after isolated liner exchanges of UKA for PE wear have to our knowledge's never been specifically reported in the literature. This is clinically relevant since for many surgeons, the solution in case of PE wear is to revise the UKA with a TKA. As stated in the literature, revision of a UKA with a TKA is not easy and both functional results and survivorship are not as good as after TKA. Our hypothesis was that isolated PE liner exchange for PE wear in well-fixed UKA may offer a simple and reliable solution without compromising any future revision. As such, the goals of our study were to assess (1) clinical outcomes and (2) survival rate after isolated liner exchange for PE wear in well-fixed metal-backed fixed-bearing UKA.

Materials and methods

In this retrospective study, we reviewed the records of patients with a UKA presenting with PE wear who underwent isolated liner exchange without removing femoral and tibial components between 1996 and 2010 at two institutions (Institute for Locomotion, Sainte Marguerite Hospital, Marseille, France, and Renée Sabran Hospital, Giens, France).

The mean age at index procedure was 60.4 years ± 9.3 (range 40.8–72.4). In the first institution, a modular prosthesis with a cemented metallic tibial tray (Miller-Galante, ZimmerTM, Warsaw, IN, USA) was used in index operation of the 10 revised knees. This prosthesis included a femoral component in chrome–cobalt alloy, a tibial tray in titanium alloy and a fixed gamma-sterilized PE insert. The surface of the PE insert was smooth and unstressed. The femoral and tibial fixation consisted of two cemented studs [4]. In the second institution, a modular prosthesis with uncemented metallic tibial tray (Alpina Uni® Biomet TM Warsaw, IN, USA) was used in index operation of the ten revised knees. This prosthesis included a femoral component in chrome–cobalt alloy, a tibial tray in titanium alloy, and a fixed gamma-sterilized cross-linked PE insert. The surface of the PE insert was also smooth and unstressed. The tibial fixation consisted of one cementless stud with or without a screw (screw size 15–25 mm), and the femoral fixation consisted of two cementless studs.

The mean delay between the index operation and revision was 8.2 years ± 2.6 (range 4.8–12.8 years).

Considering each implant, the mean delay between index operation and revision was 9.5 ± 2.5 for the cemented UKA and 6.9 ± 1.8 for the cementless UKA ($p = 0.02$). The main symptoms reported by the patients at revision were pain (100 %) in the medial compartment, with sometimes effusion (50 %) or progression of varus deformity (45 %). Instability was not reported. At the time of revision, the clinical assessment showed a competent anterior cruciate ligament (100 %), a small laxity in valgus (90 %) related to wear and a flexion of more than 90° with a full extension (100 %). The final decision to revise a well-fixed metal-backed fixed-bearing UKA by isolated liner exchange without removing femoral and tibial component was also based on a standardized preoperative radiographic evaluation, including 30°, 60° and 90° skyline, anteroposterior, lateral and Merchant views of the knee, in addition to a full-length standing hip-to-ankle radiograph and varus/valgus stress radiographs. None of the patient presented osteolysis. For all the patients, the thickness of PE was significantly decreased (Fig. 1). Thus, patients were included if they presented: a previously well-functioning medial UKA with complaints related to wear of PE with stable knee and a well-functioning ACL, a flexion higher than 90° with full extension, well-positioned implants, no septic or aseptic loosening, a mechanical axis in zone 2 according to Kennedy classification [21], no patellofemoral and lateral involvement in skyline views and lateral and Merchant views, and a minimum follow-up of 1 year after the PE exchange. Patients with previous history of infection were excluded. Thus, 19 patients (20 knees) were included with a mean age of 68.7 years ± 8.7 (range 48.5–81.5 years) at revision, the majority of patients being female (52.6 %), with a mean BMI of 26.3 kg/m^2 ± 3.3 (range 21.4–32.4 kg/m^2). The left side was involved 14 times (70 %). Patients were described according to the Charnley classification [10]: 8 patients (42.1 %) were Charnley A, 9 (47.4 %) were B and 2 (10.5 %) were C.

Surgical procedure

Revision procedures were performed by the three senior surgeons (FL, SP and JNA). Before the operation, size and thickness of the original PE liner were obtained from the patient medical record and ordered adequately. The previous scar incision was used, and a minimally invasive medial parapatellar approach was performed. The whole articulation was explored to assess cartilage and to control the integrity of the anterior cruciate ligament. Then, the failed PE was removed, and the joint was washed using pulse lavage. Care was taken to assess stability and integrity of both the femoral and tibial implants. No metallosis was found. Finally, a new PE, adapted to the primary prosthesis, was inserted. In ten knees (50 %), the same thickness of PE was

Fig. 1 Preoperative **a** anteroposterior (AP) radiograph showing a significant decrease in PE thickness with well-fixed and well-positioned tibial and femoral components and without osteolysis. AP **b** radiographs, 6 years after isolated PE liner exchange, are showing that the components are still well-fixed and well-aligned, without evidence of loosening or osteolysis

used; in four knees (20 %), a smaller PE was used; and in six knees (30 %), a thicker PE was inserted to achieve a stable knee with full extension and flexion. Drainage was not necessary. All patients were weight-bearing as tolerated postoperatively, and all patients received routine prophylaxis with low molecular weight heparin (LMWH) postoperatively for 42 days.

The mean operative time (the time from incision to the end of the closure) was 33.4 min ± 8.5 (range 20.0–50.0 min). The length of hospital stay was 5.3 days ± 1.7 (range 2.0–8.0 days). In two situations, the isolated liner exchange on one knee was associated with contralateral knee arthroplasty. No transfusion was required. No surgical complications were observed.

Follow-up

In both institutions, regular clinical and radiographic (standard AP, lateral and full-length standing hip-to-ankle radiograph) follow-up after UKA is performed at 3 months,

1 year, 2, 5 years and every 5 years thereafter. More, the Knee Society knee and function scores [18] were recorded preoperatively and at the follow-up visits. At last follow-up (mean 6.8 years ± 5.2; range 1.1–15.9 years), the 20 knees were analysed clinically and radiologically by two independent observers (XX and XX) using the Knee Society rating system [18] and a four-level satisfaction questionnaire (excellent, good, fair and poor). Range of motion was assessed using a goniometer. All the radiographic evaluations were performed according to previously validated methods independently by the two observers. In case of discrepancy for the arthritis progression evaluation or of more than 2° between the two observations, the evaluation was performed a third time with two of the senior authors to achieve a 1° accuracy of measures. The Berger scale was used to assess progression of osteoarthritis in the other compartments [7]: radiographic changes were defined as Grade 1 (evidence of radiographic changes such as osteophytes, but with no measurable loss of joint space), Grade 2 (≤25 % loss of joint space), Grade 3 (≤50 % loss of joint

Table 1 Results of the satisfaction score (excellent, good, fair and poor) and results of the Charnley classification [27] and the Berger scale [30] at the last follow-up

	Excellent (n = 7)	Good (n = 8)	Fair (n = 2)	Poor (n = 2)
Charnley classification [27]				
A	5	3	0	0
B	2	4	2	1
C	0	1	0	1
Berger scale [30]				
Grade 1–2	5	4	0	0
Grade 3–4	0	1	2	2

space) or Grade 4 (>50 % loss of joint space). Radiolucent lines and positioning of tibial and femoral components were determined (frontal positioning and slope of the tibial component, frontal positioning of the femoral component).

Complications were reported, and survival rate of revised UKA was calculated as recommended by Tew and Waugh [33] with two different end-points: (1) "revision for any reason", including revision for septic and aseptic complications and (2) "revision of UKA to TKA". Institutional Review Board (IRB)/Ethics Committee approval was obtained.

Statistical analysis

Since no other study had used KSS and function for UKA revised by PE exchanged, we have performed a post hoc sample size analysis based on mean and standard deviation of our first fifteen patients. "Eighteen" patients were statically necessary to prove a 20 points difference between pre-op and post-op KSS (alpha 0.05, beta 0.9) with standard deviation of 18 points.

ROM, Knee Society pain and function scores were described using means, standard deviations and range values. The comparative analysis for the results of KSS was performed using Student's t test. p values <0.05 were considered statistically significant. Implant survival was estimated with use of the Kaplan–Meier [20] method. 95 % Confidence intervals were determined. Analysis was performed using SPSS software (version 20; SPSS Inc, Chicago, IL, USA).

Results

Clinical outcomes

At last follow-up, 7 patients (36.9 %) were excellent, 8 (42.1 %) good, 2 (10.5 %) fair, and 2 (10.5 %) poor. Among the four patients with lower satisfaction scores (fair and poor), three patients were Charnley B and one patient was C (Table 1). More, these four patients presented all a Grade 3 or Grade 4 according to the Berger scale.

Table 2 Presence of radiolucent lines (< 1 mm) at the bone–cement or bone–prosthesis interface at the last follow-up

Radiolucent lines	Cementless UKA (n = 10)		Cemented UKA (n = 10)	
	Yes	No	Yes	No
Femoral side	0	10	3	7
Tibial side	6	4	2	8

At most recent follow-up, Knee Society knee score improved from 73.4 ± 11.3 to 86.4 ± 13.1 points (p = 0.01) and function score from 58.9 ± 14.7 to 89.2 ± 18.4 points ($p < 0.001$), and ROM was 126.5° ± 10.3° (range 110°–140°).

Radiographic results

At last follow-up, the mean hip–knee–ankle (HKA) axis was 175.2° ± 3.3° (range 168°–180°). In the frontal plane, the mean tibial component alignment was 5.5° ± 2.2° (range 0°–8°) of valgus and the mean femoral component alignment was 6.7° ± 1.1° (range, 5°–8°) of valgus. The mean tibial slope was 3° ± 2.4° (range, 0°–6°).

According to the Berger scale, five knees (25 %) presented arthritic progression (≥stage 3) of the lateral and/or patellofemoral compartments and three of these patients required a revision to a TKA (Table 1).

Stable radiolucent lines (<1 mm) at the bone–cement or bone–prosthesis interface were observed in eight knees (40 %) on the tibial side and in three knees (15 %) on the femoral side, with no clinical relevance (Table 2). A higher number of stable radiolucent lines were observed on the tibial side in cementless prostheses compared with cemented prostheses. None of these implants presented radiological signs of loosening.

Implant survival

Two knees (10 %) required revision using a total knee arthroplasty for progression of disease at 1.7 and 15.3 years after isolated liner exchange. A standard posterior-stabilized
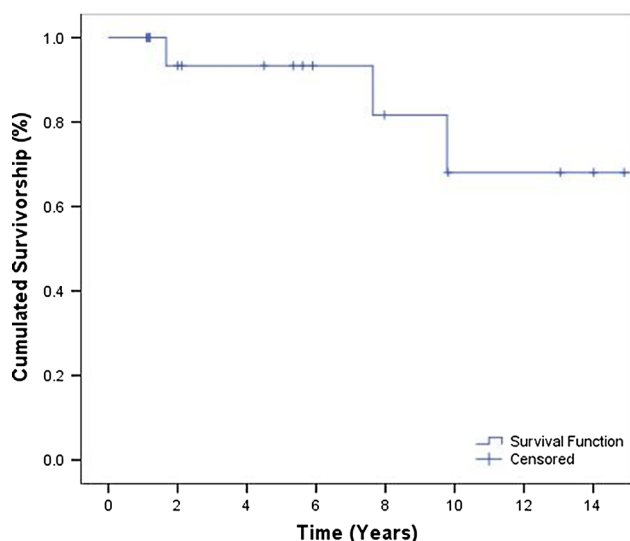
Fig. 2 Kaplan–Meier survivorship curve (and 95 % CI) considering "revision for any reason" as the end-point, including revision for septic and aseptic complications and polyethylene wear. The survival rate at 12 years was 71.3 % ± 15.3 %

Fig. 3 Kaplan–Meier survivorship curve (and 95 % CI) considering "revision by TKA for progression of disease" as the end-point. The survival rate at 12 years was 93.3 % ± 6.4 %

total knee arthroplasty (LPS® Flex Mobile; Zimmer, Warsaw, IN) was used for revision with a tibial stem in the two situations. One patient (5 %) sustained a patellar fracture 1.6 years after isolated liner exchange and required a patellofemoral arthroplasty (Gender Solutions™ Patello-Femoral Joint, Zimmer, Warsaw, IN) at 4.3 years for symptomatic post-traumatic patellofemoral osteoarthritis. Finally, for one patient (5 %), a second isolated liner exchange was performed 9.8 years after the first liner exchange and 18.8 years after implantation. On the basis of clinical and radiographic assessments at the most recent follow-up, there was no evidence of implant loosening or wear for these two patients.

Survival rate of UKAs after liner exchanged considering revision for any reason, including revision for septic and aseptic complications, as the end-point was 71.3 ± 15.3 % at 12 years (Fig. 2), and survival rate of UKAs after liner exchanged considering revision of UKA to TKA as the end-point was 93.3 ± 6.4 % at 12 years (Fig. 3).

Discussion

The most important finding of the present study was that clinical and functional results improved after isolated PE liner exchange for PE wear in well-fixed metal-backed fixed-bearing UKA with encouraging survival at the most recent follow-up ranging from 1.1 to 15.9 years without compromising any future revision.

Some limitations should be outlined. Foremost, this is a retrospective study. Second, the small number of patients
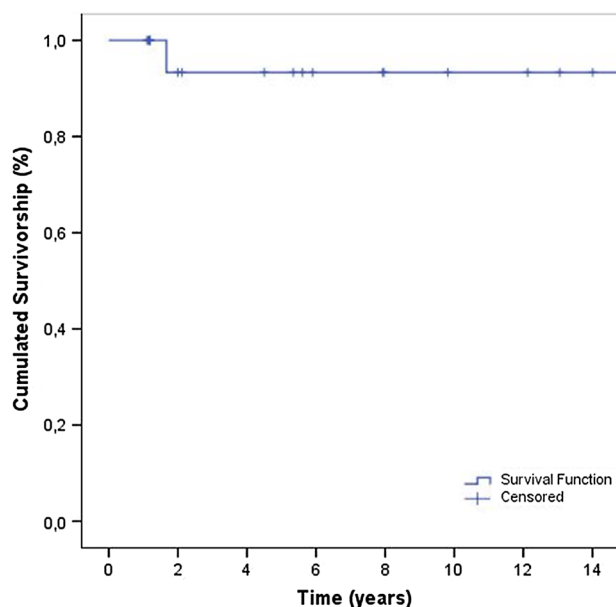
enrolled in the study is another limitation, but this procedure has limited indications and the numbers included in the current series represent to our knowledge the largest study with a mean follow-up of 6.8 years. Moreover, this is the first study to our knowledge that specifically describes clinical outcomes and survival rate after isolated insert tibial exchange for PE wear in well-fixed metal-backed fixed-bearing UKA.

Our study has specifically focused on PE wear that has not been generally described as the main reason for revision of UKA [1, 11, 12, 19, 25, 30, 31]. In some studies, however, larger proportions of PE failures have been reported with, respectively, 55 % [32] and 18 % [8] of PE wear leading to revision with a TKA or with an exchange of the tibial baseplate and the insertion of a new liner [8, 32]. In the first study with 55 % of revision for PE wear, the delay between the index surgery and revision was 8.3 years [32]. In the second one, six knees presented a PE wear, and in two times, the wear was described as "normal" wear and revision was performed at 8 and 10 years after the index surgery [8]. In our study, the delay between the initial surgery and the liner exchange was 8.2 years (range 4.8–12.8 years) with a significant difference between the two implants. If wear was considered as normal for 18 cases, at this follow-up, early and abnormal wear was also observed in our series. This has been previously described in the literature, and Böhm et al. reported four cases of early PE failures [8]. Indeed, for the ALPINA® prosthesis (Biomet TM Warsaw, IN, USA), a problem of PE quality has been

reported with high rate of early wear, as described in a mid-term analysis conducted in one of the two institutions [23]. In this analysis, the radiological evaluation confirmed that no implant malposition or no excessive under-correction of the mechanical axis may explain the early wear observed in this series [23]. Following these observations, the use of the ArCom® PE (Biomet TM Warsaw, IN, USA) since 2001 seems to have solved the problems of early failure with this implant. The results of our PE liner exchange series demonstrated that this technique can be used for both early and normal wear as long as there is no malposition of the implant to explain the PE wear.

Revision of UKA depending on the reason of failure could be difficult and most of the time is performed using a TKA with sometimes the need to use an augment and/or a stem [1, 11, 31, 33]. Results and surgical procedure of UKA's revision seem to be more close to revision of TKA than to primary TKA, even if results are contradictory [1, 8, 11, 12, 19, 25, 30–32]. Therefore, isolated liner exchange for a well-fixed metal-backed tibial component UKA seems to be an easy, simple and conservative approach (in terms of bone stock) compared to revision to a TKA. In our study, no difficulty and complication were encountered, and the mean surgical time was 33.4 min. Results of KSS at the most recent follow-up (6.8 years) were at least as good as those observed in the literature after revision of UKA with a TKA or with a UKA [1, 8, 11, 12, 19, 25, 30–32]. Another option would consist of exchanging the tibial component (both the tray and the PE liner) with a conservation of the femoral implant to replace it with a full PE implant or with a new cemented metal-backed component. We did not choose this option in our series because more bone has to be removed; the risk of collapse is more common and subsequent revision is harder [1].

In our study, the survival rate at 12 years considering "revision for any reason" as the end-point was 71.3 ± 15.3 % and the survival rate at 12 years considering "revision of UKA to TKA" as the end-point was 93.3.6 ± 6.4 %. These results were higher compared with revision of UKA with a new UKA or revision of UKA with a TKA. Indeed, in the Australian registry, the 5-year cumulative rate of re-revision was about 15 % for UKA revised with a TKA and more than 30 % for UKA revised with a UKA, with loosening as the main cause of failure [17]. Our better results can definitely be related to the fact that the implants were not loosed in our series with PE wear as the only reason for revision when in the registry, loosening was the most common reason for revision [17]. Moreover, care was taken to assess the position and the stability of tibial and femoral components and, if malpositioning or loosening of UKA was observed and associated with PE wear, revision was done with a TKA. Thus, in term of survival rate, results of revision of UKA by isolated exchange of PE liner seem to represent a valuable option compared to

other procedures of revision, but the type of prosthesis, the reason for revision, the positioning and the fixation of implants have to be clearly identified.

In our series, a revision was needed for three knees (15 %) after the liner exchange due to progression of the disease, but the surgical procedure was not impaired by previous exchange of PE. Indeed, we used a standard posterior-stabilized TKA with a tibial stem in two cases, and in one case, a patellofemoral arthroplasty was added to the UKA. Thus, it seems that revision of the UKA after the PE liner exchange seems to be not technically more demanding that a conventional revision of UKA. Longer-term follow-up study with a larger study population would however be required to confirm these observations. Based on these results and survival rate, we recommend this operation to avoid the systematic revision of the UKA into a TKA. It is important for the surgeon to clearly evaluate the conditions required to realize this easy and fast surgery, avoiding a conversion to a TKA for many of the medial UKA patients presenting with wear. This is also for us another reason to use metal-backed implants that allow a direct exchange of the liner which is not possible with an all-poly cemented tibial implant.

Conclusion

Clinical and functional results improved after isolated liner PE exchange of well-fixed metal-backed fixed-bearing UKA, with good results at the most recent follow-up without compromising any future revision. The ideal candidate would be a patient presenting with recent isolated medial pain on a previously well-functioning knee, with preserved stability and range of motion, radiologically well-fixed and well-aligned tibial and femoral components and significant wear without osteolysis. In this particular case, planning and performing an isolated PE liner exchange seems to be a valuable treatment.

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