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Hermes patellofemoral arthroplasty: Annual revision rate and clinical results after two to 20 years of follow-up

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ABSTRACT

Background: Patellofemoral arthroplasty (PFA) is an alternative to a total knee arthroplasty (TKA) in patients with severe isolated patellofemoral osteoarthritis. The main goal of this study was to determine the revision rate of the Hermes™ (Ceraver) anatomical unconstrained PFA.
Methods: A retrospective single surgeon study was performed including all patients operated for PFA between 1997 and 2015. A standardized procedure was used to perform PFA with one type of prosthesis. All patients in the study were contacted at the final follow-up. The main judgment criterion was the annual rate of revision. Secondary criteria were the severity of anterior knee pain on a numerical scale (0–10) and functional scores (IKS and AKP scores).
Results: During this period, PFA was performed in 64 patients (74 PFA), 52 women/12 men, mean age at surgery 59.6 ± 11.8 (31.3–82.1) years old. Four patients (5.4% of PFA) were lost to follow-up. Mean follow-up for the remaining 70 PFA was 7.5 ± 7.1 (2–20) years. TKA was required in 10 (14.3%) patients after a mean 5.4 ± 3.4 (1–9.3) years. The annual rate of revision was two-percent $CI_{95\%}$ [1.1–3.7%] if TKA was considered to be the defining event and 3.1% $CI_{95\%}$ [1.9–5.1%] for all types of revision (partial/total PFA replacement or TKA). Patients who underwent revision were significantly younger. After a mean eight (2–20) years of follow-up, mean anterior pain, the IKS and AKP scores improved significantly.
Conclusion: In this series, 78.6% of patients with a Hermes™ PFA did not require any revision after a follow-up of between two and 20 years.
Level of evidence: Level IV — retrospective study.

1. Introduction

The diagnosis of isolated patellofemoral (PF) osteoarthritis is sometimes difficult. It is suggested clinically in patients who are often elderly and present with anterior retro- or peripatellar pain in the knee as well as patellar tilt or crepitus [1]. The diagnosis is confirmed on X-ray by the Merchant view [2], computed tomography (CT), or magnetic resonance imaging (MRI) [1]. Stefanik

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et al. [3] analyzed the knees of 970 patients on MRI using the Whole-Organ Magnetic Resonance Imaging Score (WORMS) [4]. The prevalence of isolated PF osteoarthritis in patients with pain varied from 13.5% to 23.6% depending on the type of cartilage damage.

First-line treatment of isolated PF is conservative, including hygiene and dietetic measures, physical therapy, infiltrations, or temporary immobilization of the knee [1]. Patellofemoral arthroplasty (PFA) has been an alternative to total knee arthroplasty (TKA) since the 1950's [5]. The failure rate of first generation PFA was approximately 35%, so this approach was gradually abandoned by surgeons [6]. Second generation anatomical PFA have now been developed, and available short- and intermediate-term results are encouraging, with an annual revision rate of 2.18% [7]. PFA is usually indicated in patients with isolated PF osteoarthritis following unsuccessful appropriate conservative treatment. Contraindications are inflammatory arthritis, chondromalcia patella, associated tibiofemoral osteoarthritis, patella infera, uncorrected patellar instability, tibiofemoral valgus >8°, varus >5°, or fixed loss of knee range of motion (−10° of extension to 110° of flexion at a minimum) [8].

Compared to TKA, the PFA procedure is less aggressive, with very little bleeding, and a shorter hospital stay [9]. The tibiofemoral compartment, the meniscus and the cruciate ligaments are preserved. A recent randomized study [10] compared the clinical results in patients operated for isolated FP osteoarthritis who received PFA or TKA. The quality of life was significantly better in the PFA group during the first two years of follow-up. Results of the Knee injury and Osteoarthritis Outcome Score (KOOS) functional score were significantly better in PFA patients after two years.

The Hermes™ PFA (Ceraver, France) (Figure 1) is one of the second generation anatomical implants available on the market. It is fully congruent, unconstrained, with an asymmetric trochlear component. The main goal of this study was to determine the annual revision rate with this device. The secondary goals were to analyze the causes of failure and the clinical results at the final follow-up.

2. Patients and methods

2.1. Design of the study and patient selection criteria

A retrospective single center study was performed from a prospective data base of medical files (Osoft from MediBase). A search was performed with the key word “patellofemoral arthroplasty” between 1997 and 2015. During this period, the Hermes™ PFA (Ceraver, France) was the only device used by the same senior surgeon, according to a standardized surgical procedure. All included patients agreed to participate in the study.

2.2. Surgical technique

The surgical approach was anterior with a medial parapatellar arthrotomy. The patella was dislocated and everted and the patellofemoral joint was exposed (Figure 2a). External rotation was set at four to five degrees by alignment along the transepicondylar axis or the tibial mechanical axis with the knee in 90° flexion and an intramedullary nail was inserted (Figure 2b and c). A cutting guide was placed on the intramedullary nail and the anterior femoral osteotomy was performed (Figure 2d and e). The lateral template trochleas were used to choose the size of the trochlear component. A cutting guide was placed on the osteotomy and in the intramedullary hole; then the anterior surface of the medial and lateral parts of the condyle was cut into a “V” (Figure 2f and g). The femoral components were tested, and additional reaming was usually necessary (Figure 2h). Then the patella was resurfaced. A horizontal osteotomy was performed with a saw, and two peg holes were drilled for fixation with a bit with a depth stop perpendicular to the axis of the patellar tendon (Figure 2i). A template was used to determine the size of the patellar component then the polyethylene component and trochlear component were cemented (Figure 2j). At the end of the procedure, the surgeon confirmed

Figure 1. Hermes™ patellofemoral arthroplasty.

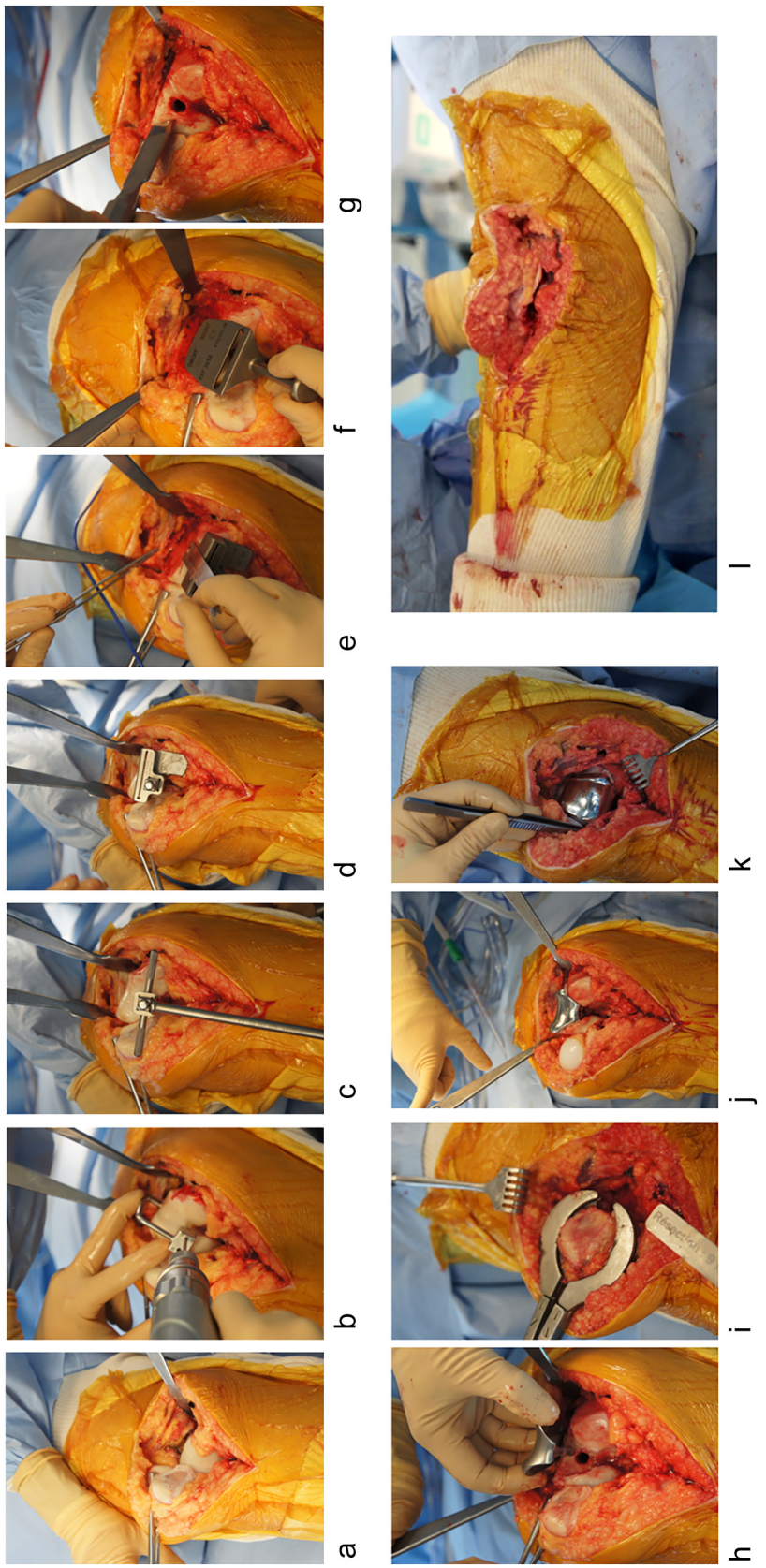

Figure 2. Illustration of the different steps of the surgical procedure.

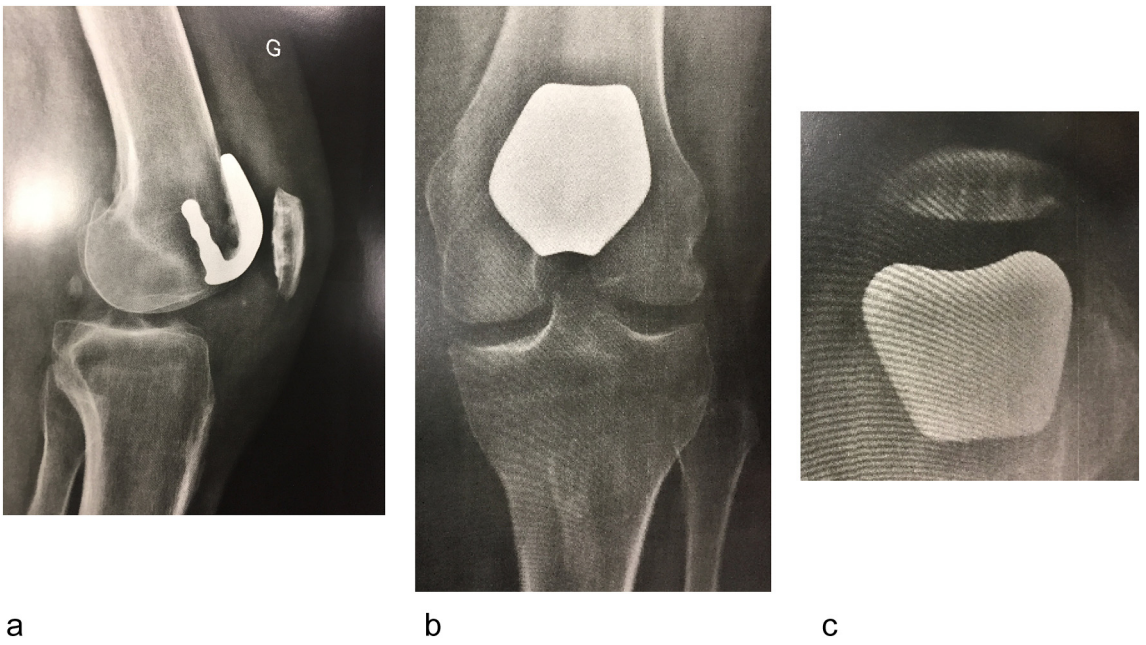

Figure 3. Standard radiographic assessment at the final follow-up (a) profile, (b) Schuss at 45° of flexion, (c) patellofemoral view.

the absence of impingement between the tibial plateau and the trochlear component in extension, and the absence of clicking of the polyethylene on the femoral component during flexion (Figure 2k and l).

2.3. Follow-up protocol and patient evaluation

Post-operative full weight bearing was allowed with crutches, with no limitation of range of motion and without a brace. A postoperative assessment was performed at six weeks and one year of follow-up. All included patients who were alive at the final follow-up were contacted for the study. A consultation was suggested with an independent surgeon or their personal physician. Clinical and radiographic examinations were performed with AP, lateral and patellofemoral views at 30° (Figure 3). Patients who did not wish to attend the consultation responded by telephone to questions concerning the possibility of another surgical procedure in the same knee, the presence and severity of anterior knee pain, as well as to the International Knee Society (IKS) pain [11], the Anterior Knee Pain (AKP) score [12], and functional questionnaire.

2.4. Evaluation criteria

The main evaluation criterion was the annual rate of revision defined as revision by TKA at the final follow-up. Secondary evaluation criteria were the annual rate of revision defined as partial or total replacement of PFA at the final follow-up, the severity of anterior knee pain on a numerical score of "0" (no pain) to "10" (the worst imaginable pain), the IKS pain (/50) and function (/100) scores [11], and the AKP score [12]. Radiographic measurements at last follow-up included the following: (1) the patellofemoral congruence angle measured by patellofemoral's view according to Merchant et al. [2], and any congruence angle greater than 16° was defined as abnormal; (2) the patellar tilt angle using the femoral component as reference [13], and any tilt angle greater than +5° was defined as abnormal; (3) the femoral and patellar components rotation [14,15]; (4) and femoral and patellar radiographic loosening in case of radiolucent lines under the components [16].

2.5. Statistical analyses

Statistical analyses were performed with STATA.10 software. Survival was estimated by the non-parametric Kaplan–Meier method by calculating the annual rate revision with a confidence interval (CI) of 95%. The defining event was partial or total replacement of PFA for any cause, then TKA. The risk factors of revision were evaluated by the Logrank test. Because of the small number of revisions, the variables were tested by non-parametric tests: Mann–Whitney for quantitative variables, functional scores at last follow-up were compared to preoperative scores by Wilcoxon test, and the Fisher exact test for qualitative variables. A p value < 0.05 was considered to be statistically significant.

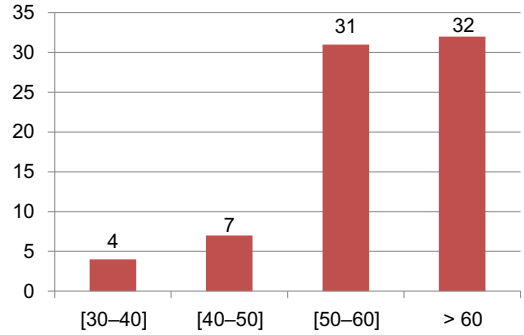

Figure 4. Distribution of age at surgery in the series of 74 patellofemoral arthroplasties.

3. Results

3.1. Description of the study population

During this period, 64 patients received a Hermes PFA including 10 bilateral arthroplasties or a total of 74 prostheses. The series included 52 women and 12 men, or four times more women than men. The mean age at surgery was 59.6 ± 11.8 (31.3–821) years old (Figure 4). During the immediate postoperative period, one patient presented with a hematoma of the knee, which healed without treatment. After a mean postoperative follow-up of eight years (2–20), four patients were lost to follow-up (5.4% of PFA), and three patients died for causes not related to PFA after three, 14, and 15 years and without any additional surgery to the involved knee. A total of 60 patients were analyzed at the final follow-up including 10 bilateral arthroplasties (70 prostheses). The mean age of patients at the final follow-up was 66.9 ± 12.2 (40.4–94.1) years old. According to Charnley classification, 31 were classified "A" (only the PFA); 28 patients were "B" (2 arthroplasties), and one patient "C" (3 prosthesis).

3.2. Number of revisions at the final follow-up

Revision by TKA was performed in 10 (14.3% of PFA) patients after a mean five years of follow-up (1–9) because of the development of tibiofemoral osteoarthritis. Moreover, complete or partial replacement of PFA was performed in five (7.1%) patients, after between one and 18 years. Partial replacement involved the trochlear component in one patient after 1.2 years because of malposition resulting in functional impairment (Figure 5) and a patellar component in two patients after 2.2 and 8.5 years because of a problem with the cement. The PFA was changed and replaced by a Hermes™ PFA in two patients at one and 18 years of follow-up because of painful loosening without tibiofemoral osteoarthritis.

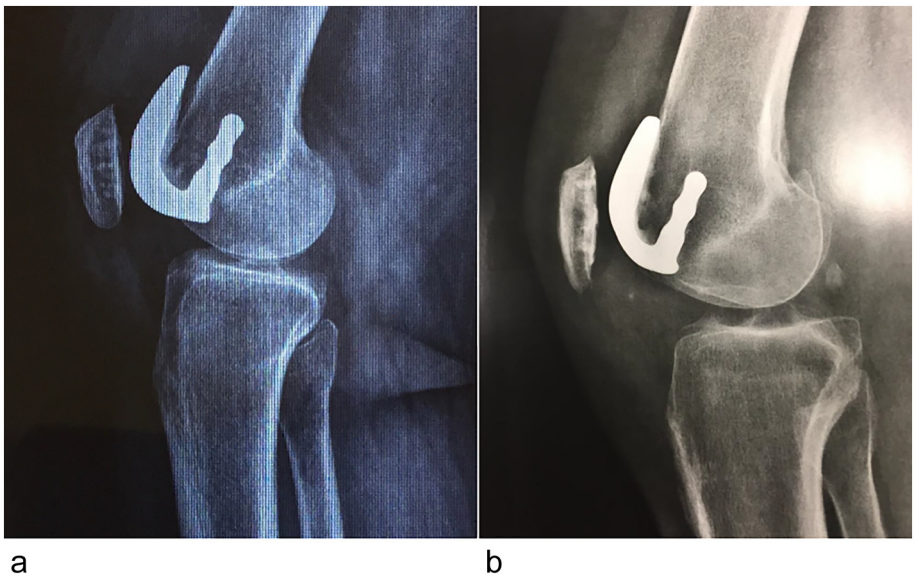

Figure 5. Malposition of the trochlear component (a) requiring replacement (b).

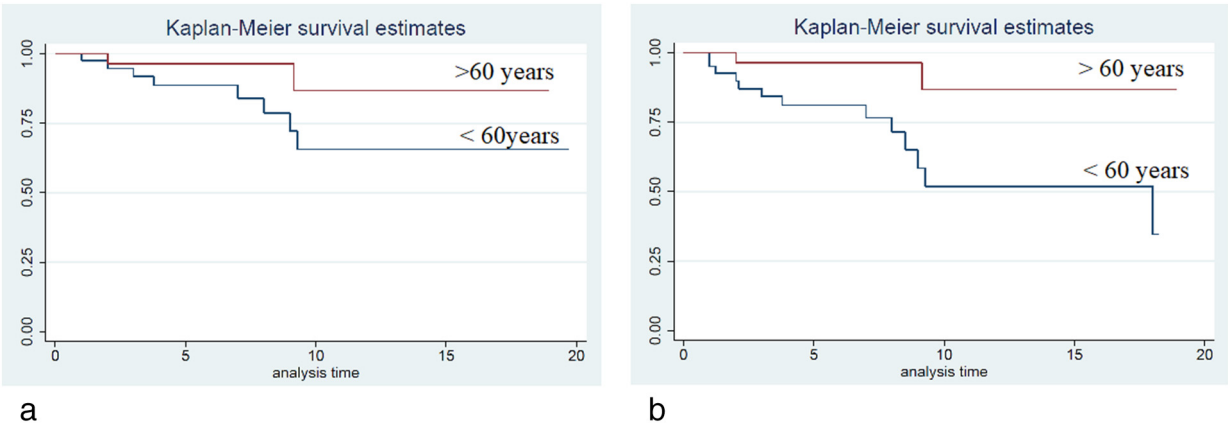

Figure 6. Kaplan–Meier survival curves by age (in red: older than 60 years of age; in blue: younger than 60 years of age) for the event (a) revision by TKA, (b) any type of revision (partial, total PFA or TKA).

3.3. Annual rate of revision and risk factors of revision

When all types of revision were considered (partial or total replacement of PFA or TKA), the annual revision rate was 3.1% CI 95% [1.9–5.1%]. When TKA was the event defining revision, the annual revision rate was two-percent CI 95% [1.1–3.7%].

The population that underwent revision was significantly younger at primary PFA: 52.4 ± 10.7 years old vs 61.4 ± 11.5, p = 0.008. Comparison of survival curves by the logrank test according to age did not show any significant difference between patients who were younger or older than 60 years for "revision by TKA" even though the rate of revision by TKA was higher in the youngest patients (2.7% vs 1%, p = 0.14) (Figure 6a). When the event "all types of revision" was considered, patients under the age of 60 years had a significantly higher rate of revision (4.7% vs 1%, p = 0.01) (Figure 6b).

3.4. Functional results at the final follow-up

At the final follow-up, 30 patients (42.8% of implants) reported anterior knee pain, with a mean severity of 2.9 ± 3/10 (0–10). The mean IKS-pain score improved from 36.3 ± 11.8/50 preoperatively to 42.3 ± 22.1/50 at the final follow-up (p = 0.03), the mean IKS-function score from 58.2 ± 19.6/100 to 79.4 ± 20.7/100 (p = 0.00001), and the mean AKP score from 47.2 ± 17.8/100 to 72.5 ± 14.6 (p = 0.00001). Fifty-two (86.7%) patients said they were satisfied or very satisfied. Patients who were not very satisfied or dissatisfied had significantly more pain (6 ± 2 vs 0.5 ± 0.8, p < 0.00001).

3.5. Radiographic assessment at the final follow-up

Among the 60 patients who were analyzed at the final follow-up, 20 radiographic files were available. The mean patellofemoral congruence angle was 6 ± 11.9° (from −11° to +30°), greater than 16° in three patients. The mean patellar tilt angle was 0.2 ± 5.5° (from −12° to +8°), greater than +5° in four patients. The femoral component was in neutral position in 10 patients, one in external rotation of one degree and nine in internal rotation from three to nine degrees. The patellar component was in neutral position in 15 patients and five in external rotation from two degrees to 10°. Both femoral and patellar radiolucent lines were found in two patients, solely femoral ones in four patients, and only patellar ones in one patient. None of these radiological measurements had a statistically significant impact on functional outcomes (IKS and AKP scores). No patellar fracture was noted. Impending revision was noted in one patient for painful loosening without tibiofemoral osteoarthritis.

4. Discussion

This study shows that 78.6% of patients with Hermes™ patellofemoral arthroplasty did not undergo any prosthesis revision (partial or total replacement of PFA or TKA), and 85.7% did not require total knee arthroplasty after a mean eight years of follow-up (from 2 to 20). Most patients (86.7%) were satisfied, and persistent pain was the main cause of dissatisfaction.

The Hermes™ PFA has already been evaluated by Hernigou and Caton [17] with a mean follow-up of 10 years. TKA was required because of the onset of tibiofemoral osteoarthritis in four percent of patients after four to 10 years. No partial or total revision of PFA was performed in their series. The authors did not calculate the annual revision rate. In our series, the rate of revision by TKA was higher, 14.3%, after a follow-up of one to nine years. One patient underwent TKA after one year because of the rapid onset of tibiofemoral osteoarthritis. The mean age of our patients at surgery was younger in ours than in previous series (59.6 vs 71 years old, respectively), which could explain the higher rate of revision by TKA in our series. This difference

Table 1
Review of the literature for survival of PFA with the same design as Hermes™ PFA.

Authors	Year	Number of patients (PFA)	Age (yrs)	Name of PFA (manufacturers)	Mean follow-up (yrs, range)	Survival w/o TKA
Starks et al. [20]	2009	29 (37)	66	Avon (Stryker)	2	100%
deDeugd et al. [21]	2017	55 (75)	52	Avon (Stryker)	3 (2–10)	94.7%
Osarumwense et al. [22]	2017	38 (52)	59	Gender (Zimmer)	3.3 (2–4.8)	96%
Liow et al. [23]	2016	51 (51)	52.7	SIGMA® (Depuy)	4.1 (2.2–6.1)	92.2%
Odumenya et al. [24]	2010	32 (50)	66	Avon (Stryker)	5.3 (2.1–10.2)	100%
Middleton et al. [25]	2018	85 (103)	61	Avon (Stryker)	5.6 (2.9–14.2)	87.4%
Ahearn et al. [26]	2016	83 (101)	60	Journey (Smith Nephew)	7.1 (5–8.8)	88%
Konan et Haddad [27]	2016	47 (51)	57	Avon (Stryker)	7.1 (5–11)	96.1%
Hernigou et Caton [17]	2014	70 (85)	71	Hermès (Ceraver)	10	96%
Bohu et al. (current)	2017	60 (70)	60	Hermès (Ceraver)	8 (2–20)	85.7%

in age could also explain why, unlike in the study by Hernigou and Caton [17], patients in our series underwent partial or total replacement of PFA, because the annual rate of revision all causes combined calculated in our series was significantly higher in patients under the age of 60 years. Younger age is not a contraindication to a PFA. Recent series show that patients undergo this procedure at an increasingly young age. Moreover, a cost-effective study based on the Markov model shows that second generation PFA is more effective than TKA in young patients [18]. This increased effectiveness was directly linked to a better survival rate of second generation PFA and better activity scores than with TKA.

The annual rate of revision in our series, defined as revision by TKA, was two percent with a survival rate of 85.7% after a mean of eight years and an IKS-function score of 79.4%. Van der List et al. [19] calculated the annual revision rate of PFA based on a systematic review of the literature including 9619 PFA performed between 1995 and 2015. The annual revision rate was 2.18% with 91.7% survival at five years, 83.3% at 10 years, 74.9% at 15 years, and 66.6% at 20 years. The IKS-function score in that review as 81.6%. The results of our study were also comparable to those with implants of the same design (Table 1). Middleton et al. [25], has reported the outcomes at 5.6 years mean follow-up (range 2.9 to 14.2 years) of 103 Avon patellofemoral arthroplasty patients. Ten revisions occurred, nine conversion to TKA for disease progression of the medial or lateral tibiofemoral compartments, and one patient underwent revision of the femoral component of the PFA to another femoral component for malpositioning. The mean time to revision was 2.9 years. Although they stated that conversion to TKA should not be the regarded as failure of the index operation, early failures might be evaluated with caution in terms of patient selection criteria or technical mistakes.

The main causes of revision TKA in the literature are persistent unexplained pain and progression to tibiofemoral osteoarthritis [19]. Persistent pain is the main cause of revision after four years [28]. Paratte et al. have shown that revision by TKA in a patient with PFA does not result in a loss of chance treatment [29]. The perioperative and clinical results of patients who underwent TKA to replace PFA were similar to those who underwent primary TKA. Dy et al. [30] have shown that unlike first generation PFA, there was no difference between second generation PFA and TKA for revision rate, pain, or mechanical complications.

This study has several limitations. First, all patients did not undergo a radiographic assessment at the final follow-up. Results in the literature have shown that although certain patients progress to tibiofemoral osteoarthritis, all of them do not require revision surgery [17]. Moreover, follow-up varied from one patient to another, and was from two to 20 years, with a mean follow-up of eight years. Finally, the patients in our series all underwent surgery by the same senior surgeon by the same standardized procedure. Although this results in less risk of variability for survival analysis of the implant, it would be interesting to perform a study including less experienced surgeons. Indeed, although PFA is a less aggressive than TKA to the anatomical structures of the knee, it is technically more difficult for the surgeon. Placement of the trochlea is complicated. Bone resurfacing must be performed gradually and carefully with a curette and a bone chisel. Before implanting the final prosthesis, the trial component must be placed several times without creating any frontal or rotational tilt until total congruence is obtained.

5. Conclusion

In this series, 78.6% of patients with a Hermes™ PFA did not undergo any prosthesis revision (partial or total replacement of PFA or TKA), and 85.7% did not require revision by TKA after a follow-up of between two and 20 years. Revision by TKA was required after a mean of five years. The annual rate of revision (partial or total replacement of PFA or TKA) in patients under 60 years old was significantly higher. At the final follow-up, anterior knee pain was reported by 43% of patients, which was usually slight. Knee function was restored with a mean IKS-function score of 79/100. Patients were globally satisfied at the final follow-up.

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Conflicts of interest

S Klouche has received fees from Ceraver as a clinical research consultant for this study. The other authors have no conflict of interest to declare.

Ethical statement

IRB: Ethics approval for this study was received from the *Comité de Protection des Personnes Ile-de-France IV (CPP IDF IV)*, Hôpital Saint-Louis.

N°IRB 00003835.

References

[1] Grelsamer RP, Stein DA. Patellofemoral arthritis. J Bone Joint Surg Am 2006;88:1849–60.
[2] Merchant AC, Mercer RL, Jacobsen RH, Cool CR. Roentgenographic analysis of patellofemoral congruence. J Bone Joint Surg Am 1974;56:1391–6.
[3] Stefanik JJ, Niu J, Gross KD, Roemer FW, Guermazi A, Felson DT. Using magnetic resonance imaging to determine the compartmental prevalence of knee joint structural damage. Osteoarthr Cartil 2013;21:695–9.
[4] Peterfy CG, Guermazi A, Zaim S, Tirman PF, Miaux Y, White D, et al. Whole-organ magnetic resonance imaging score (WORMS) of the knee in osteoarthritis. Osteoarthr Cartil 2004;12:177–90.
[5] Mc Keever DC. Patellar prosthesis. J Bone Joint Surg Am 1955;37-A:1074–84.
[6] Tauro B, Ackroyd CE, Newman JH, Shah NA. The Lubinus patellofemoral arthroplasty. A five- to ten-year prospective study. J Bone Joint Surg Br 2001;83:696–701.
[7] van der List JP, Chawla H, Zuiderbaan HA, Pearle AD. Survivorship and functional outcomes of patellofemoral arthroplasty: a systematic review. Knee Surg Sports Traumatol Arthrosc 2017;25:2622–31.
[8] Leadbetter WB, Seyler TM, Ragland PS, Mont MA. Indications, contraindications, and pitfalls of patellofemoral arthroplasty. J Bone Joint Surg Am 2006;88(Suppl. 4):122–37.
[9] Dahm DL, Al-Rayashi W, Dajani K, Shah JP, Levy BA, Stuart MJ. Patellofemoral arthroplasty versus total knee arthroplasty in patients with isolated patellofemoral osteoarthritis. Am J Orthop (Belle Mead NJ) 2010;39:487–91.
[10] Odgaard A, Madsen F, Kristensen PW, Kappel A, Fabrin J. The mark Coventry award: patellofemoral arthroplasty results in better range of movement and early patient-reported outcomes than TKA. Clin Orthop Relat Res 2018;476:87–100.
[11] Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the knee society clinical rating system. Clin Orthop 1989(248):13–4.
[12] Kujala UM, Jaakkola LH, Koskinen SK, Taimela S, Hurme M, Nelimarkka O. Scoring of patellofemoral disorders. Arthroscopy 1993;9:159–63.
[13] Grelsamer RP, Bazos AN, Proctor CS. Radiographic analysis of patellar tilt. J Bone Joint Surg Br 1993;75:822–4.
[14] Westerbeek RE, Derks RP, Zonneveld BJ, van Jonbergen HP. Femoral component rotation in patellofemoral joint replacement: a study protocol for a prospective observational study. Open Orthop J 2015;9:45–8.
[15] Kim JH, Yoo BW, Kim CW. Influence of the rotational alignment of the femoral and patellar components on patellar tilt in total knee arthroplasty. Knee Surg Relat Res 2015;27:163–7.
[16] Ewald F. The knee society total arthroplasty roentgengraphic evaluation and scoring system. Clin Orthop 1989(248):9–12.
[17] Hernigou P, Caton J. Design, operative technique and ten-year results of the Hermes™ patellofemoral arthroplasty. Int Orthop 2014;38:437–42.
[18] Chawla H, Nwachukwu BU, van der List JP, Eggman AA, Pearle AD, Ghomrawi HM. Cost effectiveness of patellofemoral versus total knee arthroplasty in younger patients. Bone Joint J 2017;99-B:1028–36.
[19] van der List JP, Chawla H, Villa JC, Pearle AD. Why do patellofemoral arthroplasties fail today? A systematic review. Knee 2017;24:2–8.
[20] Starks I, Roberts S, White SH. The Avon patellofemoral joint replacement: independent assessment of early functional outcomes. J Bone Joint Surg Br 2009;91:1579–82.
[21] deDeugd CM, Pareek A, Krych AJ, Cummings NM, Dahm DL. Outcomes of patellofemoral arthroplasty based on radiographic severity. J Arthroplasty 2017;32:1137–42.
[22] Osarumwense D, Syed F, Nzeako O, Akilapa S, Zubair O, Waite J. Patellofemoral joint arthroplasty: early results and functional outcome of the Zimmer gender solutions patello-femoral joint system. Clin Orthop Surg 2017;9:295–302.
[23] Liow MH, Goh GS, Tay DK, Chia SL, Lo NN, Yeo SJ. Obesity and the absence of trochlear dysplasia increase the risk of revision in patellofemoral arthroplasty. Knee 2016;23:331–7.
[24] Odumenya M, Costa ML, Parsons N, Achten J, Dhillon M, Krikler SJ. The Avon patellofemoral joint replacement: five-year results from an independent centre. J Bone Joint Surg Br 2010;92:56–60.
[25] Middleton SW, Toms AD, Schranz PJ, Mandalia VI. Mid-term survivorship and clinical outcomes of the Avon patellofemoral joint replacement. Knee 2018;25:323–8.
[26] Ahearn N, Metcalfe AJ, Hassaballa MA, Porteous AJ, Robinson JR, Murray JR, et al. The journey patellofemoral joint arthroplasty: a minimum 5year follow-up study. Knee 2016;23:900–4.
[27] Konan S, Haddad FS. Midterm outcome of Avon patellofemoral arthroplasty for posttraumatic unicompartmental osteoarthritis. J Arthroplasty 2016;31:2657–9.
[28] Baker PN, Refaie R, Gregg P, Deehan D. Revision following patello-femoral arthoplasty. Knee Surg Sports Traumatol Arthrosc 2012;20:2047–53.
[29] Parratte S, Lunebourg A, Ollivier M, Abdel MP, Argenson JN. Are revisions of patellofemoral arthroplasties more like primary or revision TKAs. Clin Orthop Relat Res 2015;473:213–9.
[30] Dy CJ, Franco N, Ma Y, Mazumdar M, McCarthy MM, Gonzalez Della Valle A. Complications after patello-femoral versus total knee replacement in the treatment of isolated patello-femoral osteoarthritis. A meta-analysis. Knee Surg Sports Traumatol Arthrosc 2012;20:2174–90.