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REVIEW ARTICLE

Return to the operating room after patellofemoral arthroplasty versus total knee arthroplasty for isolated patellofemoral arthritis—a systematic review

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Abstract

Purpose Patellofemoral arthroplasty (PFA) and total knee arthroplasty (TKA) are accepted treatments for end-stage isolated patellofemoral osteoarthritis (PFOA). However, complications and re-operations have historically differed between the two procedures. We performed a systematic review to report on the re-operation rates between TKA and modern PFA for isolated PFOA.

Methods Systematically identified publications reporting on patients that underwent either TKA or modern PFA for isolated PFOA were reviewed. Meta-analysis software was used to screen potential articles with at least one year follow-up that detailed reasons for re-operation. Data was extracted and analyzed for all re-operations. Survival of the implant was used as the primary outcome; return to the operating room (OR) for any reason was used as a secondary outcome.

Results The weighted rate of either conversion or revision arthroplasty in the PFA group and the TKA group was 6.34 and 0.11, respectively. The weighted rate of return to the OR for bony and soft tissue procedures was 1.06 and 0.79, respectively. The weighted rate of manipulation under anaesthesia (MUA) was 0.32 and 1.23, respectively.

Conclusion Patients who undergo PFA may be more likely to return to the operating room for conversion to TKA and/or revision surgery than those who undergo TKA.

Keywords Isolated patellofemoral arthritis · Isolated patellofemoral replacement · Total knee replacment

Introduction

End-stage, isolated patellofemoral arthritis (PFOA) can be surgically addressed using patellofemoral arthroplasty (PFA) [1–28] or total knee arthroplasty (TKA) [10, 18, 29–34]. Although PFA has been utilized for over four decades [35, 36], widespread use has been limited by high early failure rates, likely related to implant design and patient selection [37]. Many surgeons have advocated TKA with good results [29, 34]. However, the benefits of PFA that include less operative and recovery time, bone and soft tissue preservation, and the potential for better function are appealing, and interest in PFA has continued. The improvement in outcomes of patients undergoing modern PFA [38] has been linked to a better understanding of the indications and contraindications for surgery and improvements in prosthetic design. The latter include on-lay implantation, a wider and taller femoral component, with a lateralized trochlear groove, and elevated lateral flange to improve patellofemoral kinematics [37].

The evidence regarding the use of PFA versus TKA for the treatment of isolated PFOA is of relatively poor quality [39]. While TKA has demonstrated predictable outcomes, with over 90% of patients reporting excellent results, proponents of PFA believe it may be a better alternative for young, active patients [40, 41].

The knowledge on PFA is hindered by several factors: much of the literature is composed of small, retrospective studies [5, 17, 23], and prosthetic design and indications for surgery have changed over time [37, 41]. Based on these limitations, we designed a study with the aim of reporting the rate

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of return to the operating room of patients who underwent modern PFA and TKA for the treatment of PFOA.

Materials and methods

Data sources and search strategy

This study was conducted following PRISMA guidelines [42]. Article searches were performed on March 19, 2018 using Medline via PubMed (1946–date of search), Embase (1947–date of search), Cochrane library including Cochrane Central Register of Controlled Trials (CENTRAL), Cochrane Methodology Register (CMR), Database of Abstracts of Reviews of Effects (DARE), Health Technology Assessment Database (HTA), and NHS Economic Evaluation Database (EED).

Databases were searched for articles with no year restriction and utilizing both subject headings and keywords ((arthroplasty, replacement, knee or patellofemoral and arthroplasty or prostheses and implants or prosthesis implantation) and (treatment outcome or diagnostic imaging or radiography or second-look surgery or re-operation or survival analysis or clinical results or retrieval analysis or survivorship or radiographic outcome or survival rate or revision rate) and (patellofemoral pain syndrome or patellofemoral joint/injuries or isolated and patellofemoral and osteoarthritis)).

Study selection

Sourced studies were imported into a web-based platform. Blinded titles and abstracts of 1166 articles were independently reviewed by three of the authors and screened for full text eligibility (Fig. 1). Disagreements were resolved by consensus. Review papers, dissertations, conference abstracts, and technical reports were excluded. Full text review was then conducted on 152 articles. To be included, the study had to fulfill the following criteria: (1) minimum follow-up of one year, (2) details of the reason for re-operation had to be available, and (3) publication in English. We included patients with diagnoses of primary PFOA, post-traumatic PFOA, patellofemoral instability, and patellofemoral dysplasia. We excluded patients with diagnoses of rheumatoid arthritis, those undergoing bicompartmental arthroplasty, studies reporting on patients in whom the patella had not been resurfaced [43], PFA implants that have been recalled, or have a poor track record related to design flaws [44–46]. Second-generation PFA implants that have been removed from the market [47] and new inlay PFA designs were also excluded [48, 49]. TKA without patella resurfacing and TKA for tibiofemoral or tri-compartmental arthritis were also excluded. Reports on the use of robotic PFA were scant, did not have long-term follow-up, and were excluded. We included only second-generation PFA implants currently available on the market. If there were duplicate studies containing the same patient cohort at different time points, the report with the longest follow-up was included.

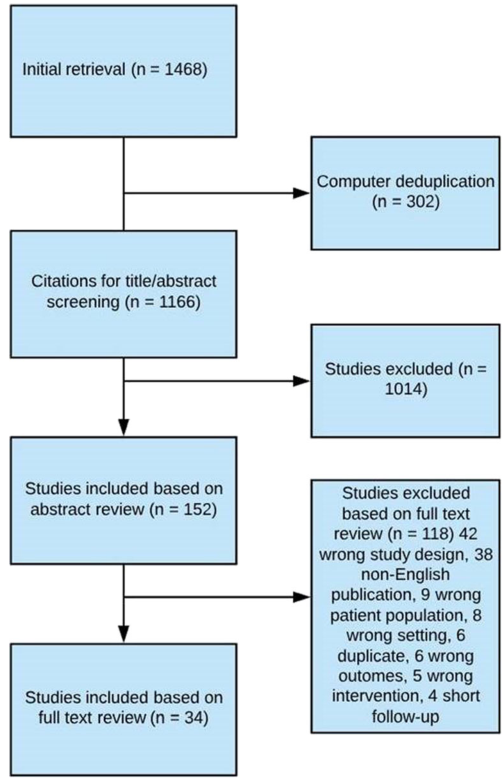

Fig. 1 Flow chart showing identification of studies included in systematic review

A total of 34 studies were included for review: 26 reporting on PFA patients [1–9, 11–17, 19–28], six reporting on TKA [29–34], and two reporting on the use of both procedures [10, 18]. They included information on 1460 patients undergoing 1732 PFAs and 257 patients undergoing 281 TKAs (Table 1; Fig. 1). There was one level I prospective randomized study, two level III case-control studies, and 31 Level IV observational studies (Table 2).

Data extraction

Data extraction was performed in a similar manner to our previous report [41]. We recorded the number of patients and number of knees, age at the time of surgery, sex, type of prosthesis, duration of follow-up, and subsequent surgeries. Data were analyzed using Comprehensive Meta-Analysis V3.0 for Windows.

Second-generation PFA implants included Avon (Stryker, Mahwah, USA), Gender Solutions and Vanguard (Zimmer Biomet, Warsaw, USA), Hermes (Ceraver Osteal, France),

Table 1 Summary of demographic information and follow-up in the systematic review

Variable	PFA	TKA	p
Mean age (years and SD)	59.2 ± 6.8	67.3 ± 6.8	0.006
Gender (% female)	75.1	47.4	0.044
Mean follow-up (years and SD)	4.4 ± 2.2	5.1 ± 2.0	0.449
Median of mean age (years and range)	60.0 (45.0–71.0)	69.5 (52.0–73.0)	N/A
Median of mean follow-up (years and range)	4.4 (1.7–12.0)	5.3 (2.0–7.4)	N/A

PFA second-generation patellofemoral arthroplasty, *TKA* total knee arthroplasty, *SD* standard deviation, *N/A* not applicable

FPV (Wright Medical, Memphis, USA), Journey (Smith & Nephew, Memphis, USA), Kinematch (Kinamed, Carillo, USA), E-motion (B. Braun Medical, Melsungen, Germany), and custom implants (Zimmer Biomet and Kinamed) (Table 2). TKA implants included AGC, NexGen Legacy, and Insall Burnstein II (Zimmer, Warsaw, USA); PCA, Duracon, and Total Condylar (Stryker, Mahwah, USA); Genesis (Smith & Nephew, Memphis, USA); and PFC (Johnson & Johnson—DePuy, Warsaw, USA) (Table 2).

Definitions

The focus of our study was the need to "return to the operating room." Within this outcome, we defined the following possible events: PFA "conversion" includes revision of a PFA to TKA or the implantation of a unicompartmental arthroplasty. "Revision PFA or TKA" includes revision of any of the arthroplasty components or removal of an implant. In addition, we were interested in manipulation under anaesthesia (MUA), return to the operating room for the treatment of infection, and the need for subsequent soft tissue or bony procedures not amounting to additional arthroplasty (revision or conversion as described above). Finally, we documented the return to the operating room for any reason as a sum of all procedures.

Quality assessments

We assessed the methodological quality of studies using the MINORS (Methodological Index for Non-Randomized Studies) instrument [50]. Two studies included comparative cohorts [10, 18]. Scores were compared between PFA and TKA cohorts using the Student's t test, and a p value of < 0.05 was considered significant. The average MINORS score was 11.7 ± 3 (standard deviation) (range 6–21) (Table 3). The average MINORS scores for the PFA and TKA cohorts were 11.4 ± 2.9 and 15.0 ± 3.5, respectively ($p = 0.006$). Excluding the two comparative studies [10, 18], the average MINORS score for PFA and TKA cohorts were 10.8 ± 2.0 and 13.7 ± 2.7, respectively ($p = 0.005$).

Statistical analysis

We performed multiple analyses to calculate the weighted pool proportions (named "pooled proportion" throughout the manuscript for simplification purposes) for conversion, revision, conversion or revision, soft tissue or bony procedures not amounting to arthroplasty, manipulation under anesthesia (MUA), return to the operating room for infection, and return to the operating room for any reason. The results were reported based on the number of knees at final follow-up. All pooled proportions were expressed as percentages.

To determine the pooled proportions, the variances of the raw proportions were first stabilized using the Freeman–Tukey transformation [51]. The pooled proportions were then calculated as the back transform of the weighted mean of the transform proportions, using the Dersimonian–Laird random effects model [47, 48]. To assess for variability across studies attributable to heterogeneity beyond chance, we used the χ^2 test based on the Cochran Q statistic and the I^2 statistic [52, 53]. A p value of > 0.10 for the χ^2 test was used as the cutoff for significance. $I^2 < 25\%$ were interpreted as signifying low level heterogeneity, while a value of 0 signifies no observed heterogeneity, and larger values indicate increasing heterogeneity.

The different lengths of follow-up reported in the studies included in this systematic review may affect the proportions of the different outcomes. Consequently, random-effects logistic regression was conducted to compare the pooled proportions for the outcomes between groups while adjusting for average of length of follow-up.

Forest plots were created to present summary statistics from each study along with the pooled proportion and test of homogeneity.

Visual inspection for funnel plot asymmetry (to evaluate if studies with significant result had higher chance of getting published) did not reveal publication bias in any of the outcomes [51].

As most of the studies included in the review have level of evidence III or IV, statistical analysis to determine whether the outcomes were significantly different between modern PFA and TKA patients was not performed.

Table 2 Summary of studies included in the meta-analysis

Study's first author (reference number)	Year of publication	Level of evidence	Knees available at final follow-up	Mean age (years)	Mean follow-up (years)	% female patients	Prosthesis
PFA studies							
Leadbetter [1]	2009	4	79	58	3.0	74.3	Avon
Ackroyd [2]	2007	4	83	68	5.2	88.2	Avon
Sisto [3]	2006	4	25	45	6.0	72.7	Custom Kinamed
Ackroyd [4]	2005	4	124	62	2.0	84.6	Avon
Butler [5]	2009	4	22	48.6	5.0	61.9	Custom Zimmer Biomet
Kazarian [6]	2016	4	70	51	4.3	66.0	Gender Solutions
Akhbari [7]	2015	4	61	66.1	5.1	89.5	Avon
Al-Hadithy [8]	2014	4	53	62.2	3.1	75.6	FPV
Benazzo [9]	2014	4	25	67	4.7	88.0	Journey and Gender Solutions
Dahm (PFA) [10]	2010	2	23	60	2.4	N/A	Avon
Dahm [11]	2014	4	61	56	4.0	93.4	Avon
Davies [12]	2013	4	52	60.7	2.0	68.2	FPV
DeDeugd [13]	2017	4	75	51.8	3.0	88.0	Avon
Hernigou [14]	2014	4	85	71	12.0	45.7	Hermes
Konan [15]	2016	4	51	57	7.1	38.3	Avon
Mont [16]	2012	4	43	49	7.0	78.4	Avon
Morris [17]	2013	4	37	55	2.6	85.7	Vanguard, Gender Solutions, Kinematch
Odgaard (PFA) [18]	2018	1	46	64	2.0	77.0	Avon
Odumenya [19]	2010	4	50	66	5.3	71.9	Avon
Osarumwense [20]	2017	4	49	59	3.3	71.1	Gender Solutions
Romagnoli [21]	2018	4	64	66.8	5.5	85.4	Gender Solutions
Saragaglia [34]	2014	4	29	72.8	5.3	87.5	E-Motion
Sarda [22]	2011	4	44	61.7	4.5	77.5	Avon
Starks [23]	2009	4	37	66	2.0	72.4	Avon
Ahearn [24]	2016	4	101	60	7.1	80.0	Journey PFJ
Middleton [25]	2018	4	103	60	5.6	78.8	Avon
Willekens [27]	2015	4	35	49	4.6	83.9	Avon
Williams [28]	2013	4	48	63.3	2.1	70.8	FPV
TKA studies							
Sabatini [26]	2016	4	6	53.3	1.7	80.0	PFC
Odgaard (TKA) [18]	2018	1	47	64	2.0	77.0	PFC
Dahm (TKA) [10]	2010	2	22	69	2.3	N/A	PFC and Zimmer
Meding [29]	2007	4	33	52	6.2	77.8	AGC and NexGen
Mont [30]	2002	4	30	73	6.8	66.7	PCA, Duracon and Insall-Burstein II
Laskin [31]	1999	2	53	67	7.4	N/A	Genesis
Parvizi [32]	2001	4	31	70	5.2	79.2	PFC, Genesis and Total Condylar
Dalury [33]	2005	4	33	70.2	5.2	68.0	PFC

N/a not available

Results

The follow-up averaged 4.4 years for studies reporting on patients who underwent PFA and 5.3 years for those focusing on TKA patients. The weighted pooled proportion of conversion and revision to TKA was 6.34, whereas the pooled proportion of revision in the TKA group was 0.11 (Table 4). The pooled proportion of PFA and TKA

Table 3 Quality assessment using the MINORS instrument

Study's 1st author	Year of publication	Implant	1	2	3	4	5	6	7	8	9	10	11	12	Total
Leadbetter [1]	2009	PFA	2	2	2	2	1	2	2	–	–	–	–	–	13
Ackroyd [2]	2007	PFA	2	1	2	1	1	2	0	–	–	–	–	–	9
Sisto [3]	2006	PFA	2	2	2	2	1	2	2	–	–	–	–	–	13
Ackroyd [4]	2005	PFA	1	0	2	2	1	1	1	–	–	–	–	–	8
Butler [5]	2009	PFA	2	2	2	2	2	2	2	–	–	–	–	–	14
Kazarian [6]	2016	PFA	2	0	0	2	1	2	1	–	–	–	–	–	8
Akhbari [7]	2015	PFA	2	2	2	2	2	1	1	–	–	–	–	–	12
Al-Hadith [8]	2014	PFA	2	2	0	2	2	2	2	–	–	–	–	–	12
Benazzo [9]	2014	PFA	2	1	1	2	1	1	1	–	–	–	–	–	9
Dahm [11]	2014	PFA	2	2	1	2	2	2	2	–	–	–	–	–	13
Davies [12]	2013	PFA	2	2	0	2	2	2	2	–	–	–	–	–	12
DeDeugd [13]	2017	PFA	2	0	0	2	1	2	1	–	–	–	–	–	8
Hernogou [14]	2014	PFA	2	2	0	2	2	2	2	–	–	–	–	–	12
Konan [15]	2016	PFA	2	2	0	2	1	2	2	–	–	–	–	–	11
Mont [16]	2012	PFA	2	2	0	1	2	2	1	–	–	–	–	–	10
Morris [17]	2013	PFA	2	2	0	1	1	0	0	–	–	–	–	–	6
Odumenya [19]	2010	PFA	2	2	0	2	2	2	1	–	–	–	–	–	11
Osarumwense [20]	2017	PFA	2	2	0	2	2	2	1	–	–	–	–	–	11
Romagnoli [21]	2018	PFA	2	2	0	2	2	2	2	–	–	–	–	–	12
Sarda [22]	2011	PFA	2	2	0	2	2	2	2	–	–	–	–	–	12
Starks [23]	2009	PFA	2	2	0	2	2	2	2	–	–	–	–	–	12
Ahearn [24]	2016	PFA	2	2	0	2	2	2	0	–	–	–	–	–	10
Middleton [25]	2018	PFA	2	2	1	2	2	2	2	–	–	–	–	–	13
Sabatini [26]	2016	PFA	1	2	0	1	2	1	2	–	–	–	–	–	9
Willekens [27]	2015	PFA	2	2	0	1	2	1	2	–	–	–	–	–	10
Williams [28]	2013	PFA	2	2	0	1	2	1	2	–	–	–	–	–	10
Dahm [10]	2010	PFA/TKA	2	2	0	1	2	1	1	–	2	2	2	2	17
Odgaard [18]	2018	PFA/TKA	2	2	2	2	0	2	2	1	2	2	2	2	21
Meding [20]	2007	TKA	2	2	0	2	2	2	2	–	–	–	–	–	12
Mont [30]	2002	TKA	2	2	0	2	2	2	2	–	–	–	–	–	12
Laskin [31]	1999	TKA	2	2	0	2	1	2	2	–	2	2	1	2	18
Parvizi [32]	2001	TKA	2	2	2	2	1	2	0	–	–	–	–	–	11
Dalury [33]	2005	TKA	2	2	2	2	1	2	2	–	–	–	–	–	13
Saragaglia [34]	2014	TKA	2	2	0	2	1	2	0	–	1	2	2	2	16

Methodological index for non-randomized studies score (MINORS). (1) A clearly stated aim. (2) Inclusion of consecutive patients. (3) Prospective collection of data. (4) End points appropriate to the aim of the study. (5) Unbiased assessment of the study end point. (6) Follow-up period appropriate to the aim of the study. (7) Loss to follow-up less than 5%. (8) Prospective calculation of the study size. (9) An adequate control group. (10) Contemporary groups. (11) Baseline equivalence of groups. (12) Adequate statistical analyses. The items are scored 0 (not reported), 1 (reported but inadequate), or 2 (reported and adequate). The global ideal score being 16 for non-comparative studies and 24 for comparative studies

patients that returned to the operating room to undergo secondary bone or soft tissue procedure was 1.06 and 0.79, respectively (Table 4).

There were 116 revision or conversion arthroplasties in patients with PFAs (106 conversions, and 10 revision PFAs) (Tables 4 and 5; Fig. 2). Conversion to TKA was performed in 103 patients and conversion consisting in the addition of a medial unicompartmental arthroplasty in 3 patients [6, 9, 21]. Within the TKA group, there were two revisions (Tables 4 and 5; Fig. 3).

There were 34 additional bony and soft tissue procedures required in patients with PFA and four in patients with TKA (Tables 4 and 5).

MUA was performed in 16 PFA patients and in six TKA patients. One patient with a TKA returned to the operating room for the treatment of infection [31] (Table 4).

Table 4 Pooled proportions for outcomes variables in patients undergoing PFA and TKA

Outcome variable	Weighted rate (95% CI)	
	PFA	TKA
Conversion	5.47 (3.94–7.19)	N/A
Revision	0.05 (0–0.38)	0.11 (0–1.38)
Conversion and revision	6.34 (4.77–8.07)	0.11 (0–1.38)
Additional bone or soft tissue surgery	1.06 (0.32–2.08)	0.79 (0–2.64)
MUA	0.32 (0.02–0.85)	1.23 (0.03–3.50)
Return to OR for infection	0 (0–0.03)	0.08 (0–1.29)
Return to OR for any reason	9.06 (6.89–11.45)	3.69 (1.30–6.92)

95% CI 95% confidence intervals, *OR* operating room

Discussion

The goal of this systematic review was to report on the rate of return to the operating room in patients undergoing modern PFA and TKA for the treatment of PFOA. Our previous systematic review on this topic encompassing 356 modern PFA patients followed for an average of 4.4 years demonstrated a non-significant increase in the likelihood of conversion or revision of PFA compared to revisions of TKA (OR 2.75; $p = 0.167$) [41]. Our initial findings are in contrast with those observed in the present study of 1738 modern PFAs followed for an average of 4.5 years, in which we observed a higher likelihood of patients returning to the operating room for conversion and revision (Table 4). The pooled proportion of revision or conversion for PFAs in the present study (6.34%) is consistent with previous higher-volume studies [1, 2, 4, 13, 24, 25]. Registry data reports higher failure rates of patients undergoing PFA. The five year revision rate for PFAs included in the National Joint Registry is 9.57%, increasing to 22.22% at 11 years [54], whereas in the Australian Joint Registry is 14.5% at a follow-up of five years and 41% after 14 years [55]. The differences in failure rates reported in national registries and in the present systematic review may be multifactorial. First, we have excluded modern PFA designs with a poor track record or that have been recalled. Second, our mean follow-up is slightly shorter. And third, registry data reflects the outcomes of the general orthopaedic community as opposed to the outcomes utilized for the present systematic review, which are generated in part by high volume surgeons and implant designers. Van del List et al. recently compared the survivorship of PFAs reported in peer-reviewed cohort studies and outcomes reported in the national arthroplasty registries of Australia, New Zealand, and England and Wales. At a follow-up of five and ten years, the survivorship of PFAs reported by the cohort studies (91.7 and

Table 5 Details of indication for revision, and other soft tissue and bony procedures in patients undergoing PFA and TKA

Procedure	PFA	TKA
Revision	10 knees Trochlear component for patella alta (*n* = 1) [4] Patellar component for undersized button (*n* = 1) [5] Patellar component for fracture (*n* = 1) [23] Resurfacing of patella (*n* = 3) [9, 23] Trochlear component for malposition (*n* = 1) [18] Revision for patellar impingement (*n* = 1) [28] Patella component removal for fracture (*n* = 1) [28]	2 knees Patellar loosening (*n* = 1) [32] Liner exchange, soft tissue realignment for patellar subluxation (*n* = 1) [32]
Soft tissue procedure	30 knees Arthroscopy for hemarthrosis (*n* = 2) [2] Distal soft tissue realignments (*n* = 3) [2, 4, 14] Arthroscopy for stiffness (*n* = 8) [5, 8, 11, 17, 25] Arthroscopy for meniscus tear (*n* = 3) [6, 7, 11] Lateral release (*n* = 8) [12, 18, 22] Arthroscopy for mechanical symptoms (*n* = 6) [25]	2 knees Patella tendon reconstruction (*n* = 1) [30] Arthroscopic lateral release (*n* = 1) [18]
Bone procedure	4 knees Tibial tubercle fracture fixation (*n* = 1) [1] ORIF medial femoral condyle fracture (*n* = 1) [6] Excision of heterotrophic ossification (*n* = 1) [7] Distal bony realignment (*n* = 1) [18]	2 knees Amputation following motor-vehicle accident (*n* = 1) [31] Treatment of supracondylar fracture (*n* = 1) [18]

PFA patellofemoral arthroplasty, *TKA* total knee arthroplasty

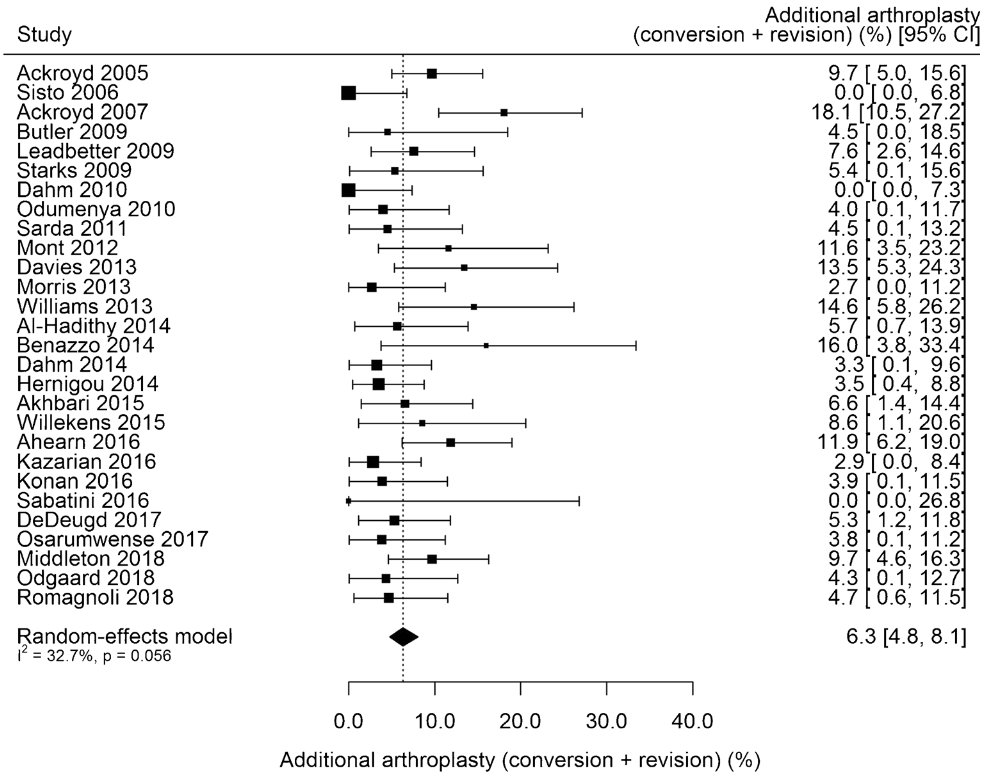

Fig. 2 Forest plot showing rate of additional arthroplasty (revision or conversion) after PFA. Squares indicate the proportion of patients requiring revision or conversion, and the bars indicate 95% confidence intervals. The sizes of the squares are proportional to the study's weight in the systematic review. Summary measure lies in the center of the diamond and associated 95% confidence intervals on its lateral tips. Dotted vertical line indicates pooled proportion. Names of the first author and years of publication are shown on the left. Proportion of knees requiring revision or conversion and 95% confidence intervals are shown on the right

83.3%, respectively) was higher than that reported by the national registries (84.7 and 71.4%, respectively) [56].

The higher failure rate of PFAs in comparison to TKA is of concern. However, it can be argued that the conversion of a PFA to a TKA due to progression of osteoarthritis may not be equivalent to a revision of a failed TKA. In this context, the lower survivorship of PFAs may be of relatively less consequence to younger, more active patients, who are already at an increased revision risk after a TKA. For this group of patients, secondary arthroplasty may be viewed as inevitable, and conversion to TKA after failed PFA may offer better function and survivorship than revision TKA after failed primary TKA. Chawla et al. recently compared the cost effectiveness of PFA and TKA for the management of patients with isolated PFOA. PFA was more expensive ($49,811 vs. $46,632, respectively) but more effective (14.3 vs. 13.3 quality-adjusted life years) over a lifetime horizon [57].

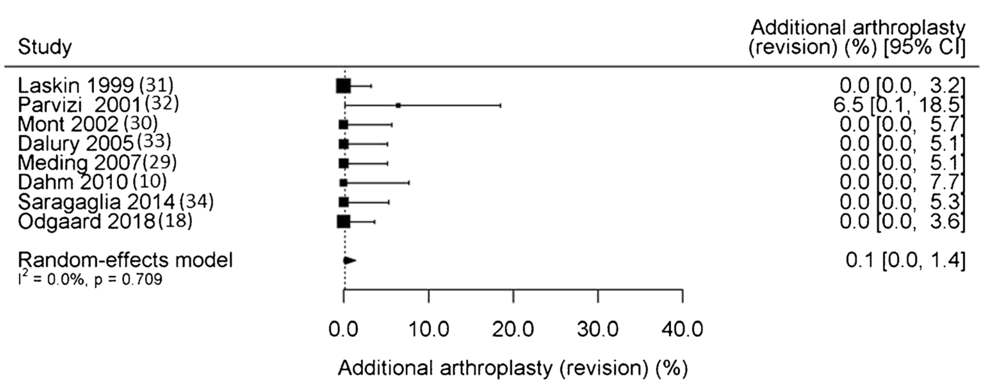

Fig. 3 Forest plot showing rate of additional arthroplasty (revision) of TKA. Squares indicate the proportion of patients requiring revision, and the bars indicate 95% confidence intervals. The sizes of the squares are proportional to the study's weight in the systematic review. Summary measure lies in the center of the diamond and associated 95% confidence intervals on its lateral tips. Dotted vertical line indicates pooled proportion. Names of the first author and years of publication are shown on the left. Proportion of knees requiring revision and 95% confidence intervals are shown on the right

Proponents of PFA also claim that the results of revision or conversion of a PFA may be similar to those of primary TKA. Lonner et al. reported the results of 12 failed PFAs converted to TKA at a mean follow-up of 3.1 years, demonstrating that all cases were performed with standard posterior-stabilized TKAs and no clinical failures [58]. Parratte et al. studied a series of 21 PFA converted to TKA. The clinical outcomes of conversion to TKA were superior to those of revision TKA, but there was a higher frequency of complications than during primary TKA [59, 60]. Our institution had a similar experience, suggesting that conversion of PFA to TKA may, like conversion of unicompartmental replacement to TKA, not approach the success of primary TKA [59, 60].

This study has several limitations: First, PFA patients were on average younger ($p = 0.006$) and were more likely to be women ($p = 0.044$). The former may partially explain the higher failure rate. Second, the average MINORS score for the PFA publications was lower than those of TKA ones, which limits out ability to draw definitive conclusion. Third, clinical scores, functional outcomes, and return to sporting activities are important considerations when deciding between PFA and TKA, but most of the literature is inconsistent in which outcomes are recorded. Our analysis of the failures requiring return to the operating room does not allow the analysis of the potential functional benefits of PFA. Fourth, studies frequently described the initial patient cohort in detail but did not list the characteristics of the patients lost to follow-up. Therefore, we decided to use the initial number of patients in each study for our analysis. This may underestimate the re-operation rates for both groups. Fifth, we did report on the aetiology of PFOA, which may correlate with implant survivorship [61]. And finally, the paucity of prospective randomized trials on this topic precluded us from determining if there is a statistically significant difference between the outcomes in both groups.

Although this study is among the largest systematic reviews reporting on the outcomes of modern PFA, further investigation is warranted. Larger, prospective studies would help elucidate whether PFA patients have improved early functional outcomes compared to TKA counterparts, and whether those patients are able to return to higher level sporting activities. Our findings can be used to help patients and surgeons understand the risks of PFA and TKA for isolated PFOA.

In conclusion, we believe that there is a higher likelihood of revision and conversion after modern PFA when compared to TKA. It is likely that patients with PFA return to the operating room more frequently than those undergoing PKA for PFOA.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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