Better outcomes with patellar resurfacing during primary total knee arthroplasty: a meta-analysis study

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Abstract

Background Total knee arthroplasty (TKA) is a feasible and cost-effective procedure. However, resurfacing of the patella sparks a heated debate. Anterior knee pain after TKA was supposed to be correlated to the patellofemoral joint, and the resurface of the patella was believed to be effective to avoid this complication.

Aim A meta-analysis was performed to update current evidence concerning the outcomes of patellar resurfacing versus retaining for total knee arthroplasty. The first outcomes of interest were to compare the rate of anterior knee pain and revision surgeries.

Material and methods This study was conducted according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA). A comprehensive review of the literature was conducted accessing the main databases: Embase, Google Scholar, PubMed, Scopus. All the prospective clinical trials comparing the outcomes between patellar resurfacing versus retaining were included in this study. Only articles classified as level of evidence I to II were considered for inclusion. Only studies reporting a minimum 24 months follow-up were included. The following data were extracted: demographic baseline, anterior knee pain, reoperations, clinical scores (HSS, KSS and related subscales) and range of motion (ROM). Studies solely reporting quantitative data under the outcomes of interest were included.

Results In favor of the resurfacing group, we observed a statistically significant reduced rate of anterior knee pain (odd ratio 1.73) and reoperation (odd ratio 3.24). In the resurfacing group, a prevalence of anterior knee pain of 11.15% was detected, whereas in the retaining group it amounted to 17.39%. Furthermore, a greater KSS pain (+0.97%), KSS clinical (+0.23%), KSS functional (+2.44%), KSS overall (+2.47%) and HSS (+5.64%) were reported. In the retaining group, we found a better range of motion (+3.09°).

Conclusion Based on the main findings of this meta-analysis, patellar resurfaced TKA was demonstrated to have performed superior overall. Patellar resurfacing detected a lower rate of postoperative anterior knee pain and reoperation. Moreover, the resurfacing group showed greater value of the HSS, KSS and related subscales. In favor of the retaining group, a slightly better ROM was evidenced.

Level of evidence Level II, meta-analysis of prospective clinical trials

Keywords Total knee arthroplasty · Prosthesis · Patellar resurfacing · Patellar retaining · Anterior knee pain

Introduction

Total knee arthroplasty (TKA) is one of the most common orthopedic procedures performed to restore the physiological joint kinematics in selected patients [1]. TKA is considered a feasible and cost-effective procedure [2], achieving a high rate of patients' satisfaction [3]. The necessity of resurfacing the patella is extensively discussed in the available literature [4–7]. Indications for tri-compartmental prosthesis reportedly are the presence of inflammatory arthritis [8] and a high grade of patellar cartilage degeneration [9, 10]. These indications,

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however, are outdated and data from national databases are inconsistent: the Australian Orthopedic Association National Joint Replacement Registry reported a rate of 43% of resurfacing [11], as opposed to 5% in Norway and 4% in Sweden [12]. Resurfacing the patella exposes the patients to a higher risk of component loosening, joint infection and instability, patella tendon damage, fracture, and greater risk of further implant revisions [9, 13, 14]. On the contrary, retaining the patella reduces the surgical duration and preserves more bone stock [11, 15, 16]. Recent meta-analyses have agreed that patella resurfacing reduced the rate of reoperations; yet, according to other clinical and functional evidence, there have been no significant improvements and controversial results have been found [5, 13, 17, 18]. Recently, several clinical trials have been published [19–22], including approximately 400 patients available for analysis. Thus, an update of the literature with the latest evidence is necessary. The goal of this study was to conduct a meta-analysis to investigate the efficiency of resurfacing versus retaining the patella during TKA, to analyze current evidence and update the literature. The first outcomes of interest were the rate of anterior knee pain (AKP) and revision surgeries. Moreover, relating to the first outcomes of interest, we performed the subgroup analysis according to the follow-up ($\geq$ 36- and $\geq$ 60-months) and according to the study type (only RCTs).

Material and methods

Literature search

The present study was carried out according to the Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement [23]. Two authors (FM, BR) cooperatively performed the literature search. The same authors accessed in January 2019 the following databases: PubMed, Scopus, Embase, Google Scholar. The following keywords were used in combination: *total knee arthroplasty, TKA, prosthesis, patellar resurfacing, patellar retaining, anterior knee pain, AKP, KSS, range of motion, ROM*. These authors independently screened the titles resulting from the databases' search for inclusion and accessed the full text of the articles of interest. The bibliography of the full-text articles was checked as well.

Eligibility criteria

All the prospective clinical studies comparing patellar retaining versus resurfacing for primary TKA were considered for inclusion. In compliance with the authors' linguistic capabilities, articles in English, German, Italian, French and Spanish were considered. According to the Oxford Centre of Evidenced-Based Medicine [24], only articles with a level of evidence I to II were considered. Reviews, letters or editorials, expert opinions, case series and retrospective studies were excluded. Biomechanical, animal, cadaveric and in vitro studies were also excluded. Only articles reporting quantitative data under the outcomes of interest were included. Any disagreement between the authors was mutually debated and solved.

Outcomes of interest

Two authors (FM, BR) exported data of interest from each clinical trial. The demographic data exported was the following: author and year of the publication, type of study, number of enrolled knees, duration of the follow-up (months). The primary outcomes of interest were to evaluate the rate of AKP and additional revisions. Secondary outcomes of interest were: the Knee Society Rating System (KSS) and related function (KSFS), pain (KSPS), and clinical (KSCS) subscales [25], the Hospital of Special Surgery Knee Score (HSS) [26] and the range of motion (ROM).

Risk of publication bias

To evaluate the risk of publication bias, we referred to the funnel plot of the most reported outcome. The funnel plot offers a graphical representation of the values of each study based on standard error (SE), confidence interval (CI) and odds ratio (OR). To evaluate the level of risk of publication bias, the referral points must report a symmetrical distribution under the shapes.

Methodological quality assessment

For the methodological quality assessment, we referred to the Review Manager Software Version 5.3 (The Nordic Cochrane Centre, Copenhagen). The articles of interest were evaluated according to several aspects: random sequence generation, allocation concealment, blinding methods, incomplete outcome data and selective reporting.

Statistical analysis

For the statistical analysis, we referred also to the Review Manager Software 5.3. For continuous variables, the inverse variance (IV) statistical method with the mean difference was adopted. We referred to the Mantel–Haenszel method to analyze dichotomous variables, with the odd ratio (OR) effect measure. The confidence interval was set at 95%. Heterogeneity was assessed by the χ^2 and Higgins (I^2) tests. A fixed model effect was set in all the comparisons. If $I^2 > 70\%$ and $\chi^2 > 0.5$ denoted high data heterogeneity, a random effect was used. The confidence interval was fixed at 95%. We carried out both forest and funnel plot to detect effect measure and publication bias, respectively. A P value < 0.5 was considered statistically significant.

Results

Search result

The database research resulted in 2089 articles, with 505 of them being duplicates. A total of 1584 articles were screened. Thereof, only 116 were clinical studies with the level of evidence I to II. Other 85 articles were rejected due to a lack of reported quantitative data under the outcomes of interest or indistinct data or measures. This last operation

left 8 nRCTs and 23 RCTs. The flowchart of literature search is shown in Fig. 1.

Risk of publication bias

To evaluate the risk of publication bias, the funnel plot of the most reported outcome was performed (Fig. 2). The plot showed an adequate symmetrical distribution of the referral points to the no-effect line. All the referral points were
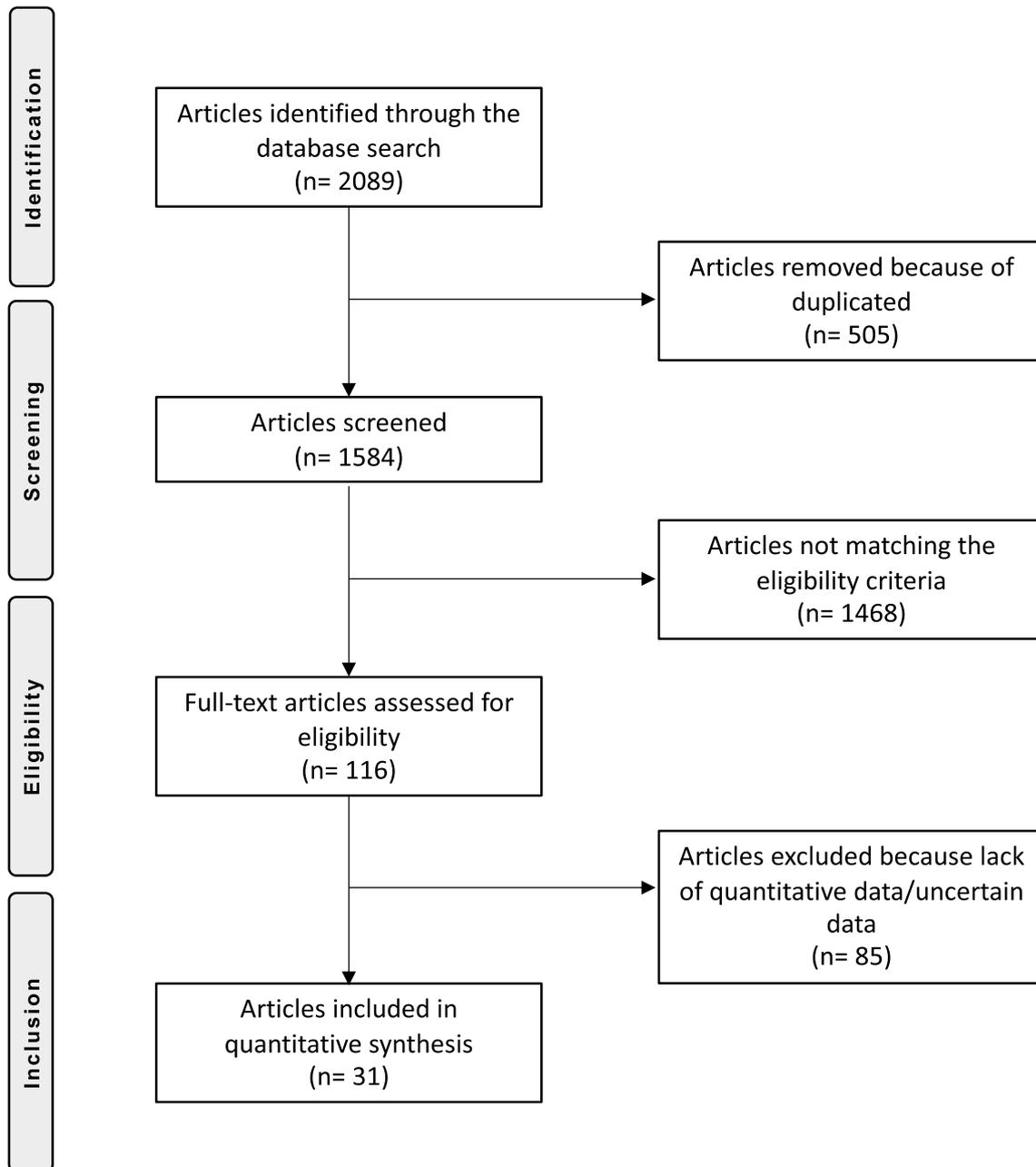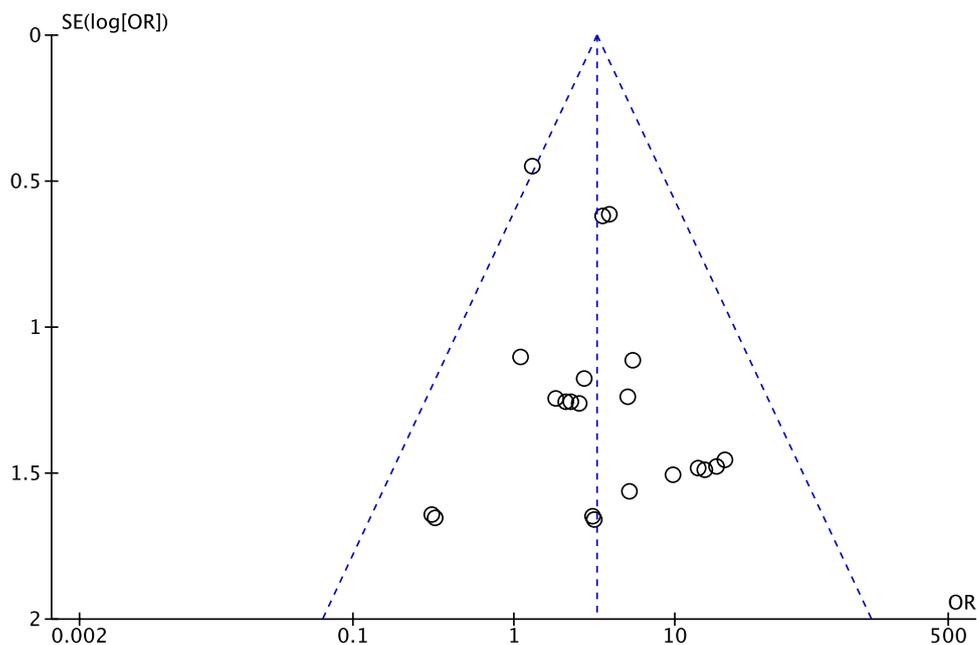

Fig. 1 PRISMA flowchart of literature search

Fig. 2 Funnel plot of the most reported outcome (revisions)

located in the range of acceptability, indicating a low risk of publication bias.

Methodological quality assessment

The most important limitation of the methodological assessment is the reduced number of articles performing a blinding method. However, three-fourths of the included studies performed a sample randomization, representing an important strong point. The included articles reported optimal follow-up, good quality of data analysis and baseline comparability. Concluding, the methodological quality assessment of the present study was overall satisfactory (Fig. 3).

Patient demographic

In this study, a total of 4132 knees were reviewed, with 2269 patients in the resurfacing group and 1863 in the retaining group. The mean follow-up was 66.64 ± 38.76 months. The demographic is shown in Table 1.

Outcomes of interest

Data analysis was in favor of the resurfacing group: less postoperative AKP rate (OR 1.76; CI 1.36–2.27; $I^2 = 63\%$; $P < 0.0001$; Fig. 4) and a lower reoperation rate (EE: 3.24; CI 2.16–4.88; $I^2 = 0\%$; $P < 0.0001$; Fig. 5). The prevalence of AKP in the patellar resurfacing group was 11.15%, but 17.39% in the retaining group. The prevalence of reoperation in the patellar resurfacing group was 1.79%, but 6.22% in the retaining group.

In favor of the resurfacing group, we reported a superior KSS pain (EE: 0.97; CI 0.13–1.80; $I^2 = 0\%$; $P = 0.02$), KSS function (EE: 2.44; CI 0.61–4.27; $I^2 = 0\%$; $P = 0.009$), KSS clinical (EE: 0.23 CI -0.97 to 1.44; $I^2 = 31\%$; $P = 0.71$), KSS overall (EE: 2.47; CI 1.45–3.50; $I^2 = 66\%$; $P < 0.0001$) and HSS Score (EE: 5.60; CI 4.42–6.86; $I^2 = 96\%$; $P < 0.0001$).

In favor of the retaining group, a better ROM was observed (EE: 3.09; CI 5.04–1.13; $I^2 = 67\%$; $P = 0.002$). The overall results of the meta-analysis comparisons are shown in Table 2.

Subgroup analysis

In the subgroup follow-up of > 36 months, the AKP-rate was reduced in favor of the resurfacing cohort (OR 1.56; CI 1.19–2.04; $I^2 = 64\%$; $P = 0.0001$). The subgroup follow-up > 60 months reported similar results (OR 1.99; CI 1.45–2.72; $I^2 = 65\%$; $P = 0.002$). The AKP rate was reduced in favor of the resurfacing cohort even when analyzing the subgroup RCTs (OR 1.56; CI 1.19–2.04; $I^2 = 70\%$; $P = 0.001$). In the subgroup follow-up of > 36 months, the reoperation rate was reduced in favor of the resurfacing cohort (OR 3.25; CI 2.10–5.01; $I^2 = 0\%$; $P < 0.0001$). The subgroup follow-up > 60 months reported similar results (OR 3.07; CI 1.88–5.00; $I^2 = 0\%$; $P < 0.0001$). The reoperation rate was reduced in favor of the resurfacing cohort even when analyzing the subgroup RCTs (OR 3.15; CI 2.01–4.94; $I^2 = 0\%$; $P < 0.0001$) as well.

Fig. 3 Cochrane methodological quality assessment

Discussion

The main findings of this meta-analysis are that patellar resurfacing for THA reported lower postoperative AKP and revision rate. Moreover, a greater HSS, KSS and related subscale scores in the resurfacing group were observed. In favor of the retaining group, a better ROM was evidenced.

Resurfacing or retaining the patella during TKA is a heated debate in the field of the orthopedic surgery. Sandiford et al. [8] found that most of the surgeons retain the patella. Curiously, they even evidenced a growing trend for experienced surgeon to resurface the patella. Tang et al. [17] found that resurfacing the patella provides better KSCS and a lower reoperation rate. Li et al. [13], analyzing over 1400 patients, found that a resurfaced patella reduces the prevalence of reoperation rate, but did not influence the functional outcomes or the patient's satisfaction. Similarly, He et al. [18] performed a meta-analysis including 3514 patients. They found no discrepancies across the two techniques regarding AKP, KSS and KSFS, but a lower rate of reoperations in the resurfacing group. Concerning the KSS, Findlay et al. [27] did not find any statistical differences between the two prosthetic implants. Chen et al. [4], concerning AKP and KSS, also found no statistical differences in over 1700 patients. They reported only a lower rate of reoperation during the follow-up term. Concluding, the role of resurfacing or retaining the patella in TKA is controversial. Further high-quality studies are required. Current evidence has found consensus only regarding the lower reoperation rate observed after patellar resurfacing. In comparison, in our analysis, the reoperation rate was considerably lower in the resurfacing group (OR 3.24). The analysis is characterized by the homogeneity of the variables, providing a very reliable and accurate result. The overall effect of this comparison evidenced that the chance of complications/incidents to result in further surgeries after patellar resurfacing was reduced by almost one-third. In the patellar resurfacing group, a reoperation prevalence of 1.79% was detected, compared to 6.22% in the retaining group. Similar results were found on analyzing the subgroups' type of study (RCTs) and follow-ups (> 36 and > 60 months). We hypothesize that an orthopedic surgeon confronted with an unsatisfactory TKA may consider resurfacing the patella. This can explain the higher rate of reoperation evidenced in the retained group.

Anterior knee pain after TKA is a relevant problem, affecting between 5 and 47% of patients [10, 28, 29]. Initially, this was allegedly correlated to the patellofemoral joint, and patellar resurfacing was believed to be effective to avoid this complication [13]. Analyzing possible variables influencing the postoperative AKP, van Jonbergen et al. [30] found no correlation between knee-specific characteristics, implant design, surgical technique, and

Table 1 Demographic of the included studies

Author, year	Study type	Follow-up (months)	Resurfacing (knees)	Retaining (knees)
Abraham et al. (1988) [35]	nRCT	60	47	53
Agarwala et al. (2018) [19]	nRCT	19	60	60
Aunan et al. (2016) [36]	RCT	36	63	66
Badhe et al. (2001) [37]	nRCT	36	99	71
Balemane et al. (2016) [38]	nRCT	12	30	30
Barrack et al. (2001) [39]	DB-RCT	70.5	47	46
Beaupre et al. (2012) [40]	DB-RCT	120	12	11
Bourne et al. (1995) [41]	RCT	24	50	50
Burnett et al. (2007) [42]	RCT	110	28	28
Campbell et al. (2006) [43]	RCT	120	30	28
Chun et al. (2017) [20]	nRCT	177.6	68	14
Dong et al. (2018) [21]	RCT	33.5	48	48
Feller et al. (1996) [44]	RCT	36	19	19
Ferguson et al. (2014) [45]	RCT	24	75	81
Ferguson et al. (2014) [45]	RCT	24	72	76
Gildone et al. (2005) [46]	RCT	25.4	28	28
Kajino et al. (1997) [47]	RCT	79.2	26	26
Kaseb et al. (2018) [22]	RCT	6	24	26
Keblish et al. (1994) [48]	nRCT	62.9	52	52
Kim et al. (2014) [49]	nRCT	84	339	34
Liu et al. (2012) [50]	RCT	84	68	64
Mayman et al. (2003) [51]	RCT	120	50	50
Myles et al. (2006) [52]	RCT	24	18	24
Newman et al. (2000) [53]	RCT	60	42	42
Patel et al. (2011) [6]	nRCT	72	60	60
Roberts et al. (2015) [54]	DB-RCT	93.6	164	163
Schroeder-Boersch et al. (1998) [55]	RCT	24	20	20
Seo et al. (2011) [56]	nRCT	74.6	168	109
Shoji et al. (1989) [57]	nRCT	32.4	35	35
Smith et al. (2008) [58]	RCT	52.44	73	86
Sreehari et al. (2014) [59]	RCT	60	75	60
Waters et al. (2003) [9]	RCT	63.6	243	231
Wood et al. (2002) [9]	DB-RCT	48	92	128

the time of assessment. They found only a weak correlation with the presurgical gait patterns. Yet, AKP is a multifactorial complication: several predisposing factors have been described, such as implant positioning, patellar maltracking, female sex, young age at surgery, presence of depression and/or anxiety and others [31, 32]. Nevertheless, in most patients suffering from AKP, no cause can be found [33, 34]. The primary outcome of interest in the present work was to analyze the postoperative rate of AKP. In the patellar resurfacing group, the AKP showed a postoperative prevalence of 11.15%, opposed to 17.39% in the retaining group. This comparison is characterized by an acceptable weight distribution and almost all confidence intervals overlapped. Because of the acceptable level of

heterogeneity, the analysis was performed using a fixed method. The overall effect was statistically significant in favor of the resurfacing group (OR 1.61). Comparable results were obtained on analyzing the subgroup follow-ups (> 36 and > 60 months) and study type (RCTs only). Concerning the analyzed scores, across all the comparisons we evidenced, a greater value in favor of the resurfacing group has been reported. Except for the clinical subscale of the KSS, all other outcomes of interest were statistically significant. The comparison ROM represented the only outcome in favor of the retaining group (+ 3.09°). Due to the high heterogeneity, this outcome was analyzed via a random model effect and data from this outcome must be interpreted with caution.
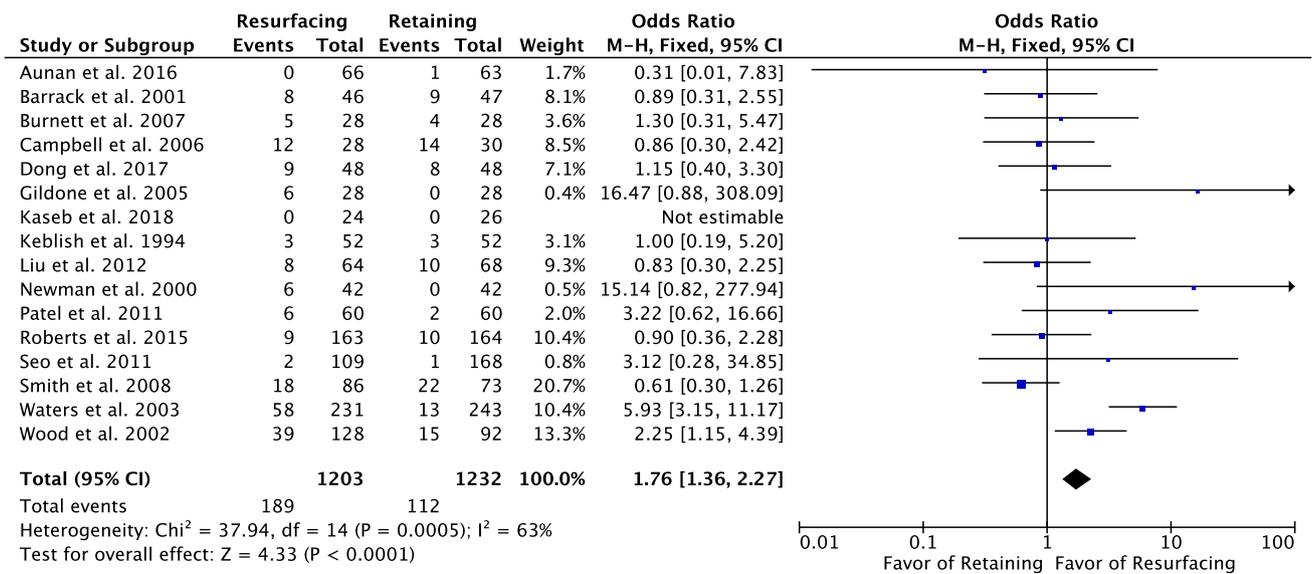
Study or Subgroup	Resurfacing Events	Total	Retaining Events	Total	Weight	Odds Ratio M–H, Fixed, 95% CI	Odds Ratio M–H, Fixed, 95% CI
Aunan et al. 2016	0	66	1	63	1.7%	0.31 [0.01, 7.83]	
Barrack et al. 2001	8	46	9	47	8.1%	0.89 [0.31, 2.55]	
Burnett et al. 2007	5	28	4	28	3.6%	1.30 [0.31, 5.47]	
Campbell et al. 2006	12	28	14	30	8.5%	0.86 [0.30, 2.42]	
Dong et al. 2017	9	48	8	48	7.1%	1.15 [0.40, 3.30]	
Gildone et al. 2005	6	28	0	28	0.4%	16.47 [0.88, 308.09]	
Kaseb et al. 2018	0	24	0	26		Not estimable	
Keblish et al. 1994	3	52	3	52	3.1%	1.00 [0.19, 5.20]	
Liu et al. 2012	8	64	10	68	9.3%	0.83 [0.30, 2.25]	
Newman et al. 2000	6	42	0	42	0.5%	15.14 [0.82, 277.94]	
Patel et al. 2011	6	60	2	60	2.0%	3.22 [0.62, 16.66]	
Roberts et al. 2015	9	163	10	164	10.4%	0.90 [0.36, 2.28]	
Seo et al. 2011	2	109	1	168	0.8%	3.12 [0.28, 34.85]	
Smith et al. 2008	18	86	22	73	20.7%	0.61 [0.30, 1.26]	
Waters et al. 2003	58	231	13	243	10.4%	5.93 [3.15, 11.17]	
Wood et al. 2002	39	128	15	92	13.3%	2.25 [1.15, 4.39]	
Total (95% CI)		**1203**		**1232**	**100.0%**	**1.76 [1.36, 2.27]**	
Total events	189		112				

Heterogeneity: Chi² = 37.94, df = 14 (P = 0.0005); I² = 63%
Test for overall effect: Z = 4.33 (P < 0.0001)

Favor of Retaining   Favor of Resurfacing

Fig. 4 Result of the comparison AKP

Study or Subgroup	Retaining Events	Total	Resurfacing Events	Total	Weight	Odds Ratio M–H, Fixed, 95% CI	Odds Ratio M–H, Fixed, 95% CI
Abraham et al. 1988	2	53	1	47	4.0%	1.80 [0.16, 20.56]	
Aunan et al. 2016	0	66	1	63	6.0%	0.31 [0.01, 7.83]	
Badhe et al. 2001	10	71	4	99	11.3%	3.89 [1.17, 12.97]	
Barrack et al. 2001	7	46	0	47	1.6%	18.04 [1.00, 325.75]	
Beaupre et al. 2012	2	11	2	12	6.2%	1.11 [0.13, 9.61]	
Bourne et al. 1995	2	50	0	50	1.9%	5.21 [0.24, 111.24]	
Burnett et al. 2007	2	28	1	28	3.7%	2.08 [0.18, 24.31]	
Burnett et al. 2009	14	60	11	58	33.7%	1.30 [0.53, 3.16]	
Campbell et al. 2006	2	28	1	30	3.5%	2.23 [0.19, 26.06]	
Chun et al. 2017	1	14	2	68	2.5%	2.54 [0.21, 30.10]	
Dong et al. 2017	1	48	0	48	1.9%	3.06 [0.12, 77.09]	
Feller et al. 1996	0	19	0	19		Not estimable	
Kajino et al. 1997	1	26	0	26	1.9%	3.12 [0.12, 80.12]	
Keblish et al. 1994	0	52	0	52		Not estimable	
Kim et al. 2014	1	34	2	339	1.4%	5.11 [0.45, 57.82]	
Liu et al. 2012	0	64	0	68		Not estimable	
Mayman et al. 2003	5	50	1	50	3.5%	5.44 [0.61, 48.40]	
Myles et al. 2006	0	24	0	18		Not estimable	
Newman et al. 2000	6	42	0	42	1.7%	15.14 [0.82, 277.94]	
Patel et al. 2011	4	60	0	60	1.8%	9.64 [0.51, 183.05]	
Roberts et al. 2015	9	163	0	164	1.8%	20.23 [1.17, 350.53]	
Shoji et al. 1989	0	35	0	35		Not estimable	
Smith et al. 2008	0	86	0	75		Not estimable	
Sreehari et al. 2014	10	60	4	75	11.6%	3.55 [1.05, 11.96]	
Wood et al. 2002	1	128	2	92		Not estimable	
Total (95% CI)		**1190**		**1573**	**100.0%**	**3.24 [2.11, 4.99]**	
Total events	79		30				

Heterogeneity: Chi² = 12.60, df = 17 (P = 0.76); I² = 0%
Test for overall effect: Z = 5.36 (P < 0.00001)

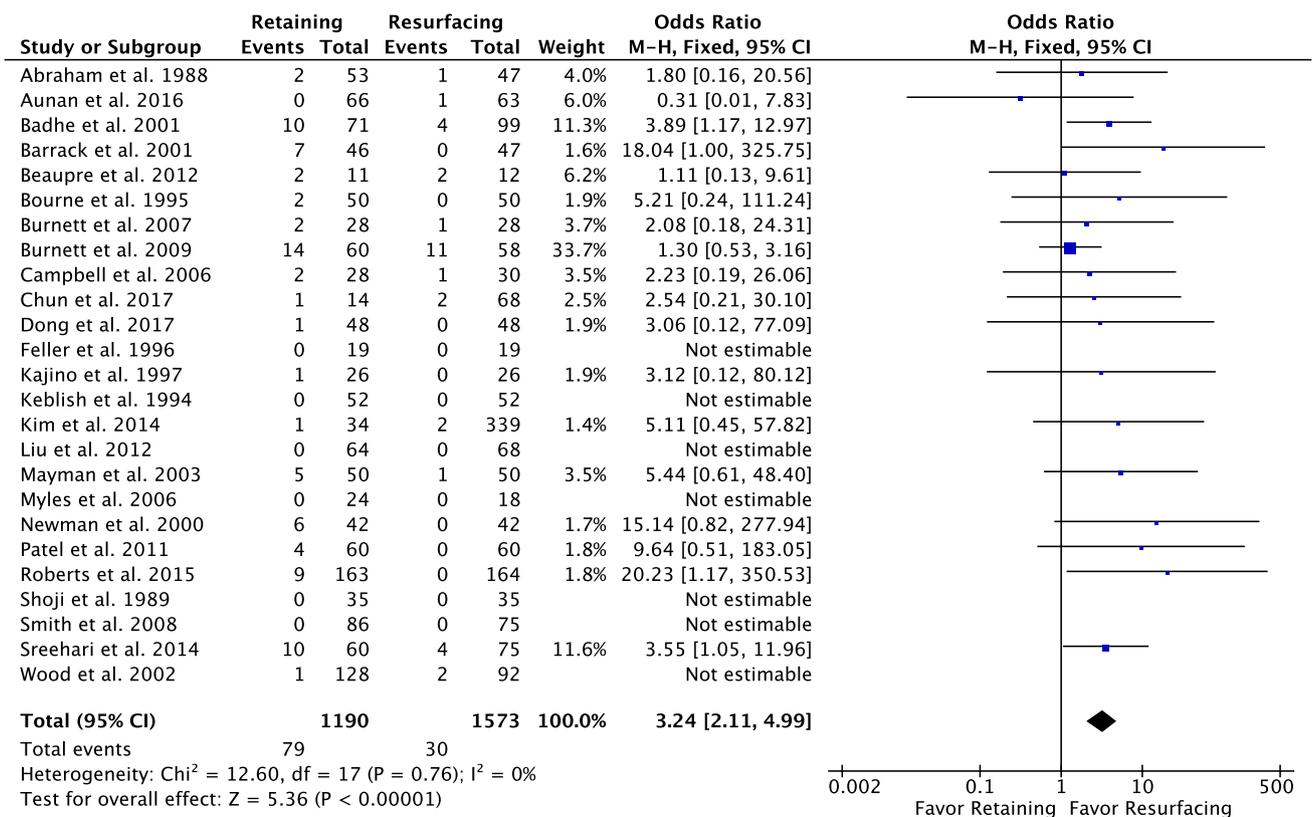Favor Retaining   Favor Resurfacing

Fig. 5 Result of the comparison reoperation

The comprehensive nature of the literature search, along with the strict eligibility criteria, presents the strong points of this work. Furthermore, the baseline demographic showed excellent comparability of the samples. Other important strengths are represented by the distinguished methodological quality assessment and the low risk of publication bias. These features ensured reliable and consistent results. The main limitation of this work was the collective analysis of

Table 2 Overall results of the meta-analysis comparisons

Comparison	Patients (n)	Effect estimate [95% CI]	I^2 (%)	P
HSS Score	651	5.64 [4.42, 6.86]	96	< 0.0001
ROM	1145	− 3.09 [− 5.04, − 1.13]	67	0.002
KSS				
KSS overall	1652	2.47 [1.45, 3.50]	66	< 0.0001
KSS pain	411	0.97 [0.13, 1.80]	0	0.02
KSS clinical	1138	0.23 [− 0.97, 1.44]	31	0.71
KSS function	2734	2.44 [0.61, 4.27]	0	0.009
AKP	2941	1.76 [1.36, 2.27]	63	< 0.0001
Reoperation	3419	3.24 [2.16, 4.88]	0	< 0.0001

the rate of further operations, devoid of differentiating type, severity and indications. It could be interesting to analyze the rate of revision surgery on the patella, further resurfacing, fractures and soft tissue damages. Other limitations are the reduced number of studies and samples enrolled. Articles were considered for analysis regardless of types of prosthetic implants and surgical approaches, representing another limitation of this study. This was done to improve the pooling data. Moreover, almost a fourth of the enrolled studies did not provide any randomization of the samples, reducing the evidence of the present work. Further studies should profit from more sophisticated and complete scores (e.g., KOOS, PRO, HSS) to amplify the spectrum of analyzed variables. Further studies should focus on investigating the nature behind anterior knee pain, clarifying the causes and devising new preventive and therapeutic solutions.

Conclusion

Based on the main findings of this meta-analysis, patellar resurfaced TKA was demonstrated to have performed superior overall. Patellar resurfacing detected a lower rate of post-operative anterior knee pain and reoperation. Moreover, the resurfacing group showed greater value of the HSS, KSS and related subscales. In favor of the retaining group, a slightly better ROM was evidenced.

Compliance with ethical standards

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