

Patellar Resurfacing in Primary Total Knee Replacement

A Meta-Analysis

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Background: Treatment of the patella during total knee replacement is an area of continuing debate. We performed a meta-analysis of randomized controlled trials to address the hypothesis that patellar resurfacing in primary total knee replacement improved patient outcome.

Methods: Randomized controlled trials comparing patellar resurfacing with nonresurfacing in primary total knee replacement were included. The primary outcomes analyzed were knee scores, anterior knee pain, and patient satisfaction. We also investigated the prevalence of complications, revision surgery related specifically to the patellofemoral joint, the infection rate, operative time, and radiographic appearance.

Results: Sixteen randomized controlled trials assessing 3465 knee replacements were eligible; 1710 procedures included patellar resurfacing and 1755 did not. The knee component of the Knee Society Score was significantly higher in the resurfacing group ($p = 0.005$); however, no significant difference was observed for the function component of the Knee Society Score or for any other reported knee score. Anterior knee pain was reported in 13% of resurfaced knees and in 24% of nonresurfaced knees; this difference was not significant ($p = 0.1$). Patients were satisfied with the outcome after 485 (90%) of 539 procedures that included patellar resurfacing compared with 488 (89%) of 548 that did not; this difference was not significant. There were ninety-three reported patellofemoral complications in the resurfacing group and 205 in the nonresurfacing group; this difference was significant ($p = 0.02$) in a random-effect model. The rate of reoperation because of anterior knee pain ($p < 0.00001$) and the rate of reoperation because of any patellofemoral complication ($p = 0.002$) were significantly higher in the nonresurfaced group. No differences were found in the analyses of infection rate, operative time, or radiographic appearance.

Conclusions: Patients who underwent patellar resurfacing experienced anterior knee pain and satisfaction with the arthroplasty procedure that were equivalent to those experienced by patients whose patella was not resurfaced; however, these patients underwent significantly fewer additional surgical procedures. Further long-term follow-up of modern prostheses in randomized studies measuring outcome with a patella-specific score is needed.

The treatment of the patella during total knee replacement continues to be debated. In a recent annual report of the National Joint Registry of England and Wales¹, 67% of primary total knee replacements were performed without patellar resurfacing, as the majority of surgeons believed that the benefits did not outweigh the risks. First-generation total knee replacements were implanted without replacing the patellar surface. As this approach was alleged to cause a high (10% to 42%) prevalence

of anterior knee pain^{2,3}, the tricompartmental total knee replacement was designed, with a concomitant reduction of anterior knee pain^{3,4}. However, resurfacing the patella led to increased patellar complications^{2,4-8}, the management of which is difficult⁹.

Several randomized controlled trials have compared resurfacing of the patella to nonresurfacing. Many of these trials involved small cohorts, and the trials demonstrated mixed outcomes¹⁰⁻¹⁵. This uncertainty has led to three approaches to patellar

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resurfacing in total knee replacement: always resurface, never resurface, or selectively resurface^{11,16-19}.

Two meta-analyses of randomized controlled trials on this topic were reported in 2005^{6,7}. Nizard et al.⁶ offered no definitive conclusion because of confounding factors, and Pakos et al.⁷ concluded that patellar resurfacing was a marginally superior strategy. These two meta-analyses, however, included a non-randomized study in their data²⁰ and their results should thus be treated with caution.

Several more randomized controlled trials with longer follow-up data have been reported since 2005^{15,18,19,21-23}. Additionally, He et al.²⁴ published a meta-analysis on patellar resurfacing, but this contained several methodological shortfalls and errors in data extraction^{9,14,20}. Thus, we undertook a further meta-analysis to address the hypothesis that resurfacing the patella in primary total knee replacement improved patient outcome with regard to knee scores, anterior knee pain, and patient satisfaction. We also investigated the complication rate, rate of revision surgery related specifically to the patellofemoral joint, infection rate, operative time, and radiographic appearance.

Materials and Methods

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist and statement for reporting systematic reviews and meta-analyses was followed in this study²⁵.

Search Strategy

MEDLINE, Embase, and the Cochrane Central Register of Controlled Trials were searched. The search terms and Boolean linkage used were “knee replacement” OR “knee arthroplasty” AND “patella resurfacing” OR “patellofemoral resurfacing” OR “patella retention” OR “patella non resurfacing.” The title and abstract of each paper were reviewed by two authors to assess eligibility. Differences were resolved by consensus, followed if necessary by scrutiny by a third reviewer. The bibliographies of the included publications were reviewed for other relevant publications.

Inclusion Criteria

The inclusion and exclusion criteria are outlined in the Appendix. Articles in a language other than English were translated by medical personnel whose first language was that of the article^{10,13,15}. Unpublished trials and abstracts were excluded to reduce the risk of bias from selective outcome reporting²⁵. Whenever the results of a trial were reported at multiple follow-up periods, we retained the most recent data. Whenever clarification was necessary, the corresponding author was contacted; if no response was received, those outcome data were excluded.

Assessment of Methodological Quality

Included studies were independently analyzed by two authors with use of domain-based risk-of-bias tables, as recommended by the Cochrane group²⁶, and the PRISMA checklist²⁵. The methodological quality was assessed with use of a five-question checklist (see Appendix) that has been used in previous meta-analyses^{27,28}. The overall quality of each study was evaluated as “good,” “satisfactory,” or “poor.” A study was considered of good quality if it was randomized, had adequate allocation concealment, had blinded assessors, and scored a “good” rating on the checklist. Disagreement was resolved by consensus. This scheme identified the five highest-quality studies^{19,21,23,29,30}, and a secondary analysis of these studies was performed to reduce the effect of randomization bias.

Outcome Measures

The primary outcome measures were knee scores and patient satisfaction. The secondary outcomes were complications, revision surgery specifically involving the patellofemoral joint, infection rate, operative time, and radiographic appearance.

Data Extraction

Data were extracted and collated independently by two authors with use of predefined data fields. Patellae that underwent patelloplasty, drilling of eburnated bone, resection of osteophytes, removal of cartilage, or no surgery were considered to be nonresurfaced.

Risk of Bias

The risk of bias in the publications is summarized in the Appendix. The risk was categorized as unclear in several studies because the randomization method for bilaterally treated knees raised a question regarding adequate allocation concealment. However, the inclusion of such knees is believed to have resulted in a negligible overall risk of bias as their numbers were small in comparison with the cohort sizes and they allowed balanced demographics.

Data Synthesis

RevMan software (version 5.1)³¹ was used for the meta-analysis. The mean difference and 95% confidence interval (CI) were calculated for continuous data, and the relative risk (RR) and 95% CI for resurfacing compared with nonresurfacing were calculated for dichotomous data. Heterogeneity was tested with use of the Cochran Q statistic and was considered significant if $p < 0.10$, in accordance with other meta-analyses^{6,7,24}. If heterogeneity was significant, a random-effect model was used to allow generalization of the results and the

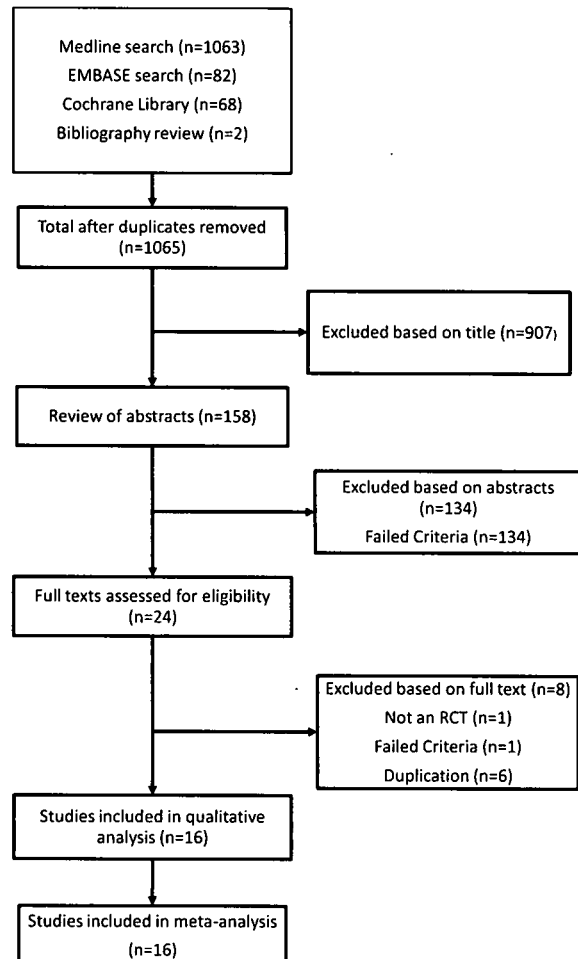


Fig. 1

Flow diagram summarizing the process by which the sixteen included studies were identified. RCT = randomized controlled trial.

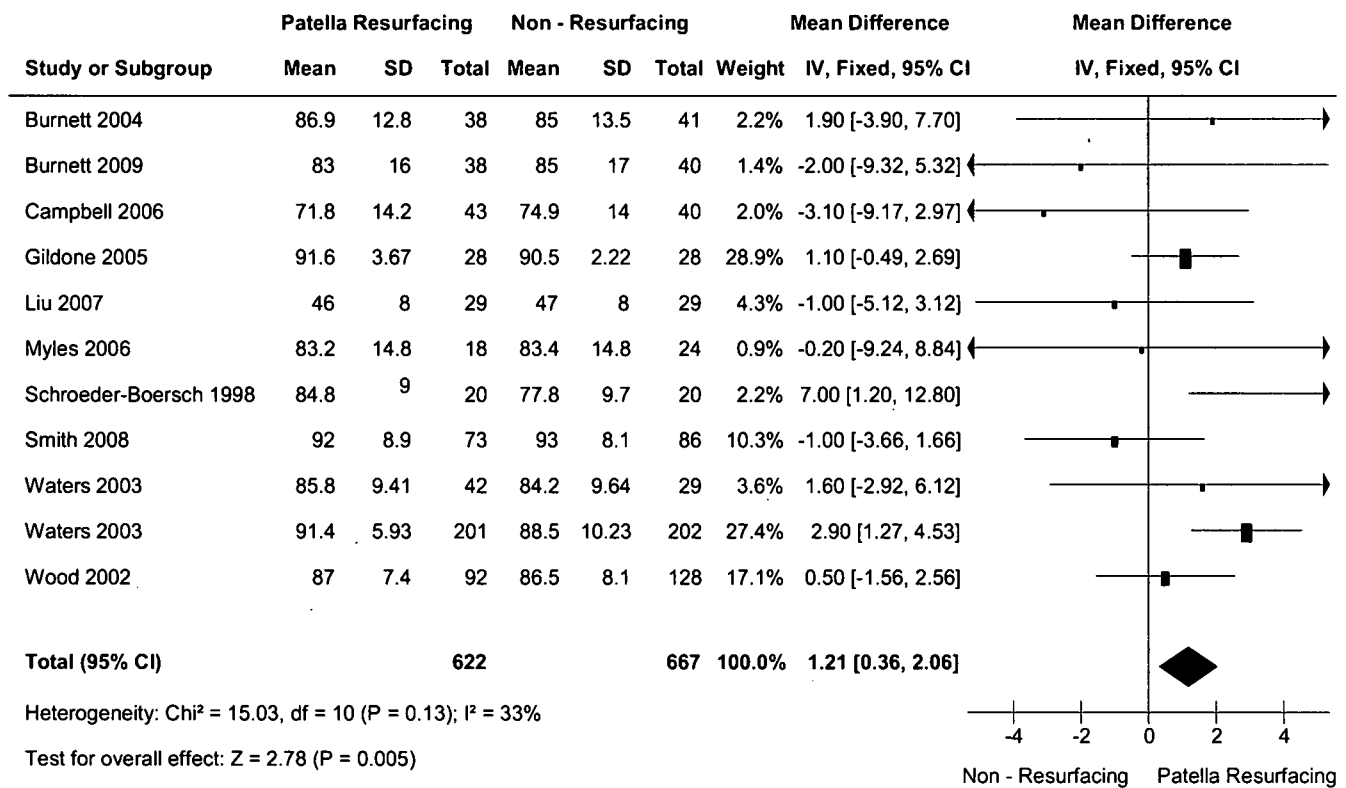


Fig. 2

Forest plot and data table (based on the standardized mean difference) for the knee component of the Knee Society Score. The black diamond does not intersect the vertical line, indicating a significant result in favor of patellar resurfacing. SD = standard deviation, IV = inverse variance, CI = confidence interval, and df = degrees of freedom.

source of the heterogeneity was considered. If heterogeneity was low, a fixed-effect model was used. The Z test was used to assess the overall effect.

The number of knees that could be analyzed varied depending on the outcome. In two studies^{30,32}, the median and interquartile range (IQR) were stated rather than the mean and standard deviation (SD). In this situation, the mean was estimated from the median and the SD was derived according to the approximation $SD = 1.35/IQR^{33}$.

Source of Funding

No external funding was received for this study.

Results

General

The final search undertaken on March 7, 2011, identified 1065 articles, and twenty-two met the inclusion criteria (Fig. 1)^{8-16,18,19,21-23,29,30,32,34-38}. Six of these articles reported on the same cases at earlier points in time; only data from the most recent publication were included. Thus, sixteen randomized controlled trials employing various randomization methods were included in this meta-analysis^{10-15,19,21-23,29,30,32,36-38}. The cumulative sample size of 3465 total knee replacements comprised 1710 with patellar resurfacing and 1755 without resurfacing.

The Appendix provides a summary of the included studies. Thirteen studies included only patients with osteoarthritis^{10-15,19,21,23,30,32,37,38}, and three included both patients with osteoarthritis and those with rheumatoid arthritis^{22,29,36}. The

data collector and patients were blinded to the study outcome in nine of the studies; blinding was not reported in the remaining seven.

Interreviewer agreement for the data extraction and assessment of the risk of bias was high ($\kappa = 0.86$). The five highest-quality studies were identified^{19,21,23,29,30}, and the analysis of each outcome using only these high-quality studies did not alter the results compared with the analysis of all included randomized controlled trials.

A cemented polyethylene dome was used to resurface the patella in six studies^{12,14,19,21,32,36}; use of a polyethylene dome was reported in three other studies but it was not stated whether this was cemented^{10,11,29}, and the type of patellar component was not reported in the remaining seven studies^{13,15,22,23,30,37,38}. The prosthesis types used are summarized in the Appendix, allowing an inference to be made regarding the type of patellar component implanted.

Six trials indicated that routine resurfacing of the patella resulted in a better outcome^{10,11,29,30,36,37}, whereas nine indicated that it did not^{12-14,19,21-23,32,38} and one was equivocal¹⁵.

Knee Scores

The only knee score that showed a significant difference between the patellar resurfacing and nonresurfacing groups was the knee component of the Knee Society Score ($p = 0.005$ in favor of resurfacing). However, the statistical significance of this result is

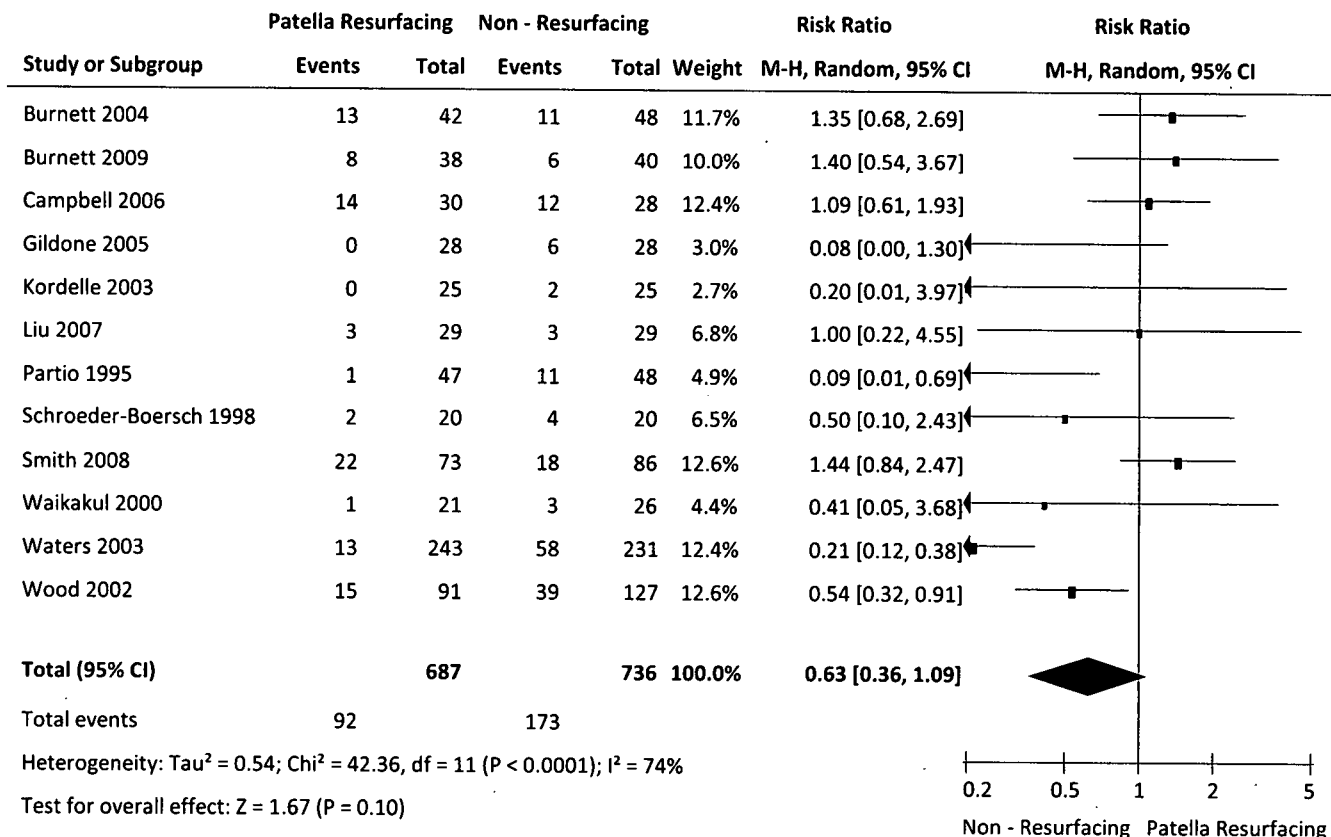


Fig. 3

Forest plot and data table (based on the risk ratio) for anterior knee pain. The black diamond intersects the vertical line, indicating that the difference in favor of resurfacing was not significant. A random-effect model was used because of the high heterogeneity ($I^2 = 74\%$). M-H = Mantel-Haenszel, CI = confidence interval, and df = degrees of freedom.

less important than the fact that the mean difference in the score (1.21; 95% CI, 0.36 to 2.06) was trivial (Fig. 2).

Patient Satisfaction

Patient satisfaction was reported in nine studies^{10,11,13-15,21,29,32,36}, eight of these used patient questionnaires and one did not identify the method used¹³. We defined the outcome as satisfactory if it was directly reported as such or if it was reported that the patient would have the procedure again. The satisfaction rate was 90.0% (485 of 539) in the resurfacing group and 89.1% (488 of 548) in the nonresurfacing group. This difference was not significant in the fixed-effect model (RR, 1.01; 95% CI, 0.97 to 1.05).

Infection Rate

Thirteen trials reported the infection rate^{10-15,19,21,22,29,30,32,36}. Infection occurred in 1.6% (twenty-five) of 1598 patients in the resurfacing group and 2.1% (thirty-five) of 1638 in the nonresurfacing group. This difference was not significant (RR, 0.74; 95% CI, 0.45 to 1.21); heterogeneity was low ($I^2 = 6\%$, $p = 0.38$).

Operative Time

Three studies^{13,15,22} indicated no significant difference in operative time between procedures in the resurfacing and non-resurfacing groups. No further analysis was possible.

Radiographic Appearance

Patellar tilt was reported in five studies^{14,19,29,30,36} and occurred in seventy-eight of 431 patients in the resurfacing group and eighty of 448 in the nonresurfacing group. The difference was not significant (RR, 1.06; 95% CI, 0.80 to 1.41) in the random-effect model.

A total of three patellar resurfacing implants loosened in three studies^{13,21,29}. Patellar shift of >5 mm was reported in two studies^{30,36} and did not differ significantly between groups (RR, 0.65; 95% CI, 0.27 to 1.58; $p = 0.34$). Four studies^{11,13,19,36} included the rate of patellar subluxation but used different classifications, making further analysis impossible.

Anterior Knee Pain

Anterior knee pain was present in ninety-two (13.4%) of 687 knees in the resurfacing group and 173 (23.5%) of 736 knees in the nonresurfacing group. The difference was not significant (RR, 0.63; 95% CI, 0.36 to 1.09; $p = 0.1$) in the random-effect model used because of the high heterogeneity (Fig. 3).

Forty-eight (6%) of 792 knees in the nonresurfacing group and eight (1%) of 748 knees in the resurfacing group had further procedures because of anterior knee pain. The difference in favor of resurfacing was significant (RR, 0.23; 95% CI, 0.12 to 0.43; $p < 0.00001$) and heterogeneity was low ($p = 0.63$, $I^2 = 0\%$) (Fig. 4).

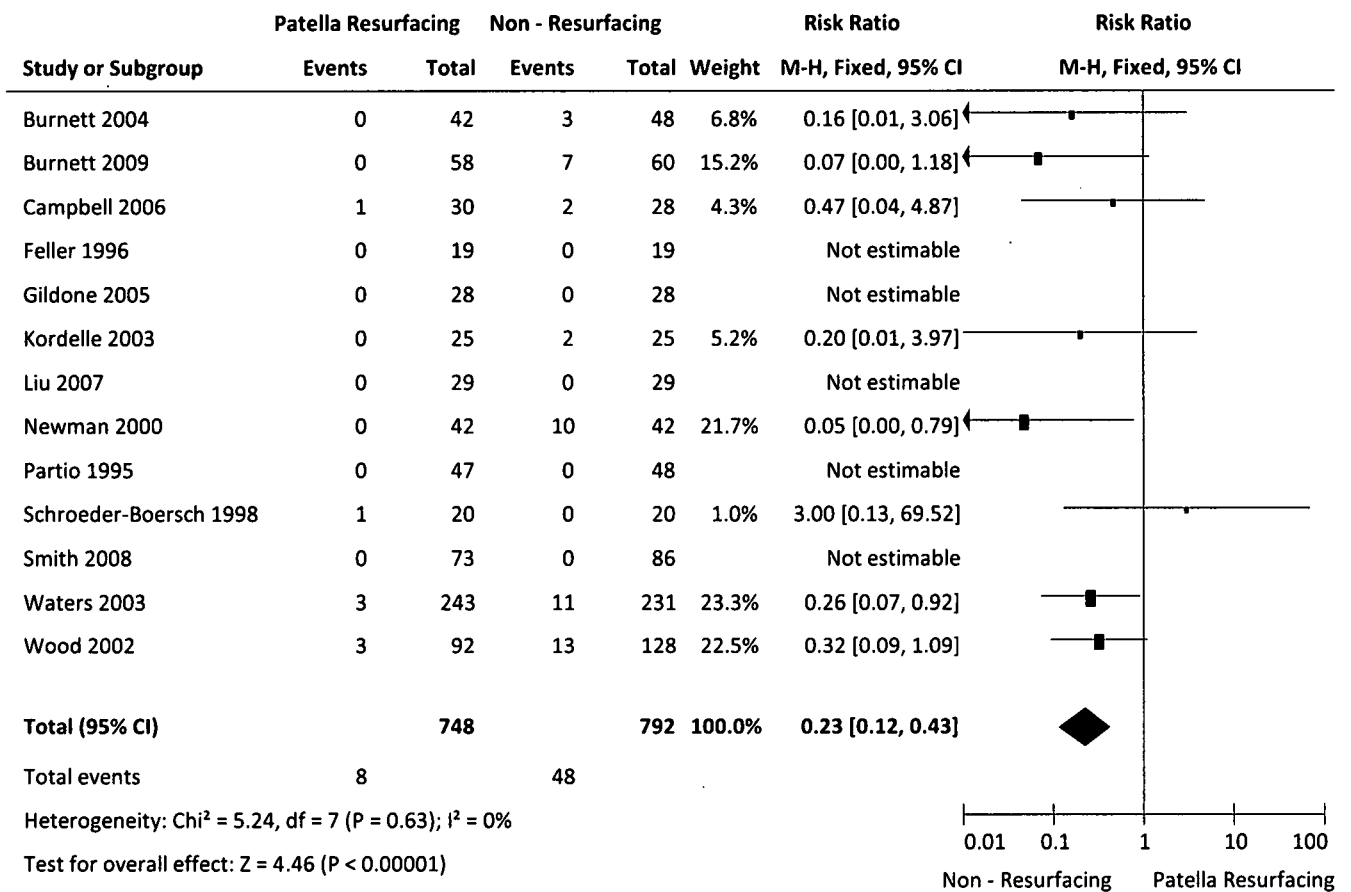


Fig. 4

Forest plot and data table (based on the risk ratio) for anterior knee pain requiring operative intervention. The black diamond does not intersect the vertical line, indicating that not resurfacing the patella significantly increased the need for a further operative intervention because of anterior knee pain. A fixed-effect model was used because of the low heterogeneity ($I^2 = 0\%$). M-H = Mantel-Haenszel, CI = confidence interval, and df = degrees of freedom.

Patellofemoral Joint Problems

Ninety-three (5.9%) of 1589 knees in the resurfacing group had complications compared with 205 (12.6%) of 1631 in the nonresurfacing group. The difference was significant (RR, 0.55; 95% CI, 0.34 to 0.90; $p = 0.02$), and heterogeneity was significantly high ($p < 0.0001$, $I^2 = 70\%$) (Fig. 5).

There were nineteen reoperations related specifically to the patellofemoral joint in the resurfacing group and forty-nine in the nonresurfacing group. The difference was significant (RR, 0.46; 95% CI, 0.28 to 0.75; $p = 0.002$), and heterogeneity was not significant ($p = 0.38$, $I^2 = 7\%$) (Fig. 6).

Patellofemoral Joint Problems Excluding Anterior Knee Pain

As anterior knee pain is a relatively common issue causing a significant difference in reoperation rates, cases in which anterior knee pain was the only complaint were excluded and the patellofemoral complication rate was recalculated. Such complications occurred in twenty knees (1.3%) in the resurfacing group and eighteen (1.1%) in the nonresurfacing group; the difference was not significant (RR, 1.29; 95% CI, 0.46 to 3.60; $p = 0.62$).

Discussion

The meta-analysis demonstrated that patellar resurfacing in total knee replacement had no significant effect on patient satisfaction, infection rate, anterior knee pain, or the majority of knee scoring systems. The difference in the knee component of the Knee Society Score was significant in favor of resurfacing; however, the statistical significance of this difference is of less importance because of the trivial size of the mean difference (Fig. 2). It is likely that this statistical result is of minimal clinical importance, particularly as analysis of all other knee scores noted no difference. Thus, the statistical and clinical significance of this finding is debatable.

Patients can be advised that nine of ten individuals who undergo primary total knee replacement are satisfied regardless of the type of patellar intervention. Although resurfacing the patella might theoretically require more time, there are no data to support a resulting increase in the infection risk.

The Knee Society Score is composed of two elements, the knee component and the function component, which are combined to obtain the total score. The reported breakdown of the scores varied among the included studies. In the present

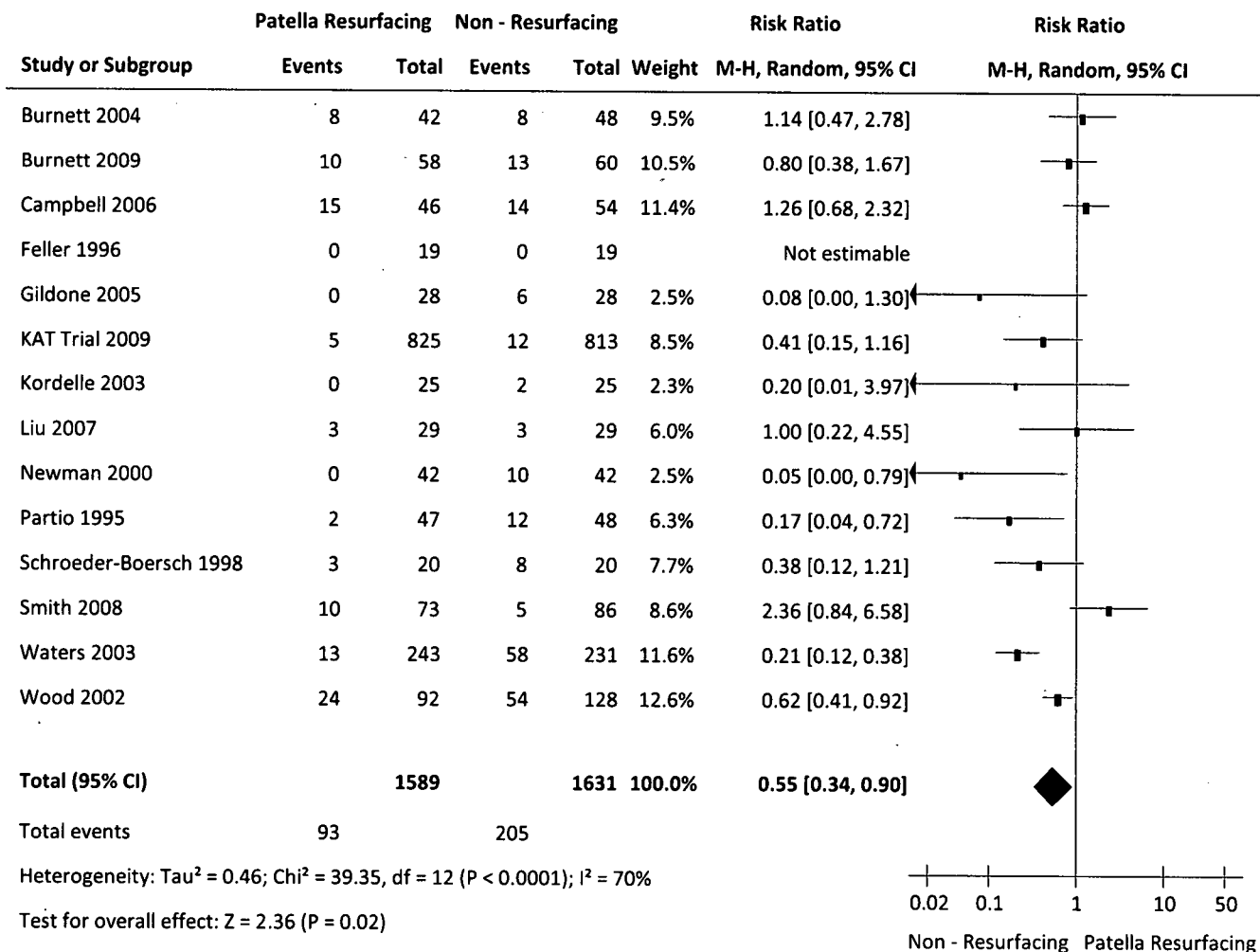


Fig. 5

Forest plot and data table (based on the risk ratio) for patellofemoral joint complications (including anterior knee pain). The black diamond does not intersect the vertical line, indicating that not resurfacing the patella significantly increased the prevalence of such complications. A random-effect model was used because of the high heterogeneity ($I^2 = 70\%$). M-H = Mantel-Haenszel, CI = confidence interval, and df = degrees of freedom.

meta-analysis, the knee component was significantly higher in the resurfacing group, in contrast to other studies^{7,24,39}. Nizard et al.⁶ and Parvizi et al.³⁹ found a significantly higher Knee Society functional component and a significantly higher combination of all knee scores. Those studies combined the different knee score systems with use of the standardized mean difference; however, because of the larger number of knees in our meta-analysis, we were able to strengthen our analysis by analyzing each knee score separately. With only one section of one knee scoring system favoring patellar resurfacing in the present meta-analysis, it is difficult to justify any firm conclusions other than that patellar resurfacing and nonresurfacing produce similar knee scores.

The prevalences of postoperative anterior knee pain in the present meta-analysis were comparable with those in other meta-analyses (7.6% to 16.2% for resurfacing and 22.3% to 26.8% for nonresurfacing)^{6,24,39}. The reported prevalence of anterior knee pain in the present meta-analysis was prior to any secondary intervention. Data were excluded from the analysis of pain if anterior knee pain in patients was reported without distinguishing

those who had undergone a secondary procedure from those who had not. There was significant heterogeneity among the studies evaluating anterior knee pain; the reasons for this may be related to the subjective nature of such pain, and caution in the interpretation of this result is therefore urged. However, anterior knee pain must be discussed during the informed consent process.

The reoperation rate following a patellofemoral complication in the nonresurfacing group was comparable with that in other meta-analyses^{6,24,39}. The chance of undergoing further surgery because of anterior knee pain was 1% if the patella had been resurfaced compared with 6% if it had not. This difference is probably due to the poorly justified temptation to attribute the anterior knee pain to lack of patellar resurfacing. Forty-eight of the forty-nine reoperations for anterior knee pain in the nonresurfacing group were secondary resurfacings. It was not possible to analyze the effects of secondary patellar resurfacing on anterior knee pain because of lack of data; in addition, several studies excluded patients from the anterior knee pain assessment following a second intervention^{10,14,30,36}. Furthermore, as

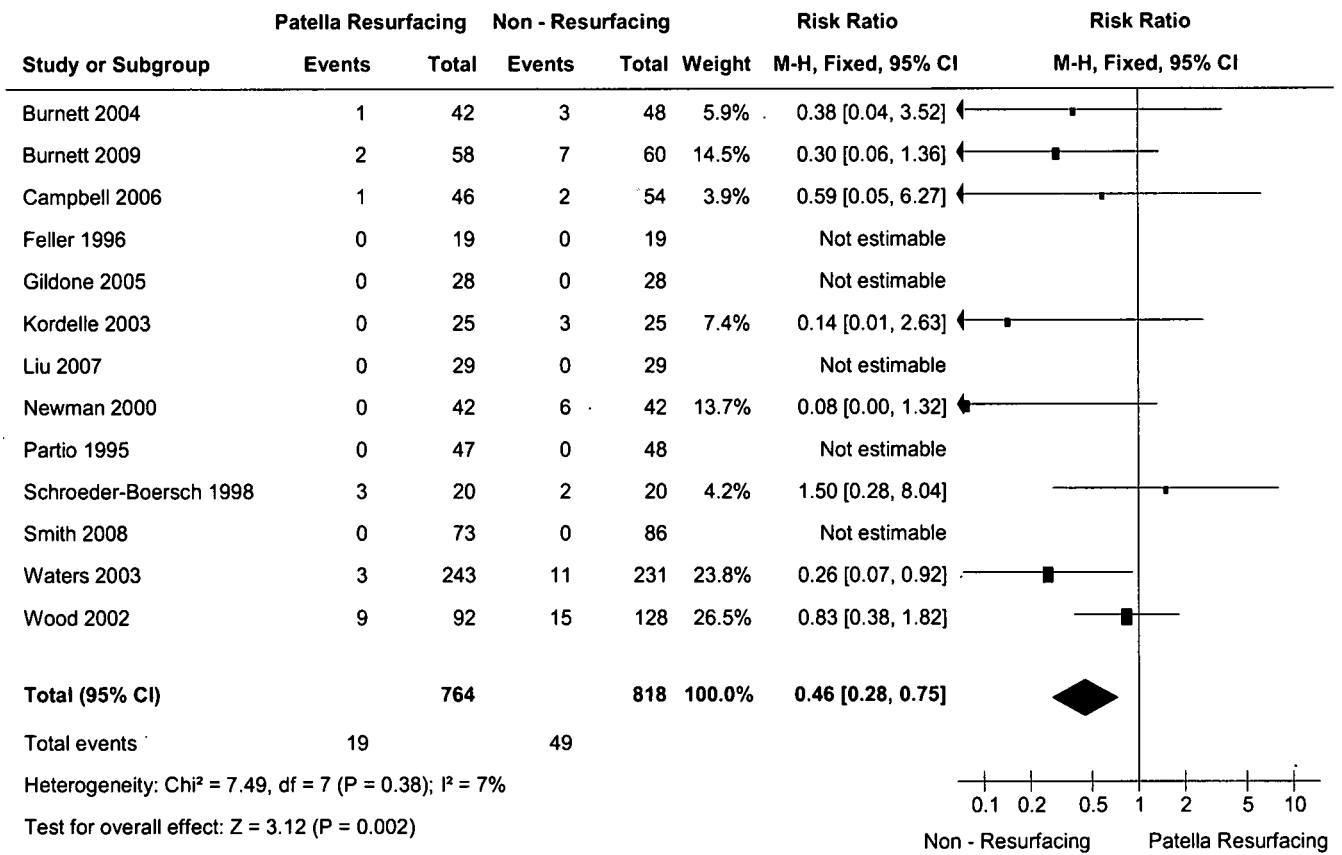


Fig. 6 Forest plot and data table (based on the risk ratio) for patellofemoral joint complications that required a further operation. The black diamond does not intersect the vertical line, indicating that not resurfacing the patella significantly increased the prevalence of complications that required reoperation. A fixed-effect model was used because of the low heterogeneity (I² = 7%). M-H = Mantel-Haenszel, CI = confidence interval, and df = degrees of freedom.

the resurfaced group presents more difficult treatment options, the nonsurgical route may have been preferred.

There are limitations to this study. Limitations inherent to meta-analysis arise from the methodology and reporting of the included studies. The assessment of the quality of included studies is important to improve the overall reliability of the conclusions drawn^{26,40}. We used domain-based evaluation of the risk of bias, as recommended by the Cochrane Collaboration²⁶, and we assessed methodological quality with use of a checklist, which is favored over scales in the literature⁴⁰⁻⁴³; however, we are aware that no method is universally accepted.

The randomization methods used in six of the studies were either incompletely reported or classified as quasi-randomized, introducing an element of bias that is difficult to quantify. Some of the data on the analyzed outcomes were incompletely presented, or not reported at all, in each of the included studies. We contacted authors for further information; however, there was a limited response.

Direct comparison among studies was complicated by confounding factors. Several studies concluded that the total knee replacement design and surgical technique were crucial in predicting the outcome^{11,15,19,29,32}. Some studies included in this analysis began recruiting patients twenty years ago, and many

of the prostheses used have been redesigned to improve tracking and tolerance of native patellae or are no longer in production^{12,14,19,21,30,37,38}.

Although the cumulative sample size of the analysis was large, many of the studies had insufficient numbers to permit the treatment effect to be calculated. Only two studies in which power calculations were performed before recruitment included enough patients at the latest follow-up to demonstrate a significant difference^{22,29}. Follow-up was short in many of the randomized controlled trials, with the latest follow-up often being within five years of the index procedure^{10-13,15,22,23,30,32,36,38}.

No knee score (Knee Society Score, Hospital for Special Surgery score, Oxford Knee Score, or Bristol Knee Score) is aimed specifically at assessing the patellofemoral joint or patellar symptoms. Thus, an actual difference between the two groups may have existed but not been found. Several studies^{1,12,14,30,37} used questionnaires or physical tests aimed at evaluating the patellofemoral joint, but these had not been validated and were not sufficiently standardized to permit meta-analysis.

In summary, resurfacing of the patella is a choice that must be made by the surgeon and patient together on the basis of the current evidence. Nine of ten patients were satisfied with the outcome regardless of the choice of patellar intervention. Anterior

knee pain was the most commonly reported symptom following total knee replacement (in 13% to 24% of cases) regardless of the choice of patellar intervention. Patients who received resurfacing were significantly less likely to have a subsequent operation. Total knee replacement with resurfacing required more time. Development of a "Patella Score" and its use in a randomized controlled trial with modern prostheses may provide better evidence on which to base firm conclusions about patellar resurfacing.

Appendix

eA Tables summarizing the inclusion and exclusion criteria, the methodological quality checklist, and the characteristics of the included studies as well as a figure summarizing the risk of bias in the included studies are available with the online version of this article as a data supplement at jbsj.org. ■

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