


REVIEW ARTICLE

Patellar Denervation with Electrocautery Reduces Anterior Knee Pain within 1 Year after Total Knee Arthroplasty: A Meta-Analysis of Randomized Controlled Trials

Ming-cheng Yuan, MM, Zi-chuan Ding, MM, Ting-xian Ling, MD, Zongke Zhou, MD 

Department of Orthopedics, West China Hospital/West China School of Medicine, Sichuan University, Chengdu, 610041, China

Objective: The effect of patellar denervation with electrocautery (PD) on anterior knee pain (AKP) after total knee arthroplasty (TKA) is still debated. The aim of this meta-analysis was to evaluate the current evidence regarding the use of PD in TKA without patellar resurfacing.

Methods: A computerized search of published studies was performed in the PubMed, Embase and Cochrane Library databases in December 2019. Eligible studies were randomized controlled trials (RCTs) comparing clinical outcomes of the PD group and the non-PD group. Subgroup analyses were carried out according to the follow-up time (3, 12 months, and over 12 months) to evaluate whether the clinical effect of PD changed with time.

Results: Ten RCTs were included in this meta-analysis. Pooled results showed a lower rate of AKP (Risk Ratio [RR] = 0.70; 95% confidence interval [CI], 0.50 to 0.97; $P = 0.03$) and a reduction in visual analogue scale (VAS) for AKP (mean difference, -0.37 ; 95% CI, -0.69 to -0.05 ; $P = 0.02$) in the PD group when compared to the non-PD group. Subgroup analyses found the differences in AKP incidence and VAS for AKP were significant at 3- and 12-month follow-up but not after 12-month follow-up. No significant difference was observed in functional scores between the two groups. No specific complication directly or indirectly related to PD was found.

Conclusion: PD can decrease the incidence and severity of AKP within 12 months after TKA, but the effect cannot be maintained after 12-month follow-up. Without significant associated complication and reoperation, the use of PD is still recommended in TKA without patellar resurfacing.

Key words: Anterior knee pain; Meta-analysis; Patellar denervation with electrocautery; Total knee arthroplasty

Introduction

Total knee arthroplasty (TKA) is considered to be the successful treatment of choice for end-stage knee osteoarthritis, and can provide excellent postoperative pain relief, remarkable deformity correction, and satisfactory function recovery. However, residual anterior knee pain (AKP) after TKA has been a common and persistent complaint, and results in dissatisfaction and low quality of life of patients^{1,2}. The reported incidence of AKP ranges from 17.5% to

29.0%³⁻⁵. The underlying cause for AKP still remains unclear, but its development was believed to be associated with the presence of substance P nociceptive afferent fibers in the peripatellar soft tissues^{6,7}.

Theoretically, patellar denervation with electrocautery (PD) can disable the pain receptors, interrupt the pain pathways, achieve denervation of the anterior knee region, and consequently prevent AKP after TKA. PD has been widely performed among surgeons who do not carry out patellar

*Address for correspondence Zongke Zhou, MD, Department of Orthopedics, West China Hospital/West China School of Medicine, Sichuan University, 37# Wuhou Guoxue Road, Chengdu, China 610041 Email: zongke2017@163.com
Mingcheng Yuan and Zichuan Ding contribute equally to this work.

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resurfacing in TKA. It has been reported that 56% of the surgeons in the Netherlands routinely use PD to prevent AKP in TKA without patellar resurfacing⁸. However, the exact effect of PD on the incidence and severity of AKP after TKA is still debated. A number of randomized controlled trials (RCTs) regarding the effect of PD have been published with controversial results. Some indicated that PD has no clear advantage over non-patellar denervation (non-PD)^{9,10}, while some believed PD can reduce incidence of AKP and improve knee function after TKA^{11,12}. Moreover, several recent studies found that PD can improve clinical outcomes at the early stage of postoperative period but the effect cannot be maintained after a longer follow-up time, suggesting that the clinical effect of PD on TKA changed in a time-dependent manner^{13–15}.

The literature search in the most recently published meta-analysis on this topic by Zhang *et al*¹⁶ was conducted in February 2015. A total of six RCTs were included in the previous meta-analysis and the authors concluded that PD has a superior effect on clinical outcomes than non-PD. Another meta-analysis including seven RCTs by Xie *et al* found PD can significantly reduce AKP and improve early knee function after TKA¹⁷. But the advantages disappear after a prolonged period of follow-up. Importantly, several additional RCTs have been published in this field in recent years. In order to draw an updated conclusion to help orthopaedic surgeons make a wiser clinical decision, a meta-analysis of RCTs was performed to investigate the effect of PD on AKP after TKA without patellar resurfacing, and to determine whether the clinical effect of PD changes with time.

Materials and Methods

The meta-analysis performed adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines¹⁸ and AMSTAR (Assessing the Methodological Quality of Systematic Reviews) Guidelines¹⁹.

Search Strategy

A computerized search was performed in the PubMed, Embase and Cochrane Library databases in December 2019 for studies published. No time frame was specified with respect to publication date and there was no language restriction. The following keywords were used along with the Boolean operator: Denervation, Electrocautery, Knee arthroplasty. Details of the search strategy are shown in Table 1. Manual search of bibliographies from reviews and selected studies was also performed for additional studies.

Article Selection

The inclusion criteria were: (i) patients underwent primary TKA without patellar resurfacing; (ii) PD were performed in the experimental group; (iii) non-PD were performed in the control group; (iv) follow-up data about postoperative AKP or knee function were provided; and (v) randomized controlled trials. Exclusion criteria were: (i) studies which

TABLE 1 Details of search strategy

Database	Search strategy
Pubmed	(Denervation[tiab] OR Electrocautery[tiab] OR Electrocoagulation[tiab] OR Denervation [MeSH] OR Electrocoagulation[MeSH]) AND (Knee arthroplasty[tiab] OR Knee replacement[tiab] OR Arthroplasty, Replacement, Knee[MeSH])
Embase	#1 "Denervation":ab,ti OR "Electrocautery":ab,ti OR "Electrocoagulation":ab,ti #2 "Denervation"/exp. #3 "Electrocoagulation"/exp. #4 "Knee arthroplasty":ab,ti OR "Knee replacement":ab,ti #5 "Knee arthroplasty"/exp. #6 (#1 OR #2 OR #3) #7 (#4 OR #5) #8 (#6 AND #7)
Cochrane Library	#1 Denervation OR Electrocautery OR Electrocoagulation:ti,ab,kw #2 MeSH descriptor: [Denervation] explode all trees #3 MeSH descriptor: [Electrocoagulation] explode all trees #4 Knee arthroplasty OR Knee replacement: ti,ab,kw #5 MeSH descriptor: [Arthroplasty, Replacement, Knee] explode all trees #6 (#1 OR #2 OR #3) #7 (#4 OR #5) #8 (#6 AND #7)

included patients with knee deformity, lower limb fracture, or previous surgery of lower limb.

Two reviewers independently assessed the titles and abstracts for initial screening of studies, and then the full texts of articles selected from initial screening were evaluated. Disagreement was resolved by discussion and consensus. When the decision was still not reached, a third reviewer's opinion was sought.

Assessment of Risk of Bias

The risk of bias of RCT was graded as high, low, or unclear according to the Cochrane Risk of Bias Tool based on the following domains: selection bias, performance bias, detection bias, attrition bias, reporting bias, and other bias²⁰. Other bias was defined as the study with unbalanced baseline characteristics of patients between the PD and non-PD group. Two reviewers independently assessed the risk of bias of included studies. Any disagreement between reviewers was resolved by a third reviewer.

Study Outcomes

Incidence of Anterior Knee Pain (AKP)

The primary outcome measure of interest was the incidence of AKP after TKA, which was the proportion of patients having AKP after TKA. AKP has been the most common complaint after TKA, and often results in dissatisfaction and

low quality of life of patients_{1,2}. The reported incidence of AKP ranges from 17.5% to 29.0%₃₋₅.

Visual Analogue Scale (VAS) for Anterior Knee Pain (AKP)

The visual analogue scale (VAS) was the secondary outcome of this study. The visual analogue scale (VAS) is the most commonly used method for measuring pain. For measurement of the magnitude of pain, the most used scale is “no pain” (corresponding to the scale of 0) and “pain too intense to be tolerated” (corresponding to the scale of 10). The severity of the AKP after TKA is evaluated by VAS in most studies regarding the use of PD in TKA.

Range of Motion (ROM)

The range of motion (ROM) was the secondary outcome of this study. ROM is the degree of flexion and extension of the knee, which is of vital importance to reflect the knee function after TKA.

Patellar Score (PS)

The Patellar Score (PS) was the secondary outcome of this study. The PS is a questionnaire which includes items on anterior knee pain, quadriceps strength, and ability to rise from a chair and climb stairs; these scores range from 3 to 30 points, with 30 points representing the best score.

American Knee Society Score (KSS)

The secondary outcomes included American Knee Society Score (KSS), which consists of knee score and function score, each with a maximum of 100 points. The American Knee Society knee score (KSS knee) evaluates the knee joint based on pain, stability and range of motion, with deduction for flexion contracture, extension lag and malalignment. The American Knee Society function score (KSS function) scores the patient’s ability to walk and climb stairs, with deduction for aids.

Oxford Knee Score (OKS)

The secondary outcomes included Oxford knee score (OKS), which is a patient-reported outcome measure that consists of 12 questions about an individual’s activities of daily living and how they have been affected by pain over the last 4 weeks. It is a reliable tool to evaluate the pain and function of the knee after TKA.

Postoperative Complication and Reoperation

All postoperative complications and reoperations reported in the included studies were extracted.

Data Extraction

Lead author, publication year, country of origin, participant characteristics (age and gender), depth of electrocautery, surgical approach, follow-up time, and study conclusion were extracted from each included study by two independent reviewers.

TABLE 2 Details of included studies

References	Country	No. of knees		Age		Gender (female)		Depth of electrocautery	Approach	Follow-up time (mean; months)	Conclusion
		PD	NPD	Total	PD	NPD	PD				
Alomran, 2015 ¹²	Saudi Arabia	92	92	184	NA	NA	NA	Within 2 mm	MP	37.4 (PD); 39.0 (NPD)	38-Month result: favor PD
Altay et al., 2012 ¹¹	Turkey	35	35	70	68	74.3%	74.3%	2–3 mm	MV	36 (24–60)	36-Month result: favor PD
Baliga, 2012 ⁹	United Kingdom	91	94	185	69.0	44.0%	55.3%	Within 1 mm	MP	12	3-, 6- and 12-Month results: neutral
Kwon et al., 2015 ¹⁰	Korea	50	50	100	66.3	100%	100%	About 1 mm	MP	64.8 (60–70)	3-, 6- and 60-Month results: neutral
Motifard et al., 2018 ²⁵	New Zealand	46	46	92	64.3	71.7%	64.1%	1–2 mm	MV	10	3-Week result: favor PD; 3-, 6- and 10-month results: neutral
Pulavarti et al., 2014 ¹³	United Kingdom	63	63	126	69.9	50.8%	57.1%	NA	MP	26.5 (PD); 26.3 (NPD)	3-Month result: favor PD; 12- and 24-month results: neutral
Saoud, 2004 ²³	Egypt	19	19	38	NA	NA	NA	1 mm	MP	11 (PD); 10 (NPD)	10-Month result: favor PD
van Jonbergen et al., 2011 ¹⁴	The Netherlands	131	131	262	71	72.5%	64.1%	Within 1 mm	MP	12	12-Month result: favor PD
van Jonbergen et al., 2014 ¹⁵	The Netherlands	103	99	202	70	72.8%	65.7%	Within 1 mm	MP	44.4 (12–50)	44-Month result: neutral
Yim et al., 2012 ²⁴	Korea	50	50	100	70.2	100%	100%	Within 2–3 mm	MP	21 (12–48)	21-Month result: neutral

MP, medial parapatellar approach; MV, midvastus approach; NA, not available; NPD, non-patellar denervation; PD, patellar denervation.

TABLE 3 Results of subgroup analyses of different follow-up times

Follow-up time and outcomes	Studies	Participants (No. of knees)			Overall effect	
		PD	NPD	Overall	OR/WMD (95% CI)	P
3 Months						
VAS	2	109	109	218	-0.52 (-0.89, -0.14)	0.007
PS	3	159	159	318	1.50 (-0.76, 3.75)	0.19
KSS knee	3	159	159	318	-1.01 (-3.77, 1.75)	0.47
KSS function	2	109	109	218	4.67 (2.07, 7.26)	<0.001
OKS	2	154	157	311	0.66 (-1.19, 2.51)	0.48
12 Months						
AKP	4	304	306	610	0.70 (0.50, 0.98)	0.03
VAS	3	200	202	402	-0.51 (-0.84, -0.19)	0.002
PS	3	159	158	317	0.07 (-0.76, 0.90)	0.88
KSS knee	4	290	289	579	0.21 (-2.06, 2.48)	0.85
KSS function	3	240	239	479	0.81 (-1.75, 3.37)	0.54
OKS	2	154	156	310	-0.18 (-2.92, 2.57)	0.90
Over 12 months						
AKP	4	306	299	605	0.68 (0.46, 1.00)	0.05
VAS	2	96	93	189	-0.31 (-0.82, 0.19)	0.22
ROM	3	188	185	373	7.68 (0.33, 15.04)	0.04
PS	3	146	143	289	0.75 (-0.25, 1.75)	0.14
KSS knee	3	188	184	372	1.83 (-0.28, 3.94)	0.09
KSS function	2	138	134	272	3.66 (0.29, 7.04)	0.03

KSS function, American Knee Society function score; KSS knee, American Knee Society knee score; NPD, non-patellar denervation; OKS, Oxford knee score; PD, patellar denervation; PS, Patellar score; ROM, range of motion; VAS, visual analogue scale.

Statistical Analysis

Risk Ratio (RR) and 95% confidence intervals (CI) were calculated for dichotomous outcomes using the Mantel-Haenszel (M-H) method. Mean difference (MD) and 95% CI were calculated for continuous outcomes using the Inverse Variance (IV) method. If the original study did not report standard deviation (SD), we estimated SD according to Hozo *et al*²¹. A random effects model was used to pool the data. Heterogeneity between studies was measured by the I^2 statistics ($I^2 > 50\%$ representing significant heterogeneity). If zero event was reported for one group in a comparison, a value of 0.5 was added to both groups for each such study. If studies reported zero events in both groups, the data was not included in the meta-analysis²². To evaluate whether the clinical effect of PD changes with time, subgroup analyses of the function outcomes were carried out according to follow-up time (3 months, 12 months, and over 12 months; Table 3). Outcomes with only one study reporting were not included in subgroup analyses. Besides, subgroup analysis was carried out according to different depths of electrocautery. Publication bias was assessed by generating funnel plots. The level of significance was defined as $P < 0.05$. Statistical analyses were performed by using Review Manager 5.3.

Results

Article Selection and Characteristics

The initial literature search identified 1198 studies, and manual search yielded one additional study²³. After duplicates

were removed, titles and abstracts of 664 studies were assessed. The full texts of 42 studies were then evaluated, and ultimately 10 studies that met the inclusion criteria were included in this meta-analysis^{9-15,23-25}.

The flow diagram is presented in Fig. 1. Two studies by van Jonbergen *et al.* from the same cohort were included as they had different follow-up times (12 and 44 months)^{14,15}. The earlier study in 2011 with 12-month follow-up was included in the subgroup analysis¹⁴.

Characteristics of included studies are summarized in Table 2. The 10 included RCTs were published from 2004 to 2019, with sample sizes ranging from 38 to 262 subjects. Participants had unilateral TKA procedures in all studies except one by Yim *et al.* (bilateral TKA)²⁴. The age and gender of participants were comparable between PD and non-PD group in all studies that reported related details. The depths of electrocautery in PD group was varied among studies: from within 1 mm to within 10 mm. Eight of the 10 included studies used medial parapatellar approach during TKA procedure and two of them used midvastus approach. The follow-up time of included studies ranged from 10 to 64 months.

Details of risk of bias are presented in Figs 2 and 3. Three studies did not provide methodology information about randomization and blinding, and thus were assessed as unclear risk of bias in selection bias, performance bias, and detection bias^{12,23,24}. Two studies that did not provide baseline data for both groups were assessed as unclear risk of bias in other bias^{23,24}.

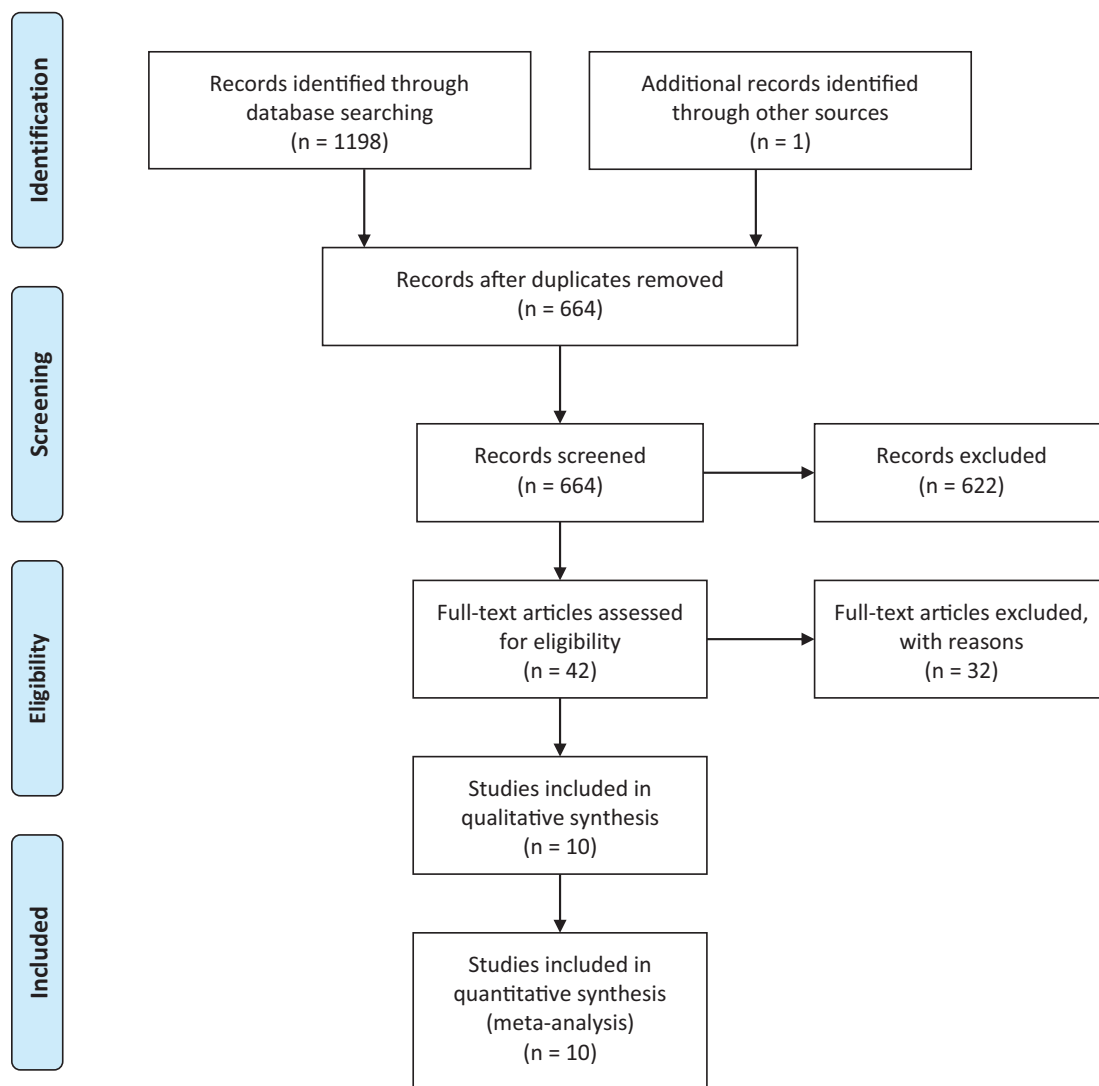


Fig. 1 Flow diagram of included studies.

Meta-analysis Results

Incidence of Anterior Knee Pain (AKP)

Six studies compared the incidence of AKP between PD and non-PD patients. A total of 99 patients out of 416 patients (23.8%) in the PD group and 139 out of 412 patients (33.7%) in the non-PD group had AKP. As shown in Fig. 4, PD was associated with significantly lower rate of AKP (RR = 0.70; 95% CI, 0.50 to 0.97; $P = 0.03$), without significant heterogeneity ($I^2 = 47\%$). In subgroup analysis, PD was associated with significantly lower rate of AKP at 12-month follow-up (RR = 0.70; 95% CI, 0.50 to 0.98; $P = 0.03$). No significant difference was observed in AKP incidence between the PD group and non-PD group

after 12-month follow-up (RR = 0.68; 95% CI, 0.46 to 1.00; $P = 0.05$) (Table 3).

Visual Analogue Scale (VAS) for Anterior Knee Pain (AKP)

Four studies involving 466 patients reported the VAS for AKP. PD was associated with a reduction in VAS (mean difference, -0.37 ; 95% CI, -0.69 to -0.05 ; $P = 0.02$; Fig. 5). No significant heterogeneity was observed across studies ($I^2 = 43\%$). In the subgroup analysis, PD was associated with lower VAS at 3-month follow-up (mean difference, -0.52 ; 95% CI, -0.89 to -0.14 ; $P = 0.007$;) and 12-month follow-up (mean difference, -0.51 ; 95% CI, -0.84 to -0.19 ; $P = 0.002$).

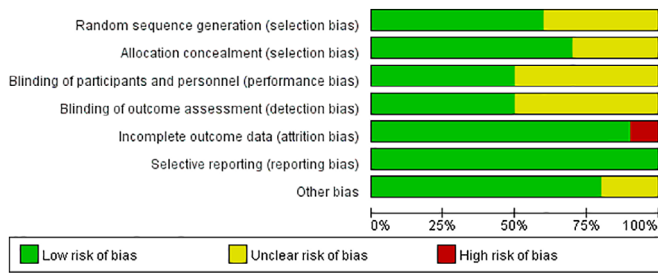


Fig. 2 Summary of the risk of bias across the included studies.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Alomran 2015	?	?	?	?	+	+	+
Altay 2012	?	+	+	+	+	+	+
Baliga 2012	+	+	+	+	+	+	+
Kwon 2015	+	+	?	+	-	+	+
Motiffard 2019	+	+	?	+	+	+	+
Pulavarti 2014	+	+	+	+	+	+	+
Saoud 2004	?	?	?	?	+	+	?
van Jonbergen 2011	+	+	+	?	+	+	+
van Jonbergen 2014	+	+	+	?	+	+	+
Yim 2012	?	?	?	?	+	+	?

Fig. 3 Risk of bias in each study. “+” indicates a low risk of bias; “-” indicates a high risk of bias; “?” indicates unclear risk of bias.

After 12-month follow-up, no significant difference was observed in VAS between the PD group and non-PD group (mean difference, -0.31; 95% CI, -0.82 to 0.19; $P = 0.22$) (Table 3).

Range of Motion (ROM)

Three studies investigated ROM of the involved knee. PD was associated with significantly higher ROM after 12-month follow-up (Mean difference, 7.68; 95% CI, 0.33 to 15.04; $P = 0.04$; Fig. 6; Table 3).

Patellar Score (PS)

Four studies involving 381 patients compared the PS between two groups. There was no significant association between PD and increased PS (mean difference, 0.61; 95% CI, -0.28 to 1.49; $P = 0.18$; Fig. 7). Subgroup analysis showed the results remained unchanged in the subgroups of 3-month, 12-month and over 12-month follow-up (Table 3).

American Knee Society Knee Score (KSS Knee)

Five studies involving 589 patients evaluated the KSS knee, and found no significant difference between two groups (mean difference, 1.40; 95% CI, -0.18 to 2.98; $P = 0.08$; Fig. 8). The results remained unchanged with different follow-up times. (Table 3).

American Knee Society Function Score (KSS Function)

Four studies involving 489 patients evaluated the KSS function, and found no significant difference between the two groups (mean difference, 1.88; 95% CI, -1.19 to 4.94; $P = 0.23$; Fig. 9). In the subgroup analysis, KSS function had an increased mean difference of 4.67 in favor of PD at 3-month follow-up (95% CI, 2.07 to 7.26; $P < 0.001$) and increased mean difference of 3.66 in favor of PD after 12-month follow-up (95% CI, 0.29 to 7.04; $P = 0.03$). There was no difference at follow-up time of 12 months (Table 3).

Oxford Knee Score (OKS)

There was no significant difference in OKS between the two groups (mean difference, -0.22; 95% CI, -2.55 to 2.10; $P = 0.85$; Fig. 10). No significant difference was observed in the subgroup analysis (Table 3).

Postoperative Complication and Reoperation

Nine studies with 1157 patients reported postoperative complication and reoperation. Five studies found no complication occurred in either group and seven studies found no reoperation occurred in either group. There was no significant difference in complication rate (RR = 0.97; 95% CI, 0.44 to 2.14; $P = 0.95$; Fig. 11) and in reoperation rate (RR = 0.53; 95% CI, 0.23 to 1.22; $P = 0.14$; Fig. 12) between the PD group and non-PD group. No complication related to the patella, such as patellar osteonecrosis, fracture, or dislocation, was reported in the included study.

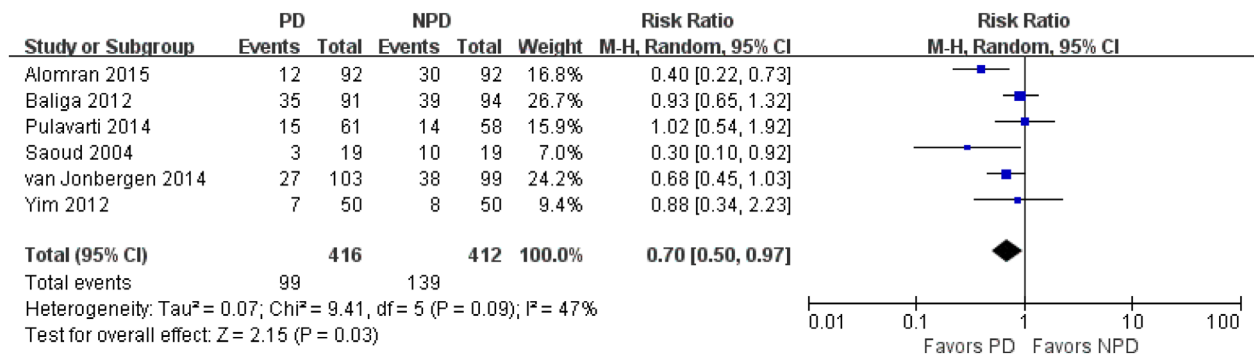


Fig. 4 Forest plot of incidence of anterior knee pain (AKP).

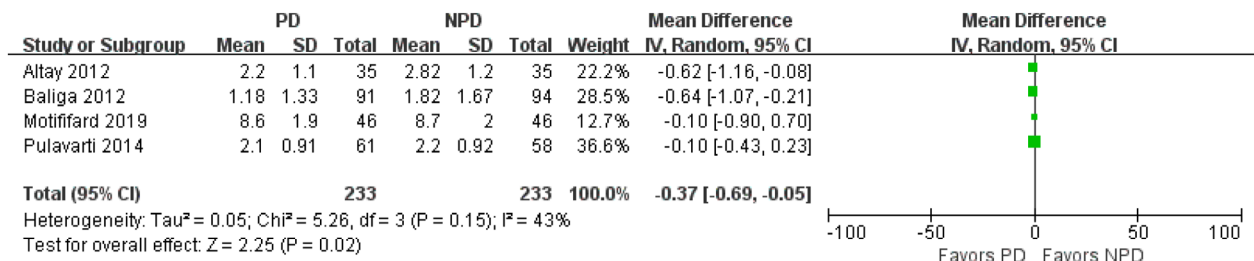


Fig. 5 Forest plot of visual analogue scale (VAS) for anterior knee pain.

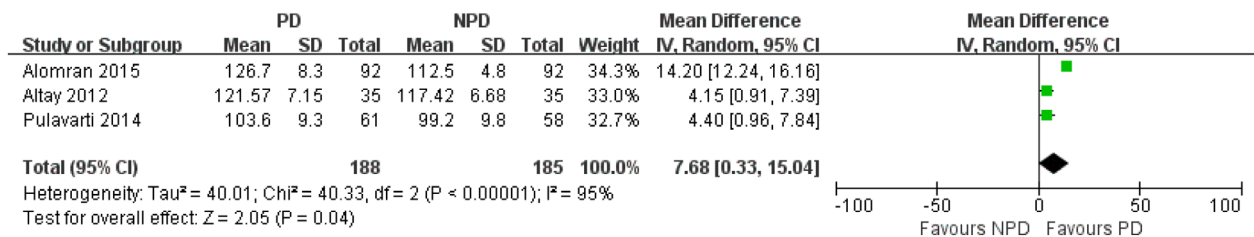


Fig. 6 Forest plot of knee range of motion (ROM).

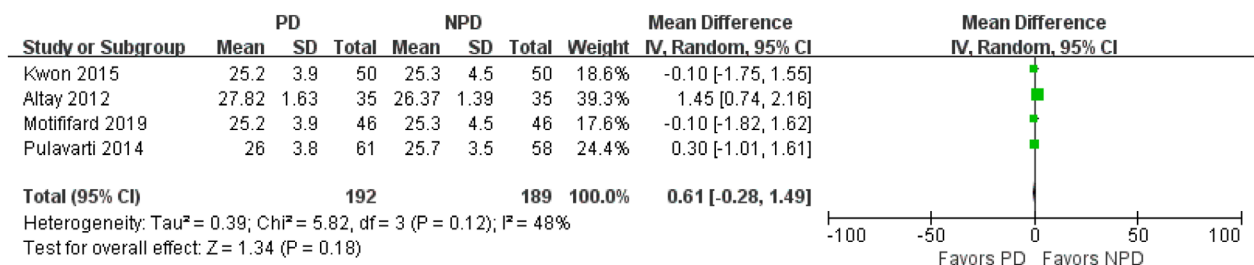


Fig. 7 Forest plot of Patellar score (PS).

Subgroup Analysis of Depths of Electrocautery

In subgroup analysis of different depths of electrocautery, we found no significant difference in the incidence of AKP between PD and non-PD patients (within 1 mm subgroup:

RR = 0.54; 95% CI, 0.26 to 1.12; P = 0.10; within 2–10 mm subgroup: RR = 0.69; 95% CI, 0.38 to 1.24; P = 0.22; Fig. 13). In within 1 mm subgroup, PD was associated with a reduction in VAS (mean difference, -0.62; 95% CI, -1.16 to

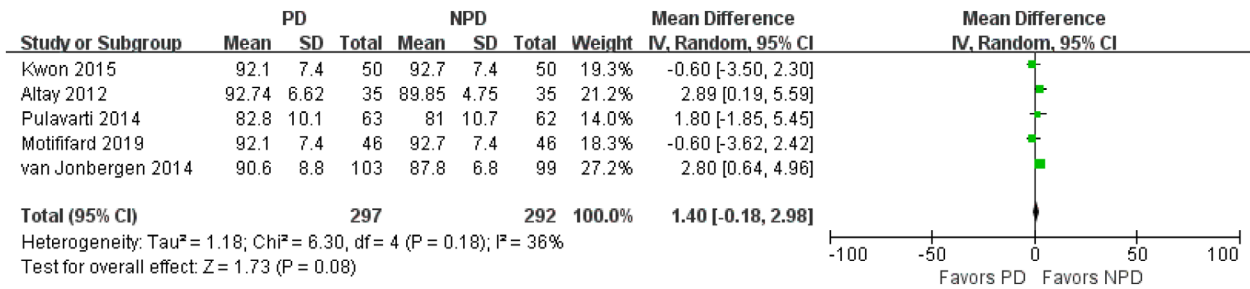


Fig. 8 Forest plot of American Knee Society knee score (KSS knee).

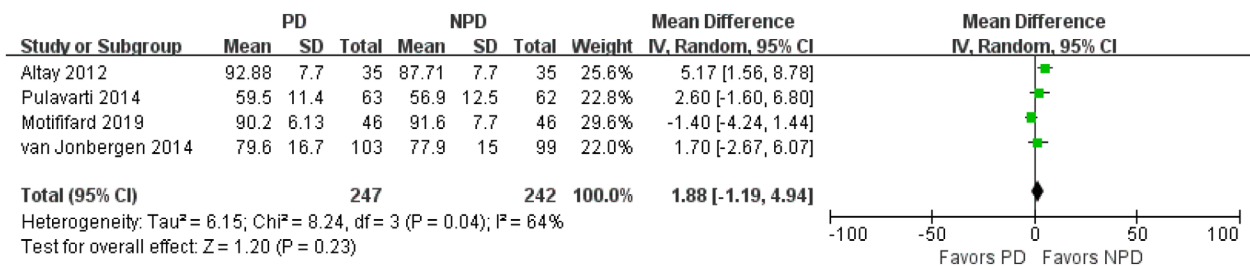


Fig. 9 Forest plot of American Knee Society function score (KSS function).

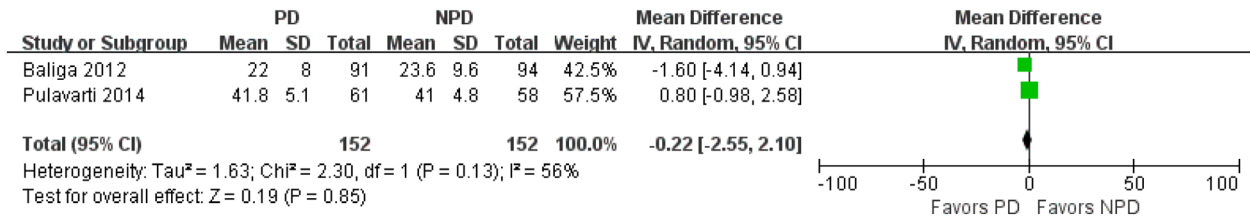


Fig. 10 Forest plot of Oxford knee score (OKS).

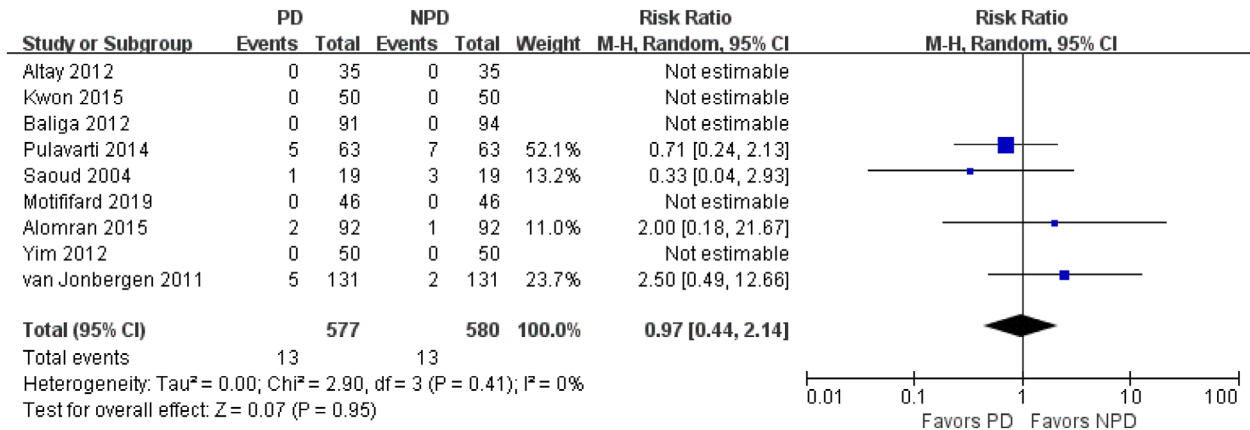


Fig. 11 Forest plot of postoperative complication.

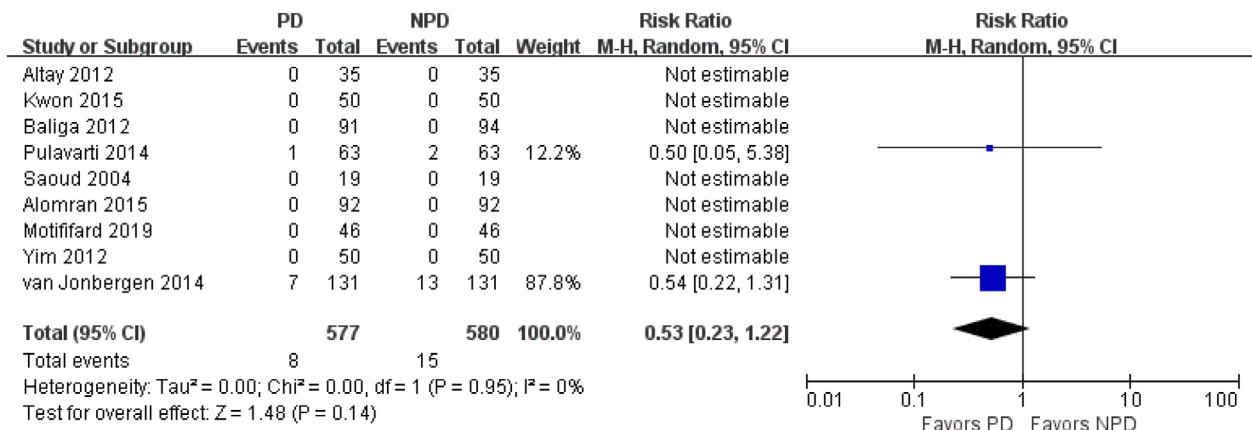


Fig. 12 Forest plot of postoperative reoperation.

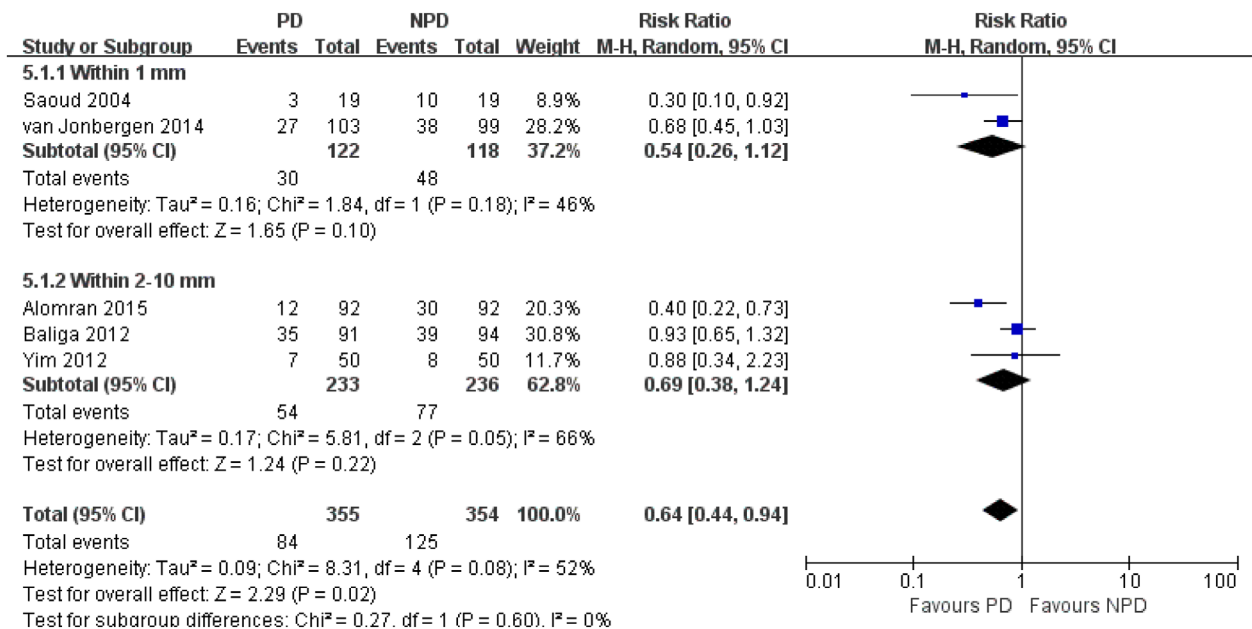


Fig. 13 Forest plot of incidence of AKP in subgroup analysis of different depths of electrocautery.

-0.08; $P = 0.02$; Fig. 14). In within 2-10 mm subgroup, no significant difference was observed in VAS between the PD and non-PD group (mean difference, -0.48; 95% CI, -0.96 to 0.01; $P = 0.05$; Fig. 14). There was no significant association between PD and increased PS in both subgroups (within 1 mm subgroup: mean difference, -0.10; 95% CI, -1.75 to 1.55; $P = 0.91$; within 2-10 mm subgroup: mean difference, 0.88; 95% CI, -0.58 to 2.35; $P = 0.24$; Fig. 15). There was no significant association between PD and increased KSS in both subgroups (within 1 mm subgroup: mean difference, 1.24; 95% CI, -2.08 to 4.56; $P = 0.46$; within 2-10 mm subgroup: mean difference, 1.21; 95% CI, -2.20 to 4.63; $P = 0.49$; Fig. 16). PD was not associated with increased KSS function in both subgroups (within

1 mm subgroup: mean difference, 1.70; 95% CI, -2.67 to 6.07; $P = 0.45$; within 2-10 mm subgroup: mean difference, 1.79; 95% CI, -4.65 to 8.22; $P = 0.59$; Fig. 17).

Publication Bias

The funnel plots for the nine outcomes are shown in Figure 18. No significant funnel plot asymmetry was detected, suggesting no evidence of publication bias.

Discussion

The most important finding of this study was that PD can significantly relieve AKP within 12 months after TKA. Incidence and severity of AKP were both lower in the PD group than in the non-PD group at 3- and 12-month follow-up,

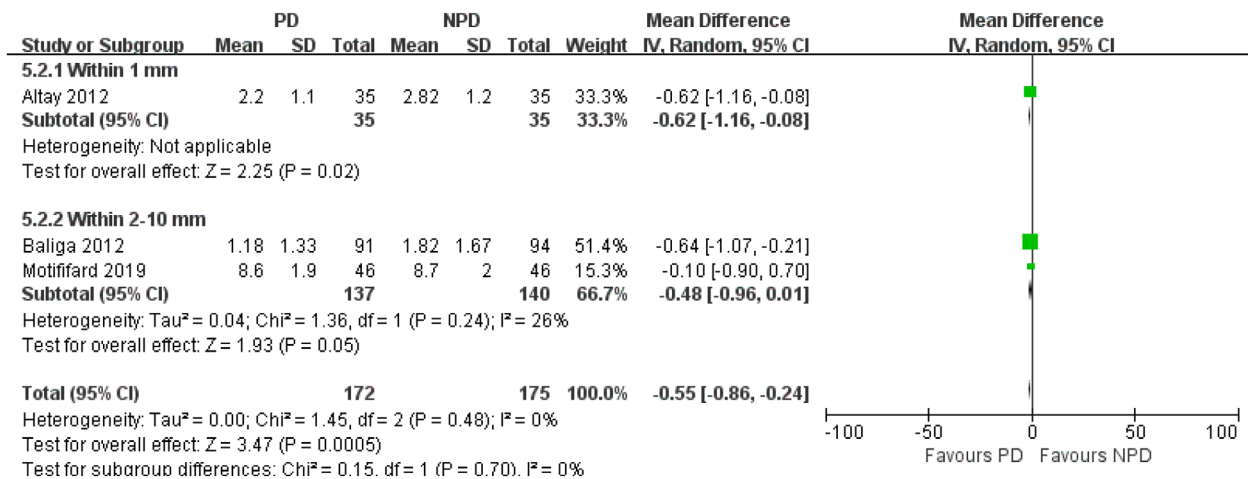


Fig. 14 Forest plot of VAS for AKP in subgroup analysis of different depths of electrocautery.

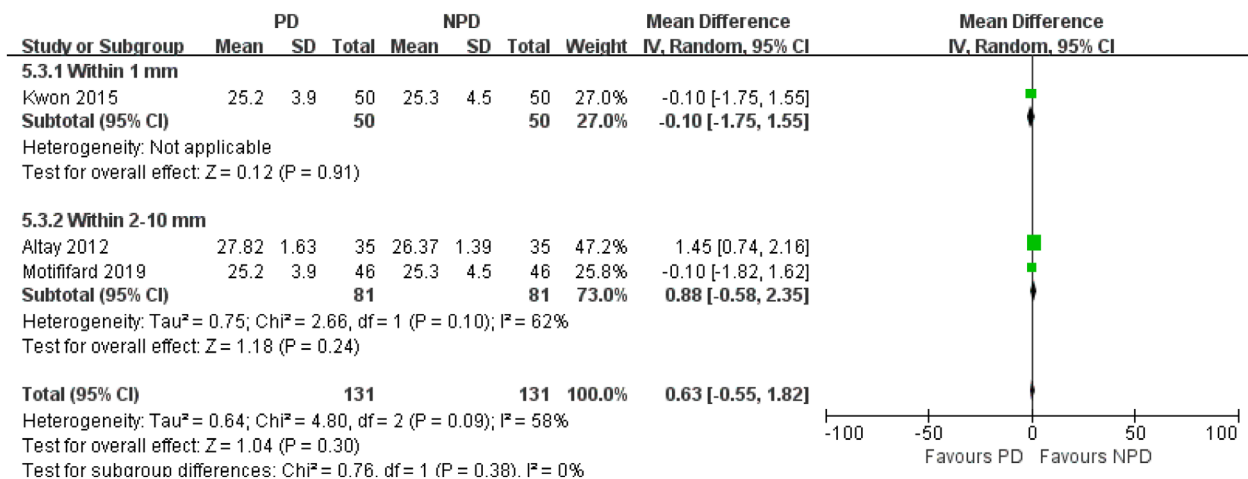


Fig. 15 Forest plot of PS in subgroup analysis of different depths of electrocautery.

but the difference was not significant after 12-month follow-up. The PD group showed significantly higher ROM than the non-PD group after 12-month follow-up. There was no strong evidence to support the idea that PD had a positive effect on functional scores after TKA. No specific complication directly or indirectly related to PD was found, and the overall complication rate and reoperation rate were comparable between PD and non-PD group. As a result, the use of PD is recommended in primary TKA without patellar resurfacing to reduce incidence and severity of AKP at the early stage of postoperative period. We believe that the present study, which includes the largest number of RCTs available in the literature, represents the most comprehensive evaluation comparing PD and non-PD, provides an updated synthesis research of the latest findings, and guides clinical practice in the management of the patella during a TKA procedure reliably.

Total joint arthroplasty is considered to be the successful treatment of choice for end-stage joint osteoarthritis, which can

provide excellent pain relief²⁶. The presence of AKP has been a common and persistent complaint after TKA, and can result in dissatisfaction and low quality of life of patients^{1,2}. A number of factors were believed to potentially contribute to the occurrence of AKP, including patellofemoral degeneration²⁷, patellofemoral joint instability²⁸, abnormal patellofemoral joint loading²⁹⁻³¹, and prosthetic design³². There is no consensus on the optimal management of the patella during a TKA procedure, and which treatment can be effective to prevent the development of AKP remains unknown. The use of patellar resurfacing and its effect on AKP are still controversial. The most recent meta-analysis involving 20 RCTs failed to show the association between patellar resurfacing and superior clinical outcomes, such as lower incidence of AKP and higher knee function scores³. Thus, patellar retention may be routinely recommended to reduce surgical time, decrease hospital cost and avoid severe complications related to patellar resurfacing^{33,34}. However, AKP still occurred in 22.6% of the patients without

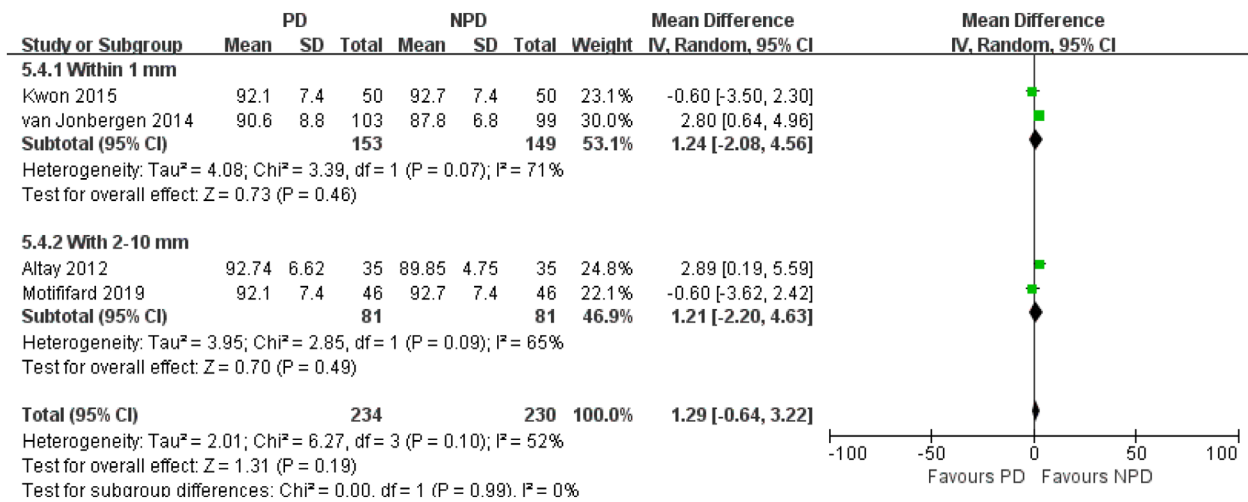


Fig. 16 Forest plot of KSS knee in subgroup analysis of different depths of electrocautery.

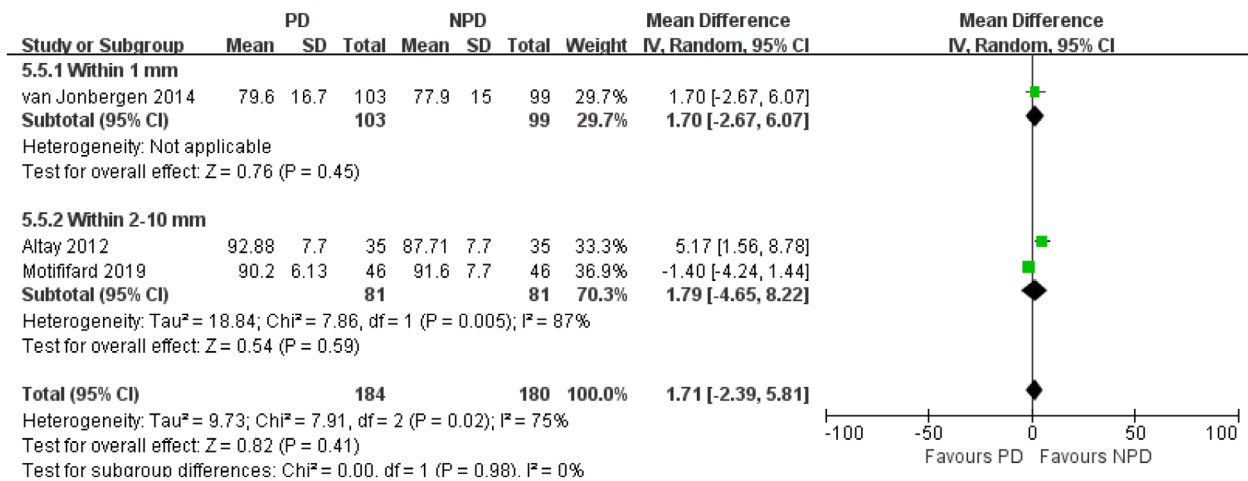


Fig. 17 Forest plot of KSS function in subgroup analysis of different depths of electrocautery.

patellar resurfacing³. Since substance P nociceptive afferent fibers were found to be rich in the peripatellar soft tissues, PD has been recommended by some surgeons to reduce the likelihood and severity of AKP through desensitization or denervation of pain receptors in anterior knee region.

Several previous meta-analyses comparing PD and non-PD in TKA without patellar resurfacing showed discordant results; one of them concluded PD had no clear advantage over non-PD³⁵ while others found PD can provide superior postoperative clinical results^{16,36,37}. One meta-analysis performed by Xie *et al*¹⁷, investigated the association between PD effects and follow-up period, and found that PD can significantly relieve AKP and improve knee function of TKA for up to 12 months of follow-up but not for over 12 months of follow-up. Including an additional three RCTs, this study confirms that PD is effective for relieving AKP within 12 months of follow-up but the effect cannot be maintained more than

12 months after surgery. Besides, the result of this study indicates PD patients have no superior knee function to non-PD patients at any follow-up time point, which is different from the result of the previous meta-analysis¹⁷.

The findings of this study are in accordance with the results of several published RCTs with good design and adequate follow-up time^{13-15,25}. The disappeared effect of PD at longer follow-up times may be explained by the large amount of potential contributors of AKP, as discussed above. Besides, it is noteworthy that the occurrence of AKP itself is a dynamic process. A gradual decline in the incidence of AKP over time was observed in several studies³⁸⁻⁴⁰, which may explain the weakened preventive effect of PD on AKP after longer follow-up time. Better pain relief at early postoperative stage may enhance the rapid recovery and functional rehabilitation after TKA, contributing to the better ROM in the PD group. In the subgroup analysis of different depths of electrocautery, there

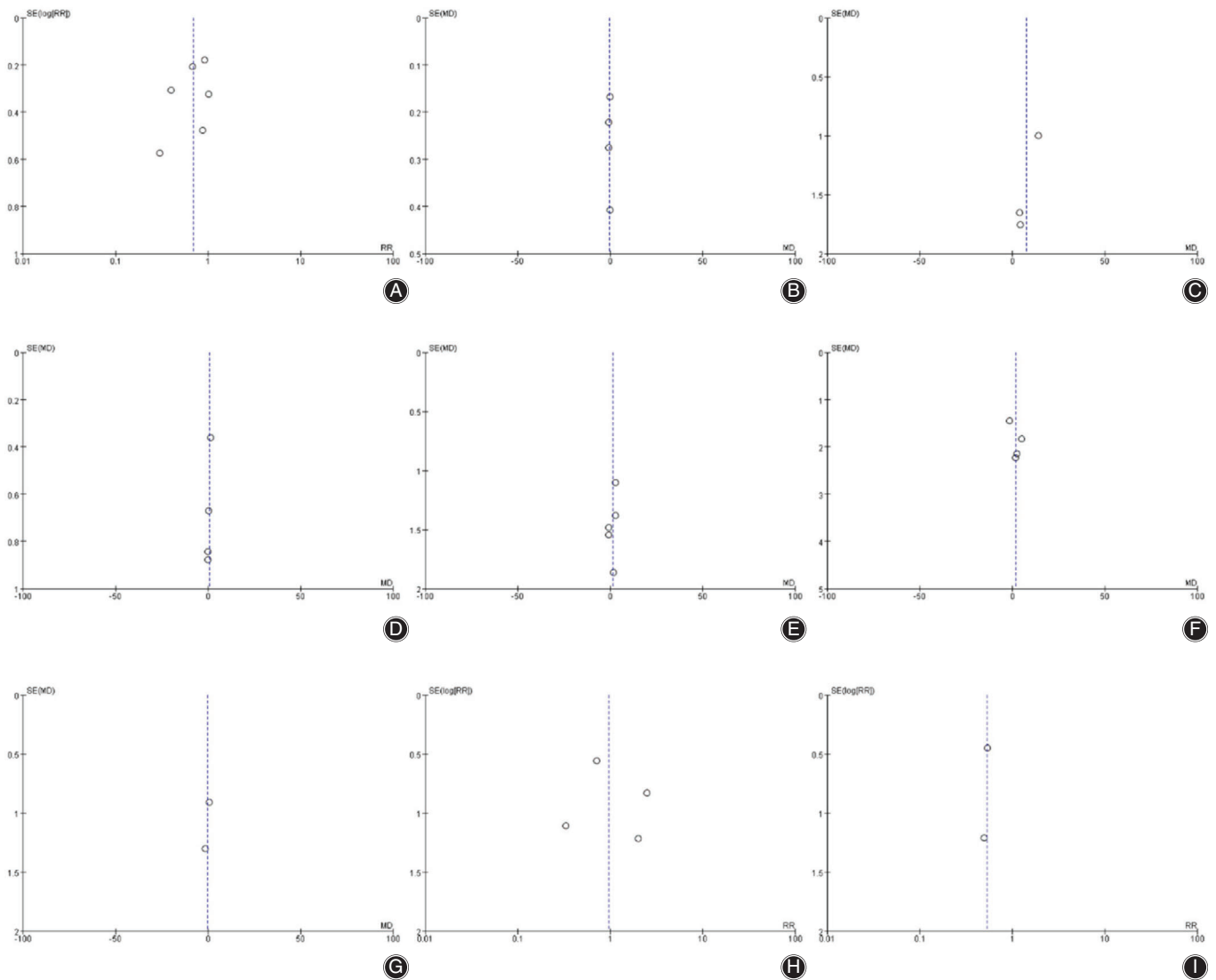


Fig. 18 Funnel plots for detecting publication bias. A: Anterior knee pain (AKP). B: Visual analogue scale (VAS). C: Range of motion (ROM). D: Patellar score (PS). E: American Knee Society knee score (KSS knee). F: American Knee Society function score (KSS function). G: Oxford knee score (OKS). H: Postoperative complication. I: Postoperative reoperation.

is almost no difference in AKP and knee function between the PD and non-PD group. The reason for this finding is still unclear. Limited number of studies and participants included in each subgroup may explain the insignificant difference.

Concerns about PD-related complications still remain. Compromised patellar blood supply caused by circumpatellar electrocautery and concomitant soft tissue injury were theoretically associated with patellar osteonecrosis and fracture^{41,42}. However, no specific complication directly or indirectly related to PD, such as patellar osteonecrosis, patellar fracture, patellar clunk, patellar dislocation, or extensor mechanism disruption, has been reported in the included study. No significant difference was observed in the overall complication rates and reoperation rates between the PD

and non-PD group. The majority of the reported complications were superficial wound complications, limited ROM needing manipulation under anesthesia and deep vein thrombosis, which were almost all successfully managed non-operatively. Van Jonbergen *et al.* reported three cases of secondary patellar resurfacing in the PD group and seven cases in the non-PD group at a mean follow-up of 44 months¹⁵. The indication for secondary patellar resurfacing in the study was severe disabled AKP after 12-month follow-up. Besides, some surgeons hypothesized that the proprioception disturbance of the patella caused by PD might induce abnormal patellofemoral joint loading⁴², which was believed to be a risk factor for the occurrence of AKP³¹. However, the result of our study did not support the

hypothesis but instead the PD can decrease the incidence and severity of AKP within 1 year after TKA.

This study has several limitations. First, significant heterogeneity was found in the outcomes of PS, KSS function, and OKS, which may be explained by the difference in the way the outcome was measured. In addition, some potential risk factors of AKP, such as race of patients, ratio of female to male, and age group, were inconsistent among included studies, which may lead to significant heterogeneity. Second, not all studies provided follow-up data for each outcome. Thus, the number of studies and sample size were limited for several outcomes, which made it difficult to perform further subgroup analysis and sensitivity analysis. Third, there is notably unclear risk of bias in several included studies due to poorly described methodology. Considering the limitations in this meta-analysis, additional high-quality

RCTs with adequate follow-up time are required to strengthen the evidence.

Conclusion

In conclusion, PD can decrease the incidence and severity of AKP within 12 months after TKA, but the effect cannot be maintained after 12-month follow-up. Better pain relief at early postoperative stage may improve ROM in the PD group after 12-month follow-up. Without significant associated complication and reoperation, the use of PD is recommended in TKA without patellar resurfacing. Additional high-quality RCTs are required to strengthen the evidence.

Disclosure Statement

All authors declared no conflict of interest.

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