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Patellar denervation with electrocautery in total knee arthroplasty without patellar resurfacing: a meta-analysis

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Abstract

Purpose The impact of patellar denervation with electrocautery in total knee arthroplasty (TKA) on post-operative outcomes has been under debate. This study aims to conduct a meta-analysis and systematic review to compare the benefits and risks of circumpatellar electrocautery with those of non-electrocautery in primary TKAs.

Methods Comparative and randomized clinical studies were identified by conducting an electronic search of articles dated up to September 2012 in PubMed, EMBASE, Scopus, and the Cochrane databases. Six studies that focus on a total of 849 knees were analysed. A random-effects model was conducted using the inverse-variance method for continuous variables and the Mantel–Haenszel method for dichotomous variables.

Results There was no significant difference in the incidence of anterior knee pain between the electrocautery and non-electrocautery groups. In term of patellar score and Knee Society Score, circumpatellar electrocautery improved clinical outcomes compared with non-electrocautery in TKAs. The statistical differences were in favour of the electrocautery group but have minimal clinical significance. In addition, the overall complications indicate no statistical significance between the two groups.

Conclusions This study shows no strong evidence either for or against electrocautery compared with non-electrocautery in TKAs.

Level of evidence Therapeutic study (systematic review and meta-analysis), Level III.

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Keywords Total knee arthroplasty · Patellar · Electrocautery · Denervation · Meta-analysis · Systematic review

Introduction

Total knee arthroplasty (TKA) is considered the successful treatment of choice for end-stage and symptomatic knee arthrosis; however, anterior knee pain has been a persistent complaint following primary TKA, with a reported range of 4 and 49 % [11, 17, 36]. Moreover, anterior knee pain has been noted responsible for patient dissatisfaction, reoperation, and morbidity after TKAs [13, 17, 33, 40, 48]. Several studies have investigated patellofemoral degenerative changes [6, 38], patellar maltracking [29], patellofemoral overstuffing [35], prosthesis design [11, 51], and preoperative gait patterns [42] as potential contributors to anterior knee pain following TKA; however, the exact cause has yet to be elucidated.

A number of arthroplasty surgeons described electrocautery around the patellar rim in TKA with and without patellar resurfacing [26, 28, 31, 43, 45, 46]. Circumpatellar electrocautery can alleviate pain in the patellofemoral area after TKA through desensitization or denervation of pain receptors in the anterior knee. However, several clinical studies compared circumpatellar electrocautery with non-electrocautery and found varying results. Three randomized controlled trials (RCTs) investigated the efficacy of electrocautery in TKA. The results indicated that circumpatellar electrocautery can reduce anterior knee pain and improve knee scores in TKA [1, 39, 49]. On the contrary, Gupta et al. [19] performed a retrospective cohort study of 192 patients who had undergone primary TKAs and found that electrocautery did not improve the outcome scores following

TKAs. Two RCTs also demonstrated no statistically significant differences between the electrocautery and non-electrocautery group for all clinical and radiographic outcomes [5, 54]. Thus, circumpatellar electrocautery has no clear advantage over non-electrocautery in TKA.

To the best of our knowledge, no meta-analysis or systematic review that compares circumpatellar electrocautery with non-electrocautery following TKA has been published. The impact of patellar denervation with electrocautery in primary TKA on post-operative outcomes has been under debate. Therefore, a meta-analysis and systematic review of comparative and randomized clinical studies were performed to establish the best evidence to address this controversy. This systematic review and meta-analysis aims to investigate evidence of the efficacy of circumpatellar electrocautery in reducing anterior knee pain and improving knee scores following TKA as well as evidence for any increase in complication rates.

Materials and methods

Search strategy

Relevant studies up to September 2012 were identified in a computer search of PubMed, EMBASE, Scopus, and the Cochrane Central Registry of Controlled Trials. The manual search focused on relevant information in *Journal of Bone and Joint Surgery* (*American and British volumes*), *Clinical Orthopaedics and Related Research, The Journal of Arthroplasty*, *The Knee,* and *Knee Surgery Sports Traumatology Arthroscopy* as well as reference lists of all selected articles and relevant narrative reviews for any additional studies. The following keywords were used to conduct the search: total knee replacement, TKA, TKR, patellar denervation, and electrocautery.

Eligibility criteria

The inclusion criteria required a study to be an RCT or a controlled clinical trial (CCT) study that compares TKAs with and without electrocautery. A minimum of six-month follow-up was required. In addition, studies had to include at least 10 patients per treatment group. The study should report at least one desirable outcome, and no language restrictions were applied. Studies were excluded if they reported on patient populations with any of the following characteristics: (1) patients who had received revision surgery; (2) patients with patellar resurfacing; (3) previous knee surgery; (4) history of patellar facture and dislocation; (5) inflammatory arthritis; (6) varus/valgus deformities greater than 15 degrees; (7) infection; and (8) tumours. A study was also excluded if analysis of adult patients older than 18 years of age was not possible or if it was clearly not a comparative study. Animal studies, cadaver studies, single case reports, comments, letters, editorials, protocols, guidelines, publications based on surgical registries, and review papers were excluded due to their methodological quality.

Data collection and analysis

Titles and abstracts of the identified studies were reviewed by two independent reviewers, and possible studies were retrieved in full-text version. Complete report of these studies was assessed for inclusion. Disagreement between reviewers was resolved through a discussion or, if a consensus could not be reached, by consultation with the senior author. The data retrieved included the following items: patients' demographics, study characteristics, operative data, follow-up rate and duration, and outcome data. The primary outcome measures comprised incidence of anterior knee pain, patellar score, American Knee Society Score (AKSS), Oxford Knee Score (OKS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Secondary outcome measures include post-operative complications and radiographic parameters. Authors of the eligible trials were contacted by e-mail to obtain any missing information when necessary. The authors of 6 studies were contacted for missing data, 3 of whom provided additional information.

Two of the authors independently assessed the methodological quality of each included study with respect to the randomization method, patients/assessors blinding, equality of baseline characteristics, adequate description of inclusion/exclusion criteria, similarity of post-operative programme, sample size calculation, and proportion of patients lost during follow-up. The three options for the quality assessment results are as follows: "Yes" indicates a low risk of bias, "Unclear" indicates a moderate risk of bias, and "No" indicates a high risk of bias.

Statistical analysis

The risk ratio (RR) and 95 % confidence interval (CI) were calculated for dichotomous data. Continuous variables were pooled across studies, where appropriate, using the weighted mean difference (WMD) method. A random-effects model was conducted using the inverse-variance method for continuous variables and the Mantel–Haenszel method for dichotomous variables. Heterogeneity tests are often underpowered; thus, random-effects model is more conservative in both within- and between-study variability. As a result, a random-effects model was used to analyse the pooled data. Statistical heterogeneity was evaluated using a standard χ^2 test at a significance level of $P < 0.1$ and using the I^2-statistic which describes the proportion of variability due to heterogeneity [21]. Meta-analysis was performed using Comprehensive Meta-analysis version 2.0 (Biostat, Englewood, New Jersey) for measuring the outcomes; a P value of <0.05 was considered statistically significant.

Results

The electronic search methodology identified 48 potentially relevant publications. After screening the title and reading the abstract and the entire article, six published studies, with a total of 849 knees, met the inclusion criteria and were eligible for the current study, including five RCTs [1, 5, 39, 49, 54] and one comparative retrospective study [19] (Fig. 1). The characteristics of these five studies are presented in Table 1. Five of these studies provided preoperative data regarding the number of patients/knees, age, and sex, which matched the available demographical data at baseline. The electrocautery group consisted of 425 patients with an age range of 43–91 years, whereas the non-electrocautery group (control group) comprised 424 patients with an age range of 45–90 years. Four studies reported on preoperative data regarding patellar articular cartilage lesions [49], range of motion [1, 54], knee pain [1, 5, 49], Feller's patellar score [1, 54], AKSS [1, 49, 54], OKS [5], WOMAC [49, 54], and radiographic assessment [1, 54]. Two studies investigated patients undergoing bilateral TKA [1, 54], with electrocautery denervation of one patella and no denervation of the other. The number of surgeons varied between studies and ranged from one to nine. Majority of the surgeons performed TKAs using a medial parapatellar approach, except for one study [1] that used a midvastus approach. Three studies favoured patellar denervation [1, 39, 49], whereas three did not support patellar denervation in TKA without patellar surfacing [5,

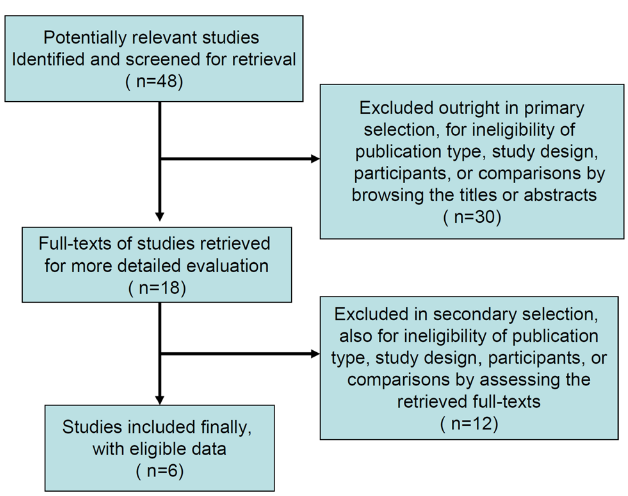

Fig. 1 Flowchart illustrating the literature search

Table 1 Characteristics of the included studies

Study (author, country)	Preoperative diagnosis	Number of knee		Gender (female: male)		Mean age (years)		Implant (Brand)	Follow-up (months)	Outcome measurements	Study conclusion
		Intervention	Control	Intervention	Control	Intervention	Control				
Atlay et al. [1] Turkey	NS	35	35	26:9	26:9	68	68	Maxim (Biomet) CR	24–60 months (mean: 36)	KSS, ROM VAS pain, complication, radiographical results	Favours PD
Baliga et al. [5] UK	OA	91	94	40:51	52:42	69.0	69.2	Low contact stress (Depuy) Kinemax (Zimmer) MB, FB	1 year	AKP, OKS, VAS pain, complication	Neutral
Gupta et al. [19] UK	NS	98	94	68:30	64:30	67.43	67.41	Low contact stress (Depuy) RF; MB	2 years (minimum)	OKS, FPS	Neutral
Saoud [39] Egypt	OA	20	20	Unclear	Unclear	Unclear	Unclear	FB	9–12 months	KSS, complication	Favours PD
van Jonbergen et al. [49] The Netherlands	OA	131	131	95:36	84:47	71	72	NexGen LPS (Zimmer) PS; FB	1 year	AKP, KSS, WOMAC, complication	Favours PD
Yim et al. [54] Korea	OA	50	50	50:0	50:0	70.2	70.2	NexGen LPS (Zimmer) PS; FB	12–48 months (mean:21)	KSS, WOMAC, FPS, ROM complication, radiographical results	Neutral

OA osteoarthritis, *AKP* anterior knee pain, *KSS* Knee Society Score, *WOMAC* Western Ontario and McMaster Universities Osteoarthritis index, *OKS* Oxford Knee Score, *FPS* Feller's patellar score, *PD* patellar denervation, *ROM* range of motion, *VAS Pain* visual analogue scale for pain, *PS* posterior-stabilized, *CR* cruciate-retaining, *RF* rotating platform; *FB* fixed-bearing, *MB* mobile-bearing

Table 2 Methodological quality of the included studies

Author	Adequate sequence generation	Allocation concealment	Binding		Baseline comparability	Inclusion/exclusion criteria	Similarity of post-operative programme	Sample size calculation	Loss to follow-up
			Patient	Assessor					
Altay et al. [1]	Unclear	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	0
Baliga et al. [5]	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	15
Gupta et al. [19]	No	Unclear	Unclear	Unclear	Yes	Unclear	Unclear	Yes	Unclear
Saoud [39]	Unclear	Unclear	Unclear	Unclear	Unclear	Yes	Yes	Unclear	1
van Jonbergen et al. [49]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	0
Yim et al. [54]	Unclear	Unclear	Unclear	Unclear	Yes	Yes	Yes	Unclear	Unclear

19, 54]. Notably, five studies provided extensive details about the extent of electrocautery [1, 5, 39, 49, 54]. Follow-up period ranged from a minimum of 9 months [39] to a maximum of 60 months [1].

Only one study [49] of the five included studies described adequate random sequence generation (computer-generated random number), and three studies [1, 5, 49] used adequate concealment of allocation (opaque-sealed envelope) and double-blind method (observer and patient blinding). Four studies stated clearly that <10 % of the patients were lost during follow-up [1, 5, 39, 49]. Three studies reported that they did not receive any commercial funding or grants in support of their research [1, 19, 49], whereas one study received financial grants from commercial supports [5]. The methodological quality of the included trials is shown in the Table 2.

Four of the five studies provided data on the incidence of anterior knee pain [5, 39, 49, 54]. Overall, 20.0 % (70/291) of the electrocauterized knees had anterior knee pain compared with 33.3 % (98/294) in the non-electrocauterized knees (RR = 0.71, 95 % CI 0.47–1.06; *n.s.*; $I^2 = 46$ %). A visual analogue scale (VAS) was used to assess post-operative anterior knee pain in two studies [1, 5]. Altay et al. [1] found a significantly greater decrease in VAS score in the electrocautery group compared with the control group ($P = 0.026$). In contrast, Baliga et al. [5] in similar to RCT of 200 patients found no significant difference in VAS between the groups during the 12-month follow-up period. Three of the included studies adopted the Feller's patellar score [16], which provides a more specific score for anterior knee pain. The electrocautery group posted significant better scores compared with the control group (WMD = 1.14, 95 % CI 0.38–1.89; $P = 0.003$; $I^2 = 17$ %).

For the knee score outcomes, the AKSS was used in four studies [1, 39, 49, 54], the WOMAC was used in two [49, 54], and the OKS was used in two [5, 19]. Only RCTs in which the KSS had been used can be included to perform an adequate comparison of this outcome. No evidence of statistical heterogeneity was found between the included studies. The pooled WMD for the KSS (knee and function scores) was 2.51 (95 % CI 0.71–4.30; $P = 0.0006$; $I^2 = 0$ %) and 3.12 points (95 % CI 1.01–5.22; $P = 0.004$; $I^2 = 2$ %), respectively, suggesting post-operative statistical significance in favour of the electrocautery group.

Five trials recorded post-operative complications during short-term follow-up [1, 5, 39, 49, 54]. Two knees in the electrocautery group and one in the control group exhibited signs of a deep infection at 6 weeks after surgery, as reported by van Jonbergen et al. [49]. In addition, three knees in the intervention group and one in the control group developed post-operative stiffness and required closed manipulation 4 weeks post-operatively. Two knees had a superficial wound disturbance in the control group and one in the electrocautery group, as reported by Saoud et al. [39]. One patient within the control group had a patellar lateralization [39]. The overall complications indicate no statistical significances between the two groups (RR = 1.05, 95 % CI 0.15–7.40; *n.s.*, $I^2 = 53$ %). No revisions or reoperation due to infection, loosening, osteolysis, or patellofemoral problems was reported in the included studies.

Post-operative knee alignment, which was assessed using the Knee Society Roentgenographic Evaluation and Scoring System, was not significantly different between the electrocautery and control groups (*n.s.*) [1]. In addition, no statistically significant differences on congruence angle and lateral patellofemoral angle were found between the two groups (*n.s.*) [54].

Discussions

The most important finding of the present study was that there were no statistically significant difference between the two groups for the incidence of anterior knee pain, the overall complication rate, and radiographic outcomes. The use of a circumpatellar electrocautery improved clinical outcomes in terms of patellar score and AKSS in contrast to non-electrocautery in primary TKA without patellar resurfacing. However, the magnitude of these differences was well below the thresholds established for clinical relevance.

The impact of patellar resurfacing in TKA on post-operative anterior knee pain still remains a controversial issue [17, 25, 40]. Two recent meta-analyses failed to demonstrate the superiority of patellar resurfacing over non-resurfacing group, even in the aspect of anterior knee pain [20, 34]. Patellar retention should be considered as one of basic treatment strategies in TKA due to lack of definite evidence for the use of patellar resurfacing. Patellar retention can conserve patellar bone stock [14, 15], achieve more physiological patellofemoral kinematics [8, 24], and avoid complications associated with resurfacing [40]. However, a high rate of anterior knee pain was reported in 166 out of 634 knees (26.18 %) in the non-resurfacing group [20]. A reduction in anterior knee pain would result in greater patient satisfaction and improved knee function in TKA patients [4, 10, 54], especially those with high-activity level. Some surgeons recommend circumferential thermocoagulation of the patellar rim with electrocautery [26, 39, 49]. This procedure was first proposed by Keblish at the 41st annual meeting of the American Academy of Orthopaedic Surgeons in 1991 [26, 40]. A postal questionnaire study found that 56 % of Dutch orthopaedic surgeons use circumpatellar electrocautery to prevent anterior knee pain when not resurfacing the patella and 32 % use electrocautery when resurfacing the patella [47]. Electrocautery can reduce the likelihood of post-operative anterior knee pain when retaining the native patella by creating a level of sensory deprivation. Hyperinnervation of peripatellar soft tissue and infrapatellar fat pad is associated with anterior knee pain [9, 30]. Furthermore, anatomical study found that superomedial and superolateral nerves are important for patellar innervation [32]. Immunohistochemical studies showed rich distribution of substance-P afferent nerve fibres in the peripatellar soft tissue around the knee joint [22, 52]. Therefore, denervation using electrocautery around the patellar rim can theoretically relieve anterior knee pain [32, 50]. This potential benefit was not confirmed in the present study and other high-quality RCTs [5, 44]. In contrast, three RCTs found circumpatellar electrocautery reduces the risk of anterior knee pain and improves clinical outcomes following TKA [1, 39, 49].The conflicting results from RCTs of similar design could be attributed to the fact that the cause of anterior knee pain following TKR is multifactorial. Except for denervation of the patella, other factors may be associated with anterior knee pain, including patient characteristics [53], prosthesis design [36, 51], component alignment [7], and patellofemoral degenerative changes [38].

In agreement with the clinician-assessed knee score (such as AKSS) from the current work, van Jonbergen et al. [49] found that the electrocautery group had a better mean total WOMAC score at a follow-up of 1 year compared with the control group. On the contrary, three studies [5, 19, 54] found that WOMAC score and OKS are comparable in the two groups, respectively. Use of difference scoring systems has resulted in variations in the objective assessment of pain and contributes to the observed heterogeneity. AKSS is a clinician-assessed score and has been used extensively in the literature to record patient outcome following TKA since its introduction [27]. Recently, the use of patient-reported outcome measures, such as WOMAC and OKS, which accurately reflect pain severity and patient satisfaction, has been increasingly emphasised [3, 18, 23, 27].

Whether electrocautery around the patella rim causes harm is of great concern to some clinicians. The possibility of disturbance to proprioception of the patella may induce abnormal load bearing and aggravate knee pain [19]. Rand and Gaffey [37] argue that electrocautery has potentially harmful effects on the articular cartilage and that it must be handled carefully when utilised in an intra-articular location to avoid cartilage damage. In the included studies, complications related to patellar osteonecrosis, fracture, dislocation, subluxation, and extensor mechanism were not reported in the electrocautery group [1, 39, 49, 54]. Post-operative complications were developed in 54 of the 472 knees in our study. However, no significant difference in the overall complication rate was found between the electrocautery and non-electrocautery groups. Almost all cases were resolved using conservative management alone. No adjuvant or revision surgery due to pain or patellofemoral problems was necessary [1, 39, 49, 54]. Moreover, the denervation procedure did not affect operative time and blood loss [1]. Based on the current available evidence, we argue that electrocautery is not time-consuming and is safe when performed during standard TKA without patellar resurfacing.

The present study has several limitations. First, both non-randomized and randomized studies were included to provide a comprehensive review of the existing comparative literature. Nevertheless, the results of this meta-analysis based only on 6 eligible studies should probably be taken into account with some caution. Any bias inherent in the studies may exaggerate the estimated intervention effects. Second, part of the studies that fulfilled the inclusion criteria had small sample sizes, which restricted the final sample size in the present study. However, the large number of patients studied is an advantage of meta-analysis and systematic review. It possibly dissipates some of the limitations previously indicated and ensures statistical evidence for what may be clinically important results. Third, the occurrence of anterior knee pain is a dynamic process, thus determining whether the clinical effect of the electrocautery technique diminishes with time is difficult due to lack of long-term follow-up studies. Some investigators reported a gradual decrease in anterior knee pain following TKA [2, 53], whereas others found that pain increases over time [12]. A long-term follow-up study found that progressive degenerative changes of the non-resurfaced patella were the most common abnormal radiographic changes [41].

Despite these limitations, no evidence of heterogeneity was observed in the primary outcome measures, such as patellar scores selected for analysis. In addition, an exhaustive search of literature was conducted to include a sufficient number of studies for systematic review and data analysis using electronic and manual search methods. Finally, the current systematic review followed international guidelines for reporting according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

The outcomes of this study indicate that either circumpatellar electrocautery or non-electrocautery can achieve satisfactory results, and there is almost no difference between the incidence of anterior knee pain. Therefore, we believe electrocautery of the patella rim is not effective for relieving anterior knee pain following TKA. However, future randomized clinical trials with sound methodological quality should be conducted to confirm these results. In addition, further follow-up is necessary to determine whether any differences on the risk of adverse events exist.

Conclusions

In summary, this systematic review and meta-analysis show no strong evidence either for or against electrocautery compared with non-electrocautery in TKAs. The minimal advantages of circumpatellar electrocautery in terms of knee scores are unlikely to be clinically relevant.

Conflict of interest The authors have no conflict of interest.

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