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A randomised, controlled trial of circumpatellar electrocautery in total knee replacement without patellar resurfacing

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The efficacy of circumpatellar electrocautery in reducing the incidence of post-operative anterior knee pain is unknown. We conducted a single-centre, outcome-assessor and patient-blinded, parallel-group, randomised, controlled trial to compare circumpatellar electrocautery with no electrocautery in total knee replacement in the absence of patellar resurfacing. Patients requiring knee replacement for primary osteoarthritis were randomly assigned circumpatellar electrocautery (intervention group) or no electrocautery (control group). The primary outcome measure was the incidence of anterior knee pain. A secondary measure was the standardised clinical and patient-reported outcomes determined by the American Knee Society scores and the Western Ontario and McMaster Universities (WOMAC) osteoarthritis index. A total of 131 knees received circumpatellar electrocautery and 131 had no electrocautery.

The overall incidence of anterior knee pain at follow-up at one year was 26% (20% to 31%), with 19% (12% to 26%) in the intervention group and 32% (24% to 40%) in the control group (p = 0.02). The relative risk reduction from electrocautery was 40% (9% to 61%) and the number needed to treat was 7.7 (4.3 to 41.4). The intervention group had a better mean total WOMAC score at follow-up at one year compared with the control group (16.3 (0 to 77.7) *versus* 21.6 (0 to 76.7), p = 0.04). The mean post-operative American Knee Society knee scores and function scores were similar in the intervention and control groups (knee score: 92.4 (55 to 100) *versus* 90.4 (51 to 100), respectively (p = 0.14); function score: 86.5 (15 to 100) *versus* 84.5 (30 to 100), respectively (p = 0.49)).

Our study suggests that in the absence of patellar resurfacing electrocautery around the margin of the patella improves the outcome of total knee replacement.

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Anterior knee pain is reported in 4% to 49% of patients after primary total knee replacement (TKR).[1-3] The cause is unknown, but may be related to the characteristics of the patient,[4,5] the degree of wear of the patellar cartilage,[6] the design of the prosthesis,[1,3,7] the operative technique[8-11] and the use of patellar resurfacing.[2,4,12] Both the peripatellar soft tissues and the infrapatellar fat pad have been implicated as a source of anterior knee pain.[10,13] Immunohistochemical research on the innervation of this area has shown the presence of substance-P nociceptive afferent fibres in the peripatellar soft tissues.[14] Therefore, the damage to these pain receptors using electrocautery could theoretically desensitise or denervate them and reduce post-operative anterior knee pain.[15-18]

Several studies have described the use of circumpatellar electrocautery in TKR with[19-21] and without[20,22,23] patellar resurfacing. However, only two have specifically addressed the results of circumpatellar electrocautery in primary TKR,[24,25] with neither providing evidence as to its value in clinical practice. A recent postal survey with a response rate of 92% showed that 56% of orthopaedic surgeons in The Netherlands use circumpatellar electrocautery when not resurfacing the patella, and 32% use electrocautery when resurfacing the patella.[26]

Our hypothesis was that primary TKR with circumpatellar electrocautery would lead to partial denervation and improved pain relief compared with no electrocautery. The primary objective of this blinded, prospective, parallel, randomised study was to determine the clinical effect of circumpatellar electrocautery on anterior knee pain in TKR without patellar resurfacing. Secondary objectives were to assess differences in standardised clinical and patient-reported outcomes.

Patients and Methods

In 2008, we initiated a prospective, outcome-assessor and patient-blinded, parallel-group,

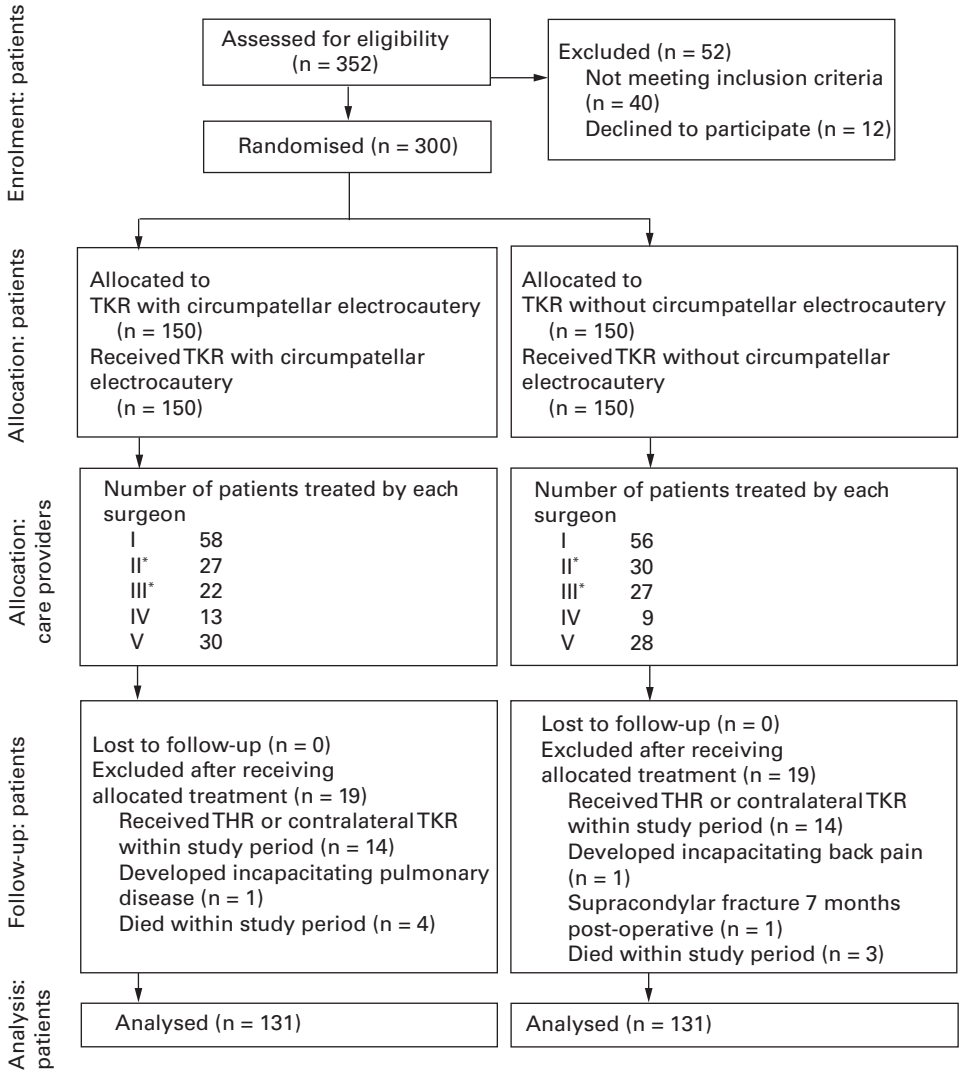

Fig. 1

CONSORT flow diagram showing the enrolment of the patients, the allocation of treatment and the completion of the study (* denotes a surgeon's preference to perform electrocautery; THR, total hip replacement; TKR total knee replacement).

randomised clinical trial according to the CONSORT statement.[27] The study was approved by the Regional Ethics Committee and Institutional Review Board.

Between May 2008 and May 2009, all patients who were to have TKR for primary osteoarthritis were considered for inclusion by the five orthopaedic surgeons involved. They excluded those who had any of the following: isolated patellofemoral osteoarthritis, contralateral patellar resurfacing (primary or revision), inability to speak Dutch, total hip replacement (THR) or contralateral TKR within the study period or less than one year beforehand, inflammatory arthritis, a history of patella fracture, patellectomy, patellofemoral instability, unicondylar knee replacement, high tibial or distal femoral osteotomy or any operation involving the extensor mechanism, a medical disorder which restricted walking and disabling disease involving other joints of the lower limbs. Eventually, 352 consecutive patients were recruited, of whom 300 provided written informed consent (Fig. 1).

All the eligible patients were assessed pre-operatively by one of the five participating surgeons who obtained the American Knee Society knee and functional scores.[28] The Dutch version of the 24-item Western Ontario and McMaster Universities osteoarthritis index (WOMAC) Likert version 3.0[29] was completed by all 300 patients who also participated in a standardised pre-operative work-up programme.

Operative technique. Each operation was performed by one of the five surgeons in a standardised manner according to the manufacturer's instructions, using the NexGen LPS (Zimmer, Warsaw, Indiana) posterior-stabilised fixed-bearing TKR without patellar resurfacing. The patients were operated on under spinal anaesthesia combined with a femoral nerve block and with tourniquet control. Blinding of the

Table I. The clinical anterior knee pain rating system described by Waters and Bentley[2]

Rating	Description
0	No pain
I	Mild pain which does not intrude on daily activities
II	Moderate pain which is a nuisance; patient not considering further surgery
III	Severe pain; patient considering further surgery

patients was achieved by shielding their view with a vertical drape.

After a midline skin incision and medial arthrotomy, the patella was everted laterally, and remained there until stability had been assessed using the trial components. In all cases, the patellar fat pad was resected to improve the exposure of the proximal tibia. When orientating the femoral component we used 5° of distal femoral valgus and 3° of external rotation relative to the posterior condyles. After cementing the femoral and tibial components, the damage to the patellar articular cartilage was assessed according to the Outerbridge[30] grading system. Osteophytes were removed only if considered necessary for correct patellar tracking. Also, a lateral release at least 2 cm lateral to the border of the patella was performed only if clinically indicated after an assessment of patellofemoral instability on passive testing of the range of movement.

The patients were randomly assigned to receive TKR with (intervention group) or without (control group) circumpatellar electrocautery. The randomisation was performed at operation using sequentially numbered, opaque sealed envelopes, each bearing only a number on the outside. Within the 300 envelopes there was an equal number of instructions for circumpatellar electrocautery or no additional treatment. These had been prepared before the study using computer-generated random-number tables by an assistant who did not participate in the study. In order to conceal the allocation, the next available numbered envelope was opened by a nurse in the operating theatre after cementing of the femoral and tibial components, assessment of the patellar cartilage, and any soft-tissue treatment for patellofemoral instability. The instructions informed the surgeon whether to undertake circumpatellar electrocautery. This was not revealed to the patient. Any electrocautery was performed using the Valleylab electrocautery unit (Valleylab Inc., Boulder, Colorado) with monopolar coagulation diathermy set to 50 W. The technique used only superficial electrocautery to a depth of no more than 1 mm in a circular fashion (360°) and within 5 mm of the edge of the patella. In both groups, after lavage, the medial arthrotomy, subcutaneous tissue and skin were closed in layers over a suction drain.

All 300 patients received the same post-operative treatment according to an integrated pathway protocol, with analgesia monitored by an anaesthetist. The physiotherapy programme was identical for both groups, with immediate post-operative protected weight-bearing with crutches. The patients were discharged from hospital after four days if they were able to actively flex the operated knee to 90°. All received antithrombotic prophylaxis for six weeks with low-molecular-weight heparin. After six weeks, full unrestricted weight-bearing was allowed without walking aids. All the patients had a scheduled follow-up at two and eight weeks and one year post-operatively. Anteroposterior standing and lateral non-weight-bearing radiographs were taken at eight weeks and one year. All the healthcare professionals involved with the follow-up examinations were blinded as to which group the patient had been assigned.

A trained nurse practitioner assessed the primary and secondary outcomes at one year post-operatively. The primary outcome was the incidence of anterior knee pain according to the rating system described by Waters and Bentley[2] (Table I). Along with the question "Do you experience pain at the anterior aspect of the knee?", patients who responded 'yes' were further questioned as to whether it interfered with activity and whether its severity warranted further surgery. The secondary outcomes at one year were assessed using the American Knee Society knee and function scores, obtained by the nurse practitioner, and the WOMAC questionnaire completed by all patients.

Statistical analysis. The baseline characteristics were analysed by descriptive statistics using the mean and range for continuous variables and frequencies for categorical variables. For the primary outcome measure, the clinical anterior knee pain rating system[2] was dichotomised. A rating of I, II or III was coded as presence of anterior knee pain, while a rating of 0 was coded as its absence. The prevalence of anterior knee pain in both groups including the 95% confidence interval (CI) was calculated, and the chi-squared test was used to compare the categorical data between the groups. A two-sided p-value ≤ 0.05 was considered to indicate statistical significance. The relative risk reduction and the number needed to treat were calculated with 95% CIs. For the three secondary outcome measures (American Knee Society knee and function scores and WOMAC index), the data were first assessed for normality using the Kolmogorov-Smirnov test with $p < 0.05$, after which repeated measures analysis of variance was used to analyse for differences over time between both groups. All the analyses were performed according to the intention-to-treat principle. Before the study began, a calculation of sample size was performed using estimates of the prevalence of anterior knee pain of 25% after TKR without patellar resurfacing.[2] With the use of a 15% effect size, a

Table II. Clinical details of both groups

	Intervention group (n = 131)	Control group (n = 131)	p-value*
Side			
Right:left	77:54	81:50	0.71§
Mean (range) age at operation in years	71 (53 to 91)	72 (47 to 90)	0.87
Female:male	95:36	84:47	0.14§
Mean (range) height in cm	167 (148 to 194)	169 (145 to 193)	0.21
Mean (range) weight in kg	84 (55 to 120)	84 (55 to 125)	0.88
Mean (range) BMI† in kg/m^2	30.1 (19.2 to 42.8)	29.4 (20.5 to 43.8)	0.22
ASA‡ classification			0.46§
1	13	10	
2	105	102	
3	13	19	
Predominant location of pre-operative knee pain			0.97§
Anterior	16	14	
Medial	67	69	
Posterior	3	2	
Lateral	10	12	
Generalised	35	34	
Intra-operative cartilage patella (Outerbridge grading)[30]			0.96§
0	10	13	
1	11	12	
2	40	36	
3	39	39	
4	31	31	
Mean (range) duration of follow-up in years	1.1 (1.0 to 1.1)	1.0 (1.0 to 1.1)	0.45

* analysis of variance, unless otherwise stated

† BMI, body mass index

‡ ASA, American Society of Anesthesiologists

§ chi-squared test

significance level (alpha) of 0.05 using a two-sided test and a power of 80%, a sample size of 113 knees in each group was required to detect a significant difference.

Results

There were no statistically significant differences between groups pre-operatively (Table II). The characteristics of the 19 patients who were excluded after receiving electrocautery did not differ from the 19 who were excluded in the non-electrocautery group (Fig. 1). All patients received the allocated treatment. Eight knees in the intervention group and nine in the control group required lateral retinacular release. Three knees, two in the intervention group and one in the control group, showed signs of a deep infection within six weeks of TKR and received successful operative and antibiotic treatment. At their one-year follow-up, these patients had no clinical signs of infection of their TKR. In three knees in the intervention group and one in the control group, manipulation under anaesthesia was performed to improve flexion after the fourth post-operative week. These patients had obtained more than 90° of flexion at the final review. There were no radiological signs of patellar osteonecrosis.[31]

At one year of follow-up, 67 patients reported anterior knee pain, representing an overall incidence of 25.6% (95% CI 20 to 31). There were 25 patients in the intervention group and 42 in the control group with a respective incidence of 19.1% (95% CI 12 to 26) and 32.1% (95% CI 24 to 40) (p = 0.02).

The number of knees in each group and grading of anterior knee pain rating is presented in Table III. The differences in gradings were statistically significant (p = 0.03). The use of circumpatellar electrocautery resulted in a relative risk reduction of 40% (95 CI 9 to 61) for post-operative anterior knee pain, with a number needed to treat of 7.7 (95% CI 4.3 to 41.4).

The intervention group had a better mean total WOMAC score at follow-up at one year (16.3 (0 to 77.7)) compared with the control group (21.6 (0 to 76.7)) (p = 0.04). Additional analysis of the component items within the mean WOMAC questionnaire showed a statistically significant better mean WOMAC function subscale for the intervention group (15.3 (0 to 77.9)) compared with the control group (20.4 (0 to 80.9)) (p = 0.02). However, no statistically significant differences were noted between the intervention and control groups for the mean WOMAC pain

Table III. Number of patients with anterior knee pain at follow-up at one year

Anterior knee pain rating	Intervention group (n = 131)	Control group (n = 131)
0	106	89
I	18	24
II	6	9
III	1	9

Table IV. Clinical outcome after total knee replacement with pre- and post-operative clinical scores (mean, range). The Western Ontario and McMaster Universities osteoarthritis index (WOMAC) is normalised and expressed on a scale of 0 to 100

	Intervention group (n = 131)	Control group (n = 131)	p-value*
AKSKS†			
Pre-operative	51.7 (18 to 77)	52.7 (17 to 89)	
Post-operative	92.4 (55 to 100)	90.4 (51 to 100)	0.14
AKSFS‡			
Pre-operative	54.4 (0 to 80)	54.4 (10 to 90)	
Post-operative	86.5 (15 to 100)	84.5 (30 to 100)	0.49
WOMAC total score			
Pre-operative	56.6 (16.0 to 98.3)	57.0 (22.8 to 94.6)	
Post-operative	16.3 (0 to 77.7)	21.6 (0 to 76.7)	0.04
WOMAC pain score			
Pre-operative	54.2 (0 to 95)	55.3 (15 to 100)	
Post-operative	10.7 (0 to 70)	15.8 (0 to 85)	0.14
WOMAC stiffness score			
Pre-operative	58.8 (0 to 100)	59.1 (0 to 100)	
Post-operative	23.2 (0 to 100)	28.2 (0 to 100)	0.18
WOMAC function score			
Pre-operative	57.0 (8.8 to 100)	56.3 (0 to 95.0)	
Post-operative	15.3 (0 to 77.9)	20.4 (0 to 80.9)	0.02

* Analysis of variance
† AKSKS, American Knee Society knee score
‡ AKSFS, American Knee Society function score

subscale (10.7 (0 to 70) *versus* 15.8 (0 to 85), respectively; p = 0.14) or stiffness subscale (23.2 (0 to 100) *versus* 28.2 (0 to 100), respectively; p = 0.18). Similarly, no statistically significant differences were observed in the mean American Knee Society knee score (92.4 (55 to 100) *versus* 90.4 (51 to 100), respectively; p = 0.14) or function score (86.5 (15 to 100) *versus* 84.5 (30 to 100), respectively; p = 0.49) (Table IV).

Discussion

In this study, circumpatellar electrocautery gave a significantly lower incidence of anterior knee pain at one year post-operatively compared with no circumpatellar electrocautery. Moreover, we found that the WOMAC score was better in the intervention group, mostly attributed to its function component. This suggests that anterior knee pain might be related to the functional results.

Numerous studies have assessed various factors thought to be related to anterior knee pain, including the characteristics of the patients,[4,5] the degree of wear of the patellar cartilage,[6] the design of prosthesis,[1,3,7] the operative technique,[8-11] and the use of patellar resurfacing.[2,4,12] Although some of these factors could be related to denervation, others are probably not. Therefore it seems likely that the cause of anterior knee pain after TKR is multifactorial. Some of these variables may have influenced our results. In a randomised, controlled trial comparing patellar resurfacing with non-resurfacing, weight but not the body mass index (BMI) was found to be associated with the development of anterior knee pain in those who did not have patellar resurfacing.[4] In our study, the baseline characteristics including weight, height and BMI, were similar in the groups. However, we did not stratify our analysis for weight or BMI. The degree of wear of the patellar articular cartilage is another factor which potentially influences the prevalence of anterior knee pain.[6] Selective resurfacing has been recommended in patellae with Outerbridge grade-IV changes, since patients with this degree of patellofemoral wear are 21 times more likely to require revision and undergo patellar resurfacing than those with lesser grades.[6] We did not find a correlation between the incidence of anterior knee pain and the extent of cartilage damage, which has been reported in other studies.[4,32-34] We used the posterior-stabilised, fixed-bearing NexGen prosthesis in all

patients. It has been suggested that a fixed design may be associated with a higher incidence of anterior knee pain than a mobile-bearing prosthesis.[3] We undertook TKR without patellar resurfacing, since definite evidence for its use is lacking.[12]

The manner by which circumpatellar electrocautery results in a reduced rate of anterior knee pain may be desensitisation or denervation of the pain receptors in the anterior knee.[17,18] This mechanism could be operating in the different procedures collectively described as patelloplasty. Since patellar resurfacing requires removal of osteophytes and synovial tissue to allow accurate resection and restore patellar thickness, this may at least in part result in denervation.

Gupta et al[25] reported a lack of improvement after patellar rim electrocautery at a minimum of two years following TKR without patellar resurfacing when using the rotating-platform, mobile-bearing Low Contact Stress total knee prosthesis (LCS; DePuy International, Leeds, United Kingdom). This alone may account for the lower incidence of anterior knee pain compared with the posterior-stabilised, fixed-bearing NexGen prosthesis used in our study.[3] Also, their patients had not been randomised, but were matched retrospectively.[25] Whether this difference arises from our relatively short follow-up warrants further attention. Some authors[4,35] have reported a gradual decrease in anterior knee pain after TKR, whereas others have described an increase over time.[36] In order to assess the long-term outcome, we will re-evaluate our patients to determine whether the clinical effect of circumpatellar electrocautery diminishes with time.

In summary, the results of our randomised, controlled trial at one year show that circumpatellar electrocautery in TKR without patellar resurfacing results in a lower incidence of anterior knee pain and better WOMAC scores compared with no circumpatellar electrocautery.

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