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Effect of adductor canal block on pain in patients with severe pain after total knee arthroplasty: a randomized study with individual patient analysis

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Editor's key points

- Effective postoperative analgesia is important after total knee arthroplasty as severe pain can impair mobilization.
- Adductor canal block was studied in patients with severe postoperative movement-related pain.
- With an effective block, there was a clinically significant reduction in pain scores on knee flexion.
- Further work is needed to establish the place of this block in clinical practice.

Background. Total knee arthroplasty (TKA) is associated with varying degrees of pain. A considerable proportion (25–40%) of patients experience severe pain, despite a comprehensive multimodal analgesic regimen. We hypothesized that adductor canal block (ACB) would reduce pain in this patient category compared with placebo.

Methods. Fifty patients with severe pain, defined as having a visual analogue scale (VAS) pain score of >60 during active flexion of the knee on the first or the second postoperative day after TKA, were included in this randomized, double-blind, placebo-controlled trial. All the patients had received a comprehensive multimodal analgesic regimen. Group A received an ACB with ropivacaine 0.75%, 30 ml at time 0 and isotonic saline after 45 min. Group B received an ACB with isotonic saline at time 0 and ropivacaine 0.75%, 30 ml after 45 min.

Results. A 32-mm difference in VAS pain score, during active flexion of the knee (primary endpoint), was observed in favour of Group A, 95% confidence interval (CI): 23–42, $P<0.0001$. At rest, the difference in VAS pain score was 15 mm in favour of Group A, 95% CI: 8–23 mm, $P=0.0001$. Individual patient analysis revealed that 25% of the patients had no effect during active flexion. At rest, however, only 8% had more than mild pain after ACB compared with 57% at inclusion.

Conclusions. ACB reduced VAS with 32 mm, during active flexion of the knee, in patients with severe pain after TKA, but a large proportion (78%) still had at least moderate, movement-related pain.

Clinical trial registration. www.clinicaltrials.gov, NCT01549704.

Keywords: acute pain; arthroplasty, replacement, knee; nerve block; pain, postoperative

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Total knee arthroplasty (TKA) is a procedure often associated with intense postoperative pain, despite a comprehensive multimodal analgesic regimen.[1]

Epidural analgesia is an alternative. However, this procedure faces a relatively high failure rate[2 3] and produces well-known side-effects such as urinary retention and motor block,[4] the latter potentially hindering mobilization.

Femoral nerve block (FNB) is a well-established treatment for postoperative pain after TKA.[5] FNB is, however, invariably followed by reduced quadriceps muscle strength[6 7] and associated with the risk of falling.[8–10]

Adductor canal block (ACB) is a relatively new block with promising results reported in initial studies.[11 12] Compared with FNB, ACB results in less reduction in the quadriceps muscle strength[13] as only the motor nerve to the vastus medialis of the quadriceps muscle traverses the adductor canal. Injecting a large volume of ropivacaine in the adductor canal should, in theory, affect not only the two largest sensory contributors from the femoral nerve to the knee—the saphenous nerve and the branch to vastus medialis—but also the terminal end of the posterior branch of the obturator nerve as it enters the distal part of the adductor canal.

The aim of this study was to evaluate the effect of ACB on pain during active flexion of the knee (primary outcome) and at rest (secondary outcome), in patients with severe pain after TKA, compared with placebo, and to evaluate the effect of the block in individual patients. Our definition of severe pain is a visual analogue scale (VAS) score of >60 mm out of

100 mm during an active 45° knee flexion, despite a comprehensive multimodal analgesic regimen.

Methods

The study was approved by the Danish Medicines Agency (EudraCT nr.2011-005368-5), the local Regional Ethics Committee (H-4-2011-154), and the Danish Data Protection Agency and registered at ClinicalTrials.gov (NCT01549704). The Copenhagen University Hospital Good Clinical Practice Unit monitored the trial. The study was carried out in accordance with the principles of the Helsinki declaration and data are presented in accordance with the CONSORT statement.[14]

From January 2012 to November 2012, patients who were about to undergo elective, unilateral, primary TKA at Copenhagen University Hospital, Gentofte Hospital, Denmark, attended a full-day seminar ~1 week before surgery. At this seminar, besides being informed about the surgery, anaesthesia, and what to expect regarding the perioperative period, they were informed about the study—both in plenum and during the following individual contact with an anaesthesiologist. The information about the study was given in accordance with recommendations and requirements from the local Regional Ethics Committee. Patients were screened on the first or the second post-surgical day for inclusion in the study. Written informed consent was obtained from all the subjects before enrolment. The primary investigator, who also performed all the blocks and assessments, did the screening and enrolment.

The inclusion criteria were: unilateral TKA and a VAS pain score of >60 mm during an active 45° flexion of the knee on the first or second postoperative day, age 30–85 yr, ASA classification I–III, and BMI 18–40 kg m^{-2}.

The exclusion criteria were: inability to cooperate, inability to understand or speak Danish, allergy to ropivacaine, and medicine or alcohol abuse.

Surgery, anaesthesia, and postoperative analgesia

TKA was performed by one of four different surgeons with insertion of tricompartmental prostheses using a standard medial parapatellar approach. Cruciate-substituting and cruciate-retaining designs were used. Surgery was performed in a bloodless field using a femoral tourniquet (100 mm above systolic arterial pressure). At the end of the surgery, a compression bandage from the toes to the mid-thigh was applied. Surgery was performed under spinal anaesthesia with 10–15 mg bupivacaine 0.5% or under general anaesthesia with propofol and remifentanil.

All the patients had received a standardized multimodal analgesic regimen (unless contraindicated): (i) Before operation—oral celecoxib 400 mg, acetaminophen 1 g, and gabapentin 600 mg; (ii) Intraoperatively—local infiltration analgesia (LIA) with 150 ml of ropivacaine 0.2% with epinephrine (10 μg ml^{-1}) performed as described by Kerr and Kohan[15]; and (iii) After operation—oral acetaminophen 1 g×4, ibuprofen 400 mg×3, gabapentin 300 mg (7 a.m.) and 600 mg (10 p.m.), and opioids as required. For the purposes of the present study, a minimum of 1 h should pass between administration of medication and evaluation of eligibility for inclusion.

Randomization and blinding

The pharmacy performed a random allocation sequence and prepared 50 consecutive boxes containing the study medication for each patient. Each box contained two smaller boxes, one marked '1. injection' and the other marked '2. injection'.

For Group A, the '1. injection' box contained 2×20 ml containers with ropivacaine 0.75% and the '2. injection' box 2×20 ml containers with isotonic saline.

For Group B, the '1. injection' box contained 2×20 ml containers with isotonic saline and the '2. injection' box 2×20 ml containers with ropivacaine 0.75%.

Ropivacaine and isotonic saline are visually indistinguishable and the containers were of identical appearance. From each box, 30 ml of study medication was used for each block.

Interventions

After obtaining a baseline VAS pain score at rest and at an active 45° flexion of the knee, the patient received the first ACB with 30 ml of study medication marked '1. injection', at time 0 (t0). Immediately after the 45 min (t45) assessments, the patient received the second ACB with 30 ml of study medication marked '2. injection'. In this way, we assured that all the patients had received an active treatment after the two injections. The ACB was performed during real-time ultrasonography. The needle tip was placed anterior to the femoral artery, deep to the sartorius muscle, at the mid-thigh level, as described by Jæger and colleagues.[12] Thirty millilitres of study medication was slowly injected with repeated aspirations. The primary investigator performed all blocks.

Outcomes and assessments

The primary endpoint was difference in VAS pain score between Group A and Group B, during an active 45° flexion of the knee at t45.

Secondary outcomes were differences in VAS pain scores between the groups at different time points both at rest and during flexion of the knee.

VAS pain scores were assessed at baseline and 15, 30, 45, 60, 75, and 90 min hereafter. VAS scores at rest were assessed before VAS scores during flexion.

The success rate of the block was assessed by testing for sensation of cold in the saphenous area of the lower leg before the first block and at the end of the study period.

Statistical analysis

A 15-mm reduction in VAS in Group A compared with Group B, during an active 45° flexion of the knee, 45 min after the first block was considered clinically relevant. We estimated a standard deviation (SD) of 15 from a previous study at our institution. With α=0.05 and a power of 90%, 2×22 patients would be required. To account for the uncertainty in predicting the actual SD, 2×25 patients were included. The data were analysed using IBM SPSS Statistics version 20.