Educational and clinical aspects of peripheral nerve blockade
Wegener, Jessica

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Chapter 7

**Value of single-injection or continuous sciatic nerve block in addition to a continuous femoral nerve block in patients undergoing total knee arthroplasty**

A prospective, randomized controlled trial

Jessica T. Wegener, Bas van Ooij, C. Niek van Dijk, Markus W. Hollmann, Benedikt Preckel, Markus F. Stevens

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Abstract

Background and Objectives
Continuous femoral nerve block in patients undergoing total knee arthroplasty (TKA) improves and shortens postoperative rehabilitation. Primary aim of this study was to investigate whether the addition of sciatic nerve block to continuous femoral nerve block will shorten time-to-discharge readiness.

Methods
Ninety patients undergoing TKA were prospectively randomized to 1 of 3 groups: patient-controlled analgesia via femoral nerve catheter alone (F group) or combined with a single injection (Fs group) or continuous sciatic nerve block (FCS group) until the second postoperative day. Discharge readiness was defined as the ability to walk and climb stairs independently, average pain on a numerical rating scale at rest lower than 4, and no complications. In addition, knee function, pain, supplemental morphine requirement, local anesthetic consumption and postoperative nausea and vomiting (PONV) were evaluated.

Results
Median time-to-discharge readiness was similar: group F 4 (2-16) days, group Fs 4 (2-7) days and group FCS 4 (2-9) (P=0.631). No significant differences were found regarding knee function, local anesthetic consumption or PONV. During the day of surgery, pain was moderate to severe in group F, while group Fs and FCS experienced minimal pain (P<0.01). Patients in group F required significant more supplemental morphine on the day of surgery and the first postoperative day. Until the second postoperative day pain was significantly less in group FCS (P<0.01).

Conclusion
A single-injection or continuous sciatic nerve block in addition to a femoral nerve block did not influence time-to-discharge readiness. A single-injection sciatic nerve block can reduce severe pain on the day of the surgery, whereas a continuous sciatic nerve block reduces moderate pain during mobilization on the first 2 postoperative days.
Value of single-injection or continuous sciatic nerve block in addition to a continuous femoral nerve block in patients undergoing total knee arthroplasty
A prospective, randomized controlled trial

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Postoperatively on Postanesthesia Care Unit
Postoperatively on surgical ward
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Statistical Analysis

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Introduction

Total knee arthroplasty (TKA) reduces pain and improves function resulting in a higher quality of life for patients with knee osteoarthritis. These patients can suffer from considerable postoperative pain, which is known to impair early intensive physical therapy and rehabilitation. Good postoperative pain control is probably the most important factor to accelerate knee rehabilitation. Meanwhile, hospital stay after TKA has been shortened by introduction of clinical pathways including standardized pain therapy allowing accelerated mobilization: a good postoperative pain management should allow intensive physical therapy and early discharge.

With patient-controlled intravenous (IV) opioids alone, moderate to severe pain can persist, especially during mobilization. Continuous epidural analgesia as well as continuous peripheral nerve blocks provide improved analgesia and a significantly shortened rehabilitation time when compared to pure opioid therapy. In a risk-benefit analysis peripheral nerve blocks offer more site specific analgesia with lower incidence of adverse effects compared to epidural analgesia. For balancing adequate analgesia with limited quadriceps motor impairment, patient-controlled femoral nerve block can be used. Although a recent meta-analysis could not find any advantage of a continuous femoral nerve block in comparison to a single injection, in most institutions it is considered standard for TKA. However, continuous femoral nerve block might lead to insufficient pain relief in the posterior region of the operated knee. Yet, the discussion continues whether a supplemental sciatic nerve block plus analgesia via a femoral nerve catheter is beneficial in these patients. Pham et al. demonstrated better pain relief at rest and decreased morphine consumption when combining continuous femoral and sciatic nerve blockade. Unfortunately, in this study, data from patients with continuous and single-injection sciatic block were not analyzed separately. Morin et al. reported improved analgesia in patients undergoing TKA with combined continuous femoral and sciatic nerve block for a median of 3 days but also reported more problems while performing active exercises and more insecure walking in patients with an additional sciatic nerve block. Therefore, we shortened the time of nerve blocks in order to not interfere with early ambulation. Finally, a recent meta-analysis concluded that further studies are needed to evaluate the value of adding sciatic nerve block to femoral nerve block in patients undergoing TKA.

We hypothesize that addition of sciatic nerve block (single-injection or continuously) to a patient-controlled femoral nerve blockade will shorten time-to-discharge readiness, and improve postoperative knee mobilization and pain relief after TKA.
Methods

This trial was designed as a single center, prospective, randomized, controlled study. Approval of the study was obtained by the Medical Ethics Committee of the Academic Medical Centre of Amsterdam (07/321 MEC) and the study was registered in the national trial register (NTR2207). Progress of the study and adverse event rates were annually reviewed by the hospital ethics committee.

Study participants
All eligible patients scheduled for total knee replacement arthroplasty (TKA) in a clinical pathway were enrolled 1 week before knee operation. After provided with written and verbal information, the subject’s written informed consent was obtained on admission. Inclusion criteria consisted of age older than 18 years and American Society of Anesthesiologists (ASA) classification I to III. Exclusion criteria were infection near the insertion site of any catheter, coagulation disorders, allergy to local anesthetics, prior surgery near the site of nerve block, inability to use the patient-controlled analgesia device, pregnancy or lactation, known hepatic or renal insufficiency and preexisting neurologic deficit of the operated leg. Normal motor and sensory function of the operated leg was evaluated before randomization. The study period included the time from admission for TKA until hospital discharge.

Randomization
Eligible patients were randomized into 3 groups using opaque-sealed envelopes containing the treatment assignment. Thus, 90 patients were randomly allocated to 1 of 3 equally sized groups:
F: Patients receiving patient-controlled femoral nerve block only
Fs: Like group F combined with a single-injection sciatic nerve block
FCS: Like group F combined with a continuous sciatic nerve block

Preoperative knee function and pain assessment
Preoperative functional capacity of the knee was assessed by active range of motion, measuring knee flexion with a goniometer. Ratings were documented of preoperative knee pain on a numeric rating scale (NRS, range 0 - 10, 0 = no pain, 10 = most imaginable pain) during movement.

Nerve block techniques
After establishing venous access and standard hemodynamic monitoring
(electrocardiogram, pulse oximetry, noninvasive blood pressure measurement),
peripheral nerve blocks were placed under aseptic conditions in the preoperative
holding area by 1 of 3 anesthesiologists with extensive experience in ultrasound-
guided nerve block procedures. All patients received a stimulation femoral nerve
catheter (Stimucath continuous nerve block set with a 18-gauge Tuohy needle
and 20-gauge catheter, Arrow International, Inc, Reading, Pa), inserted via an
ultra-sound guided inguinal in-plane approach in supine position. The needle tip
was positioned dorsomedial to the femoral nerve under ultrasound guidance
(HFL 38 probe connected to Micromaxx, Sonosite Inc., Bothell, WA) and nerve
stimulation (Stimuplex HSN12, B.Braun, Melsungen, Germany; pulse width,
0.1 ms; frequency, 2 Hz). The stimulating catheter was advanced or repositioned
aiming for stimulation current < 0.6 mA. Ultrasound identification of the
catheters was difficult in patients with a body mass index greater than 30 kg/m².
The lowest current inducing muscle contractions via the catheter was registered.
After negative aspiration, a loading dose of 20 mL levobupivacaine 0.375% was
administered slowly in fractions of 5 mL.
For patients of group Fs and FCS, before placement of the femoral nerve catheter, a
sciatic nerve block was established via a parasacral approach, as described by
Mansour,20 in lateral decubitus position with guidance of a nerve stimulator. In the
Fs group, a stimulating needle (15 cm 20 G needle, Stimuplex A [B.Braun] was
used, and in the FCS group, a stimulating needle with a catheter set was used (15
cm 18 G needle, 100-cm 20 G catheter, Contiplex Tuohy, [B.Braun]). After
eliciting dorsal or plantar flexion of the foot with a current preferably below 0.6
mA, a loading dose of 20 mL levobupivacaine 0.375 % was injected intermittently
after negative aspiration. In the FCS group, the catheter was inserted 5 cm beyond
the needle tip. Nerve catheters were secured to the skin with a catheter stabilization
device (Statlock, for winged catheters, Bard, Inc, Covington, Ga) and covered with
a transparent dressing (Tegaderm; 3M, St. Paul, Minn).
Time needed for establishing the nerve block from first needle penetration to
withdrawal of the needle (for single-injection blocks) and catheter fixation (for
continuous techniques) was registered. All electrical stimulation thresholds
were noted.
After injection of local anesthetics, sensory and motor block was examined
based on a 3-point scale every 5 minutes during the first 45 minutes (Table 1).21
Femoral sensory function was tested by pinprick 10 cm proximal of the patella
and femoral nerve motor function by knee extension. Sciatic motor function was
tested by foot plantar/dorsal extension and sensory function by pinprick
sensation at the lateral calf and the dorsum of the foot.

111 total knee arthroplasty
During the surgery
Patients received lorazepam 1 mg 2 hours and acetaminophen 2 g 1 hour before surgery. 45 minutes after application of the initial bolus at the femoral nerve site, a continuous infusion of levobupivacaine 0.125% 10 ml/h was started via the femoral nerve catheter in all groups. In group FCS, a second continuous infusion of levobupivacaine 0.125% 10 ml/h was started via the sciatic catheter 45 min after catheter placement.

General anesthesia was induced with propofol target-controlled infusion set to 3 to 5 µg/ml and remifentanil 0.5 µg/kg per minute and maintained with 2 to 3 µg/ml and 0.1 to 0.25 µg/kg per minute, respectively. Infusion rates were adjusted as required, and patients were ventilated via a laryngeal mask. A pneumatic tourniquet was placed on the thigh before surgery and inflated to 300 mmHg during surgery. Total needs of propofol and remifentanil, duration of surgery and time of tourniquet were recorded.

Postoperatively on Postanesthesia Care Unit
Postoperatively, the continuous femoral nerve infusion was changed to patient-controlled femoral nerve infusion (5-mL bolus, 30-minute lockout; basal rate 6 ml/h [Perfusor fm; B Braun]) in all groups. In the FCS group, the additional continuous sciatic infusion was maintained during the postoperative period (10 ml/h).
Supplemental morphine IV was administered for pain control if pain on a NRS was higher than 4. Consumption of morphine and NRS at 1, 2, and 3 hours postoperatively were noted. The extent of postoperative nausea and vomiting (PONV) were graded as none = 0, mild = 1 and severe = 2. Patients with PONV received ondansetron 4 mg IV and, when the symptoms persisted, additionally droperidol 0.625 mg IV was added.

Postoperatively on surgical ward
All patients received standardized postoperative analgesia with acetaminophen 1 g 4 times daily. In the absence of any contraindications, diclofenac 50 mg was added 3 times daily, combined with esomeprazol 20 mg once daily for gastric protection. Alternatively, tramadol was started 50 mg 3 times daily. An extra dose of tramadol (100 mg) was administrated before removal of nerve catheters. If NRS remained high despite these treatments, morphine was administered for pain relief as required. Perineural infusions were continued for 36 hours and catheters were removed on the morning of the second postoperative day (POD 112).
CONSORT Flowdiagram

**Enrollment**

Assessed for eligibility (n = 170)

- Excluded (n = 80)
  - Not meeting inclusion criteria (n = 24)
  - Declined to participate (n = 51)
    - Logistic reasons (n = 5)

Randomized (n = 90)

**Allocation**

- Group F (n = 30)
  - Femoral nerve catheter

- Group Fs (n = 30)
  - Femoral nerve catheter + Sciatic single injection

- Group FCS (n = 30)
  - Femoral nerve catheter + Sciatic nerve catheter

**Follow up**

- Group F (n = 29)
  - Consent withdrawal (n = 1)

- Group Fs (n = 30)
  - 2 unsuccessful sciatic nerve blocks

- Group FCS (n = 30)
  - 1 unsuccessful femoral nerve block

**Analysis**

- Group F (n = 29)
  - 29 analyzed

- Group Fs (n = 30)
  - All analyzed (intention to treat)

- Group FCS (n = 30)
  - All analyzed (intention to treat)

Figure 1 CONSORT diagram showing flow of patients for TKA through the study
2). Deep vein thrombosis prophylaxis was provided with fondaparinux 2.5 mg/0.5 mL subcutaneously daily, starting the evening on the day of surgery and continued for 4 weeks. Physical therapy started on POD 1 until discharge. Functional capacity was assessed daily and recorded with the Medical Research Council scale for muscle strength of the quadriceps (MRC-Q) and active range of motion of the knee (AROM) with a goniometer by the physical therapist.

**Readiness to discharge and functional outcome**
The primary endpoint was time-to-readiness for discharge. Criteria were as follows:
1. Ability to walk 25 m or more with walking aids and to climb a flight of stairs. This endpoint was checked daily at 10 am and 2 pm by a physical therapist.
2. A pain score below 4 on a numeric rating scale as taken by nurses educated in pain measurement and therapy.
3. Absence of serious complication as examined by an orthopedic surgeon on a daily base.
These discharge criteria were checked daily by an investigator. Furthermore, short-term functional capacity was determined by MRC-Q and active flexion of the knee daily by a physical therapist. Duration of actual admission was also noted. Secondary endpoints were pain scores measured on a NRS at rest and during movement, supplemental consumption of morphine, local anesthetic consumption and grade of PONV. These variables were noted daily at 8 am and 6

**Scale of sensory and motor function**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>normal sensation</td>
</tr>
<tr>
<td>S2</td>
<td>touch sensation, no pain</td>
</tr>
<tr>
<td>S3</td>
<td>no sensation</td>
</tr>
<tr>
<td>M1</td>
<td>full power</td>
</tr>
<tr>
<td>M2</td>
<td>decreased power</td>
</tr>
<tr>
<td>M3</td>
<td>no power</td>
</tr>
</tbody>
</table>

**Table 1** Scale of sensory and motor function
Examination of sensory and motor block based on a 3 point scale and tested every 5 minutes during the first 45 minutes after femoral and sciatic nerve blocking.
pm on the ward starting the day of operation until the third postoperative day. Patients were assessed daily by the surgeon for complications during admission, as well as six weeks postoperatively.

**Statistical Analysis**
We considered a 25% reduction in discharge readiness to be clinically relevant (normal length of stay 4 days). On the basis of previous data, we assumed a standard deviation of 1 day. Sample size analysis indicated that a group size of 30 patients would allow showing a 25% difference between groups at a 90% power and at a 2-tailed alpha level of 0.05 (after bonferroni correction for multiple comparisons). Intention-to-treat analysis was conducted. Comparisons between groups were made by Kruskal-Wallis test and, if significant, by unpaired 2-sided Mann-Whitney U-test. Dichotomous variables were compared on contingency table by Fisher exact test. A value of $p < 0.05$ was considered significant. The $p$-values of the primary end points (readiness to discharge) were corrected by Bonferroni-Holmes adjustment for multiple comparisons.

### Demographic data

<table>
<thead>
<tr>
<th></th>
<th>Group F ($n = 29$)</th>
<th>Group Fs ($n = 30$)</th>
<th>Group FCS ($n = 30$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>62 (50-79)</td>
<td>65 (43-81)</td>
<td>66 (43-83)</td>
</tr>
<tr>
<td><strong>Sex (M/F)</strong></td>
<td>11/18</td>
<td>9/21</td>
<td>8/22</td>
</tr>
<tr>
<td><strong>Height (cm)</strong></td>
<td>174 (158-188)</td>
<td>171 (150-187)</td>
<td>173 (159-188)</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>84 (72-116)</td>
<td>82 (62-125)</td>
<td>89 (68-118)</td>
</tr>
<tr>
<td><strong>BMI (kg.m-2)</strong></td>
<td>30.3 (23.2-39.7)</td>
<td>28.6 (21.0-48.8)</td>
<td>27.8 (22.1-39.6)</td>
</tr>
<tr>
<td><strong>ASA I/II/III</strong></td>
<td>13/13/3</td>
<td>13/17/2</td>
<td>9/16/5</td>
</tr>
<tr>
<td><strong>NRS preop</strong></td>
<td>5.4 (3.0-7.5)</td>
<td>6.5 (2.0-10)</td>
<td>6.3 (0-10)</td>
</tr>
<tr>
<td><strong>AROM (degrees)</strong></td>
<td>120 (70-130)</td>
<td>110 (60-135)</td>
<td>110 (80-135)</td>
</tr>
</tbody>
</table>

Table 2 Demographic data. Patient characteristics presented as median (range) or absolute number as appropriate. There were no significant demographic differences between the 3 groups ($p > 0.05$). ASA = American Society of Anesthesiologists status; NRS = pain score as numeric rating scale; AROM = active range of motion of the knee.
### Characteristics of block and surgical

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group F (n = 29)</th>
<th>Group Fs (n = 30)</th>
<th>Group FCS (n = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfentanil (mcg)</td>
<td>500 (250-1000)</td>
<td>1000 (0-1750)</td>
<td>1000 (250-2000)</td>
</tr>
<tr>
<td>Propofol (mg)</td>
<td>0 (0-40)</td>
<td>0 (0-50)</td>
<td>0 (0-100)</td>
</tr>
<tr>
<td>Femoral catheter placing duration (min'sec“)</td>
<td>5'56” (2'30” 21'00”)</td>
<td>7'41”(2'20”-26'00”)</td>
<td>6'40”(3'20”-24'12”)</td>
</tr>
<tr>
<td>Femoral catheter threshold (mA)</td>
<td>0.44 (0.20-0.80)</td>
<td>0.40 (0.20-0.90)</td>
<td>0.35 (0.1-0.6)</td>
</tr>
<tr>
<td>Sciatic injection duration (min'sec“)</td>
<td>3’ 49’”(1’10’”-22’0”)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sciatic threshold (mA)</td>
<td>0.38 (0.2-0.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sciatic catheter placing duration (min'sec“)</td>
<td></td>
<td></td>
<td>4’46”(2’00”-15’15”)</td>
</tr>
<tr>
<td>Sciatic catheter threshold (mA)</td>
<td></td>
<td></td>
<td>0.30 (0.1-0.60)</td>
</tr>
<tr>
<td>Length of surgery (min)</td>
<td>93 (51-150)</td>
<td>87 (53-178)</td>
<td>93 (69-134)</td>
</tr>
<tr>
<td>Tourniquet time (min)</td>
<td>88 (33-152)</td>
<td>75 (14-158)</td>
<td>69 (15-109)</td>
</tr>
</tbody>
</table>

Table 3
Data are given as median (range). There were no statistical significant differences between groups (p > 0.05).
Results

Patients were included between February 2008 and April 2010. A CONSORT flow diagram of eligible and participating patients is demonstrated in Figure 1. Four patients had a staged bilateral TKA. One patient (F group) withdrew consent after randomization and refused to give NRS scores or other data. Therefore, no data from this patient could be analyzed. Patients with primary failed blocks (1 femoral in group FCS, 2 sciatic blocks in group Fs) were included in an intention-to-treat analysis.

Demographic data and values for required sedation, block performance, and tourniquet as well as surgery duration are shown in Tables 2 and 3 per group. There were no significant demographic differences between the 3 groups. Three patients had no signs of nerve block within 40 minutes. The other 86 patients developed signs of motor and sensory block within 15 min, whereas complete block took up to 40 minutes. There were no significant differences between groups regarding onset times of blocks.

Readiness to Discharge and Functional Outcome

Median time-to-readiness to discharge was similar for all 3 groups: group F, 4.0 days (2.0-16.0 days), group Fs, 4.0 days (2.0-7.0 days) and group FCS 4.0 (2.0-9.0 days) (Figure 2). The actual median length of hospital stay was equal to the time-to-readiness to discharge and did not differ between groups: group F, 4 days (3-16 days), group Fs, 4 days (4-10 days), group FCS, 4 days (4-10 days).

Similarly, no significant differences were found in active knee flexion at the time-of-readiness to discharge: F group, 75 degrees [range, 55-90 degrees], Fs group 80 degrees [range,55-95 degrees] and in FCS group 80 degrees [range, 40-95 degrees] or in MRC-Q: F group, 3 [range, 3-4], Fs group 3 [range, 2-4] and FCS group 3 [range, 2-5]). Likewise, there were no significant differences in active flexion (Figure 3) or MRC-Q between all groups at POD 2, 3, and 4 or at discharge.

Postoperative pain and analgesic consumption

Patients in F group had significantly more postoperative pain at the day of TKA compared with those in the Fs and FCS groups (Figure 4). During the first postoperative hours in the postanesthesia care unit, patients of F group experienced moderate to severe pain with a median pain score of 7 (range, 0-10), whereas patients of Fs and FCS groups had a median pain score of 0 (range 0-10, p < 0.01). Patients in the F group needed 16 mg (range, 0-42 mg) morphine IV in contrast to the Fs (2 mg [range, 0-22]) and FCS groups (0 mg [range,0-12], p < 0.01; Table 4).
When patients still experienced pain scores higher than 4 after morphine 15 to 20 mg IV, supplemental medication like S-ketamine 5 to 10 mg IV and clonidine 75 to 150 μg were administered (9 patients of group F, 1 patient of group Fs and 1 patient in group FCS, p < 0.01). Nevertheless, patients in the F group still had more pain at the end of the day (NRS POD 0, at 6 pm in group F, 4 [range, 0-7], Fs group, 0 [range, 0-8] and FCS group, 0 [range, 0-6]; p < 0.01). Until POD 2, pain at rest and during mobilization was significantly less in FCS group. However, pain during mobilization was moderate in F and Fs groups (median NRS ≤ 5; figure 4B) and mild at rest in all groups. Rescue medication with morphine was increased in the F group on POD 0 to 2 (Table 4). Incidence of postoperative nausea and vomiting was 6.7% without significant difference between groups.

No significant difference for delivered boluses of levobupivacaine 0.125% applied via the patient-controlled femoral nerve block was found between groups (Table 5).

### Postoperative morphine consumption

<table>
<thead>
<tr>
<th>Morphine (mg/24 h)</th>
<th>Group F (n = 29)</th>
<th>Group Fs (n = 30)</th>
<th>Group FCS (n = 30)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>POD 0 16(0-42)</td>
<td>27/29</td>
<td>2(0-22) 16/30</td>
<td>0(0-16) 11/30</td>
<td>0.000</td>
</tr>
<tr>
<td>POD 1 0(0-48)</td>
<td>5/29</td>
<td>0(0-5) 1/30</td>
<td>0(0-0) 0/30</td>
<td>0.006</td>
</tr>
<tr>
<td>POD 2 0(0-48)</td>
<td>7/29</td>
<td>0(0-8) 3/30</td>
<td>0(0-0) 0/30</td>
<td>0.011</td>
</tr>
<tr>
<td>POD 3 0(0-40)</td>
<td>3/29</td>
<td>0(0-13) 1/30</td>
<td>0(0-0) 0/30</td>
<td>0.149</td>
</tr>
</tbody>
</table>

Table 4  Postoperative morphine consumption. A significant difference was found between group F and both other groups on POD 0 & 1, but only between group F and group FCS on POD 2. After the day of operation (POD 1-3) median (range) morphine consumption was 0 mg for all groups. When morphine was given orally the equipotent dose was calculated (oral:iv; 3:1) and added to the total morphine requirement. The number of patients per group who required morphine is given below.
Complications

Twelve patients did not mobilize according to the schedule because of hematoma, swelling, or wound leakage (4 patients in the F group, 5 patients in the Fs group, 3 patients in the FCS group). One patient (F group) required surgical drainage on POD 3. The number of patients with delayed mobilization included 3 of totally 4 patients (3 patients in the Fs group and 1 patient in the FCS group), who had fallen down because of unaccompanied mobilization on POD 2.

After diagnosis of a full motor block of the foot in 11 patients of group FCS on POD 1, infusion of continuous sciatic nerve block was interrupted temporarily until motor function was restored and then infusion of levobupivacaine was continued at a lower infusion rate (6 ml/hr) and motor block did not reappear in any of these patients.

Active Range of Motion

Figure 2  The range of motion of the different treatment groups over time. Box plots representing the degree of active knee flexion per group and per day. The white boxes represent the F group (only femoral catheter), light gray boxes represent the Fs group (femoral catheter and sciatic single injection), and dark gray boxes represent the FCS group (femoral and sciatic catheter). There were no significant differences between groups at any time.
Discussion

Addition of a single-injection or continuous sciatic nerve block to a continuous femoral nerve block for postoperative pain treatment after TKA did not improve time-to-discharge readiness or knee function in this randomized controlled trial. However, early postoperative pain relief was much better controlled at rest and during mobilization, whereas opioid requirements were reduced in patients with a sciatic nerve block. The group receiving a continuous sciatic catheter had significantly less pain during mobilization. Patients with continuous femoral nerve block alone experienced severe postoperative pain on day of TKA, whereas the addition of a sciatic block provided complete pain relief. Thus, sciatic nerve block combined with a continuous femoral nerve block improved the quality of early postoperative analgesia significantly and also in a clinical relevant manner. The difference in median pain score between groups was 7 on a NRS from 0 to 10 and are in line with observational studies\(^{22,23}\) and 2 other randomized trials.\(^{24,25}\) The high pain scores in the F group are concerning and may be explained by the fact that our patients received only short-acting and ultra short-acting opioids before and during the surgery. However, the use of longer-acting opioids might be insufficient for those patients requiring up to 42 mg morphine and who still had

<table>
<thead>
<tr>
<th></th>
<th>Group F (n = 29)</th>
<th>Group Fs (n = 30)</th>
<th>Group FCS (n = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>POD 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 am</td>
<td>25 mg (0-119)</td>
<td>6 mg (0-163)</td>
<td>6 mg (0-144)</td>
</tr>
<tr>
<td>6 pm</td>
<td>13 mg (0-94)</td>
<td>3 mg (0-106)</td>
<td>0 mg (0-75)</td>
</tr>
<tr>
<td><strong>POD 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 am</td>
<td>6 mg (0-44)</td>
<td>0 mg (0-56)</td>
<td>0 mg (0-25)</td>
</tr>
</tbody>
</table>

Table 5

Levobupivacaine (mg/12 hours) delivered as bolus via patient-controlled femoral nerve block (basic infusion rate levobupivacaine 0.125% 6 ml/hr). There were no statistically significant differences between groups.
moderate to severe pain scores during the early postoperative period. Even the addition of S-ketamine and clonidine as nonopioid rescue analgesics was needed frequently in the F group to achieve sufficient pain control. One may argue that patient-controlled systemic analgesia would have reduced the maximum pain scores and might have been a better indicator for a good postoperative pain therapy. However, it is difficult to include an additional patient-controlled infusion pump and handling two patient-controlled systems in elderly patients shortly after a major operation under general anesthesia.

Because median pain scores at rest were 2.0 or lower in all groups from POD 1 on, we could not demonstrate any advantage of a sciatic nerve block for pain relief at rest from that time on. However, addition of a continuous sciatic nerve block controls pain significantly better during mobilization. Although the pain reduction is according to International Association for the Study of Pain (IAPS) definitions clinically relevant, the median pain scores during mobilization were moderate in patients receiving a femoral nerve block with or without single-injection sciatic nerve block.

Readiness to discharge was not affected when combining a sciatic nerve block to a continuous femoral nerve block in our study. While Ilfeld et al. demonstrated in two multi-center studies a difference in time to reach discharge

**Figure 3** Time points when each of 89 patients reached discharge criteria for each treatment group. There were no statistical significant differences between groups (P=0.631).
Pain at rest (A) and during mobilisation (B)

Figure 4  Pain at rest (A) and during mobilization (B) over time per group. The white boxes represent the F group (only femoral catheter), light gray boxes represent the Fs group (femoral catheter and sciatic single injection), and dark gray boxes represent the FCS group (femoral and sciatic catheter). For each patient, POD 2 pain score measurements (NRS, numeric rating scale) are performed at 8:00 am (left) and 6:00 pm (right). All patients who received a sciatic block had significant lower pain scores at rest on POD 0 (postanesthesia care unit and 6:00 pm) (p < 0.01), whereas only the patients with a sciatic nerve catheter had significantly less pain on POD 1 (p < 0.05). Although the differences were clinically relevant on day 0 according to International Association for the Study of Pain (IASP) definition ([Delta] NRS >2), they were not clinically relevant on day 1. The patients with a continuous sciatic nerve catheter had statistically significant pain reduction during mobilization on POD 1 and 2; however, postoperative pain during mobilization was always below preoperative values in all groups. *p < 0.05. **p < 0.01.
criteria when pain was better controlled with an extended continuous femoral nerve block over four days compared to a continuous femoral nerve block overnight addition of a sciatic nerve block did not have an effect on readiness to discharge in our study. However, because discharge criteria, patient population, clinical pathway, and systemic analgesic management were different between the cited study and the present investigation, it is difficult to draw conclusions from comparisons of these two studies.26,27

A sciatic nerve block, specially a continuous block, might impair motor function and thereby might have a negative effect on active knee movement, thereby delaying hospital discharge. Of the patients in the FCS group, 36.7% had a motor block on POD 1. Subsequently, the infusion was stopped and later restarted at a lower rate. Thus, none of the patients had a motor block on POD 2; furthermore, all regional anesthesia was stopped at 6 am on POD 2. No patient of any group reached discharge criteria on POD 1. Therefore, it is highly unlikely that the high incidence of motor block in group FCS had influenced the discharge criteria.

One may also argue that the addition of a sciatic nerve block requires more patient preparation time. Establishing of sciatic nerve block took, on average, less than 5 min, and therefore had little impact on the clinical pathway. However, in institutions with less experience in regional techniques, this time might be longer and more relevant.

In patients having considerable more pain (like those in the F group) one should expect an increased demand and delivery of levobupivacaine 0.125%. However, no differences were found between groups in total bolus dose via patient-controlled femoral block.

Worrisome are the four falls during mobilization at the beginning of the study period. Falls occurred in three patients of the Fs group and one patient of the FCS group on POD 2. In all cases our safety instructions for mobilization were violated. We repeated education to nurses and patients about nerve block induced motor weakness and risks of falling and observed no further falls thereafter. Our study is underpowered to draw conclusions on the influence of blocks on fall incidents. Previously, worries about the risk of falling when using a femoral block in patients undergoing TKA have been expressed.28,29 The incidence of falls reported by these authors is lower than the incidence we determined, probably due to underreporting in these retrospective studies. Recently Ilfeld et al.30 re-analyzed the risk of falling in their prospective randomized studies in patients undergoing TKA with or without continuous femoral nerve block. The authors observed significantly more fall incidents in
the groups with continuous femoral nerve block, although none of the falls led to a change in treatment or delay of hospital discharge. Incidents of falls were moderately higher than the incidents we observed. As shown recently, effective fall prevention is much more than handle an information folder or to just advice the patient that he/she should not ambulate on his own.31 A limitation of the study is the missing blinding of patients.

In conclusion, combining sciatic nerve block to femoral nerve catheter did not influence readiness to discharge or short-term knee function. A single-injection sciatic nerve block can reduce severe pain on the day of operation, whereas a continuous sciatic nerve block reduces moderate pain during mobilization on the first 2 postoperative days. Therefore, improved pain therapy cannot simply be translated into reduced hospital stay and improved short-term rehabilitation.
References


