A prospective comparative study between the effect of adductor canal block and femoral nerve block on early pain management among post-operative unilateral total knee arthroplasty patients

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Abstract
Analgesia after TKA can be achieved by integrated multimodal analgesic protocols using two or more analgesic modalities that work by different mechanisms that will optimize the analgesia and minimize the potential risks and side effects. The study was a prospective, randomized Trial. It was approved by the Ethics Committee. All the patients who were diagnosed clinically and radiologically as severe osteoarthritis of the knee planning for unilateral TKR were selected for the study. Written informed consent was obtained from all patients. When patients during the postoperative period were asked to perform the TUG and 10-min walk tests, all patients in the ACB group were able to perform it on POD1 and POD2, whereas in the FNB group, four patients were not able to complete the walk test (fall risk) on POD1 but all of the patients performed the test on POD2. Furthermore, patients in the ACB group performed both tests significantly faster than the FNB patients on POD1.

Keywords: Adductor canal block, femoral nerve block, unilateral total knee arthroplasty

Introduction
Total-knee arthroplasty (TKA), one of the most common orthopedic surgeries, which is performed in patients with severe degenerative osteoarthritis. However, over 60% of patients have suffered severe pain after TKA, which has affected the quality of sleep, appetite, and functional exercise [1–4]. Immediate postoperative pain is top on the list of concerns for TKA candidates, which often results in a delay or cancellation of the surgical intervention. Therefore, Good post-operative analgesia after TKR facilitates early mobilization less post-operative complications, reduction of length of hospital stay, prevents progression of acute pain to chronic pain and provides a hemodynamic stability [5].

Analgesia after TKA can be achieved by integrated multimodal analgesic protocols using two or more analgesic modalities that work by different mechanisms that will optimize the analgesia and minimize the potential risks and side effects [6]. In addition to the preemptive analgesia such as NSAIDs, analgesia after knee surgery can be provided by multiple non-systemic methods such as local anesthetic infiltration and peripheral nerve block, which is commonly used to relieve post-operative pain and decrease opioid requirement and its adverse effects.

Femoral nerve block (FNB) is commonly used in TKA to control postoperative pain. However, as the FNB is invariably associated with reduced quadriceps muscle strength [7], increased risk for fall is estimated to be 2% [8, 9]. Consequently, with the FNB, the goal of pain relief will compromise the goal of preserving the muscle strength. The ideal nerve block for TKA should provide effective analgesia while preserving the muscle power to expedite the recovery.

The introduction of USG and its use in different nerve blocks was the key of inventing the adductor canal block (ACB), which is relatively new block with high success rate [10].
strength with the favorable earlier mobilization than the FNB \[11\]. ACB blocks the main sensory contributions from the femoral nerve to the knee, namely the saphenous nerve and the nerve to vastus medialis while they pass through the adductor canal \[12\]. Because of the small size and the absence of motor component, the conventional nerve localization techniques such as nerve stimulation have inconsistent success \[10\].

**Methodology**

The study was a prospective, randomized Trial. It was approved by the Ethics Committee. All the patients who were diagnosed clinically and radiologically as severe osteoarthritis of the knee planning for unilateral TKR were selected for the study. Written informed consent was obtained from all patients. The inclusion criterion includes primary unilateral TKA for osteoarthritis who belongs to 60 – 80 years, a BMI of 18–35, and ability to follow the study protocol.

Exclusion criteria included contraindication for neuroaxial anesthesia or nerve block (bleeding diathesis, pre-existing lower extremity neuromuscular disorder, local infection, or sepsis), allergy or contraindication to the drugs used in the study (local anesthetic, NSAIDs, opioids), epilepsy, mental illness, dementia, preexisting neuropathy on the operative limb, chronic opioid use (defined as daily use of narcotic analgesic equivalent to oral morphine 60 mg for >1 month), alcohol or drug abuse, renal impairment, or obstructive sleep apnea, history of abnormal liver enzymes, hepatic failure, renal insufficiency, uncontrolled hypertension, congestive heart failure, previous heart or coronary bypass surgery, history of stroke or major neurological deficit, sensory and motor disorders in the operated limb, gastritis or gastrointestinal bleeding, organ transplantation, chronic pain requiring opioid medications, neuropathic pain, failure in preoperative Timed-Up and Go (TUG) test, and subject refusal.

Demographic characteristics, preoperative VAS, functional performance-based evaluation including TUG test and quadriceps muscle strength, were recorded by a research assistant. TUG test measures the time to rise from an armchair (seat height, 50 cm), walk 10 metres, turn, and return to sitting in the same chair. Quadriceps muscle strength of each subject was evaluated by a digital dynamometer.

**Standardized anesthesia and analgesia**

All patients received a standardized anesthesia and analgesia upon hospitalization. Preoperative oral paracetamol (650mg, twice a day) was administered day before surgery. On the day of the surgery, all patients were randomly assigned to the ACB and FNB groups (1:1 allocation, parallel trial design) 30 minutes before the surgery using sequentially numbered, opaque-sealed envelopes, based on a computer-generated randomization list created by an independent researcher (anesthesiologist). The patient and research assistant were blinded to the group assignment, but the anesthesiologist performing the block was aware of the treatment. In the ACB group, ultrasound-guided ACB (20 mL of 0.5% of ropivacaine with 5mg/mL epinephrine, via a 22 gauge 2-inch needle) was performed at the mid-thigh level using a high-frequency linear ultrasound transducer (10–12Hz.). Block success was verified by testing for pinprick sensation in the saphenous nerve distribution. Ultrasound guided FNB (30mL of 0.33% of ropivacaine with 5mg/mL epinephrine, via a 22-gauge 2-inch needle) with nerve stimulator confirmation was performed below the inguinal ligament, block success was verified by testing for pinprick sensation in the femoral nerve distribution.

All surgeries were performed under spinal anaesthesia with paramidam approach using a 27-gauge spinal needle at the L3/L4 or L2/L3 intervertebral space with the patient in the sitting position. Spinal anaesthesia using 0.5% hyperbaric bupivacaine 3 ml was used in all patients. If the spread of the sensory block was insufficient, the patient was excluded from the study, and general anaesthesia was later administered. All patients received intravenous dexamethasone 10 mg and Ondanestron 4 mg for postoperative nausea and vomiting prophylaxis. The decision of whether to provide intravenous fluid during operation or to sedate using propofol was made at the discretion of the anesthesiologist. The minimally invasive mini-midvastus approach was applied in all knees, with the use of tourniquet.

After operation, we used acetaminophen (500mg, twice a day) and to control the postoperative pain. Moreover, we administered pethidine hydrochloride (50mg) to the patients who experienced persistently severe postoperative pain or when their visual analog scale (VAS) at rest was over 5. After a 4-hour postoperative care in the anesthesia recovery unit, all patients returned to the in-patient unit. It was on the day of the surgery that all patients began walking after the assessment of the physiotherapist. From the day of the surgery until the day of discharge, each patient underwent physical therapy supervised by a physiotherapist 2 times per day.

**Outcome measurements**

Postoperative pain at rest was measured using VAS at 6, 12 and 18 hours after surgery. VAS during knee flexion and extension were measured in the morning and evening on postoperative day (POD) 1. VAS during stand-up and walking was measured on POD 2, 3. The results were recorded by research assistants who were blinded from group randomization. Pethidine consumption via PCA device was recorded at the first-time requirement and 12, 24 and 48 hours, postoperatively. Quadriceps strength and TUG test on POD 2, 3 were recorded by a physiotherapist who was blinded to studied group. The incidence of nausea and vomiting (1= none, 2= queasy, 3= severe nausea, 4= vomiting), pruritus (1= none, 2= mild, 3= moderate, treatment requested, 4= severe, treatment requested), patient satisfaction (0-10), length of hospital stay, adverse events including local anesthetic toxicity and incidence of fall were recorded.

Home discharge criteria included (1) no pain on functional activities of daily living, (2) ability to get in and out of bed and a chair with minimal assistance, (3) walk along a hallway independently or with standard walker, crutches or cane, (4) ability to go up and down stairs safely. If a higher level of ongoing support was required, the patient was retained for further rehabilitation facilities.

The primary outcome was the total pethidine consumption during postoperative 24 hours. Secondary outcomes included postoperative pain score, time to first and total dosage of rescue pethidine in postoperative 48 hours, early and late postoperative period (from POD 0 to 3 months follow-up) performance-based test (TUG test, and quadriceps strength). Postoperative nausea and vomiting, length of hospital stay, patient satisfaction and other adverse events were also evaluated.

**Results**

A total of 200 patients were initially screened for inclusion criteria. In all, 152 patients met the inclusion criteria. A total of 108 patients were recruited and consented to participate in the study. Two patients were excluded from the study due to...
difficult spinal with necessity of general anesthesia. All of these
two patients were excluded from the study before knowledge of
which of the study groups they belonged to. The 108 patients
were randomized to receive either FNB (n = 52) or ACB (n =
54). All patients completed the study and were included in the
data analysis. Both groups were similar with respect to the
patient demographic characteristics and perioperative data
(Table 1).

Table 1: Demographic characteristics and perioperative data

<table>
<thead>
<tr>
<th>Variables</th>
<th>FNB group (n = 52)</th>
<th>ACB group (n = 54)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>60 +/- 12</td>
<td>65 +/- 15</td>
<td></td>
</tr>
<tr>
<td>Sex (male/female)</td>
<td>25/27</td>
<td>23/31</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>160.3 +/- 9.4</td>
<td>162.2 +/- 8</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>85.2 +/- 7.8</td>
<td>86.4 +/- 7.2</td>
<td></td>
</tr>
<tr>
<td>Tourniquet time (min)</td>
<td>87.2 +/- 15</td>
<td>86.8 +/- 14</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m2)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>TUG test (s)</td>
<td>4.1 +/- 0.5</td>
<td>4.0 +/- 0.3</td>
<td></td>
</tr>
<tr>
<td>10m walk test (s)</td>
<td>4.8 +/- 0.3</td>
<td>4.6 +/- 0.2</td>
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</tbody>
</table>

When patients during the postoperative period were asked to
perform the TUG and 10-min walk tests, all patients in the ACB
group were able to perform it on POD1 and POD2, whereas in
the FNB group, four patients were not able to complete the walk
test (fall risk) on POD1 but all of the patients performed the test
on POD2. Furthermore, patients in the ACB group performed
both tests significantly faster than the FNB patients on POD1,
but the difference was non-significant on POD2 as illustrated in
Table 2.

Table 2: Outcome of Tests

<table>
<thead>
<tr>
<th>Tests</th>
<th>POD 1</th>
<th></th>
<th>POD 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FNB (N=52)</td>
<td>ABC (N=54)</td>
<td>P Value</td>
<td>FNB (N=52)</td>
</tr>
<tr>
<td>TUG test</td>
<td>11.2 +/- 4.3</td>
<td>5.6 +/- 0.8</td>
<td></td>
<td>4.9 +/- 0.6</td>
</tr>
<tr>
<td>10m WALK test</td>
<td>11.8 +/- 5.5</td>
<td>5.8 +/- 0.9</td>
<td></td>
<td>4.7 +/- 0.7</td>
</tr>
</tbody>
</table>

the difference between both study groups with respect to the
Visual analogue scale and the opioid consumption was
statistically nonsignificant, suggesting that the ACB was not
inferior to FNB with respect to the postoperative analgesia.

Discussion
Effective analgesic modalities are essential in TKA to facilitate
early rehabilitation and postoperative recovery [13]. The ideal
analgesic regimen after TKA should offer adequate analgesia
with little or no effect on motor power to allow for safe early
ambulation [14]. The local anesthetic that can selectively
anesthetize sensory nerves while sparing motor nerves does not
exist [15].

Our results suggest that the use of the ACB was associated with
improvement regarding early postoperative ambulation in
patients with TKA surgery compared with patients who received
FNB and this difference was significant on POD1 but non-
significant on POD2. This was indicated by the difference in the
TUG test and 10-min walk test between both groups. This
finding was supported by other previous studies [14, 16–18].
However, Jaeger et al. [17] and Mudumbai et al. [18] studied
the continuous catheter infusion technique, whereas we studied
single-shot technique, and they collected data for 24 h
postoperatively, whereas our data were for 48 h postoperatively.

Worth to mention that Kim et al. [10] used dynamometer to
measure the quadriceps strength and their anesthetic technique
was combined spinal epidural neuroaxial block with
postoperative epidural patient-controlled analgesia with
continuous background epidural infusion.

In addition, a study performed on healthy volunteers showed
that ACB preserved quadriceps strength and ability to ambulate
better than what FNB did [9]. In addition to the positive effect of
early ambulation on the surgical outcome of TKA, it helps to
decrease the incidence of deep venous thrombosis of the legs [19]
and enhance muscle strength and gait control [20]. Furthermore,
there have been concerns raised regarding a potential risk for

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