Comparison between Ultrasound Guided Femoral Nerve Block versus IPACK Block in Patients Undergoing Total Knee Replacement on Postoperative Ambulation and Pain: A randomised controlled clinical trial.

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Abstract

Background

Total knee replacement (TKR) is a widely used surgical technique for knee disorders. The study is aimed to assess the interspace between the popliteal artery and capsule of the posterior knee (IPACK) block concerning postoperative ambulation as a primary outcome and analgesic efficacy as a secondary outcome when compared to the femoral nerve block (FNB) following TKR.

Methods

Under spinal anaesthesia, forty patients undergoing elective unilateral TKR were divided into two groups: FNB, receiving ultrasound-guided FNB, and IPACK Block, receiving ultrasound-guided IPACK block. Ambulation was assessed with the timed up-and-go (TUG) and 10-meter walk tests. Post-surgery, pethidine consumption in 24 hours and VAS scores were recorded.

Results

After 24 hours postoperative, TUG showed a mean value of 4.8±1.2 seconds in the IPACK group compared with 8.7±2.1 seconds in the FNB group (p < 0.001). The time needed for a 10-meter walk test was significantly longer in the FNB group (12.1±2.1 seconds) than in the IPACK group.
(8.3±1.2 seconds) in the first 12 hours postoperative. Similarly, 24 hours postoperatively, values were 6.4±1.2 seconds Vs 10.4±2.1 seconds respectively (p < 0.001). Using the VAS score, the FNB group demonstrated a greater analgesic effect than the IPACK group, while taking less total pethidine (73.8±17.2 mg) compared to 110.0±29.7 mg in the IBACK group.

**Conclusion**

There was delayed ambulation in FNB than in IPACK. The FNB has a better analgesic profile compared to the IPACK block with less total analgesics consumption over 24 hours postoperatively.

**Keywords:** Ultrasound Guided Femoral Nerve Block, IPACK Block, Total Knee Replacement, Postoperative Ambulation, Pain.

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**Background**

TKR is a surgical procedure commonly used for severe osteoarthritis, resulting in postoperative pain and immobilization. The most difficult factor to control is pain, but early movement following surgery can be facilitated by motor-sparing regional anaesthetic blocks, multimodal analgesia, and ultrasound-guided nerve blocks. These interventions may also speed the rehabilitation process, reduce the need for opioids, and shorten hospital stays.

FNB is a safe and effective analgesia method that is ideal for treating pain in the elderly population. Compared to epidural or IV analgesia, FNB provides effective pain control while shortening recovery time and hospital stay without any adverse effects. However, there is a 2% increased risk of falls due to the typically diminished quadriceps muscle strength associated with FNB. As a result, the goal of pain relief in TKR should prioritize preserving muscle strength alongside reducing pain to promote healing.

IPACK block targets the terminal sensory nerve endings of the posterior knee joint, which is believed to have minimal effects on motor and sensory functions below the knee.

This study aimed to evaluate IPACK block for postoperative ambulation and analgesic efficacy compared to femoral nerve block after TKR surgery.

**Patients and methods**

This prospective, randomized, double-blinded, controlled trial was conducted at Ain Shams University Hospitals from October 2022 to November 2023.

Approval from the Institutional Ethics Committee (MS 591/2022) and written informed consent were obtained from all participants or their legal guardians. The trial was registered in the Pan African Clinical Trial Registry (PACTR/2023/05/731865991, www.pactr.org). The 2013 Declaration of Helsinki principles were followed in the conduct of the study.

*Eligibility criteria* included elective unilateral TKR under spinal anaesthesia in patients aged between 40 and 85 years, with the American Society of Anaesthesiologists (ASA) physical status of I –III from both
sexes. *Exclusion criteria* included contraindications for neuraxial anaesthesia or regional nerve block (e.g., bleeding diathesis, pre-existing lower extremity neuromuscular disorder, local infection, or sepsis), allergy or contraindication to the drugs used in the study (local anaesthetic, NSAIDs, opioids), declining to provide written informed consent, psychiatric or cognitive disorders, and ASA Physical Status Class IV.

Forty patients undergoing unilateral TKR were randomly assigned to two groups (20 patients each). Group I (control) received an Ultrasound-guided FNB, while Group II (interventional) received an Ultrasound-guided IPACK block.

Patients were assigned to treatment groups using a computer-generated block randomization method maintaining a 1:1 ratio. Ten blocks, each comprising four patients, were created for this purpose. Allocation concealment was ensured by sealing the assignments in opaque envelopes. Nerve blocks were administered by a single, highly experienced regional anesthesiologist not affiliated with the study, ensuring consistency, and eliminating potential performance bias.

Preoperative investigations were requested for all patients, including a complete blood count, prothrombin time, partial thromboplastin time, kidney function, liver function, viral markers, ECG, and echocardiography if needed clinically.

Intraoperative monitoring included electrocardiography, non-invasive blood pressure, and pulse oximetry. Baseline parameters (MAP, HR, oxygen saturation) were recorded. IV lactated Ringer's solution was started, and a crystalloid bolus (10 ml/kg) was administered as preload before spinal anesthesia. Spinal anesthesia was performed using a spinal needle (27 G) in a midline approach under complete aseptic conditions with 3.5 ml of 0.5% hyperbaric bupivacaine and 25 µg of fentanyl for both groups.

In the control group, FNB was administered post-spinal injection under sterile conditions using ultrasound guidance. The femoral nerve was located using a high-frequency linear probe, and 20 ml of 0.25% bupivacaine was injected beneath the fascia iliaca after confirming the needle tip's position.

In the interventional group, the IPACK block was performed post-spinal anaesthesia but before surgery, with the patient supine and the knee slightly flexed. Using ultrasound, the popliteal fossa was located to identify the popliteal artery and femur. After confirming negative aspiration, 20 ml of 0.25% bupivacaine was injected near the popliteal artery's medial edge.

The surgeries were achieved by skilled surgeons utilizing the traditional TKR technique for all patients. Postoperative pain was assessed using VAS after operating room discharge. Side effects like hypotension, arrhythmia, bradycardia, nausea, vomiting, shivering, and local anesthetic toxicity were recorded and managed. Hypotension was treated with 15 mg IV ephedrine increments, and bradycardia with 0.5 mg IV atropine. Vital signs and pain intensity were checked every 2 hours for the first 6 hours post-op, then every 6 hours for the next 24 hours. All the patients received 1 gm IV paracetamol every 6 hours, with 25 mg IV pethidine if
VAS ≥ 4; additional doses were given for VAS ≥ 4 complaints.

The study's primary outcomes were evaluated using two tests: the TUG test and the 10-meter walk test. The TUG test assesses the time taken for a patient to stand, walk 3 meters, turn, return, and sit. The 10-meter walk test measures the time to walk 10 meters. These tests were conducted only if deemed safe for the patient and repeated twice on the first postoperative day every 12 hours.

The study assessed VAS scores postoperatively every 2 hours for the initial 6 hours, then every 6 hours for the next 24 hours. Rescue analgesic intake was measured every 12 hours within the first 24 hours. HR and MAP were evaluated every 2 hours for the initial 6 hours, then every 6 hours for the following 24 hours.
By using PASS 11 for sample size calculation, setting power at 80%, and alpha error at 5%, we estimated that the FNB would cause weakness in the quadriceps muscle at least twice that was caused by the IPACK; assuming an effect size of 0.9, a sample of 16 patients in each group is recommended to recruit to fulfill this rate. To compensate for dropouts, we planned to recruit a total of 40 patients.

Data were reviewed, coded, tabulated, and inputted into SPSS v20 (IBM, Chicago, IL). Quantitative data are presented as mean ± SD, while qualitative data as frequencies and percentages. Data distribution normality was checked using the Kolmogorov-Smirnov test. Student’s t-test analyzed continuous variables, while categorical variables were compared using the \( \chi^2 \)-test or Fisher’s exact test. Significance was set at \( p < 0.05 \).

**Results**

Sixty-three patients undergoing TKR were initially assessed for enrollment, 17 of whom were later excluded for not fulfilling the inclusion criteria, and another six patients refused to participate. The remaining 40 patients were equally divided between the two groups [Figure 1].

Basic demographic data, including age, sex, and ASA were comparable between the study groups [Table 1].

MAP increased gradually from admission to the PACU until 24 h postoperatively in both the study groups. MAP was lower in the FNB group than in the IPACK group; however, the difference was not significant [Figure 2].

<table>
<thead>
<tr>
<th>Variables</th>
<th>FNB group (Total=20)</th>
<th>IPACK group (Total=20)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>58.6±9.5</td>
<td>60.1±10.9</td>
<td>0.657</td>
</tr>
<tr>
<td>Sex (n, %)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>6 (30.0%)</td>
<td>8 (40.0%)</td>
<td>0.507</td>
</tr>
<tr>
<td>Female</td>
<td>14 (70.0%)</td>
<td>12 (60.0%)</td>
<td></td>
</tr>
<tr>
<td>ASA Classification (n, %)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>5 (25.0%)</td>
<td>6 (30.0%)</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>9 (45.0%)</td>
<td>7 (35.0%)</td>
<td>0.811</td>
</tr>
<tr>
<td>III</td>
<td>6 (30.0%)</td>
<td>7 (35.0%)</td>
<td></td>
</tr>
<tr>
<td>Duration of surgery (min)</td>
<td>95.65 ± 14.02</td>
<td>90.35 ± 15.46</td>
<td>0.099</td>
</tr>
<tr>
<td>Total pethidine consumption in the first 24 hours (mg)</td>
<td>73.8±17.2</td>
<td>110.0±29.7</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

\(^{\text{Independent t-test. \#Chi square test.}}\)

Data are expressed as mean ± SD or number (%),

\( P \) value > 0.05 is considered non-significant.
The HR increased gradually from admission to the PACU until 24 h postoperatively in both study groups. Comparing the FNB and IPACK groups, the statistical difference in HR was not significant [Figure 3].

The IPACK group showed significantly lower TUG and 10-meter walk test values postoperatively compared to the FNB group. At 12 hours postoperative, the mean TUG test time was $6.7 \pm 1.1$ seconds for the IPACK group and $10.5 \pm 2.0$ seconds for the FNB group.
group (p < 0.001). After 24 hours postoperative, the IPACK group showed a mean value of 4.8 ± 1.2 seconds, while the FNB group had a mean value of 8.7 ± 2.1 seconds (p < 0.001). Patients in the FNB group were slower than those in the IPACK group at both 12 and 24 hours postoperatively [Table 2].

Table 2 TUG and 10-m walk tests among the study groups.

<table>
<thead>
<tr>
<th>Time</th>
<th>FNB group (Total=20)</th>
<th>IPACK group (Total=20)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUG test (seconds)</td>
<td>Preoperative</td>
<td>4.5±0.5</td>
<td>4.4±0.4</td>
</tr>
<tr>
<td></td>
<td>After 12hrs PO</td>
<td>10.5±2.0</td>
<td>6.7±1.1</td>
</tr>
<tr>
<td></td>
<td>After 24hrs PO</td>
<td>8.7±2.1</td>
<td>4.8±1.2</td>
</tr>
<tr>
<td>10-m walk test</td>
<td>Preoperative</td>
<td>6.2±0.6</td>
<td>6.1±0.6</td>
</tr>
<tr>
<td>(seconds)</td>
<td>After 12hrs PO</td>
<td>12.1±2.1</td>
<td>8.3±1.2</td>
</tr>
<tr>
<td></td>
<td>After 24hrs PO</td>
<td>10.4±2.1</td>
<td>6.4±1.2</td>
</tr>
</tbody>
</table>

PO: Postoperative. ^Independent t-test. *Significant. Data are expressed as mean ± SD.
P value < 0.05 is considered significant.

The mean VAS score of the patients gradually increased over time. During the first 6 h, there was no significant difference among the groups; however, the FNB group had a significantly lower VAS pain score than the IPACK group, from 6 h postoperatively until 24 h (p < 0.05) [Table 3].

Total pethidine consumption (mg) in the first 24 h was significantly lower in the FNB group (73.8±17.2 mg) than in the IPACK group (110.0±29.7 mg) [Table 1].

Discussion

Several pain management techniques have been developed, and nerve blockade has gained popularity in recent years due to its effectiveness [4]. Various methods are available for evaluating mobility after knee replacement surgery, including measuring knee joint movement and muscle strength, and administering tests such as the TUG and 10-meter walk tests, which have high validity and reliability [5,6,7]. In our study, we used these two tests to assess postoperative ambulation. The FNB group exhibited better pain control compared to the IPACK group, with lower VAS scores starting from 6 hours postoperatively and less use of pethidine [8]. However, both groups had similar pain control upon admission and up to 4 hours postoperatively.

Affection of the quadriceps muscle and, therefore, the inability to ambulate early is a characteristic of FNB, as reported by many studies. Hegazy and Sultan studied 110 TKR patients (under spinal anaesthesia),
comparing ACB with FNB using 20 ml ropivacaine 0.5%. They found FNB associated with significantly longer TUG and 10-meter walk tests than ACB [2].

The IPACK block has been recognized as a valuable addition to multimodal analgesia for TKR surgeries, as it functions as a motor-sparing block. Thobhani et al. divided primary unilateral TKR patients into three groups: FNB alone, FNB with IPACK, and ACB with IPACK. The ACB with IPACK group showed better physical therapy performance and earlier hospital discharge compared to the other two groups [11]. Kuang et al. compared FNB and ACB, finding FNB to offer varying effectiveness with a similar analgesic profile [12]. A study by Shanthanna et al. compared continuous epidural analgesia with continuous femoral block techniques for pain relief following TKR and found that VAS scores were higher in the femoral group at 6 h post-surgery but were similar after 24 h. [13]

Most prior studies have investigated the IPACK block either independently or in combination with adductor canal block, [14] [15] genicular nerve block [16] or tibial nerve block [17] with or without periarticular local anaesthetic infiltration. [18] Overall, the IPACK block has shown promise as a valuable addition to multimodal analgesia for TKR surgeries.

Scimia et al. assessed IPACK block with continuous ACB for post-TKR analgesia and early rehabilitation within 72 hours. Compared to FNB, it offers comparable analgesia and opioid usage [19].

Ochroch et al. studied IPACK block's effectiveness in TKR patients alongside delayed movement until postoperative day 2 [19]. Nanker et al. reported delayed quadriceps motor function return with FNB compared to ACB [10].

Table 3 Visual analogue scale (VAS) among the study groups

<table>
<thead>
<tr>
<th>Time to PACU</th>
<th>FNB group (Total=20)</th>
<th>IPACK group (Total=20)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission to PACU</td>
<td>0.0 (0.0 – 0.0)</td>
<td>0.0 (0.0 – 0.0)</td>
<td>^0.999</td>
</tr>
<tr>
<td>After 2hrs PO</td>
<td>0.0 (0.0 – 1.0)</td>
<td>1.0 (0.0 – 1.0)</td>
<td>^0.119</td>
</tr>
<tr>
<td>After 4hrs PO</td>
<td>1.5 (1.0 – 2.0)</td>
<td>2.0 (2.0 – 3.0)</td>
<td>^0.061</td>
</tr>
<tr>
<td>After 6hrs PO</td>
<td>2.0 (2.0 – 3.0)</td>
<td>4.0 (3.3 – 4.0)</td>
<td>^0.001*</td>
</tr>
<tr>
<td>After 12hrs PO</td>
<td>3.0 (3.0 – 3.0)</td>
<td>4.0 (4.0 – 4.0)</td>
<td>^0.001*</td>
</tr>
<tr>
<td>After 18hrs PO</td>
<td>3.0 (3.0 – 3.0)</td>
<td>4.0 (3.0 – 4.0)</td>
<td>^0.001*</td>
</tr>
<tr>
<td>After 24hrs PO</td>
<td>3.0 (3.0 – 4.0)</td>
<td>4.0 (3.0 – 4.0)</td>
<td>0.007*</td>
</tr>
</tbody>
</table>

PO: Postoperative. IQ: Interquartile.
^Independent t-test.
*Significant. Data are expressed as Median (1st–3rd IQ).
P value < 0.05 is considered significant.

Tran et al. studied 200 TKR patients (under general anaesthesia), randomly assigning ACB or FNB with 30 ml 0.33% ropivacaine. They found weaker quadriceps strength in the FNB group versus the ACB group 24 hours postoperatively [8].

Kandasamin et al. found a 2% increase in major postoperative falls among 250 FNB patients, with nearly 70% experiencing delayed movement until postoperative day 2 [9]. Nanker et al. reported delayed quadriceps motor function return with FNB compared to ACB [10].

A study by Shanthanna et al. compared continuous epidural analgesia with continuous femoral block techniques for pain relief following TKR and found that VAS scores were higher in the femoral group at 6 h post-surgery but were similar after 24 h. [13]

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ACB. Those receiving IPACK reported less knee pain six hours post-surgery and similar opioid needs compared to the placebo block group\[^{20}\]. Greater pethidine use in the IPACK group may imply its insufficiency as a sole pain control method post-TKR.

The IPACK block might not suffice for postoperative analgesia as the surgical technique involves an anterior knee incision, not fully covered by the block. Also, oedema formation in the posterior capsule during surgery can dilute the anaesthetic, reducing its effectiveness.

This study's limitations included its single-centre nature and small sample size. Long-term effects and potential nerve block complications weren't assessed. Quadriceps muscle strength and knee range of motion were also overlooked, potentially impacting outcomes. Additionally, the short postoperative follow-up might not have been sufficient for observing related complications.

**Conclusion**

IPACK block has a lower effect on motor power postoperatively than FNB with a reduced analgesic effect than FNB block.

**Acknowledgments**

The authors acknowledge the regional anaesthetiologist for their assistance and performing the regional blocks during the study period.

**Financial support and sponsorship**

Nil.

**Disclosure statement**

There are no conflicts of interest.

**References**


