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# Comparative study of ultrasound guided fascia iliaca compartment block with femoral nerve block with iPACK in total knee arthroplasty for postoperative analgesia

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**Abstract:**

**Background:** Significant pain after surgery following total knee arthroplasty (TKA) is usually controlled with regional anaesthetic. Although femoral nerve block (FNB) provides effective pain relief, it may hinder movement because of quadriceps weakness. On the other hand fascia iliaca compartment block (FICB) might offer more or comparable pain alleviation with same or enhanced motor preservation. In terms of pain management, the usage of rescue analgesics, quadriceps strength, safety, and patient satisfaction, this study contrasts the effectiveness of continuous FICB + iPACK (Infiltration between the Popliteal Artery and Capsule of the Knee) with FNB + iPACK. **Methods:** A randomized controlled study was conducted with 62 ASA grade I–III patients (ages 35–75) who underwent unilateral TKA between October 2020 and March 2022, divided into two equal groups: FICB and FNB. Group A was given continuous FICB with ultrasound guidance + iPACK; Group B was given continuous FNB + iPACK. Main results: pain levels after surgery (NRS) and usage of additional pain relief medication. Additional outcomes: strength of quadriceps (MMT), complications, and patient satisfaction. **Results:** The FICB group had significantly lower NRS scores and rescue analgesic intake (local anaesthetic, non-opioid, and opioid) on surgical day 1 ($p < 0.01$–$0.001$). Better quadriceps function was shown by the FICB group's significantly higher MMT scores ($p = 0.002$). **Conclusion:** When contrasted with FNB in unilateral TKA, FICB enhanced with iPACK gives better postoperative analgesia, lower analgesic needs, and earlier mobilization.

**Keywords:** Total knee arthroplasty, femoral nerve block, fascia iliaca compartment block

## Introduction

Total knee replacement (TKR) is a commonly done surgery for advanced knee osteoarthritis, particularly with increasing life spans, obesity rates, and improvements in medical care [1]. In India, more than 70,000 hip and knee replacement surgeries are conducted each year, with an

expected 25% rise in the next five years [2]. Although it has advantages, TKA is a the most painful orthopedic procedures because of significant innervations from both anterior and posterior sensory nerves in the knee [3].

Post-surgery pain arises from incision damage, inflammatory substances, and systemic reactions including sympathetic activation. Proper pain management is crucial to enable early mobilization, decrease hospital duration, and minimize complications, such as chronic pain and readmission. Preferred multimodal analgesia combines systemic (e.g., NSAIDs, opioids) and regional methods (e.g., peripheral nerve blocks, local infiltration, epidural) [4].

Epidural analgesia, while effective, may lead to bilateral motor block, urinary retention, and hypotension, which is particularly hazardous for anticoagulated patients. Patient-controlled opioid analgesia is linked to nausea, constipation, and respiratory depression. Peripheral nerve blocks provide a safer option with reduced systemic side effects [5].

Femoral nerve block (FNB) is frequently utilized after TKA, but it often weakens quadriceps strength, raising the risk of falls. Fascia iliaca compartment block (FICB), first introduced as a substitute for the 3-in-1 block, is capable of targeting the femoral, lateral femoral cutaneous, and obturator nerves while maintaining motor function more effectively. The use of ultrasound guidance has greatly enhanced the success rates of FICB, establishing it as a dependable technique for surgeries involving the lower limb [5,6].

However, both FNB and FICB mainly address anterior, medial, and lateral discomfort in the knee. The popliteal plexus innervates the back of the knee, and although a sciatic nerve block can alleviate this pain, it comes with an increased risk of complications like foot drop. To tackle this issue, the iPACK (Infiltration between the Popliteal Artery and Capsule of the Knee) block offers posterior knee pain relief without affecting motor function [7,8].

In our research, we enhanced continuous FICB and FNB by incorporating the iPACK block with the assistance of ultrasound guidance. Ropivacaine was chosen for its prolonged action, motor-sparing characteristics, and reduced cardiotoxic effects in comparison to bupivacaine. Ultrasound guidance was conducted using a Fujifilm SonoSite Micromaxx device equipped with linear (13–6 MHz) and curved (5–2 MHz) transducers for the corresponding blocks. This method sought to enhance postoperative pain management, reduce opioid consumption, maintain motor function, and facilitate early rehabilitation after unilateral TKA.

**Material and methods**

Study population: Following written consent from the patient, 62 ASA grade I–III patients of either sex, ages 35–75, following unilateral total knee replacement surgery at the Department of Anaesthesiology, Max Super Speciality Hospital, Patparganj, New Delhi, were added to the study. The study was approved by the scientific and ethical committee of the institution. In accordance with a computer-generated random sequence, the patients were split into two groups of 31 subjects each. It should be mentioned at this stage that patients who underwent bilateral TKR but only had one knee inspected repeatedly on different dates were handled as distinct cases.

Study design: A forward-looking, randomized controlled trial. The subjects were separated into two categories. GROUP ‘FICB’ (n=31): Patients assigned to receive a continuous fascia iliaca compartment block combined with iPACK as a method for pain management. GROUP

'FNB' (n=31): Patients to receive Continuous Femoral Nerve Block utilizing iPACK, a method for pain management.

**Inclusion Criteria:** Patients aged 35 to 75 years who were categorized as American Society of Anesthesiologists (ASA) physical status Grade I, II, or III were part of the study. Eligibility was restricted to individuals scheduled for elective unilateral total knee arthroplasty. Moreover, patients were required to be mentally capable and able to give informed consent for involvement.

**Exclusion Criteria:** Patients were not included if they had a documented allergy to local anesthetics or if there was an infection present at the intended needle insertion site. People who could not understand or use the Numeric Rating Scale (NRS) for evaluating pain were also omitted. Additionally, individuals with prior sensory or motor deficiencies were excluded from the study.

**Study Intervention:** STUDY INTERVENTION: Steps of intervention

1. Patients were divided into two test groups FICB or FNB.
2. Baseline vitals noted.
3. Patients were induced with standard general anaesthesia.
4. USG guided iPACK block was given.
5. USG guided Fascia iliaca compartment block/femoral nerve block with catheter placement was done subsequently
6. In the iPACK block 20cc of 0.2% Ropivacaine single shot was given and no catheter was placed.
7. In the fascia iliaca compartment block 20cc of 0.2% ropivacaine injected, catheter for continuous infusion placed, and 0.2% ropivacaine started at 3 - 5ml/hr titrated to maintain VAS<2/10 postoperatively.
8. In the femoral block again , 20cc of 0.2% ropivacaine injected, catheter for continuous infusion placed, and 0.2% ropivacaine started at 3 -5ml/hr titrated to maintain VAS<2/10 postoperatively.
9. TKA surgery started and vitals noted at every 15 min intraoperatively.
10. Rescue analgesia-patient will be assessed for pain at different time intervals using NRS scale. In subjects with NRS>4 first line of rescue drug will be non-opioid followed by opioid
11. Nerve blocks were done with the help of real time ultrasonographic guidance. The FUJIFILM SonoSite MicroMaxx Ultrasound machine was used in our study. For IPACK block we used the curved transducer 5-2Mhz, for Fascia iliaca compartment block and femoral nerve block we used the linear transducer 13-6Mhz. write it in paragraph wise in concise form

**Details of the iPACK block technique:**

1. The patient was placed in supine position.
2. Part preparation done with chlorhexidine solution and sterile drapes were applied
3. Place the transducer transversely over the medial aspect of the knee, approximately 2-3 cm above the patella. Slide the transducer proximally/distally to identify the distal femoral shaft and popliteal artery.
4. If the femoral condyles are initially visualized, slide the transducer proximally until the condyles disappear, and the femoral shaft is identified. Use color Doppler to facilitate the

identification of the popliteal vessels. Insert the needle in-plane, from the antero-medial aspect of the knee, toward the space between the popliteal artery and femur. When the posterior aspect of the popliteal artery is reached, inject 2 mL of the local anaesthetic to confirm proper needle position. An adequate spread should layer the local anaesthetic in the space between the popliteal artery and femur shaft.

5. In this area, we injected 20 cc of 0.2% Ropivacaine solution.

**Details of the Femoral nerve block and catheter placement**

1. This nerve block is typically performed with the patient in supine position.
2. Part preparation done with chlorhexidine solution and sterile drapes were applied.
3. The transducer is then placed transversely on the femoral crease, over the pulse of the femoral artery, and moved slowly in a lateral-to-medial direction to identify the artery
4. The nerve, was then identified, lying lateral to the vessel and covered by the fascia iliaca, it is typically hyperechoic and roughly triangular or oval in shape . If the nerve is not immediately apparent lateral to the artery, tilting the transducer proximally or distally often helps to image and highlight the nerve from the iliacus muscle and the more superficial adipose tissue .Also we used colour flow doppler to identify vessels and compression to help differentiate between arteries and veins.
5. Once the femoral nerve is identified, the needle is inserted in-plane in a lateral to medial orientation and advanced toward the femoral nerve
6. Upon visualisation of the tip of the needle next to the nerve we aspirated to check for the intravascular puncture subsequently repositioning the needle tip inferior to the nerve so that the local anaesthetic elevates the nerve and separate it from the artery rather than push it away. Then we injected local anaesthetic aspirating after every 5ml, observing both the image of local anaesthetic spread and the patient for signs of discomfort or toxicity.
7. Spread was directly visualised below the fascia iliaca and surrounding, isolating and highlighting the nerve, scanning up and down the thigh to view the extent of the local anaesthetic spread and nerve envelopment.
8. The next phase of the procedure was maintaining the needle in the proper position and inserting a catheter 2 to 4 cm past the needle tip into the space surrounding the femoral nerve. Catheter position was confirmed on ultrasound as the catheter was being inserted and/or with an injection through the catheter to document its proper location. The catheter was then secured by tunnelling and antiseptic dressing was applied over it.

**Details of the fascia iliaca compartment block and catheter placement:**

- This nerve block is performed with the patient in the supine position.
- Part preparation done with chlorhexidine solution and sterile drapes were applied.
- The pulsating femoral artery is then visualized by placement of the transducer transversely on the inguinal crease, followed by slow movement laterally or medially.
- Other landmarks like hyperechoic fascia iliaca superficial to the hypoechoic iliopsoas muscle are identified by tilting the probe while pressing. Also, medially the femoral nerve can be visualized lying deep to the fascia and lateral to the femoral artery .

- The transducer is then moved laterally until the typical triangular shaped sartorius muscle is identified. The needle is then inserted in-plane. As the needle passes through fascia iliaca, the fascia is first seen indented by the needle. And as the needle eventually pierces the fascia, a "pop" may be felt, and the fascia may be seen to "snap" back on the ultrasound image. After negative aspiration, 1–2 mL of local anesthetic is injected to confirm the proper injection plane between the fascia and the iliopsoas muscle.
- A proper injection will result in the separation of the fascia iliaca by the local anesthetic in the medial–lateral direction from the point of injection as described. Releasing the pressure of the transducer may reduce the resistance to injection and improve the distribution of local anesthetic.
- The success of the block is best predicted by documenting the spread of local anesthetic toward the femoral nerve medially and underneath the sartorius muscle laterally
- The next phase of the procedure was maintaining the needle in the proper position and inserting a catheter 2 to 4 cm past the needle tip into the space. Catheter position was confirmed on ultrasound as the catheter was being inserted and/or with an injection through the catheter to document its proper location. The catheter was then secured by tunnelling and antiseptic dressing was applied over it.
- In case of inadequate nerve blockade, failure of block, catheter dislodgement etc; we used intravenous fentanyl for rescue analgesia. The upper limit for cut off of NRS scoring for opioid use was 6.
- Lastly, in face of any complications arising due to study intervention or otherwise, we managed it according to standard protocol and excluded the patient from the study when required.

**Methods of Measurement and Data Collection:**

Postoperative pain was primarily assessed using the Numerical Rating Scale (NRS), recorded at rest and during mobilization at 2, 6, 12, and 24 hours post-surgery. Patients self-reported their pain levels, with scores ranging from 0 (no pain) to 10 (worst possible pain), and categorized as mild (1–3), moderate (4–6), or severe (7–9). In addition to pain scores, the requirement for rescue analgesics—both non-opioid and opioid—was documented within the first 24 hours, along with the total amount of local anaesthetic used.

Quadriceps muscle strength was evaluated 24 hours postoperatively using the Manual Muscle Testing (MMT) method, conducted by a physiotherapist. Patient satisfaction was recorded qualitatively at the end of 24 hours as either satisfied or not satisfied, and also scored using a three-point scale: 1 for very satisfied, 2 for satisfied, and 3 for not satisfied. Any complications encountered were noted and managed accordingly. Vital parameters, including pulse rate, non-invasive blood pressure (NIBP), and oxygen saturation ($SpO_2$), were monitored and documented to support pain and safety assessments.

All relevant information was systematically recorded using data collection forms. These forms included a serial identification number, demographic details (age, sex, weight), ASA grading, assigned group (FICB or FNB), NRS scores, vitals charting, MMT results, rescue analgesic usage, presence of complications, and patient satisfaction scores. Prior to the

intervention, the procedure was explained in detail to all patients, and informed written consent was obtained during the preoperative period.

| OXFORD SCALE EXPLANATION | |
|---|---|
| 0 | No contraction is present. |
| 1 | There is flicker contraction. |
| 2 | Full ROM with gravity counter balanced (Eliminated). |
| 3 | Full ROM against gravity. |
| 4 | Full ROM against gravity + added resistance. |
| 5 | Muscle functions normally. |
| ROM – Range Of Motion | |

**Statistical analysis**

Post-operative pain relief will be measured by NRS and compared between the two groups by Student t-test at different points in time. A significance level of 5% was used for statistical tests.

**Observation & Results**

In this research with 62 patients receiving total knee arthroplasty, the average age of the participants was similar in the FICB (62.65 ± 9.06 years) and FNB (65.16 ± 9.09 years) groups ($p=0.28$) as displayed in table 1. The distribution of ASA grading was comparable in both groups as shown in table 2. The intraoperative and postoperative vital signs, such as pulse rate and blood pressure, were mainly similar; however, at the 24-hour mark, the pulse rate was notably reduced in the FICB group ($p=0.02$), as indicated in table 3. Muscle strength assessed through MMT demonstrated considerably improved retention in the FICB group, with a reduced number of patients displaying Grade 2 weakness ($p=0.002$), as illustrated in table 4. Postoperative pain scores measured using NRS at stress were significantly reduced in the FICB group at 2, 12, and 24 hours ($p<0.01$), indicating improved analgesia as displayed in table 5. The quantity of non- opioid analgesics administered over 24 hours was markedly reduced in the FICB group ($p<0.001$) as indicated in table 6; while the difference in opioid usage did not attain statistical significance ($p=0.33$), fewer patients in the FICB group needed opioids as presented in table 7. The overall ropivacaine amount administered during the intraoperative and 24-hour postoperative phases was considerably reduced in the FICB group (236.13 ± 17.45 mg vs. 280.32 ± 31.67 mg; $p<0.001$), reflecting a more effective use of analgesics as demonstrated in table 8. Satisfaction among patients was greater in the FICB group, although the difference was not statistically significant ($p=0.29$) as indicated in table 9. Complication rates were low in both

groups, with nausea slightly more common in the FICB group, but this difference was not significant shown in table 10.

**Table1: Comparison of mean age between Pulse rate (at different interval) both groups**

| Parameter | Time Point | FICB Group (n=31) | FNB Group (n=31) | p-value |
|---|---|---|---|---|
| **Mean Age** | — | 62.65 ± 9.06 | 65.16 ± 9.09 | 0.28 |
| **Pulse Rate (beats/min)** | Pre-op | 77.13 ± 7.30 | 76.23 ± 6.94 | 0.62 |
| | 2 hours | 76.10 ± 6.73 | 77.26 ± 7.08 | 0.51 |
| | 6 hours | 74.13 ± 4.93 | 74.94 ± 6.23 | 0.57 |
| | 12 hours | 70.29 ± 4.98 | 72.03 ± 7.25 | 0.27 |
| | 24 hours | 69.32 ± 4.23 | 72.90 ± 7.67 | 0.02 |

**Table2: ASA grading between both study group**

| ASA grade | FICB group (n=31) | | FNB group (n=31) | | p value |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| Grade II | 12 | 38.7 | 11 | 35.5 | 0.79 |
| Grade III | 19 | 61.3 | 20 | 64.5 | |

**Table3: Systolic and Diastolic BP (mmHg) between both study groups at different interval**

| SBP | FICB group (n=31) | FNB group (n=31) | p value |
|---|---|---|---|
| Preop | 126.19±11.08 | 124.06±9.64 | 0.42 |
| 2 hrs | 126.65±7.18 | 131.48±12.84 | 0.07 |
| 6 hrs | 127.39±8.80 | 126.06±13.04 | 0.64 |
| 12 hrs | 129.10±12.24 | 128.97±12.72 | 0.96 |
| 24 hrs | 122.94±11.51 | 122.97±8.76 | 0.99 |
| **DBP** | **FICB group (n=31)** | **FNB group (n=31)** | **p value** |
| Preop | 74.23±7.97 | 73.74±7.92 | 0.81 |
| 2 hrs | 76.81±5.81 | 76.26±7.02 | 0.73 |
| 6 hrs | 74.71±5.28 | 76.58±7.83 | 0.27 |

| | | | |
|---|---|---|---|
| 12 hrs | 71.87±8.93 | 75.71±7.87 | 0.07 |
| 24 hrs | 69.0±5.76 | 72.58±9.48 | 0.07 |

**Table4: MMT scale at24 hrs in both groups**

| MMT scale | FICB group (n=31) | | FNB group (n=31) | | p value |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| 2 | 16 | 51.6 | 28 | 90.3 | **0.002** |
| 3 | 15 | 48.4 | 3 | 9.7 | |

**Table5: Post operative pain assessment between both study groups at different intervals**

| NRS at stress | FICB group (n=31) | FNB group(n=31) | p value |
|---|---|---|---|
| 2 hrs | 2.32±0.47 | 3.16±1.32 | **<0.01** |
| 6 hrs | 2.71±0.82 | 3.03±1.16 | 0.37 |
| 12 hrs | 2.68±1.11 | 3.45±0.99 | **<0.01** |
| 24 hrs | 1.87±0.84 | 2.55±0.62 | **<0.001** |

**Table6: Number of non-opioid in 24 hrs between both groups**

| No of non opioid | FICB group (n=31) | | FNB group (n=31) | | p value |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| 0 | 15 | 48.4 | 2 | 6.7 | **<0.001** |
| 1 | 13 | 41.9 | 11 | 36.7 | |
| 2 | 3 | 9.7 | 17 | 56.7 | |

**Table7: Need of opioids in 24 hrs between both groups**

| Need of opioids in 24 hrs | FICB group (n=31) | | FNB group (n=31) | | p value |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| No | 27 | 87.1 | 23 | 74.2 | 0.33 |
| Yes | 4 | 12.9 | 8 | 25.8 | |

**Table8: Comparison of total dose of local anaesthetic during intraoperative +24 hrs postoperative period between both the groups**

| | FICB group (n=31) | FNB group (n=31) | p value |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Total dose of ROPIN during intraoperative +24hr postoperative | 236.13±17.45 | 280.32±31.67 | **<0.001** |

**Table9: Patient satisfaction between both study groups**

| Patient satisfaction score | FICB group (n=31) | | FNB group (n=31) | | p value |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| 1 | 22 | 71.0 | 17 | 54.8 | 0.29 |
| 2 | 9 | 29.0 | 14 | 45.2 | |

**Table10: Complications between both groups**

| Complications | FICB group (n=31) | | FNB group (n=31) | | p value |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| No | 27 | 87.1 | 30 | 96.8 | 0.35 |
| Nausea | 4 | 12.9 | 1 | 3.2 | |

## Discussion

The current research sought to evaluate the effectiveness of ultrasound-guided fascia iliaca compartment block (FICB) versus femoral nerve block (FNB) for postoperative pain relief in patients undergoing total knee arthroplasty (TKA). Both groups were similar regarding baseline demographic factors, including average age and ASA grading, thereby reducing potential confounding variables. In the research conducted by Hasan Kandali et al., the average age of subjects in the FICB Group was 62.64±10.70 years, whereas in the FNB group, the average age was 66.96±7.90 years [9].

Hemodynamic factors such as pulse rate and blood pressure stayed consistent in both groups during the perioperative phase. Nonetheless, a statistically significant decrease in pulse rate at 24 hours in the FICB group (p=0.02) could imply enhanced autonomic stability or diminished pain-related sympathetic stimulation in this group. Usha Shukla et al. reported comparable findings, indicating that there was no statistically significant difference between the three groups (FICB, FNB, control) concerning the mean arterial pressure and heart rate at every time interval [10]. A different investigation conducted by Nihal G.E Nooh et al. involving 60 patients undergoing lower limb surgeries, contrasted general anaesthesia with continuous FICB and general anaesthesia with epidural analgesia [11].

Crucially, higher MMT ratings (p=0.002) indicated that the FICB group preserved muscle strength considerably better. This implies that FICB might provide the benefit of motor-sparing analgesia, which is essential for early movement and recovery following total knee arthroplasty. At important time points (2, 12, and 24 hours postoperatively), the FICB group consistently and significantly had lower pain scores measured by the numeric rating scale (NRS) at stress,

suggesting more effective analgesia. The decreased requirement for non-opioid analgesics ($p<0.001$) and a trend toward lower opioid consumption—though the latter did not achieve statistical significance ($p=0.33$)—further supported this. These results demonstrate FICB's capacity to spare opioids, which is an important factor in improved recovery after surgery (ERAS) procedures. Similar to our findings, a study by Fan et al. found no statistically significant difference in opioid intake between FNB and FICB at 12, 24, and 48 hours after surgery [12]. In their research, Semih Baskan et al. found a statistically significant difference ($p<0.05$) between the two groups (FNB & FICB) in terms of requests for more analgesia at the two and eight-hour marks [13].

The FICB group showed more effective use of local anesthetics, as seen by the much lower total dose of ropivacaine needed throughout the intraoperative and 24-hour postoperative periods. The FICB group had greater patient satisfaction ratings, although the difference was not statistically significant. Only mild nausea was observed more frequently in the FICB group, which had no discernible impact on results. Complication rates were modest in both groups. Hasan Kandli et al. investigated how FICB and FNB affected pain in the first 24 hours following total knee arthroplasty. The Visual Analog Scale (VAS) values at 30 minutes, 1 hour, 2 hours, 6 hours, and 12 hours after surgery did not show any discernible changes. However, the FICB group's VAS level at 24 hours ($2.1\pm0.8$) was considerably lower than the FNB group's ($2.64\pm0.71$, $P=0.002$) [9]. In a related trial, Fan et al. examined how FICB and FNB affected established pain in the first 48 hours following total knee arthroplasty. However, they did not find any significant differences in VAS pain scores at 12, 24, and 48 hours after surgery [13]. Xiao-yan Zhang et al.'s study [14] likewise confirmed the results of our investigation. For the purpose of reducing postoperative pain in elderly patients who had hip replacement surgery under general anesthesia, Yu et al. conducted a comparison between continuous FICB and continuous FNB [15]. After a 24-hour period, postoperative VAS scores were similar in both groups. When combined, these findings imply that FICB offers analgesia that is on par with or better than FNB, along with other advantages such improved preservation of motor function, less need for analgesics, and a lower dosage of local anesthetic.

## Conclusion

For postoperative analgesia following total knee replacement, ultrasound-guided fascia iliaca compartment block (FICB) provides a secure and efficient substitute for femoral nerve block (FNB). FICB uses less local anaesthetic, maintains muscle strength, and decreases the need for additional analgesics in addition to offering improved pain relief at different postoperative intervals. Although both methods are clinically feasible, FICB seems to have a number of benefits that justify its application in improved recovery protocols, making it a better choice for multimodal pain treatment in total knee arthroplasty.

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