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Femoral Nerve Block Combined with Sciatic Nerve Block, Adductor Canal Block or (Interspace between the Popliteal Artery and The Capsule of the Posterior Knee) Ipack Block for Postoperative Analgesia after Major Knee Surgeries: A Randomized trial

Mostafa Saieed Mansour*, Amany Ammar, Yasser Fathy, Mohamed Elganainy, Tarek Elhennawy
Department of Anesthesiology, Intensive Care and Pain Management,
Faculty of Medicine, Menoufia University, Egypt
***Corresponding Author:** Mostafa Saieed Mansour, **Mobile:** (+20) 1225484055, **E-mail:** dr.mostafa_s_fahim@yahoo.com

ABSTRACT

Background: Since unmanaged pain might result in further difficulties, postoperative analgesia is essential to a complete recovery. Improved pain control and faster mobilization following knee surgeries are achieved by combining femoral nerve block with sciatic nerve block and adductor canal block (ACB), or infiltration between the popliteal artery and the capsule of the knee (IPACK) for postoperative analgesia following major knee surgeries.

Objective: This study aimed to compare local anesthetic IPACK with ACB or sciatic nerve block (anterior approach) in conjunction with femoral nerve block. **Methods:** Cases between the ages of 40 and 75 undergoing major knee surgery were the subjects of this double-blind, randomized trial that was conducted at Menoufia University Hospitals. All volunteers received femoral nerve block and general anesthesia before being randomly assigned to one of three cohorts: IPACK, ACB and sciatic nerve block (SNB). Over the course of 48 hours, the research assessed pain, morphine use, surgical time, and complications following surgery. **Results:** The IPACK cohort experienced the least amount of discomfort, the longest period of time before receiving more analgesia, and the least amount of opiate use. The IPACK cohort also consumed the least amount of morphine and paracetamol overall. All cohorts showed similar complications and case satisfaction, with IPACK and ACB having a minor edge over sciatic nerve block.

Conclusion: Compared to ACB and SNB, the IPACK block plus a femoral nerve block produced better pain alleviation, decreased opioid consumption, and postponed further analgesia, while maintaining comparable hemodynamic stability and complication rates.

Keywords: Acute postoperative pain, ACB, IPACK, Analgesia, SNB.

INTRODUCTION

An essential component of a successful surgical outcome is postoperative analgesia. The likelihood of postoperative complications rises when postoperative pain is not managed [1, 2]. Following knee surgery, the most successful analgesic method is still epidural analgesia with catheterization. It is limited, nevertheless, in individuals who are taking anticoagulants and have heart problems because of severe hemodynamic abnormalities, which could be harmful to them [3]. Following total knee arthroplasty (TKA), the acute postoperative pain is so intense that appropriate analgesia is required, which is a case' right and avoids the negative effects of pain on different bodily systems [4, 5]. For major knee surgeries, femoral nerve blocks are the gold standard for analgesia. They can be coupled with additional blocks to provide even more effective analgesia. A varied strip of skin on the medial leg and foot, as well as numbness of the anterior and medial thighs down to and including the knee, are the effects of femoral nerve block [6, 7]. A local anesthetic when combined with femoral canal block following major knee surgeries, IPACK, ACB, and sciatic nerve block may be effective methods for managing postoperative pain [8, 9]. Cases having total knee arthroplasty may benefit from early mobilization and perioperative pain management when femoral nerve block is combined with either of these blocks [10].For postoperative analgesia following major knee surgeries, the research compared the effects of local anesthetic IPACK with ACB or sciatic nerve block (anterior approach) in conjunction with femoral nerve block.

PATIENTS AND METHODS

This investigation was carried out at Menoufia University Hospitals as a comparative, double-blinded, randomized experiment. Cases with ASA I or II physical status who were scheduled for elective major knee surgery and were between the ages of 40 and 75 were included in the trial.

Exclusion criteria: Cases with psychological issues, preexisting coagulation disorders, known allergies to amino amide local anesthetics, local infection at the block site, morbid obesity, hepatic or renal illnesses, and reluctance to give informed consent.

Using computerized randomization, cases were divided into three cohorts at random, with an equal number of cases in each cohort:

- **Cases in cohort I:** They got 20 ml of 0.25% bupivacaine for ultrasound-guided local anesthetic IPACK.
- **Cases in Cohort A:** They received 20 ml of 0.25% bupivacaine for ultrasound-guided adductor canal block**.**
- **Cases in cohort S:** They received an anterior approach sciatic nerve block guided by ultrasonography, along with 20 ml of 0.25% bupivacaine.

Preoperative assessment: A thorough medical check was part of the preoperative evaluation, which was carried out at the Orthopedic Surgery preadmission clinic two weeks before to surgery. Cases were informed about the research and the type of anesthetic during this

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session, and their consent was acquired. Additionally, preoperative laboratory tests were finished. Cases learned how to utilize the VAS, which ranges from 0 (no pain) to 10 (worst agony imaginable), as part of the anesthetic assessment. Continuous ECG, pulse oximetry, and NIBP were used for monitoring as soon as the case arrived in the operation room. After inserting an IV-line, 0.03 mg/kg of IV midazolam was administered to induce drowsiness. All cases had the same general anesthetic and femoral nerve block. Only the anesthesiologist who performed the nerve block knew about the randomization. Data collection was handled by another anesthesiologist. When the case was admitted to the operating room, their baseline HR and MAP were noted. Fentanyl (1 µg/kg), propofol (2 mg/kg), and atracurium (0.5 mg/kg) were used to induce general anesthesia, which was followed by tracheal intubation. Oxygen, isoflurane, and volume-controlled breathing were used to maintain anesthesia. Administering morphine for elevated HR or MAP, modifying the level of anesthesia, giving ephedrine for hypotension, and utilizing atropine for bradycardia were the methods used to treat intraoperative hemodynamic abnormalities. After surgery, cases received 100% oxygen, isoflurane was stopped, and intravenous neostigmine (0.04 mg/kg) and atropine were used to reverse the neuromuscular blockade. When the case began to exhibit symptoms of recovery, such as spontaneous eye opening and a sufficient cough reflex, extubation took place.

Femoral nerve block technique: The case was placed in a supine posture for the femoral nerve block, and the skin covering the femoral crease was cleaned. To locate the femoral artery and nerve, the transducer was positioned. A spinal needle (22G x 3.5 inches) was placed latero-medially toward the femoral nerve once it was visualized lateral to the femoral artery. 20 ml of 0.25% bupivacaine was gradually delivered with cautious aspiration, making sure the needle moved the femoral nerve away from the injection site.

IPACK Block (Cohort I): The case was placed in a supine position with a little bending of the knee for the IPACK block. A 22G x 3.5-inch spinal needle was moved from the lateral aspect toward the area between the popliteal artery and the femur following skin infiltration with 2 cc of 1% lidocaine. Following confirmation of negative aspiration, 20 ml of 0.25% bupivacaine was gradually given once the needle had reached the medial edge of the femur.

Adductor canal block (Cohort A): The transducer was positioned anteromedialy for the adductor canal block, roughly where the middle and distal thirds of the thigh meet. The needle was placed toward the femoral artery in a lateral-to-medial position following skin disinfection. After negative aspiration was verified and the needle tip was in front of the artery, 20 milliliters of 0.25% bupivacaine were gradually administered.

Sciatic nerve block anterior approach (Cohort S): The case was positioned supine with the leg externally rotated and the hip and knee flexed for the anterior approach to the sciatic nerve block. To locate the sciatic nerve, the ultrasound transducer was placed about 8 cm distal to the inguinal crease. A 22G × 3.5-inch spinal needle was moved parallel to the ultrasound transducer, from anteromedial to posterolateral, until it was in close proximity to the nerve following skin sterilization and infiltration with 2 ml of 1% lidocaine. Following confirmation of a negative aspiration, 20 milliliters of 0.25% bupivacaine were gradually administered.

Assessment parameters: Throughout the trial, a number of parameters were documented, including hemodynamic measures (MAP & pulse) at different intervals, the number of dermatomes blocked, and case characteristics (age, weight, and sex). Baseline, every hour for the first six hours after surgery, every four hours for the next twenty-four hours, during post-Anesthesia Care Unit (PACU) admission, and every fifteen minutes after general anesthetic induction were among them. The research also monitored the amount of intraoperative morphine used overall, the number of cases who needed it, and the number of cases who required atropine and/or ephedrine at the appropriate dosages. The time of the initial request for analgesia (VAS ≥ 4), the duration of the anesthesia and surgical procedures, and the use of morphine (2 mg IV, repeated after 20 minutes if VAS ≥ 5, up to 4 mg/h) for analgesia management were additional characteristics. Additionally, VAS scores upon PACU admission, hourly for the first 6 hours, and every 4 hours for the next 24 hours, as well as VAS during case movement during the first 48 hours, were recorded, along with the total amount of morphine used during the first 48 hours.
Lastly, the injection sites for the sciatic nerve block, adductor canal block, IPACK block, and femoral nerve block were checked for problems such hematomas or infection two- and twenty-four-hours following surgery.

Ethical approval: The Ethics Committee of the Menoufia Faculty of Medicine authorized this study. After receiving all of the information, each participant signed a permission. The study adhered to the Helsinki Declaration throughout its execution.

Statistical analysis

This study's statistical analysis was carried out using SPSS version 23.0. After determining if the data had a normal distribution using the Shapiro-Wilk and Kolmogorov-Smirnov tests, the data were either shown as a median with interquartile range or Mean ± SD. A one-way ANOVA with Tukey's post hoc test was used for parametric comparisons, while the Kruskal-Wallis and Mann Whitney U tests were used for non-parametric data. Fisher's exact test and chi-square test were used for categorical data. With a 5% margin of error, the 95% confidence interval was employed. P-values were classified as significant if they were ≤ 0.05, highly significant if they were ≤ 0.001, and insignificant if they were > 0.05.

RESULTS

Cohort S had the highest mean values of monitored anesthesia care (MAC) and morphine (mg), followed by Cohort A and then Cohort I (with P < 0.05). In contrast, there was no significant difference in fentanyl levels between the cohorts (with P > 0.05) (Table 1).

Table (1): Comparison between cohorts according to intraoperative anesthetic consumption

Anesthetic consumption	Cohort I (n=50)	Cohort A (n=50)	Cohort S (n=50)	Test value	p-value	P1	P2	P3
MAC								
Mean ± SD	1.28 ± 0.19	1.30 ± 0.19	1.44 ± 0.32	5.993	0.003*	0.622	0.002*	0.007*
Min-Max	1.2-2	1.2-2	1.2-2					
Morphine (mg)								
Mean ± SD	0.24 ± 0.52	0.34 ± 0.56	0.64 ± 0.83	5.149	0.007*	0.442	0.002*	0.022*
Min-Max	0-2	0-2	0-2					

P1: p-value related comparison between Cohort I and Cohort A
P2: p-value related comparison between Cohort I and Cohort S
P3: p-value related comparison between Cohort A and Cohort S

There was a statistically significant highest mean value of first call for rescue analgesia (hrs.) in cohort I, followed by cohort A and then the cohort S, with p-value (P < 0.05) (Table 2).

Table (2): Comparison between cohorts according to first call for rescue morphine analgesia (hrs.)

First call for rescue analgesia (hrs)	Cohort I (n=50)	Cohort A (n=50)	Cohort S (n=50)	Test value	p-value	P1	P2	P3
Mean ± SD	3.98±0.62	3.70±0.51	3.58±0.50	7.093	<0.001**	0.011*	<0.001**	0.273
Min-Max	3-5	3-5	3-4					

There was a statistically significant highest median value of VAS score at rest in cohort S, followed by cohort A and then the cohort I, with p-value (p<0.05), at postoperative 4 hrs, postoperative 6 hrs and postoperative 24 hrs (Table 3).

Table (3): Comparison between cohorts according to VAS at rest

VAS at rest	Cohort I (n=50)	Cohort A (n=50)	Cohort S (n=50)	Test value	p-value	P1	P2	P3
Post Op. 1hr.								
Median (IQR)	0(0-1)	0(0-1)	0(0-1)	4.302	0.116	0.040*	0.394	0.226
Min-Max	0-1	0-1	0-1					
Post Op. 2hr.								
Median (IQR)	1(1-1)	1(1-1)	1(1-1)	0.000	1.000	1.000	1.000	1.000
Min-Max	1-1	1-1	1-1					
Post Op. 4hr.								
Median (IQR)	1(1-2)	3(1-3)	3(1-3)	24.803	<0.001**	<0.001**	<0.001**	0.210
Min-Max	1-3	1-4	1-3					
Post Op. 6hr.								
Median (IQR)	2(2-2)	4(4-4)	5(4-5)	94.728	<0.001**	<0.001**	<0.001**	<0.001**
Min-Max	2-5	2-5	2-5					
Post Op. 12hr.								
Median (IQR)	2(2-3)	2.5(2-3)	2(2-3)	2.619	0.270	0.123	0.682	0.250
Min-Max	2-3	2-4	2-3					
Post Op. 24hr.								
Median (IQR)	2(2-3)	3(2-3)	4(3-4)	52.068	<0.001**	0.003*	<0.001**	<0.001**
Min-Max	2-4	2-4	2-4					

There was a statistically significant highest median value of VAS score in cohort S, followed by cohort A and then the cohort I (with P < 0.05), at postoperative 2 hrs to end follow up **(**Table 4).

Table (4): Comparison between cohorts according to VAS with movement

VAS	Cohort I (n=50)	Cohort A (n=50)	Cohort S (n=50)	Test value	p-value	P1	P2	P3
Post Op. 1hr.								
Median (IQR)	1 (1-2)	1 (1-2)	1 (1-2)	2.185	0.116	0.060	0.407	0.215
Min-Max	1-2	1-2	1-2					
Post Op. 2hr.								
Median (IQR)	2 (2-2)	3 (2-3)	3 (2-3)	17.614	<0.001**	<0.001**	<0.001**	0.656
Min-Max	2-3	2-3	2-3					
Post Op. 4hr.								
Median (IQR)	3 (3-4)	5 (3-5)	5 (3-5)	15.518	<0.001**	<0.001**	<0.001**	0.173
Min-Max	3-5	3-6	3-5					
Post Op. 6hr.								
Median (IQR)	3 (3-4)	4 (3-5)	5 (5-5)	27.582	<0.001**	<0.001**	<0.001**	<0.001**
Min-Max	3-5	3-5	4-5					
Post Op. 12hr.								
Median (IQR)	3 (3-4)	3 (3-5)	4 (4-5)	4.332	0.038*	0.171	0.039*	0.032*
Min-Max	3-5	3-5	3-5					
Post Op. 24hr.								
Median (IQR)	3 (3-4)	4 (3-4)	5 (4-5)	17.385	<0.001**	0.004**	<0.001**	<0.001**
Min-Max	3-5	3-5	3-5					

There was a statistically significant highest morphine consumption “mg” in cohort S, followed by cohort A and then the cohort I (with P = 0.001), at postoperative 2 hrs to post-operative 24 hrs and total morphine consumption “mg” **(**Table 5).

Table (5): Comparison between cohorts according to postoperative morphine consumption (mg)

Morphine Consumption (mg)	Cohort I (n=50)	Cohort A (n=50)	Cohort S (n=50)	Test value	p-value	P1	P2	P3
Post Op. 2hrs.								
Median (IQR)	0(0-0)	0(0-0)	0(0-0)	0.000	1.000	1.000	1.000	1.000
Min-Max	0-0	0-0	0-0					
Post Op. 6hrs.								
Median (IQR)	2(2-2)	2(2-2)	2(2-2)	15.519	<0.001**	0.004*	<0.001**	0.442
Min-Max	1-2	1-3	2-4					
Post Op. 12hrs.								
Median (IQR)	1(1-2)	2(1-3)	3(2-3)	57.816	<0.001**	<0.001**	<0.001**	<0.001**
Min-Max	0-2	1-3	1-4					
Post Op. 24hrs.								
Median (IQR)	0(0-0)	1(1-2)	2(2-3)	90.437	<0.001**	<0.001**	<0.001**	<0.001**
Min-Max	0-2	0-4	0-4					
Total 24h morphine								
Median (IQR)	3(3-4)	5(4-7)	7(6-8)	85.748	<0.001**	<0.001**	<0.001**	<0.001**
Min-Max	2-6	2-9	3-10					

DISCUSSION

The purpose of this research was to assess the efficacy of three regional anesthesia approaches for postoperative pain control in major knee surgeries: Sciatic nerve block (anterior approach), local anesthetic IPACK, and ACB, when paired with femoral nerve block. When opiate use, the period until the case requests analgesia for the first time, and overall case satisfaction are secondary objectives, the main goal was to use the VAS to measure pain levels both at rest and when moving.

Comparing the IPACK approach to the other two, the results showed that it lowered opioid use, improved pain alleviation, and postponed the need for additional analgesia. Over time, cases who got the IPACK block reported less pain and used less morphine and paracetamol after surgery. The sciatic nerve block cohort had higher anesthetic and opioid requirements, with earlier analgesia requests and higher pain scores, even though hemodynamic parameters were constant across all cohorts. Each of the three methods showed a similar safety profile with few issues. Because IPACK and ACB approaches provided better pain control, case satisfaction was higher in these cohorts. These findings imply that for postoperative analgesia following large knee surgeries, the IPACK block would be a better choice. In a similar vein, **Qiao *et al.*** [11] discovered that IPACK block dramatically reduced postoperative opioid needs when paired with multimodal analgesia. On the other hand, **Nakase *et al.*** [12] found that sciatic nerve block, especially in conjunction with femoral nerve block, effectively relieved pain after anterior cruciate ligament replacement, despite being linked to an increased risk of motor blockage.

Due to the sciatic nerve block's emphasis on the posterior knee, which may have left some anterior knee pain untreated, the sciatic nerve block cohort in our research consumed more morphine. According to **Kampitak *et al.*** [13], sciatic nerve blocks are useful for treating posterior knee discomfort, but they don't offer complete pain relief for anterior knee tissues.

The sciatic nerve block cohort had the greatest MAC, while the IPACK cohort had the lowest, according to the research. Similarly, the IPACK cohort used the least amount of morphine, whereas the sciatic nerve block cohort consumed the most. These findings imply that the IPACK approach may reduce the requirement for opioids by providing more effective analgesia. Results from **Et *et al.*** [14] found that including an IPACK block into the ACB enhanced postoperative analgesia and decreased opioid usage. Additionally, **Domagalska *et al.*** [15] showed that, in comparison with alternative methods, IPACK and ACB combos dramatically reduce opioid usage. Besides, IPACK block cases used fewer opioids and spent less time in the hospital, according to **Eccles *et al.*** [16], confirming the technique's efficacy in multimodal analgesia.

Prior to requiring rescue analgesia, cases in the IPACK cohort waited the longest, followed by those in the ACB cohort. The sciatic nerve block cohort required analgesia the earliest. This implies that the IPACK approach has higher analgesic efficacy in postoperative pain delay.

Hussien *et al.* [17], however, discovered that femoral-sciatic blocks needed less rescue analgesia than the adductor-IPACK combination, suggesting that the efficacy of these methods may differ based on certain clinical settings. According to a related research by **Teixeira *et al.*** [18]**,** the IPACK block postpones the initial need for analgesia without affecting the case's mobility. Furthermore, **Tak *et al.*** [19] pointed out that when paired with IPACK, continuous adductor canal blocks may be more effective at prolonging the duration of analgesia.

When comparing IPACK and ACB with PAI, **Laoruengthana *et al.*** [20] discovered that the former resulted in improved postoperative pain management and decreased opiate consumption. In a similar vein, **Pryambodho *et al.*** [21] showed that proximal adductor canal block plus IPACK allowed for earlier mobilization following total knee replacement, supporting the notion that IPACK improves useful results. Other research, however, has indicated that although IPACK is useful, PAI might provide similar analgesic advantages when paired with multimodal pain management techniques [22]**.** After comparing IPACK, ACB, and PAI in more detail, **Knecht *et al.*** [23] found that although IPACK offered superior pain relief, PAI was still a good substitute in situations where nerve block knowledge or resources were scarce. However, other research has indicated that although IPACK helps manage pain, in certain situations, the benefit might not be appreciably greater than multimodal periarticular injections [24, 25]**.** This disparity could result from discrepancies in nerve block administration, case demographics, or surgical procedures.

At various time intervals, the IPACK cohort reported considerably lower postoperative pain scores than the other cohorts. The sciatic nerve block cohort had the highest pain scores. This is consistent with **Teixeira *et al.*** [18] findings, which showed that the IPACK block can help with early mobilization following total knee replacement without having a major effect on postoperative muscular strength. Similarly, a comprehensive review by **Guo *et al.*** [8] demonstrated that IPACK with ACB resulted in lower VAS scores than ACB alone. The addition of an IPACK block considerably lessens pain severity, particularly in the early postoperative phase, as **Roy *et al.*** [26] also confirmed.

The Sciatic Nerve Block cohort consumed much more morphine and paracetamol overall over the course of 24 hours, whereas the IPACK cohort consumed the least. This demonstrated even more how well the IPACK block works to lessen the need for opioids and enhance pain management. According to **Domagalska *et al.*** [15] the best analgesic impact is obtained when the IPACK block is combined with a peripheral nerve block, especially the ACB. This is consistent with research by

Kandil *et al.* [27] who showed that, in comparison with other nerve blocks, combining ACB with IPACK dramatically decreased postoperative opioid consumption. **Sikachi *et al.*** [28] contended, however, that while IPACK is successful in decreasing opioid use, its contribution to multimodal pain management should be maximized in conjunction with other tactics such systemic analgesics and periarticular injection. Furthermore, IPACK dramatically reduced postoperative opioid consumption while maintaining quadriceps function, as shown by **Zeng *et al.*** [29]. These results are consistent with previous research by **Anthony & Diaz** [30], who proposed that integrating IPACK into routine pain management procedures lowers the risk of opioid-related problems.

In knee arthroplasty cases, **Celik *et al.*** [31] contrasted epidural anesthesia with a combination of ACB and IPACK blocks. In comparison with the epidural anesthetic cohort, they discovered that the ACB with IPACK cohort experienced fewer side effects, better ambulation, and higher pain levels. These findings align with our research, which found that the IPACK cohort had lower pain scores and delayed requests for analgesia, indicating improved analgesic efficacy. In addition, the effects of ACB plus IPACK versus ACB alone on immediate postoperative rehabilitation following complete knee replacement were assessed by **Reddy *et al.*** [32]. According to their findings, the combination promoted early recovery and improved pain management. This confirms our findings that the IPACK approach provides better analgesia and encourages early mobility, particularly when paired with ACB.

The results of the research indicated that, in comparison with ACB and sciatic nerve block procedures, the IPACK technique provided better analgesia and lower opioid use when used in conjunction with a femoral nerve block. Nevertheless, other researches showed conflicting findings, suggesting that the usefulness of these methods may differ depending on particular clinical settings.

CONCLUSION

In major knee surgeries, this research showed that the IPACK block in conjunction with a femoral nerve block, offered better postoperative analgesia than the ACB and SNB. In order to improve pain management and lessen side effects, the IPACK approach considerably lowered postoperative VAS, delayed the time before the first analgesia request, and reduced opioid use. All cohorts maintained hemodynamic stability, and no appreciable variations in complications were noted. The IPACK block is a promising alternative for optimizing analgesia in knee surgeries because of its efficacy in improving postoperative pain management, while reducing the usage of opioids.

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