International Journal of Anesthesia and Clinical Medicine
2022; 10(2): 57-64
http://www.sciencepublishinggroup.com/j/ijacm
doi: 10.11648/j.ijacm.20221002.13

Continuous Adductor Canal Block (ACB) Versus ACB with Peri-Articular Injection and ACB with IPACK for Postoperative Analgesia in Total Knee Arthroplasty

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To cite this article:

Rabab Mohamed Mohamed, Jehan Mohammad Darwish Hamed. Continuous Adductor Canal Block (ACB) Versus ACB with Peri-articular Injection and ACB with IPACK for Postoperative Analgesia in Total Knee Arthroplasty. *International Journal of Anesthesia and Clinical Medicine*. Vol. 10, No. 2, 2022, pp. 57-64. doi: 10.11648/j.ijacm.20221002.13

Received: November 5, 2022; **Accepted**: December 7, 2022; **Published**: December 27, 2022

Abstract: *Background:* Acute postoperative pain after total knee arthroplasty (TKA) is so severe that patients are entitled to analgesia that avoids the detrimental effects of pain on several body systems. Objectives: This study compared the post-operative analgesic impact of continuous adductor canal block to that of adductor canal block with peri-articular injection (PAI) and adductor canal block (ACB) with infiltration of the interspace between the popliteal artery and the capsule of the posterior knee (IPACK) in TKA. *Patients and Methods:* This prospective randomized trial included 60 adult cases with severe knee osteoarthritis scheduled for elective TKA. Patients were randomly divided into three equal groups: group I received ACB and a continuous adductor canal block (CACB), group II received ACB and PAI, group III received ACB and IPACK. *Results:* Significant increase in NRS values was detected in CACB patients at 2h post operative (p=0.001) while a significant decrease in NRS in PAI group patients at 6h and 12 h post operative (All P values < 0.05) respectively. Motion ability was recorded through the use of Time Up and Go test (TUG) showed the shortest records in PAI block group than CACB and IPACK groups, p=0.001 at 12h post operative. At 24 h post operative, the IPACK group showed the shortest time records than PAI and CACB patients (p value < 0.05). *Conclusion:* In TKA, PAI has higher quadriceps muscle power and lower TUG and length hospital stay compared to ACB with IPACK and continuous ACB. ACB with PAI and ACB with IPACK are associated with better analgesia (prolonged action and lower morphine consumption) compared to continuous ACB.

Keywords: Analgesia, Adductor Canal Block, Peri-Articular, Infiltration, IPACK, Total Knee Arthroplasty

1. Introduction

Acute postoperative pain after total knee arthroplasty (TKA) is severe enough to need analgesia, which is a patient's legal entitlement and avoids the detrimental consequences of pain on several body systems. Inadequate pain management also prolongs hospital stays and rehabilitation periods and increases the probability that acute pain might occur into chronic pain [1]. Non-opioid analgesics alone are insufficient to provide appropriate analgesia following this kind of surgery, and opioids alone are often not supplied at ideal dosages due to their unpleasant side effects, like nausea, vomiting, respiratory depression, and the risk of addiction. Relatively lately, peripheral nerve blocks, like adductor canal block (ACB), femoral nerve block (FNB), and sciatic nerve block, were utilised to reduce pain following TKA [2].

In current years, ACB guided by ultrasonography is preferred on FNB for pain relief in TNK cases. The adductor canal extends from the apex of the femoral triangle to the adductor hiatus. The adductor canal includes the femoral artery and vein, as well as two fascicular branches of the femoral, vastus medialis, the saphenous nerves, and the articular contribution of the obturator nerve that enters the distal adductor muscle [3].

ACB reduces pain effectively without weakening the quadriceps. ACB is fewer efficient than before in alleviating posterior knee pain [4].

Recent ultrasound-guided local anaesthetic infiltration of

the interspace between the popliteal artery and the posterior knee capsule (IPACK) has been proven to give significant posterior knee analgesia without compromising the common peroneal nerve [5].

PAI is an analgesic provided by the surgeon to alleviate early postoperative pain without compromising quadriceps strength. It is a combination of treatment that frequently comprises a local anesthetic, tramadol, and morphine, but is not limited to these substances. It has demonstrated stronger analgesic properties than placebo [6].

It comprises epidural, intrathecal morphine, a single-shot FNB or ACB; ACB joined with local infiltration anesthesia. [7].

Therefore, quick and sufficient postoperative analgesia may allow the cases to practice and attain early movement perfection, hence reducing hospital stay length and enhancing functional recovery.

In order to determine the postoperative analgesic impact of continuous ACB vs ACB with PAI and ACB with IPACK in TKA, this research was conducted.

2. Patients and Methods

This prospective, randomized clinical research included sixty adults with severe knee osteoarthritis, ASA class I, II, or III, and planned to undergo TKA. The local ethics Committee authorized the research (code 35527). All patients provided a signed, informed consent form.

Exclusion criteria were sensitivity to local anesthetics, local infection at block site, progressing renal, cardiac and hepatic diseases, bleeding and coagulation disorders, preexisting lower extremity neurological abnormality and chronic utilization of pain medication.

2.1. Grouping and Allocation

Computer-generated random numbers were utilised to split patients into two equal groups. A second investigator opened the packet's seal (who had no other roles in the trial).

Sixty cases were randomly allocated into three equal groups: Group I obtained ACB and CACB, group II obtained ACB and PAI and group III obtained ACB and IPACK.

All nerve blocks were administered by a single anesthesiologist, while measurements were obtained by a 2nd anesthesiologist that was blind to the research groups and had no further participation with the study. The surgical procedures were done by the selfsame team of surgeons using medial approach with thigh tourniquet.

2.2. Anesthetic Technique

Preoperative assessment was obtained included complete history discussing, clinical assessment, routine laboratory tests (CBC, random blood sugar, coagulation profile, renal and liver function tests. Throughout the pre-anesthetic estimation, all cases were habituated with numeric rating scale (NRS) score. Standard monitors; 5 leads ECG, noninvasive blood pressure and pulse oximetry. To preserve hemodynamics, an intravenous line was inserted, and lactated Ringer's solution was given at a rate of 10mL/kg/h via a face mask.

Spinal anesthesia was conducted using midline path at the L3/4 or L4/5 interspaces with 3 ml 0.5% (15 mg) hyperbaric bupivacaine plus 25 μgm fentanyl using 25G Quincke needle. after stability of the block, antibiotics were given 30 min before surgery and every 8h post operative according to the regimen of orthopedic department. patients were sedated by midazolam 0.05 mg/kg and designed for administration of ACB. ACB was performed in all patients after spinal anesthesia, the IPACK block was Start after the ACB and before surgery in the IPACK group. PAI was done by surgeon after the surgery, and the CACB was done in PACU after the accomplishment of the surgery. All patients stayed in PACU for 2 hours for close observation and suitable management before shifting to the ward.

The postoperative anesthetic routine consists of paracetamol 1 g intravenously each 8 hours, ketorolac 30 mg each 12 hours, and release analgesia as 0.05 mg/kg of intravenous morphine when the NRS was greater than 3, with the total dose not exceeding 20 mg in 24 hours unless otherwise specified.

Equipment were sterile towels and gauze packs, 20 ml syringe with local anesthetic, sterile gloves, gel, betadine ® (Povidone-iodine), levobupivacaine 0.25% (Chirocaine®, Abbvie), 22-gauge regional needle block (Visioplex-Vygon ®) for infiltration of local anesthetic, ultrasound machine equipped with elevated frequency linear and low frequency curvilinear probe.

2.3. Regional Anesthesia Technique

ACB*:* A great incidence ultrasound linear probe was positioned transversely in mid-thigh halfway amidst the anterior superior iliac spine and the patella visualizing a short axis prospect of the femoral artery and saphenous nerve in the adductor canal. Under the sartorius muscle, the femoral artery was discovered, with the vein inferior and the saphenous nerve lateral to the artery (A 100 mm 22G block needle was integrated from the lateral side of the transducer using the in-plane technique within the sartorius muscle till the apex of the needle was slightly laterally of the artery and 20 mL of levobupivacaine 0.25% was inoculated.

Group I [Continuous ACB]: In order to expand the adductor canal during the ACB procedure, the endpoint of a Tuohy needle was positioned immediately adjacent to the artery and saphenous nerve, and 5mL of levobupivacaine containing 0.5 percent was administered. Four centimeters of a 20 G catheter were inserted via the cannula. Under ultrasound guidance, the catheter was gradually removed during the delivery of a bolus dosage until an expansion between the fascia and vasculature was noted, and then 5 mL.h-1 of 0.125 percent levobupivacaine was delivered.

Group II [Adductor + PAI]: Peri-articular injection (PAI): Through medial parapatellar arthrotomy, a single surgeon gave peri-articular (cocktail) injections intraoperatively. 50 milliliters were the total volume of the periarticular injection

combination. The solution contained 27.5 mL of normal saline, 20 mL of 0.25 percent levobupivacaine, 2 mL of ketorolac (30 mg), and 0.5mg (0.5mL) of adrenaline (4.5ugm/mL). Before implant insertion, the infiltrate was injected with a 21-gauge needle. The following areas were injected with the mixture: Medial compartment: medial retinaculum, medial collateral ligament, and medial meniscus capsular connection; posterior capsule; anterior compartment: Patellar tendon and fat pad, cut ends of quadriceps muscle and tendon, and subcutaneous tissue. The lateral compartment is composed of the lateral collateral ligament, the connection of the lateral meniscus to the capsular sheath, and the lateral retinaculum.

Group III [Adductor + IPACK group]: Technique of IPACK: The technicality was performed using the curvilinear ultrasound probe, the case is positioned in lateral view. Betadine will be applied to the popliteal fossa, and the ultrasonic probe will be inserted into the popliteal crease till the femoral condyles are visible. Then, the probe directed proximally till the condyles are no longer visible and the femoral shaft is discernible. In this position, the needle for the regional block is injected between the popliteal artery and the femur, 1-2 cm posterior to the lateral border of the artery, and 20 ml of 0.25 percent Levobupivacaine is injected.

The primary outcome was post-operative pain NRS from 0 to 10 (NRS; 0 no pain while 10 is the maximum pain) at 2,6 12, 24, 48 and 72 hours then every 6 hours for 24 hours at rest and at; 12, 24, 48 and 72 hours during physiotherapy.

The 2nd findings were time of first rescue analgesia, total morphine consumption post-operatively, the quadriceps muscle power which was assisted by Medical Research Council scale (MRC): The quadriceps muscle power was aided with cases in the supine positioning and raised straight leg at12h, and 24 h following doing the block using the MRC scale [8] graded from 0 to 5 (grade 0 = no voluntary contraction possible, grade 1 = muscle flicker, or trace of contraction but no movement of limb, grade 2 = active movement only with cancellation of the gravity, grade 3 = active motor against gravity without resistance, grade 4 = active motor against gravity with some resistance and grade 5= normal motor power against resistance.

Mobilization ability which was assisted by Timed Up-and-Go test (TUG): Mobilization capability was assessed at 12h and 24 h after performing the block using the TUG test [9] calculates time required for the case to rise from a chair, walk 3m, turn, return to the chair and sit down. As assisted aids throughout performing the test: all cases utilized a high walker with arm help. This test was only administered when the patient believed he would be able to stand and walk without falling.

2.4. Sample Size Calculation

The sample size calculation was performed by Minitab software statistical package designed by Pennsylvania state university, USA version 16. The calculation of the sample size was dependent on the level of postoperative NRS. Based on the results of the previous studies, [10] which demonstrated that the mean ± standard deviation in NRS with ambulation at 24 hours will be 1.7 ±1.6 points, 18 patients was required per group to detect difference of 2 points in the pain score and achieve a power of 95% and confidence interval of 95. For possible dropouts, The decision was made to involve at least 20 cases. * Significant p value was considered when $p< 0.05$.

2.5. Statistical Analysis

For statistical analysis, IBM's SPSS v27 (Chicago, Illinois, United States) was used. Using the Shapiro-Wilks test and histograms, the normality of the data distribution was determined. The mean and standard deviation (SD) of parametric quantitative data were explored by an unpaired student t-test. The median and interquartile range (IQR) of nonparametric quantitative data were evaluated using the Mann-Whitney test. If applicable, qualitative data were given as frequency and percent and examined using the Chi-square test. A two-tailed P value < 0.05 was deemed statistically significant.

3. Results

73 patients were eligible for knee arthroplasty, 13 of them were excluded (7 cases rejected to contribute in the research, 4 cases with chronic use of different analgesic therapy, 2 patients showed disorder in coagulation) the remaining 60 cases were randomly classified into 3 equal groups, and were submitted to analysis. Figure 1.

Demographic data (age, gender, ASA and BMI) were insignificantly different among the three groups. Table 1.

Post operative analgesia expressed in NRS were recorded during rest and during the time of physical therapy; At rest a significant increase in NRS values was detected in CACB patients at 2h post operative (p=0.001) while a significant decrease in NRS in PAI group patients at 6h and 12 h post operative with p values (p1=0.002, p2= 0.621, p3 =0.001) & (p1=0.003., p2=0.630., p3=0.001) respectively. This significant decrease faded with time during 24h (p1=0.001, p2=0. 61, P3=0.001), 48h (p1=0.011, p2=0.794, p3=0.005) and 72h (p1=0.003, p2=1.0, p3=0.003) post operative giving the CACB and the IPACK block the upper hand in pain control at these times. This pattern was also clearly reported during the time of physical therapy as PAI group patients had experienced the lowest NRS among the studied groups at 12h post operative (p, p3=0.001, p2=0.513) and still clinically but not statistically significant at 24h. And again, NRS values were reversed by 48h (p1=0.005, p2=0.679, p3=0.002) and finally at 72h (p1=0.018, p2=0.788, p3=0.009). Table 2.

The mean time of 1st rescue analgesic was significantly longer in PAI group (15.55+_5.82) compared to (9.5+_6.18) in CACB and (10.75+_6.31) in IPACK patients with p value of p=0.007 but this was unexpectedly accompanied by a significant increase in total morphine consumption (9.6+_3.08) compared to (7.5+_2.48) in CACB and (7.45+_1.96) in IPACK patients with p value p=0.003. Table 3.

Motion ability was recorded through the use of Time Up and Go test TUG showed the shortest records in PAI block

group (38.05+_3.86) compared to (54.7+_11.42) in CACB and (39.05+_5.58) in IPACK group, p=0.001. at 12h post operative. At 24 h post operative, the IPACK group showed the shortest time records (32.25+_1.71) compared to (32.4+_1.76) in PAI group and (37.8+_3.66) in CACB patients with p=0.001. Quadriceps muscle power was assisted by Medical Research Council score MRC at 12h and it ranged between 1-5 in PAI group compared to a range of 1-3 in other groups with (p1, p3=0.001, p2=0.544). and was still recording the highest score at 24h post operative with a range of 3-5 compared to a range of 2-5 in both CACB and IPACK groups with (p1, p3=0.001, p2=0.875). Table 4.

Two cases in PAI group and one case in each other group developed post operative nausea and vomiting, and hypotension, fortunately in early post operative time during PACU stay, all patients received the prompt management at time. None of them experienced bradycardia or other complications. Table 5.

Patients' satisfaction was reported to be 70% in IPACK patients, 65% in CACB patients and 60% in PAI group. A long hospital stay was recorded in CACB with (p1, p2=0.001, p3=0.757). Table 6.

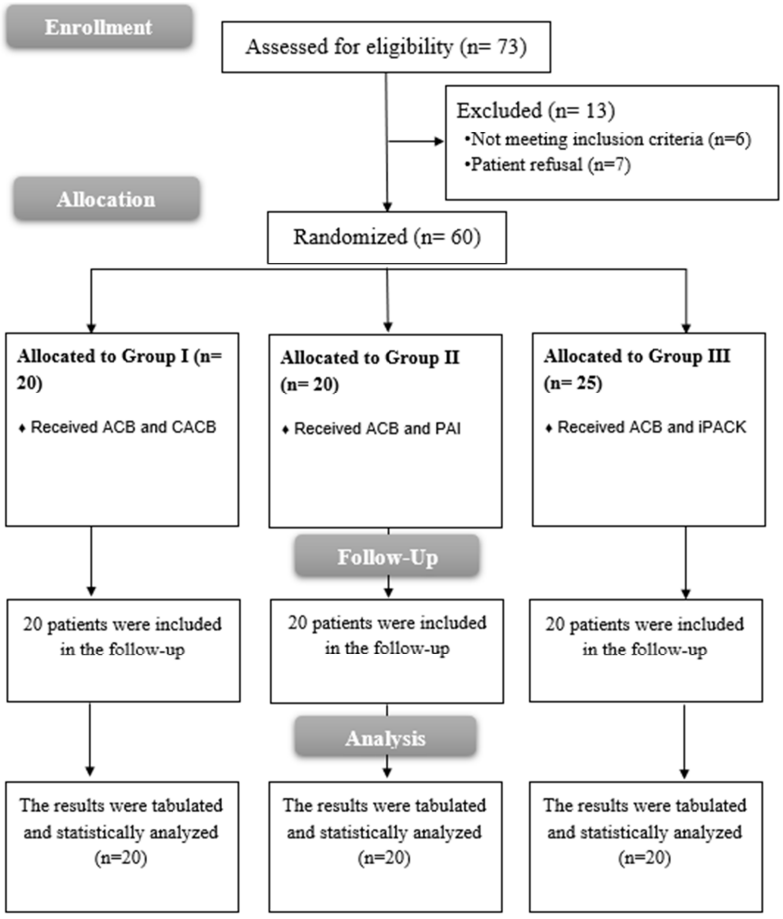

Figure 1. *CONSORT flowchart of the studied patients.*

ACB: adductor canal block
CACB: continuous adductor canal block
PAI: peri-articular injection
IPACK: interspace between popliteal artery and the capsule of posterior knee block.

Table 1. *Demographic data of the three groups.*

		Group I CACB N=20	Group II PAI N=20	Group III IPACK N=20	p. value
Age (years)		54.65 ± 3.99	55.8 ± 4.18	53.15 ± 5.16	0.180
Sex	Male (%)	11 (55%)	10 (50%)	9 (45%)	0.819
	Female (%)	9 (45%)	10 (50%)	11 (55%)	
ASA Physical status	I (%)	3 (15%)	4 (20%)	4 (20%)	0.970
	II (%)	9 (45%)	9 (45%)	10 (50%)	
	III (%)	8 (40%)	7 (35%)	6 (30%)	
BMI (kg/m^2)		30.97 ± 2.85	31.45 ± 2.49	30.17 ± 3.35	0.381

Data are presented as mean ± SD, ratio, numbers & percentages; BMI: Body mass index; ASA: American society of Anesthesiologists; CACB: continuous adductor canal block; PAI: periarticular injection block; IPACK: infiltration between popliteal artery and capsule of the knee block.

Table 2. *NRS during rest and physical therapy in the three groups.*

NRS during rest		Mean ± S. D	P value		
	Group I	1.45 ± 0.51		P1	0.001*
2h	Group II	0.5 ± 0.51	0.001*	P2	0.001*
	Group III	0.45 ±.51		P3	0.758
	Group I	3.45 ± 0.51		P1	0.002*
NRS 6h post operative at. Rest	Group II	2.8 ± 0.83	0.001*	P2	0.621
	Group III	3.55 ± 0.51		P3	0.001*
	Group I	3.5 ± 0.51		P1	0.003*
NRS 12h post operative at. Rest	Group II	2.85 ± 0.88	0.001*	P2	0.630
	Group III	3.6 ± 0.50		P3	0.001*
	Group I	1.95 ± 0.76		P1	0.001*
NRS 24h post operative at. rest	Group II	3.4 ± 0.50	0.001*	P2	0.611*
	Group III	2.45 ± 0.51		P3	0.001*
	Group I	1.45 ± 0.51		P1	0.011*
NRS 48h. Post operative at Rest	Group II	1.95 ± 0.76	0.009*	P2	0.794
	Group III	1.4 ± 0.50		P3	0.005*
	Group I	1.45 ± 0.51		P1	0.003*
NRS 72h post operative at. Rest	Group II	2.05 ± 0.76	0.003*	P2	1.0
	Group III	1.45 ± 0.51		P3	0.003*
NRS during physical therapy					
	Group I	4.75 ± 1.02		P1	0.001*
NRS 12h. Post operative during physical therapy	Group II	2.90 ± 0.85	0.001*	P2	0.513
	Group III	4.55 ± 1.00		P3	0.001*
	Group I	4.4 ± 0.99		P1	0.143
NRS 24h. post operative during physical therapy	Group II	3.95 ± 0.83	0.274	P2	0.869
	Group III	4.35 ± 1.04		P3	0.192
	Group I	2.1 ± 0.72		P1	0.005*
NRS 48h. post operative during physical therapy	Group II	2.8 ± 0.83	0.003*	P2	0.679
	Group III	2 ± 0.73		P3	0.002*
	Group I	1.45 ± 0.51		P1	0.018*
NRS 72h. post operative during physical therapy	Group II	1.9 ± 0.72	0.016*	P2	0.788
	Group III	1.4 ± 0.50		P3	0.009*

Data are presented as mean ± SD, * Significant p value < 0.05, P1: Group I & Group II, P2: Group I & Group III, P3: Group II & Group III, Group I=CACB, Group II=PAI, Group III =IPACK.

Table 3. *Time to first rescue analgesic received and total morphine consumption in the three groups.*

	Group I CACB N=20	Group II PAI N=20	Group III IPACK N=20	P value	P1	P2	P3
1st rescue analgesic time /h	9.5 ± 6.18	15.55 ± 5.82	10.75 ± 6.31	0.007*	0.003*	0.520	0.016*
Total Morphine consumption /mg	7.5 ± 2.48	9.6 ± 3.08	7.45 ± 1.96	0.003*	0.002*	0.605	0.007*

Data are presented as mean ± SD, * Significant p value < 0.05, P1: Group I & Group II, P2: Group I & Group III, P3: Group II & Group III

Table 4. *Time up and Go test TUG and Medical research council MRC in the three groups.*

	Group I CACB N=20	Group II PAI N=20	Group III IPACK N=20	p. value	P1	P2	P3
TUG 12h post operative	54.7 ± 11.42	38.05 ± 3. 86	39.05 ± 5.58	0.001*	0.001*	0.001*	0.682
TUG 24h post operative	37.8 ± 3.66	32.4 ± 1.76	32.25 ± 1.71	0.001*	0.001*	0.001*	0.853
MRC 12h post operative	1.75 ± 0.72	3.35 ± 1.46	1.95 ± 0.76	0.001*	0.001*	0.544	0.001*
MRC 24h post operative	3.05 ± 1.15	4.35 ± 0.81	3.10 ± 1.02	0.001*	0.001*	0.875	0.001*

Data are presented as mean ± SD, * Significant p value < 0.05, P1: Group I & Group II, P2: Group I & Group III, P3: Group II & Group III.

Table 5. *Peri operative complications in the three groups.*

Peri operative Complications	Group I CACB N=20	Group II N=20 PAI	Group III IPACK N=20	P-value
Nausea & vomiting	1 (5%)	2 (10%)	1 (5%)	0.765
Hypotension	1 (5%)	2 (10%)	1 (5%)	0.765
Bradycardia	0 (0%)	0 (0%)	0 (0%)	----
Length of hospital stay/days	4.45 ± 0.51	3.55 ± 0.51	3.6 ± 0.50	0.001*
	P1: 0.001*, P2: 0.001*, P3: 0.757			

Data are presented in mean ± SD, numbers and percentages, * Significant p value < 0.05, P1: Group I & Group II.
P2: Group I & Group III, P3: Group II & Group III

Table 6. *Patients' satisfaction in the three groups.*

Patients Satisfaction score	Group I CACB N=20	Group II PAI N=20	Group III IPACK N=20	X^2	P-value
Not satisfied	1 (5%)	2 (10%)	1 (5%)	1.140	0.980
Somewhat non satisfied	3 (15%)	2 (10%)	2 (10%)		
Somewhat satisfied	3 (15%)	4 (20%)	3 (15%)		
Very satisfied	13 (65%)	12 (65%)	14 (70%)		

Data are presented in numbers and percentages, * Significant p value < 0.05.

4. Discussion

PAI block is easily administered safe infiltration, with its eclectic sensory block took more advantage upon epidural or FNB however, was supposed to have a Shortened term control of pain and also the injected medications variability and the non-control of the local anesthesia concentration should be considered in practice [11].

The use of blocks that innervate the posterior region of the joint capsule utilizing PAI or IPACK in combination with ACB may give a thorough block of knee intervention, resulting in adequate and effective analgesia [12]. Many recent studies recorded that adductor canal nerve block provided the Selfsame analgesic efficacy as PAI [13]. other concluded that ACB was better than PAI block in pain command at 2,4h at rest [14], As well as in the post operative day [15].

The addition of IPACK to ACB lowered postoperative pain levels in a recently published trial, however there was insignificant change in opiate consumption, physical treatment performance, or hospital stay [16]. Comparing IPACK to PAI, another study discovered that IPACK patients required less post-operative analgesia and had less discomfort [4]. The addition of IPACK to ACB considerably decreased resting and active pain ratings in our study. In addition, early ambulation and speedier hospital release were accomplished by combining these two blocks.

Another research on the practical application of the IPACK block found no reduction in postoperative pain after 12 hours and an increase in opiate use. 36 hours after surgery, patients with IPACK block noticed much less pain than those with PAI block [17].

The scientists discovered that IPACK block combined with ACB gives comparable analgesia to PAI than ACB, hence improving pain management [16, 18].

24 hours after surgery, the pain scores of all three groups rose. These increased scores correlate with rebound pain [18, 19]. Continuous peripheral nerve blocks are advised to alleviate rebound discomfort [20].

Nevertheless, catheter use may result in several difficulties during insertion and recovery. Extra sub cut lipid tissue of the case requires severe monitoring of the catheter in the ward and verification of its position; the catheter tip might be dislodged by rotating tissue motion around the femur; consequently, the ACB catheter might not be advantageous for the quick movements of the TKA case. It is also advised to combine peripheral blocks to decrease post-TKR pain rebound [21].

In contrast with a study, evaluated 48-h pain scores, following recovery implementation began [22] early amputation and physical therapy was started at 12h according to the protocol in orthopedic department and this gives more clinical significance through evaluating patients starting from 2h till the next 72h. In the present study we found that, IPACK block in conjunction with ACB as well as, PAI block combined with ACB had been shown to preserve motor function expressed by quadriceps muscle power and the mobility expressed in TUG score.

IPACK can induce complete and effective analgesia following TKA by obstructing the nerves' terminal branches that enter the anterior and posterior areas of the knee as well as the sciatic nerve, according to the literature. The motor-sparing impact produced by the blockage of terminal nerve branches expedites surgical recovery and minimizes the number of falls on the ward [23-25].

During PAI, intraoperative injections of local anesthetic, adrenaline, and ketorolac numb the nerves, muscle, and tissue on the posterior, lateral, and medial sides of the knee. Other research involves the combination of opioids with preservatives, which may result in systemic absorption [26].

With its unpleasant impacts, like nausea, vomiting, pruritus, sedation, hypotension, and respiratory depression, which might impact functional rehabilitation [23].

Hypotension, urinary retention, and pruritus are most popular in cases with axial nerve blocks as intrathecal and epidural anesthesia and analgesia [27]. In our study, two cases in PAI group and one case in each other group developed post operative nausea and vomiting, as well as hypotension (less than 20% drop in the base line of patients' blood pressure) that was detected in monitoring with no patients compromised. this could be related to the use of morphine rescue analgesia. All patients received their prompt management at time. None of them experienced tachycardia, bradycardia or other cardiovascular or neurological complications.

Limitations: small sample size, also possibility of catheter migration in CACB, quadriceps muscle strength was not evaluated before giving the blocks and the lack of guidelines to determine the optimal doses, concentrations and volume of the studied medications.

5. Conclusions

In TKA, PAI has higher quadriceps muscle power and lower TUG and length hospital stay compared to ACB with IPACK and continuous ACB. ACB with PAI and ACB with IPACK are associated with better analgesia (prolonged action and

lower morphine consumption) compared to continuous ACB.

Conflicts of Interest and Source of Funding

The authors declare that they have no competing interests.

Author Contributions

Each author participated in the conceptualization and design of the study. Material preparation, information collecting and analysis were done by Rabab M. Mohamed and Jehan M. Darwish. The first draft of the manuscript was written by Rabab M. Mohamed, and each contributor provided feedback on earlier versions of the article. The final manuscript was read and approved by all writers.

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