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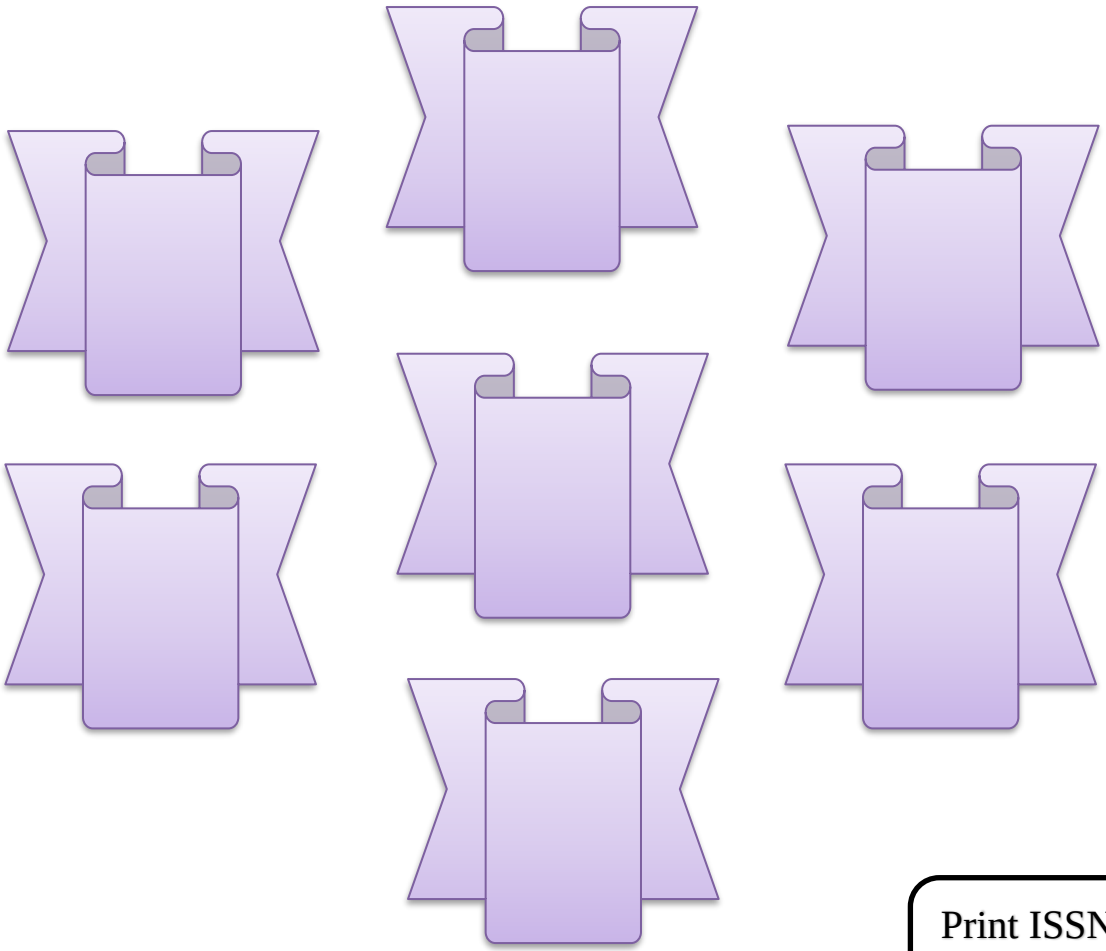

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Original Article

Ultrasound Guided Infiltration of Popliteal Artery and Capsule of Knee [IPACK] versus IPACK with Adductor Canal Block [ACB] for Postoperative Knee Surgery Analgesia: A Comparative Study

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ABSTRACT

Background: Perioperative pain control largely affects postoperative recovery and surgical outcome. Post-operative pain after knee surgery may delay early ambulation and impair quality of recovery. Relieving postoperative pain provides functional recovery which leads to early rehabilitation.

Aim of the work: To evaluate and compare postoperative analgesia and efficiency of IPACK in combination with ACB with IPACK alone using the visual analogue scale [VAS] for postoperative pain assessment after knee arthroscopic surgery as primary outcome. Also, hemodynamic changes, total opioid consumption and patient satisfaction as secondary outcomes.

Patients and Methods: This prospective comparative randomized clinical trial included 60 patients, aged 21-60 years, who underwent elective knee arthroscopic surgery. They were divided into two groups; group I [control group]: a local anesthetic was injected between the popliteal artery and the knee joint capsule. This procedure is known as an IPACK block, and group II [ACB group] received IPACK block plus adductor canal block [ACB].

Results: Our study demonstrated that there was a statistically significant lower pain score assessed by VAS score after 16 hours among IPACK plus ACB group than IPACK alone group with p-value <0.001. Also, there was a statistically significant increased 1st time for request analgesia and increased patient satisfaction in IPACK+ ACB compared to IPACK alone with p-value <0.001. Also, there is a statistically significant higher MAP and HR at 16 hours with IPACK alone group compared to IPACK+ Adductor block group with p-value <0.05.

Conclusion: Combination of IPACK and ACB after knee surgeries better than IPACK alone regarding reducing postoperative pain, 1st time to rescue analgesia and patient satisfaction, with less effects on hemodynamics.

Keywords: Knee Joint; Visual Analog Scale; Popliteal artery; Hemodynamics; Postoperative pain.

INTRODUCTION

Post-operative pain following knee surgery may delay early ambulation, impair quality of recovery, and may be associated with increased use of opioid analgesia with its potential side effects [1].

Poor management of pain can result in longer hospital stays and rehabilitation periods and can increase the risk of acute pain developing into chronic pain [2].

When it comes to knee surgeries, utilizing regional analgesia techniques is crucial as they can mitigate the negative impact of pain on functional recovery. Additionally, these techniques can reduce the likelihood of chronic postoperative pain development [3].

The adductor canal block [ACB] is a regional analgesia technique commonly used for pain relief after total knee arthroplasty [TKA]. This technique can impact the vastus medialis muscle as its associated nerve is located within the adductor canal. However, ACB is not effective in alleviating pain in the posterior region of the knee, which can be particularly intense [4].

Since 2014, a novel regional analgesia technique called IPACK [Infiltration between Popliteal Artery and Capsule of the Knee] has been employed in medical practice. This technique involves blocking the superomedial and lateral genicular nerves, articular branches of the obturator nerve, and branches of the sciatic nerve in the popliteal area. By doing so, the IPACK technique can provide pain relief to the posterior capsule of the knee joint, without adversely affecting the motor function of the limb [5].

IPACK is a desirable block as it specifically targets the sensory nerves associated with the knee, while leaving the motor nerves unaffected. By blocking the nerves in the popliteal region, including the articular branches of the obturator, common peroneal, and tibial nerves, IPACK can provide pain relief to the posterior area of the knee [6].

The IPACK technique employs ultrasound guidance to ensure accurate needle placement and the precise injection of local anesthetic. Ultrasound also enables visualization of neighboring structures, such as the popliteal artery and sciatic nerve [7].

THE AIM OF THE WORK

The objective of this study is to assess and contrast the effectiveness of IPACK as a standalone technique versus the combined use of IPACK with ACB for the management of postoperative pain following knee surgery.

Primary outcome: Assessment of postoperative pain relief following knee arthroscopic surgery using the visual analogue scale [VAS] for pain evaluation.

Secondary outcomes: Hemodynamic changes, total opioid consumption during postoperative 24 hours and patient satisfaction.

PATIENTS AND METHODS

This study is a prospective, randomized clinical trial involving 60 patients of both genders, who have ASA physical status I or II, and are between the ages of 21 and 60 years old, undergoing elective knee arthroscopic surgery. After approval of ethics committee at Al-Azhar University, and informed written consent taken from all patients. It was carried out at Al-Azhar University Hospitals [Damietta and Cairo].

Exclusion criteria: Patients who declined to participate in the study, have neuromuscular disorders, are allergic to local anesthetics, have an infection at the injection site, or have contraindications to spinal anesthesia [such as coagulopathies].

Sample size calculation: To determine the appropriate sample size for this study, the researchers used the MedCalc® version 12.3.0.0 program from Ostend, Belgium, which is a statistical calculator. The sample size was calculated based on a 95% confidence interval with a power of 90% and an α error of 5%. According to the formula used, a minimum of 60 participants were required for the study, with 30 patients in each group, in order to detect a significant difference at an α value of 0.05 and a power of 90%. Therefore, a total of 60 participants, with 30 patients in each study group, were included in the study.

Methods: The study included 60 patients who were randomly assigned to one of two equal groups using computer-generated random number tables; group I, which served as the control group, patients were administered local anesthetic infiltration between the popliteal

Artery and the capsule of the knee [IPACK block] only, and group II, which served as [ACB group], received IPACK block plus adductor canal block [ACB].

Preoperative management: Prior to the surgery, the patients underwent pre-operative assessments, included history taking, clinical examination, and laboratory investigations. The laboratory tests included CBC, sodium and potassium levels, bleeding time, clotting time, INR, liver function tests [AST, ALT], and kidney function tests [urea and creatinine]. Then, fasting instructions were given to the patient in the form of 8 hours for solids and 2 hours for bulb and electrolyte free.

Anesthetic techniques

Upon arrival of the patient to the operating room without any prior medication, an intravenous line [IV] was established by inserting an IV cannula, and a fluid preload of 10ml/kg of lactated ringer solution [Otsuka pharmaceutical CO., Egypt] was administered over a period of 30 minutes. During the procedure, the patients' vital signs were continuously monitored through ECG tracing using five leads, non-invasive arterial blood pressure measurement, and pulse oximetry.

Once the patient was positioned in a seated position, the area was disinfected using a betadine solution, and sterile drapes were applied. The intervertebral space [L2_3] was then punctured using a 25-gauge spinal needle with a cutting tip [B BRUNE]. After ensuring proper placement of the spinal needle and obtaining free, clear cerebrospinal fluid [CSF], a combination of bupivacaine and fentanyl was injected into the subarachnoid space.

Intervention

IPACK block [performed in both groups]: The patient was positioned in a supine position with a slight flexion of the knee. The area was prepared under sterile conditions, and an ultrasound probe was used to identify the popliteal artery and femur in the popliteal fossa. The probe was then moved distally to reveal both femoral condyles, and then slid proximally until the humps of the femoral condyles disappeared and the flat metaphysis appeared. A 22-gauge spinal needle, measuring 3.5 inches in length, was inserted from the lateral aspect and directed across the space between the popliteal artery and femur. Once the needle reached the medial edge of the femur, which was approximately at the level of the popliteal artery, negative aspiration was confirmed. Bupivacaine 15ml of 0.5% was then injected incrementally as the needle was withdrawn.

Adductor Canal Block [ACB] in group II only combined with IPACK

The patient was positioned in a supine position with the thigh abducted and externally rotated to provide access to the medial thigh. The skin was disinfected, and the ultrasound transducer was placed in an anteromedial position, approximately at the junction between the middle and distal third of the thigh or slightly lower.

To minimize the inhibition of the motor nerve block of the vastus medialis, the saphenous nerve block should be performed at the most distal level where the artery is still immediately below the sartorius muscle. In contrast, an adductor canal nerve block is typically administered at a more proximal location around the mid-thigh level. An aspiration needle, measuring 22G and 3.5 inches in length, was inserted in-plane in a lateral-to-medial orientation and advanced toward the femoral artery.

Post-operative pain assessment

The Visual Analog Scale [VAS] is a pain assessment tool that uses a straight line, typically 1-10 mm in length, with the phrase "no pain" marked at one end and "the worst possible pain" at the other end ".

Time for 1st request of analgesia is recorded and if VAS ≥ 4 30 mg ketolac is given as rescue analgesic.

The patients' hemodynamic status, including mean arterial blood pressure and heart rate, was initially measured immediately after the surgical procedure and then monitored every hour for a period of 24 hours.

Statistical analysis: The data obtained from the study were entered and analyzed using SPSS [Statistical Package of Social Sciences] version 24 [SPSS Inc., Chicago, IL, USA]. The normality of the data was tested using the Shapiro-Wilk test. The qualitative data were presented as frequencies and relative percentages, while the

quantitative data were reported as mean ± SD [standard deviation] for normally distributed data and median and range for non-normally distributed data. The statistical comparisons were two-tailed, with a significance level of p-value ≤ 0.05 indicating a significant difference.

RESULTS

In this study, the mean age of the patients was 52 ± 6 years, with 51.7% of the patients being male and 48.3% female. The patients had a mean weight of 68 ± 6 Kg and a mean BMI of 27.3 ± 1.8 Kg/m2. Most of the patients included in the study had an ASA grade II. There were no significant differences observed between the IPACK + ACB group and the IPACK alone group with respect to the demographic data, BMI, and ASA status of the patients, as shown in Table 1.

As regards postoperative pain score [VAS] there is statistically significant lower pain score assessed by VAS score after 16 h among IPACK added adductor canal block group compared to IPACK alone group with p-value <0.001 as shown in table [2].

As regards 1st time to rescue analgesia and patient satisfaction there is statistically significant decreased total analgesia consumption in IPACK+ ACB group compared to IPACK group with p-value <0.001 with statistically significant increased 1st time for request analgesia in IPACK+ ACB compared to IPACK alone with p-value <0.001 and increased patient satisfaction in IPACK+ ACB compared to IPACK alone with p-value <0.001 as stated in table [3].

No statistically significant difference was found between the studied groups regarding failure of the technique [2 cases in IPACK alone and 4 cases in IPACK + ACB group; p-value = 0.542] as presented in table [4].

As for MAP, there was a significant higher MAP after 16 hours with IPACK alone group compared to IPACK + Adductor block group with p-value <0.05 at 16-24 hours [table 5].

Regarding heart rate, there was a statistically significant higher HR after 16 h with IPACK alone group compared to IPACK + Adductor block group with p-value < 0.05 at 16-24 hours [table 6].

Table [1]: Demographic data of the studied patients

		Group		Test	P
		IPACK [n=30]	IPACK+ ACB [n=30]		
Age [years]		53±7	51±3	-0.9	0.367
Sex	Females	15 [50.0%]	14 [46.7%]	0.067	0.796
	Males	15 [50.0%]	16 [53.3%]		
Weight [Kg]		67±5	68±7	-0.3	0.76
Body mass index [Kg/m^2]		27.1±1.5	27.5±2.0	-0.1	0.94
ASA	I	14 [46.7%]	12 [40.0%]	0.271	0.602
	II	16 [53.3%]	18 [60.0%]		

Table [2]: Comparison of VAS score between both study groups

	Group		MW Test	P
	IPACK [n=30] Median [Range]	IPACK+ ACB [n=30] Median [Range]		
VAS score 30 min	1 [0-1]	1 [0-1]	0.0001	1
VAS score 1 h	1 [0-1]	1 [0-1]	0.0001	1
VAS score 1.5 h	1 [1-2]	1 [0-1]	-3.1	0.062
VAS score 2 h	1 [1-2]	1 [0-2]	-3.7	0.54
VAS score 3 h	2 [1-4]	2 [1-3]	-4.4	0.42
VAS score 4 h	2 [1-2]	2 [0-2]	-4.0	0.074
VAS score 5 h	2 [1-3]	2 [1-2]	-3.9	0.06
VAS score 6 h	2 [1-3]	2 [1-2]	-3.7	0.51
VAS score 9 h	2 [1-3]	2 [1-3]	-5.8	0.54
VAS score 12 h	3 [2-4]	3[1-5]	-6.2	0.052
VAS score 16 h	3 [2-4]	1 [1-3]	-6.2	**<0.001**
VAS score 18 h	3 [2-3]	2 [1-3]	-4.2	**<0.001**
VAS score 21 h	4 [3-4]	2 [1-2]	-7.0	**<0.001**
VAS score 24 h	4 [3-5]	2 [2-4]	-6.0	**<0.001**

Table [3]: Comparison of 1st time for request analgesia, patient satisfaction and total analgesia consumption/mg between both study groups

	IPACK [n=30]	IPACK+ ACB [n=30]	Test	P
The 1st time for request analgesia	15.8 [14.0-17.0]	18.0 [16.0-19.5]	**-6.4**	**<0.001**
Patient satisfaction	2±1	3±0	**-5.4**	**<0.001**
Total analgesia consumption/mg	8 [5-9]	5 [3-6]	**-5.7**	**<0.001**

Table [4]: Comparison of failure between both study groups

		IPACK [n=30]	IPACK+ ACB [n=30]	X^2 test	P
Failure	**No**	28 [93.0%]	26 [86.0%]	0.373	0.542
	Yes	2 [7.0%]	4 [14.0%]		

Table [5]: Comparison of mean arterial pressure between both study groups.

	IPACK [n=30]	IPACK+ ACB [n=30]	t-Test	P
Mean arterial pressure 1 h	82±3	75±4	-6.0	0.07
Mean arterial pressure 2 h	77±2	74±4	-3.0	0.072
Mean arterial pressure 3 h	75±3	73±7	-0.3	0.727
Mean arterial pressure 4 h	75±4	70±5	-3.7	0.05
Mean arterial pressure 5 h	70±5	65±7	-2.9	0.063
Mean arterial pressure 6 h	63±5	60±6	-2.1	0.067
Mean arterial pressure 7 h	56±11	52±12	-0.9	0.372
Mean arterial pressure 8 h	63±8	58±5	-2.8	0.066
Mean arterial pressure 9 h	72±5	61±8	-5.5	0.061
Mean arterial pressure 10 h	70±6	61±5	-4.6	0.07
Mean arterial pressure 11 h	63±10	56±9	-2.4	0.06
Mean arterial pressure 12 h	65±12	60±9	-2.2	0.09
Mean arterial pressure 13 h	64±9	63±5	-1.0	0.337
Mean arterial pressure 14 h	66±7	55±8	-5.1	0.06
Mean arterial pressure 15 h	59±12	59±8	-1.1	0.293
Mean arterial pressure 16 h	69±6	62±10	-0.7	**0.002**
Mean arterial pressure 17 h	63±10	61±7	-3.0	**0.048**
Mean arterial pressure 18 h	68±8	66±6	-0.9	**0.034**
Mean arterial pressure 19 h	62±5	60±8	-1.1	**0.027**
Mean arterial pressure 20 h	63±11	57±9	-1.9	**0.04**
Mean arterial pressure 21 h	65±7	60±6	-1.9	**0.04**
Mean arterial pressure 22 h	67±7	55±9	-4.8	**<0.001**
Mean arterial pressure 23 h	61±9	60±7	-0.7	**0.04**
Mean arterial pressure 24 h	68±7	64±10	-1.2	**0.02**

Table [6]: Comparison of heart rate in both study groups

	IPACK [n=30]	IPACK+ ACB [n=30]	t-Test	P
Heart rate 1 h	67±5	65±4	**-1.7**	0.09
Heart rate 2 h	64±4	63±4	**-1.0**	0.336
Heart rate 3 h	62±4	61±2	**-1.5**	0.14
Heart rate 4 h	61±4	58±2	**-3.3**	0.713
Heart rate 5 h	58±4	56±3	**-3.0**	0.107
Heart rate 6 h	56±4	55±3	**-0.4**	0.704
Heart rate 7 h	55±6	54±2	**-1.1**	0.264
Heart rate 8 h	93±6	86±8	**-3.0**	0.071
Heart rate 9 h	90±7	87±10	**-2.1**	0.86
Heart rate 10 h	90±12	79±7	**-3.6**	0.19
Heart rate 11 h	76±10	72±11	**-1.6**	0.102
Heart rate 12 h	89±10	85±8	**-1.7**	0.099
Heart rate 13 h	86±12	79±9	**-2.5**	0.071
Heart rate 14 h	75±10	68±9	**-2.6**	0.918
Heart rate 15 h	78±7	74±11	**-1.7**	0.086
Heart rate 16 h	94±8	80±10	**-4.9**	**<0.001**
Heart rate 17 h	81±11	75±14	**-2.1**	**0.034**
Heart rate 18 h	79±9	73±10	**-2.6**	**0.011**
Heart rate 19 h	78±12	76±10	**-0.4**	**0.001**
Heart rate 20 h	81±8	75±11	**-1.6**	**0.003**
Heart rate 21 h	79±12	73±11	**-1.8**	**0.002**
Heart rate 22 h	76±11	73±10	**-0.2**	**0.04**
Heart rate 23 h	84±9	81±11	**-1.3**	**0.011**
Heart rate 24 h	77±7	76±9	**-0.1**	**0.009**

DISCUSSION

This study was a prospective, randomized, comparative clinical trial that included 60 patients undergoing elective knee arthroscopic surgery. The patients were divided into two groups: one group received IPACK block alone [30 patients], while the other group received IPACK block with ACB local anesthesia [30 patients].

The search for the ideal regional analgesic technique for patients undergoing total knee arthroplasty [TKA] is an ongoing process, as the goal of achieving effective pain control must be balanced with other factors such as early ambulation.

In the present study the mean age of the included patients is 52 ± 6 years old, male gender accounted 51.7% while female gender accounted 48.3%, with mean of their weight 68 ± 6 Kg, the mean of their BMI is 27.3 ± 1.8 Kg/m^2 and most of the included patients were ASA II.

The current study revealed statistically significant decrease of pain score assessed by VAS score after 16hours among IPACK added adductor canal block group compared to IPACK alone group with p-value <0.001.

Similarly, **Mou *et al.*** [8] conducted a study in 2022 involving 120 patients who underwent total knee arthroplasty, and were randomly divided into three groups: Group A [ACB+IPACK block], Group B [ACB], and Group C [IPACK block]. The purpose of this study was to evaluate postoperative pain, and it was found that the ACB+IPACK group had statistically significant lower pain scores within the first 8 hours after surgery compared to the IPACK alone group, with a p-value of <0.001. Additionally, the ACB+IPACK group had a significantly lower need for opioid consumption for pain management.

Also, another study conducted by **Sankineani *et al.*** [9] compared IPACK+ACB to ACB alone and showed statistically significant decreased VAS score with p-value <0.005.

This goes in run with another systemic review analysis showed that ACB added to IPACK in total knee arthroplasty provides more effective analgesia with statistically significant decreased VAS score and lower doses of opioids consumed with p-value=0.048 [10].

In this study; there was statistically significant decreased total analgesia consumption in IPACK+ ACB group compared to IPACK group with p-value <0.001 with statistically significant increased 1st time for request analgesia in IPACK+ ACB compared to IPACK alone with p-value <0.001.

Similarly; a study conducted by **Et *et al.*** [11] showed that adding adductor canal block to IPACK in knee arthroplasty compared to ADC block alone is much more effective with statistically significant decreased requirements for postoperative opioids and decreased used doses with p-value <0.001.

In this research there is a statistically significant higher heart rate at 16 hours with IPACK alone group compared to IPACK+ Adductor block group with p-value <0.05.

Similarly, **Patterson *et al.*** [12] study that performed to evaluate hemodynamics after IPACK alone group compared to IPACK+ Adductor block and showed that there was a statistically significant increased heart rate and MBP at 16 hours with IPACK alone group compared to IPACK+ Adductor block group with p-value <0.05 but within normal range.

Conclusion

Combination of IPACK and ACB after knee surgeries has better effect than IPACK alone regarding reducing postoperative pain, prolongation of time after which patient require analgesia and patient satisfaction, with less effects on hemodynamics including heart rate and arterial blood pressure, so combination of IPACK and adductor canal block is more ideal than IPACK alone.

Conflict of Interest and Financial Disclosure: None.

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