Original Article

A Comparative Study between Adductor Canal Block and IPACK Block (Interspace between Popliteal Artery and the Capsule of Posterior Knee) VS ACB Alone VS IPACK Alone after Total Knee Arthroplasty for Post Operative Pain and Mobility

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ABSTRACT

Background: Adductor canal block is a peripheral nerve blockade technique that provides good pain control for patients undergoing unilateral total knee arthroplasty which however does not relieve and spare posterior knee pain. The recent technique of an ultrasound-guided local anesthetic infiltration of the interspace between popliteal artery and the capsule of posterior knee has shown promising results in providing significant analgesia for posterior knee pain without affecting the motor nerves. The aim of the study is to evaluate the effect of ACB plus IPACK vs ACB only VS IPACK only in patients post unilateral knee arthroplasty for post operative pain and mobility.

Results: There results showed significant difference between groups at amount of opioids used. Opioid consumption was lower in group C compared to group A and group B. There was statistically significant difference between groups regarding time to mobility being significantly lower in Group C in comparison to both groups A and B.

Conclusions: The ACB + IPACK is a promising technique that offers improved pain management in the immediate postoperative period without affecting the motor function around the knee joint resulting in better ROM and ambulation compared to ACB alone and IPACK alone.

Key Words: ACB, IPACK, knee arthroplasty.

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INTRODUCTION

Postoperative pain management after total knee arthroplasty (TKA) continues to evolves with better treating strategies being formulated to improve patient satisfaction, clinical outcomes and reduce total opioid use in the immediate postoperative period[1-3]. Appropriate perioperative pain management has been shown to fasten the recovery period and facilitates in the rehabilitation leading to better functional outcome in patients undergoing TKA. This has necessitated the need to develop multimodal analgesia regimens involving the use of both regional anesthesia along with systemic analgesics[4]. Peripheral nerve blockade has been reported to deliver optimal postoperative pain relief which is increasingly preferred in most of patients undergoing knee arthoplasty procedures, and various different techniques such as sciatic nerve block, femoral nerve block and adductor canal block have been described[5-7]. Adductor canal block (ACB) is a peripheral nerve block that has been shown to relief pain significantly and thereby minimizing total opioid consumption with minimal effect on motor quadriceps function[8]. Though ACB provides analgesia to the peripatellar and intra-articular aspect of knee joint, it spares posterior knee pain which is moderate to severe in intensity[9,10]. The recent technique of an ultrasound (US)-guided local anesthetic infiltration of the interspace between popliteal artery and the capsule of posterior knee (IPACK) has shown to provide significant coverage for posterior knee pain without affecting the common peroneal nerve (CPN)[11]. We postulated that the combination of ACB+IPACK will provide better pain relief and improve knee function in the immediate postoperative period compared to ACB alone or IPACK alone and therefore have conducted this prospective study to verify this hypothesis.

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METHODS

This study is a prospective randomized clinical study (RCT) conducted in Ain Shams University Hospitals, with a sample size of 60 patients. Patients were randomized by sealed envelope technique.

Using PASS II program for sample size calculation setting power at 90% and *X* error at 0.05. According to the previous literature[12] the expected means 24Hrs post operative VAS score in group A (ACB)= 3.18±0.7 and in group C (ACB and IPACK) 2.05±0.42, sample size of at least 20 patients per group were needed to detect the difference between 2 groups. No available precious literature for sample size calculation of group B (IPACK) (comparing the 3 groups) so the same number of patients were taken for this group (A-B).

The study was performed after obtaining ethical committee approval of Faculty of Medicine, Ain shams University and written informed consent from the patients. The study protocol was explained to the patients before taking their informed consent. All study procedures were done by the most competent anesthesiologists.

Inclusion Criteria

Age 50-70 years, Unilateral-total knee arthroplasty, all patients received spinal anesthesia.

Exclusion Criteria

Patients undergoing bilateral or revision total knee replacement, history of bleeding diathesis, prior vascular surgery on femoral vessels on operated site, severe renal insufficiency (GFR <50), History of seizures or sepsis, Pre existing lower extremity neurological abnormalities, patients suffering from mental or psychological disorders.

Sample size calculation

The study design included three equal groups, each consisting of 20 patients. Total 60 patients.

Study Intervation

Anesthetic plan: All patients were given spinal anesthesia with 3ml 0.5% hyperbaric bupivacaine at the L3/4 interspaces (alternatively at the L4/5 interspaces) under complete aseptic conditions. All the surgeries were performed by using the medial parapatellar approach, and posterior stabilized knee prosthesis was used in all the patients. Randomization was done by sealed envelope technique.Anaesthesia was provided according to the hospital protocol regarding preoperative investigations, fasting hours, intra-operative monitoring, and calculating drugs toxic doses according to each patient body weight. In an attempt to facilitate contrasting data, records were taken at fixed intervals perioperatively.

Study Interventions

Group 1: Received ACB in the immediate postoperative period under a high-frequency ultrasound guidance (SonoSite™, Inc., Bothell, WA 98021, USA) in which the adductor canal was identified beneath the sartorius muscle and 20ml of 0.5% bupivacaine was injected in the canal using a 22-gauge 100-mm short-beveled regional block needle (Stimuplex® insulated B Braun Medical Germany), using a non cutting needle to avoid nerve injury and ensuring to provide the dose that causes adequate deep block of the distal branches of femoral nerve including saphenous nerve and branches of mixed sensory and motor nerves to the Quardicep and branches of the obturator nerve and providing postoperative adequate analgesic effect to minimize total opioids consumption as secure analgesia (Figure 1).

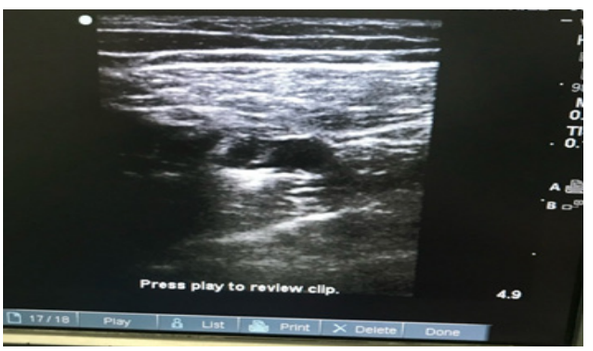

Figure 1: Adductor canal block.

Group 2: Received IPACK block[13] in which the patient was placed in a supine position and knee was placed in position of 90° flexion. A low-frequency ultrasound probe was positioned in the popliteal crease, and spinal needle was inserted from medial aspect of the knee from anteromedial to posterolateral direction in a plane between the popliteal artery and the femur. The tip of the needle was placed 1–2cm beyond the lateral edge of the artery, and 15ml of 0.5% bupivacaine was injected (Figure 2).

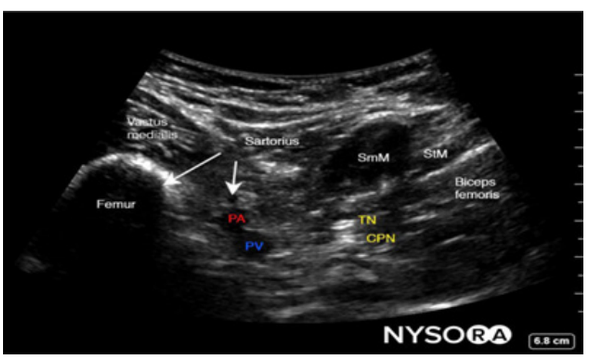

Figure 2: IPACK block.

Group 3: Received both ACB and IPACK. Blocks was done by the same anesthesiologist. All the patients received 30mg ketolac before skin incision and received the same postoperative analgesic regimen which was paracetamol 1g intravenously every 8h for 3 days followed by oral paracetamol 1g every 8h for 1 month. Pethidine 0.15mg/kg in the form of rescue analgesia in patients experiencing breakthrough pain if VAS ≥3. Then was reassessed again after 10 minutes if VAS >3 then repeat Pethidine dose for up to total dose of 75mg. A uniform supervised rehabilitation protocol followed the surgery (Figure 3).

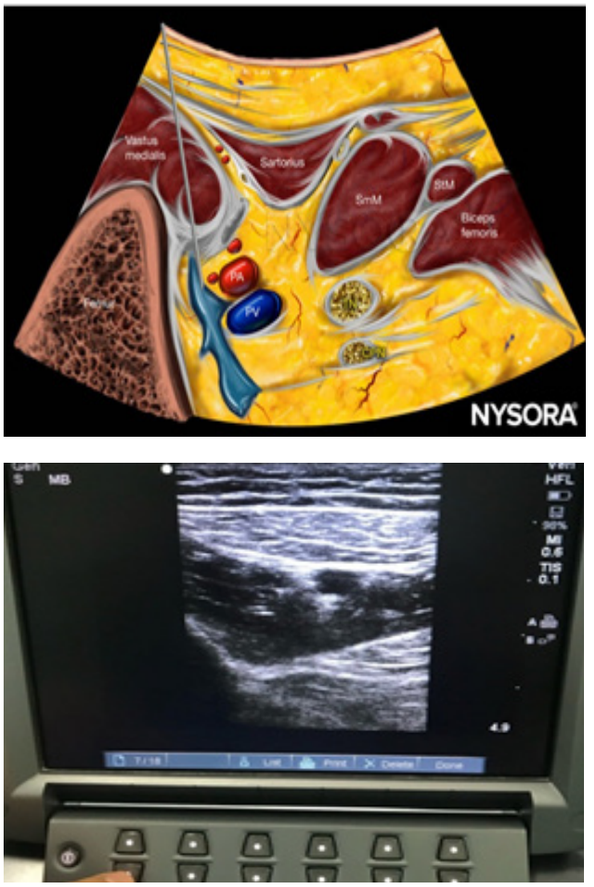

Figure 3: ACB and IPACK blocks[14].

Measured outcomes

Primary outcome

Postoperative pain at rest was the primary outcome measure which was assessed using the visual analog scale (VAS) (scale 0–10, where 0= no pain and 10= worst imaginable pain). Pain assessment by VAS score was explained to all the patients before surgery and taught the VAS score for self-assessment of pain at the time of enrollment for the study and to the nurse staff attending the patients. Post operative pain at rest was assessed by VAS score of scale from 0-10 and was recorded at 24h after surgery.

Secondary outcome

Measured time to mobility after surgery and total dose of rescue analgesia given and was observed by another anesthesiologist.

Statistical analysis

Data were analyzed using Statistical package for Social Science (SPSS) version 22.0., Quantitative data were expressed as mean±standard deviation (SD) or Median (IQR) when indicated. Qualitative data were expressed as frequency and percentage.

The following tests were used

1. For quantitative parametric data, an analysis of variance was used with post hoc tests to compare the three groups. If there was a significant difference between the groups, Tukey's analysis was applied. For the comparison of subjective data, the chi-square test was used.

2. Chi-square (X^2) test of significance was used in order to compare proportions between qualitative parameters.

3. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the *p*-value was considered significant as the following:

4. Probability (*P*-value)

P-value <0.05 was considered significant.
P-value <0.001 was considered as highly significant.
P-value >0.05 was considered non-significant.

RESULTS

Sixty-seven patients were screened for eligibility for the trial. Four patients declined to participate in the study, three patients did not match all the inclusion criteria, and the remaining sixty patients were followed up on 20 patients in each group.

Demographics and block properties

Groups were compared in demographic data in terms of age, sex, BMI and ASA and there was no statistically significant difference between groups (*p*-value >0.05). (Table 1).

Duration of surgery

There was no statistical difference in duration of surgery across the three groups (Table 2).

PACU time

There was no statistical difference in the PACU duration across the three groups (Table 3).

Time for first analgesia and opioid consumption

The time for first analgesia was longer in group C (7.75± 0.44 hours) compared to group A (6.05±0.6 hrs) and group B (4.7±0.47) (Table 4).

Using the post hoc Tukey's test for pairwise comparison within the ANOVA data, there was considered significant between group A and group B. Also, the result was considered significant between group B and group C.

There was statistically significant difference between groups at amount of opioids used. Opioid consumption was lower in group C compared to group A and group B.

Time to mobility

There was statistically significant difference between groups regarding time to mobility being significantly lower in Group C in comparison to both groups A and B (Table 5).

Hospital stay was significantly shorter in group C compared to the other 2 groups (Table 6).

Pain scores were significantly lower in group C compared to the other 2 groups (Table7).

Table 1: Comparison between groups as regard demographic data:

Demographic data		Group A (*n*= 20)	Group B (*n*= 20)	Group C (*n*= 20)	*p*-value
Age (years)		61±6.72	61.05±7.19	63.45±5.98	0.42
ASA	I	3(15%)	2(10%)	2(10%)	0.79
	II	8(40%)	10(50%)	12(60%)	
	III	9(45%)	8(40%)	6(30%)	
Sex	Male	10(50%)	1(55%)	1(55%)	0.94
	Female	10(50%)	9(45%)	9(45%)	
BMI		32.2±3.38	32.15±3.12	33.4±3.1	0.38

Data expressed as mean±SD; percentage $P>0.05$ was considere statistically non-significant between the 3 groups.

Table 2: Comparison between groups as regard duration of surgery:

	Group A (*n*= 20)	Group B (*n*= 20)	Group C (*n*= 20)	*p*-value
Duration of Surgery	103.75±11.11	103.5±10.77	104.25±10.67	0.98

Data expressed as mean±SD.

Table 3: Comparison between groups as regard PACU time:

	Group A (*n*= 20)	Group B (*n*= 20)	Group C (*n*= 20)	*p*-value
PACU Time	28.75±3.8	28.1±3.97	29.4±2.95	0.52

Data expressed as mean±SD.

Table 4: Comparison between groups as regard time for first analgesia and opioid consumption:

	Group A (*n*= 20)	Group B (*n*= 20)	Group C (*n*= 20)	A vs. B	B vs. C	A vs. C	*p*-value
				Post hoc Tukey's test			
Time for first analgesia (hours)	6.05±0.6	4.7±0.47	7.75±0.44	<0.001	<0.001	<0.001	<0.001
Opioid consumption (mg)	38.75±17.16	53.75±16.77	27.5±7.69	0.005	<0.001	0.046	<0.001

Data expressed as mean±SD; *t*= Student *t* test; $P<0.05$ was considered statistically significant between the 3 groups.

Table 5: Comparison between groups as regard time to mobility:

	Group A (*n*= 20)	Group B (*n*= 20)	Group C (*n*= 20)	A vs. B	B vs. C	A vs. C	*p*-value
				Post hoc Tukey's test			
Time to mobility (hours)	13.38±1.94	20.05±1.95	11.73±1.47	<0.001	<0.001	<0.001	<0.001

Data expressed as mean±SD; *t*= Student *t* test; $P<0.05$ was considered statistically significant between the 3 groups.

Table 6: Comparison between groups as regards hospital stay time:

	Group A (*n*= 20)	Group B (*n*= 20)	Group C (*n*= 20)	A vs. B	B vs. C	A vs. C	p-value
				Post hoc Tukey's test			
Hospital stay (days)	21.05±1.94	20.05±1.95	11.73±1.47	<0.001	<0.001	<0.001	<0.001

Table 7: Comparison between groups as regard VAS score:

	Group A (*n*= 20)	Group B (*n*= 20)	Group C (*n*= 20)	*p*-value (ANOVA)
		Median (IQR)		
VAS 1 hr	1(1–1.5)	2.5(2–3)	1(0–1)	<0.001
VAS 24 hrs	3(2–3)	3(3–4)	2(1–2.5)	<0.001

Data are presented as median (IQR); *p*-value <0.05 is considered statistically significant between the 3 groups.

DISCUSSION

The increasing number of TKA surgeries performed worldwide has resulted in a greater need for emphasizing adequate pain management and faster recovery modalities in the immediate postoperative period. This led to the emerging of various postoperative pain management strategies of which peripheral nerve blocks have achieved higher levels of adequate pain management post operative[15]. ACB is a peripheral nerve block, which has been reported to provide significant pain relief and earlier mobilization in patients due to its quadriceps motor power sparing[16]. However, this technique provides pain relief only for anterior and medial knee pain sparing posterior knee pain due to sparing the effect on deep genicular nerves and as a result posterior knee pain is not covered by this technique, which precludes complete knee extension and thereby affecting early ambulation which delays rehabilitation[17,18]. Different techniques needed to block the contribution of sciatic nerve to the posterior capsule without involving the common peroneal nerve have been attempted but without a significant success[13].

In our study, we contrasted the analgesic effects of ACB alone and IPACK alone and ACB in combination with IPACK in knee arthroplasty.

According to the study, there was no statistically significant difference between the three groups' demographic characteristics (age, sex, BMI, and ASA score) (*P* value >0.05).

Additionally, there was a discernible difference in the three groups' use of opioids in the first 24 hours following surgery (*P* value <0.001).

Measurement of the pain score using the visual analogue scale (VAS) at regular intervals (24 hours) showed a better pain control among the group which received a combination of both ACB + IPACK block than in the group that received ACB alone and IPACK alone (*P*-value <0.05).

The study also discovered that when compared to the ACB alone group and IPACK alone group, the group that received both ACB+IPACK had a longer walking distance and a greater range of motion (*P*-values were 0.001 for both outcomes).

Unfortunately, we didn't come across many published studies discussing the effect of IPACK block in knee surgeries.

In agreement with our study, Sankineani *et al*., reported that the group which received ACB + IPACK has shown a better pain control on VAS, a better range of motion together with better ambulatory distance than in the group that received ACB alone. They also mentioned that the chief complaint of patients who received ACB only was pain limited to the posterior side of the knee on the first 24 hours following surgery[12].

According to Donghai *et al.*, the ACB+IPACK group displayed lower pain scores, less morphine use, and a longer analgesic duration than the ACB solo group. Additionally, he claimed that there was little difference regarding the mobility between the two groups[15].

In a different study, Tayfun *et al*., discovered that patients who received a combined ACB + IPACK had shorter discharge and mobilisation days, less pain, and less opioid demands than patients who received only ACB[16].

In a 2021 study by Singtana, it was discovered that compared to ACB alone, opioid intake at 12 hours postoperatively was statistically significantly lower with IPACK block than with ACB alone. Between the two groups, there were no statistically significant differences in the numerical pain rating scale, analgesic dosage, satisfaction ratings, or complications[17].

Elliot *et al*., stated that the combination of ACB + IPACK improves the response to physical therapy and can reduce pain scores, opioid consumption and hospital stay. In their study, ACB+IPACK group didn't show lower VAS scores. In comparison to the femoral nerve block (FNB) + IPACK group, they also displayed somewhat increased opioid demands and consumption. However, during the first 48 hours following surgery, the ACB + IPACK group demonstrated considerably longer walking distance and a greater rate of discharges[18].

Additionally, a recent study conducted here in Egypt discovered that patients who received ABC with IPACK had lower VAS scores during the first 48 hours following surgery than those who simply received ACB[19].

On contrary to the present study, a study by Terkawi *et al.,* in 2017 showed that using IPACK with ACB decreased pain scores during the immediate postoperative period only and had no beneficial effect during subsequent pain assessment. Also, they found no significant difference in opioid demands. They recommended that the indications for IPACK block may be applied where there are contraindications to the standard multimodal pain management (as patients with contraindications to paracetamol or NSAIDs), in case of chronic pain, or if the patient has opioid dependence[20].

CONCLUSIONS

ACB + IPACK is a promising technique that offers improved pain management in the immediate postoperative period without affecting the motor function around the knee joint resulting in better ROM and ambulation compared to ACB alone and IPACK alone.

LIST OF ABBREVIATIONS

Abb: Full term; **ACB:** Adductor canal block; **IPACK:** Interspace between popliteal artery and capsule of the posterior knee; **ASA:** American society of anesthesiologists; **CBC:** Complete blood picture; **VAS:** Visual analogue scale.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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