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Ultrasound Guided High Volume Adductor Canal Block Versus Combined Low Volume With Infiltration Between Popliteal Artery And Capsule Of Knee For Post-Operative Analgesia In Total Knee Arthroplasty

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Abstract

One of the most popular treatments to address joint pain in individuals with advanced osteoarthritis or rheumatoid arthritis of the knee is total knee arthroplasty (TKA). TKA, on the other hand, is followed by moderate to severe postoperative pain, which has a negative impact on postoperative rehabilitation, patient satisfaction, and the overall results of the procedure. Multimodal analgesia regimens including the Adductor Canal Block (ACB), Infiltration between the Popliteal Artery and the Capsule of the Knee (IPACK) block, and a combination of these are routinely utilised to provide safe early ambulation and rehabilitative activity. The purpose of this research was to assess and evaluate postoperative analgesia following total knee arthroplasty between a combination low volume + Ipack block and a large volume adductor canal block. A prospective, randomised, blind, and matched-pairs clinical trial was used for this study. The institutional ethics committee at Benha University Hospital gave its assent to the study's protocol. There were two groups of sixty patients each. Ultrasound-guided ACB with 20 mL of 0.125 bupivacaine was given to Group I:- Those in this group got the procedure. For Group II, the ACB was performed utilising ultrasound guidance, along with 10 mL of 0.125 bupivacaine and one pack block. Results: The low volume adductor canal block with IPACK block had a lower VAS score and lower opoid intake in the first 24 hours than the large volume adductor canal block, according to this research. In the end, we propose the low volume ACB with IPACK block for postoperative pain after total knee arthroplasty.

Key words: Ultrasound guided**,** high volume adductor canal block, combined low volume with infiltration, popliteal artery, capsule of knee, post-operative analgesia, total knee arthroplasty**.**

1. Introduction

It is critical for the patient's comfort, early mobility, and quicker recovery to control postoperative pain. High-risk patients' perioperative morbidity from acute coronary events and thrombotic events may be reduced with appropriate postoperative pain management. Analgesics widely used in the perioperative phase include opioids, which give analgesia but have their own set of risks. As a result, it is critical to use a multimodal analgesic approach. It has been shown that regional anaesthesia and analgesia give great analgesia as well as advantages that endure beyond the period of time immediately after surgery [1].

In the recent decade, ultrasonography guidance for the treatment of acute and chronic pain has received more and more acceptance. Adductor Canal and i-PAK Blocks, which might be the primary component of multimodal postoperative analgesia, are among the most often utilised methods for severe knee surgery pain postoperatively. The adductor canal block (ACB) may preserve quadriceps muscular power while delivering analgesia comparable to a conventional femoral nerve block (FNB) in patients having significant knee surgery [2].

While the motor innervation of the quadriceps muscle group is spared with this ACB procedure, its primary advantage over other techniques is that it is a pure sensory block that provides postoperative analgesia at least as well as FNB while preserving quadriceps strength hel [3].

To the saphenous and obturator nerves, the vastus medialis, medial femoral cutaneous, and articular branches of the adductor canals are all connected in the adductor canal. These nerves provide sensation to the knee's medial, lateral, and anterior regions. As a result of its influence on the nerve to the vastus medialis as it traverses the adductor canal, ACB is a near-pure sensory nerve block that solely affects the muscle's motor function. For patients who have had total knee arthroplasty (TKA), various clinical trials and meta-analyses reveal that ACB, when used in place of FNB, may preserve quadriceps muscle strength, improve mobility, and hasten functional recovery [4].

Additional narcotics are often needed by patients who have had TKA and received a FNC block or ACB. Analgesia and narcotic intake are improved when the sciatic nerve block is paired with the FNC block. A sciatic nerve block, on the other hand, may cause sensory and motor impairments below the knee and increase the risk of tripping and stumbling. As a result, a regional block that offers analgesia to the posterior knee without causing distal neurologic impairment would be a preferable regional anaesthetic method [5].

An ultrasound-guided injection of local anaesthetic into the interspace between the popliteal artery and the knee capsule has been reported by Sanjay Sinha, MD, from Hartford, CT (IPACK). The IPACK block targets just the sciatic nerve's terminal branches, making it a viable choice for treating post-TKA posterior knee discomfort and preventing foot drop [6].

When doing an adductor canal block (ACB), the appropriate amount of local anaesthetic is supposed to prevent proximal diffusion of the local anaesthetic to the tibial triangle [7].

For postoperative analgesia after total knee arthroplasty, this study aims to evaluate and compare the effects of a large volume adductor canal block to a combination of low volume and Ipack blocks.

2. Patients and Methods

Ethics committee:

- The study protocol will be approved by the institional ethical committee of Benha University Hospital.
- Written informed consent will be obtained from all enrolled patients.

Type of study:

Prospective blind randomized comparative clinical trial.

Methods of randomization :

The patients will be randomized into two groups. An online randomization programme will be used to generate a random number list. Patient`s numbers will be concealed in opaque envelops will be opened by the study investigator.

The inclusion criteria:

- Patients of either sex aged between 45 and 75 years.
- ASA physical status I–III.
- BMI 28-40 kg/m^2 .

The exclusion criteria:

1- Body mass index ≥40 kg/m2 .
2- ASA>III.
3- Patient refusal.
4- Revision knee arthroplasty.
5- Bilateral knee arthroplasty.
6- Lack of mental ability to provide informed consent.
7- Neuropathic pain or sensory disorders of the surgical limb.
8- Contraindication to regional anesthesia (intolerance to the study drugs, bleeding diathesis, coagulopathy, malignancy or infection at the site of block).
9- Chronic opioid use defined as > 30 mg of daily oral morphine equivalents.

Group's allocation:

Sixty patients will be allocated into two groups.

- **Group I:-** Will receive ultrasound-guided ACB with 20 mL of 0.125 bupivacaine.
- **Group II:-** Will receive ultrasound-guided ACB with 10 mL of 0.125 bupivacaine plus I pack block using same volume and concentration as ACB.

Pre-operative visit:

One day before the intervention, all the patients will be interviewed to explain the procedure & the visual analogue scale (VAS), (which is designed to present to the respondent a rating scale in which the respondents mark the location on the 10-centimeter line corresponding to the amount of pain they experienced. This gives them the greatest freedom to choose their pain's exact intensity. It also allows for each respondent to express a personal response style). Also routine investigations as complete blood count (CBC) and coagulation profile (prothrombine time and INR), random blood sugar, should be fulfilled.

Prior to the regional block:

An IV access is established and patients will be monitored with electrocardiography , blood pressure monitoring , pulse oximetry and capnography then they will receive standard spinal anaeshtesia.

The patients will be transferred to the post anesthesia care unit (PACU) for a 2 hours observation period.

Additional analgesia was provided by injecting paracetamol 1G intravenous 8hrly for the first 48hours. Injection pethidine 50mg when required was advised for rescue analgesia.

Description of the Techniques:

The ultrasound used for the block in all groups, we have used (General Electric; GE, “LOGIQ P5" ultrasound machine) (figure 1) with 6 -13 MHz probes and colour Doppler imaging capability.

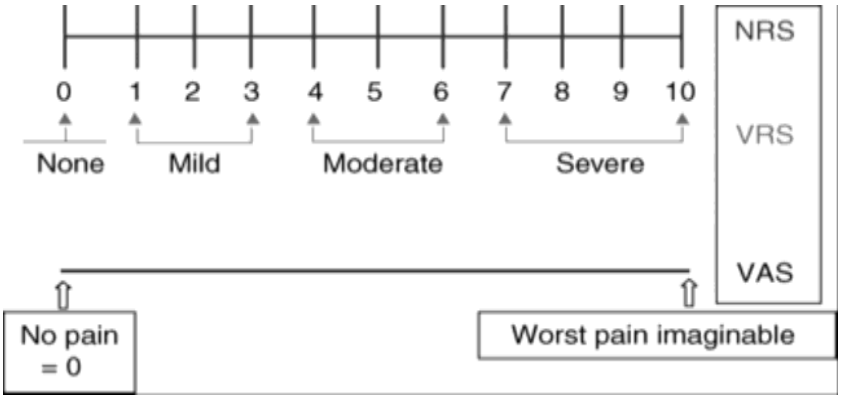

Fig. (1) Pain assessment scales: visual analogue scale (VAS), numerical rating scale (NRS) and verbal rating scale (VRS).[8]

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Fig. (2) GE LOGIQ P5 ultrasound machine.

A standard regional anesthesia tray was prepared with the following equipment:

- Sterile towels and 4"x4" gauze packs.
- 20-mL syringes with local anesthetic.
- Sterile gloves and marking pen.
- An 18 gauge 8 cm Tuohy-tip needle from epidural set (Perifix.B.BRAUN Melsungen AG, Germany).
- A 3 ways stopcocks with Polyvinyl chloride (PVC) extension linefor injection (figure 3).

Fig. (3) A standard regional anesthesia tray prepared for the blocks.

1.The ultrasound guided adductor canal block:

The skin is disinfected and the transducer is placed anteromedially, approximately at the junction between the middle and distal third of the thigh or somewhat lower. If the artery is not immediately obvious, several maneuvers can be used to identify it, including color Doppler scanning to trace the femoral artery caudally from the inguinal crease. Once the femoral artery has been identified, the probe is moved distally to trace the artery until it passes through the adductor hiatus to become the popliteal artery (figure 4).

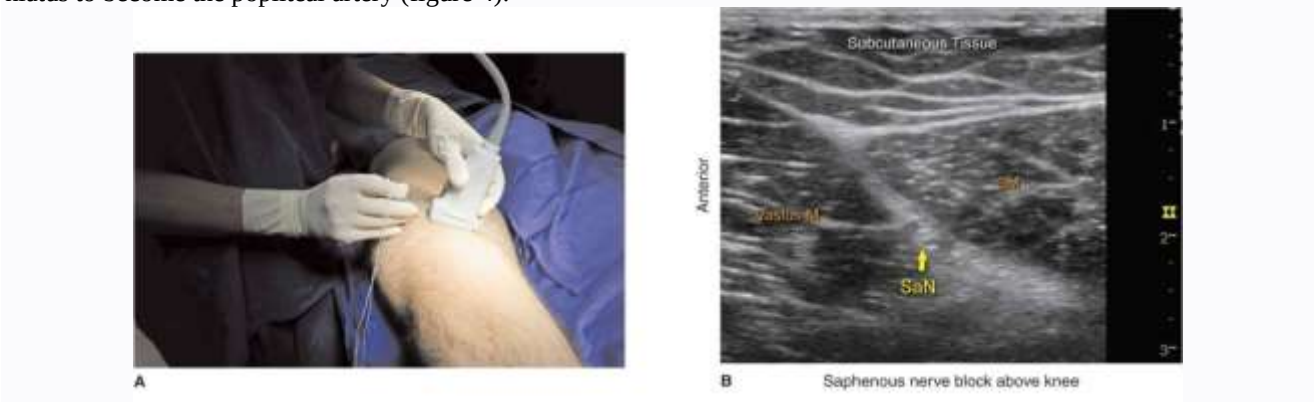


Fig. (4) patient positioning with ultrasound guided adductor canal block.

The saphenous nerve block should be performed at the most distal level where the artery still lies immediately deep to the sartorius muscle, thus minimizing the amount of motor nerve block of the vastus medialis; an adductor canal nerve block is typically performed more proximally, around the mid-thigh level. The needle is inserted in-plane in a lateral-to-medial orientation and advanced toward the femoral artery .Once the needle tip is visualized anterior to the artery and after careful aspiration, 1–2 mL of local anesthetic is injected to confirm the proper injection site (figure 4) . When injection of local anesthetic does not appear to result in its spread around the femoral artery, additional needle repositions and injections may be necessary.[9]

2. The ultrasound guided IPACK block technique:

The patient was placed in a supine position and knee 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 1–2 cm beyond the lateral edge of the artery, and 10 ml of 0.128% bupivacaine was injected (Figure 6).

Statistical analysis

Analysis of data will be done by using SPSS (statistical program for social science version 16) as follows: Description of quantitative variables as mean,standard deviation (SD) using Student's t-test. Description of qualitative variables as number and percentage. Chi-square test will be used to compare qualitative variables between groups. For binomial data, Fisher's exact test was used. P- value < 0.05 was considered statistically significant. P- value < 0.01 was considered statistically highly significant.

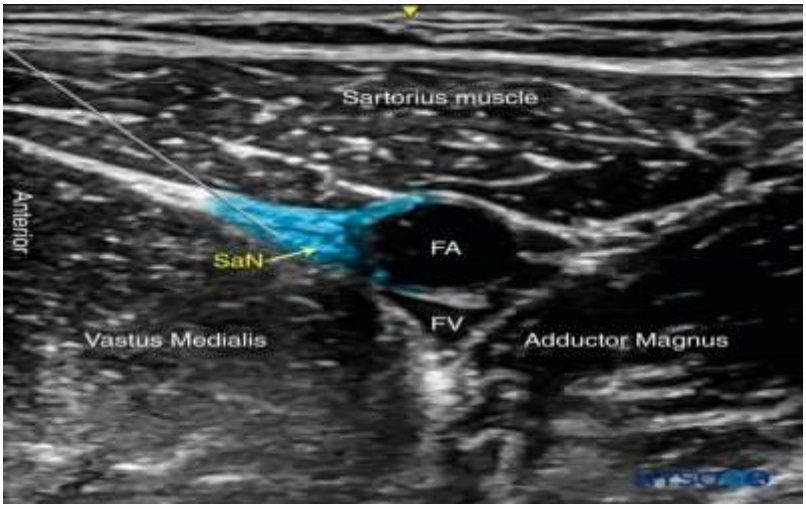
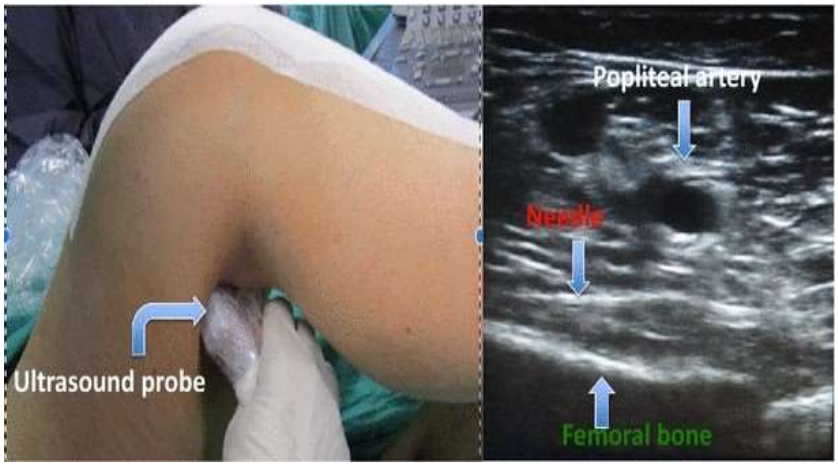


Fig. (5) Simulated needle path, needle tip position and local anesthetic initial distribution (blue-shaded area) to anesthetize the Saphenous nerve (SaN) at the level of the thigh. FA, femoral artery: FV, femoral vein.



Fig(6) The ultrasound probe is placed in the popliteal fossa on the lateral side and the needle introduced posteromedially with the patient placed in supine position. Popliteal artery, femoral bone surface identified on the ultrasound and the needle placed in capsular space between the artery and femur and anesthetic injected.

3. Results

VAS at rest differed significantly differed between both groups throughout the study. It was significantly lower in group II than in group I in the first 24 hours. No significant differences were observed at 48 hours ***(Table 1, Figure 1)***.

Table (1) VAS at rest at different follow up times in both groups.

VAS at rest	Group I (n = 30)	Group II	VAS at rest
At 30 minutes	3 (1 - 5)	2 (0 - 4)	<0.001
At 2 hours	3 (1 - 5)	1 (0 - 3)	<0.001
At 4 hours	2 (1 - 5)	1 (0 - 3)	<0.001
At 6 hours	2 (0 - 5)	2 (0 - 5)	0.206
At 12 hours	2 (1 - 5)	2 (0 - 4)	0.034
At 24 hours	2 (1 - 5)	2 (0 - 4)	0.031
At 48 hours	2 (0 - 4)	2 (0 - 4)	0.830

Data were presented as median (min-max); * Significant

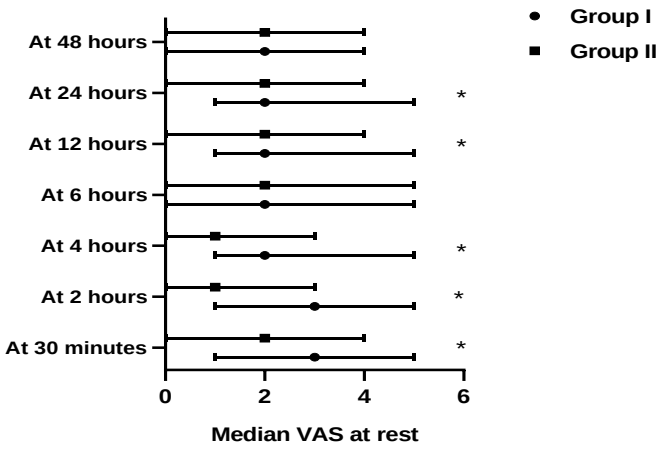


Fig. (1) VAS at rest at different follow-up times in both groups.

VAS at movement differed significantly between both groups throughout the study. It was significantly lower in group II than in group I in the first 24 hours. No significant differences were observed at 48 hours ***(Table 2, Figure 2)***.

Table (2) VAS at movement at different follow up times in both groups

VAS at movement	Group I (n = 30)	Group II (n = 30)	P-value
At 30 minutes	2 (1 - 5)	2 (1 - 4)	0.035
At 2 hours	2 (1 - 5)	2 (1 - 5)	0.588
At 4 hours	3 (0 - 4)	2 (0 - 4)	<0.001
At 6 hours	2 (1 - 5)	1 (0 - 3)	<0.001
At 12 hours	2 (0 - 4)	1 (0 - 3)	0.032
At 24 hours	2 (0 - 5)	2 (0 - 4)	0.024
At 48 hours	2 (1 - 4)	2 (0 - 4)	0.802

Data were presented as median (min-max); * Significant

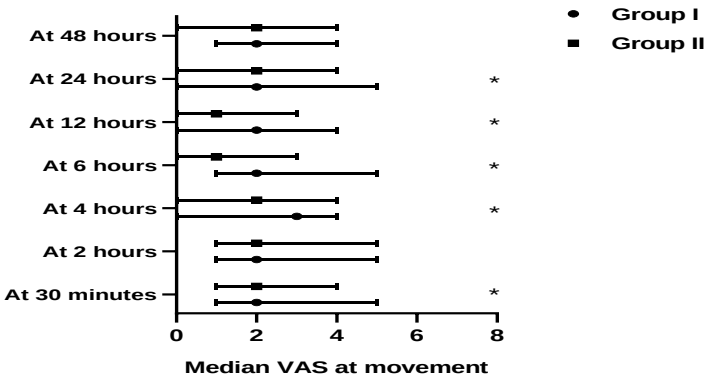


Fig. (2) VAS at movement at different follow-up times in both groups

Table (5) Pain rescue analgesia at different follow-up times in both groups

	Group I (n = 30)	Group II (n = 30)	P-value
Pain rescue analgesia at 24 hrs	100 (25 - 200)	75 (25 - 200)	0.025*

Data were presented as median (min-max); * Significant

Pain rescue analgesia at 24 hours was significantly lower in group II (median = 75, range = 25 – 200) than in group I (median = 100, range = 25 – 200) (P = 0.025) ***(Table 5)***.

4. Discussion

Group II (low volume ACB + IPACK block) showed a lower VAS score at rest on the first 24 hours compared to group I (high volume ACB + IPACK block), however there were no significant changes after 48 hours of motion compared to group I. (high volume ACB). Group II also had a reduced 24-hour morphine consumption, a lower incidence of adverse events, and a greater postoperative knee range of motion.

A research by Sankineani et al. [10] examined the VAS scores of 120 patients who had had unilateral total knee replacement surgery. It was divided into two groups: Group 1, which got ACB + IPACK (n=60), and Group 2, which received only ACB. All patients were assessed for pain using the VAS scale on the eighth hour, the first postoperative day, and the second postoperative day (POD). As an added bonus, we looked at things like range of motion (ROM) and ambulation distance (AD). VAS scores in the ACB + IPACK group were considerably (p 0.005) better than those in the ACB group. The ACB + IPACK group outperformed the ACB group in terms of average knee ROM and ambulation distance.

Kertkiatkachorn et al. [11]also found that patients who had ACB + IPACK block had considerably decreased pain at rest and walking on POD 1 compared to patients who received ACB alone, and our study is consistent with their findings.

Patients who got ACB + IPACK block had lower rest and active pain ratings 4–8 hours after surgery than those who received ACB alone, according to another case study by Zhou et al. [12]. Rest and activity VAS pain ratings, on the other hand, did not vary significantly between the two groups.

Opiod consumption was found to be lower in the low volume ACB + IPACK block group than in the high volume ACB alone in the first 24 hours, which is in line with Kampitak et al. [13] who found that the low volume ACB + IPACK block had significant advantages over the high volume ACB in delaying the first requirement for rescue opioid and decreasing the number of patients requiring rescue opioid as compared to high volume ACB. It's possible that these benefits didn't last more than 6-8 hours since IPACK block's analgesic impact diminishes with time. Neither the high-volume ACB nor the low-volume plus IPACK block affected the patient's quadriceps strength, allowing them to walk more freely, resulting in a quicker recovery and return to normal activities. Low volume ACB + IPACK block and high volume ACB groups showed no difference in TUG and quadriceps strength at any time point of follow-up.

These findings are consistent with a few small trials in which ACB (20–22 h) was shown to be more effective for postoperative analgesia than IPACK block (6–12 h).

Using the continuous reassessment approach, Jaeger et al. [14[evaluated the appropriate amount of local anaesthetic for adductor canal block: they recruited 40 healthy males to participate in their research. All participants were given an ACB with 1% lidocaine. Following Bayesian analysis to identify the ED95, volumes were successively allocated to the individuals using the ongoing reassessment approach. With the use of magnetic resonance imaging, the adductor canal's distal filling was determined (primary outcome). There was a 25 percent reduction in quadriceps weakness proximal to the femoral triangle when volume was increased from baseline. Findings: The present research does not support Ma's and colleagues' (15) findings of an earlier discharge and no significant changes in VAS score, Morphine use and duration of hospital stay for patients receiving ACB + IPACK block as opposed to those receiving ACB alone.

5. Conclusion

ACB with IPACK block had a lower VAS score at rest and during movement in the first 24 hours postoperatively with much reduced opoid intake, improved range of motion, and no significant adverse effects compared to the large volume adductor canal block (ACB). Both groups showed no significant differences in quadriceps muscle motor power.

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