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Comparative Study between Ultrasound-Guided Fascia Iliaca Block Versus Adductor Canal Block for Postoperative Analgesia in Patients undergoing Knee Surgeries

Soliman Ramadan Naser[1*], Sameh Mohammed Refaat[1], Nagat Sayed El Shmaa[1] and Sabry Mohammed Amin[1]

[1]*Anesthesiology, Surgical Intensive Care and Pain Medicine Department, Faculty of Medicine, Tanta University, Tanta, Egypt.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Peripheral nerve block may provide effective unilateral postoperative analgesia following knee and hip surgeries with a lower incidence of opioid-related and autonomic side-effects, less motor block. Fascia iliaca block (FIB) and adductor canal block (ACB) have been shown to be a successful technique for postoperative pain relief after knee surgeries. The aim of our study was to compare the effect of ultrasound guided FIB versus ultrasound guided ACB for postoperative analgesia in patients undergoing knee surgeries.

Methods: Our randomized controlled trial was conducted over 105 patients aged between 18 and 65 years, (ASA) class I and II undergoing knee surgeries. Patients divided into three groups: Group I control (C): Patients received spinal anesthesia alone. Group II (FIB): Patients received spinal anesthesia with postoperative ultrasound guided FIB. Group III (ACB): Patients received spinal anesthesia with postoperative ultrasound guided ACB.

Results: Both FIB and ACB provided better pain control compared to control group. The need for

**Corresponding author: E-mail: soliman.ramadan@ymail.com;*

first dose of supplemental analgesic was earlier in the control group than FIB and ACB groups postoperatively. Additionally, the total 24-h pethidine consumption was highest in the control group compared to fascia FIB and ACB groups. FIB was shown to reduce the strength of the quadriceps muscle, which resulted in delayed early postoperative mobilization and influencing patient satisfaction .There was statistically significant increase in heart rate and mean arterial blood pressure in group I as compared to group II and group III at 6hrs and 12hrs postoperatively.

Conclusions: Both FIB and ACB provide excellent postoperative analgesia after knee surgeries, however the ACB is superior to FIB because it has no prolonged muscle weakness and FIB did.

Keywords: Ultrasound-guided; fascia iliaca block; adductor canal block; analgesia; knee surgeries; peripheral nerve block.

1. INTRODUCTION

Relief of intraoperative and postoperative pain has gained importance in recent years, considering the central, peripheral and immunological stress response to tissue injury. Any expertise acquired in this field should be extended into the postoperative period, which is the period of severe, intolerable pain requiring attention, so there is need of extended analgesia without any side effects in the process of achieving this goal [1].

Knee surgeries are common surgical procedures for treatment of the degenerative disorders and traumatic diseases [2]. However, a majority of patients often experience moderate to severe postoperative pain after these operations [3].

Postoperative pain control has a significant impact on earlier ambulation, initiation of physiotherapy, and better functional recovery [4]. In addition, effective pain control would lower the length of hospital stay and the risk of thrombotic events which improves patients' satisfaction. Multiple analgesic strategies have been proposed including intramuscular, intravenous opioid, epidural analgesia, and peripheral nerve block [5].

The well-known side-effects of opioids (e.g. acute opioid tolerance, hypoventilation, sedation, postoperative nausea and vomiting, constipation, urinary retention) limit their use and would influence rehabilitation [6].

The use of ultrasound allows imaging of the needle, nerves, surrounding anatomical structures and spread of local anesthesia. In addition, it can help avoid complications such as intraneural and intravascular injection [7].

Peripheral nerve block may provide effective unilateral postoperative analgesia following knee and hip surgeries with a lower incidence of opioid-related and autonomic side-effects, less motor block. Recently fascia iliaca block (FIB) became an attractive analgesic technique which involves local infiltration anesthesia under the fascia of iliacus muscle to block femoral, lateral femoral cutaneous, and obturator nerves [8].

Also, adductor canal block (ACB) has been shown to be a successful technique to FIB for postoperative pain relief after knee surgeries. Recent data suggested that ACB may contribute to adequate analgesia with a multimodal analgesic regimen [9] and be associated with better quadriceps strength, postoperatively, in comparison with FIB [10].

The aim of our study was to compare the effect of ultrasound guided FIB versus ultrasound guided ACB for postoperative analgesia in patients undergoing knee surgeries.

2. PATIENTS AND METHODS

Our randomized controlled trial was conducted over 105 patients aged between 18 and 65 years American Society of Anesthesiologists (ASA) class I and II undergoing knee arthroscopic surgeries at orthopedic department, Tanta University Hospitals after approval from Ethical Committee and obtaining informed written consent.

The exclusion criteria were patient refusal, general contraindication to regional nerve block, local infection or anatomic malformation at the site of the block., history of allergy to local anesthetics (amides), patients with coagulopathies and neurological deficit in lower limb.

Patients divided into three groups: Group I control (C): Patients received spinal anesthesia alone. Group II (FIB): Patients received spinal anesthesia with postoperative ultrasound guided FIB. Group III (ACB): Patients received spinal anesthesia with postoperative ultrasound guided ACB.

Patients were subjected to the following: history taking, clinical examination and routine laboratory investigations including: CBC, bleeding time, clotting time, liver function tests, kidney function tests.

All patients were premedicated with iv midazolam 1 mg 15 min before surgery and two peripheral cannulas were inserted in dorsum of hand. We monitored operating room, Electrocardiogram, pulse oximetry, and noninvasive arterial blood pressure at 5 min intervals were applied.

2.1 Anesthetic Technique

The primary anesthetic technique in all groups was spinal anesthesia with 15 mg of hyperbaric bupivacaine 0.5% at L3-4 or L4-5 in the sitting position.

2.2 Technique of Fascia Iliaca Block

After completion of the surgical procedure, the patient was placed supine. The skin was disinfected. A high frequency ultrasound probe (6-12 MHz, linear array) was placed in a transverse direction over the anterior thigh below the inguinal ligament. The femoral artery was identified and the muscle was seen lateral to it, covered by the fascia iliaca. Then, the probe was moved laterally till the artery was not being seen in the view. The 22-gauge needle was advanced until the tip was placed underneath the fascia iliaca. As the needle passed through fascia iliaca the fascia was be first seen indented by the needle. As the needle eventually was piercing through the fascia, a pop was felt and the fascia was seen to "snap" back on the ultrasound image. After negative aspiration, 2 mL of saline was injected to confirm the proper injection plane between the fascia and the iliopsoas muscle then 30 mL bolus of 0.25% bupivacaine was injected. Fig. 1.

2.3 Technique of Adductor Canal Block

After completion of the surgical procedure, the patient was placed supine with knee slightly flexed and leg externally rotated (frog leg position). The block area was disinfected. A high frequency ultrasound probe was placed on the anterior aspect of the patient's thigh, approximately mid-point between the inguinal crease and medial condyle. The femur was identified (usually at a depth of 3-5cm) and probe was moved medially until the boat shaped Sartorius muscle was visualized. The 22-gauge needle was advanced into the adductor canal. After negative aspiration, 2 mL of saline was injected to confirm the needle tip was within the adductor canal then 30 mL bolus of 0.25% bupivacaine was injected. Fig. 2.

2.4 Measurements

Heart rate and mean arterial blood pressure was recorded at 1, 2, 4, 6, 12 and 24 hours postoperatively. Postoperative pain was assessed by the Numerical Rating Scale (NRS) score (from 0 to 10) at1, 2, 4, 6, 12 and 24 hours postoperatively. In all groups, rescue analgesia was administered in the form of pethidine 10-15 mg and repeated every 15-20 min (intravenous, IV) when NRS score ≥ 5. Considering that, the total dose not exceeding 1mg\kg\day. The time to first analgesic request was recorded (which defined as the time from completion of surgery till the time for first request for analgesic). Total dose of rescue analgesia in the first 24 h postoperative was recorded.

Quadriceps muscle power; the patients (in the supine position) was asked to perform a straight leg raise. The motor block was graded as follows: Grade 0, normal muscle power; grade I, motor weakness; grade II, complete motor paralysis [11]. The assessment started in the postoperative period (0 h, which was 4 h after completion of the surgery) and every 6 hours thereafter for 24 hours. Any undesirable postoperative side effects or complications as local anesthetic toxicity, hypotension, nausea & vomiting were recorded.

The sample size calculation was performed using Open Epi provided online by World Health Organization (WHO) and by Centers for Disease Control and Prevention (CDC). The calculated sample size was 35 per group based on the following considerations: 95% level of significance, 80% power of the study and control to experimental ratio 1:2.

2.5 Statistical Analysis

The data was analyzed with the SPSS v 22 (IBM Inc., Chicago, IL, USA). Shapiro-Wilks normality test and histograms were used to test the distribution of quantitative variables. Parametric variables were expressed as mean and standard deviation (SD) and were compared using ANOVA test among the three groups with post hoc (LSD) test to compare each two groups. Non-parametric variables were expressed as median and interquartile range (IQR) and were analyzed using Kruskal-Wallis test; further analysis was performed by Mann–Whitney (U) test to compare each two groups. Categorial variables were expressed as frequency and percentage and were statistically analyzed by Chi-square test. A p value of less than 0.05 was considered statistically significant.

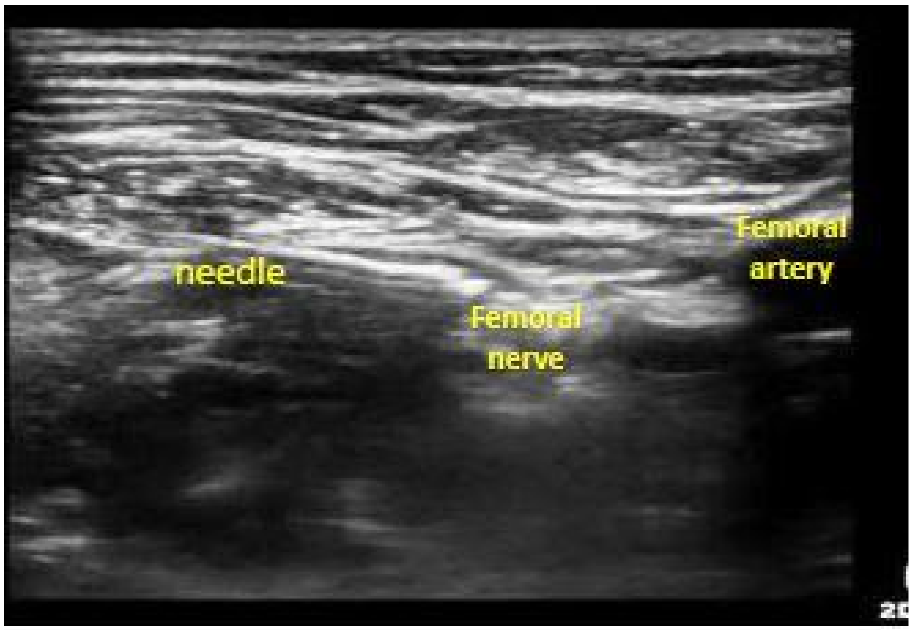

Fig. 1. Ultrasound view of needle advancement towards the fascia iliaca

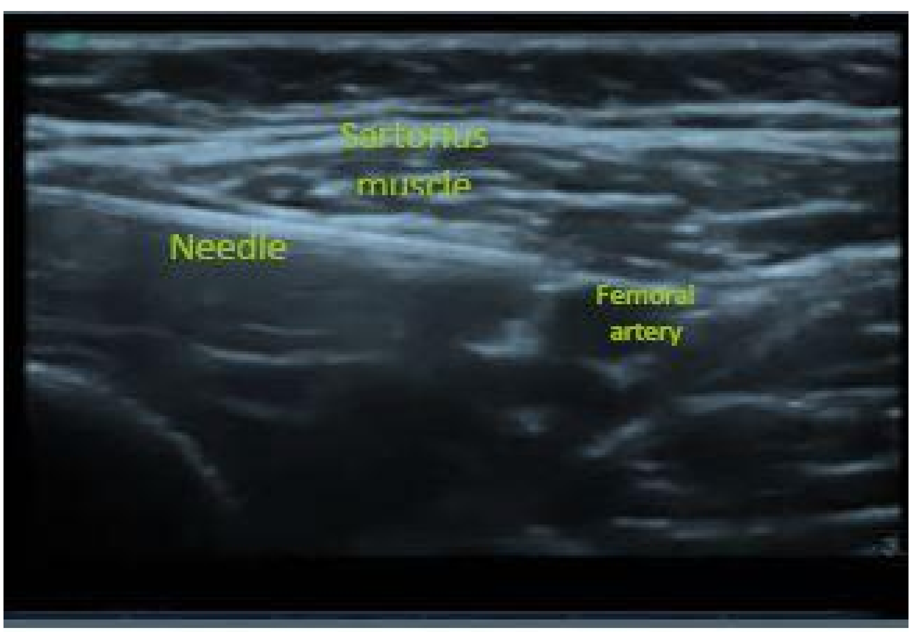

Fig. 2. Ultrasound view of needle advancement towards the adductor canal

3. RESULTS

Flowchart of the studied patients is shown in Fig. 3.

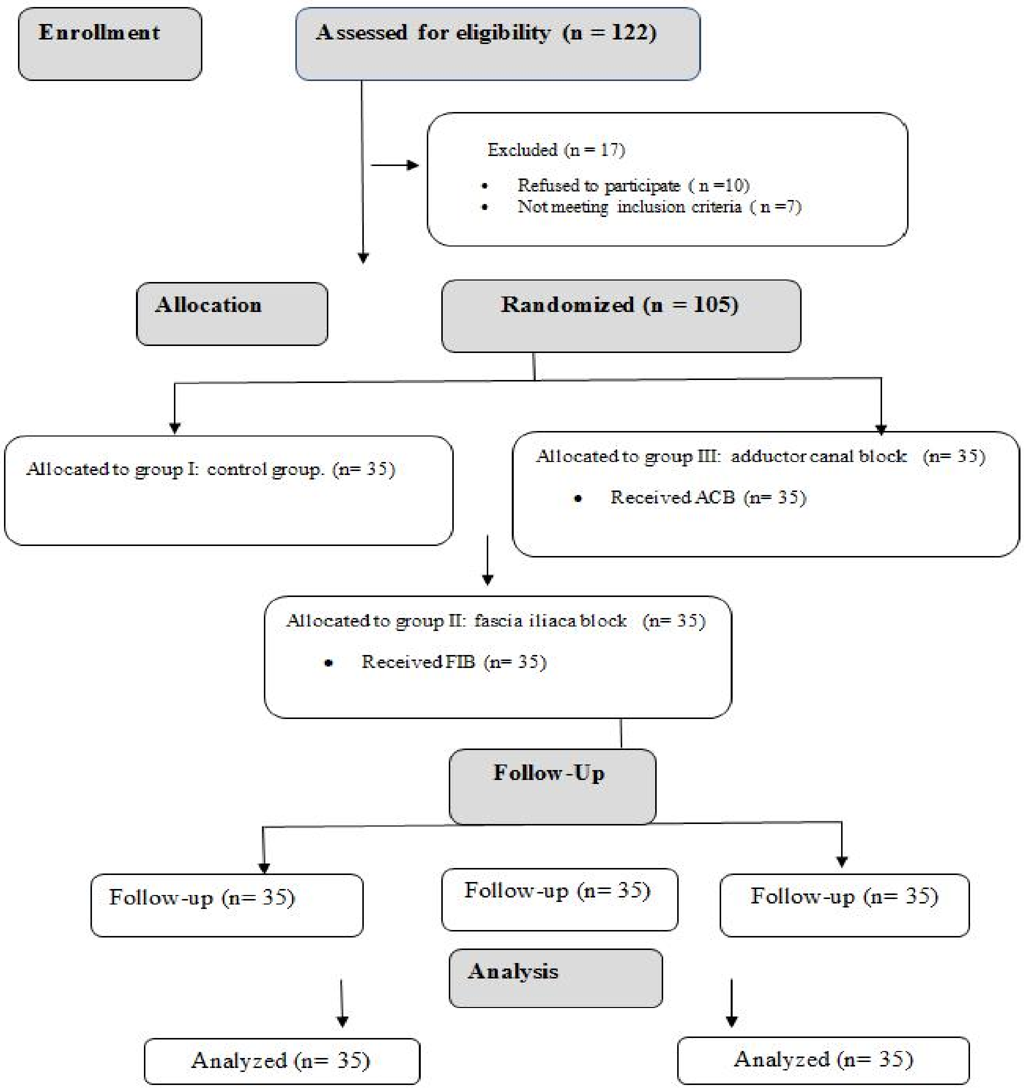

Fig. 3. Flow chart of the studied groups

Comparison among the three studied groups show statistically insignificant difference as regard age, weight and sex (Table 1).

Table 1. Demographic data of the studied groups

		Group I	Group II	Group III	p value
Age (y)	Mean ± SD	38.9 ± 11.5	35.7 ± 11.2	39.8 ± 12.1	0.299
Gender	Male	21 (60%)	16 (45.7%)	18 (51.4%)	0.484
	Female	14 (40%)	19 (54.3%)	17 (48.6%)	
Weight (Kg)	Mean ± SD	81.1 ± 10.2	78.37 ± 8.6	83.51 ± 8.9	0.078

There was statistically significant increase in heart rate in group I as compared to group II and group III at 6hrs and 12hrs postoperatively while there was no statistically significant change in heart rate between group II and group III (Fig. 4).

There was statistically significant increase in mean arterial blood pressure in group I as compared to group II and group III at 6hrs and 12hrs postoperatively while there was no statistically significant change in mean arterial pressure between group II and group III (Fig. 5).

There was statistically significant increase in numerical rating scale score in group I as compared to group II and group III at 6hrs and 12hrs postoperatively while there was no statistically significant change in numerical rating score between group II and group III Table 2.

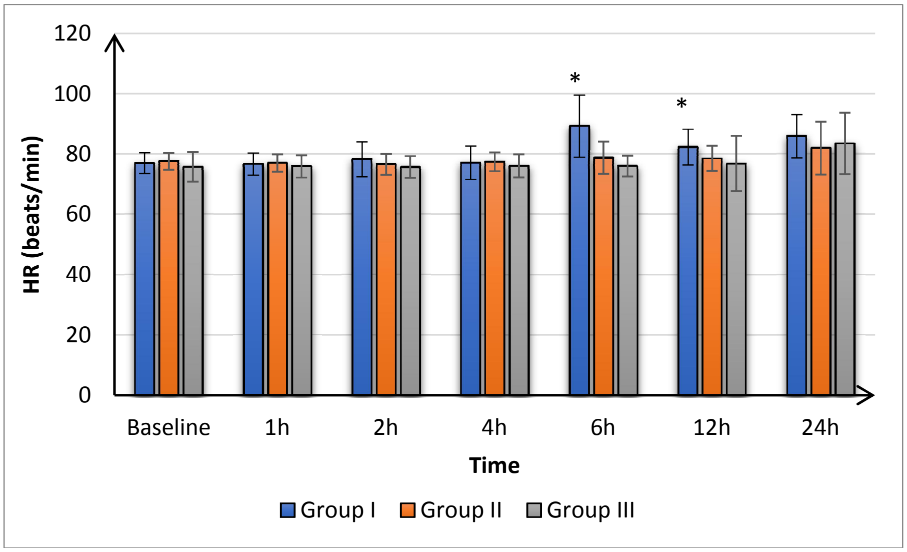

Fig. 4. Comparison of heart rate changes (beats/min) among the studied groups.

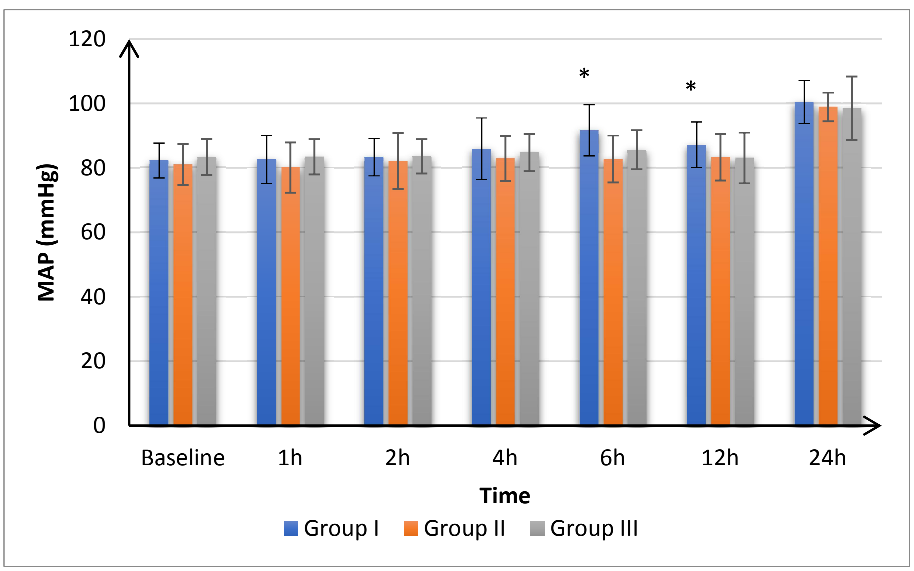

Fig. 5. Comparison of Mean arterial blood pressure changes (mmHg) among the studied groups

Table 2. Comparison of Numerical Rating Scale (NRS) score changes among the studied groups

		Baseline	1h	2h	4h	6h	12h	24h
Group I	Median	2	2	2	2	5	3	4
	Range	1-4	1-3	1-3	1-5	1-6	2-5	1-6
Group II	Median	2	2	2	2	2	3	4
	Range	1-3	1-3	1-3	1-3	1-5	1-4	2-6
Group III	Median	2	2	2	2	2	2	3
	Range	1-3	1-4	1-4	1-4	1-4	2-5	2-5
p value		0.933	0.923	0.121	0.585	<0.001*	0.001*	0.623
P1		0.931	0.744	0.172	0.980	<0.001*	0.001*	0.870
P2		0.748	0.719	0.359	0.483	<0.001*	0.001*	0.431
P3		0.755	0.964	0.617	0.277	0.368	0.581	0.379

*P1: comparison between group I & II, P2: comparison between group I & III, P3: comparison between group II & III, *: significant as p value <0.05*

Table 3. Comparison of quadriceps muscle power among the studied groups

		0	6hr	12hrs	18hrs	24hrs
Group I	Median	1	0	0	0	0
	Range	0-2	0	0	0	0
Group II	Median	1	1	1	1	0
	Range	0-2	0-2	0-2	0-1	0
Group III	Median	1	0	0	0	0
	Range	0-2	0-0	0-1	0-1	0
P value		1.000	<0.001*	<0.001*	<0.001*	
P1		1.000	<0.001*	<0.001*	<0.001*	
P2		1.000	1.000	0.079	0.154	
P3		1.000	<0.001*	<0.001*	<0.001*	

*P1: comparison between group I & II, P2: comparison between group I & III, P3: comparison between group II & III, *: significant as P value <0.05*

Table 4. Postoperative need to analgesic among the studied groups

		Time of first postoperative need to analgesic (hr)	Total received dose of analgesic (mg)
Group I	Median	8	50
	Range	6-12	35-80
Group II	Median	18	25
	Range	15-24	0-50
Group III	Median	19	25
	Range	16-24	0-45
p. value		0.001*	0.001*
P1		0.001*	0.001*
P2		0.001*	0.001*
P3		0.832	0.791

*P1: comparison between group I & II, P2: comparison between group I & III, P3: comparison between group II & III, *: significant as P value <0.05*

There was significant increase in the duration of motor block in group II as compared with group I&III (p value<0.001), while there was no significant change in the duration of motor block between group I and group III (Table 3).

Only three cases showed postoperative nausea and vomiting in group I and this may be attributed to repeated doses of postoperative analgesia. There were no other complications recorded.

The time to first analgesic requirement was earlier in group I than in group II and group III. While total dose of rescue analgesia in the first 24 h postoperative was higher in group I when compared to group II and group III (Table 4).

4. DISCUSSION

In the present study, it was observed that: FNB and ACB both provided better pain control compared to control group. This was proved by NRS values which were significantly higher in the control group than FIB and ACB groups at 6 and 12hrs postoperatively. The need for first dose of supplemental analgesic was earlier in the control group than FIB and ACB groups postoperatively. Additionally, the total 24-h pethidine consumption was highest in the control group compared to FIB and ACB groups. Regarding comparison of the quadriceps muscle power among the studied groups, FIB was shown to reduce the strength of the quadriceps muscle, which resulted in delayed early postoperative mobilization and influencing patient satisfaction.

Ultrasound guidance was used in this study to confirm local anesthetic spread around the target nerve. This is the difference from blind techniques, which can fail because local anesthetic does not uniformly surround the target nerve.

Ultrasound guidance also helped to ensure that we avoided vascular structures to avoid vascular injury or intravascular injection. Ultrasound decreases the need for multiple trials, error, and decreases the times of performance

The use of ultrasound guidance for FIB significantly improved the success of femoral and obturator motor block, and sensory block to the medial thigh.

In agreement with our study; Markman and Barton [12] who were among the first to note that subcutaneous fascia in certain regions may consist of several layers that become separated by adipose tissue in patients with increasing adiposity [12]. Ultrasound guidance often revealed the presence of multiple fascial planes in the inguinal area. Blind penetration of any of these fascial planes may have been wrongly perceived as that of the fascia iliaca. Placement of local anesthetic in the wrong plane will reduce the success of any regional anesthetic technique [13].

Also, Dolan et al [14] compared the efficacy of FIB, performed by loss of resistance and ultrasound guidance techniques. They concluded that ultrasound-guided FIB increased the frequency of sensory loss in the medial aspect of the thigh and also increased the frequency of femoral and obturator motor block.

As regard to postoperative pain control and pethidine consumption, In agreement with our results, the study of Stevens et al [15] where FICB was studied for postoperative analgesia after total hip arthroplasty, they concluded that fascia iliaca compartment block has significant morphine-sparing effect after total hip arthroplasty.

Also, Lundblad et al [16] in their comparison between the infrapatellar nerve block and placebo for the ACL arthroscopy repair. They found that the patients with a higher pain score at rest were significantly lower in patients receiving an IPNB during postoperative period, also on muscular power postoperatively.

Moreover, Hanson et al [17] compared between the effect of saphenous nerve block and the placebo effect on controlling postoperative pain after meniscectomy. Their result was that ACB decreased the pain score significantly and also narcotic use was significantly reduced with ACB than placebo.

In the same context, Chisholm et al [18] compared between ACB and FNB and reported that there were no significant difference between the two groups (ACB and FNB) in pain score and opioid consumption within postoperative 24 hours.

Regarding comparison of the quadriceps muscle power, in agreement with our results; Sharma et al [19] described the relation between femoral nerve blocks, used for controlling postoperative pain after knee surgery, and increased fall risk. This was the start to establish a new method to avoid affecting the motor strength of the thigh muscles and find other substitutes to the femoral block which causing decreased risk of falls.

Also, Jaeger et al [20] found that the reduction of quadriceps strength from baseline was 49% with FNB but only 8% with ACB in healthy young subjects. Performance in all mobilization tests was reduced after an FNB compared with an ACB ($P < 0.05$). This 8% percentage is minor to cause risk of falls. Quadriceps strength was significantly decreased when comparing FNB with ACB.

Moreover, Kwofie et al [21] performed the ACB in one leg and the FNB in the other leg in 16 volunteers using a randomized block manner. Voluntary contraction of knee extension and hip adduction was assessed at baseline and at 30 and 60 minutes after block. They found that Quadriceps strength and balance scores were similar to baseline following ACB. Following FNB, there was a significant decrease in quadriceps strength and balance scores compared with baseline.

In the same context, David K et al [22] studied 10 patients undergoing a total knee replacement under either saphenous nerve block or a FNB and motor strength was measured. Quadriceps strength was measured at 6–8 h after the block. They found that the FNB resulted in at least 50% reduction in motor strength as compared with the saphenous nerve block.

On the other hand, Chisholm et al [18] compared between ACB and FNB and they attribute the quadriceps muscle weakness in their study to the FNB or the original injury. Therefore, they advised to assess quadriceps muscle power over six or nine month follow up in another trial.

In addition, Luo et al [23] stated that children and Youngman's undergoing ACL reconstruction, either arthroscopy or not, had preserved quadriceps strength. Also, a delayed return to exercise at 6 months was found in patients who were treated with a femoral nerve block compared to those who did not.

Also, Abdallah et al [24] studied 100 patients undergoing knee surgeries who were allocated to receive ACB or FNB and found that ACB provides similar analgesia up to 24 h postoperatively and preserves quadriceps muscle strength when compared with FNB in patients undergoing ACL reconstruction.

In a review on ACB for knee surgeries Vora et al. [25] concluded that ACB provides equivalent analgesia to FNB for primary total knee arthroplasty with the more advantage of adequate quadriceps strength, early ambulation, and faster discharge. It can also be used as a rescue analgesia in patients who exhibit moderate to severe pain following minor arthroscopic knee procedures.

In controversy to our results, Espelund et al [26] in 2014 and 2015, in two different studies compared the ACB and placebo, one study in the minor arthroscopic procedure and the other for postoperative moderate and severe pain after arthroscopic knee surgery. They concluded that there was no significant analgesic effect of the ACB after minor arthroscopic knee surgery with a basic analgesia, which may be due to mild pain that could be overcome by basic analgesia. However, the ACB was highly reproducible and low risk option in treating patient with significant pain after arthroscopic knee surgery.

Also, El Ahl MS [27] compared the ACB with the FNB after ACL surgery and concluded that in spite of significant preservation to the quadriceps muscle power in the ACB group than FNB group, the VAS pain score and opioid consumption was significantly higher in the ACB group. The study was done on 128 patients who had been scheduled to patellar graft ACLR, and were randomly allocated into two groups; group ACB and group FNB. At the end of the surgery, patients in group FNB received a FNB and those in group ACB received an ACB. In his study the local anesthetic used was ropivacaine 0.5% which is less potent than Bupivacaine.

5. CONCLUSIONS

Both FIB and ACB provide excellent postoperative analgesia after knee surgeries, however the ACB is superior to FIB because it has no prolonged muscle weakness and FIB did.

CONSENT

It's not applicable.

ETHICAL APPROVAL

It's not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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