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ORIGINAL ARTICLE

Patient Controlled Analgesia: Fascia Iliaca Compartment Block Versus Epidural Analgesia for Postoperative Pain Relief Following Total Knee Replacement Under Spinal Anesthesia: A Comparative Study

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ABSTRACT

Background: Adequate postoperative pain relief facilitates rapid recovery by enhancing early ambulation. The aim of the study was a comparison between the efficiency of patient-controlled analgesia via continuous fascia iliaca block and continuous epidural block in patients undergoing total knee replacement under Spinal anesthesia.

Patients and methods: A comparative prospective clinical trial was performed upon 48 patients undergoing total knee replacement randomly distributed into two equal groups: Continuous Fascia Iliaca Compartment block (CFICB) and Continuous epidural block (CEB). Two hours after spinal anesthesia, a bolus of 30ml and 10 ml of 0.25% bupivacaine were given in the first and second groups respectively; then patient-controlled analgesia (PCA) infuser was connected to perineural and epidural catheters and bupivacaine (0.125%) was infused for 48 hrs. postoperatively at a rate of 5 ml/h, the bolus infusion volume was 2ml, and the lockout time was set to 15 minutes.

Results: Statistically, the analgesic efficacy and the level of patient satisfaction in both groups were comparable. The mean blood pressure was significantly lower in CEB group in 1st hour after activation of the catheter, however no significant difference at other times. Nausea, vomiting, and urine retention occurred exclusively in CEB group. Success in Rehabilitation and duration of hospital stay were comparable between groups.

Conclusion: The efficiency of patient-controlled analgesia via CFICB was comparable with that via CEB for pain relief after total knee replacement. Only, CEB was associated with minimal side effects.

Keywords: Patient controlled analgesia, epidural, Fascia iliaca block, Ultrasound guided block, knee arthroplasty.

1. INTRODUCTION

Total joint arthroplasty (TJA) is prevalent surgical operation for treatment of the degenerative disorders and traumatic diseases[1]. Most of the patients often complain from moderate to severe postoperative pain after TJA. The consequences of post-operative pain include increase in blood pressure, heart rate, respiratory rate, deep vein thrombosis, impaired immune system, and delay in return of muscle function [2].Patient-controlled analgesia (PCA) is an effective and safe technique for postoperative analgesia. Postoperative analgesia has a significant role on earlier ambulation, starting physiotherapy and better functional recovery, shortening the duration of hospital stay and decreases the hazards of thrombotic events that improves patients' satisfaction [3].Epidural analgesia has been a regular regimen used for postoperative analgesia after total joint arthroplasty. In spite of being nonselective for the side of the operation, neuraxial techniques have an effective role in reducing perioperative hypercoagulability and the surgical neuroendocrine stress response [4].In total knee replacement patients, perineural catheters are placed within the fascia iliaca compartment which contains the femoral and lateral femoral cutaneous nerves. The use of ultrasound guidance during fascia iliaca compartment block (FICB) increases the success rate leading to an increased interest in FICB as a postoperative analgesic option for knee surgical procedures [5]. Especially it has an effective role in decreasing the postoperative pain, earlier release, and improvement of patient's movement [2].The aim of the study was a comparison between the efficiency of patient-controlled analgesia via Continuous Fascia Iliaca Compartment Block (CFICB) and Continuous Epidural Block (CEB) for pain relief after total knee replacement under Spinal anesthesia to find

out which one is more efficient and with fewer side effects.

2. THE PATIENTS AND METHODS

This Comparative prospective randomized clinical trial was carried out at Zagazig University Hospitals, over a 2-years period (from February 2018 to February 2020) in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans. This study was approved by the University's Institutional Review Board (ZU-IRB #4330/4-2-2018) and written informed consent was obtained from all subjects participating in the study. Forty-eight both sexes patients of American Society of Anesthesiology physical status (ASA ps) class I–II and undergoing elective total knee replacement were enrolled in this study. The age of these patients ranged from 21 –50 years. Consort checklist was applied for enrollment and allocation of the selected patients (Fig. 1).Exclusion criteria were patient's refusal, infection at the site of needle insertion, allergy to the used local anesthetics, coagulopathy, history of severe cardiovascular, respiratory, hepatic, renal, and mental disease, also patients with motor and sensory impairment, Body Mass Index (BMI) over 39 kg/ m2 or rheumatoid arthritis, failed block.Routine preoperative assessment was done to all patients by careful history taking, clinical examination and laboratory investigations. Procedure explanation to the patient was done the day before surgery.On entering the pre-anesthesia room, standard monitors (ECG, NIBP and SPo2) were attached and baseline measurements of patients' vital signs were recorded. After inserting a suitable venous line (IV access) all patients were premedicated with 0.02 mg/kg midazolam 15 minute before surgery and 10 ml/kg normal saline was infused as a preload. All patients received spinal anesthesia and vital signs were monitored at 5,10,15 minutes after spinal anesthesia and then every 15 minutes throughout the procedure. Post operative analgesia was either continuous epidural block or continuous fascia iliaca compartment block. The selected patients were divided randomly by using a computer-generated randomization table, into 2 equal groups. One group received CFICB for post operative analgesia and was called CFICB group (24 patients) and the other group received CEB for post operative analgesia and was called CEB group (24 patients).Method of application of epidural catheter for CEB: First, we prepared epidural tray including Tuohy epidural needle 18 gauge, Epidural catheter 20 G, Lidocaine 2% for skin infiltration and epidural test, Appropriate needles and syringes, Povidone-iodine or alcohol solution, dressing, Transparent drape with central opening and adhesive, Preservative-free normal saline, 10 mL (Saline is sometimes used for the loss of resistance technique. Saline is also useful to expand the epidural space and to facilitate the passage of the epidural catheter.

Then in the sitting position, the skin of patient's back was sterilized using povidone-iodine solution. The epidural space was located at the L3/4 interspace (the level of the iliac crests usually corresponds to the spinous process of L4 (Tuffier's line). After subcutaneous infiltration with local anesthetic 4 ml of 2%lidocaine (80mg),18 G Tuohy needle was advanced through the skin and subcutaneous tissue with stylet in place until the interspinous ligament was entered as noted by increase in the tissue resistance. The stylet was removed and aplastic loss of resistance syringe filled 2 ml of air was attached to the hub of the needle. The needle was then slowly advanced millimeter by millimeter with repeating attempts at injection, as the tip of the needle just entered the epidural space there was sudden loss of resistance and injection was easy. Insertion of the epidural catheter as gentle as possible and its introduction for 4-5 cm in the epidural space was done.A test dose composed of 2 ml of 2%lidocaine (40 mg) was given to exclude subarachnoid injection and the catheter was tapped along the back of the patient.Method of application of perinural catheter for CFICB.In the supine position, the inguinal crease area was sterilized using povidone-iodine solution. After putting the 8 to 14MHz linear probe (SonoSite M-Turbo) parallel to the inguinal ligament on the inguinal crease, we found the femoral artery, fascia lata, fascia iliaca, iliacus muscle, and femoral nerve. From this view, after rotating the probe 90 to 135 ° counterclockwise, we made the probe parallel to the vertebrae axis. Moving superiolaterally along the inguinal ligament, the anterior inferior iliac spine was imaged and identified by the sudden rising of the ilium towards the transducer as the probe is moved laterally. In this position the probe was found lateral to the femoral nerve. The deep circumflex iliac artery was identified superficial to the fascia iliaca 1–2 cm superior to the inguinal ligament as it formed a landmark for the needle placement. After dermal anesthesia with 2 ml of 2%lidocaine (40 mg), 18G Tuohy needle was inserted along the plane, approximately 2 cm inferior to the inguinal

ligament and advanced toward the fascia iliaca and iliacus muscle. After confirming the passage of the needle through the fascia iliaca using fascial click, 2 mL of saline were injected forming a lens deep to the fascia. Through this process of hydro-dissection the needle was passed superiorly deep to the fascia iliaca into the space created by the distending fluid. Then a non-stimulating flexible epidural-type catheter was advanced 5–10cm beyond the placement needle tip, tunneled and secured via transparent adhesive tape.Technique of establishment of spinal anesthesia. After epidural or perineural catheter application, L4/5 interspace (i.e., the interspace below the site of epidural catheter was inserted) was identified while patient in sitting position with bending his back. After subcutaneous infiltration of the site of needle insertion with 2ml of 2% lidocaine, 25 G Quincke spinal needle was inserted in the midline with 15°cephalad angulation, the needle was advanced until a click or pop was felt. After free flow of cerebro-spinal fluid (CSF), a syringe containing a mixture of 2.5ml (12.5 mg) of 0.5% hyperbaric bupivacaine and 0.5ml (25 mcg) of fentanyl was connected to the spinal needle hub and its content was injected intrathecally. After that, patients were immediately placed in the supine position. Spinal anesthesia was considered successful when a bilateral sensory block reach to T1 level within 10 minutes after the intrathecal injection. Sensory block was assessed by loss of pain prick sensation via usage 23-gauge needle. Time of administration, type, and the dose of the selected local anesthetic for postoperative analgesia in both groups. Two hours after performance of spinal anesthesia, a bolus of 10 ml and 30 ml of 0.25% bupivacaine were given as inducting analgesic dose in group CEB and group CFICB respectively; then patient-controlled analgesia (PCA) infuser was connected to epidural catheter in CEB group and perineural catheter in CFICB group and continuous infusion of 5 ml/h of 0.125% bupivacaine was given in both groups. during the first 48 hrs. postoperatively and a bolus of 2ml of 0.125% bupivacaine was allowed to be given by patients in both groups with lockout time of 15 minutes. Postoperatively, the patients of both groups were shifted to the wards and instructed how to use of the numerical rating scale (NRS) and patient-controlled analgesia (PCA) infuser. The patients were instructed to press the PCA button for a bolus injection if their self-reported pain score exceeded 4 at rest. If pain did not subside after the bolus injection, IV morphine 0.05 mg/kg was given, the local analgesic infusion continued to 48 hours after surgery.The data measured in both groups were In this study the following data were detected and recorded in both groups: Patients characteristics and duration of surgery. Post operative pain intensity was measured at rest state and movement at 1, 2, 4, 6, 12, 24 and 48 hours after activation of the catheter based on NRS (Numerical rating scale)[6], this is a scale of 11 points that initiates in "0" (no pain) and ends in "10" (the worst imaginable pain); patients were asked to choose the number between 0 and 10 that fits best to their pain intensity, The required local anesthetic boluses and iv morphine as rescue analgesia in the first and second postoperative days: The frequency of pressing patient-controlled analgesia (PCA) bolus button and the total dose of morphine consumption as rescue analgesia on the first and the second postoperative days. The level of patient satisfaction: The level of patient satisfaction was assessed by using a 1-3 verbal scale [7] (1= unsatisfactory analgesia, 2=satisfactory analgesia, 3= excellent analgesia)

Cardiovascular changes: Mean blood pressure (MBP) and heart rate (HR) values were recorded at rest state at 1, 2, 4, 6, 12, 24, 48 hours after activation of the catheter (injection of loading dose of local anesthetic). Hypotension (i.e. decrease of MBP more than 20% from the baseline) was managed by intravenous fluid administration and bradycardia (i.e. decrease of HR more than 20% from the baseline) was managed by iv atropine (1mg) administration, the incidences of various associated side effects: hypotension, bradycardia, sedation, nausea, vomiting, urine retention and pruritus. Rehabilitation (number of patients who succeeded in starting the rehabilitation from the first day postoperative), duration of hospital stays and degree of sedation: using five points scale [8] (0 = alert, 1 = occasionally drowsy, 2 = frequently drowsy, 3 = sleep but easy to arouse, 4 = difficult to arouse).Sample size .Assuming that the number of cases undergoing total knee replacement surgery attending Zagazig University Hospital is 4 cases / month (48 cases per year) according to 2017 attendance rate, so all cases were included in the study as a comprehensive sample.

3. STATISTICAL ANALYSIS

All data were collected, tabulated, and statistically analyzed using Statistical Package for the Social Sciences (SPSS version 20.0) software. Quantitative data was presented as mean and standard deviation. Qualitative data was presented

as number and percentage. Comparisons between the 2 groups for normally distributed numeric variables was done using the Student t-test while for non-normally distributed numeric variables was done by Mann-Whitney test. Comparisons between the 2 groups of categorical variables was done using Chi square test. p-value < 0.05 was considered statistically significant, p-value < 0.001 was considered highly statistically significant, and p-value ≥ 0.05 was considered statistically insignificant. **4.**

RESULTS

Sixty patients were assessed for eligibility, while eight patients not meeting inclusion criteria and four patients were declined to participate, so forty-eight patients were enrolled the study **(figure 1)**. Statistically, patient's demographic data (age, body mass index, sex ratio and ASA ps classes ratio), and durations of surgery of the two studied groups were comparable (P > 0.05) **(Table 1)**. The corresponding pain intensity scores at various times of measurements during rest and during movement in both groups were comparable **(Fig. 2)**. The number of the required local anesthetic boluses in the first and in the second post operative days were comparable in both groups. Rescue morphine analgesia was required only in the first postoperative day in both groups. Statistically, the total dose of morphine consumption as rescue analgesia in CFICB group (4.4±1.2 mg) was comparable with that (4.8±1.51) in CEB group **(Table 2)**. Level of patient satisfaction was comparable in both groups **(Table 2)**. The corresponding MBP levels of both groups at various times of measurements were comparable except at the first hour after activation of the catheter, the MBP level in CEB group was significantly lower than that in CFICB group **(Figure 3)**. The corresponding heart rate values of both groups at various times of measurements were comparable **(Figure 4)**.Hypotension, bradycardia, nausea, vomiting, and urine retention were not detected in CFICB group, but hypotension, nausea, vomiting, and urine retention were detected in 25%, 12.5%, 12.5% and 8.3% respectively of the patients in CEB group. Statistically, the incidence of occurrence of hypotension in CEB group (25%) was significantly higher than that in CFICB group (0%) but the incidences of occurrence of other side effects in CEB group were comparable with the corresponding incidences in CFICB group **(Table 3)**.The duration of hospital stay was not significantly different in either group with a p value of 0.99 **(Table 1)**. Moreover, there was no significant difference between studied groups regarding the success in rehabilitation (p=0.63) **(Table 1)**.

Table 1: Patients demographic data and duration of surgery in the two studied groups**.**

		Group CFICB *(n=24)*	**Group CEB *(n=24)***	**P**
Age *(years)*		56.04±5.75	54.95±5.35	0.503
BMI *(kg/m^2)*		31.75±2.57	32.08±3.2	0.693
Duration of surgery*(min)*		153.33±8.42	153.54±7.86	0.930
Hospital stay *(days)*		5.58±0.77	5.61±0.84	0.89
Sex	Female	15(62.5%)	13(54.2%)	0.56
	Male	9(37.5%)	11(45.8%)	
ASA	I	12(50%)	10(41.7%)	0.56
	II	12(50%)	14(58.3%)	
Rehabilitation	Failed	2(8.3%)	3(12.5%)	0.63
	Succeeded	22(91.7%)	21(87.5%)	

Data were expressed as mean and standard deviation (SD) or number (n) and percentage (%) by T:student's t-test and X^2: Chi-square test .P: statistically significant if p<0.05 .BMI: Body Mass Index; ASA: American Society of Anesthesiologists.

Table 2: The required local anesthetic boluses and morphine dose as rescue analgesia and patient satisfaction levels in the two studied groups**.**

		Group CFICB *(n=24)*	Group CEB *(n=24)*	P
The number of the required local anesthetic boluses	POD 1	9.25±1.39	9.16±1.43	0.82
	POD 2	4.58±1.1	4.62±1.01	0.89
Total dose of iv Morphine as rescue analgesia (mg)	POD 1	4.4±1.2	4.8±1.51	0.31
	POD 2	0.00 ± 0	0.00 ± 0	…..
Patient satisfaction	Satisfactory analgesia	14(58.3%)	4.62±1.01	0.38
	Excellent analgesia	10(41.7%)	4.8±1.51	

Data were expressed as mean and standard deviation (SD) or number (n) and percentage (%) by T:student's t-test , X^2: Chi-square test. P: statistically significant if p<0.05. POD1:Post-Operative Day one, POD2:Post-Operative Day two.

Table 3: The incidences of the various associated side effects in the two studied groups

Adverse Effect		Group CFICB *(n=24)*	Group CEB *(n=24)*	P
Hypotension	**N**	0	6	**0.009***
	%	0.0%	25.0%	
Bradycardia	**N**	0	0	…….
	%	0.0%	0.0%	
Nausea	**N**	0	3	0.074
	%	0.0%	12.5%	
Vomiting	**N**	0	3	0.074
	%	0.0%	12.5%	
Urine retention	**N**	0	2	0.148
	%	0.0%	8.3%	

Data were expressed as number (n) and percentage (%) by X^2: Chi-square test. * P: statistically significant if p<0.05

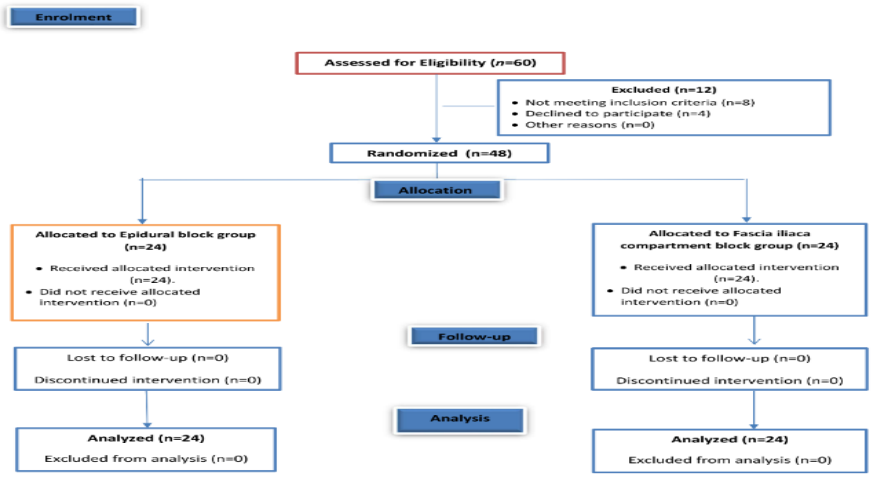

Figure 1. Consort flow diagram of participants through each stage of the randomized trial

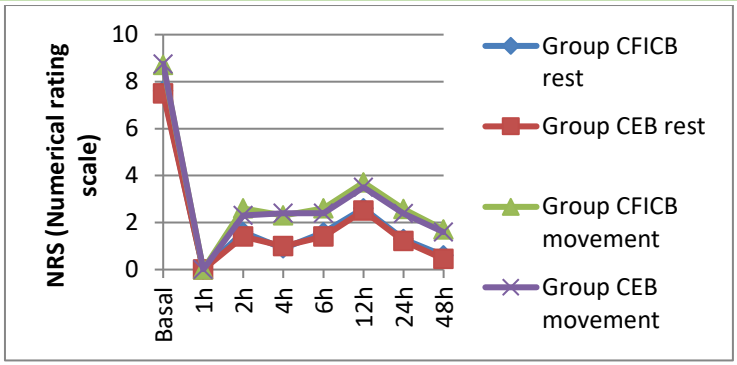

Figure2. Numerical rating scale (NRS) during rest and movement at various postoperative times of measurements in the two studied groups

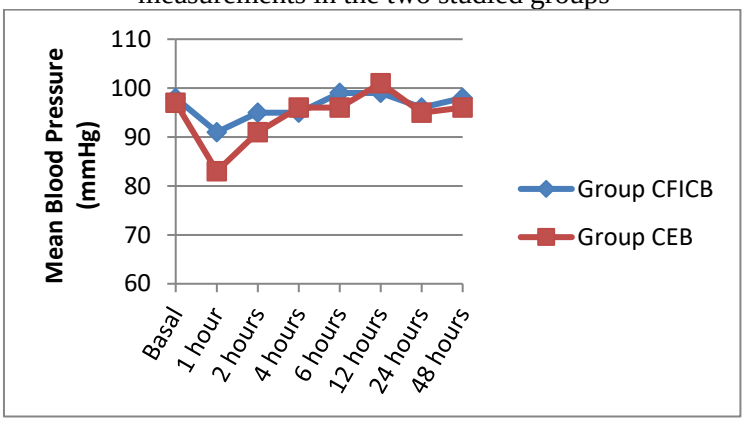

Figure 3. Mean blood pressure values at the various postoperative times of measurements in the two studied groups.

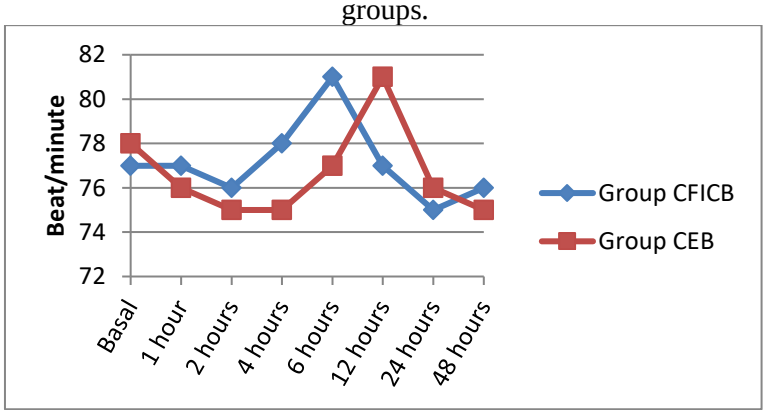

Figure 4. The heart rate values at the various postoperative times of measurements in the two studied groups.

5. DISCUSSION

Total knee arthroplasty (TKA) is a very painful orthopedic surgery. So, adequate pain control is essential to optimize the rehabilitation process. Patient-controlled analgesia (PCA) is an effective and safe technique for postoperative analgesia. The use of regional anesthetic techniques controls the postoperative pain and avoid side effects of opioids. Continuous epidural block and Fascia iliaca compartment block (FICB) are effective techniques for postoperative analgesia in lower limb orthopedic surgery. Fascia iliaca compartment block (FICB) is an alternative to central neural block and can provide adequate unilateral analgesia with fewer adverse-effects than epidural analgesia [9-11]. In the current study, we compared the postoperative pain severity based on Numerical rating scale, frequency of pressing patient-controlled analgesia bolus button, total morphine consumption, hemodynamic changes, incidence of complications, success in starting the rehabilitation from the first day postoperative, patient's satisfaction and duration of hospital stay between the continuous FICB group and continuous epidural block group in patients undergoing total knee replacement.The present study showed no significant difference in NRS score between the epidural block group and fascia iliaca compartment block (FICB) group. These results agreed with the results of Gandhi et al. [12]. Gallardo et al. [13] compared postoperative analgesia from a fascia iliaca compartment block and continuous epidural analgesia following knee arthroplasty; both groups received spinal anesthesia. In their study, Postoperative pain assessment using VAS showed no statistically

significant difference in both groups.While Davies et al. [14] performed a study that compared between epidural analgesia and peripheral nerve block (PNB) regarding postoperative analgesia in patients undergoing knee arthroplasty under general anesthesia. In contrast to our study, they recorded lower pain scores in patients who received PNB 24 h postoperatively; this could be attributed to their use of higher concentrations of bupivacaine (0.375%).Sundarathiti et al. [15] compared continuous femoral nerve block and continuous epidural infusion in postoperative analgesia and knee rehabilitation after total knee arthroplasty. In their study the postoperative pain scores using VAS showed statistically significant difference between groups that favored the epidural analgesia group, and this could be attributed to the blockage of the femoral nerve alone in the other group which was not enough for producing analgesia in knee surgeries. However, in our study, the use of fascia iliaca compartment block provided better analgesia by blocking the femoral, lateral femoral cutaneous nerve, anterior and posterior branches of the obturator nerve. Also, they used bupivacaine plus morphine in epidural group however in femoral nerve block group they used bupivacaine only. The current study showed no significant difference in the use of a rescue analgesia among studied groups, similar conclusion was reached by Fowler et al. [16] Moreover, Vishwanatha and Kalappa [17] in their study, patients who complained of pain with corresponding VAS >3 received rescue analgesia in the form of injection tramadol 50 mg intravenously. The consumption of tramadol between groups was not significant.

Rashwan[18] found that the doses of postoperative tramadol consumed IV was statistically significantly lower in epidural group than FICB group, this could be due to their use of blind technique of FICB. However, in our study the use of ultrasound guided technique and suprainguinal approach increased efficacy of the block.

Concerning hemodynamic changes secondary to the blockade our study showed that arterial hypotension was significantly higher in the epidural group compared with the fascia iliaca group and this coincide with the results of Gallardo et al. [13] and Nooh et al. [19].However, Lingaraj and Thangasami [20] showed that the hemodynamic parameters were comparable between epidural group and FICB group, this may be due to not using an initial bolus of local anesthetic that we used for intensifying the block and better analgesia, as they started with the continuous infusion of 8 ml/ hr. of 0.125% bupivacaine. Also, in contrast to our study, Vishwanatha and Kalappa [17] found in their study that the hemodynamics were stable throughout in both continuous femoral nerve block group and Epidural group, this may be attributed to the low concentration of local anesthetic used which was 0.0625% of bupivacaine at rate 5 ml/h.

The incidence of postoperative nausea, vomiting and urine retention were higher in epidural group than FICB group, but this was statistically insignificant, and this coincide with the results of Gandhi et al. [12] and Park et al. [21].The most dangerous side effect of opioid administration is respiratory depression. Especially with Epidural morphine which is about 5 to 10 times more potent than its intravenous form, other adverse reactions of morphine include CNS effects (sedation, dizziness), cardiovascular effects (bradycardia, hypotension) and pruritus [22].

We didn't use opioids in our infusions that may explain absence of these serious side effects in our study. And this was in concordance with Lingaraj and Thangasami]20] they found that there was no incidence of bradycardia, respiratory depression in both groups and those were common when opioids used in neuraxial blockade. Also, their study agreed with us in patients' satisfaction where there were no significant differences between both groups. Regarding success in starting the rehabilitation from the first day postoperative, our study showed that no significant difference between both groups which was in agreement with the results of Park et al. [21]Concerning duration of hospital stay our results showed no significant differences between both groups and this in agreement with results of Singelyn et al. [23]. In their study on IV patient-controlled analgesia (PCA) Group, continuous 3-in-1 block Group and epidural block Group; the study revealed that there was no significant difference between continuous 3-in-1 block Group and epidural block group in the duration of hospital stay. Similar conclusion was reached by Gandhi et al. [2] and Barrington et al. [24].

The limitations of this study included the limited number of investigated patients and inability to do a double-blind study due to the visible site of catheter insertion.

6. CONCLUSION

The efficiency of patient-controlled analgesia via CFICB was comparable with that via CEB for pain relief after total knee replacement. Only, CEB was associated with minimal side effects.

Conflict of interest Authors report no conflict of interest.

Financial Disclosure

Authors report no financial Disclosures

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