A Comparison of Continuous Femoral Nerve Block (CFNB) and Continuous Epidural Infusion (CEI) in Postoperative Analgesia and Knee Rehabilitation after Total Knee Arthroplasty (TKA)

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Background: *Postoperative epidural analgesia (EA) and femoral nerve block (FNB) provided effective pain relief. However, EA has common side effects such as nausea, vomiting, pruritus, dizziness, and hypotension. Some investigations found that those side effects were less in FNB than in EA. However, the analgesic equivalent of both techniques have not been confirmed.*
Objective: *The authors compared continuous epidural infusion (CEI) with continuous femoral nerve block (CFNB) regarding the postoperative analgesic efficacy, side effects, postoperative knee rehabilitation, and hospital length of stay (LOS).*
Material and Method: *In this prospective, randomized controlled study, 61 ASA physical status I-III patients scheduled for elective unilateral total knee arthroplasty (TKA) under spinal anesthesia (SA) participated. The patients were allocated into two groups. In the ward, patients in Group I (CEI) were maintained by continuous infusion of 0.125% levobupivacaine with morphine 0.0125 mg/ml (4ml/hr), Group II (CFNB) were maintained by 0.125% levobupivacaine (8 ml/hr).*
Results: *Patients in the CFNB group, the VAS scores at PO6-12 hr and tramadol IV requirement were significantly greater than the CEI group (VAS: PO6 hr p-value = 0.001, PO12 hr p-value = 0.004). Patients in the CEI group experienced dizziness, pruritus, and PONV more than the CFNB group significantly. Patient 'satisfaction was greater with the CFNB group although postoperative knee rehabilitation and the hospital LOS were not different.*
Conclusion: *CFNB represents the optimal analgesia with fewer side effects and greater patient, satisfaction. The rehabilitation indices and duration of hospital stay are comparable in both groups.*

Keywords: *Continuous femoral nerve block, Postoperative analgesia, Total knee arthroplasty, Levobupivacaine*

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Total knee arthroplasty (TKA) causes severe postoperative pain. Improvement of postoperative pain facilitates more rapid achievement of functional outcome[1,2]. Multiple techniques of postoperative pain control have been used after TKA, including intravenous (IV) opioids, epidural analgesia (EA), and femoral nerve block (FNB). Postoperative EA provided pain relief that was superior to pain relief from IV opioid[1,3]. There are, however, common side effects such as nausea, vomiting, pruritus, urinary retention, dizziness, and hypotension[3,4]. Most previous studies comparing peripheral nerve block (PNB) with EA for major knee surgery have demonstrated equivalent analgesia and improvement in side-effect profile associated with PNB[5]. The peripheral technique such

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as FNB provided better analgesia than with EA[6]. Singelyn et al found that those side effects were less in FNB than in EA[7]. However, some investigations have not confirmed the analgesic equivalent of both techniques[8].

In this prospective, randomized controlled study, the authors compared continuous epidural infusion (CEI) with continuous femoral nerve block (CFNB). The primary outcomes were the postoperative analgesic efficacy and the incidence of nausea and vomiting (PONV), pruritus, dizziness, and hypotension. The secondary outcomes were postoperative knee rehabilitation and hospital length of stay (LOS) after unilateral TKA.

Material and Method

After written informed consent and with Institutional Ethics Committee approval, 61 ASA physical status I-III patients scheduled for elective unilateral TKA under spinal anesthesia (SA) were included in the present prospective, randomized controlled study. Exclusion criteria included age < 35 years or > 80 years, body mass index (BMI) > 45, renal insufficiency (Cr > 1.5 mg/dl), preexisting neurological deficit, inability to comprehend pain scales, chronic opioid use, and contraindications to either neuraxial block or FNB.

All patients were premedicated with oral lorazepam 0.5 mg 1 hr before surgery and were sedated with midazolam 1 mg and fentanyl 25 mcg intravenously before conducting anesthesia. All patients received SA with 2.8 ml levobupivacaine at L3-4, 27 G needle in lateral position. The patients allocated into two groups using random number of tables. Group I (CEI), the epidural needle 18 G (Portex® Spinal/Epidural Minipack-system, Lancet Point 26G/18G, UK) was used with a catheter inserted 5 cm past the cannula and 0.125% levobupivacaine 10 ml plus 2 mg morphine was given. Group II (CFNB), FNB was placed by the inguinal paravascular approach, 19 G, 50 mm needle (PAJUNK®, PlexoLong NanoLine acc, Meier, Germany). Localized femoral nerve was defined by quadriceps twitch at < 0.5 mA using a stimulation of 0.1 ms at 2 Hz. After negative aspiration, 20 ml of 0.25% levobupivacaine was administrated and catheter was inserted 5 cm past the cannula. Urinary catheters were placed in all patients and were continued until 24 hr post-op. The standard monitoring was used, including none invasive blood pressure, SpO_2, electrocardiogram. The anesthetic time was noted as the time from local anesthetic infiltration for SA to the end of surgery.

On arrival in the Postanesthesia Care Unit (PACU), pain, and other adverse effects such as nausea, vomiting, pruritus, dizziness, hypotension (30% reduced from baseline), numbness, and motor blockade were recorded every 15 min. Motor blockade was estimated using a modified Bromage scale (0 = no blockade: extended limb lift off the bed; 1 = flexion/extension at knee and ankle joint; 2 = no flexion/extension at knee or ankle joint; 3 = complete blockade). Pain was assessed by visual analog scale (VAS 0-10, 0 = no pain, 10 = worst pain). Tramadol 50 mg IV was given if the VAS $\geq$ 4.

In the ward, patients in the CEI group were maintained by continuous infusion of 0.125% levobupivacaine with morphine 0.0125 mg/ml, infusion rate 4 ml/hr for 24 hr post-op and then reduced to 3 ml/hr if VAS $\geq$ 3. Patients in the CFNB group were maintained by continuous infusion of 0.125% levobupivacaine, infusion rate 8 ml/hr for 24 hr post-op and then reduced to 6 ml/hr if VAS $\geq$ 3. The epidural or femoral catheters were removed at 48 hr post-op.

During the hospital stay, all patients received oral ultracet one tab three times a day, oral acetaminophen 500 mg four times a day, and oral lorazepam 0.5 mg before bed time. The patients having breakthrough pain (defined as VAS $\geq$ 4) were treated on demand with tramadol 50 mg IV every 4 hr until discharge. The residents made visits at 6, 12, 24, 36, 48, and 72 hr post-op to record adverse effects, pain scores, rehabilitation indices, patient 'satisfaction (1 = poor, 2 = fair, 3 = good, and 4 = excellent), discharge criteria, and the hospital LOS.

Rehabilitation indices on the first operative day (POD1), the patients were expected to be able to sit at the bedside and stand with help. On the POD2, they were expected to stand without help, use the walker, and transfer to chair with help. On the POD3, transfer to a chair and walker mobilization without help was expected.

Discharge criteria included medical stable conditions, ability to transfer safely to and from a supine and sitting position to standing, ability to ambulate safely level at ground with a walker, ability to navigate safely up and down stairs, and understanding of both rehabilitation goals and safety precautions.

Based on the data from Jacques et al [6], fifty-five percent of patients with EA after TKA experienced PONV. If this incidence of 57% was reduced by 20% in a CFNB group, 26 patients in each group would suffice to demonstrate a significant difference with a probability of type I error of 0.05 and power of 80%.

Data were collected and analyzed using SPSS 15 statistical package (SPSS; Inc., Chicago, IL) for Windows. Results are expressed as mean ± SD for continuous variable, and independent-sample t-test was used for the statistical analyses. Nominal variables were analyzed by Chi-squared test and Fisher exact test. A p-value < 0.05 was considered statistically significant.

Results

Thirty-one patients received a combined spino-epidural anesthesia (CEI group); thirty patients received SA and CFNB (CFNB group). Patient's demographics data (Table 1) in each group were not different. All patients had satisfactory anesthesia and operation without intraoperative complications.

Residual motor blockade was estimated using a modified Bromage scale (Table 2). Both groups were not different in residual motor blockade (MBS = 3) at PO60 minutes.

The VAS scores are presented in Table 3. There were no significant differences in the VAS scores for the first hour and at PO12-72 hr between the two groups. At PO6-12 hr, the VAS scores were significantly greater in the CFNB group compared with the CEI group (PO6 hr p-value = 0.001, PO12 hr p-value = 0.004). Systemic analgesic requirements are presented in Fig. 1. Cumulative tramadol IV requirement for PO72 hr were more in the CFNB group (median = 150 mg, range 0-350 mg) compared with the CEI group (median = 50 mg, range 0-150 mg, p = 0.001).

Table 1. Demographic data

	CFNB group (n = 30)	CEI group (n = 31)
Sex (M/F)	4/26	5/26
Age (yr)	66.8 ± 9	65.6 ± 10
Height (cm)	153.8 ± 7	159.5 ± 19
Weight (kg)	62.5 ± 7	64.9 ± 13
BMI (kg/m^2)	26.5 ± 4	26.4 ± 4
ASA (I/II/III)	1/18/11	5/19/7
Anesthetic time (hr)	2.25 ± 0.5	2.44 ± 0.4
MAP baseline	93.03 ± 5.4	92.90 ± 5.7

The values are expressed as number of patients or mean ± SD
CFNB = continuous femoral nerve block; CEI = continuous epidural infusion

Table 2. Motor blockade at 0 min and 60 min

MBS	0 min		60 min	
	CFNB (%) (n = 30)	CEI (%) (n = 31)	CFNB (%) (n = 30)	CEI (%) (n = 31)
0	0 (0)	0 (0)	7 (23.3)	12 (38.7)
1	4 (13.3)	6 (19.4)	16 (53.3)	15 (48.4)
2	7 (23.3)	10 (32.3)	6 (20.0)	3 (9.7)
3	19 (63.3)	15 (48.4)	1 (3.3)	1 (3.2)
p-value	0.527		0.588	

The values are expressed as number of patients (percent)
MBS = modified bromage scale (0 = no blockade; 1 = for flexion/extension at knee and ankle joint; 2 = no flexion/extension at knee and ankle joint; and 3 = complete blockade)

Table 3. Pain evaluation for postoperative care

VAS	No pain		Mild pain		Moderate pain		Severe pain		p-value
	CFNB (n = 30)	CEI (n = 31)	CFNB (n = 30)	CEI (n = 31)	CFNB (n = 30)	CEI (n = 31)	CFNB (n = 30)	CEI (n = 31)	
PO1 hr	12 (40.0)	15 (48.4)	18 (60.0)	16 (51.6)	0 (0.00)	0 (0.0)	0 (0.0)	0 (0.0)	0.51
PO6 hr	0 (0.0)	10 (32.3)	30 (100)	21 (67.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.001*
PO12 hr	0 (0.0)	6 (19.4)	6 (20.0)	13 (41.9)	22 (73.3)	12 (38.7)	2 (6.7)	0 (0.0)	0.004*
PO24 hr	1 (3.3)	2 (6.5)	29 (96.7)	29 (93.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.573
PO36 hr	1 (3.3)	2 (6.5)	22 (73.3)	25 (80.6)	7 (23.3)	4 (12.9)	0 (0.0)	0 (0.0)	0.515
PO48 hr	2 (6.7)	3 (9.7)	28 (93.3)	28 (90.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.668
PO72 hr	2 (6.7)	5 (16.1)	28 (93.3)	26 (83.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.246

The values are expressed as number of patients (percent)
VAS = visual analogue scale (0 = no pain; 1-3 = mild pain; 4-7 = moderate pain; 8-10 = severe pain)

Table 4. Incidence of side effects

Side effects	Dizziness			PONV			Pruritus			Numbness			Urine retention		
	CFNB (n = 30)	CEI (n = 31)	p-value	CFNB (n = 30)	CEI (n = 31)	p-value	CFNB (n = 30)	CEI (n = 31)	p-value	CFNB (n = 30)	CEI (n = 31)	p-value	CFNB (n = 30)	CEI (n = 31)	p-value
PO1 hr	2 (6.7)	10 (32.3)	0.012*	9 (30.0)	16 (51.6)	0.086	0 (0.0)	3 (9.7)	0.081	12 (40.0)	6 (19.4)	0.077	F	F	-
PO6 hr	4 (13.3)	11 (35.5)	0.045*	6 (20.0)	17 (54.8)	0.005*	0 (0.0)	10 (32.3)	0.001*	7 (23.3)	20 (6.5)	0.063	F	F	-
PO12 hr	4 (13.3)	7 (22.6)	0.348	6 (20.0)	17 (54.8)	0.005*	1 (3.3)	8 (25.8)	0.013*	7 (23.3)	0 (0.0)	0.004*	F	F	-
PO24 hr	2 (6.7)	7 (22.6)	0.080	5 (16.7)	13 (41.9)	0.031*	1 (3.3)	5 (16.1)	0.093	4 (13.3)	1 (3.2)	0.150	0 (0.0)	1 (3.2)	0.508
PO36 hr	1 (3.3)	5 (16.1)	0.090	4 (13.3)	5 (16.1)	0.758	0 (0.0)	3 (9.7)	0.081	3 (10.0)	1 (3.2)	0.285	0 (0.0)	1 (3.2)	0.508
PO48 hr	2 (6.7)	1 (3.2)	0.534	3 (10.0)	1 (3.2)	0.285	1 (3.3)	1 (3.2)	0.981	1 (3.3)	1 (3.2)	0.981	0 (0.0)	1 (3.2)	0.508
PO72 hr	0 (0.0)	1 (3.2)	0.321	0 (0.0)	0 (0.0)	.a	0 (0.0)	0 (0.0)	.a	0 (0.0)	0 (0.0)	.a	0 (0.0)	0 (0.0)	.a

The values are expressed as number of patients (percent). PONV= postoperative nausea and vomiting; F= retained Foley's catheter; .a= no statistics are computed because variable is a constant

Fig. 1 Cumulative tramadol IV requirement for PO72 hr

The values are expressed as mean of mean arterial blood pressure of patients

Fig. 2 Mean arterial blood pressure

The incidences of each side effect for the PO72 hr are presented in Table 4. Patients in the CEI group experienced side effects more than the CFNB group. Dizziness, pruritus, and PONV were greater significantly in the CEI group on PO1-6 hr, PO6-12 hr and PO6-24 hr respectively. However, numbness sensation was significantly greater in the CFNB group. After the removal of Foley's catheters, one patient in the CEI group had a urinary retention but was not statistically significant. Mean of MAP in the CEI group was significantly lesser on PO12 hr and no patients developed hypotension.

There was no significant difference in fulfillment of the rehabilitation program and hospital LOS (CFNB 4.23 $\pm$ 0.27 days vs. CEI 4.35 $\pm$ 0.40 days, p = 0.169). Patient 'satisfaction appears to be greater with CFNB (CFNB 3.86 $\pm$ 0.35 vs. CEI 3.48 $\pm$ 0.57, p = 0.02).

Table 5. Rehabilitation indices

Patients with accomplished goals	CFNB (%) (n = 30)	CEI (%) (n = 31)	p-value
POD1	19 (63.3)	11 (35.4)	0.054
POD2	28 (93.3)	23 (74.1)	0.182
POD3	30 (100)	28 (80.6)	0.238

The values are expressed as number of patients (percent)
POD = postoperative day

Discussion

Managing postoperative pain in TKA patients can be a significant clinical challenge. It is severe in 60% of patients and moderate in 30%, and it hinders early intense physical therapy[9,10]. Kehlet highlighted the importance of analgesia in optimizing postoperative rehabilitation[8]. Postoperative pain relief can be achieved by a number of techniques, such as IV PCA[1], EA with narcotics and/or local anesthetics[11], and PNB[12]. EA provides superior pain relief compared with IV PCA with morphine[13,14]. However, it is associated with side effects, such as PONV, pruritus, urinary retention, dizziness, bilateral motor blockade, and arterial hypotension. FNB provides better pain relief than IV PCA. It is as efficient as EA and induces fewer side effects[15]. Some considered it as the analgesic technique of choice after open knee surgery[16].

The femoral nerve along with contributions from the sciatic and obturator nerves at the posterior and medial aspects, respectively, provide sensory innervation of the knee. These three terminal nerves are targeted by PNB techniques for major knee surgery[5,17,18]. In response of surgeons' concerns regarding postoperative sciatic block (e.g, difficulty in diagnosing peroneal nerve injury), the authors attempted to limit the use of sciatic block. In addition, the patients with FNB alone or without sciatic block, failed to demonstrate inferior analgesia between 0 and 24 h after operation[5,18]. It is still not clear that obturator block translates into improved patient recovery after TKA[18]. Inguinal paravascular FNB is easily performed, with the patient in supine position. It lacks complete sympathectomy, less invasive, and associated with fewer serious complications[19,20,21].

In the present study, the authors demonstrated that postoperative pain scores in the CFNB group were significantly higher than those in the CEI group at PO6-12 hr (Table 2). Inability of femoral approach to block the sciatic nerve and obturator nerve may explain its decreased efficacy compared to EA[22]. Some are now adding a sciatic nerve block to CFNB[17]. The efficacy of this practice requires further evaluation. A multiple analgesic modalities including regional analgesic technique with parenteral and/or oral analgesic should be privileged to augment analgesic effect for rehabilitation. The present study does not justify the use of NSAIDs due to the fear of delay bone healing and renal dysfunction[6]. The authors used IV tramadol and oral weak opioid in combination with acetaminophen (ultracet) for analgesic supplementation.

Patients in the CEI group experienced side effects such as dizziness, pruritus, and PONV more than the CFNB group (Table 4). These results correlated with the study of Dusanka et al[3], Singelyn et al[7], and Capdevila et al[8], but not Davies et al[23]. The ideal concentration, infusion rate, and nature of the local anesthetic for PNB are not established. In the present study, the numbness sensation was significantly greater in the CFNB group and only the operated limb was affected. The intensity of motor blockade was not significantly different at PO1 hr (Table 2) and ability for rehabilitation is comparable in both groups.

The authors found no catheter-related infections or nerve injury during hospitalization. There were absent signs and symptoms of local anesthetic toxicity. From the literature available to date, the maintenance of catheter for longer than 36 hr probably increases the risk of infection[22]. Therefore, the authors maintained the catheter only for 48 hr postoperative period. The lack of blinding is a limitation of the present study.

Use of CFNB provides prolonged duration of analgesia and it is not subject to the concern of spinal hematoma from continuous EA in the recommended practice of anticoagulation. Moreover, CFNB would be preferable for those who present challenges regarding catheter placement such as the patients with previous lumbar spine surgery.

Conclusion

CFNB represents the optimal analgesia with fewer side effects and greater patient 'satisfaction as a choice of postoperative technique for TKA. CEI has a better analgesic efficacy at PO6-12 hr but greater side effects such as dizziness, pruritus, and PONV more than CFNB. The rehabilitation indices and duration of hospital stay are comparable in both groups.

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การเปรียบเทียบประสิทธิภาพของการระงับปวดหลังผ่าตัดเปลี่ยนข้อเข่า และการฟื้นตัวการทำงานของข้อเข่า ระหว่างการได้รับ continuous femoral nerve block (CFNB) กับ continuous epidural infusion (CEI)

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วัตถุประสงค์*: การศึกษานี้ได้เปรียบเทียบประสิทธิภาพในการให้ยาระงับปวด, ผลข้างเคียง และการฟื้นตัวการทำงานของข้อเข่า 72 ชั่วโมงหลังผ่าตัด ระหว่างการได้รับยาระงับปวดอย่างต่อเนื่องทางสายอิพิดูรอล (continuous epidural infusion: CEI) กับ การได้รับยาระงับปวดอย่างต่อเนื่องทางเส้นประสาทฟีโมรอล (continuous femoral nerve block: CFNB)*

วัสดุและวิธีการ*: ผู้ป่วยจำนวน 61 คน ที่มารับการผ่าตัดเปลี่ยนข้อเข่า แบ่งเป็นกลุ่ม CEI 31 คน และ กลุ่ม CFNB 30 คน อายุระหว่าง 35-80 ปี ASA physical status I-III โดยทั้ง 2 กลุ่มจะได้การระงับความรู้สึกทางช่องไขสันหลัง (spinal anesthesia) หลังผ่าตัดกลุ่ม CEI ได้รับ 0.125% levobupivacaine + morphine 0.0125 มิลลิกรัม/มิลลิลิตร ปริมาณ 4 มิลลิลิตร/ชั่วโมง ส่วนกลุ่ม CFNB ได้รับ 0.125% levobupivacaine ปริมาณ 8 มิลลิลิตร/ชั่วโมง*

ผลการศึกษา*: ผู้ป่วยกลุ่ม CFNB มีค่า visual analog scale (VAS) หลังการผ่าตัด 6-12 ชั่วโมงแรก (PO6 hr p = 0.001, PO12 hr p = 0.004) และความต้องการ tramadol ทางหลอดเลือดดำที่สูงกว่ากลุ่ม CEI แต่พบว่าผู้ป่วยในกลุ่ม CEI มีผลข้างเคียงในเรื่องคลื่นไส้อาเจียน วิงเวียนศีรษะ และคันมากกว่ากลุ่ม CFNB อย่างมีนัยสำคัญ ความพึงพอใจของผู้ป่วยในกลุ่ม CFNB สูงกว่ากลุ่ม CEI ส่วนเรื่องการฟื้นตัวการทำงานของข้อเข่า และจำนวนวันที่นอนโรงพยาบาล ไม่มีความแตกต่างกันอย่างมีนัยสำคัญ*

สรุป*: CFNB สามารถให้การระงับปวดหลังผ่าตัดเปลี่ยนข้อเข่าได้ดี และลดอุบัติการณ์เกิดผลข้างเคียง สำหรับการฟื้นตัวการทำงานของข้อเข่าใกล้เคียงกันทั้งสองวิธี*