Original Article

Does Preemptive Femoral Nerve Block Provide Additional Pain Relief for Periarticular Injection in Total Knee Arthroplasty?

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Background: Severe postoperative pain following total knee arthroplasty [TKA] may cause patients agony and persistent postsurgical pain [PPSP]. Periarticular injection [PAI] and femoral nerve block [FNB] are widely accepted as effective options for reducing postoperative pain and morphine consumption. Preemptive analgesia theoretically can has the ability to prevent sensitization of the nervous system and consequent amplification of postoperative pain.

Objective: To explore whether the preemptive femoral nerve block [FNB] can provide additional pain relief for periarticular injection [PAI] after primary TKA.

Materials and Methods: The records of 112 patients, 53 who had received spinal anesthesia with periarticular injection (PAI group) and 59 who had received spinal anesthesia combined with preemptive femoral nerve block [FNB] and PAI (FNB + PAI group) were retrospective analyzed. All the data had been routinely recorded in a sequential fashion at our institution.

Results: Morphine consumption by the FNB + PAI group during the first 24 and 48 hours post operation were 7.13 and 11.61 mg, respectively, significantly lower than the 14.11 and 20.43 mg consumed by the PAI group ($p = 0.001$, and $p = 0.01$, respectively). The FNB + PAI group had lower pain scores in the first 24 hours, although that difference was not statistically significant. In terms of knee rehabilitation, the degrees of straight leg raise [SLR] in the FNB + PAI group was significantly higher in the first 24 hours, while, the degrees of knee flexion and extension lag [EL] were comparable between the two groups.

Conclusion: Preemptive femoral nerve block [FNB] can reduce morphine consumption in the first 48 hours after total knee arthroplasty. In addition, the FNB tends to reduce the pain score and to facilitate knee rehabilitation on the first day after the index surgery.

Keywords: Total knee arthroplasty, Femoral nerve block, Periarticular injection, Preemptive analgesia

J Med Assoc Thai 2018; 101 [Suppl. 3]: S243-S248
Full text. e-Journal: http://www.jmatonline.com

Total knee arthroplasty [TKA] has been identified as an effective procedure for osteoarthritic knees. However, severe postoperative pain may cause patient distress and is one of the factors that can lead to persistent postsurgical pain [PPSP]. Well-controlled postoperative pain after TKA will enhance recovery, improve knee rehabilitation, decrease the length of hospital stay, decrease postoperative complications, decrease patient anxiety and sleep deprivation, and increase patient satisfaction[1-4].

Currently there is no definite consensus regarding the optimal analgesia protocol for TKA. Morphine is an effective pain relief medication to treat severe pain, but high doses of morphine may cause complications or other unwanted adverse effects. Recently, periarticular injection [PAI] has gained popularity as a local anesthetic technique due to its

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How to cite this article: Kositanurit I, Toolyodpun S, Podjanasupawun S, Rasamimongkol S, Weerakul S, Laoruengthana A. Does Preemptive Femoral Nerve Block ProvideAdditional Pain Relief forPeriarticular Injection in Total Knee Arthroplasty?. J Med Assoc Thai 2018;101;Suppl.3: S243-S248.

simplicity and effectiveness. Several studies have shown that periarticular injection with a mixture of several types of medication helps control postoperative pain compared with placebo, giving pain control similar to intrathecal morphine but with fewer adverse effects[5,6]. Femoral nerve block [FNB] is another effective option that can reduce postoperative pain and morphine consumption. The literature includes demonstrations of comparable analgesic effects and complications with PAI and with FNB[7-9]. Therefore, both modalities are widely accepted for pain control.

Preemptive analgesia that begins before the onset of noxious stimuli theoretically can prevent sensitization of the nervous system and subsequent amplification of postoperative pain. The prevention of this process may reduce patients' postoperative pain as well as the risk of chronic neuropathic pain[10-12]. However, some reports involving preemptive analgesia found no significant difference in patient benefits, e.g., between those receiving FNB before surgery and those receiving it after surgery[13,14]. This study attempted to examine whether the preemptive femoral nerve block [FNB] could provide additional pain relief when combined with periarticular injection [PAI] following primary TKA.

Materials and Methods

The authors reviewed the medical records of patients who had undergone unilateral total knee arthroplasty [TKA] by a single surgeon during the period January 2015 to July 2017. All the patients were implanted with a cemented, posterior stabilized knee prostheses using a standard medial parapatellar approach. We categorized patients into two groups based on pain relief regimen. The first group received spinal anesthesia with periarticular injection [PAI] (the PAI group). The second group received spinal anesthesia combined with preemptive femoral nerve block [FNB] and PAI (the FNB + PAI group). Patients who had received other types of anesthesia were excluded. Patient data including demographic information, drainage blood loss [DBL], visual analogue scale [VAS] for pain, range of motion [ROM], straight leg raise [SLR], degree of extension lag [EL], morphine consumption, and length of hospital stay [LOS] were routinely recorded in a sequential fashion by the team of physicians at Department of Orthopedics. The study was approved by the Institutional Review Board.

All TKA procedures were performed using an identical perioperative protocol including preemptive medication at night before the index surgery, surgical techniques, and rehabilitation. Spinal anesthesia was performed at the L2-3 or L3-4 intervertebral space with 2.8 to 3.6 mL of Bupivacaine (Marcaine, Spinal Heavy 0.5% AstraZeneca, Sweden). In the PAI group, 20 mL Bupivacaine (0.5% Marcaine, Astra Zeneca, Sweden) and 30 mg Ketorolac (Ketolac 1 mL, Siu Guan, Taiwan) was diluted with normal saline solution to a total volume of 75 mL. The anterior part of the knee (medial retinaculum, quadriceps muscle, pes anserinus, and retropatellar fat pad) was injected with 50 mL of the mixture, and the posterior part (posterior capsule, medial and lateral collateral ligaments (MCL and LCL), and medial and lateral meniscal remnants) of the knee received the remaining 25 mL. In the FNB + PAI group, a single ultrasonography with nerve stimulator guided shot of femoral nerve block (10 mL of Bupivacaine diluted with normal saline solution to a total volume of 20 mL) was administered prior to the spinal anesthesia. The same regimen used with the FNB + PAI group was applied in the identical fashion to the PAI group, but with the addition of 10 mL of Bupivacaine and 30 mg Ketorolac. Prophylactic antibiotics combined with intravenous morphine PCA were applied for the first 48 hours after surgery and 30 mg of Ketorolac was administered intravenous every 8 hours. After 48 hours, the morphine PCA, Ketorolac, antibiotic, and intravenous fluid were discontinued and the Foley catheter and drains were removed. Beginning at 56 hours, 250 mg of naproxen was administered orally every 12 hours with an additional 2 mg of morphine as rescue analgesia every 4 hours until discharge. Postoperative physical therapy, including a continuous passive motion [CPM] device,was applied on the day after the surgery and walking with gait aids was permitted as tolerated. All patients received a routine assessment by an independent physician in our Orthopedics department. The visual analogue scale [VAS] for pain was completed at 6, 12, 24, 48, 72, and 96 hours postoperatively for pain evaluation. VAS was scored on a scale from 0 to 10, where 0 means no pain while 10 means the worst pain in one's life. The amount of morphine used via the PCA was recorded daily. The knee flexion angle was measured with a CPM device daily following the surgery. The degree of SLR and EL were also determined using a goniometer. A higher degree of SLR and lower degree of EL were considered to indicate better quadriceps recovery. The DBL and LOS were also recorded.

The unpaired Student's t-test was used to compare the difference in measured outcomes between the two groups. Statistical significance was defined

as $p<0.05$. The SPSS software (Statistical Package for Social Sciences, version 17.0, SPSS Inc., Chicago, IL, USA) was used for data analysis.

Results

This study enrolled 112 patients, fifty-three in the PAI group and 59 in the FNB + PAI group. The mean age and BMI of the patients were not significantly different between the two groups (Table 1).

The perioperative characteristics of the PAI and the FNB + PAI groups are presented in Table 2. This study measured DBL for 2 days. On day 1, the mean DBL of the PAI group (161.15 mL) and of the FNB + PAI group (190.35 mL) were not significantly different ($p = 0.122$). However, on day 2, the mean DBL of the FNB + PAI group (180.71 mL) was significantly higher than that of the PAI group (105.13 mL) ($p<0.01$). VAS was measured 6 times, at 6, 12, 24, 48, 72, and 96 hours after the surgery. The overall mean VAS of the PAI and the FNB + PAI groups was less than 4.5, and there were no significant inter-group differences at any of the evaluation times. Degree of knee flexion using CPM was measured on day 1, 2 and 3. The mean degrees of knee flexion using CPM were not significantly different between the PAI and the FNB + PAI groups for any of the 3 days. SLR was measured 6 times, at 6, 12, 24, 48, 72, and 96 hours after the surgery. At 6, 12, and 24 hours after surgery, the mean SLR of the FNB + PAI group was significantly higher than the PAI group, but at 48, 72, and 96 hours, the differences were not statistically significant. EL was measured at 48, 72, and 96 hours after surgery. The EL means were not significantly different for any of the 3 times measured. Morphine consumption was measured at 24 and 48 hours after surgery. The means at both times were significantly lower in the FNB + PAI group than the PAI group (14.11 and 7.13 at 24 hours, 20.43 and 11.61 at 48 hours, $p = 0.001$ and 0.010, respectively).

Discussion

Multimodal analgesia is commonly used for postoperative pain management after TKA, although determination of the appropriate analgesic techniques is still controversial. Preemptive analgesia that begins before the onset of noxious stimuli may prevent sensitization of the nervous system and amplification of postoperative pain.

The present study found that the FNB + PAI group had significantly lower morphine consumption than the PAI group. Although VAS scores were not significantly different, the FNB + PAI group tended to have lower pain scores in the first 24 hours. An explanation for that could be that the VAS in our study was evaluated at rest; values might have been altered with activities or rehabilitation. Another reason that the VAS was not different might be an effect of the higher postoperative morphine consumption by the PAI group. In addition, the mean SLR of the FNB + PAI group was significantly higher than the PAI group at 6, 12, and 24 hours after the surgery. The finding of better ROM in the FNB + PAI group in first 24 hours might be a reason why the DBL of the FNB + PAI group was significantly higher than the PAI group on day 2. However, degree of knee flexion using CPM, EL, and LOS were not significantly different between the two study groups. In accordance with many studies, application of PAI or FNB would be most effective during the first 24 to 48 hours postoperative, thus could be expected to significantly reduce pain scores and opioid consumption[15-17]. A recent meta-analysis reported that single shot FNB may result in better pain relief compared with single shot PAI with no difference in complications. However, the authors stated that an affirmation of the superiority could not be concluded because of variation among the included studies[9]. Based on the multimodal and preemptive approaches, a combination of 2 effective methods, FNB and PAI, could provide greater postoperative pain relief than PAI or FNB alone, particularly for the first 24 hours.

Chinachoti et al[18] randomized patients to receive either a periarticular injection of 20 ml 0.25% bupivacaine (B-gr) or isotonic saline solution (S-gr) in

Table 1. Demographic data

Demographic data	PAI	FNB + PAI	*p*-value
Age[a] (years)	66.02±7.60	66.24±7.95	0.881
Gender (male:female)	11:42	14:45	
BMI[a] (kg/m^2)	26.85±3.33	26.35±5.23	0.566

[a] Data are presented as mean ± standard deviation (SD). The *p*-value <0.05 indicates statistical significance

Table 2. Perioperative characteristics of the PAI and FNB + PAI groups

Parameter	PAI group	FNB + PAI group	*p*-value
DBL (mL)			
Day 1	161.15±67.78	190.35±102.47	0.122
Day 2	105.13±60.21	180.71±92.28	<0.01*
VAS			
6 hrs	3.54±2.98	2.45±3.19	0.129
12 hrs	4.33±2.55	3.46±2.78	0.169
24 hrs	3.85±1.97	3.39±2.40	0.289
48 hrs	3.19±1.94	3.07±2.19	0.771
72 hrs	2.40±1.82	2.40±1.90	0.991
96 hrs	1.68±1.80	2.05±1.83	0.367
Degrees of knee flexion using CPM			
Day 1	48.63±14.48	51.16±15.14	0.410
Day 2	72.93±16.19	68.20±17.17	0.168
Day 3	80.10±14.47	81.11±17.82	0.777
SLR (degrees)			
6 hrs	14.92±27.59	37.64±30.65	0.033*
12 hrs	19.32±31.95	48.86±36.94	0.020*
24 hrs	23.35±28.57	42.72±35.92	0.020*
48 hrs	31.00±32.31	38.69±35.27	0.367
72 hrs	45.51±36.27	46.57±38.89	0.903
96 hrs	51.69±39.64	46.52±36.21	0.615
EL (degrees)			
48 hrs	20.05±9.58	16.27±9.95	0.264
72 hrs	20.15±8.61	18.00±10.56	0.341
96 hrs	20.32±12.44	16.91±13.10	0.304
Morphine consumption (mg)			
24 hrs	14.11±10.55	7.13±7.39	0.001*
48 hrs	20.43±16.69	11.61±11.49	0.010*
LOS (days)	6.42±1.12	6.30±0.71	0.510

All parameters are presented as mean ± standard deviation (SD); * $p<0.05$ indicates statistical significance.
PAI = periarticular injection; FNB = femoral nerve block; DBL = drainage blood loss; VAS = visual analog scale score; CPM = continuous passive motion; SLR = straight leg raising; EL = extension lag; LOS = length of stay in the hospital

addition to intrathecal morphine (0.2 mg) and single shot FNB with 20 ml bupivacaine 0.25%. Among patients who required morphine, B-gr provided a longer pain free period (25 hours compared to 14.8 hours, $p<0.001$) and needed a lower dose of morphine (5.16 mg compared to 8.67 mg, $p = 0.005$). The longer pain free period may be due to the intrathecal morphine included in that protocol. Another randomized controlled trial evaluated the effectiveness of postoperative pain control by PAI and/or FNB for primary TKA. They demonstrated that the combination of PAI and FNB provided greater postoperative pain control and reduction of morphine consumption than either alone during the first 24 hours after the index surgery[16]. Those results support the hypothesis that the combination of FNB and PAI give superior pain control than using a single technique. In addition, Nagafuchi et al[19] assessed the effectiveness of continuous FNB combined with PAI and continuous FNB with single shot sciatic nerve block [SNB]. They reported a greater reduction of pain as measured by a numeric rating scale in the group that received PAI than in the group that received SNB during the first 3 to 12 hours after TKA. Taken together, it appears that further studies are needed to clarify the optimal multimodal analgesia to manage postoperative pain and to minimize the adverse effects.

A limitation in the present study is that in this retrospective approach some clinical information regarding pain-free duration, adverse effects of analgesic techniques, and medication provided were not recorded. Other data, including DBL, VAS, ROM, SLR, EL, and morphine consumption, were routinely

recorded at our institutionin a prospective fashion during the same interval.

Conclusion

Preemptive femoral nerve block [FNB] can reduce morphine consumption in the first 48 hours after total knee arthroplasty. In addition, the FNB tends to reduce the pain score and to facilitate knee rehabilitation on the first day after the index surgery.

What is already known on this topic?

Well-controlled postoperative pain after TKA will enhance recover, improve knee rehabilitation, decrease postoperative complication, and increase patient satisfactions. Currently, no definite consensus was made regarding the optimal analgesia protocol for TKA. Several studies show that periarticular injection with a mixture of several types of medication helps control postoperative pain. Femoral nerve block [FNB] is another effective option that can reduce the postoperative pain and morphine consumption. There is limited evidence that demonstrate benefit of the preemptive femoral nerve block [FNB] in addition to the periarticular injection [PAI] for the primary TKA.

What this study adds?

This study demonstrates that the preemptive FNB in conjunction with the PAI can reduce morphine consumption in first 48 hours after total knee arthroplasty, and tended to reduce the pain score and to facilitate knee rehabilitation on the first day after the index surgery.

Acknowledgements

The authors wish to thank Rossukon Khotcharrat MD, Apirak Tewaritruangsri MD, Chawisachon Nonsri MD, Panapol Varakornpipat MD, Kongpob Reosanguanwong MD, and Bhuwad Chinwatanawongwan MD for their technical assistance.

Potential conflicts of interest

The authors declare no conflicts of interest.

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