Incidence of Delayed Recovery from Femoral Nerve Block in Total Knee Arthroplasty

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Objective: *Femoral nerve block has been proven as an effective analgesia for total knee arthroplasty (TKA). Delayed recovery from nerve block can result in serious complication during postoperative period. This prospective, single-center, observational study investigated the incidence in delayed recovery from femoral nerve block more than 24 hours postoperatively.*
Material and Method: *Two hundred and forty patients with femoral nerve block as part of anesthesia plan for elective unilateral TKA were recruited into study. Participants were assessed for sensory or motor impairment lasting longer than 24 hours post operation. Factors associated with delayed recovery form femoral nerve block were analyzed.*
Results: *Five patients (incidence = 2.08%) reported sensory or motor impairment more than 24 hours post operation. All of the patients could ambulate within 4 days post operation without permanent nerve injury or serious complication. Higher dose of local anesthetic agent using for femoral nerve block showed association with the delayed recovery (p-value = 0.01).*
Conclusion: *This study demonstrated 2.08% incidence in delayed recovery from femoral nerve block. High concentration and dose of local anesthetic agent may lead to fall during early ambulatory period.*

Keywords: *Neurological complication, Femoral nerve block, Total knee arthroplasty*

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Multiple anesthetic techniques were selected for total knee arthroplasty (TKA). Femoral nerve block (FNB) has been proven as an effective anesthetic technique to reduce pain and accelerate rehabilitation after TKA[1]. While these studies have documented improved analgesia, various neuromuscular complications have been encountered. Incidences of neurological complications after FNB have been estimated approximately 0.03-2%[2]. Falls due to quadriceps weakness have been associated with wound dehiscence or even peri-prosthetic fractures in patients undergoing TKA with FNB[3,4]. These reports primarily refer to local complications within the distribution of the involved peripheral nerve.

In Siriraj Hospital approximately 1,000 TKA per year has been done, however incidence of post operative neurological complication has not been reported. Therefore, we would like to explore the incidence of delayed recovery from FNB of more than 24 hours and related factors of the complication after FNB for TKA in Siriraj Hospital.

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Material and Method

After approved by Siriraj Institutional Review Board [005/2557 (EC3)], this prospective observational study was performed. Patients scheduled for elective unilateral TKA in Siriraj Hospital during April 2014-March 2015 with FNB as a part of anesthetic plan were recruited into the study. Exclusion criteria included age less than 18 years old, contraindicated to FNB, allergic to local anesthetic drug, refused to attend the study, uncooperative or had pre-operative physical examination of neurological abnormality in lower extremities.

After obtained inform consent, standard technique for FNB was performed prior to surgery by resident or staff member of Anesthesiology Department, Faculty of Medicine Siriraj Hospital. Either ultrasonography or nerve stimulator was used to locate the femoral nerve. Basically, the patient was placed in the supine position. The groin on the operative side was exposed and prepped by using aseptic technique. A line was drawn between the anterior superior iliac spine and the pubic tubercle to identify the inguinal ligament. The femoral artery was marked. By using a nerve stimulator, a 22-gauge, 4-cm needle was advanced lateral to femoral artery. The amplitude of nerve stimulator was decreased to 0.5 mA while seeking maximal patellar ascension as the quadriceps contracts

(frequency 2 Hz, pulse width 300 microseconds). If there were continued contraction when at 0.2 mA or less, the needle was withdrawn. By using ultrasonography, the femoral nerve and artery were visualized instead of seeking for quadriceps contractions by nerve stimulator. Type, volume and concentration of local anesthetic agent were based on anesthesiologist's choice. The anesthetic agent was injected incrementally after negative aspiration. Presence or absence of paresthesia (defined as an electric shock-like sensation) or intravascular puncture during procedure was recorded. Intra-operative anesthetic record form and additional details of the FNB procedure were collected for further analysis.

Primary outcome of the study was delayed recovery from FNB at 24 hours after operation. We defined "delayed recovery" by presence of abnormal sensation (numbness or shock-like sensation) or inability flexion of hip joint as motor impairment of femoral nerve. At twenty-four hours after operation, patients were evaluated by a third year resident of a research team member. If abnormality was detected, the anesthesiologist and surgeon were reported. The standard treatments were set for the patient. Neurologist was consulted if neurological impairment persisted more than 48 hours to confirm diagnosis of nerve injury. Post operative follow-up of clinical symptoms was made daily until discharge from hospital. Factors associated with delayed recovery were analyzed. Other complications defined as fall in hospital, delayed in rehabilitation, catheter-associated infection and local anesthetic systemic toxicity are reported by both nurse note and evaluator.

Sample size was calculated by considered the primary outcome as a rare incidence event. Using the expected prevalence of neuropathy of 0.7% and power of 80%, the sample size of 230 was required to observe at least one critical event.

Quantitative variables were demonstrated as mean and standard deviation (SD). Nominal and ordinal variables were reported as frequencies and percentages. Incidence was reported as percentage and 95% confidence interval was calculated based on binomial distribution. Fisher exact test and Student's t-test were used where appropriate. All data analyses were performed using R version 3.2.3[5] and the *p*-value less than 0.05 were considered as statistical significant.

Results

Demographic data of all patients was shown in Table 1. From complete neurological evaluation in 24 hours after FNB in 240 cases, five patients reported numbness or weakness of quadriceps 24 hours after FNB. Two patients had impaired pinprick and temperature sensation while other three patients showed motor weakness, which limited their ability to rehabilitation (Table 2). Therefore, we reported 2.08% (95% confidence interval 0.68-4.8%) incidence of delayed recovery from FNB. There was no permanent nerve injury reported. All of the patients could start rehabilitation within 72 hours after operation and showed full recovery within 4 days. There was no report of fall during hospital stay as well as any infection or local anesthetic systemic toxicity.

Factors associated with delayed recovery from FNB were analyzed (Table 3). The present study found no association between delayed in recovery to block performers, nerve localization technique or tourniquet time. However, higher dose of local anesthetic agent was associated with delayed in recovery from FNB (*p*-value = 0.0106) where 4 out of 5 patients with delayed recovery received higher dose of local anesthetic agent (20 ml of 0.5% bupivacaine).

Discussion

In previous studies, low incidences of neurological complications after FNB were reported. Most of the studies are retrospective studies and primarily aim at permanent nerve damage[2,6,7]. In this study, we focus on delayed recovery from FNB more than 24 hours due to the time to start rehabilitation. TKA is a painful surgery that needs early mobilization

Table 1. Demographic data

Age (year) (mean ± SD)	68.76±8.10
Range	47-86
Gender, n (%)	
Male	34 (14.16)
Female	206 (85.84)
ASA class*, n (%)	
I	13 (5.42)
II	182 (75.83)
III	45 (18.75)
Height (cm) (mean ± SD)	63.20 (11.56)
Weight (kg) (mean ± SD)	153.92 (7.45)

* American society of anesthesiologists (ASA) physical status classification

ASA I = normal healthy patient; ASA II = patient with mild systemic disease; ASA III = patient with severe systemic disease that is not incapacitating

Table 2. Details of patients with delayed recovery from femoral nerve block more than 24 hours

#	Age (year)	Choice	Performer	Femoral nerve block					Post-operative day 1			Post-operative day 2		
				Guide	mA (Amp)	Local anesthetic agent	TT (min)	Patient reported	Motor grade	Sensory impaired	Activity	Motor grade	Sensory impaired	Activity
A	68	SB	Staff	US	-	0.5% bupivacaine 20 ml	50	Numb	V	Pinprick	Walk 2-3 step	V	None	Up-down stair
B	72	SB	Staff	NS	0.5	0.25% bupivacaine 20 ml	90	Numb	V	Temperature	Walk bedside	V	None	Up-down stair
C	70	SB	Staff	NS	0.3	0.5% bupivacaine 20 ml	100	Weak	IV	None	Walk 2-3 step	V	None	Walk
D	77	SB	Resident	NS	0.3	0.5% bupivacaine 20 ml	80	Weak	IV	Temperature	Knee extension	V	None	Walk 6 month
E	80	SB	Resident	NS	0.4	0.5% bupivacaine 20 ml	80	Weak	IV	None	Standing	IV	None	Walk 7 month

SB = spinal block; NS = nerve stimulator; US = ultrasonography; mA = minimum current use for nerve stimulator to located femoral nerve; TT = tourniquet time
Motor grading based on medical research council muscle grading scale: I = flicker of movement, II = movement possible but cannot move against gravity, III = movement against gravity, IV = movement against moderate resistance, V = movement against full resistance
Activity: The best activity that patient could do on rehabilitation.

to improve surgical outcome and reduce post operative complications. Although, FNB provides effective analgesia, serious complication can occur in the presence of delayed in recovery. A fall after FNB, usually post operative, causes concerns when using femoral nerve catheter. In this study, we report delays in recovery even after single-injection FNB, with an incidence of 2.08%. Similar incidence was showed by Sharma et al[7] which 1.6% of patients treated with single-injection FNB sustained falls on post operative day 1, three of whom underwent reoperations (0.4%). Klein et al[8] also reported 1 fall out of 263 single-shot FNB using 0.5% ropivacaine. However, in this study, no falls were reported after surgery.

Factors associated with delayed recovery are higher doses of local anesthetic agent. This is a conclusion based on comparisons between 0.25% and 0.5% bupivacaine 20 ml. In this study, we found 4 from 46 cases or 8.7% of delayed recovery in the use of 0.5% Bupivacaine and only 1 from 166 cases or 0.6% in the used of 0.25%. Compared between these two groups, even the *p*-value was 0.01 but they was a lack of statistical power to detect an association with delayed recovery from FNB due to the limited number of the patients. No difference in the duration of analgesia were found between 0.25% and 0.5% bupivacaine. Mulroy et al[9] also shows similar results with the duration of analgesia up to 20 hours after FNB using 25 ml of 0.25% and 0.5% bupivacaine. De Lima e Souza et al[10] reported motor block 10-24 hours after FNB with 40 mL of 0.25% bupivacaine containing epinephrine. Prolonged duration of motor block up to 30 hours after 0.5% bupivacaine 30 ml was reported[11]. Therefore, the authors suggested the use of a low concentration of a local anesthetic agent, such as 0.25% bupivacaine instead of 0.5% bupivacaine. Continuous FNB via insertion of femoral catheter should be considered only when early mobilization is not necessary.

Under estimated neurological deficit, especially motor weakness after FNB, serious complications can occur. Early ambulation, especially within 24 hours after operation, should be performed under special care of unexpected quadriceps weakness. Measurements for fall prevention need to be introduced. Lareau et al[12] suggested initiation of prevention program as well as knee mobilizer during rehabilitation.

Conclusion

Our study demonstrated 2.08% incidence in delayed recovery more than 24 hours after FNB. Higher

Table 3. Factors associated with delayed recovery from femoral nerve block

Compared factor	Non-neuropathy (n = 235)	Neuropathy (n = 5)	*p*-value
Choice of anesthesia			
Spinal block	222	5	
General anesthesia	13	0	1.000+
Femoral nerve block			
Ultrasonography guide	110	1	
Nerve stimulator guide	125	4	0.3769+
Mean ± SD of minimum NS current (amp)	0.376±0.11	0.37±0.094	0.9058*
Range minimum NS current (amp)	0.25-0.8	0.3-0.5	
Performer			
Staff	96	3	
Residence	139	2	0.4059+
Tourniquet time			
Mean ± SD tourniquet time (min)	97.17±28.25	80 (18.70)	0.2563*
Local anesthetic agent:			
0.50% bupivacaine 20 ml (100 mg)	46	4	
0.25% bupivacaine 20 ml (50 mg)	166	1	0.0106**
Others	23	0	

NS = nerve stimulator

+ Fisher exact test *p*-value; * Student t-test *p*-value; ** Fisher exact test *p*-value compared between 0.5% bupivacaine 20 ml vs. 0.25% bupivacaine 20 ml

concentration of local anesthetic agent showed higher incidence of delayed recovery. Fall prevention program needed for unexpected weakness of quadriceps in early ambulation after TKA.

What is already known on this topic?

Prolong motor block after FNB for TKA can cause a serious complication.

What this study adds?

Incidence of delayed recovery with quantitative assessment of motor and sensory impairment after femoral nerve block 24 hours post operation. The incidence of 2.08% is high enough to be a definite risk of falling in the early ambulatory period.

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Potential conflicts of interest

None.

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การศึกษาอุบัติการณ์ของการชาหรือการอ่อนแรงของกล้ามเนื้อที่คงอยู่นาน จากการฉีดยาชาบริเวณเส้นประสาทฟีเมอรอล

ฐิติมา ชินะโชติ, วรรธนันทน์ มะกรสาร

ภูมิหลัง: *การฉีดยาชาที่บริเวณเส้นประสาทฟีเมอรอลหรือ femoral nerve block เป็นวิธีการระงับปวดหลังผ่าตัดเปลี่ยนข้อเข่าที่ได้ผลดี อย่างไรก็ตาม อาการชาหรืออ่อนแรงของกล้ามเนื้อ ภายหลังจากการผ่าตัดอาจทำให้เกิดภาวะแทรกซ้อนที่อันตรายภายหลังการผ่าตัดได้ การศึกษานี้เป็นการศึกษาแบบ prospective, observational study เพื่อศึกษาถึงอุบัติการณ์ของการเกิดอาการชาหรืออ่อนแรงของกล้ามเนื้อภายหลังได้รับการฉีดยาชาที่เส้นประสาทฟีเมอรอลที่ 24 ชั่วโมง ภายหลังการผ่าตัด*

วัสดุและวิธีการ: *การศึกษานี้ได้ดำเนินการศึกษาในผู้ที่รับการผ่าตัดเปลี่ยนข้อเข่าข้างเดียว ณ โรงพยาบาลศิริราช ที่ได้รับการฉีดยาชาเส้นประสาทฟีเมอรอล จำนวน 240 คน โดยติดตามประเมินอาการชาและอ่อนแรงของกล้ามเนื้ออย่างครบถ้วนสมบูรณ์ หลังการผ่าตัดเพื่อค้นหาอุบัติการณ์ของอาการชาหรืออ่อนแรง และปัจจัยที่เกี่ยวข้องต่อการฟื้นตัวของเส้นประสาทฟีเมอรอลที่ 24 ชั่วโมง ภายหลังการผ่าตัด*

ผลการศึกษา: *จากการศึกษาพบว่ามีผู้ป่วย 5 ราย หรือคิดเป็นอุบัติการณ์ร้อยละ 2.08 มีอาการชาหรืออ่อนแรงที่ 24 ชั่วโมงหลังการผ่าตัดทั้ง 5 ราย สามารถทำกายภาพบำบัดได้ภายใน 4 วันหลังการผ่าตัด และไม่พบภาวะแทรกซ้อนรุนแรงหรือการทำลายเส้นประสาทถาวร จากการศึกษาพบว่าการให้ยาชาในปริมาณสูง ทั้งความเข้มข้นและปริมาณยามีผลเกี่ยวข้องต่อการฟื้นตัวของเส้นประสาทฟีเมอรอล (p-value = 0.0106)*

สรุป: *การศึกษานี้พบว่าอุบัติการณ์ของการชาหรืออ่อนแรงที่นานเกิน 24 ชั่วโมง ภายหลังการระงับปวดโดยวิธีการฉีดยาชาที่เส้นประสาทฟีเมอรอลนั้นเท่ากับร้อยละ 2.08 การใช้ยาชาที่มีความเข้มข้นสูงและในปริมาณมาก อาจมีผลทำให้เกิดภาวะแทรกซ้อนจากการล้มในระยะเริ่มการฝึกยืนและเดินภายหลังการผ่าตัดเปลี่ยนข้อเข่า*