# THE FEMORAL NERVE BLOCK CHARACTERISTICS USING ROPIVACAINE 0.2% ALONE, WITH EPINEPHRINE, OR WITH LIDOCAINE AND EPINEPHRINE

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**Keywords:** anesthetic techniques, regional, femoral; anaesthetics local, ropivacaine; equipment, ultrasound machines.

## Abstract

**Background:** The objective of this study was to evaluate the femoral nerve block characteristics (onset, success rate and duration) using ropivacaine 0.2% alone; with epinephrine, or with lidocaine and epinephrine compared with that using ropivacaine 0.5%.

**Methods:** Ninety six patients were included in this prospective controlled double blind study and were randomly allocated into four equal groups (n=24). All the patients received ultrasound guided femoral nerve block using 15 ml of either ropivacaine 0.5% (group 1), ropivacaine 0.2% (group 2), ropivacaine 0.2% with epinephrine (group 3) and ropivacaine 0.2% with lidocaine and epinephrine (group 4). The block onset, success rate and duration were recorded.

**Results:** The motor onset was significantly delayed in group 2 (compared with the other three groups) and in group 3 (compared with group 4). However, the block success rate and duration were comparable in the four groups.

**Conclusion**: In femoral nerve block, ropivacaine 0.2% may have a comparable success rate and duration to ropivacaine 0.5% but with a remarkably delayed motor onset that may be improved by adding epinephrine. Addition of lidocaine may further accelerate the motor onset.

## Introduction

The femoral nerve block (FNB) is a commonly indicated block, and ropivacaine is a widely used long acting local anesthetic (LA)[1,2]. Peripheral nerve blocks can provide excellent anesthesia and postoperative analgesia [3,4]. However, the inappropriate block characteristics (delayed onset, low success rate, too long or too short block duration), and the potential risk of LA toxicity may limit the use of nerve block anesthesia in lower limb surgeries. Both the block characteristics and the risk of toxicity are significantly affected by changes in the LA concentration or by adding adjuvant[5-8]. High LA concentration may enhance the block onset and success rate[8-10], but it increases

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the peak plasma level and consequently the potential risk of LA toxicity[11]. Recently, we showed that low ropivacaine concentrations can block the femoral nerve successfully[10]. In theory, the use of low ropivacaine concentration may impair the FNB onset and duration, while the addition of adjuvant may improve them. The objective of this study was to evaluate the FNB characteristics (onset, success rate and duration) using ropivacaine 0.2% alone, with epinephrine or with lidocaine and epinephrine compared with ropivacaine 0.5%.

## Methods

This prospective controlled randomized double blind study was approved by the Research and Ethical Committee of Abu Dhabi Knee and Sport Medicine Centre. Ninety six patients, who were scheduled for knee ligament reconstruction, were included in this study and their written informed consents were obtained. The patients were randomly allocated into four groups (24 patients each). They received FNB using one of the following solutions: ropivacaine 0.5% (group 1), ropivacaine 0.2% (group 2), ropivacaine 0.2% with epinephrine (group 3), or ropivacaine 0.2% with lidocaine 0.5% and epinephrine (group 4).

In the block room, routine monitoring (ECG, $SapO_2$ and noninvasive blood pressure) and supplemental oxygen were applied and 3 mg of midazolam was injected intravenously. Parasacral sciatic, proximal interfacial obturator and lateral femoral cutaneous nerve blocks were performed under the ultrasound guidance, as described elsewhere[12-14], using 20, 10 and 2 ml of 0.5% ropivacaine with epinephrine, respectively. The FNB was then performed using an S-Nerve machine (SonoSite Inc, Bothell, WA, USA), a linear ultrasound probe (HFL 38, 13-6 MHz), and a 5-cm needle (21G, Locoplex, Vygon, Ecouen, France). The femoral nerve and artery were identified at the level of the inguinal crease[15]. Under aseptic conditions, the needle was advanced from lateral to medial (via in-plane approach) and 15 ml of the block solution was injected (10 ml deep to the nerve and 5ml superficial). Adequate LA spread all around the femoral nerve was confirmed. Intra-neural injection was avoided. The 15 ml of the block solution contained either:-**a**) 75 mg of ropivacaine (5mg/ml) used in group 1, **b**) 30 mg of ropivacaine (2mg/ml) used in group 2, **c**) 30 mg of ropivacaine (2mg/ml) and 75mcg of epinephrine (5mcg/ml) used in group 3, or **d**) 30 mg of ropivacaine (2mg/ml), 75mg of lidocaine (5mg/ml) and 75mcg of epinephrine (5mcg/ml) used in group 4. All block solutions were prepared by the assistant.

The femoral sensory block was assessed by testing the pinprick sensation along the medial aspect of the leg (from the knee distal to the medial malleolus**)**. The sensory block was classified into three grades: 0 (normal sensation), I (decreased sensation) and II (absent sensation). The motor block was classified according to the patient's ability to extend his knee into three grades: 0 (normal motor power), I (motor weakness) and II (complete motor paralysis). The sensory and motor femoral blocks were assessed every 5 min until a corresponding grade II block was achieved or to a maximum of 40 min. The times required to achieve grade II sensory and motor blocks were defined as the sensory and motor onsets, respectively. The patients with grade II sensory and motor blocks within 40 min were considered to have a successful femoral block. Before starting the surgery, incomplete nerve blocks (if any) were supplemented[16]. After surgery, sensory and motor femoral blocks were assessed every 1 hour (starting 5 hours after the block performance) until the block faded. All the patients were assessed neurologically before discharge and during the physiotherapy visits for 3 weeks after surgery. The FNB sensory and motor block onsets, success rate, duration and any complications were assessed and recorded by the operator anesthetist and the ward nurse who were unaware of the LA used.

## Statistical analysis

The femoral motor block onset was the primary end point of this study. Assuming its mean and standard deviation (using 0.5% ropivacaine) are 25 and 5 min respectively[2], 24 patients per group were required to detect at least 5 min difference, with a power of 0.8, at two tail alpha of 0.05 as calculated using Minitab® 16.1 (Minitab, Inc., State College, PA, USA). The Patients' allocation was performed by block randomization

*Fig. 1*

Box and whisker plot showing the motor (A) and sensory (B) block onsets. ♦ Significantly delayed compared to group 4; ‡ Significantly delayed compared to group 1, 3, and 4; † Significantly delayed compared to group 1 and 4. * Extreme value; O Outlier value.

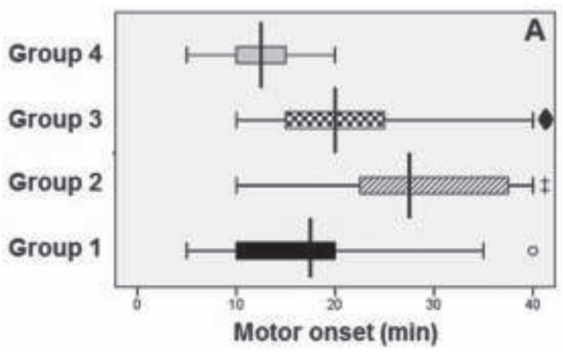
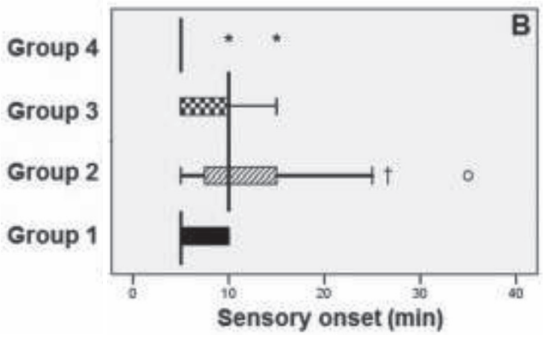



*Fig. 2*

*Box and whisker plot showing the motor (A) and sensory (B) block durations. O Outlier value.*




using the package "blockrand" in R (R Foundation for Statistical Computing, Vienna, Austria). Opaque sealed envelopes were used for concealment of randomized allocation. Data were analyzed using SPSS® (version 16.0, SPSS Inc, Chicago, IL, USA). Numerical variables were presented as mean (standard deviation) or median ($1^{st}$-$3^{rd}$ quartiles) as appropriate, while categorical variables were presented as frequency. If its assumptions were fulfilled, one-way ANOVA was used for between-group comparisons of numerical variables. Otherwise, Kruskal-Wallis test was used. For *post hoc* analysis, Tukey's test or the Mann–Whitney test with application of Bonferroni's correction was used whenever appropriate. For analysis of categorical variables, $\chi^2$ test was used. For all tests a p-value less than 0.05 (or 0.008, if Bonferroni's correction was applied) was considered statistically significant.

*Table 1*

*Patients' characteristics.*

| | Group 1 (n=24) | Group 2 (n=24) | Group 3 (n=24) | Group 4 (n=24) | P value |
|---|---|---|---|---|---|
| Age (yr) [mean (SD)] | 30.8 (8.5) | 26.3 (6.3) | 26.8 (7.2) | 29 (9.2) | 0.179 |
| Body mass index ($kg.m^{-2}$) [mean (SD)] | 27.1(4.6) | 28.2(5.2) | 25.8 (4.4) | 26.9(4.4) | 0.367 |
| ASA class I/II [n] | 23/1 | 24/0 | 24/0 | 21/3 | 0.099 |
| Gender male/ female [n] | 24/0 | 20/4 | 23/1 | 21/3 | 0.141 |
| Surgeries [n] | | | | | 0.949 |
| ACLR using hamstring graft | 17 | 19 | 20 | 19 | |
| ACLR using patellar tendon | 3 | 2 | 2 | 3 | |
| Others | 4 | 3 | 2 | 2 | |
| Blocks required supplementation [n] | | | | | |
| Sciatic nerve block | 1 | 1 | 1 | 0 | 0.793 |
| Obturator nerve block | 0 | 0 | 1 | 0 | 0.389 |
| LFCN block | 3 | 0 | 0 | 2 | 0.127 |

ASA, American Society of Anesthesiologists; ACLR, Anterior cruciate ligament reconstruction; LFCN, Lateral femoral cutaneous nerve. Include patellar tendon repair, medial patellofemoral ligament reconstruction and multiligament reconstruction.

## Results

The patients' characteristics were comparable across the four groups (table 1). The femoral motor block onset was significantly delayed in group 2 (compared with the other three groups) and in group 3 (compared with group 4). The sensory onset was significantly delayed in group 2 compared with group 1 and 4 (fig 1). The femoral nerve was successfully blocked in all patients (100%) in the four groups. Durations of the sensory and motor blocks were comparable in all groups (fig 2). All patients had painless surgery (no opioid was required) and no complications were recorded.

## Discussion

The success rate and duration of FNB using ropivacaine 0.2% were comparable to that of ropivacaine 0.5%. However, ropivacaine 0.2% has a significantly delayed motor onset which was accelerated by adding epinephrine alone or with lidocaine.

The femoral nerve innervates the hip and knee joints, the thigh, and the skin at the medial aspect of the leg and foot[17]. Therefore, its block is indicated in almost all lower limb surgeries. Peripheral nerve block can provide excellent and safe anesthesia for lower limb surgeries[10]. However, its long performance time, the requirement large LA dose and the inappropriate block characteristics (delayed onset, low success rate, too long motor block or too short sensory block) may limit its use. Various methods have been used to improve these disadvantages[7-10]. In this study, we evaluated the effect of lowering the ropivacaine concentration and adding adjuvant (epinephrine and lidocaine) on the FNB characteristics (onset, success rate and duration).

The block onset markedly affects the efficacy of the operating room (especially where there is no block room) [18]. The onset of the complete motor block is always associated with painless surgery, but it usually requires more time than the sensory onset (especially at the low LA concentrations)[10,16]. Many factors can affect the block onset, including the LA type and its concentration, the use of adjuvant, the nerve to be blocked, the block approach and the localizing technique [1,7,8,19]. Increasing the ropivacaine concentration or adding lidocaine, in the current study, accelerated the block onset. Similar results have been reported [1,7]. Adding epinephrine to ropivacaine 0.2%, in this study, improved the femoral motor block onset (which became comparable to that of ropivacaine 0.5%). However, this was not true for other nerve block[20]. The use of ultrasound guidance may explain the faster onset of ropivacaine 0.5% in this study (in spite of using smaller volume) compared to what has been previously reported[2,19].

The success rate is another cardinal characteristic of the nerve block. Failed block requires block supplementation (more LA and more time are required) or addition of general anesthesia (exposing the patient to additional risks)[18]. High ropivacaine concentrations (0.5-1%) are usually used to achieve a successful FNB[1-2]. Recently, low ropivacaine concentrations were shown to block the femoral nerve successfully[10]. Similarly, in the current study, ropivacaine 0.2% alone (without adding epinephrine or lidocaine) resulted in successful FNB in all the patients (100%).

Surprisingly, the block duration of ropivacaine 0.2 %, in the current study, was not affected by increasing the ropivacaine concentration or by adding epinephrine or lidocaine. Previous studies have shown contradictory results regarding the effect of changing the LA concentration (or volume) on the block duration[1,5-6]. It was proposed that beyond a certain threshold, increasing the LA concentration (or volume) is not associated with significant prolongation of the block duration. This threshold varies according to the type of local anesthetic, the nerve to be blocked and the block approach[5]. Possibly due to its intrinsic vasoconstrictor activity, the ropivacaine block duration seemed to be relatively less affected by changes in concentrations or by adding epinephrine[5,20]. Addition of lidocaine to ropivacaine, in a previous study, was shown to accelerate the block recovery[7]. However, adding lidocaine to ropivacaine may aggravate the risk of LA toxicity[7,11]. Adding epinephrine, in contrast, slows down the LA absorption and may decrease its peak plasma level [8,21-22]. It is also a marker for IV injection, however, it may worsen the nerve injury when intra-neural injection occurs[8].

Most of patients who participated in this study were middle aged, athletic healthy males. Therefore our result may not applicable for other aged groups, gender or patients with peripheral neuropathy (as diabetics).

## Conclusion

In femoral nerve block, ropivacaine 0.2% may have a comparable success rate and duration to ropivacaine 0.5% but with a remarkably delayed motor onset that may be improved by adding epinephrine. Addition of lidocaine may further accelerate the motor onset.

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