Original Article

Adductor canal block: Effect of volume of injectate on sciatic extension

ABSTRACT

Context: Spread of local anesthetic within adductor canal to peroneal and tibial nerves is described in literature. This spread could be volume-dependent.

Aims: In this study, we compared the diffusion of two volumes of 0.375% ropivacaine to popliteal fossa.

Settings and Design: This was a prospective, randomized controlled, single-blind study conducted in Kassab Orthopaedic Institute of Tunis for 1 year (2018).

Materials and Methods: A total of 42 patients, American Society of Anesthesiologists I/II scheduled for knee arthroscopy under spinal anesthesia scheduled to receive adductor canal block, were randomized into two groups: group N received 20 mL of ropivacaine 0.375% and group H received 40 mL. We evaluated sensory motor blocks of both peroneal and tibial nerves at 30 and 60 min.

Statistical Analysis Used: Chi-square or Fisher's exact test was used to compare the number and percentage. P <0.05 was significant.

Results: At 60 min, complete sensory block of the peroneal nerve was obtained for 16 patients in group H versus 15 patients in group N with no statistically significant difference (P = 0.60). The difference was also not significant (P = 0.27) for the tibial nerve: 14 patients for group H versus 16 for group N. Motor blockade was rare in the two nerve territories.

Conclusion: Spread of 0.375% ropivacaine to popliteal fossa resulted in high rate of complete sensory blockade of both peroneal and tibial nerves. Diffusion of local anesthetic was not volume-dependent.

Key words: Adductor canal block; knee arthroscopy; motor block; peroneal nerve; sensory block; tibial nerve

Introduction

Postoperative nerve blocks provide excellent analgesia after knee surgery allowing early functional rehabilitation.[1] Adductor canal block (ACB) is gaining popularity as an analgesic technique after knee surgery as it provides a similar degree of analgesia compared with femoral nerve block and also preserves quadriceps strength.[2-5] Because the adductor canal (AC) runs in continuation of the femoral triangle, local anesthetic (LA) can spread to the common femoral nerve and impairment of quadriceps muscle was reported after ACB.[6]

Access this article online	
Website: www.saudija.org	Quick Response Code
DOI: 10.4103/sja.SJA_410_19	

How to cite this article: Raddaoui K, Radhouani M, Bargaoui A, Nasri O, Zoghlami K, Trigui E, *et al*. Adductor canal block: Effect of volume of injectate on sciatic extension. Saudi J Anaesth 2020;14:33-7.

Khaireddine Raddaoui, Mohamed Radhouani, Abderahmen Bargaoui, Oussama Nasri, Karima Zoghlami, Emna Trigui, Olfa Kaabachi

Department of Anaesthesiology and Intensive Care, Kassab Orthopaedic Institute, Faculty of Medicine of Tunis, University Tunis El Manar, Tunis, Tunisia

Address for correspondence: Prof. Olfa Kaabachi, Department of Anaesthesiology and Intensive Care, Kassab Orthopaedic Institute, Ksar Said 2010, La Manouba, Tunisia. E-mail: olfa.kaabachi@gnet.tn

Received: 19th June, 2019, **Accepted:** 16th July, 2019, **Publication:** 06th January, 2020

As AC contains neither the sciatic nerve nor its branches, additional analgesic effect could also be explained by a potential spread of LA to popliteal fossa. Cadaver studies supported these hypothesis.[7-9] Clinical studies confirmed the spread out both into femoral triangle[10,11] and popliteal fossa.[12,13] However, whether the volume of LA influences the number of nerves affected remains undetermined. The objective of our study was to compare the distribution to the peroneal and tibial nerves of two volumes of ropivacaine.

Materials and Methods

Type of study

It was a prospective, randomized controlled, double-blind study conducted over a 12-month period from 01 January 2018. All patients had given informed consent for enrolment. Ethical approval was obtained from the local ethical committee in 15th December, 2015, under number IMKO-CE 110/2016.

Patients

We included patients over 18 years of age, American Society of Anesthesiologists ASA I or II (classification of the ASA), scheduled for knee arthroscopy under spinal anesthesia.

We did not include patients refusing locoregional anesthesia, having an allergy to one of the medications used in this study, having a contraindication to the realization of the block (infection to the site of puncture, disorder of hemostasis, etc.), and having peripheral neuropathy known or suspected. Failure of locoregional block (total absence of the sensory block in the territory of the saphenous nerve at T60) and incomplete data collection were the exclusion criteria.

Patients were randomized into two groups using a randomization computed table: group N received 20 mL of ropivacaine 0.2% (Fresenius Kabi France, France) and group H received 40 mL of ropivacaine 0.2%.

Study protocol

All patients received a premedication based on hydroxyzine 1 mg/kg 2 h before their transfer to the operating theater. Patients were accommodated in the operative room at least 1 h before the procedure; they were installed in supine position and monitored by electrocardioscopy, measurement of noninvasive arterial pressure, and pulse oximetry, with the placement of an 18-gauge peripheral venous catheter.

An anesthesist was instructed to prepare the anesthetic product: a syringe (normal volume) or two syringes (high volume) of 20 mL containing ropivacaine at a concentration reduced to 0.375% (10 mL of water distilled supplemented with 10 mL of ropivacaine 0.75%).

After skin disinfection and application of a sterile gel (Sonogel®; Asept InMed, France), ultrasound-guided ACB was performed in the mid-thigh. The probe was positioned transversely midway from the patella and the inguinal ligament. The AC was visualized with the femoral artery lying immediately under the sartorius muscle. A 10-cm 22-G needle was advanced in-plane. Intracanalar injection was confirmed by hydrolocalization.

Data collected

Data collection was carried out by an anesthesiologist who did not participate either in the randomization or in the realization of the block. T0 is taken as the end time of the injection to the ACB. The sensory and motor blocks were evaluated after 30 min (T30) and after 1 h (T60).

Sensitive blockade was tested by cold perception, comparatively to the nonoperated side. S2 was defined as "similar to the operated side," S1 as "slightly different from the operated side," and S0 as "very different from the operated side." S0 was considered as complete sensitive blockade. The femoral nerve was tested in the anterior mid-thigh, the saphenous nerve in the internal face of the leg, the peroneal nerve in the dorsal face of the foot, and the tibial nerve in the plantar face of the foot.

Motor blockade was tested for the femoral nerve by extension of the knee, the peroneal nerve by dorsal flexion of the ankle, and the tibial nerve by plantar flexion of the ankle. Muscular force was rated from 0 to 5 using American Spinal Injury Association (ASIA) scale. ASIA score ≤M2 was considered complete motor block. Our primary outcome was the percentage of successful extension of sensitive blockade to the peroneal or tibial nerve. Secondary outcomes were extension to sensitive motor blocks of femoral nerve, motor blockade of peroneal and tibial nerves, and complications of nerve block.

Statistics

We based prevision of the number of patients on the results of Gautier *et al*.[12] showing that approximately 40% of patients had a sensitive blockade in the territory of the peroneal nerve after a 20-mL injection in the AC. We calculated that 40 patients are required to have 80% chance of detecting sensitive blockade extension, as significant at the 5% level. Statistical analyses were performed using SPSS® software (version 17; SPSS Inc., IBM, USA). Quantitative data were expressed in median (interquartile). Categorical data were expressed as *n* (%). Extension success was analyzed

by Chi-square test. $P < 0.05$ was considered statistically significant.

Results

A total of 42 patients were included at the beginning of the study with 21 patients in each group. One patient was excluded in group N because of failure of the block. Both groups were comparable in terms of demographic data [Table 1].

At T30, the rate of complete sensory block of the peroneal nerve and the tibial nerve was not statistically different in both groups ($P = 0.22$ and $P = 0.57$, respectively). For the femoral nerve, the difference between groups was also not significant ($P = 0.21$). At T60, more patients had complete sensory block of both peroneal and tibial nerves with no difference between groups ($P = 0.60$ and $P = 0.12$, respectively) [Table 2].

In each group, only one patient presented a complete motor block for the femoral and tibial nerves. For the peroneal nerve, complete motor block was noted in one patient of group H [Table 3]. No complication such as accidental vascular puncture was observed during the realization of peripheral nerve blocks. No symptoms of systemic toxicity related to LAs were found during the study.

Table 1: Demographic characteristics of patients

	Group H	Group N	*P*
Number	21	20	
Sex (H/F)	17/4	16/4	0.62
ASA 1	20	18	0.48
ASA 2	1	2	
Age (years)	32±11.7	31±8	0.66
BMI (kg/m^2)	26.3±4.4	23.3±5.0	0.05

ASA: American Society of Anesthesiologists; BMI: Body mass index

Table 2: Rate of complete sensory block (scale S0) in both groups

Sensitive block	T30 min			T60 min		
	Group H	Group N	*P*	Group H	Group N	*P*
Saphenous N	20 (95.2%)	20 (100%)	0.51	21 (100%)	20 (100%)	0.20
Femoral N	10 (47.6%)	13 (65%)	0.21	11 (52.3%)	15 (75%)	0.12
Peroneal N	13 (61.9%)	9 (45%)	0.22	16 (76.2%)	15 (75%)	0.60
Tibial N	12 (57.1%)	11 (55%)	0.57	14 (66.6%)	16 (80%)	0.27

N: Nerve

Table 3: Number of patients with complete motor block in both groups

Motor block	T30 min			T60 min		
	Group H	Group N	*P*	Group H	Group N	*P*
Femoral nerve	1	0	0.5	1	1	0.60
Peroneal nerve	1	1	0.9	1	1	0.90
Tibial nerve	1	1	0.6	1	0	0.85

Discussion

The main result of our study was the high rate of complete sensitive blockade of both peroneal and tibial nerves within ACB. The probable spread of ropivacaine 0.375% into popliteal fossa was independent of volume injectate.

The ACB can provide reliable sensory blockade to the medial-anterior part of the lower leg, but it has variable effects on the sensory components of the knee. Extension of this block by diffusion to other nerves especially to the peroneal and tibial nerves or even femoral nerve has been described in the literature.[7-13] This diffusion could be the origin of a motor block delaying early postoperative rehabilitation.[6] The volume of LA could be one factor explaining extension of blockade to other nerves. By comparing two groups of patients receiving either 20 mL of ropivacaine 0.375% or 40 mL in ACB, we demonstrated that extension of the sensory block to the territory of peroneal and tibial nerve was noted in more than 75% of patients. Varying the volume of ropivacaine 0.375% used for ACB between 20 and 40 mL did not have a significant clinically relevant impact on the extension of the sensory block to the territory of peroneal and tibial nerves. More than 50% of patients also had a complete sensory block of femoral nerve. Motor block was rare in both groups.

The majority of studies were interested in quadriceps muscle weakness after ACB block.[6,8] This motor block can be explained by the extension of LA to the vastus medialis nerve, a branch of the posterior division of the femoral nerve and which is responsible for motor weakness after ACB.[14] For this reason, some authors have compared proximal and distal or subsartorial canal block. They recommended subsartorial canal block because LA spreads distally in the AC but not proximally so that it can provide analgesia for knee surgery with preservation of quadriceps strength.[8] Whereas impairment of quadriceps function could be the consequence of LA spread proximally into femoral triangle.[15] Several studies compared several volumes of LA injected into AC with controversies regarding a volume effect.[10,11,16-18]

In cadaver studies,[7-9] spread of dyed injectate throughout the entire AC to the femoral triangle and into the popliteal fossa was confirmed independently of the volume of injectate. The lack of significant correlation between LA volume and proximal spread to femoral nerve or quadriceps strength was reported by several authors.[10,16,18] However, studies

had defined a volume of 20 mL as the ED95 of lidocaine 1% that was needed to fill the AC distally[10] and a volume of 10.4 mL as the median effective volume of ropivacaine 0.5% for ultrasound-guided ACB.[11] Similar results were reported by Jæger *et al*.[19] who founded that increasing concentration or total dose of lidocaine for an ACB did not increase block duration. But in two recent studies, a strong association between volume and muscle strength has been reported.[11,17] A volume of 30 mL of lidocaine 1% resulted in an affection of vastus medialis muscle in all subjects, a volume of 20 mL resulted in an affection in 84% of the subjects, whereas a volume of 10 mL only resulted in an affection in 35% of the subjects.[17] Despite large differences in electromyography recordings, there were no statistically significant differences in quadriceps femoris muscle evaluated using a dynamometer. In a study by Johnston *et al*,[11] the ED50 of ropivacaine 0.5% needed for a 30% decrease in quadriceps power was 46.5 mL and the estimated ED95 was 50.32 mL, with significant of correlation volume injected with degree of quadriceps weakness at 20 min postblock ($P < 0.001$) and in the postanesthesia recovery unit ($P = 0.032$). In our study, only sensory block was frequently reported but without any volume effect. Complete motor block with ASIA score of less than 3 at T60 min was reported only in two patients.

Few articles focused on block extension to the peroneal and tibial nerves within ACB after publication of the first case report[12] and the cadaver study of Andersen *et al*.[7] Spread appears to occur through the adductor hiatus, the accessory hiatus, and/or in the intermuscular plane of the adductor magnus, resulting in some sensory block of the sciatic nerve and/or its branches.[7] In a clinical study, Gautier *et al*.[18] included 15 patients who received ultrasound-guided injections of 20 mL of mepivacaine 1% at the level of the adductor hiatus. Sensation with pinprick test was markedly diminished or absent in peroneal nerve territory in 14% and in tibial nerve territory in 34% of cases. In six patients who had computed tomography examinations, contrast solution was detected in the AC and extended into the popliteal fossa near the popliteal vessels and the sciatic nerve. Motor weakness was not apparent for knee extension or for flexion or extension of the foot. This was the first clinically relevant study confirming the spread of injectate in AC to the popliteal fossa. Our results were quiet different; complete sensory block was more frequent in both nerve territories (at 60 min 75% for peroneal nerve and 80% for tibial nerve). However, there was no muscle impairment in foot in our study as in Gautier *et al.*'s study.[18] These results could be explained by study differences either in injection location or in LA used. In our study, ACB was performed at mid-thigh, whereas in Gautier *et al.*'s study,[18] CAB was done at the level of adductor hiatus. We used ropivacaine 0.375% which provides a potent and long-lasting sensory blockade. Mepivacaine 1% was chosen in Gautier *et al.*'s study[18] for its greater motor-blocking property. However, our study was a comparative trial including more patients than Gautier *et al.*'s study.

Several limitations of this study should be noted. First, we did not use any imaging examination to show spread of LA into popliteal fossa. Second, we did not use a dynamometer for quadriceps muscle evaluation. Third, duration of motor or sensitive block and quality of analgesia were not searched in the postoperative period. Finally, postoperative rehabilitation was not studied.

We demonstrated in this study that LA injected in AC diffused to popliteal fossa resulting in high rate of sensory blockade of both popleteal and tibial nerves without significant motor block. This spread was not volume-dependent. Distribution of LA within the AC to popliteal fossa could participate in analgesic effect of ACB in knee surgery. Other studies are necessary to confirm this conclusion.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Sargant SC, Lennon MJ, Khan RJ, Fick D, Robertson H, Haebich S. Extended duration regional analgesia for total knee arthroplasty: A randomised controlled trial comparing five days to three days of continuous adductor canal ropivacaine infusion. Anaesth Intensive Care 2018;46:326-31.
2. Karkhur Y, Mahajan R, Kakralia A, Pandey AP, Kapoor MC. Comparative analysis of femoral nerve block with adductor canal block following total knee arthroplasty: A systematic literature review. J Anaesthesiol Clin Pharmacol 2018;34:433-8.
3. Tan Z, Kang P, Pei F, Shen B, Zhou Z, Yang J. A comparison of adductor canal block and femoral nerve block after total-knee arthroplasty regarding analgesic effect, effectiveness of early rehabilitation, and lateral knee pain relief in the early stage. Medicine (Baltimore) 2018;97:e13391.
4. Kim MK, Moon HY, Ryu CG, Kang H, Lee HJ, Shin HY. The analgesic efficacy of the continuous adductor canal block compared to continuous intravenous fentanyl infusion with a single-shot adductor canal block in total knee arthroplasty: A randomized controlled trial. Korean J Pain 2019;32:30-8.
5. Jenstrup MT, Jæger P, Lund J, Fomsgaard JS, Bache S, Mathiesen O, *et al*. Effects of adductor-canal-blockade on pain and ambulation after total knee arthroplasty: A randomized study. Acta Anaesthesiol Scand 2012;56:357-64.
6. Chen J, Lesser JB, Hadzic A, Reiss W, Resta-Flarer F. Adductor canal block can result in motor block of the quadriceps muscle. Reg Anesth Pain Med 2014;39:170-1.

7. Andersen HL, Andersen SL, Tranum-Jensen J. The spread of injectate during saphenous nerve block at the adductor canal: A cadaver study. Acta Anaesthesiol Scand 2015;59:238-45.
8. Cowlishaw Ph, Kotz P. Adductor canal block—or subsartorial canal block? Reg Anesth Pain Med 2017;42:413-4.
9. Nair A, Dolan J, Tanner KE, Kerr CM, Jones B, Pollock PJ, *et al*. Ultrasound-guided adductor canal block: A cadaver study investigating the effect of a thigh tourniquet. Br J Anaesth 2018;121:890-8.
10. Jæger P, Jenstrup MT, Lund J, Siersma V, Brøndum V, Hilsted KL, *et al*. Optimal volume of local anaesthetic for adductor canal block: Using the continual reassessment method to estimate ED95. Br J Anaesth 2015;115:920-6.
11. Johnston DF, Sondekoppam RV, Giffin R, Litchfield R, Ganapathy S. Determination of ED50 and ED95 of 0.5% ropivacaine in adductor canal block to produce quadriceps weakness: A dose-finding study. Reg Anesth Pain Med 2017;42:731-6.
12. Gautier PE, Lecoq JP, Vandepitte C, Harstein G, Brichant JF. Impairment of sciatic nerve function during adductor canal block. Reg Anesth Pain Med 2015;40:85-9.
13. Gautier PhE, Hadzic A, Lecoq JP, Brichant JF, Kuroda MM, Vandepitte. Distribution of injectate and sensory-motor blockade after adductor canal. Anesth Analg 2016;122:279-82.
14. Rahimzadeh P, Faiz HR, Imani F, Hobika GG, Abbasi A, Nader ND. Comments on "relieving pain after arthroscopic knee surgery: Ultrasound-guided femoral nerve block or adductor canal block?" Turk J Anaesthesiol Reanim 2018;46:249.
15. Davis JJ. Bond TS, Swenson JD, Jeffrey D. Adductor canal block: More than just the saphenous nerve? Reg Anesth Pain Med 2009;34:618-9.
16. Jæger P, Koscielniak-Nielsen ZJ, Hilsted KL, Fabritius ML, Dahl JB. Adductor canal block with 10 ml versus 30 ml local anesthetics and quadriceps strength a paired, blinded, randomized study in healthy volunteers. Reg Anesth Pain Med 2015;40:553-8.
17. Grevstad U, Jæger P, Kløvgaard Sørensen J, Gottschau B, Ilfeld B, Ballegaard M, *et al*. The effect of local anesthetic volume within the adductor canal on quadriceps femoris function evaluated by electromyography: A randomized, observer- and subject-blinded, placebo-controlled study in volunteers. Anesth Analg 2016;123:493-500.
18. Tao Y, Zheng SQ, Xu T, Wang G, Wang Y, Wu AS, *et al*. Median effective volume of ropivacaine 0.5% for ultrasound-guided adductor canal block. J Int Med Res 2018;46:4207-13.
19. Jæger P, Koscielniak-Nielsen ZJ, Hilsted KL, Grevstad U, Siersma V, Fabritius ML, *et al*. Effect of total dose of lidocaine on duration of adductor canal block, assessed by different test methods: A report of two blinded, randomized, crossover studies in healthy volunteers. Anesth Analg 2016;123:1026-32.