Randomized Controlled Trial

Comparison of Classic Block and Sub-Branch Block During Sono-Guided Obturator Nerve Blocks: A Randomized Clinical Trial

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Background: The obturator nerve block (ONB) is commonly performed using anterior and posterior branch blocks at the inguinal crease level. However, in practical situations, we have found that variable adductor muscle twitching can remain even after a successful main branch block.

Objectives: This study evaluates how much an additional twitching block affects the complete adductor motor block compared to the classic ONB. Additionally, the study analyzes the patterns of residual twitching sites.

Study Design: A randomized, controlled trial.

Setting: The Department of Anesthesiology and Pain Medicine at the Gachon University Gil Medical Center.

Methods: In the classic group (n = 35), posterior and anterior branch blocks were performed by ultrasound with a nerve stimulator at the inguinal crease. In the sub-branch group (n = 35), the main branch block was performed in the same way as in the classic group. Fifteen minutes later, additional twitching blocks were performed. The primary outcome was the extent of the obturator reflex–graded adductor motor block, which was measured 15 minutes after the ONB in both groups, and the secondary outcome was the analysis of twitching site patterns.

Results: The total dose of local anesthetic was higher in the sub-branch group, but the quality of obturator reflex grading was statistically significantly better than in the classic group. No patient in either group required general anesthesia to complete surgery. Residual twitching was usually observed in the adductor brevis, adductor magnus, or pectineus muscles or at the inner portion of the fascial line through which the anterior or posterior branch passed.

Limitation: The success of the ONB was evaluated using obturator reflex grades, which might not have provided an accurate measure of success.

Conclusions: Although a main branch block alone does not usually result in inadvertent adductor muscle contraction severe enough to cause complications such as bladder perforation, partial residual muscle movement is observed. Therefore, supplementing the main branch block with an additional sub-branch block can be a reasonable strategy to achieve more complete motor blockade.

Key words: inguinal crease, nerve block, obturator nerve, spinal anesthesia, TURB, ultrasound

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Transurethral resection of bladder tumor (TURB) is an essential treatment for bladder tumors (1). Direct electrical stimulation of an obturator nerve (ON) during TURB can trigger an inadvertent adductor muscle contraction and cause serious bladder perforation (2,3). Therefore, the use of spinal anesthesia with an obturator nerve block (ONB) can provide safe anesthesia for patients.

After exiting the obturator canal, ONs divide into 2 branches. The anterior branch is located in the fascial planes between the adductor longus, adductor brevis, and pectineus muscles, and the posterior branch is located between the adductor brevis and adductor magnus muscles at the inguinal crease (4-6). In this study, the term "classic ONB" means an anterior and posterior branch block at the inguinal crease level, which we also refer to as "main branch block." In practical situations, we have found that variable adductor muscle twitching can remain even after a successful main branch block confirmed by a nerve stimulator.

The main branch of the ON has multiple branching patterns, and sub-branches are extensively distributed among adductor muscles (7). Therefore, we supposed that unblocked sub-branches could cause a residual twitching response even after a main branch block and that adding a sub-branch block would increase the efficacy of a classic ONB at the inguinal crease level.

An incomplete ONB can result in serious bladder perforation (4), so we consider residual twitching after ONB an important element to observe. In this study, we evaluated the extent to which an additional sub-branch block could provide a complete adductor motor block as compared to a classic ONB and analyzed the patterns of residual twitching sites.

Methods

Written informed consent was obtained from all patients after obtaining approval from our institutional ethics committee (GBIRB2016-125) and registering the study at the University Hospital Medical Information Network (UMIN) Clinical Trials Registry (UMIN000022716). This study was performed in accordance with the CONSORT 2024 checklist.

Seventy patients whose physical statuses ranged from I to III on the American Society of Anesthesiologists' (ASA's) classification system were enrolled in the study. All underwent spinal anesthesia with ONBs for elective TURB due to bladder tumors. The exclusion criteria applied were as follows: the presence of diabetes or peripheral neuropathy, motor or sensory deficits in the lower extremities, an ASA status of ≥ IV, a coagulation disorder, current use of anticoagulant medication, a known allergy to local anesthetics, contraindication for spinal anesthesia (infection at the injection site, severe scoliosis, or fusion operation), lack of cooperation, and refusal to participate.

The study was conducted with a randomized, controlled, parallel group design (Fig. 1). We received 48 patients' informed consent as registered with the IRB, and 70 blocks were implemented (both blocks in 22 patients and single blocks in 26 patients). Therefore, all uses of N in this paper refer to block number, not patient number: we treated one nerve block as one case in this study.

Written informed consent was obtained the day before surgery. Patients were randomly assigned to one of 2 groups—a control group of patients who received ultrasound-guided ONBs with nerve stimulation (the classic group) or an experimental group of patients who received additional sub-branch blocks with existing ONBs (the sub-branch group). In each group, every patient was assigned to receive an ONB at the inguinal crease using a random integer set generator (www.random.org). The ratio of allocation was one to one. A researcher not involved in performing the block generated the randomization set and enrolled the patients. All procedures were conducted in the operating room of Gil Medical Center at the Gachon University College of Medicine, Incheon, Korea, from January 2019 to September 2019.

Routine monitoring was initiated, and spinal anesthesia with 12–15 mg of hyperbaric 0.5% bupivacaine was administered to achieve a level of anesthesia above T10 (at least T10 to T4) in all patients. With the patient in a supine position, an anesthetic nurse (unrelated to this study) closed the curtain in front of the patient's face to hide the procedure. The patient's affected leg was then slightly abducted and rotated externally without knee flection (8), and the inguinal region was prepared with a povidone iodine solution. A 10 MHz linear probe (Zonare Medical Systems) equipped with a sterile plastic cover and gel was then positioned parallel to the inguinal crease at 90° to the skin; image depth was set at 4-5 cm. The inguinal region was examined laterally from the femoral vein until the pectineus muscle was identified with the adductor longus, adductor brevis, and adductor magnus medially at the inguinal crease (Fig. 2A).

In the classic group (4,6), a 22-gauge, 120-mm stimulating needle (Stimuplex® D Plus, B. Braun Medical

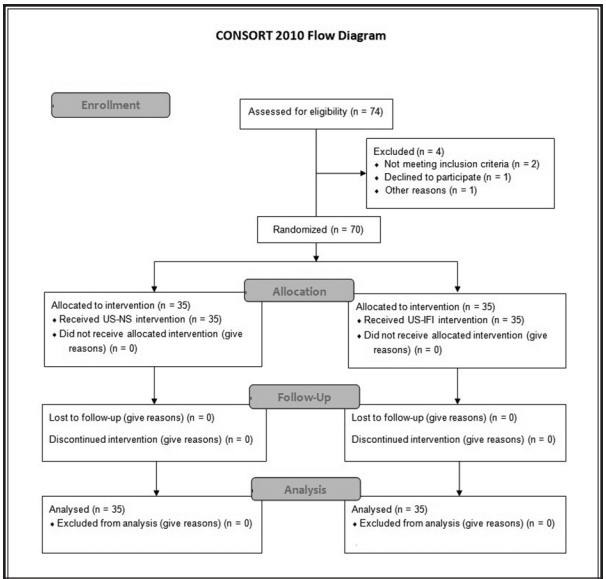


Fig. 1. *Patient enrollment algorithm.*
All uses of n refer to the block number, not the patient number. We treated one block as one case in this study.

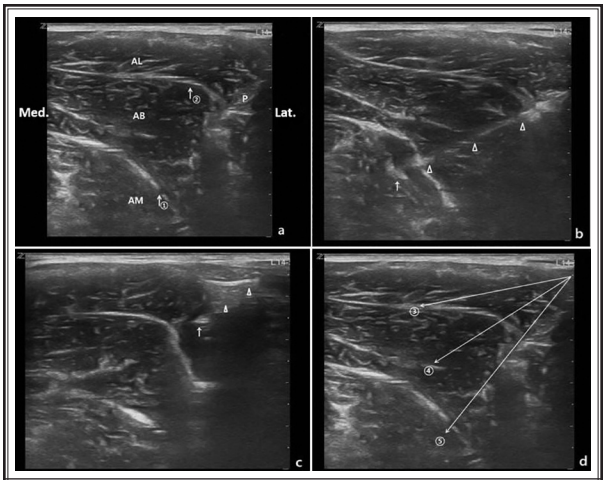


Fig. 2. *Obturator nerve block (ONB) sites in the 2 groups. For the ONB, fascial planes of adductor and pectineus muscles are identified (A). Arrow ① indicates the target of the posterior branch block, and Arrow ② indicates the target of the anterior branch block. The separation of interfascial planes for posterior branch block (B) and anterior branch block after LA injection (C) is shown. In the sub-branch group, targeting areas that show residual twitching is performed using a fanlike injection technique (D). The arrow indicates the needle tip, and the arrowhead indicates the needle.*
Abbreviations: AL, adductor longus muscle; AB, adductor brevis muscle; AM, adductor magnus muscle; P, pectineus muscle.

Ltd.) attached to a nerve stimulator (Stimuplex® HNS 12; B. Braun Medical Ltd.) was advanced via an ultrasound in-plane approach in a lateral-to-medial direction to position the needle tip at the junction of the adductor brevis and adductor magnus muscles within the fascia for a posterior branch block (Fig. 2A, arrow ①). The nerve stimulator was turned on at 0.5 mA. If adductor muscle twitching was observed even at 0.3 mA, 10 mL of local anesthetic (LA; 1.5% lidocaine + epi 1: 200,000) were injected slowly into the twitching point after negative aspiration (Fig. 2B). The needle was then positioned at the junction of the adductor longus, adductor brevis, and pectineus muscles within the fascia for an anterior branch block (Fig. 2A, arrow ②); 10 mL of LA were injected in the same manner (Fig. 2c).

In the sub-branch group, the main branch block was performed in the same way as described above, and 15 minutes after the main branch block (6), additional needling was performed (Fig. 2D). The same anesthesiologist re-advanced the needle in a fan-like manner to search for residual unblocked sub-branches with the nerve stimulator at a starting current of 2 mA. If twitching was observed even at 0.3 mA, another 3 mL of LA were injected into each twitching site.

All blocks were performed by a single anesthesiologist with experience of more than 100 ONBs.

The primary outcome was the extent of the adductor motor block, as determined by obturator reflex grading (9) measured 15 minutes after the ONB by 2 urologic assistants unaware of group assignments. Obturator reflex grading was performed as follows: Gr I—no movement, no palpable muscle twitching; Gr II—palpable muscle twitching but no movement; Gr III—slight movement of the thigh not interfering with the surgical procedure but possibly requiring holding of the leg, Gr IV—vigorous movement interfering with the surgical procedure, requiring a switch to general anesthesia.

After the evaluations, patients were prepared in a lithotomy position. Neoplasm endoscopic resection was started using a bipolar resectoscope (electrical current: 280W); a normal saline solution was used for endovesical irrigation (4). Surgery was performed by one of 5 surgeons.

The secondary outcome was the analysis of residual twitching site patterns (Fig. 3). We supposed that residual twitching sites indicated unblocked sub-branch pathways located where the main branch of the ON passed through the adductor longus, brevis, magnus, or pectineus muscles or other fascial points.

Results are presented as mean ± SDs unless otherwise indicated. The statistical analysis was performed using SPSS 12.0 for Windows (SPSS Inc.). The chi-squared

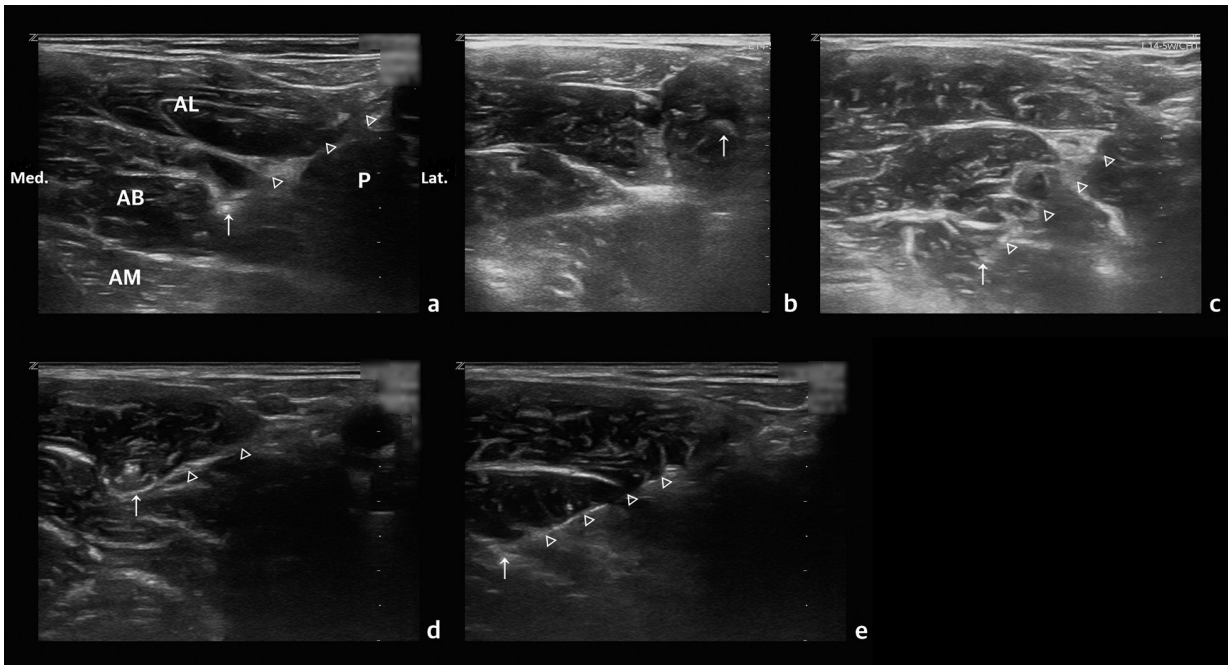


Fig. 3. *Residual twitching patterns in the sub-branch group.*
Unblocked twitching is usually observed in the adductor brevis (a), pectineus (b), or adductor magnus muscle (c), or in the inner part of the fascial line through which the anterior (d) or posterior (e) branch passes. The arrow indicates the needle tip, and the arrowhead indicates the needle.
Abbreviations: AL, adductor longus muscle; AB, adductor brevis muscle; AM, adductor magnus muscle; P, pectineus muscle.

test or Fisher's exact test was used to analyze categorical data (gender, ASA status, block site, spinal level, or reflex grade), and Student's unpaired t-test was used to compare continuous data (age, height, weight, surgery duration, bupivacaine doses, or lidocaine dose). Statistical significance was accepted for *P*-values < 0.05. In a preliminary study, success was achieved in 9 of 10 patients in a control group and all 10 patients in an experimental group. Thirty-five blocks were required per group for an α value of 0.05 and a power of 80%.

Results

All 70 blocks were included in the present study.

The patient enrollment algorithm is shown in Fig. 1, group demographic data in Table 1, and data regarding the ONB procedure in Table 2. In the sub-branch group, the total LA dose was higher, and the quality of the block as determined by obturator reflex grading was better in statistical significance than in the classic group. No patient in either group required general anesthesia. The total LA doses in the 2 groups are detailed in Table 3; LA toxicity was not observed in any patient.

No vascular puncture or blood aspiration occurred during procedures, and no neurological, vascular, or infection-related complications were detected by follow-up urology chart review.

Fig. 3 shows that some sites were prone to twitching. Residual twitching was observed in a total of 13 cases; in the adductor brevis muscle (7 cases), the adductor magnus muscle (one case), the pectineus muscle (2 cases), or the inner part of the fascial line that the anterior (one case) or posterior (2 cases) branch of the ON passed through.

Discussion

In this study, 5 of 35 blocks in the classic group showed incomplete adductor motor blocks that did not affect the progression of surgery, which demonstrates that a successful main branch block does not guarantee a complete adductor motor block.

Anatomically, there are many ON branching patterns, and the nerve exhibits high anatomical variability at the inguinal crease, so sub-branches can remain in an unblocked state (7). In an anatomical study of the ON at the inguinal crease by Anagnostopoulou et al (7), 23% of division levels were at the obturator canal,

and 51% were at the medial thigh. In 66% of cases, the anterior nerve branches in 3 to innervate the adductor longus, adductor brevis, and gracilis muscles; and in 60% of cases, the posterior nerve branches in 2 to innervate the adductor brevis and adductor magnus muscles. In particular, the adductor brevis muscle demonstrates a double innervation pattern by the anterior and posterior branches in 70% of cases. The adductor brevis muscle was the most commonly observed twitching site in this study.

The effects of unblocked sub-branches on adductor muscle contraction are not well known. Particularly, it has not been established whether leaving some unblocked sub-branches increases the risk of severe muscle contraction. In clinical situations, we have witnessed the grade IV obturator reflex even after successful main branch blocks, a result attributed to an unidentified ON branch passing through the pectineus muscle, requiring general anesthesia for surgery (10). In this study, we supposed 5 patients exhibiting obturator reflex grade II or III in the classic group had unblocked sub-branches. This observation should be taken seriously because of the possibility that only the sub-branch, not the main branch, is blocked during the procedure (7); while we can observe the twitching, we cannot see its origin. Akata et al described a case of life-threatening hemorrhage following an obturator artery injury due to an incomplete ONB (11).

Incomplete motor block may be a technical problem associated with the use of ultrasound. At the inguinal crease, where the common ON and its main branches are located, a caudally positioned transducer may be able to find divisions or subdivisions, not the main branches of the ON (7). Moreover, many muscle layers are near the ON pathway, which is intertwined and complicated, so a slight tilting of the transducer can alter the visualized nerve position and result in the false spreading of LA into peripheral nerve tissue (12).

Even when the above factors have been fully addressed, achieving a complete motor block through a main branch block alone may be impossible because innervations from the femoral and sacral plexus also contribute to adductor motor strength (5). Therefore, we believe it is not enough to focus on a single main branch block even when ultrasound and a nerve stimulator are used, and that blocks on residual twitching foci are necessary, regardless of their cause. Various ON ramification termination patterns in the adductor muscles have been reported (13), and Ishiyama et al have insisted that multiple injections at fascial sites between adductor muscles might be necessary for complete ONBs (14).

Table 1. *Characteristics of the patients in each group.*

Variables	Classic Group (n = 35)	Sub-Branch Group (n = 35)	*P*-value
Age, year; mean ± SD	75.6 ± 7.8	72.3 ± 10.2	0.127
Gender (M/F); N	33 / 2	32 / 3	0.645
Height, cm; mean ± SD	163.6 ± 7.0	163.4 ± 6.2	0.857
Weight, kg; mean ± SD	64.6 ± 9.8	63.2 ± 10.5	0.558
ASA class (I/II/III); N	3 / 27 / 5	2 / 28 / 5	0.795

Abbreviations: M, Male; F, Female; ASA, physical status according to the American Society of Anesthesiologists; n, block number.

Table 2. *Obturator nerve block data of the 2 groups.*

Variables	Classic Group (n = 35)	Sub-Branch Group (n = 35)	*P*-value
Duration of surgery, min; mean ± SD	40.1 ± 18.0	37.7 ±18.8	0.582
Surgeon (A/B/C/D/E); N	15/3/1/7/9	18/5/3/4/5	0.171
Dose of 0.5% hyperbaric Marcaine, mg; mean ± SD	14.3 ± 1.0	14.2 ± 1.2	0.502
Spinal level (T10/T8/T6/T4); n	5/11/15/4	7/12/14/2	0.340
Sedation (yes/no); n	18/17	20/15	0.634
Side (Right/Left); n	20/15	17/18	0.476
Dose of 1.5% lidocaine, mL; mean ± SD	19.7 ± 1.7	21.6 ± 2.6	0.000 *
Obturator reflex grade (I/II/III/IV); n	30/3/2/0	35/0/0/0	0.30*
Conversion to G/A; n	0	0	

Abbreviations: T, thoracic level; G/A, general anesthesia; n, block number.
*Statistical significance is accepted for *P* values < 0.05.

Table 3. *LA doses per patient in each group.*

	Classic Group (n = 35)	Sub-Branch Group (n = 35)
LA dose (15mg/mL); mL(mg), N	20 (300), n = 34	20 (300), n = 22
	10 (150), n = 1*	23 (345), n = 9
		26 (390), n = 2
		29 (435), n = 2

Abbreviation: n, block number.
*In one case (a 78-year-old man of ASA II), we could not find the right posterior branch, so we injected the LA at the anterior branch only. The operation proceeded with no problems.

The sub-branch block is not an entirely new way but rather a means of addressing residual twitching sites by conducting an additional needling during the

classic method. Our clinical experience indicates that the pathways responsible for twitching were similar (Fig. 3). Therefore, we believe that the fanlike injection technique is sufficient for needling. At the same time, the considerations in this situation should not be overlooked: time, safety of needling, and amount of LA.

In the sub-branch group, we waited 15 minutes after the main branch block to administer the additional sub-branch block, which is enough time for LA to activate. Total block times, excluding the waiting times, were similar in the 2 groups (2.3 mins ± 0.5 in the classic group vs. 2.5 mins ± 0.7 in the sub-branch group, *P*-value 0.114). Shortening unnecessary waiting time in the operating room is important. Thus, further study into how to reduce that time is needed. Another 15 minutes of waiting to evaluate the efficacies of ONB can be used as time to prepare for surgery, so we think that waiting time need not be considered.

As for the safety of using the fanlike injection technique to block sub-branches, it should be noted that this method is not a re-stimulation of already injected ON but a technique used to inject new twitching sites. In our experience, we can predict the needling pathway, examining the ultrasound screen in real time while avoiding needling at already injected sites. No problems associated with the fanlike injection technique were encountered during the study, during which only one skin puncture for the ONB was used in all patients.

Regarding the amount of LA injected into the patients in this study, textbooks' current recommendations for maximum LA doses are not evidence based (15). In most cases, no scientific justification for exact doses is provided; instead, only clinically adequate doses in which the site of LA or patient-related factors, such as age and organ dysfunction, are considered. Moreover, mixing epinephrine with LA increases the availability thereof (15). In this study, we injected 10 mL of LA for each main branch block and an additional 3 mL of LA for each sub-branch block. The maximum doses administered in the study were 435 mg of LA with epinephrine in 2 patients' cases of a single block and 825 mg of LA with epinephrine in one patient's case of both blocks. Subsequent surgeries and follow-up findings were unremarkable. Further study is needed to determine whether LA amounts can be reduced.

We evaluated the success of ONBs using obturator reflex grades, which might not accurately represent an exact success. Definitions of complete ONB have not been standardized, and in clinical situations, the evaluation of the ONB is time-consuming and challenging because it depends on the anesthetic and surgical technique used, the tumor location and extent, and the intensity of the electric current. These factors also can make ONB study difficult (6,7).

Conclusion

Although a main branch block alone does not usually result in inadvertent adductor muscle contraction severe enough to cause complications such as bladder perforation, partial residual muscle movement is observed after the procedure. Therefore, supplementing the main branch block with an additional sub-branch block can be a reasonable strategy to achieve a more complete motor blockade.

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