The Effect of Interfascial Injection on Obturator Nerve Block Compared with Nerve Stimulating Approach by Ultrasound-Guide: A Randomized Clinical Trial

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Purpose: This study was conducted to evaluate whether the ultrasound-guided interfascial injection technique is really compatible with the ultrasound-guided nerve stimulating technique for obturator nerve block (ONB) at the inguinal crease after bifurcation of the obturator nerve.

Materials and Methods: A total 62 ONBs were performed for transurethral resection of bladder tumors under spinal anesthesia, and were divided into two groups, that is, to an ultrasound-guided ONB with nerve stimulation control group (the US-NS group) or an ultrasound-guided interfascial injection experimental group (the US-IFI group). In the US-IFI group, complete ONB was confirmed using a nerve stimulator at 5 min after completing the injection, and if residual twitching remained, another local anesthetic was injected; in such cases blocks were considered to have 'failed'. During TURB surgeries, two urology assistants determined obturator reflex grade (I-IV) at 15 min after injection completion in both groups.

Results: We assumed that the US-NS group achieved complete ONB in all cases. Six cases in the US-IFI group failed to achieve complete ONB (failure rate: 0% versus 19.4%, P = .012). There was one case of grade II obturator reflex in each group.

Conclusion: The ultrasound-guided interfascial injection technique was not compatible with the ultrasound-guided nerve stimulating technique for ONB at the inguinal crease.

Keywords: bladder tumor; nerve block; obturator nerve; transurethral resection; ultrasound

INTRODUCTION

Transurethral resection of bladder tumor (TURB) is an essential treatment for bladder tumors,[1] but direct electrical stimulation of the obturator nerve (ON) during TURB can trigger an inadvertent adductor muscle spasm, which can cause a serious complication like bladder perforation.[2,3]

The majority of bladder cancer patients are elderly and have various comorbidities, which increase the risk of complications after general anesthesia.[4] Furthermore, even general anesthesia with muscle relaxants does not eliminate the risk of adductor muscle spasm.[2]

Spinal anesthesia using a selective obturator nerve block (ONB) offers an alternative means of anesthesia for TURB, but adductor muscle spasm can be induced when ONB is incomplete.[2,3] Nerve stimulators have been used under ultrasound guidance to enhance the efficacy of ONB,[2,5,6] though recently, it has been reported ONB can be performed by interfascial injection under ultrasound guidance without a nerve stimulator with similar efficacies.[7,8]

Basically, the ON is known to divide into two branches after exiting the obturator canal. The anterior branch is located in fascial planes among adductor longus, adductor brevis, and pectineus muscles, whereas the posterior branch is located between the adductor brevis and adductor magnus muscles at the inguinal crease.[7,8] Therefore, ONB has been performed using anterior and posterior branch blocks at the inguinal crease level.[4,7,8] But many clinicians are reluctant to perform ONB caused by varied anatomic locations.[9] Moreover, ON itself is very thin and generally embedded in an intermuscular septum, so it is difficult to be found even in ultrasound image and also difficult to be electrically stimulated.[5] Therefore, we were interested in ultrasound-guided interfascial injection, which only needs to distinguish interfascial layers, not ON, and does not need to use nerve stimulator. Since incomplete block can cause direct harm to patients, we thought that decreasing the rate of incomplete block was important for generalization of that injection clinically.

In this study, we sought to determine whether ultrasound-guided interfascial injection is really compatible with ultrasound-nerve stimulation for TURB under spinal anesthesia.

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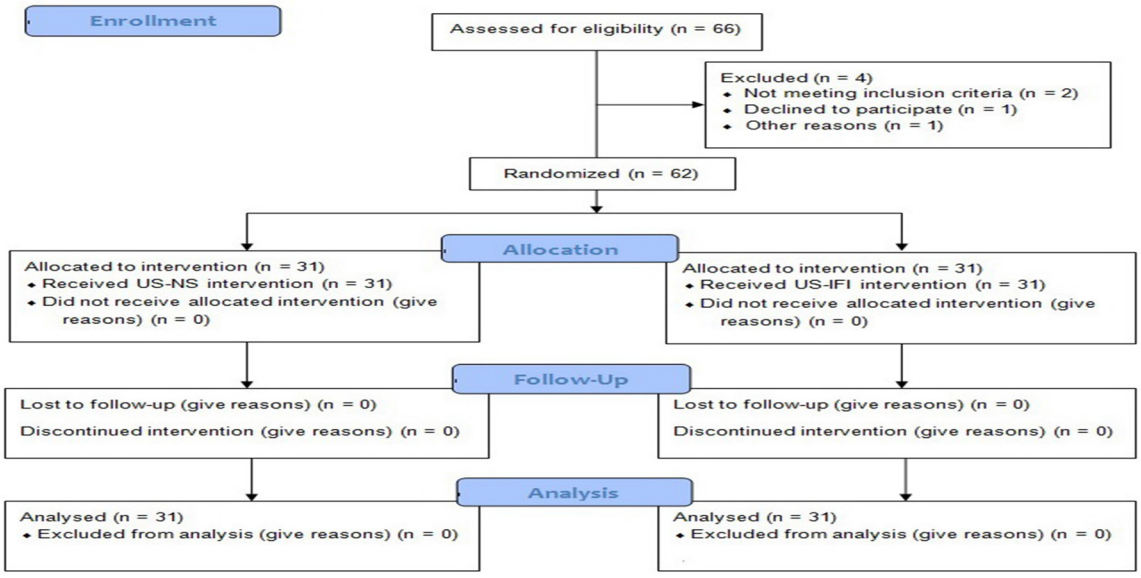

Figure 1. Patients' enrollment algorithm.

MATERIALS AND METHODS

Study Population

Written informed consent was obtained from all patients after obtaining approval from our institutional ethics committee (GAIRB2014-337) and registering in the University hospital Medical Information Network (UMIN) Clinical Trials Registry (UMIN000020534). This study was performed in accordance with the CONSORT 2010 checklist.

Inclusion and exclusion criteria

Sixty-two American Society of Anesthesiologists physical status (ASA) I or II patients were enrolled in the study, who underwent spinal anesthesia with ONB for elective TURB due to bladder tumors. The exclusion criteria were as follows: diabetes or peripheral neuropathy, motor or sensory deficits in the lower extremities, ASA of III or greater, a coagulation disorder, anticoagulant medication, known allergy to local anesthetics, contraindication for spinal anesthesia (infection at injection site, severe scoliosis, or fusion surgery), lack of cooperation, and refusal to participate.

We conducted a randomized, controlled, parallel group study (**Figure 1**). Written, informed consent was obtained on the day before the surgery. Patients were assigned into 1 of 2 groups randomly, that is, an ultrasound-guided ONB with nerve stimulation control group (the US-NS group) or an ultrasound-guided interfascial injection experimental group (the US-IFI group) to receive ONB in the inguinal crease using random integer set generator (http://www.random.org/). The ratio of allocation was 1:1. The researcher not involved in performing the block generated the randomization set, and enrolled participants. All the performances were conducted in the operating room of Gil Medical Center, Gachon University College of Medicine, Incheon, Korea, from Jan 2016 to March 2016.

Procedures

Routine monitoring was begun and spinal anesthesia with hyperbaric 0.5% bupivacaine 12-15 mg was administered to achieve a level of anesthesia above T 10 (at least T10 to T4) in all patients.

After setting the patient in a supine position, an anesthetic nurse who is unrelated in this study closed the curtain in front of the patient's face to hide the procedure. And the patient's affected leg was slightly abducted and rotated externally without knee flexion,[9] and

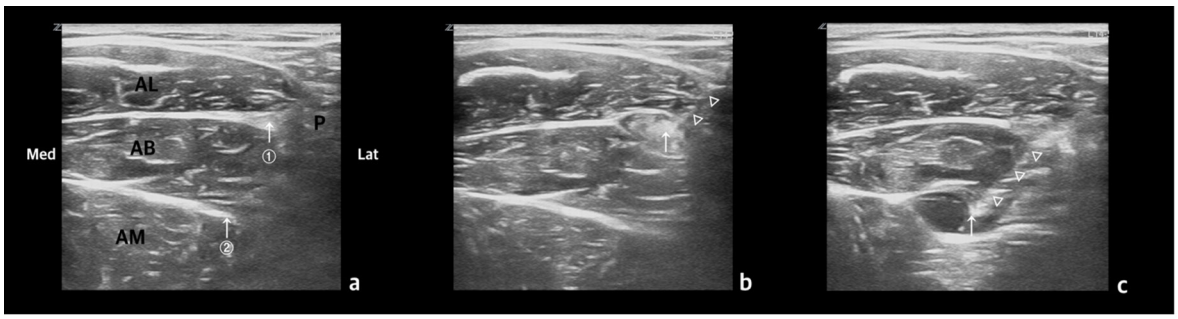

Figure 2. Obturator nerve block sites.

The fascial planes of the adductor muscles and the pectineus muscle are identified **(a)**. The target of anterior branch block is arrowed ①, and that of the posterior branch block is also arrowed ②. Separation of target muscles for anterior branch block **(b)** and posterior branch block **(c)** is shown. The arrowhead indicates the needle. AL, adductor longus muscle; AB, adductor brevis muscle; AM, adductor magnus muscle; P, pectineus muscle.

Table 1. Patients'characteristics in two groups.

Variables	US-NS Group (N = 31)	US-IFI Group (N = 31)	*P*-value
Age, year; mean ± SD	70 ± 11	68 ± 14	.461
Sex (M/F); N	25/6	25/6	.625
Height, cm; mean ± SD	166.3 ± 6.3	164.1 ± 7.6	.226
Weight, kg; mean ± SD	63.1 ± 10.2	61.9 ± 11.3	.655
ASA class (I/II); N	11/20	7/24	.201

Abbreviations: M, Male; F, Female; ASA, American Society of Anesthesiologists physical status; US-NS group, ultrasound-guided nerve stimulator group; US-IFI group, ultrasound-guided interfascial injection group.

the inguinal region was prepared with a povidone iodine solution. A 10 MHz linear probe (Zonare Medical Systems, California, USA) was equipped with a sterile plastic cover and gel, and the transducer was positioned parallel to the inguinal crease at 90° to the skin and the 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 (**Figure 2a**).

In the US-NS group, a 22-gauge, 120-mm stimulating needle (Stimuplex insulated needle; D Plus B. Braun, Melsungen, Germany) attached to a nerve stimulator (Stimuplex HNS12; B. Braun, Melsungen, Germany) was advanced via an ultrasound in-plane approach in a lateral to medial direction to position the needle tip at the junction of adductor longus, adductor brevis, and pectineus muscles within the fascia for an anterior branch block (**Figure 2a**, arrow ①). The nerve stimulator was then turned on, and if adductor muscle twitching was observed even at 0.3 mA, 10 ml of local anesthetic (LA; 1.5% lidocaine + epi 1:200,000) was slowly injected into the muscle interface after negative aspiration (**Figure 2b**), and then the needle was positioned at the junction of adductor brevis and adductor magnus muscles within the fascia for a posterior branch block (**Figure 2a, arrow ②**); 10 ml of LA was injected in the same manner (**Figure 2c**). If adductor muscle twitching did not occur at these locations, additional needling was performed to locate the target branch within the fascia. Transducer tilting cranially 0°-20° was also allowed if twitching did not occur with the transducer normal to skin. If LA misdistributed into muscle, the needle was redirected until the correct spread of LA was visualized.

In the US-IFI group, the same amount of LA was injected at anterior and posterior branch sites within fascia without a nerve stimulator. Five minutes after the main branches block,[10] the needle was re-advanced to search for residual twitching by the same anesthesiologist.[11] If twitching was still observed in both the medial aspect of thigh and the sonogram even at 0.5 mA, another 5 ml of LA was injected into the twitching site and block was documented as a failure.

After the LA injection on both groups, we were able to confirm that the adductor muscle twitching disappeared. All blocks were performed by one anesthesiologist with experience of more than 60 ONBs.

Evaluations

The primary outcome was failure rate of ONB confirmed with nerve stimulator only according to this study design. In the US-NS group, failure rate was assumed zero in all cases because we confirmed the twitch of adductor muscles was disappeared when we injected the LA. In US-IFI group, the performer blocked the first injection using only the anatomical landmark on the US image, and then blocked with nerve stimulator at the second injection for evaluating the twitches on the first injection site, the failure rate. Therefore, we made sure that the same researcher performed both injections, and made other researchers who unknown group assignments confirmed images, and check the success or failure of ONB. It can also introduce performer bias, but different approaches were necessary in this study.

The secondary outcome was the extent of adductor motor block measured with obturator reflex grade. After ONB, two urologic assistants who were unaware of the group assignments entered the operating room, and patients were positioned in a lithotomy position. Neoplasm endoscopic resection was started using a bipolar resectoscope (electrical current: 280 W) and endovesical irrigation with a normal saline solution. Surgery was performed by either of six surgeons at random. We requested two urologic assistants to perform obturator reflex grading 15 min after completing injection on both groups as described by Lee et al.[10]: Gr I - no movement or palpable muscle twitching, Gr II - palpable muscle twitching without movement, Gr III - slight movement of the thigh not interfering with the surgical procedure, and Gr IV - vigorous movement interfering with the surgical procedure.

Table 2. Obturator nerve block data for the two groups.

Variables	US-NS Group (N = 31)	US-IFI Group (N = 31)	*P*-value
Duration of surgery, min; mean ± SD	71.9 ± 40.6	69.4 ± 42.1	.807
Dose of 0.5% hyperbaric Marcaine, mg; mean ± SD	13.8 ± 1.4	13.9 ± 1.1	.762
Spinal level (T10/T8/T6/T4); N	1/3/18/9	5/4/15/7	.343
Side (Right/Left); N	15/16	17/14	.400
Failure rate; N (percentage)	0 (0)[a]	6 (19.4)	.012[b]
Obturator reflex grade (I/ II/ III / IV); N	30 / 1 / 0 / 0	30 / 1 / 0 / 0	

Abbreviations: T, thoracic level; US-NS group, ultrasound-guided nerve stimulator group; US-IFI group, ultrasound-guided interfascial injection group.

[a] Nerve stimulator is the only tool in confirming the complete ONB before TURB surgery. Thus, it is assumed complete ONB is achieved in all cases in the US-NS group.

[b] Statistical significance is accepted for *P* values < .05.

Statistical Analysis

Results are presented as mean ± standard deviations, unless otherwise indicated. The statistical analysis was performed using the Statistical Package for Social Sciences software (SPSS 12.0 for Windows; SPSS Inc., Chicago, IL, USA). The Chi-squared test or the Fisher's exact test were used to analyze categorical data (gender, ASA status, block site, spinal level, failure rate, and reflex grade), and the Student's unpaired t-test was used to compare continuous data (age, height, weight, surgery time, and marcaine doses). Statistical significance was accepted for P values < .05. In a preliminary study, success was achieved in 7 of 10 patients who underwent ultrasound-guided interfascial injection. Twenty eight blocks were required per group for an α value of 0.05 and a power of 90%, and 31 blocks were determined necessary assuming a dropout rate of 10%.

RESULTS

In all, 62 patients were included in the present study. Patients' enrollment algorithm has been illustrated in **Figure 1**.

Group demographic data are shown in **Table 1**, and data regarding the ONB procedure in **Table 2**. The number of skin punctures to ONB was one for all 62 blocks. No vascular puncture or blood aspiration occurred during procedures, and no neurologic, vascular or infection-related complications were detected by follow-up urology chart reviews.

Nerve stimulator was the only tool in confirming the success or failure of ONB before TURB surgery. Thus, we assumed that complete ONB was achieved in all cases in the US-NS group, and six cases in the US-IFI group failed to achieve complete ONB.

One case in each group exhibited grade II obturator reflex during the surgery, but with no other complication. No case in either group required general anesthesia to complete surgery.

DISCUSSION

Our results show that the ultrasound-guided interfascial injection technique is not compatible with the ultrasound-guided nerve stimulating technique for ONB at the inguinal crease. Block was not achieved in six cases in the US-IFI group. Two types of residual twitching were found in failed cases, that is, four cases of twitching on the inner part of the fascial layers beyond the area of LA spread (2 cases of anterior branch block, 2 cases of posterior branch block), and two cases of another form of twitching near an LA injected site when the transducer was changed slightly (1 case of anterior and posterior branch block, 1 case of anterior branch block). In this study, we decided to target fascia, not an ON,[9] which is very small and difficult to image.[2,4,5,7] ON echogenicity within fascia is not distinguishable from fascia in many cases.[9]

In US-IFI group, we confirmed LA spread along the adjacent interfascial layers, not stagnating on a spot of injection. Initially, we supposed that the US-IFI group would be compatible with US-NS group, but twitching points beyond the area of LA spread were observed in some cases. It has been well-established incomplete ONB is due to inadequate LA diffusion despite a correct electrical end point.[7,8]

At the inguinal crease, many muscle layers are near the ON pathway, which is intertwined and complicated,[12] and thus, slight tilting of the transducer can result in missing the pathway. For example, in some cases there was no twitching when the probe was held perpendicular to skin, but twitching occurred when the probe was tilted 10° cranially. Saranteas T et al. addressed the dynamics of nerve position and found that probe angulations can change nerve position within the anatomic line.[13] We allowed 10-20° angulation of the probe, because high transducer angles make ONB technically difficult and increasing the risk of serious complications.[2,12]

Reports about anterior branch block cite success rate of more than 90%,[3,6,10] and other interfascial techniques also have been reported to have good success rates.[7,8] However, even one failed-case should be avoided because of the seriousness of bladder perforation.[11] Interfascial injection is a volumetric technique that relies on diffusion of the injected drug, and it has been shown the anterior and posterior divisions of ON have multiple branching patterns that are widely distributed among the adductor muscles.[9,10,12,13] The authors of a study showing the compatibility of interfascial injection approach on ONB stated that using nerve stimulator showed better accuracy in blocking the posterior branch.[7]

We reapplied the nerve stimulator for searching the failed-cases of US-IFI group, and additional LA was injected for patients' safety. Just once, stimulation of electric resectors to the bladder walls for checking the block quality can cause a strong contraction of the adductor muscles and induce a bladder perforation.[7] So we used sufficiently low level of stimulant current (0.3-0.5 mA) to confirm that the needle tip was placed as close as possible to the nerve and for the safety reasons.[11]

In this study, we could not prevent obturator reflex totally even when complete ONB had been achieved. We tend to be nervous about even slight muscle contraction due to severity of bladder perforation, but in practical situations, operators need to be aware that even complete ONB does not guarantee complete adductor motor block because innervations from the femoral and sacral plexus also dominate contribute to adductor motor strength.[8]

Definitions of complete ONB have not been standardized, and in clinical situations, evaluation of ONB is time-consuming and difficult.[7,12] We assumed that complete ONB was achieved in all cases in the US-NS group, and counted failed cases in the US-IFI group, which can introduce bias.

This study cannot be categorized as a double-blind study, which is one of the limitations of this study. The performers were not blinded to the group assignments (one injection for US-NS group or. two injections for US-IFI group), even though urologic assistants who evaluate obturator reflex were unaware of the group assignments because they entered the operating room after ONB.

CONCLUSIONS

In conclusion, the ultrasound-guided interfascial injection technique was not compatible with the ultrasound-guided nerve stimulating technique for ONB at the inguinal crease, and thus, we suggest that combined use of ultrasound and nerve stimulator for ONB. Finally, we emphasize successful ONB does not guarantee complete adductor motor block.

CONFLICT OF INTEREST

None declared.

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