Ultrasound Guided Obturator Nerve Block in Transurethral Surgery - Inguinal Crease Approach assisted with Nerve Stimulator –

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Introduction

During transurethral resection of bladder (TURB), accidental stimulation of obturator nerve (ON) can cause violent inadvertent adductor muscle contraction which can lead to serious intraoperative complications such as bladder perforation, excessive bleeding or discontinuation of operation. Spinal anesthesia combined with obturator nerve block (ONB) has been commonly used to prevent this obturator reflex for transurethral resection (TUR) surgery when the tumor exists along the course of ON.(1,2,3)

It is well established that ON arises from the ventral division of the 2nd, 3rd and 4th lumbar nerves and emerges from medial border of the psoas major muscle at the pelvic brim. It then courses inferoanteriorly through the pelvis and obturator canal into the thigh as it divides into ant and post divisions. These branches are first separated by the fibers of the obturator externus muscle (OE) and separated by adductor brevis (AB). After short course in the inguinal region, the ant branch of ON runs between adductor longus (AL) and AB and the post branch runs between AB and adductor magnus muscle (AM).(4,5)

The majority of the literature reports that ant division provides for motor innervation of AL, AB, gracillis and rarely pectineus (Pc) and also has an articular branch to the hip joint. Whereas the post division is responsible for motor function of the AM, OE and AB and has an articular branch to the knee joint.(2,4,5) Theoretically, common ONB is the best choice to prevent ON reflex, however, its deep location of the structure surrounded by thick fascia makes visualization of the nerve difficult and the ultrasound (US) beam cannot penetrate in this area.(2,4,6,7)

As US is a new paradigm recently in regional anesthesia that facilitates the identification of nerves that may aid in avoiding damage to non-neural structures and increase the success rates.(4,6,8,9) Therefore, we proposed to performing the ONB under dual guidance (US and nerve stimulator (NS)) in

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Fig. 1. The location of ultrasound probe. The site and angle of needle puncture that is formed in the inguinal crease. The skin was punctured 1~2 cm laterally to the probe and the needle was angled 30~45˚ using in-plane approach.

Fig. 2. Ultrasonographic visualization of the fascial plane of adductor muscles. Arrows ① indicates the target point of anterior branch and ② indicates posterior branch. Obturator nerve block was performed under real time sonographic view of muscle twitch under dual guidance of ultrasound and nerve stimulator. Pc: pectineus, AL: adductor longus, AB: adductor brevis, AM: adductor magnus muscle.

inguinal crease area to prevent obturator reflex during TURB. We want to know its success rate and inadvertent event (IAE) during ONB in TURB surgery.

Method

After obtaining approval from the Institutional Review Board and written informed consent, 26 patients scheduled for elective transurethral resection of lateral bladder wall tumor under spinal anesthesia who required ONB to inhibit the obturator reflex were enrolled from January to December 2013 (Table 1). Exclusion criteria were ASA physical status greater than 3, who had motor or sensory deficits in the lower extremities, coagulation abnormality and known allergy to local anesthetics. After peripheral intravenous access was established, standard monitoring was begun and any sedatives or premedications were not administered.

Spinal anesthesia with hyperbaric 0.5% bupivacaine was performed to reach the level of spinal anesthesia approximately T10 in all patients. Then, patients were positioned supine with the thigh slightly abducted and externally rotated and the knee flexed about 30~40˚. The skin was prepared and draped in a sterile fashion, and US transducer was enclosed in a sterile sleeve (Fig. 1). The US probe of 5-10 MHz (CX50 Compact Xtreme Ultrasound System, Philips, Andover, MA, USA) was placed in inguinal crease to identify the femoral artery and vein. And then, the probe was moved medially and slightly downward along the inguinal crease to identify the fascial planes of Pc, AL, AB and AM (Fig. 2). A 22-gauge insulated 10 cm needle connected to NS (Stimulex R Dig Rc B/Braun, Melsungen, Germany) with 0.5~0.8 mA current was inserted through the skin transversely and obliquely 1~2 cm lateral to the ultrasound probe at the angle of approximately 30˚ toward the thickest fascial plane between AL and AB as ant branch and between AB and AM as post branch (Fig. 1, 2). After confirming the muscle twitch by NS, 10 ml of 1% lidocaine was injected to each site under real time sonographic view (Fig. 2). In cases of showing multiple muscle twitching, we injected 0.25% ropivacaine 10 ml. All
TURB procedures were performed by the same surgeon. Data collection included time required for identifying the interfascial plane by US (TUS) and time required for confirming the real-time sonographic muscle twitching by using NS to each ant and post branch of ON (TNS). In case of performing both sides of ONB in a same patient, each side was assumed as an independent ONB. If there was no muscle twitching of the adductor muscle group after 3 attempts of trial to confirming the ON using NS (FONDG), we injected local anesthetics (LA) to the thickest interfascial plane between AL and AB as an ant branch and between AB and AM as a post branch.

Needle depth (ND) of ant and post branches were recorded in each case and block performance time (BPT) were estimated. BPT was defined as the time elapsed between the start of sonography and needle removal at the end of the block.

The grade of muscle twitch (GMT) was assessed by the same surgeon (G1: no movement, G2: palpable muscle twitching without movement, G3: slight movement of thigh not interfering the surgical procedure, G4: vigorous movement interfering the surgical procedure). G1 and G2 were regarded as success rate of ONB. IAE such as vascular puncture or showing various sites of muscle twitch were recorded.

Data are presented as means±standard deviations.

### Results

The demographic data of the patients are shown in Table 1.

TUS was 21.0±14.9 sec and TNS ant was 39.6±27.4 sec and post was 24.3±11.7 sec (Table 1). BPT was 174.5±65.1 sec and ND were 4.8±0.8 cm for anterior branch and 6.2±1.1 cm for posterior branch (Table 1).

Total success rate of ONB including G1 and G2 showed 23/26 (88.5%) and failure ratio (G3+G4) was 3/26 (11.5%) (Table 1).

In GMT G4 cases (2/26, 7.7%), the identification of ON under dual guidance was performed easily, however their results were all G4 (Table 1).

IAE during ONB revealed in 5/26 (19.2%), among them, 2/26 (7.7%) cases showed muscle twitching in PC, in the interfascial plane between AL and AB were 3/26 (11.5%) (Table 2). In 9/52 (17.3%) cases, showed FONDG, 2/26 (7.7%) cases were in anterior branch, 7/26 (26.9%) cases were in posterior branch. All cases of IAE revealed GMT G1 during surgical procedure (Table 2).

There were no cases of vessel puncture.

### Table 1. Demographics and Block Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n=26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>67.5±11.1</td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>22/4</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>165.4±7.2</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>65.8±7.7</td>
</tr>
<tr>
<td>BMI (kg/m2)</td>
<td>24.1±3.5</td>
</tr>
<tr>
<td>Side (Rt/Lt)</td>
<td>8/18</td>
</tr>
<tr>
<td>TUS (sec)</td>
<td>21.0±14.9</td>
</tr>
<tr>
<td>TNS (sec)</td>
<td>Ant 39.6±27.4 Post 24.3±11.7</td>
</tr>
<tr>
<td>BPT (sec)</td>
<td>174.5±65.1</td>
</tr>
<tr>
<td>ND (cm)</td>
<td>Ant 4.8±0.8 Post 6.2±1.1</td>
</tr>
<tr>
<td>GMT during TURB</td>
<td>G 1 22/26 (84.7%)</td>
</tr>
<tr>
<td></td>
<td>G 2 1/26 (3.8%)</td>
</tr>
<tr>
<td></td>
<td>G 3 1/26 (3.8%)</td>
</tr>
<tr>
<td></td>
<td>G 4 2/26 (7.7%)</td>
</tr>
<tr>
<td>Success rate of ONB (G1+G2)</td>
<td>23/26 (88.5%)</td>
</tr>
<tr>
<td>Fail ratio of ONB (G3+G4)</td>
<td>3/26 (11.5%)</td>
</tr>
</tbody>
</table>

Demographic data are presented as mean±SD, categorical variables are presented as mean±SD, count and percentage. BMI: body mass index, TUS: time for identifying the sonographic fascial plane, TNS: time for confirming obturator nerve using nerve stimulator, Ant: anterior branch, Post: posterior branch, BPT: block performance time, ND: needle depth, GMT: grade of muscle twitch, TURB: transurethral resection of bladder tumor, G1: no movement during TURB, G2: palpable muscle twitching without movement, G3: slight movement not interfering TURB, G4: vigorous movement interfering TURB, ONB: obturator nerve block.
Table 2. Inadvertent Events during Procedure of ONB

<table>
<thead>
<tr>
<th>Kind of events</th>
<th>No. of cases</th>
<th>Solution</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple m twitch in Pc</td>
<td>2/26 (7.7%)</td>
<td>IM to Pc</td>
<td>All G1</td>
</tr>
<tr>
<td>AL and AB</td>
<td>3/26 (11.5%)</td>
<td>IF one more</td>
<td>All G1</td>
</tr>
<tr>
<td>FONDG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ant</td>
<td>2/26 (7.7%)</td>
<td>IF between AL and AB</td>
<td>All G1</td>
</tr>
<tr>
<td>Post</td>
<td>7/26 (26.9%)</td>
<td>IF between AL and AM</td>
<td>All G1</td>
</tr>
<tr>
<td>Vascular puncture and postop. complication</td>
<td>None</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Multiple sites of muscle twitching and fail to confirm the obturator nerve under dual guidance were revealed as inadvertent events during obturator nerve block. The local anesthetics injected to the twitching site, intramuscular or interfascial area. ONB: obturator nerve block, Pc: pectineus m, IM: intramuscular injection, AL and AB: between adductor longus and adductor brevis m, IF: interfascial injection of local anesthetics, FONDG: fail to confirm the obturator nerve after 3 attempts of trial using dual guidance, Ant: anterior branch, Post: posterior branch, AM: adductor magnus m, G1: no movement during surgical procedure, Postop.: postoperative.

Discussion

In general, the success rate of ONB with US guidance reported more than 90% because US is useful for identifying the nerve itself. However, in most of the studies, the results were the success rate of motor weakness or postoperative analgesia in knee surgery not the results of ONB during TURB surgery. (2,4,5,6,7,8)

Cadaveric studies confirmed the variability in anatomy with only 50% of ON dividing classically into anterior and posterior divisions and then, each division travels together through the obturator foramen and showed multiple branching patterns.(4,5) Assuming that reasons, it is necessary that anterior and posterior branches must be blocked separately as 2 distinct nerves in inguinal crease area,(6) so we blocked each branch in this region.

The US-guided interfascial approach is a simple and rapid procedure for ONB,(4,6,7) and the ON exhibits a predominantly hyperechoic and flat or lip-shaped appearance corresponding to the connective tissue network with discrete internal hypoechoic dots corresponding to the fascicles in the sonographic view.(8) However, the visibility of the anterior branch with US was 84% and posterior branch was 92%.(4) Therefore, rather than identification the ON itself, correct identification of the sonographic adductor muscle group is necessary because the anterior and posterior divisions of the ON run within the interfascial planes.(4,5,7) In addition, in case of initial failure to identify the ON by US, adding NS improved the success rate of motor weakness 100%.(6)

In our study, the success rate revealed 88.5% using dual guidance, that is similar to the results of Manassero et al.(6) Also, we could not identify the ON itself at all in sonographic view, as same as the report of Simeoforidou et al.(10) However ONB under dual guidance is time consuming technique, our results of BPT was 174.5 sec as similar as that of Manassero et al.(6)

Unfortunately, in 2/26 cases (7.7%) in anterior branch and 7/26 cases (26.9%) in posterior branch, we could not confirm the ON by dual guidance. FONDG showed in total 9 cases of 52 (17.3%), in that cases, we injected LA toward the thickest interfascial area and their results were all G1. If we tried more than 3 times of trial, it could be possible to increase the
success rate of confirming ON under dual guidance. Nevertheless, ON is the one such nerve that can be both difficult to electrically stimulates and images sonographycally.(6)

In all of the failed cases of ONB during TURB (3/26, G3+G4, 11.5%), we performed the ONB easily without any problems in identifying and confirming the ON. These facts make us have any question whether LA can spread easily along the interfascial plane, also that seems to be possible enough to induce motor weakness of adductor muscle group. But then, it is difficult to ascertain that only motor weakness alone can prevent obturator reflex during TURB surgery.(2,6,7,8,11)

The reliable reasons for these results may be explained by the multiple divisions of the ON in conjunction with the complicated anatomy of the surrounding area and the presence of its accessory branch makes ONB difficult in the inguinal region.(4,9,11) In addition, stimulation of the ON cephalad to the anesthetic block may provoke a muscle twitch by the unblocked divisions of the nerve.

In inguinal region, the number of the anterior branch is more than 2 in 100%, more than 3 branches in 70% and the posterior branch has more than 2 branches in 80%.(4) In 76.92%, hip articular branch derives from common ON as single articular branch and in 19.23% from anterior branch and in 3.84% from posterior branch.(4) Clinically, the posterior branch of the ON is more important because it yields a sensitive branch for the knee and a motor branch for AM that provides hip adduction.(6)

The presence of the accessory obturator nerve (AcON) is also the one of the problem in ONB to prevent the obturator reflex during TURB. AcON follows a different path from that of the ON and may have the limit of the efficiency of ONB if unblocked, and its incidence was 10~30%.(11) The anterior branches of the 3rd and 4rd lumbar nerves fuse to form the AcON and runs along the lateral wall of the pelvis and along the posterior of the external iliac artery. Unlike the ON, it branches off by extending downward over the superior pubic ramus on the remainder of its route. After branching into the Pc and hip joint, it may also generate a communication branch to the anterior branch of the ON underneath the Pc.(11) AcON crosses the superior pubic ramus and innervates the hip and pectineus (100%) and to the trunk of the ON (6.1%), to the anterior branch of the ON (14.3%), the posterior branch (4.65%) and the anastomosing branch to the femoral nerve (2.3%).(11)

In ONB, the challenges are necessary because of its high variability in the anatomic path of the ON and high incidence of the AcON to obtain a desirable clinical outcome. The problem of inadequate ONB has not been thoroughly studied. Our study showed muscle twitch in Pc in 2 cases (2/26) and Sinha et al.(7) reported that 2 of 30 patients were injected to pc intramuscularly rather than in interfascial area because the ON was not identified.

According to these high anatomic variations, it is possible enough to occur the variable IAE during performing ONB. Since we could not find any reports that mentioned about IAE such as many sites of muscle twitching or no visible muscle twitching by NS when needle passing practically, so we could not anticipate IAE although IAE might occur possibly.

In our study, ND was longer than other results of reports.(5,8,9,13) The depth were different according to the different sites from the surface of US transducer,(5) from skin to nerve,(8) from skin to the site of sonographic Pc twitching site(9) or from pubic tubercle.(13) Also, the power of compression of the US probe to the skin surface and in or out-plane of approaching method may affect ND.

In this inguinal femoral region, must be very
cautious not to puncture the medial circumflex artery or femoral vein.(12) These vessels arise from the medial and posterior aspect of the profunda femoris vessels or sometimes directly from the femoral vessels and then, run interfascially between Pc and iliopsoas muscle and between OE, AM and AB.(12) Fortunately, we did not experience the puncture of vessels in any cases.

In conclusion, dual guidance of ultrasound and nerve stimulator does not increase the success rate of the obturator nerve block during transurethral surgery and many inadvertent events occurred in inguinal crease area.

For successfully performing obturator nerve block in inguinal region, certain problems such as the interfascial course of the obturator nerve, the high variability and complicated branching patterns of the obturator nerve and accessory obturator nerve divisions must be overcome.

The proximal level of obturator nerve block is more important rather than dual guidance.

Acknowledgement

We appreciate Professor Dong Su Park as a general urologist, for evaluating the grade of muscle twitching during TURB.

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경요도 절제술을 시행받는 환자에서 초음파기를 이용한 폐쇄신경 차단 - 서혜부 주름부위 접근법

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