Research Article

Retrospective Evaluation of Patients with Upper Extremity Peripheral Nerve Block

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Abstract

Objectives: In this study, we aimed to examine the effect of US-guided periferic nerve stimulator (PNS) versus PNS alone during establishing ISBPB and ABPB on sensory block initiation (SNI), motor block initiation (MBI), total motor block (TMB), and postoperative analgesia (PoAn) durations and related complications.

Methods: Records of adult patients with ASA I-II patients who underwent upper extremity surgery under ISPBP (n=40) or ABPB (n=60) with PNS alone or ISBPB (n=40) or ABPB (n=60) with US-guided PNS between January 2016 and January 2018 were collected.

Results: Our study showed significantly shorter duration of SBI, MBI, TMB, and PoAn in patients who underwent ISBPB through PNS alone compared to that in those who underwent the procedure under US guidance. However, a study investigating benefits of US reported duration of block initiation shorter than that in those receiving PNS alone.

Conclusion: In conclusion, our study seems to indicate possible prevention of complications with US-guided procedure with no substantial contribution to the success rate of the BP block.

Keywords: Axillary brachial plexus block, interscalene brachial plexus block

Cite This Article: Mutlu M, Turkmen S. Retrospective Evaluation of Patients with Upper Extremity Peripheral Nerve Block. EJMI 2021;5(2):184–188.

Regional anesthesia techniques are widely used in upper extremity surgery. Brachial plexus (BP) block is a commonly used method in upper extremity interventions for both surgical anesthesia and outpatient anesthesia to establish postoperative analgesia and rehabilitation.[1]

Interscalene brachial plexus block (ISBPB) is the blockage of the BP between the anterior and middle scalene muscles.[2] Axillary brachial plexus block (ABPB) is the blockage of the plexus by administering local anesthetic around the artery in the axillary region.[3] Regional anesthesia is practically established by paresthesia or through the peripheral nerve stimulator (PNS).[4] Recently, ultrasound (US)-guided blocks have become increasingly popular.[5] The success of US-guided BP block has also become increased with decreased

rates of complications owing to the advantages provided by US.[6] Several studies reported diminished need for local anesthetics with the use of US.[7,8] While intravenous injection of local anesthetic and possible brachial damage can be observed during US-guided blockade, this is not possible with PNS.[9,10] Compared to general anesthesia, BP blocks are reported to reduce postoperative pain, narcotic need, and length of hospital stay, accelerate recovery, and improve the efficiency of the operating room.[11]

The success of upper extremity blocks depends on several factors, including the skill of the operator, patients' characteristics, and the techniques used to identify the nerves. There is still limited experience and clinical data on how to apply successful techniques despite many studies per-

formed. In this study, we aimed to examine the effect of US-guided PNS versus PNS alone during establishing ISBPB and ABPB on sensory block initiation (SNI), motor block initiation (MBI), total motor block (TMB), and postoperative analgesia (PoAn) durations and their complications.

Methods

After being approved by the ethics committee, the study was performed by reviewing the medical records of patients who underwent upper extremity surgery under regional anesthesia. This retrospective study was conducted in 2018 for 3 months from January 1st at Department of Anesthesiology and Reanimation in Okmeydani Training and Research Hospital. Records of adult (>18 years) patients with American American Society of Anesthesiologist (ASA) I-II patients who underwent upper extremity surgery under ISPBP (n=40) or ABPB (n=60) with PNS alone or ISBPB (n=40) or ABPB (n=60) with US-guided PNS between January 2016 and January 2018 were collected. We evaluated the correlation of us-guidance with block success for each type of block performed in this study and this was our primary outcome. Data on patients' demographic characteristics, block type, block technique, SBI and MBI durations, TMB duration, and PoAN durations were collected. Block-related complications and medications to resolve these complications were recorded and relation of complication with us-guidance was our secondary outcome. Patients with incomplete forms were not included to the study.

All patients were routinely monitored in the operating room and were administered intravenous midazolam 0.06 mg/kg for sedation before underwent BP block using PNS with 50 or 100-mm needles (Stimuplex A; B.Braun, Melsungen, Germany) with or without US (Mindray Mobile Trolley M5 UMT-200) using linear probes (PL1E-30-43-611 MODEL: 7L4s probe). Randomization was not performed in this study. When USG was available, RA was performed by US-guided PNS, or else RA was established by PNS alone.

When BP was visualized between the anterior and middle scalene muscles via US, PNS was advanced through the skin and subcutaneous tissue from posterolateral to medial direction, after which the PNS was turned on with an output current of 0.5 mA and a frequency of 2 Hz. The detection of contraction in deltoid or biceps muscle was the confirmation of the correct placement of the needle. In those ISBPB patients who were performed with PNS alone, anterior and middle scalene muscles were palpated lateral to the sternocleidomastoid muscle at the level of cricoid cartilage. PNS output current was set to 1 mA at a frequency of 2 Hz. After confirming contraction at deltoid or biceps muscles, the output current was refined to 0.5 mA. For ISBPB, 0.5%

bupivacaine 1 mg/kg was completed to 20 ml as the local anesthetic administered. In patients who underwent US-guided ABPB, axillary artery and vein and their surrounding BP terminal branches were identified by US and the needle was advanced through the skin and subcutaneous tissue before the PNS was turned on. The output current was set to 0.5 mA at 2 Hz frequency. After inspecting motor movements of medial, ulnar, radial, and musculocutaneous nerves and verifying these on US, local anesthetic was injected. In those undergoing ABPB with PNS alone, the needle was advanced through the skin and subcutaneous tissue after palpation of the axillary artery, and then PNS was turned on with an output current of 1 mA at 2 Hz frequency. After visualization of medial, ulnar, radial, and musculocutaneous nerves, the output current was refined to 0.5 mA. PNS was turned off at the presence of motor movements of these nerves to administer local anesthetics. For ABPB, 0.5% bupivacaine 1 mg/kg was completed to 20 ml and 2% prilocaine 4 mg/kg was completed to 20 ml to deliver a total of 40 ml as local anesthetic agent.

After blocks, all patients were examined at every 5 minutes up to 30 minutes for block success. After block spontaneous movements and existance of pain perception was accepted as unsuccessful block and excluded from the study. The time to sensory and motor blocks, total dose of given midazolam was noted. A heart rate below 60 beats per minute was accepted as bradycardia and patients with bradycardia were treated with 0.5 mg intravenous atropine. In addition, unless interrupting the surgery, data on observed complications such as nausea, vomiting, Horner's syndrome, hoarseness, dyspnea, neurological sequelae, and local anesthetic toxicity were noted from patients' records.

Statistical Analysis

When evaluating the findings obtained in the study, IBM SPSS Statistics 22 for statistical analysis (SPSS IBM, Turkey) programs were used. While evaluating the study data, the suitability of the parameters to the normal distribution was evaluated with the Shapiro Wilks test. Quantitative data were expressed as mean±SD and Median (IQR: 25th percentile-75th percentile) while numbers and percentages were used to express qualitative data. While evaluating the data of the study, Student's t-test was used for the comparisons of normally distributed parameters between the two groups, and the Mann Whitney U test was used for the comparison of parameters that did not show a normal distribution between the two groups. Significance was evaluated at the p<0.05 level.

Results

In this study we have not found any statistically significant difference in the median age, mean body mass index (BMI),

the median durations of SBI, MBI, TMB, and PoAn values in patients who had ABPB with PNS under US guidance (n=60) from patients who had ABPB with PNS alone (n=60) (p>0.05), (Table 1).

Fifteen patients (12.5%) undergoing ABPB were found to need for additional sedation. Eight of these patients were detected to have PNS alone. No patient was found to have any anesthesia-induced complication after the block (Table 1).

The median age and mean BMI did not differ between those having the PNS procedure under US guidance or alone (p>0.05) in patients who underwent ISBPB. The median durations of SBI, MBI, TMB, and PoAn of the patients who had ISBPB alone with PNS were significantly lower than those undergoing US-guided PNS (p<0.001 for each), (Table 2).

Additional sedation was detected to be required in 12 patients (15.0%) undergoing ISBPB. A half of these patients (n=6) were found to have PNS alone.

Patients undergoing ISBPB with PNS had a higher rate of complications. Among these, three cases (7.5%) developed Horner's syndrome, all of which were found to recover with spontaneous resolution before the discharge during perioperative period. In addition, 12 different cases (33.3%) were detected to develop bradycardia which was relieved with 0.5 mg atropine.

Discussion

Our study showed significantly shorter duration of SBI, MBI, TMB, and PoAn in patients who underwent ISBPB through PNS alone compared to that in those who underwent the procedure under US guidance. However, a study investigating benefits of US reported duration of block initiation shorter than that in those receiving PNS alone.[12] Therefore, it may be suggested that anesthesiologist could be a more important factor than the technique. Another study evaluating stress response after ISBPB, no difference was reported between block durations after PNS alone and US-guided procedures.[13] The study by Zhai et al.[14] evaluated the efficacy of three different doses of local anesthetics where they performed ISBPB through US-guided PNS and reported an association between duration of motor block initiation and the concentration of the local anesthetic agent. However, ISBPB patients in our study had received standard 1 mg/kg dose of 0.5% bupivacaine in 20 ml. The PNS alone subgroup of ISBPB patients had several complications like Horner's syndrome and bradycardia, which were not observed in US-guided PNS subgroup. Another study by Orebaugh et al.,[15] which was similar to ours, reported three cases of epileptic attack in PNS alone group of ISBPB and these complications were not reported in those undergoing US-guided procedure. The authors further re-

Table 1. Comparison of ABPB performed patient groups' in terms of age, BMI, DBI, MBI, MBT, and PoAn

	ABPB with PNS (n=60) Median (IQR) Mean±SD	ABPB with US-guided PNS (n=60) Median (IQR) Mean±SD	p
Age, years	28.0 (25.0–34.0)	27.0 (23.0–33.5)	0.388
BMI, kg/m^2	25.68±2.03	25.71±2.43	0.932
Duration			
SBI, min	8.0 (7.0–9.0)	8.0 (7.0–9.0)	0.897
MBI, min	15.0 (14.0–16.0)	15.5 (14.0–17.0)	0.485
TMB, min	200.0 (180.0–220.0)	200.0 (190.0–217.5)	0.601
PoAn, min	275.0 (260.0–290.0)	275.0 (252.5–290.0)	0.765

ABPB: Axillary brachial plexus block; BMI: Body mass index; MBI: Motor block initiation; PNS: Peripheral nerve stimulation; PoAn: Postoperative analgesia; SBI: Sensory block initiation; SD: Standard deviation; IQR: 25th percentile-75th percentile; MB: Total motor block; US: Ultrasound.

Table 2. Comparison of ISBPB performed patient groups' in terms of age, BMI, DBI, MBI, MBT, and PoAn

	ISBPB with PNS (n=40) Median (IQR) Mean±SD	ISBPB with US-guided PNS (n=40) Median (IQR) Mean±SD	p
Age, years	23.0 (21.0–33.5)	24.0 (21.0–40.0)	0.563
BMI, kg/m^2	25.53±2.75	26.03±2.56	0.402
Duration			
SBI, min	5.0 (5.0–6.0)	8.0 (7.0–9.0)	<0.001
MBI, min	11.0 (9.25–11.0)	15.0 (14.0–16.0)	<0.001
TMB, min	270.0 (265.25–280.0)	320.0 (310.0–330.0)	<0.001
PoAn, min	362.5 (350.0–370.0)	417.5 (410.0–420.0)	<0.001

BMI: Body mass index; IBPB: Interscalene brachial plexus block; MBI: Motor block initiation; PNS: Peripheral nerve stimulation; PoAn: Postoperative analgesia; SBI: Sensory block initiation; SD: Standard deviation; IQR: 25th percentile-75th percentile; TMB: Total motor block; US: Ultrasound.

ported two of these complications occurred after performance of the block by specialist anesthesiologist and the other by a resident anesthesiologist. Implementation of ISBPB through PNS alone by identifying anatomical landmarks requires experience and it is easier and more feasible procedure for experienced anesthesiologists. However, no matter the performing anesthesiologist is experienced, it is a blind technique and use of only PNS during interscalene block render the patient to complications especially considering potential anatomical variations. The study by Kapral et al.[16] reported variations of the brachial plexus located within the scalene muscle. This study also reported that the success rate of PNS alone with 20 ml local anesthetic was significantly lower than that with 30-40 ml local

anesthetic under US-guided PNS, which was attributed by the authors to the low volume of local anesthetic used. The complications observed in our study may also be associated with the volume of the local anesthetic used. However, the occurrence of complications only in PNS alone group despite the equivalent amounts of local anesthetics in both groups seem to unlikely to account for the potential association of the volume of used local anesthetic agent. In fact, previous study reported the failure of the block could be explained by the 20-ml volume of local anesthetic, which was considered as low. Zhang Q et al. in their study where they performed ISBPB using US-guided PNS, reported similar efficacy of postoperative analgesia between those receiving 5 ml or 20 ml local anesthetic agents. The authors further reported that lung functions were better preserved in those where the block was established with low volume of anesthetic.[6] Some studies reported use of US to diminish the amount of local anesthetic required for PNS-mediated ISBPB compared to that performed with no US.[17]

The patients who underwent ABPB with or without US-guided PNS had similar block and analgesia durations in our study. Imasogie et al.[18] compared the number of injections to the subjects who had block via US-guided PNS and reported shorter time to initiate block with no difference in block success and block durations in those administered lower number of injections. We found no complications in any of our patients we performed ABPB. A similar study reported one case of epileptic attack who had PNS alone to perform ABPB compared to no complication in patients who received the block under US guidance.[15] Another similar study by Barrington et al.[5] reported no difference of block initiation and total block durations between the two techniques applied. In addition, the survey also noted that the success rate and duration of blocks did not differ by the two applied techniques.[19]

In our study, Horner's syndrome developed in three (7.5%) patients who underwent ISBPB using needle-only PNS. In another recent study, the syndrome was reported in 12% of patients undergoing block using PNS only, in 6% of patients with block using US-guided PNS, and in 9% of patients with block using US alone.[20] In this respect, our study also may indicate both the safety of US and its dependence on individual factors. Similarly, bradycardia developed in 12 patients (33.3%) who had block procedure using needle-assisted PNS. Contrary to our findings, the study in which post-block stress response was evaluated with two different techniques reported lower heart rate in patients who underwent US-guided block.[13]

Phrenic nerve block or injury is a rare complication after ISBPB while it was not observed in our study. In one study,

phrenic nerve block was reported in 4% and 20% of patients who underwent US-guided and PNS-mediated ISBPB, respectively.[13]

The first step to increase the success of the block and reduce the possible complications is to determine the appropriate indication and technique. The two different BP blocks that we evaluated in this study are not alternative options to each other. Nevertheless, the two different techniques that we used to implement each of them could be regarded as alternative. While we did not observe any difference in the success and duration of the techniques used for ABPB, this was not the case for the findings related with ISBPB.

Different techniques could be performed more easily, safely, and effectively in a variety of indications especially in US-guided block procedures in future, which might be possible when the quality of the images are improved, or clearly and easily visualizable needles are developed, or even the distribution of the local anesthetic agent could be directly visualized through the use of US.

In conclusion, our study seems to indicate possible prevention of complications with US-guided procedure with no substantial contribution to the success rate of the BP block. In parallel, regional anesthesia has become a less appealing and a more preferred method by surgeons. Our study further indicates the need for conducting new and large-sized studies regarding BP blocks performed under US-guided or lone PNS.

Disclosures

Ethics Committee Approval: Ethics Committee approval for the study was obtained from the Ethics Committee Of Okmeydanı Training And Research Hospital (Decision no: 556, Date: December 06, 2016).

Peer-review: Externally peer-reviewed.

Conflict of Interest: The authors declared no conflict of interest.

Authorship Contributions: Concept – M.M.; Design – S.T.; Supervision – M.M.; Materials – S.T.; Data collection and/or processing – M.M.; Analysis and/or interpretation – S.T.; Literature search – M.M.; Writing – M.M.; Critical review – S.T.

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