doi.org/10.36721/PJPS.2020.33.1.REG.079-083.1

Saline vs. dextrose for local anesthetic dilution in brachial plexus block: A randomized study

Faramarz Mosaffa[1], Fahimeh Hosseini[2] and Shideh Dabir[3]
[1]Anesthesiology Research Center, Department of Anesthesiology and Critical Care, Akhtar Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2]Department of Anesthesiology and Critical Care, Akhtar Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[3]Tracheal Diseases Research Center, Department of Anesthesiology and Critical Care, Akhtar Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Abstract: Higher sodium ions in saline diluted local anesthetic may reduce the anesthetic action of the drug as injected around the nerves. However, the impact of local anesthetic dilution agents on the quality of peripheral nerve blockades has not yet been widely investigated. This study was aimed at evaluating the impact of lidocaine dilution with normal saline vs dextrose 5% on onset time of supraclavicular approach to brachial plexus block. Sixty American Society of Anesthesiologists class 1or2 patients, scheduled for elective upper extremity surgeries under sono-guided supraclavicular block were randomly assigned to receive lidocaine 2% diluted with either dextrose 5% or normal saline. At the end of lidocaine injection, sensory and motor blocks were evaluated at 5 min intervals for 30 min in the areas innervated by median, radial, ulnar and musculocutaneous nerves. Block onset time and number of patients with complete sensory or motor blockade were similar in both groups. Lidocaine diluted with either normal saline or dextrose 5% produces comparable sensory and motor block onset time and success rate in ultrasound guided supraclavicular block.

Keywords: Brachial plexus block, local anesthetics, lidocaine, sodium, dextrose

INTRODUCTION

Local anesthetic (LA) agents provide anesthesia and pain relief by interrupting nerve conduction through reversible block of sodium channels located in nerve membranes. When LA is deposited near the nerve, it binds to the sodium channels and prevent opening of the channels in response to stimulation, thereby inhibiting the influx of sodium ions into nerve's axons and the consequent development of an action potential (Heavner 2007; Vadhanan *et al*., 2015). Nerve conduction may be influenced by the amount of sodium ions in extracellular fluid around the peripheral nerves (Ochardsonj, 1978). Ultrasound-guided supraclavicular block of brachial plexus with LA drugs is a popular anesthesia method for the upper limb surgeries (Hanmanthaiah *et al*., 2013; Perlas *et al*., 2009). For an effective blockade of the brachial plexus, LA is commonly diluted with normal saline (NS) to provide appropriate volume of the drug (Duggan *et al*., 2009; Tran *et al*., 2011). However, according to some studies, higher sodium ions in saline diluted ropivacaine or bupivacaine can displace the LA from its binding site on sodium channels or antagonize its anesthetic activity and result in insufficient peripheral nerves blockade (Dhir et 1 al., 2012; Lim *et al*., 2016; Shah *et al*., 2014). Lidocaine is a fast onset LA in contrast with ropivacaine or bupivacaine used in the earlier studies. Though to our knowledge, the impact of lidocaine diluents on the characteristics of supraclavicular blockade has not yet been investigated by randomized prospective controlled trials. Therefore, this study was planned to evaluate the impact of saline diluted lidocaine on onset of motor and sensory block and compare it to the lidocaine diluted with dextrose 5% (D5%) in sono- guided supraclavicular block. We selected D5% as a comparator diluent because it is a sodium-free solution, its osmolality is similar to that of NS, and its injection is painless (Tsui *et al*., 2005). The primary outcome measure was the sensory and motor blocks onset time. The secondary measure was the percentage of patients with complete nerve blockade.

MATERIALS AND METHODS

The Research Ethics Committee of the Shahid Beheshti University of Medical Sciences, Tehran, Iran approved the protocol of this prospective randomized, double- blind clinical trial on 14 June 2015 with protocol number of 2015- 303. Sixty American Society of Anesthesiologists class 1 or 2 patients, from 18-85 years of age, scheduled for elective surgery of forearm, hand, or wrist under ultrasound-guided supraclavicular block were included in the study. They gave their written informed consent prior to the surgery. Patients were excluded if they had coagulation disorders, liver disease, allergy to LA, neurological or neuromuscular deficit in upper limb, infection at blockade site, contraindications to supraclavicular brachial plexus blockade, communication difficulties, or refused to participate. Pregnant women or patients with alcohol or substance abuse or cognitive impairment were also excluded. Eligible patients were

**Corresponding author:* e-mail: shdabir@yahoo.com

allocated by chance to 2 groups of 30 patients each to receive lidocaine hydrochloride 2% with epinephrine 1:2, 00,000, diluted with either D5% or NS for the nerve block. Randomization was performed using a computer-generated random table and group allocation was covered in a sealed envelope. No premedication was given before entrance to the operating room. A blinded anesthesiologist drew the sealed envelope just before block performance. Patients were monitored with electrocardiogram, pulse oximetry and noninvasive blood pressure. An anesthesia staff not involved in the study prepared 30mL solution by diluting 20mL of 2% lidocaine with 10mL of either D5% or NS in non-identified, similar syringes. The patients were positioned supine and head turned to contra- lateral side with arm placed beside the body. Before the block, patients were given intravenous midazolam 1-2 mg to relieve anxiety. All neural blocks were done by the same anesthesiologist experienced in the technique, who was unaware of the group allocation. The brachial plexus was identified as a compact group of nerves using an ultrasound system with a 6-13 MHz linear probe (SonoSite S-Nerve, Bothell, WA, USA) in a transverse short-axis view. Under aseptic technique, a 22G-bevel 30°, 85 mm block needle (Visioplex®, Vygon, Ecouen, France) was introduced in-plane in a lateral-to-medial approach towards the target nerves. When the needle reached the brachial plexus, 20 ml of lidocaine solution was injected incrementally inside the neural clusters and the remaining volume was injected in the corner pocket, so as to visualize adequate spread of LA around the nerves at the time of injection. The patients, surgeons, and anesthesia personnel were also blinded to the study groups.

After the end of injection, nerve block was assessed by a blind anesthesiologist every 5 minute for 30 minutes in the areas innervated by median, radial, ulnar, and musculocutaneous nerves. Degree of sensory loss was evaluated in target nerve areas by pinprick sensation with a 23 gauge needle using a three point score: 0 = sharp sensation (no block), 1 = dull sensation (partial block), 2= no sensation (complete block). Sensory block onset time was defined as interval between ends of lidocaine injection to onset of dull sensation in the operative area. Scores of motor block were also assessed in the distribution of the radial (elbow, wrist, and finger extension), ulnar (finger opposition), musculocutaneous (elbow flexion), and median nerves (finger and wrist flexion) using a three-point scale: 0=no block (full movement), 1=paresis (reduced movement) and 2= paralysis (no movement). Motor block onset time was described as interval between ends of lidocaine injection to experiencing heaviness over nerve areas. A successful blockade was defined as complete sensory and motor loss of all innervation regions. In case of total blockade failure, the patient received general anesthesia. In patients with partial anesthesia, propofol (25-75µ g/kg/min) and boluses of fentanyl (1-2µg/kg) were given during surgery. Patients who felt pain or were uncomfortable received general anesthesia. Complications were recorded during and after the block performance.

STATISTICAL ANALYSIS

Was performed using IBM Statistical Package for Social Sciences version 20.0. Sample size was calculated with the software package NCSS-PASS 11. Based on the previous studies, with the standard deviation of 3.2 min for onset time of block in all four nerves and a power of 0.80 at significance level of 0.05, 30 patients in each group were needed to detect a 2.5 minutes difference in mean onset time between two groups. The normality of data was assessed using Shapiro Wilk test. Demographical data were analyzed by independent t-test and chi-square test. Mann- Whitney and Chi-square tests with a Bonferroni correction were used to analyze onset of nerve block and proportion of patients with complete block, respectively. Data are presented as mean ± SD, numbers and percent. A P value less than 0.05 was statistically significant.

RESULTS

Fig. 1 shows flow of patients in the study. There was no significant difference in patients' characteristics between the two groups (table 1). Block onset time and the number of patients with complete neural blockade were not significantly different between the groups (table 2, 3). 3 patients in D5 % and 2 in NS group had partial nerve blockade and underwent surgery under sedation supplementation. There were 2 and 1 block failures for the NS and D5% group, respectively and required general anesthesia. All patients underwent uneventful surgeries and no important complication such as Horner's syndrome, pneumothorax, accidental vascular puncture, and systemic toxicity occurred.

DISCUSSION

In the present study, we found that dilution of lidocaine with either D5% or NS provides similar sensory and motor block onset time and success rate in ultrasound-guided supraclavicular block. The limitations of this study were that the time for complete neural block, as well as block duration was not assessed. Contrary to our results, Dhir *et al*. (Dhir *et al*., 2012) showed that dilution of ropivacaine with 5% dextrose provides significant faster onset of axillary brachial plexus block in comparison to NS when using dual guidance of ultrasound and nerve stimulation. Likewise, another study (Lim *et al*., 2016) reported a significant decrease in onset of sensory blockade with ropivacaine diluted with 5% dextrose compared to NS for ultrasound guided supraclavicular block. However, they found no significant differences in

Table 1: Patients' characteristics

Variable	NS group (n=30)	D5% group (n=30)	P value
Age (year)	35.43±15.06	38.33±14.58	0.452
Sex: male/female	22/8	25/5	0.347
Height (cm)	171±9.54	173.2±8.97	0.764
Weight (kg)	73.4±16.40	74.6±14.3	0.361
Surgery (forearm/ wrist/ hand)	19/4/7	16/7/7	0.584

Data are mean ± SD and number. There were no significant differences between groups (P> 0.05). ASA: American Society of Anesthesiologists. NS: normal saline, D5%: dextrose 5%

Table 2: Onset times of sensory and motor blockades.

Variable	NS group (n=30)	D5% group (n=30)	P value
Onset of sensory block			
In four nerves (min)	7.17 ±4.86	7.17 ± 3.13	> 0.999
In individual nerves (min)			
Radial	6.83±4.82	6.83±3.08	> 0.999
Median	7.17±4.86	7.17±3.13	> 0.999
Ulnar	7.17±4.86	6.83±3.08	> 0.999
Musculocutaneous	6.33±4.72	5.67±1.73	> 0.999
Onset of motor block			
In four nerves (min)	8.33±5.62	8.33±5.77	> 0.999
In individual nerves (min)			
Radial	7.50 ± 5.53	8 ± 5.19	> 0.999
Median	8 ± 5.66	8 ± 5.35	> 0.999
Ulnar	7.41 ± 5.45	7.50 ± 4.1	> 0.999
Musculocutaneous	6.33 ± 4.72	5.33 ± 1.27	> 0.999

Data are mean ± SD. There were no significant differences between groups (P> 0.05). NS: normal saline, D5%: dextrose 5%.

Table 3: Numbers (percentages) of patients with complete sensory and motor blockades

Variable	NS group (n=30)	D5% group (n=30)	P value
Complete sensory block			
In four nerves	26 (86.7%)	26 (86.7%)	> 0.999
In individual nerves			
Radial	27 (90%)	28 (93.3%)	> 0.999
Median	27 (90%)	27 (90%)	> 0.999
Ulnar	28 (93.3%)	28 (93.3%)	> 0.999
Musculocutaneous	27 (90%)	27 (90%)	> 0.999
Complete motor block			
In four nerves	26 (86.7%)	26 (86.7%)	> 0.999
In individual nerves			
Radial	27 (90%)	25 (83.3%)	> 0.999
Median	26 (86.7%)	26 (86.7%)	> 0.999
Ulnar	27 (90%)	25 (83.3%)	> 0.999
Musculocutaneous	27 (90%)	28 (93.3%)	> 0.999

There were no significant differences between groups (P> 0.05). NS: normal saline, D5%: dextrose 5%.

the time for onset of total paresis between the groups. Our finding is also different from the study by Shah *et al.* (Shah *et al*., 2014) who concluded that dilution of bupivacaine and lidocaine mixture with 5% dextrose for supraclavicular block significantly reduces onset of total sensory and motor loss compared to NS. In our view, possible reasons for discrepancies between our results and the aforementioned studies would be differences in definition of block onset time, different used LA agents, different site for block of brachial plexus, and different techniques of supraclavicular block.

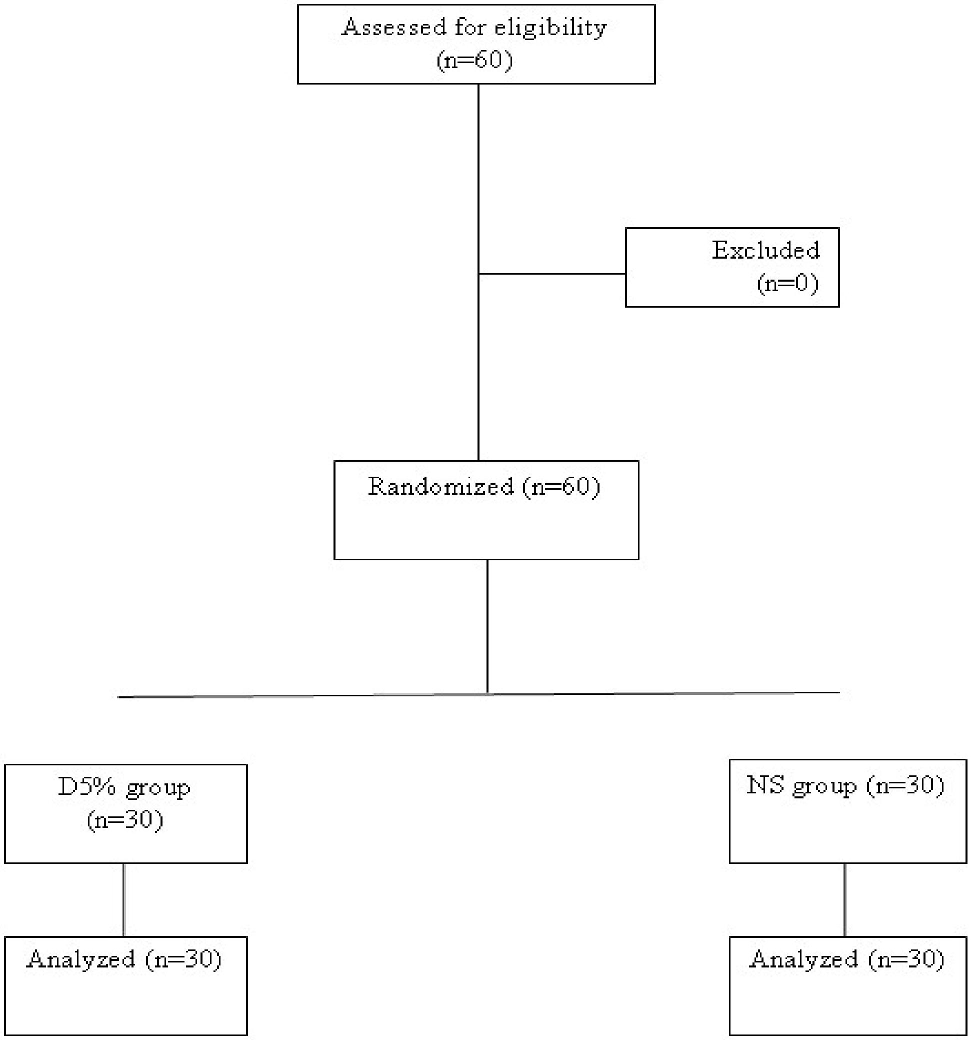

Fig. 1: Flow diagram D5%: dextrose 5%; NS: normal saline.

In addition to the peripheral nerves, in epidural anesthesia the potential effect of lidocaine dilution with NS was also different from our study. Contrary to our results, dilution of 2% lidocaine with saline caused insufficient epidural block than commercial plain 1% lidocaine (Kanai and Hoka, 2006). Similarly, one study (Jung-Ho *et al*., 2008) showed a significantly higher degree of epidural blockade with lidocaine diluted in distilled water than diluted in saline.

CONCLUSION

This study suggests that lidocaine diluted with either NS or D5% provides comparable sensory and motor block onset time and success rate for ultrasound guided supraclavicular block.

REFERENCES

Dhir S, Tureanu L, Bouzari A, Masood A, Francispragasam M and Ganapathy S (2012). Reduction in sodium content of local anesthetics for peripheral nerve blocks: A comparative evaluation of saline with 5% dextrose-A randomized controlled double-blind study. *Anesth. Analg.,* **114**(6): 1359-1364.

Duggan E, El Beheiry H and Perlas A (2009). Minimum effective volume of local anesthetic for ultrasound-guided supraclavicular brachial plexus block. *Reg Anesth. Pain. Med.,* **34**(3): 215-218.

Hanumanthaiah D, Vaidiyanathan S, Garstka M, Szucs S and Iohom G (2013). Ultrasound guided supraclavicular block. *Med Ultrason* **15**(3): 224-229.

Heavner JE. Local anesthetics (2007). *Curr. Opin. Anesthesiol.,* **20**: 336-422.

Jung-Ho K, Sie-Jeong R, Soo-Bong Y, Kyung-Han K, Tae-Ho C and Se-Hwan K (2008). Effect of normal saline and distilled water used for dilution of 4% plain lidocaine in epidural anesthesia. *Korean J. Anesthesiol.,* **54**(3): 256-260.

Kanai A and Hoka S (2006). A Comparison of epidural blockade produced by plain 1% lidocaine and 1% lidocaine prepared by dilution of 2% lidocaine with the same volume of saline. *Anesth. Analg.,* **102**(6): 1851-1855.

Lim HJ, Hasan MS and Chinna K (2016). Faster onset time of supraclavicular brachial plexus block using local anesthetic diluted with dextrose. *Rev. Bras. Anestesiol.,* **66**(4): 341-345.

Orchardsonj R (1978). The generation of nerve impulses in mammalian axons by changing the concentrations of the normal constituents of extra cellular fluid. *J. Physiol.,* **275**: 177-189.

Perlas A, Lobo G, Lo N, Brull R, Chan VW and Karkhanis R (2009). Ultrasound-guided supraclavicular block: Outcome of 510 consecutive cases. *Reg. Anesth. Pain Med.,* **34**(2): 171-176.

Shah B, Vyas AB, Mandowara N, Chauhan D, Thakker A and Karrupiah (2014). Comparative study between 5% dextrose and normal saline in brachial plexus block for onset and duration of complete sensory and motor block. *Res. J. Pharm. Biol. Chem. Sci.,* **5**(2): 50-57.

Tran DQ, Dugani S, Correa JA, Dyachenko A, Alsenosy N and Finlayson RJ (2011). Minimum effective volume of lidocaine for ultrasound-guided supraclavicular block. *Reg. Anesth. Pain Med.*, **36**(5): 466-469.

Tsui BCH and Kropelin B (2005). The electrophysiological effect of dextrose 5% in water on single-shot peripheral nerve stimulation. *Anesth. Analg.* **100**(6): 1837-1839.

Vadhanan P, Tripaty DK and Adinarayanan S (2015). Physiological and pharmacologic aspects of peripheral nerve blocks. *J. Anaesthesiol. Clin. Pharmacol.,* **31**(3): 384-393.