ONSET AND DURATION OF ANESTHESIA OF VARYING LIDOCAINE AND EPINEPHRINE CONCENTRATIONS USED IN WALANT: A RANDOMIZED DOUBLE BLIND COMPARATIVE STUDY

Michael Paul S. Balgos, MD
Ian Jason C. Magtoto, MD, FPOA

ABSTRACT

BACKGROUND

Wide awake local anesthesia no tourniquet (WALANT) is an increasingly popular anesthetic technique used in hand surgery which utilizes a combination of local anesthetic and epinephrine to achieve adequate anesthesia and eliminates the need of a tourniquet. Lidocaine is the most common local anesthetic used and this study aims to compare the onset and duration of the three most used concentrations of lidocaine and epinephrine for WALANT.

METHODOLOGY

This is a randomized double blind comparative study of 78 middle fingers subjected to either 1% lidocaine with 1:100,000 epinephrine, 0.5% lidocaine with 1:200,000 epinephrine or 0.25% lidocaine with 1:400,000 epinephrine. Onset time and anesthetic duration for the local effect and as a digital nerve block were measured via pin prick test.

RESULTS

The contents of each arm were as follows: Arm A: 0.25% lidocaine with 1:400,000 epinephrine, Arm B: 1% lidocaine with 1:100,000 epinephrine and Arm C: 0.5% lidocaine with 1:200,000 epinephrine. Statistically significant results were seen for onset times in both local and digital block effect, Arm B had the shortest onset time followed by Arm C and Arm A, respectively. Longer duration of anesthetic effect was achieved in both local and digital block for Arm B followed by Arm C then Arm A, which were statistically significant.

CONCLUSION

In conclusion, higher concentration of lidocaine and epinephrine provides faster onset and longer duration of anesthesia both as a local agent and in digital nerve block however lower doses can prove sufficient for simple hand procedures that does not entail lengthy operative time. Achieving the required effect and utilizing lower concentrations of lidocaine and epinephrine is more favorable in terms of its safety profile.

KEYWORDS

WALANT, Onset time of anesthesia, Duration of anesthesia, Hand surgery, Local anesthesia

INTRODUCTION

Wide-awake local anesthesia, no tourniquet (WALANT) is a technique commonly employed in hand surgery where a mixture of lidocaine and epinephrine is injected in a tumescent fashion over the surgical field.[1] This was popularized by Lalonde and is now being utilized by many surgeons in performing minor hand procedures. There are several advantages of this method, some examples are hemostasis without the use of tourniquet due to the effect of epinephrine, eliminating the need for sedation resulting in decreased operative time, and permitting intraoperative assessment in surgery leading to improved results of tendon repairs, transfers and hand fracture fixations.[2] Lidocaine with epinephrine has long been used and is generally safe with a maximal dose of 7mg/kg. It was standard practice to adjust the concentration of lidocaine and epinephrine based on the anticipated anesthetic volume that will be used in the surgery. If 50 ml or less volume is needed, 1% lidocaine with 1:100,000 epinephrine is used. If 50-100 ml volume is required, 0.5% lidocaine with 1:200,000 epinephrine is used and for 100-200 ml volume, 0.25% lidocaine with 1:400,000 epinephrine is used.[3]

It was presumed that even with varying concentrations of lidocaine and epinephrine, sufficient anesthetic effect will be achieved for common procedures lasting roughly less than 2 hours. We did a literature review and did not find any study directly comparing the quality of anesthesia of different lidocaine and epinephrine concentrations. The goal of this study was to compare and assess the clinical utility of three different lidocaine and epinephrine concentrations commonly used in WALANT in terms of anesthetic onset time and duration.

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MATERIALS AND METHODS

A total of 39 individuals ages 18 to 60 years old with uninjured hands were invited to participate in this randomized double blind comparative study after approval from the Institutional Research Board and Ethics Review Board. All the participants were informed regarding the planned interventions and written consents were obtained. Participants were excluded from the study if they have known allergy to local anesthesia, with existing cardiovascular disease, peripheral neuropathy, liver disease, hypercoagulable state, immunocompromised state, pregnancy, chronic pain, consumes sedative or analgesic daily, local skin infection of the hand, and needle-phobia. After screening, eligible participants were randomized using Urbaniak, G. C., & Polus, S. (2013). Research Randomizer (Version 4.0) [Computer software] to three anesthetic mixture groups. Three different anesthetic mixtures were prepared by the second author. One % lidocaine with 1:100,000 epinephrine, 0.5% lidocaine with 1:200,000 epinephrine and 0.25% lidocaine with 1:400,000 epinephrine was randomly assigned to three groups: Arm A, Arm B and Arm C. The contents of each arm were not disclosed to the primary author and the participants.

The study was done in the Philippine Orthopedic Center Emergency Room for management of possible adverse events. Both middle fingers of each participant were randomly assigned to an anesthetic solution for injection. After preparing the finger with an antiseptic solution, the volar surface of each proximal phalanx was pinched for sensory distraction prior to injection of the anesthetic solution. A 27-gauge needle was introduced perpendicularly and after the pain from the pinch was gone, the needle was progressed deeper up to the subcutaneous layer and 2 ml of the anesthetic solution was introduced.[4] The onset time and duration of anesthesia for both local effect and digital nerve block were measured using pin prick test. Onset time of anesthetic effect was measured from the time of solution injection up to the disappearance of pain on pin prick test and the duration of anesthesia was measured from the disappearance of pain until return of pain sensation on pin prick test.

STATISTICAL ANALYSIS

Descriptive statistics was used to summarize the demographic and clinical characteristics of the participants. Frequency and proportion were used for categorical variables and mean and SD for normally distributed continuous variables. One-way ANOVA and Fisher's exact test was used to determine the difference of mean and frequency, respectively, among different Lidocaine and Epinephrine concentrations in terms of anesthetic onset and duration. Null hypotheses were rejected at 0.05α-level of significance. STATA 13.1 was used for data analysis.

RESULTS

There were 39 participants and a total of 78 middle fingers subjected to anesthesia in this study. The mean age was 25 years old with majority being males (n=28). Demographic data between groups were not statistically significant (Table 1). The contents of each arm are as follows: Arm A: 0.25% lidocaine with 1:400,000 epinephrine, Arm B: 1% lidocaine with 1:100,000 epinephrine and Arm C: 0.5% lidocaine with 1:200,000 epinephrine. For the local onset of anesthesia, 1% lidocaine with 1:100,000 epinephrine had the fastest onset (30.77 + 10.39 sec) followed by 0.5% lidocaine with 1:200,000 epinephrine (38 + 17.17 sec) and 0.25% lidocaine with 1:400,000 epinephrine (55.38 + 18.48 sec) (Table 2). Same observation was found with anesthetic onset with regards to digital nerve blocks. One % lidocaine with 1:100,000 epinephrine had the shortest onset (2.78 + 0.69 mins) followed by 0.5% lidocaine with 1:200,000 epinephrine (4.30 + 1.62 mins) and 0.25% lidocaine with 1:400,000 epinephrine (5.18 + 1.46 mins) (Table 2).

The difference in onset times for local and digital nerve block of the three groups were found to be statistically significant. The duration of anesthesia showed statistically significant findings both for local and digital blocks. One % lidocaine with 1:100,000 epinephrine had the longest local anesthetic duration (5.07 + 0.34 hours) followed by 0.5% lidocaine with 1:200,000 epinephrine (4.44 + 0.31 hours) and 0.25% lidocaine with 1:400,000 epinephrine (3.01 + 0.33 hours) (Table 3). Digital nerve block duration also showed that 1% lidocaine with 1:100,000 epinephrine had the longest digital block effect (4.26 + 0.33 hours) followed by 0.5% lidocaine with 1:200,000 epinephrine (3.36 + 0.24 hours) and 0.25% lidocaine with 1:400,000 epinephrine (2.29 + 0.29hours) (Table 3). There were no adverse reactions encountered during the study.

DISCUSSION

In this study, onset time and duration of anesthesia of three different solutions containing varying concentrations of lidocaine and epinephrine were compared: (1) 1% lidocaine with 1:100,000 epinephrine, (2) 0.5% lidocaine with 1:200,000 epinephrine and (3) 0.25% lidocaine with 1:400,000 epinephrine. These were randomly assigned to Arm B, Arm C, and Arm A, respectively. The onset time and duration of anesthesia were investigated in respect to their local effect and as a digital nerve block. The results showed that higher concentration of lidocaine and epinephrine yielded shorter onset time and longer duration of anesthesia. This supported our hypothesis that varying concentrations of lidocaine and epinephrine affects the onset time and the length of anesthetic effect. Local anesthetic onset time was achieved 1.8 times faster

and 1.5 times faster for Arm B and Arm C respectively in comparison to Arm A. Onset time was also 1.9 times shorter for digital block in Arm B and 1.2 times shorter for Arm C in contrast to Arm A. Local anesthetic duration of Arm A was 59% and Arm C was 88% of the total duration time of Arm B. Almost similar results were observed for digital block duration with 54% and 79% of the total duration of Arm B for Arm A and Arm C, respectively.

Similar findings were observed in the study of Wang, Zhen, et al. which compared different lidocaine concentrations in combination with stellate ganglion block for preemptive analgesia on postoperative pain. [5] Ranganatha, Anil, et al. investigated the effects of anesthetic dilution on the characteristics of brachial plexus block and they concluded that shorter onset time and longer anesthetic duration is achieved with higher concentration of lidocaine even with lesser volume.[6] It is well known that epinephrine enhances the duration of local anesthesia. Prasetyono and Lestari compared the anesthetic onset and duration of 2% plain lidocaine and 0.2% lidocaine with 1:1,000,000 epinephrine. Longer duration was achieved even with lower lidocaine concentration due to the pharmacologic effect of epinephrine however onset time was observed to be more dependent on the local anesthetic concentration to achieve a shorter onset. [7] In this study, the onset times were observed to be much faster as the concentration of lidocaine increase.

The average time for simple hand procedures is around 20 minutes. [8,9] This is within the anesthetic duration of 0.25% lidocaine with 1:400,000 epinephrine solution and we can conclude that even with less concentration, sufficient quality of anesthesia can be achieved for simple hand surgeries. A similar conclusion was made by Ban et.al. comparing three different concentrations of lidocaine and even explored lower concentrations in the inguinal hernia mesh repairs. The study outcome showed that effective anesthesia was achieved even at lower concentrations of lidocaine. [10] Short and effective procedural anesthesia has benefits as mentioned in the study of Viny comb and Sahhar such as reduction of accidental injuries and unrecognized complications associated with prolonged anesthesia. [11]

Ping et.al. did a study on the use of 4% vs 2% lidocaine both with 1:100,000 epinephrine. Onset was more rapid with the 4% group, but the duration of anesthesia was not statistically significant between the two groups. [12] In our study, digital nerve block had shorter duration and longer onset times compared to the local anesthetic effect using the same concentration. This can be attributed to substance distribution and clearance. The measuring tool used in this study was more objective compared to earlier studies. [8,9,13,14] Previous studies assessed onset time and duration through subjective sensory perception in contrast to our study which used pin prick as an objective tool to measure the onset time and anesthetic duration.

Lidocaine with epinephrine has long been used and is generally safe with a maximal dose of 7mg/kg.[3] Although rare, adverse reaction associated with WALANT are fainting secondary to vasovagal response and jitters. Seizure, altered mentation and cardiac ischemia are more severe reactions that are infrequently encountered. [15] No adverse events were recorded during this study, but it is noteworthy that we achieved similar or comparable efficacy of anesthesia with lower concentration. This further reduces the risk of possible anesthetic toxicity. The same was also observed by Song et.al. which compared three different lidocaine concentrations for tension-free inguinal hernia repair under local infiltration anesthesia and determined that the lowest concentration provided satisfactory anesthesia and pain relief. [16]

A limitation of this study is that the tests were performed in uninjured fingers. Better clinical correlation can be deduced if the study were to involve injured or pathologic subjects. The force applied to test for pain via pin prick was not uniform. Use of von Frey filament with a standard force could have aided this problem. Our standard 1% lidocaine with 1:100,000 epinephrine is proven to have a wide safety profile. Using a lower concentration and achieving satisfactory and comparable effect may benefit from a cost effectiveness study in the future.

CONCLUSION

In conclusion, higher concentration of lidocaine and epinephrine provides faster onset and longer duration of anesthesia both as a local agent and in digital nerve block however lower doses can prove sufficient for simple hand procedures that do not entail lengthy operative time. Achieving adequate anesthesia and utilizing lower concentrations of lidocaine and epinephrine is more favorable in terms of its safety profile.

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TABLE

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Table 1. Demographic Profile of Participants

	Anesthetic Mixtures				
	Total (n=78)	**Arm A (n=26)**	**Arm B (n=26)**	**Arm C (n=26)**	**P-value**
	Frequency (%); Mean ± SD				
Age	25.21 + 2.67	25.23 + 2.80	25.15 + 2.60	25.23 + 2.70	0.993
Sex					1.000
Male	56 (71.79)	18 (69.23)	19 (73.08)	19 (73.08)	
Female	22 (28.21)	8 (30.77)	7 (26.92)	7 (26.92)	

Table 2. Onset of Anesthesia

	Anesthetic Mixtures			
	Arm A (n=26)	**Arm B (n=26)**	**Arm C (n=26)**	**P-value**
	Mean ± SD			
Local, seconds	55.38 ± 18.48	30.77 ± 10.39	38 ± 17.17	**<0.001**
Digital, minutes	5.18 ± 1.46	2.78 ± 0.69	4.30 ± 1.62	**<0.001**

Table 3. Duration of Anesthesia

	Anesthetic Mixtures			
	Arm A (n=26)	**Arm B (n=26)**	**Arm C (n=26)**	**P-value**
	Mean ± SD			
Local, hours	3.01 ± 0.33	5.07 ± 0.34	4.44 ± 0.31	**<0.001**
Digital, hours	2.29 ± 0.29	4.26 ± 0.33	3.36 ± 0.24	**<0.001**