The Philippine Journal of Orthopaedics

ORIGINAL ARTICLE

Onset and Duration of Anesthesia of Varying Lidocaine and Epinephrine Concentrations Used in WALANT: A Randomized Double-Blind Comparative Study

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ABSTRACT

Background. Wide awake local anesthesia no tourniquet (WALANT) is an increasingly popular anesthetic technique used in hand surgery which uses local anesthetic and epinephrine, achieves adequate anesthesia, and eliminates the need for a tourniquet.

Objective. This study compares the onset and duration of the three most commonly used concentrations of lidocaine and epinephrine for WALANT.

Methodology. This was 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. The pinprick test was used to measure onset time and anesthetic duration for the local effect and as a digital nerve block.

Results. The contents of each treatment 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. Arm B had the shortest onset time (30.77 ± 10.39 seconds for local, 2.78 ± 0.69 minutes for digital block) followed by Arm C (38 ± 17.17 seconds for local, 4.30 ± 1.62 minutes for digital block) and Arm A (55.38 ± 18.48 seconds for local, 5.18 ± 1.46 minutes for digital block, p <0.001). A longer duration of anesthesia was achieved in both local and digital blocks for Arm B (5.07 ± 0.34 hours for local, 4.26 ± 0.33 hours for digital block) followed by Arm C (4.44 ± 0.31 hours for local, 3.36 ± 0.24 hours for digital block) then Arm A (3.01 ± 0.33 hours for local, 2.29 ± 0.29 hours for digital block, p <0.001).

Conclusion. Higher concentrations of lidocaine and epinephrine provided faster onset and longer duration of anesthesia for both local block and digital nerve block. Lower concentrations in higher volumes may be sufficient for short procedures (less than three hours).

Keywords. WALANT, onset, duration, local anesthesia, digital block

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] Advantages of this technique include achieving hemostasis without the use of a tourniquet due to the effect of epinephrine, eliminating the need for sedation resulting in decreased operative time, and permitting intraoperative assessment leading to improved results of tendon repairs, transfers, and hand fracture fixations.[2]

Lidocaine with epinephrine is generally safe with a maximal dose of 7 mg/kg. The concentrations of lidocaine and epinephrine are adjusted based on the anticipated required

ISSN 0118-3362 (Print)
eISSN 2012-3264 (Online)
Printed in the Philippines.

Received: September 27, 2024.
Accepted: October 21, 2024.
Published Online: November 7, 2024.
https://doi.org/10.69472/poai.2024.21

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anesthetic volume. If 50 ml or less is needed, 1% lidocaine with 1:100,000 epinephrine is used. For procedures requiring 50–100 ml, 0.5% lidocaine with 1:200,000 epinephrine is used. If 100-200 ml is needed, 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 would be achieved for common procedures lasting roughly less than two hours.

The study aimed 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.

METHODOLOGY

Thirty-nine individuals aged 18 to 60 with uninjured hands were invited to participate in this randomized double-blind comparative study upon approval from the Institutional Review Board and Ethical Review Board. The participants were informed regarding the planned interventions and gave consent. Participants were excluded from the study if they had a known allergy to local anesthesia, existing cardiovascular disease, peripheral neuropathy, liver disease, hypercoagulable state, immunocompromised state, pregnancy, chronic pain, daily sedative or analgesic use, local skin infection, and needle-phobia. After screening by the primary author, the second author randomized eligible participants using Research Randomizer (Version 4.0) [Urbaniak, G. C., & Polus, S. (2013)] to three groups. The second author prepared three different anesthetic mixtures. The three treatments—1% lidocaine with 1:100,000 epinephrine [49 ml of normal saline solution (NSS), 50 ml of 2% lidocaine, 1 ml of 1:1,000 epinephrine], 0.5% lidocaine with 1:200,000 epinephrine (74.5 ml of NSS, 25 ml of 2% lidocaine, 0.5 ml of 1:1,000 epinephrine) and 0.25% lidocaine with 1:400,000 epinephrine (86.75 ml of NSS, 12.5 ml of 2% lidocaine, 0.25 ml of 1:1,000 epinephrine)—were 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 Emergency Room setting to manage possible adverse events. Both middle fingers of each participant were randomly assigned to an anesthetic solution for injection. For each middle finger, the anesthetic was aspirated aseptically from the previously prepared mixtures. After preparing the finger with an antiseptic solution, the volar surface of each proximal phalanx was pinched for sensory distraction. The single-injection volar subcutaneous block technique was used for each finger.[4] Using a syringe with the respective anesthetic and a 27-gauge needle, the needle was introduced perpendicularly into the subcutaneous space at midline of the proximal digital flexion crease, and 2 ml of anesthetic was injected.[4] The time of onset and duration of anesthesia for both the local effect at the injection site and digital nerve block at the finger pulp were measured using the pinprick test (using a safety pin) every 10 seconds. The onset of anesthesia was measured from the time of injection up to the disappearance of pain on the pinprick test, and the duration of anesthesia was measured from the disappearance of pain until pain sensation returned on the pinprick test every 5 minutes.

Descriptive statistics were 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 were used to determine the differences in mean and frequency, respectively, among the groups. Null hypotheses were rejected at 0.05 α-level of significance.

RESULTS

There were 39 participants (78 middle fingers) subjected to anesthesia in this study. The mean age was 25 years old with most being males ($n = 28$). There were no statistically significant differences in the baseline demographic data between the three groups (Table 1). 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.

For the local onset of anesthesia, 1% lidocaine with 1:100,000 epinephrine had the fastest onset (30.77 $\pm$ 10.39 seconds) followed by 0.5% lidocaine with 1:200,000 epinephrine (38 $\pm$ 17.17 seconds) and 0.25% lidocaine with 1:400,000 epinephrine (55.38 $\pm$ 18.48 seconds) (Table 2). The same observation was found for the digital nerve blocks. One percent lidocaine with 1:100,000 epinephrine had the fastest onset (2.78 $\pm$ 0.69 minutes) followed by 0.5% lidocaine with 1:200,000 epinephrine (4.30 $\pm$ 1.62 minutes) and 0.25% lidocaine with 1:400,000 epinephrine (5.18 $\pm$ 1.46 minutes) (Table 2). The differences in onset times for local (p <0.001) and digital nerve block ($p < 0.001$) of the three groups were found to be statistically significant.

Statistically significant differences were also found for the duration of anesthesia of the three groups for local ($p < 0.001$) and digital blocks (p <0.001). One percent lidocaine with

Table 1. Demographic profile of participants

	Anesthetic mixtures				*P*-value
	Total (n = 78)	Arm A (n = 26)	Arm B (n = 26)	Arm C (n = 26)	
Age (Mean)	25.21 (SD 2.67)	25.23 (SD 2.80)	25.15 (SD 2.60)	25.23 (SD 2.70)	0.993
Sex (Frequency (%))					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			*P*-value
	Arm A (n = 26)	Arm B (n = 26)	Arm C (n = 26)	
Local, seconds (Mean)	55.38 (SD 18.48, Range 32–93)	30.77 (SD 10.39, Range 15–65)	38 (SD 17.17, Range 15–92)	**<0.001***
Digital, minutes (Mean)	5.18 (SD 1.46, Range 3.24–9.12)	2.78 (SD 0.69, Range 1.12–4.22)	4.30 (SD 1.6, Range 1.8–7.97)	**<0.001***

*statistically significant

Table 3. Duration of anesthesia

	Anesthetic mixtures			*P*-value
	Arm A (n = 26)	Arm B (n = 26)	Arm C (n = 26)	
Local, hours (Mean)	3.01 (SD 0.33, Range 2.37–3.82)	5.07 (SD 0.34, Range 4.2–5.9)	4.44 (SD 0.31, Range 3.52–4.92)	**<0.001***
Digital, hours (Mean)	2.29 (SD 0.29, Range 1.82–3.1)	4.26 (SD 0.33, Range 3.48–4.95)	3.36 (SD 0.24, Range 2.7–3.77)	**<0.001***

*statistically significant

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). For digital nerve block, 1% lidocaine with 1:100,000 epinephrine lasted the longest (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 ± 0.29 hours) (Table 3). There were no adverse reactions encountered during the study.

DISCUSSION

In this study, the onset time and duration of anesthesia of three different solutions containing varying concentrations of lidocaine and epinephrine were compared. The onset time and duration of anesthesia were investigated concerning their local effect and as a digital nerve block. The results showed that higher concentrations of lidocaine and epinephrine yielded shorter onset time and longer duration of anesthesia.

The same can be concluded for brachial plexus blocks, achieving shorter onset time and longer anesthetic duration with higher concentrations of lidocaine in smaller volumes.[5]

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. Onset time however was observed to be more dependent on the local anesthetic concentration to achieve a shorter onset.[6] In this study, the onset times were faster with higher concentrations of lidocaine.

The average time for simple hand procedures is around 20 minutes.[7,8] This is within the anesthetic duration of 0.25% lidocaine with 1:400,000 epinephrine solution. Even when using this lower concentration, sufficient quality of anesthesia can be achieved for simple hand surgeries. Ban et al. concluded similarly after comparing three different concentrations of lidocaine in inguinal hernia mesh repairs. The study outcome showed that effective anesthesia was achieved even at lower concentrations of lidocaine.[9] Short and effective procedural anesthesia helps reduce accidental injuries and other unrecognized complications associated with prolonged anesthesia.[10]

The use of 4% vs 2% lidocaine both with 1:100,000 epinephrine has also been previously compared. The onset was faster with the 4% group, but the duration of anesthesia did not differ significantly.[11] This may suggest that the maximum duration plateaus after a certain concentration of anesthetic.

In our study, digital nerve block had shorter durations and longer onset times compared to the local block 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, which used subjective sensory perception,[9,10,12,13] in contrast to our study which used sequential pin pricks.

Lidocaine with epinephrine has long been used and is generally safe with a maximal dose of 7 mg/kg.[3] Although rare, adverse reactions associated with WALANT include fainting secondary to vasovagal response and jitters. Seizures, altered mentation and cardiac ischemia are rare severe reactions.[14] No adverse events were recorded during this study, but it is noteworthy that we achieved similar or comparable efficacy of anesthesia with lower concentrations. This further reduces the risk of possible anesthetic toxicity. The same was also observed by Song et al. who compared three different lidocaine concentrations for tension-free inguinal hernia repair under local infiltration anesthesia and determined that even the lowest concentration provided satisfactory anesthesia and pain relief.[15]

CONCLUSION

Higher concentrations of lidocaine and epinephrine provide faster onset and longer duration of anesthesia both as a local agent and in digital nerve block. Using lower concentrations in higher volumes may be sufficient for short procedures (less than three hours). For procedures which require low volumes, using higher concentrations within the allowable dose may still be beneficial to provide longer lasting post-operative analgesia.

STATEMENT OF AUTHORSHIP

All authors certified fulfillment of ICMJE authorship criteria.

AUTHORS DISCLOSURE

The authors declared no conflict of interest.

FUNDING SOURCE

None.

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