Buffered Versus Plain Lidocaine for Digital Nerve Blocks

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Study objectives: To test whether buffered lidocaine is less painful to administer as a digital nerve block than plain lidocaine.

Design: Randomized, double-blind, prospective clinical trial.

Setting: University hospital emergency department.

Participants: Adults not allergic to lidocaine requiring a digital nerve block.

Interventions: Subjects received digital nerve blocks by injection of buffered lidocaine on one side and plain lidocaine on the other in a predetermined, randomized order. Pain of infiltration was assessed. Scores were compared using a two-tailed *t*-test. Standard 1% lidocaine was used if additional anesthetic was required.

Measurements and main results: Thirty-one patients were enrolled. Buffered lidocaine was significantly less painful to administer than plain lidocaine ($P < .001$; $t = 4.21$). Supplemental anesthesia was required less often for buffered lidocaine (two times) compared with plain lidocaine (six times), although this difference was not statistically significant.

Conclusion: Because it causes less pain and is equally efficacious, buffered lidocaine is preferable to plain lidocaine for digital nerve blocks in adults.

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INTRODUCTION

Lidocaine is frequently used for local and regional anesthesia in emergency departments. Infiltration of lidocaine is known to cause pain.[1] Previous studies have demonstrated that buffering lidocaine (pH adjusted to 7.2 to 7.4) attenuates the pain of infiltration.[2-5]

Buffered lidocaine has been shown to be preferable to plain lidocaine during simple laceration repair,[2] but a study involving digital nerve blocks has not been reported previously. Digital nerve blocks afford a unique opportunity to compare buffered with plain lidocaine because a different anesthetic can be used on the radial and ulnar aspects of the finger. During this study we tested the hypothesis that buffering lidocaine will attenuate the pain of infiltration during digital nerve blocks in a randomized, double-blind clinical trial.

MATERIALS AND METHODS

The study was performed in the ED at Albany Medical Center from May 5, 1991, through October 1, 1991. All patients 18 years of age and older who required digital nerve blocks were eligible for participation. Patients allergic to lidocaine or with any condition that interfered with pain perception, such as altered mental status or abnormal sensory examination of the involved digit, were not considered for enrollment. The study was approved by the Albany Medical College Committee on Research Involving Human Subjects.

The same investigator prepared all study solutions and was not subsequently involved in data acquisition. Nine-to-one dilutions were prepared by replacing 2 mL of a 20-mL multidose vial of 1% lidocaine with 2 mL of diluent. The diluent was sodium bicarbonate, 44 mEq/50 mL, for the buffered lidocaine and normal saline for the plain lidocaine. The resulting study solutions were letter coded. We have shown previously that buffered lidocaine remains effective for at least one week after preparation and maintains a pH of 7.38 to 7.41 when stored at room temperature.[3] The study solutions therefore were prepared once a week and stored at room temperature.

Neither the physician administering nor the patient receiving the anesthetic was aware of the contents of the vials; a double-blind protocol was thus established. After informed consent was obtained, subjects were given digital nerve blocks. Every subject received both study solutions as two separate injections in the vicinity of the neurovascular bundle: one on the radial and the other on the ulnar aspect of the finger. The order that the injections were given was predetermined and randomized.

The skin was prepared with Betadine solution and 70% isopropyl alcohol. A maximum of 2.5 mL per injection was then administered through 25-gauge needles. Once complete anesthesia was verified, the necessary procedure was performed. Standard 1% lidocaine was used if additional anesthetic was required either before or during the procedure.

To ensure uniformity, the same physician administered both injections for each digital nerve block. The precise location along the neurovascular bundle, total volume per injection, and speed of infiltration were determined by each physician. However, physicians were instructed to use the same volume and technique for both injections.

Immediately after each separate injection, subjects were asked to rate the pain of infiltration using a previously validated visual-analog pain scale.[6] Pain scales were later quantified by making measurements to the nearest millimeter from the point of origin to the point marked by the patient (total pain scale length, 100 mm). Differences in pain scores were calculated for each subject by subtracting the pain of infiltration of buffered lidocaine from the pain of infiltration of plain lidocaine. These differences were analyzed using a two-dependent sample Student's *t*-test and verified using the Wilcoxon median test. Multiple regression analysis was used to assess the possible mitigating effects of order of infiltration, age, and sex.

RESULTS

Thirty-one patients, 19 men and 12 women, were enrolled. Ages ranged from 18 to 59 years with a mean of 28 years and a standard deviation of 8.4 years. The first injection given was buffered lidocaine for 15 patients and plain lidocaine for 16 patients. Procedures performed were laceration repair (24), nail bed repair (three), incision and drainage (three), and dislocation reduction (one).

Based on differences in pain scores, buffered lidocaine was reported to be significantly less painful to administer than plain lidocaine (t-test: $P < .001$, $t = 4.21$; Wilcoxon median test: $P < .001$). Infiltration of buffered lidocaine was found to be less painful than plain lidocaine in 24 cases, equivalent in three, and more painful in four. The magnitude of these differences in pain scores is shown (Figure).

Multiple regression analyses were used to determine whether the magnitude of the difference in pain scores was mitigated by order of infiltration, age, or sex. Neither individually nor collectively were any differences found with respect to these variables using either the original pain scores or their rank orders (all incremental $Fs < 1.00$, NS).

Six patients required supplemental anesthesia on the side anesthetized with plain lidocaine. Two of these patients also required supplementation on the buffered lidocaine side while the other four required supplementation only on the plain side. No patient required supplementation only on the buffered lidocaine side. Therefore, digital nerve blocks performed with plain lidocaine required supplemental anesthesia more often than those performed with buffered lidocaine; however, this difference was not statistically significant (Fisher's exact test, $P > .1$). Power analysis indicated that we would require 160 subjects to show a statistically significant difference of this magnitude at $\alpha = .05$, $\beta = .2$.[7]

DISCUSSION

Like other amide anesthetics, lidocaine is unstable in alkaline environments.[8] It therefore is marketed at a pH of 6.0 to 7.0.[9,10] Infiltration of lidocaine is known to cause pain.[1] Buffered lidocaine (pH 7.2 to 7.4) is significantly less painful to administer than plain lidocaine.[2-5] Attenuation of pain by buffering lidocaine has been demonstrated for intradermal injection in uninjured skin[3-5] and during simple laceration repair.[2] The agent can be stored at room temperature for at least one week without compromising this advantage.[3]

It has been shown previously that the pain of infiltration of different anesthetics is not simply a function of acidity.[11] Being a weak base (pKa 7.9), lidocaine exists as both an uncharged free base and a positively charged cation. The relative concentration of these species is pH dependent. The fraction of free base in buffered lidocaine (pH 7.4) increases more than tenfold compared with commercially available lidocaine (pH 6.2).[7] Because only the lipophilic free base is thought to be capable of diffusing into nerve axons,[8,12,13] buffered lidocaine may be less painful than plain lidocaine because of more rapid access to its intracellular site of action rather than simply because it is less acidic.

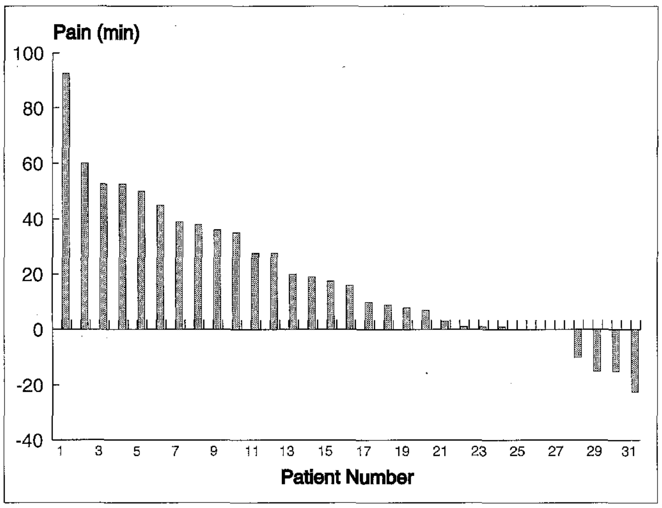
Buffered lidocaine has been shown to be safe and more effective than plain lidocaine during epidural and other forms of regional anesthesia.[14-16] However, the agent has never been compared with plain lidocaine for digital nerve blocks.

We have shown through a randomized, double-blind clinical trial that buffered lidocaine is significantly less painful than plain lidocaine during administration of digital nerve blocks ($P < .001$). Although buffered lidocaine appeared to be more efficacious, as evidenced by fewer instances in which it required supplemental anesthesia, this difference did not reach statistical significance.

This study had several limitations. First, due to its relatively small sample size, we were unable to detect a statistically significant difference in the need for supplemental anesthesia comparing buffered lidocaine with plain lidocaine. Logistic limitations did not allow us to measure and compare the time to onset of anesthesia.

Because clinicians typically allow several minutes for the onset of complete anesthesia after administering a digital nerve block, even if a small difference in time of onset did exist, this may not have any clinical relevance. Finally, our results cannot be extrapolated to other anesthetic agents.

Figure.
Differences in pain scores for plain lidocaine minus buffered lidocaine for each patient (maximum possible, 100 mm)



CONCLUSION

Buffered lidocaine is less painful to administer as a digital nerve block than plain lidocaine. The two agents are equally efficacious, suggesting that buffered lidocaine may be preferable to plain lidocaine for digital nerve blocks.

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