Virtually Painless Local Anesthesia: Diluted Lidocaine Proves to Be Superior to Buffered Lidocaine for Subcutaneous Infiltration

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ABSTRACT

Background: Many physicians believe that buffering local anesthetics with sodium bicarbonate is the best technique for reducing the pain and discomfort associated with subcutaneous infiltration.
Objective: To compare the level of pain and discomfort associated with subcutaneous infiltration of lidocaine diluted with normal saline to that associated with traditionally buffered lidocaine.
Patients/Methods: In a prospective, double-blind trial, 31 patients were asked to use a visual analog scale to rank the level of pain and discomfort caused by two different solutions of lidocaine with epinephrine. *Solution A*: 3 mL of 1% lidocaine + epinephrine in 30 mL of bacteriostatic 0.9% sodium chloride in a 1:10 ratio, in which each mL contained 9 mg of sodium chloride and 9 mg of benzyl alcohol. *Solution B*: 5 mL of 8.4% sodium bicarbonate solution and 50 mL of 1% lidocaine + epinephrine in a 1:10 ratio.
Results: Twenty-eight out of 31 patients reported that the solution of lidocaine diluted with normal saline was the least painful upon injection.
Conclusion: Pain and discomfort during subcutaneous injection of lidocaine can be reduced by diluting the anesthetic with normal saline in a 1:10 ratio.

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INTRODUCTION

Of all the procedures that the average dermatologist performs today, none is more common than the skin biopsy. Although the premise behind local anesthesia is to reduce the pain and discomfort associated with many procedures, it is often the infiltration of the skin with anesthetic that is perceived by the patient as being the most unpleasant part of his or her dermatology visit.

Several experiments have been conducted in order to offer patients a more pleasant experience during the subcutaneous injection of local anesthetics (LAs). Tactile stimulation, cooling devices, and warming and buffering of the LAs, as well as prior application of topical anesthetics, are all techniques that have been used to minimize the pain of injection and infiltration of LAs.

Although buffered lidocaine has been shown to be effective at reducing pain during subcutaneous infiltration,[1] patients still report pain and discomfort during this procedure. The aim of this study is to compare the clinical efficacy of pain attenuation using lidocaine with epinephrine diluted with normal saline vs lidocaine with epinephrine buffered with sodium bicarbonate.

MATERIALS AND METHODS

The study protocol and all related materials were registered, approved, and monitored by the University of Miami Institutional Review Board. Informed consent was obtained from 31 patients who needed two biopsies of the facial area, seen in a private, community-based hospital clinic over a period of two months. Participant demographics included Caucasian and Hispanic males and females, aged 25 to 85 years old, who needed facial biopsies (ie, either shave or punch) to rule out potential skin cancer. All patients in the study denied any allergy to lidocaine or sensitivity to epinephrine.

The same medical assistant prepared two different fresh solutions of lidocaine with epinephrine for each biopsy:

Solution A (unbuffered): 3 mL of 1% lidocaine and epinephrine in 30 mL of bacteriostatic 0.9% sodium chloride in a 1:10

TABLE 1.

Difference in Pain at Injection Site[a]

	Pain at Injection Site			
Patient	First Administered	Solution A (unbuffered)	Solution B (buffered)	Difference
1	A	2.0	3.5	1.5
2	B	1.0	2.9	1.9
3	B	2.0	7.0	5.0
4	A	1.0	4.0	3.0
5	A	0.0	0.6	0.6
6	B	0.3	0.3	0.0
7	A	1.0	1.6	0.6
8	B	0.1	1.7	1.6
9	A	0.0	2.0	2.0
10	B	1.0	2.0	1.0
11	A	1.0	3.0	2.0
12	A	2.0	5.0	3.0
13	B	1.3	3.0	1.7
14	A	0.8	7.7	6.9
15	B	3.0	8.0	5.0
16	A	0.4	3.4	3.0
17	B	0.0	1.0	1.0
18	B	0.0	1.5	1.5
19	A	2.0	5.0	3.0
20	A	2.0	8.0	6.0
21	B	2.0	4.2	2.2
22	A	0.8	4.6	3.8
23	B	2.0	1.5	-0.5
24	B	0.2	2.1	1.9
25	B	4.0	9.8	5.8
26	A	1.0	3.9	2.9
27	B	0.6	4.7	4.1
28	A	0.9	3.4	2.5
29	B	0.2	3.2	3.0
30	B	0.4	4.0	3.6
31	A	0.8	5.8	5.0
	A FIRST = 15 B FIRST = 16	Mean A 1.1	Mean B 3.8	Mean difference 2.7 (P=2.26 x 10^{-9})

[a]Pain was reported using a visual analog scale from 0 (no pain) to 10 (severe pain).

ratio, in which each mL contained 9 mg of sodium chloride and 9 mg of benzyl alcohol.

Solution B (buffered): 5 mL of 8.4% sodium bicarbonate solution and 50 mL of 1% lidocaine and epinephrine in a 1:10 ratio.

Both solutions were kept at room temperature. One dermatologist, M.Z., determined the need for biopsies for each individual, and the same physician then gave each patient subcutaneous injections with a 31-gauge needle that contained 0.3 mL of each solution in two discrete but comparable sites with regard to pain fiber distribution (ie, the left and right cheeks) before either a shave or a punch biopsy. The rate of injection was standardized to the best of the physician's ability, the same injection technique was used for each patient, and the same biopsy technique was then used for both sites on each patient.

The buffered and unbuffered LAs were handed to the physician in a blinded fashion by the same medical assistant who prepared the solutions (ie, neither the physician nor the patients were aware of the content of each solution or the order in which they were administered). In order to ensure consistency, the same number of patients received the buffered solution followed by the unbuffered solution as received the unbuffered solution first followed by the buffered solution. The sequence was randomly assigned using a statistical program (IBM SPSS Statistics 17.0.1) method to maximize internal validity. Between 15 and 20 seconds after the injection of the local anesthetic, patients were asked to rate the pain of the needle insertion and solution infiltration by using a visual analog scale (VAS) from 0 (no pain) to 10 (severe pain) in order to determine which injection solution was the most comfortable (see Figure 1). Biopsies were subsequently performed, and patients were immediately asked to rate the pain experienced during the biopsy alone.

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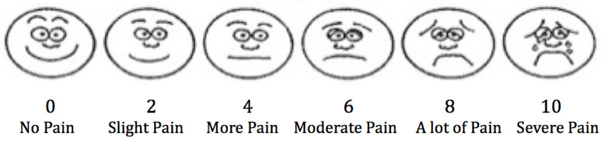
Only peak severity of pain upon injection and upon biopsy was recorded. The duration of pain was not recorded because providing anesthesia during biopsy was deemed most relevant for our study purposes.

FIGURE 1. Pain scale



RESULTS

Twenty-eight out of 31 patients reported that the unbuffered LA was more comfortable and less painful upon injection than the buffered LA. The distribution of pain fibers was similar because the injection sites were on the face where two biopsies were needed to rule out two separate potential skin cancers. Pain reported upon biopsy was negligible (the average reported pain was 0 on the VAS). The sample size was determined before data collection and based on a potential size that would be of statistical significance. The sample size calculation of 31 was based on a power of 80% and a 95% confidence interval

Since injections were given in separate, discrete locations, we may assume the independence of samples and, therefore, rule out sequence or blocking effects. The observations in each group were independent. Since each patient was acting as his own control, there were no differences in baseline characteristics between treatment groups.

Using a VAS of 0 to 10 for perceived pain, when comparing pain upon injection in the buffered LAs vs. unbuffered LAs, nearly every patient reported less pain from the injection with the unbuffered LA compared with the buffered LA (28 out of 31) with one patient reporting no difference and one patient reporting a 0.5 difference in pain favoring the unbuffered LA. The average difference in pain reported was 2.7 (see Table 1 for results). Traditionally, a difference in VAS of greater than 1.520 is considered clinically relevant.[2] Statistical analysis of this difference between pain reported upon injection with the buffered LA versus the unbuffered LA using a two-tailed Student paired *t* test revealed this to be a significant difference (P=2.3x10^{-9} = .0000000023). Therefore, the authors conclude that there is a significant difference in reported pain upon injection with the buffered LA vs the unbuffered LA, with less pain associated with the latter.

DISCUSSION

In search for painless anesthesia, physicians continue to use a myriad of techniques that will decrease the pain (analgesia) or eliminate the pain (anesthesia) associated with LAs. Hand-holding and talking (talkesthesia) are viewed as helpful.[3,4] Vibration devices have also been used to reduce pain.[5] Cooling the skin with cryogel packs before local anesthetic injection has been shown to decrease patient discomfort and improve the overall anesthetic experience.[6] Iontophoresis has been reported to be useful, but it requires training and instrumentation.[7] Warming the lidocaine to body temperature has also been shown to be somewhat effective in increasing analgesia, and buffering and warming the lidocaine solution before infiltration is significantly superior to buffering alone.[8]

A variety of topical anesthetics with or without occlusion have also been helpful during the needle insertion, but they often do not provide sufficient pain relief during infiltration of the local anesthetic.[9]

Of all the commonly employed techniques to induce analgesia, buffering lidocaine is the preferred technique among many dermatologists.[10] A minor setback is that buffering lidocaine shortens its shelf life.[11] As with buffered lidocaine, we found that the shelf life of our mixture is also shortened to approximately one month.

To date, the mechanism through which the infiltration of lidocaine causes pain is not completely understood. Many hypotheses exist that try to determine what influences pain perception. Liposolubility, changes in protein kinase A (PKA), and protein-binding properties are just a few of the theories currently found in the medical literature.[12]

The reason why adding sodium bicarbonate leads to pain reduction is also not well understood. Some authors believe that the increase in pH reduces the concentration of hydrogen ions, while others support the hypothesis that an increase in pH leads to an increase in the quantity of nonionized anesthetic.[13] It is believed that an increase in nonionized anesthetic will increase the amount of tissue diffusion, the concentration in nervous fibers, and the onset of the block, thereby masking the perception of pain.

The aim of our study was to determine if diluting lidocaine with normal saline would decrease the pain associated with subcutaneous infiltration and how this mixture would compare with traditionally buffered lidocaine. Lidocaine diluted with normal saline proved to be superior to traditionally buffered lidocaine for pain attenuation. Reduced pain secondary to tumescent anesthesia did not contribute to the decreased pain perceived by subjects, as both types of injection were of equal volume. In addition, tumescent anesthetics have a longer onset of action as compared with the total time of the injection and subsequent biopsy. The perceived pain of the injection in the normal saline group may be accounted for by the presence of benzyl alcohol in the normal saline.

Limitations of this study included the patient population, which consisted of Caucasian and Hispanic patients in a private, community-based hospital. Although we cannot state with certainty why our combination is more effective, we suspect that it is mostly due to the alteration of PKA.

CONCLUSION

Our results demonstrate that diluted lidocaine is superior to traditionally buffered lidocaine for pain attenuation during subcutaneous infiltration. We have found this mixture to be superior when obtaining skin biopsies, either by the punch or the shave technique. In addition, we recommend this mixture as a preanesthetic before more extensive procedures such as Mohs micrographic surgery or formal excisions, where long-lasting anesthetics such as bupivacaine would need to be added. Another benefit of this technique is that the mixture of lidocaine with normal saline is more cost-effective than either lidocaine buffered with sodium bicarbonate or lidocaine alone.

DISCLOSURES

The authors have no relevant conflicts of interest to disclose.

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