Dermatology Practical & Conceptual

Impact of Lidocaine Concentration on Analgesic Efficacy and Adverse Events in Dermatologic Infiltrative Anesthesia

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Key words: Lidocaine, Infiltrative anesthesia, Dermatological procedures, VAS, Pain management, Adverse events

Citation: Thanh LTV, Thong NT, Hung TQ, et al. Impact of Lidocaine Concentration on Analgesic Efficacy and Adverse Events in Dermatologic Infiltrative Anesthesia *Dermatol Pract Concept*. 2025;15(3):5382. DOI: https://doi.org/10.5826/dpc.1503a5382

Accepted: May 25, 2025; **Published:** July 2025

Funding: None.

Competing Interests: None.

Authorship: All authors have contributed significantly to this publication.

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ABSTRACT

Introduction: Infiltrative anesthesia with lidocaine plays a vital role in pain management during dermatological procedures, ensuring patient comfort throughout the process.

Objective: We aimed to investigate the correlation between three different concentrations of lidocaine (2% lidocaine with 1:100,000 epinephrine diluted at ratios of 1:2, 1:4, and 1:6) used in infiltrative anesthesia and their analgesic efficacy and adverse effects in dermatological procedures.

Methods: This study employed a randomized design, with 240 patients assigned to receive varying concentrations of lidocaine with epinephrine (2% lidocaine with 1:100,000 epinephrine diluted at ratios of 1:2, 1:4, or 1:6) during seven common dermatological procedures: punch biopsy, excisional biopsy, CO2 laser biopsy, surgical excision, CO2 laser excision, fractional CO2 laser treatment, and filler injection. Total lidocaine dosage and patient comfort assessments were recorded for each participant.

Results: All three lidocaine concentrations demonstrated comparable analgesic efficacy during the procedures, as measured by visual analog scale scores. The 1:6 dilution group required a significantly lower lidocaine dose, with a 39.3% reduction compared to the 1:4 dilution group and a 75.3% reduction compared to the 1:2 dilution group ($P<0.001$). The 1:6 dilution group experienced

significantly less pain during injection than that of the 1:4 dilution group and the 1:2 dilution group (P<0.001).

Conclusion: Lidocaine 2% with 1:100,000 epinephrine at dilutions ranging from 1:2 to 1:6 for infiltrative anesthesia in dermatological procedures provided similar analgesic efficacy. Importantly, the 1:6 dilution significantly reduced both injection pain and total lidocaine dosage. More studies are required to confirm our results.

Introduction

Effective analgesia in dermatological procedures is paramount to ensuring patient comfort and optimizing treatment outcomes. Infiltrative anesthesia with lidocaine is a mainstay technique for pain management in this setting. While minimizing the total dose of lidocaine is desirable to mitigate potential systemic toxicity [1], definitive guidelines regarding the minimum effective concentration for adequate analgesia in dermatological procedures are lacking.

Recent evidence from a comparative study evaluating 1% lidocaine with epinephrine versus 0.5% lidocaine with epinephrine in Mohs micrographic surgery demonstrated comparable analgesic efficacy, with the 0.5% formulation using half the lidocaine dosage [2]. However, no study has yet investigated the comparative analgesic efficacy of different lidocaine concentrations in other dermatological procedures.

This research aimed to determine the optimal lidocaine concentration for infiltrative anesthesia in various dermatological procedures, balancing maximal analgesic efficacy with the minimization of potential adverse effects.

Objective

This study aimed to investigate the correlation between different lidocaine concentrations (2% lidocaine with 1:100,000 epinephrine diluted to 1:2, 1:4, and 1:6) and their analgesic efficacy and adverse effects in infiltrative anesthesia for dermatological procedures. The objective was to identify the optimal lidocaine concentration that maximized pain relief while minimizing adverse effects, thereby enhancing patient comfort and satisfaction during dermatological procedures.

Methods

Participants

The investigation was a randomized controlled trial (RCT) with randomized allocation and single-blind evaluation. A total of 240 patients aged 18 years and older presenting for dermatological procedures for which infiltrative anesthesia is used were included in the investigation, with the patients blinded as to their treatment assignment. This research was conducted at the Dermatology - Skin Aesthetics Department of the University Medical Center at Ho Chi Minh City, a tertiary hospital in southern Vietnam, between November 2023 and June 2024. All participants were provided with comprehensive information regarding the study's aims, methodology, and potential risks, and written informed consent was obtained prior to enrollment. The study was approved by the Institutional Review Board of the University of Medicine and Pharmacy at Ho Chi Minh City (No. 1014/HĐĐĐ-ĐHYD, dated October 20, 2023).

The following criteria led to patient exclusion: (i) concurrent use of topical anesthesia at the site of infiltrative anesthesia administration; (ii) significant respiratory disease, hepatic pathology, or renal insufficiency; (iii) myocardial infarction within the preceding six months, or diagnosed or currently treated arrhythmia; (iv) history of chronic pain; (v) psychiatric disorders; (vi) history of regular use of analgesics, anxiolytics, or antidepressants; (vii) history of allergy to lidocaine or other local anesthetics.

Procedure

Seven dermatological procedures were performed in this study: (i) punch biopsy; (ii) excisional biopsy; (iii) CO_2 laser biopsy; (iv) surgical excision; (v) CO_2 laser excision; (vi) fractional CO_2 laser; (vii) filler injection. All anesthetic injections and dermatological procedures were administered by the blinded principal investigator. The infiltrative anesthetic solution consisted of 2% lidocaine with 1:100,000 epinephrine diluted with 0.9% sodium chloride solution to achieve dilutions of 1:2, 1:4, or 1:6.

Group A received a 1:2 volumetric dilution (one part 2% lidocaine with 1:100,000 epinephrine to one part 0.9% sodium chloride), resulting in a final concentration of 10 mg lidocaine per mL. This refers to volumetric dilution, not a percentage concentration.

Group B received a 1:4 volumetric dilution (one part 2% lidocaine with 1:100,000 epinephrine to three parts 0.9% sodium chloride), resulting in a final concentration of 5 mg lidocaine per mL. This refers to volumetric dilution, not a percentage concentration.

Group C received a 1:6 volumetric dilution (one part 2% lidocaine with 1:100,000 epinephrine to five parts 0.9%

sodium chloride), resulting in a final concentration of approximately 3.3 mg lidocaine per mL. This refers to volumetric dilution, not a percentage concentration.

To ensure randomization, a researcher not involved in patient care utilized the random number generator function in Microsoft Excel software to randomly assign participants to Group A, B, or C. Patients received an initial infiltrative anesthetic injection with a volume determined by the treating physician to ensure adequate analgesia for the specific procedure. The researcher recorded patient information and assigned patients to the corresponding lidocaine concentration groups (Figure 1). All diluted solutions were stored in the same room temperature environment. Infiltrative anesthesia was administered using a 30 G needle with a length of 13 mm.

Immediately after injection (approximately 5–10 seconds), patients were asked to rate their pain level using a visual analog scale (VAS).

Approximately one minute after the administration of infiltrative anesthesia, the designated procedure was performed. The duration of the procedure was recorded. If, during the procedure, a patient reported pain or exhibited signs of discomfort, the treating physician could administer additional anesthesia until the patient confirmed adequate pain relief. Both the initial and additional anesthetic volumes were recorded and converted to the corresponding lidocaine dosages.

Following the procedure, patients were again asked to rate their pain level during the procedure using the VAS. All local and systemic adverse effects were documented for up to 60 minutes post-lidocaine administration.

In summary, the following variables were recorded: age, sex, height, weight, anatomic site of the procedure, treatment area size, type of procedure, procedure duration, initial anesthetic volume, additional anesthetic volume (if applicable), lidocaine dose, VAS score for pain during the procedure and during anesthetic injection, local adverse effects (if any: erythema, edema, ecchymosis), and systemic adverse effects (if any: allergic reaction, local anesthetic systemic toxicity).

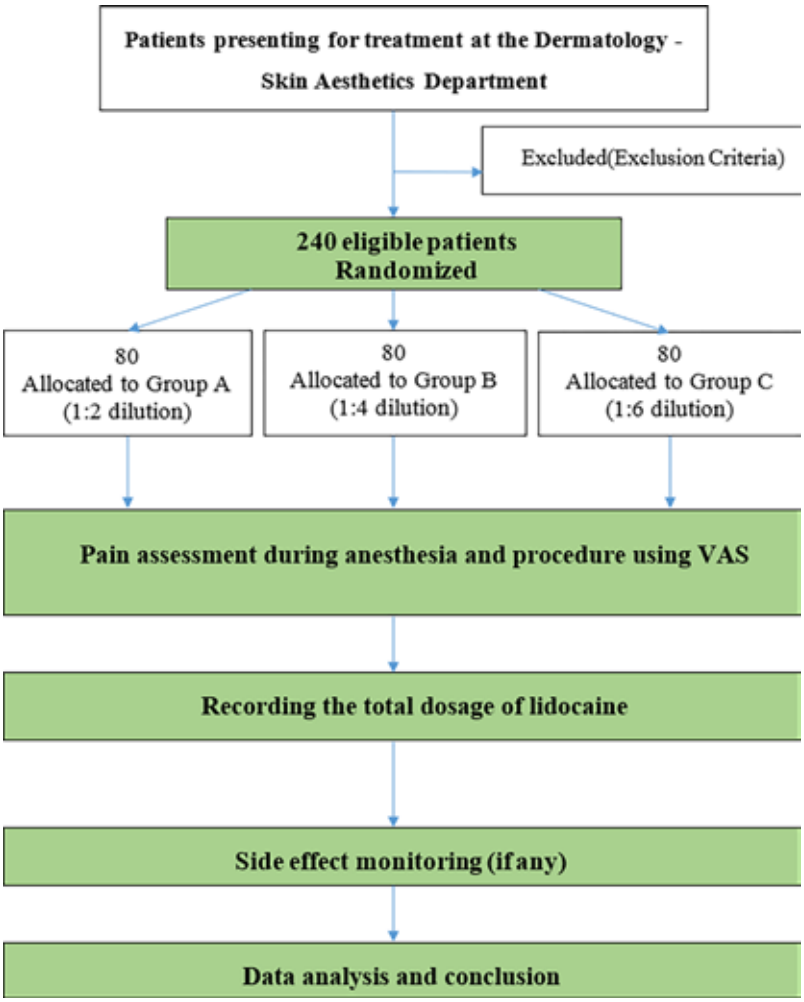

Figure 1. Patient flow.

Outcome Measures

The primary outcome of this study was the analgesic efficacy of the different lidocaine concentrations, assessed by the total lidocaine dose administered and the achieved level of pain control during the procedure. Pain control was evaluated using both subjective (VAS score during the procedure) and objective (volume of additional anesthesia required) measures. Secondary outcomes included adverse effects associated with infiltrative anesthesia, encompassing pain during injection (assessed by VAS score during injection), other local adverse effects, and any systemic adverse effects.

The VAS for pain assessment consists of a 100 mm horizontal line with "no pain" anchored at 0 point and "worst imaginable pain" at 100 [3]. Patients marked the line to indicate their subjective pain intensity during the procedure [3]. The VAS was selected for this study due to its extensive use in clinical research, established validity and reliability [4-7], and continuous scale, which allows for ratio comparisons of pain scores [8].

Bijur et al. (2001) demonstrated that 90% of paired VAS measurements for acute pain were consistent within 9 mm and suggested that a change of 10 mm or more on the 100 mm scale likely represents a clinically significant difference in pain intensity [5]. In a randomized trial investigating lidocaine dosing during dermatological surgery, Morganroth et al. (2009) found that 90.4% of patients reported VAS scores ≤10 mm, a threshold interpreted as indicative of no pain based on both subjective pain ratings and objective parameters such as the volume of rescue anesthesia administered [2]. Collectively, these findings support the use of a VAS score ≤10 mm as a valid cutoff to define the absence of pain. Accordingly, in the present study, participants were categorized as having "no pain" if their VAS score was ≤10 mm, and as having "pain" if the score exceeded this threshold.

Statistical Analysis

To estimate the sample size required to compare the mean lidocaine dose used in infiltrative anesthesia across three groups (2% lidocaine with 1:100,000 epinephrine diluted at ratios of 1:2, 1:4, and 1:6) for dermatological procedures, we employed the formula for comparing multiple means.

$$n \geq \left(1+\sqrt{g-1}\right)\frac{\left(z_{1-\frac{\alpha}{2}}+Z_{1-\beta}\right)^2}{(ES)^2}+\frac{Z^2_{1-\frac{\alpha}{2}}\sqrt{g-1}}{2(1+\sqrt{g-1})}$$

Where:

- n: sample size per group
- g: number of groups (g=3)
- α: probability of type I error (α=0.05)
- β: probability of type II error (β=0.2)
- ES: effect size

An effect size (ES) of 0.49, classified as small effect according to Cohen's effect size classification [9], was chosen to enhance the precision and reliability of the study results. Based on these parameters, the calculated sample size per group was 80 patients, resulting in a total sample size of 240 patients for the entire study.

Categorical variables (sex, anatomic site of the procedure, type of procedure, VAS score categorizations) are presented as percentages. Non-normally distributed continuous variables (treatment area size, procedure duration, volume of anesthetic used, lidocaine dose, VAS scores) are presented as median and interquartile range. Normally distributed continuous variables are presented as mean and standard deviation.

Chi-squared or Fisher's exact tests were used to examine the association between categorical variables and lidocaine concentration groups. The non-parametric Kruskal-Wallis test was employed to compare the three non-normally distributed group means. Logistic regression models were utilized to evaluate the association between binary dependent variables ("pain" or "no pain" based on VAS score categorizations) and independent variables (lidocaine concentration groups). Statistical significance was defined as $P< 0.05$.

Results

Between November 2023 and June 2024, 240 patients undergoing dermatological procedures received infiltrative anesthesia as part of this study. The mean age of the study participants was 39.9 ± 15.4 years. The majority of participants were female (61.7%). The mean height and weight of the participants were 1.61 ± 0.08 m and 58.8 ± 10.5 kg, respectively. There was no statistically significant difference in age, sex, height, or weight between the three study groups (Table 1).

A total of 12 anatomical locations were recorded as sites for procedures involving infiltrative anesthesia in this study (Table 2). The most common procedure location was the face, accounting for 51.7% of all procedures. The median treatment area size was 16 mm², with an interquartile range of 10.1 mm² to 43.2 mm². CO_2 laser excision was the most frequently performed procedure, representing 54.6% of all procedures. The median procedure duration was three minutes, with an interquartile range of 2–4 minutes (Table 2). There was no statistically significant difference in procedure location, treatment area size, procedure type, or procedure duration between the three study groups.

No participant required supplemental anesthesia in any of the study groups. Therefore, the initial anesthetic volume administered was the total anesthetic volume utilized. While the median anesthetic volumes used in groups A (0.4 ml), B (0.33 ml), and C (0.3 ml) showed some variation, this

Table 1. Participants' Characteristics (n=240).

Variable	All patients (N=240)	Group A (n= 80)	Group B (n= 80)	Group C (n=80)	p-value[1]
Age (years)†	39.9 ± 15.4	39.5 ± 14.2	40.6 ± 17.1	39.5 ± 15	0.98
Sex‡					
Male	92 (38.3)	31 (38.8)	29 (36.3)	32 (40)	0.88
Female	148 (61.7)	49 (61.3)	51 (63.7)	48 (60)	
Weight (kg) †	58.8 ± 10.5	58 ± 9.4	59.6 ± 11.7	58.8 ± 10.3	0.84
Height (m) †	1.61 ± 0.08	1.61 ± 0.08	1.61 ± 0.08	1.61 ± 0.08	0.72

† Data presented as mean ± standard deviation (SD). ‡ Data presented as number and percentage [No. (%)]. [1]p-value calculated using one-way ANOVA for continuous variables and the chi-squared test for categorical variables.

Table 2. Characteristics of the Treatment Area and Performed Procedure (n=240).

Variable	All Patients (N=240)	Group A (n=80)	Group B (n=80)	Group C (n=80)	p-value[1]
Procedure Location‡					0.49
Head (%)	4 (1.7)	1 (1.3)	1 (1.3)	2 (2.5)	
Face (%)	124 (51.7)	38 (47.5)	45 (56.3)	41 (51.2)	
Neck (%)	9 (3.8)	2 (2.5)	1 (1.3)	6 (7.5)	
Chest (%)	5 (2.1)	2 (2.5)	1 (1.3)	2 (2.5)	
Abdomen (%)	10 (4.2)	2 (2.5)	5 (6.3)	3 (3.8)	
Back (%)	17 (7.1)	8 (10.0)	4 (5.0)	5 (6.3)	
Arm (%)	16 (6.7)	5 (6.3)	3 (3.8)	8 (10.0)	
Hand (%)	8 (3.3)	3 (3.8)	1 (1.3)	4 (5.0)	
Finger (%)	18 (7.5)	8 (10.0)	6 (7.5)	4 (5.0)	
Leg (%)	19 (7.9)	8 (10.0)	9 (11.3)	2 (2.5)	
Foot (%)	5 (2.1)	1 (1.3)	3 (3.8)	1 (1.3)	
Toe (%)	5 (2.1)	2 (2.5)	1 (1.3)	2 (2.5)	
Treatment Area Size (mm²)†	16 (10.1–41.3)	16 (9.0–36.3)	16 (9.6–36.5)	17.5 (14.1–51.5)	0.45
Procedure Type‡					0.43
Punch biopsy (%)	65 (27.1)	24 (30.0)	23 (28.7)	18 (22.5)	
Excisional biopsy (%)	27 (11.3)	11 (13.8)	10 (12.5)	6 (7.5)	
CO2 laser biopsy (%)	4 (1.7)	2 (2.5)	1 (1.3)	1 (1.3)	
Surgical excision (%)	10 (4.2)	1 (1.3)	5 (6.3)	4 (5.0)	
CO2 laser excision (%)	131 (54.6)	42 (52.5)	40 (50.0)	49 (61.3)	
Fractional CO2 laser (%)	1 (0.4)	0 (0.0)	1 (1.3)	0 (0.0)	
Filler injection (%)	2 (0.8)	0 (0.0)	0 (0.0)	2 (2.5)	
Procedure Duration (min)†	3 (2–4)	3 (2–4)	3 (2–4)	3 (2–4)	0.38

†Data presented as median (interquartile range). ‡Data presented as number and percentage [No. (%)]. [1]p-value calculated using the Kruskal-Wallis test for continuous variables (e.g., treatment area size and procedure duration) and the chi-squared test for categorical variables (e.g., procedure location and type).

difference was not statistically significant (P=0.7). However, the median lidocaine doses in groups A (4 mg), B (1.63 mg), and C (0.99 mg) differed substantially. Notably, group C received a significantly lower lidocaine dose compared to both group B (39.3% lower) and group A (75.3% lower). This difference in dosage was statistically significant (P<0.001) (Table 3).

Across all three study groups, the vast majority of participants (97.5%, or 234/240) reported minimal to no pain (VAS score ≤10) during the procedure. While the proportion of participants reporting "no pain" varied slightly across the groups–95% (76/80) in group A, 97.5% (78/80) in group B, and 100% in group C–this difference was not statistically significant (P=0.17) (Table 3).

Table 3. Comparison of Anesthetic Volumes, Lidocaine Doses, and Pain Outcomes Across Groups (n=240).

Variable	Group A (n=80)	Group B (n=80)	Group C (n=80)	p-value[1]
Anesthetic volume (mL)†	0.4 (0.2–0.5)	0.33 (0.2–0.55)	0.3 (0.15–0.6)	0.7
Lidocaine dose (mg)†	4 (2–5)	1.63 (1–2.75)	0.99 (0.5–1.98)	<0.001
Procedural pain (VAS Score)‡				
0–10 (No Pain) (%)	76 (95.0)	78 (97.5)	80 (100)	0.17
11–20 (%)	3 (3.8)	2 (2.5)	0 (0)	
21–30 (%)	1 (1.2)	0 (0)	0 (0)	
Injection pain (VAS Score)				
Median VAS Score (mm) †	29.9 (17.6–48.7)	15 (9.1–22.2)	2 (0–4.4)	<0.001
Categories of injection pain (VAS Score) ‡				
0–10 (No Pain) (%)	4 (5.0)	24 (30.0)	69 (86.3)	< 0.001
11–20 (%)	24 (30.0)	30 (37.5)	10 (12.5)	
21–30 (%)	12 (15.0)	18 (22.5)	0 (0)	
≥31 (%)	40 (50.0)	8 (10.0)	1 (1.3)	

† Data are presented as median (interquartile range). ‡ Data are presented as number and percentage [No. (%)]. [1]p-value calculated using the Kruskal-Wallis test for continuous variables (e.g., anesthetic volume and injection VAS scores) and the chi-squared test for categorical variables (e.g., pain intensity categories).

The sole adverse effect observed among participants was pain experienced during the administration of lidocaine; no other local or systemic adverse effect was reported. A statistically significant difference (P<0.001) in pain scores was observed, with group C exhibiting an 86% and 93% reduction in VAS scores (2 mm) compared to group B (15 mm) and group A (29.9 mm), respectively (Table 3). Group C also exhibited a significantly higher proportion (P<0.001) of participants reporting "no pain" (VAS score ≤10) during injection (86.3%) compared to group A (5%) and group B (30%) (Table 3). Moreover, the odds of experiencing "pain" (VAS score >10) during injection were significantly elevated for group A (OR = 119.2, 95% CI: 36.3–391.7, P<0.001) and group B (OR = 14.6, 95% CI: 6.6–32.4, P< 0.001) relative to group C.

Discussion

Although previous research has compared the analgesic efficacy of different local anesthetics for infiltrative anesthesia [10] as well as the total lidocaine dose required for two different lidocaine concentrations (1% and 0.5%) in Mohs surgery [2], this study contributes to the literature by investigating the relationship between different dilutions of 2% lidocaine (1:2, 1:4, and 1:6) used in infiltrative anesthesia and the analgesic efficacy and adverse effects (specifically pain on lidocaine injection) across seven different dermatological procedures. Lidocaine concentration is the primary determinant of dosage for any given volume. To mitigate the risk of dose-dependent adverse effects, including potentially life-threatening complications associated with lidocaine toxicity, clinicians should prioritize achieving adequate anesthesia with the lowest effective dose. Furthermore, a lower lidocaine concentration appears to reduce pain during anesthetic injection, thereby improving patient comfort during infiltrative anesthesia administration [11-12].

Group C (2% lidocaine diluted 1:6) utilized a comparable volume of anesthetic to group A (2% lidocaine diluted 1:2) and group B (2% lidocaine diluted 1:4) while maintaining effective analgesia throughout the procedures. The absence of a need for additional anesthetic suggests that the procedures were either painless or that any pain experienced was minimal and tolerable. This observation provides an objective measure of the effectiveness of the anesthetic, complementing the subjective assessment of pain using the VAS.

The median lidocaine dose used in this study was 1.98 mg, with 75% of cases using less than 3.45 mg. The highest dose used was 20 mg, which is considerably lower than the recommended maximum dose of 500 mg for lidocaine with epinephrine for infiltrative anesthesia in adults [1]. When 400 mg of lidocaine is administered via infiltrative injection, the peak plasma lidocaine concentration reaches 1 µg/mL with a 1:200,000 epinephrine solution after approximately 15 minutes [13-16]. At plasma lidocaine concentrations of 1–5 µg/mL, the initial symptoms of lidocaine toxicity, such as tinnitus, dizziness, circumoral and fingertip paresthesia, diplopia, metallic taste, anxiety, and agitation, may appear [17]. The results of this study demonstrate that the lidocaine doses used for infiltrative anesthesia in the included procedures were far below the threshold for toxicity and likely very safe. Furthermore, the lidocaine dose used in group C (median

0.99 mg) was approximately 39.3% lower than in group B (median 1.63 mg) and 75.3% lower than in group A (median 4 mg). This reduction in lidocaine dosage can provide cost benefits and potentially decrease the risk of toxicity in procedures requiring larger areas of anesthesia.

The results demonstrate excellent analgesic efficacy across all three groups, with 97.5% of patients reporting "no pain" (VAS ≤10) during the procedures. This indicates effective pain control, with patients experiencing minimal to no pain throughout the procedures (the proportion of patients reporting "no pain" in groups A, B, and C was 95%, 97.5%, and 100%, respectively). These findings are consistent with the previously mentioned objective pain assessment, where no participant in any of the three groups required additional anesthesia.

Group C exhibited the lowest median VAS pain score during anesthetic injection (2 mm), followed by group B (15 mm) and group A (29.9 mm). This suggests that patients in group C generally experienced less pain during infiltrative anesthesia compared to the other two groups. Specifically, the median VAS pain score during injection in group C was approximately 86% lower than in group B and 93% lower than in group A, indicating a significant difference in pain levels between the groups. Furthermore, group C also had the highest proportion of patients who reported "no pain" (VAS ≤10) during injection at 86.3% (95% CI: 78.8%–93.5%). Group B had a lower proportion of pain-free injections at 30% (95% CI: 19.7%–40.3%), while group A had the lowest at 5% (95% CI: 1.1%–10.1%). This difference was statistically significant (P<0.001), indicating a real difference in the proportion of pain-free injections between the groups. The significantly higher proportion of pain-free injections in group C compared to groups A and B suggests that the lidocaine concentration used in group C may be more effective in reducing pain during infiltrative anesthesia. This finding may be related to the pH of the diluted lidocaine solution. A highly acidic solution can cause more pain during local anesthesia. According to a previous study by Simon Frank, the average pH of a 1% lidocaine solution with 1:100,000 epinephrine was 4.24 ± 0.42, while a 2% lidocaine solution with 1:100,000 epinephrine had an average pH of 3.93 ± 0.4 [18]. Although the pH of more diluted solutions was not reported, it is reasonable to hypothesize that increasing dilution may lead to a higher pH and, consequently, less pain on injection.

However, the pH of the diluted lidocaine solutions was not measured in our study. The proposed mechanism linking lidocaine dilution and reduced injection pain is therefore speculative and based solely on inference from previously published data. Future studies are warranted to directly investigate the relationship between lidocaine dilution, solution pH, and pain perception during infiltration.

Logistic regression analysis evaluating the impact of lidocaine concentration group on pain during anesthetic injection revealed that patients in group A were 119.2 times more likely to report pain during injection (VAS >10) compared to group C. Similarly, patients in group B were 14.6 times more likely to report pain during injection compared to group C. The p-value of < 0.001 indicates that these results are highly statistically significant. This analysis demonstrates a strong correlation between lidocaine concentration and pain experienced during infiltrative anesthesia.

As in previous studies worldwide, due to resource limitations, we were unable to measure plasma lidocaine concentrations. Various factors can influence systemic lidocaine levels, such as injection site vascularity and individual differences in hepatic metabolism and renal excretion. However, throughout the study period, no patient exhibited signs of lidocaine toxicity, and the doses used were significantly below known toxic thresholds.

In addition, the study has several other limitations. First, we did not perform longer-term follow-up beyond 60 minutes post-procedure, which may have limited detection of delayed adverse events. Second, although all assessments and data collection were conducted by a single principal investigator, infiltrative anesthesia was administered by multiple treating physicians. While standard injection protocols were followed, minor variations in technique, such as needle angle, depth of insertion, injection speed, and tissue resistance, may have contributed to differences in pain perception among patients. However, all treating physicians were senior dermatologists with substantial experience at major tertiary hospitals in Vietnam, which likely minimized inter-operator variability. Finally, this study was conducted in a single tertiary dermatology center in Vietnam, and all participants were Vietnamese patients undergoing dermatological or cosmetic procedures. Therefore, the generalizability of our findings to other populations, ethnic groups, or clinical settings may be limited.

Conclusion

In summary, the use of 2% lidocaine with 1:100,000 epinephrine at dilutions ranging from 1:2 to 1:6 for infiltrative anesthesia in dermatological procedures provided similar analgesic efficacy across seven types of dermatological procedures in this study. However, lower concentrations, particularly the 1:6 dilution, minimized pain during injection and reduced the required lidocaine dose. Future studies could investigate even lower dilutions of lidocaine with epinephrine to further explore the optimal concentration for infiltrative anesthesia in dermatologic and cosmetic procedures.

Ethics Approval: The study was approved by the institutional ethics committee (No. 1014/ HĐĐĐ-ĐHYD, dated 20-Oct-2023).

References

1. Kouba DJ, LoPiccolo MC, Alam M, et al. Guidelines for the use of local anesthesia in office-based dermatologic surgery. *J Am Acad Dermatol*. 2016. 74(6): 1201-19. PMID: 26951939. DOI:10.1016/j.jaad.2016.01.022
2. Morganroth PA, Koshnick RL, Ratz JL. A randomized, double-blind comparison of the total dose of 1.0% lidocaine with 1:100,000 epinephrine versus 0.5% lidocaine with 1:200,000 epinephrine required for effective local anesthesia during Mohs micrographic surgery for skin cancers. *J Am Acad Dermatol*. 2009;60(3):444–452. PMID: 19231641. DOI:10.1016/j.jaad.2008.08.001
3. Hawker GA, Mian S, Kendzerska T, French M. Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). *Arthritis Care Res (Hoboken)*. 2011;63(S11):S240–S252. PMID: 22588748. DOI:10.1002/acr.20543
4. Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. *J Clin Nurs*. 2005;14(7):798–804. PMID: 16000093. DOI:10.1111/j.1365-2702.2005.01121.x
5. Bijur PE, Silver W, Gallagher EJ. Reliability of the visual analog scale for measurement of acute pain. *Acad Emerg Med*. 2001;8(12):1153–1157. PMID: 11733293 DOI:10.1111/j.1553-2712.2001.tb01132.x
6. Scott J, Huskisson EC. Vertical or horizontal visual analogue scales. *Ann Rheum Dis*. 1979;38(6):560. PMID: 317239. DOI:10.1136/ard.38.6.560
7. McCormack HM, Horne DJ, Sheather S. Clinical applications of visual analogue scales: a critical review. *Psychol Med*. 1988;18:1007–1019. PMID: 3078045. DOI:10.1017/s0033291700009934
8. Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analogue scales as ratio scale measures for chronic and experimental pain. *Pain*. 1983;17(1):45–56. PMID: 6226917. DOI:10.1016/0304-3959(83)90126-4
9. Samritin S, Purnama B, Ulfah M. A meta-analysis study of the effect of the blended learning model on students' mathematics learning achievement. *Jurnal Elemen*. 2023;9(1):16. DOI:10.29408/jel.v9i1.6141
10. Howe NR, Williams JM. Pain of injection and duration of anesthesia for intradermal infiltration of lidocaine, bupivacaine, and etidocaine. *J Dermatol Surg Oncol*. 1994;20:459-64. PMID: 8034840 . DOI: 10.1111/j.1524-4725.1994.tb03216.x
11. Vent A, Wu Y, Ghadially R, et al. Buffered lidocaine 1%/epinephrine 1:100,000 with sodium bicarbonate in a 3:1 ratio is less painful than a 9:1 ratio: a double-blind, randomized, placebo-controlled, crossover trial. *J Am Acad Dermatol*. 2020;83(1):159–165. PMID: 31958526. DOI:10.1016/j.jaad.2019.09.088
12. Zaiac M, Hochman LG. Virtually painless local anesthesia: diluted lidocaine proves to be superior to buffered lidocaine for subcutaneous infiltration. *J Drugs Dermatol*. 2012;11(10):39–42. PMID: 23134997
13. Malamed SF. Pharmacology of local anesthetics. In: Malamed SF, ed. *Handbook of Local Anesthesia*. 6th ed. Elsevier; 2019:27–39.
14. Adams HA, Hammersen F, Heckmann M, et al. Plasma level of lidocaine and epinephrine in local anesthesia with addition of colloid in eye surgery. *Fortschr Ophthalmol*. 1990;87(2):209–213. PMID: 1694158
15. Donald MJ, Derbyshire S. Lignocaine toxicity: a complication of local anaesthesia administered in the community. *Emerg Med J*. 2004;21(2):249–250. PMID: 14988367. DOI:10.1136/emj.2003.008730
16. Piveral K. Systemic lidocaine absorption during liposuction. *Plast Reconstr Surg*. 1987;80(4):643. PMID: 3659178. DOI:10.1097/00006534-198710000-00038
17. Giordano CN, Lidsky ME, Lyon VB. Local anesthesia: evidence, strategies, and safety. *Curr Dermatol Rep*. 2015;4:97–104. DOI:10.1007/s13671-015-0110-9
18. Frank SG, Lalonde DH. How acidic is the lidocaine we are injecting, and how much bicarbonate should we add? *Can J Plast Surg*. 2012;20(2):71–73. PMID: 23730153. DOI:10.1177/229255031202000207