A Pilot Study: 0.2% vs. 0.5% Lidocaine For Intravenous Regional Anesthesia

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Abstract

Background: Standard intravenous regional anesthesia (IVRA) uses 3 mg/Kg of 0.5% lidocaine. However, a lower dose, larger volume lidocaine may be as effective.

Methods: Randomized single blind study of emergency department patients with closed Colles fractures reduced with either 3 mg/Kg (0.6 mL/Kg) 0.5 % lidocaine (N=11) or 2 mg/Kg (1.0 mL/Kg) 0.2% lidocaine (N=10). Anesthesia outcome measured with 4-category pain rating scale.

Results: Analysis of pooled data showed no significant difference in pain rating between IVRA methods (p=0.35). There were no significant differences in age, tourniquet time, or vital signs between groups. Mean body weight was 11.3 Kg less in experimental group (p<0.05). Mean±SD lidocaine volume and dose (standard vs experimental) were: 46.7±6.9 mL vs 66.9±12.4 mL, and 233.7±35.2 mg vs 133±24.8 mg. One woman (standard group) experienced transient lidocaine toxicity.

Conclusion: Low-dose lidocaine is as effective and may be safer than the standard dose for IVRA.

This study was conducted in the Department of Emergency Medicine at Los Angeles County-University of Southern California Medical Center, Los Angeles, CA, USA.

INTRODUCTION

Standard intravenous regional anesthesia (IVRA) involves administration of 0.5% lidocaine solution using a dosing scheme of 3 mg/Kg body weight (0.6 mL/Kg).[1] Some literature suggests that a more dilute lidocaine solution may provide equally effective anesthesia.[2,3,4,5] Eckstein et al[6] investigated the efficacy of 0.5%, 0.33%, and 0.25% solutions of mepivacaine administered at 1.0-1.5 mL/Kg for IVRA. In reducing the concentration by way of an increase in volume, along with a simultaneous reduction in the absolute amount of drug given, the number of successful blockades increased as the concentrations of mepivacaine successively decreased. Mepivacaine and lidocaine share many similar physiochemical and biologic properties such as potency, duration of action, pKa, and maximum dose.[7] The quality of anesthesia obtainable by IVRA is, in part, a function of local anesthetic volume, dose and concentration. However, the optimal proportions of these are unknown.

The purpose of this pilot study was to compare the effectiveness of 0.2% versus 0.5% lidocaine for IVRA.

MATERIALS AND METHODS

Following approval by the institutional review board and written informed consent, this prospective randomized single blind study was carried out on 21 ASA I and ASA II physical status patients, aged 18-70 who presented to the emergency department with closed Colles fracture requiring closed reduction under IVRA. Exclusion criteria were any contraindication to IVRA, hypersensitivity to study drugs, pregnancy or nursing.

Patients were randomized to receive either the standard dose of 3 mg/Kg of 0.5% lidocaine solution (0.6 mL/Kg) or the experimental dose of 2 mg/Kg of 0.2% lidocaine solution (1.0 mL/Kg). Randomization was performed by assigning an IVRA method to each patient based upon the terminal digit of each patient's medical record number. By predetermined assignment, individuals with even last digits received 0.5% lidocaine solution, and individuals with odd last digits received 0.2% lidocaine solution.

Each patient received meperidine (50-100 mg IM) with or without hydroxyzine (25-50 mg IM) for preanesthesia analgesia and anxiolysis, respectively. Standard chest electrode placement for cardiac monitoring was applied to each patient, and attached to a portable cardiac monitor/defibrillator. Cardiac monitoring was continuous throughout IVRA, and for 10 minutes following tourniquet deflation. An automated vital sign monitor was used to measure heart rate (HR), blood pressure (BP), and mean arterial pressure (MAP) on the uninvolved arm. HR, BP and MAP were obtained at 5, 10, 15, 20, 25 and 30 minutes during IVRA, and again at 1, 2, 3, 4, 5, 7.5 and 10 minutes following tourniquet deflation.

Standard IVRA technique was performed using the following procedural highlights. Limb exsanguination was performed by arm elevation for 3 minutes along with simultaneous manual compression of the brachial artery. This was followed by inflation of a single cuff arm tourniquet to 285 mmHg. A solution of 0.5% plain lidocaine (Abbott Laboratories, North Chicago, IL) was used for both methods. The 0.2 % lidocaine solution was made by diluting four parts 0.5% lidocaine solution with six parts normal saline (Abbott Laboratories, North Chicago, IL). Both solutions were injected into a dorsal hand vein at a rate approximating 1 mL/sec. Minimum tourniquet inflation time was 20 minutes, and the tourniquet was released all at once without cycling at the end of the procedure. During and following IVRA, patients were monitored for lidocaine toxicity.

A four-category verbal pain rating scale that was previously explained to each patient was used to determine anesthetic outcome in terms of pain relief. Patients were asked to rank their pain sensation as: 0) no pain, 1) mild pain, 2) moderate pain or 3) severe pain. Although patients were asked to describe their pain sensation after their procedure was completed, they were asked to rate the pain that they had at the time of the actual closed reduction maneuver. Closed reductions took place as close as possible to 20 minutes of tourniquet inflation time after lidocaine injection for all patients.

Pain categories were pooled for data analysis, and were analyzed using Fisher's exact test. Colles fracture parity between groups was assessed using chi-square for independence. Age, weight, lidocaine, meperidine and hydroxyzine dose and volume between IVRA groups were analyzed with the unpaired t-test. Comparisons of heart rates, systolic, diastolic, and mean arterial blood pressures were performed using repeated measures ANOVA.

RESULTS

Table 1 summarizes the four-category verbal pain rating scale raw data.

Figure 1

Table 1: Four-category pain scale data

Lidocaine	No Pain	Mild Pain	Moderate Pain	Severe Pain
0.2%	4	4	1	1
0.5%	7	4	0	0

Analysis of pooled data showed no significant difference in pain rating between the two methods of IVRA (p=0.35) (Table 2). There was parity between groups with regard to type of Colles fracture (p=0.39).

Figure 2

Table 2: Pooled pain ratings between IVRA methods

Lidocaine	No Pain	Pain
0.2%	4	6
0.5%	7	4

Table 3 summarizes the age, weight, lidocaine dose and volume, meperidine dose, hydroxyzine dose, total tourniquet time, and gender for patients in each lidocaine group.

Figure 3

Table 3: Comparison of 0.2% with 0.5% lidocaine IVRA groups

	0.2% Lidocaine Group	0.5% Lidocaine Group
Age (Years)	49 ± 10.5 (32-70)	43.5 ± 14.1 (24-70)
Weight (Kg)	66.9 ± 12.4* (47-83)	78.2 ± 11.9* (58-102)
Lidocaine dose (mg)	133.8 ± 24.8* (94-166)	233.7 ± 35.2* (170-300)
Lidocaine volume (mL)	66.9 ± 12.4* (47-79)	46.7 ± 6.9* (34-60)
Meperidine (mg)	80.0 ± 15.8 (50-100)	79.5 ± 15.1 (50-100)
Hydroxyzine (mg)	37.5 ± 13.2 (25-50)	31.8 ± 16.2 (0-50)
Tourniquet time (min)	30.1 ± 1.9 (29-35)	32.0 ± 2.4 (29-36)
Gender (Male:Female)	2:8	4:7

Values expressed as mean ± SD (min, max) except for gender
* Significantly different between methods (p<0.05)

As expected, the 0.2% lidocaine group received significantly smaller lidocaine dose and larger volume compared with the 0.5% lidocaine group. All individuals within the 0.2% lidocaine group received less lidocaine than did any patient in the 0.5% lidocaine group. Only the mean body weight was otherwise significantly different between groups with the 0.2% lidocaine group being 11.3 Kg less than that of the 0.5% lidocaine group.

No significant differences were found between the 0.2% and 0.5% lidocaine IVRA groups with regard to the following physiologic parameters monitored during and after anesthesia: HR, systolic BP, diastolic BP, and MAP (data not shown).

One patient within the 0.5% lidocaine group was observed to be restless for approximately 3 minutes following tourniquet release. During this same time interval, this individual reported transient tinnitus, and stated that the voices within the room sounded "far away." The patient was a 38-year-old female, and weighed 63 Kg. She received 38 mL of 0.5% lidocaine solution (190 mg). Two minutes following tourniquet release, her MAP increased from a resting value of 92 mmHg to 103 mmHg. This was followed by a return to 92 mmHg at 3 minutes. Her baseline HR was 75 beats/min which increase to 87 beats/min, 1 minute following tourniquet deflation. This returned to 76 beats/min, 2 minutes following tourniquet deflation. At no time did this patient lose consciousness, nor did she develop hypotension or bradycardia. Aside from the transient increase in HR, there were no other EKG changes. This patient had no further event, and was completely stable with normal sensorium at the time of discharge. Her selection on the pain assessment scale was "no pain." There were no other subjective reports or objective findings suggestive of lidocaine toxicity.

DISCUSSION

The 0.2% and 0.5% lidocaine IVRA methods produced statistically equivalent degrees of anesthesia. However, one patient in the 0.2% lidocaine group reported moderate pain, and another reported severe pain. No such reports occurred within the 0.5% lidocaine group. One patient within this latter group experienced an episode highly suggestive of transient lidocaine toxicity.

The selection of 0.2% lidocaine as the experimental dose was based upon available data. A 0.2% lidocaine solution using a dosing scheme of 1 mL/Kg approximated an equipotent midway point between the Juliano[5] and Eckstein[6] investigations. Although chosen somewhat arbitrarily, available evidence suggested that this lidocaine solution and volume of administration would provide a sufficient quantity of drug, dispersed in an adequate volume, to provide quality anesthesia.

In the present study, individuals from the 0.2% lidocaine group received 1 mL/Kg without any limitation being placed upon a maximum volume. Five of 10 individuals within this group received volumes of injection greater than 60 mL, including the 2 individuals who reported moderate and severe pain. These 2 individuals also received among the largest volumes of injection within their group, 77 mL and 83 mL, respectively. Mabee et al[8] demonstrated that

intravenous injections up to 60 mL of saline in atraumatic volunteers undergoing simulated IVRA of the upper limb did not cause intravenous pressures to exceed applied tourniquet pressure. Although none of the patients in the 0.2% lidocaine group developed subjective or objective findings of lidocaine toxicity, if the intravenous pressures that developed during injection exceeded the applied tourniquet pressure, it is conceivable that some of the injected lidocaine leaked underneath the tourniquet. This could have resulted in suboptimal anesthetic effect. While blood samples taken at that time would have confirmed the presence or absence of lidocaine in the circulation, these were not obtained.

The 0.2% lidocaine group also had a lower overall body weight compared with the 0.5% lidocaine group. Although they received a lidocaine volume that was proportionate with their body weight, it is unknown if this difference between groups impacted the anesthetic outcome.

The rate of adverse events from local anesthetic agents used in IVRA ranges from 1.6-2.1%.[9,10] While a single patient (9%) within the 0.5% lidocaine group had clinical evidence of a mild transient lidocaine toxic episode following tourniquet release, the sample size of this pilot study precludes making proper inferences regarding adverse events from the available data.

In conclusion, this pilot study demonstrates the clinical effectiveness of a low-dose lidocaine solution for IVRA in adults. This study provides a basis from which further investigations can be undertaken to define the optimal volume-dose-concentration of lidocaine for use in IVRA.

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