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Research article

Buffered Versus Non Buffered Lignocaine with Adrenaline for Pain Control in Hand Surgery: A Comparative study

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ABSTRACT

Background and Objectives: Patients with hand injuries and other conditions presenting to ER or office are usually given local anaesthesia to evaluate the case or perform a certain procedure. Lignocaine in various concentrations with or without adrenaline is used. Lignocaine with adrenaline is shown to be more acidic than plain lignocaine of similar concentration causing more pain. Sodium bicarbonate has been shown to decrease the pH of lignocaine hence decrease the pain related to injection. So this study is carried out to compare buffered (sodium bicarbonate) and plain lignocaine with adrenaline for pain control and analgesia for patients undergoing hand surgery.

Material and methods: Patients in the age group of 18-60 years were divided into two groups- a control group (receiving lignocaine hydrochloride with adrenaline) and a study group (receiving carbonated lignocaine with adrenaline) and were evaluated for pain at the site of injection, onset of action of the anesthetic and its duration of analgesia and anaesthesia.

Results: A total of 38 patients were included, 19 in each group. There was a significant difference in the pain score at time of injection between study group and control group (median,range: 2(1-5) and 7(4-9) respectively) with $p<0.001$. However, there was no significant difference in terms of onset of action, duration of anaesthesia and return of pain sensation. One patient developed swelling over wrist joint who received buffered solution.

Conclusion: Local anesthetics used routinely in hand department should be buffered with sodium bicarbonate to reduce pain on injection of drugs in the patients.

Key words: Alkalization of local anaesthesia, Buffered lignocaine, Freshly prepared Lignocaine with adrenaline, Sodium bicarbonate, Hand surgery anesthesia

INTRODUCTION

Hand and microsurgery is new and rapidly developing sub-speciality in developing and underdeveloped countries. Pain is invariably caused by administration of local anaesthetic solutions and multiple factors have been attributed like speed of injection, needle used , technique of administration and pH of the solution [1] and additives (Dexamethasone, mannitol) [2,3]. Various types of local anaesthetic in various concentrations and with preservatives are available in the

market. Local anaethetic solution consists of bases (uncharged molecules) and cations (positively charged molecules). The base form diffuse through the nerve sheath and revert back to charged form within the axoplasm and block the sodium channels inducing nondepolarising nerve block. The higher the pH of solution, the more free base form of solution exists. When pH of local anaesthetic equals pka (dissociation constant), equal amount of cation and base form [4]. pH of various concentrations and with adrenaline has been given by Frank and Lalonde given in table 1. They have also shown that a previously opened lignocaine is more acidic than a freshly opened lignocaine [5, 6].

Table 1: pH of different local anesthetics

S. N	Local Anaesthetic	pH
1.	1% lidocaine with 1:100,000 adrenaline	4.24±0.42
2.	Plain 1% lidocaine	6.09±0.16
3.	2% lidocaine with 1:100,000 adrenaline	3.93±0.43
4.	plain 2% lidocaine	6.00±0.27

Best in his study on pH and effect of alkalization has showed that there is relative increase in non ionized fraction of local anaesthetic. However, there is higher relative increase of non-ionized fraction of lignocaine and bupivacaine containing adrenaline than their plain solutions [7]. Basic pH solutions of local anaesthetic convert it to its active non ionized form decreasing the time of onset of its effects [8].

Sodium bicarbonate in various concentrations is the most commonly used drug for neutralization of local anaesthetics. Sodium bicarbonate is available in concentrations of 7.5% and 8.4% in ampoules and vials as sterile, nonpyrogenic solution for IV use . The solution is intended for single use since it has no bacteriostatic, antimicrobial agent or added buffer. It dissociates in water to provide sodium (Na+) and bicarbonate ($HCO3^-$) ions [9]. Frank et al. in their titration curve of 1% lidocaine with 1:100,000 adrenaline versus 8.4% sodium bicarbonate have shown that a ratio of 1.1 mL:10 ml achieved a mean pH of 7.38±0.12 and ratio of 1.8 ml:10 ml achieved a mean pH of 7.62±0.12. They recommended a ratio of 10ml:1ml of 1%lignocaine with 1:100000 adrenaline against 8.4% sodium bicarbonate [5].

Best recommends a combined solution of 2% lidocaine with 1:100,000 adrenaline and 0.5% bupivacaine with 1:200,000 adrenalines in a 1:1 ratio, buffered with NaHCO3. In a 10ml syringe containing 4.5 mL of 2% lidocaine with 1:100,000 adrenaline, 4.5 mL of 0.5% bupivacaine with 1:200,000 adrenaline, and 0.4 mL of 8.4% $NaHCO_3$ had a mean of 11hrs 18 min of anaesthesia [7]. Frank has recommended the ratio of lignocaine and bicarbonate required to achieve a tissue pH between 7.3-7.6 to be between 1.1-1.8 mL:10 mL . For clinical purpose, 10 mL of 1% lidocaine with 1:100,000 epinephrine with 1 mL of 8.4% sodium bicarbonate solution to attain a near physiological pH [5].

The aim of the study was to compare the local anesthetic drug lignocaine (1%) with adrenaline (1:1,00,000) buffered with sodium bicarbonate (7.5%) with plain solution in terms of onset of anesthesia, pain on injection, duration of anesthesia and return of pain sensation.

MATERIAL AND METHODS

The prospective study was carried out at Kirtipur Hospital. All the patients of age

group 18-60 yrs giving consent for the study, attending the emergency department and hand clinics presenting with hand injuries or other hand conditions requiring surgical interventions during a period of 2 months (15 March- 15 May, 2019), were included and a detailed case history was recorded. Assuming P=.05, power =.8 and a medium effect size= 0.5, a sample size of 34 was needed for continuous measures of the onset and duration of anesthesia. Patients meeting following exclusion criteria were excluded from the study.

Exclusion criteria:

- Patients taking any medications that alter pain perception
- Medically compromised conditions or with systemic illness eg sepsis
- Patients allergic to any components of medication
- Pregnant women
- Acute infections
- Injuries involving regions beyond hand
- Patients with medical conditions where perception of pain may be altered, e.g., coma, diabetes, peripheral neuropathies

Procedure: All the cases included were numbered serially and divided into two groups. All participants with odd serial number were categorized in Group A and received non buffered solution (Solution A). Participants with even serial number were categorized in Group B and received buffered solution (solution B). All the solutions were freshly prepared by using Lignocaine 2% available in vial of 30 ml, inj Adrenaline 1:1000 concentration available in 1ml ampoule and Sodium bicarbonate (7.5%) available in 10ml ampoule. The details of the composition are given in the table 2.

Table 2: Composition of Solutions

Solution	Composition
A (two 10ml syringe) Non Buffered Solution	5ml lignocaine 2% + 0.1 ml adrenaline + 6.1ml NS
B (two 10ml syringe) Buffered solution	5ml lignocaine 2% + 0.1 ml adrenaline + 4.9ml NS + 1.2ml Sod. Bicarbonate (7.5%)

The solution was thoroughly mixed and screened for any precipitate against a bright background, if any, was discarded. The solution was given to the operating surgeon for giving wrist block.

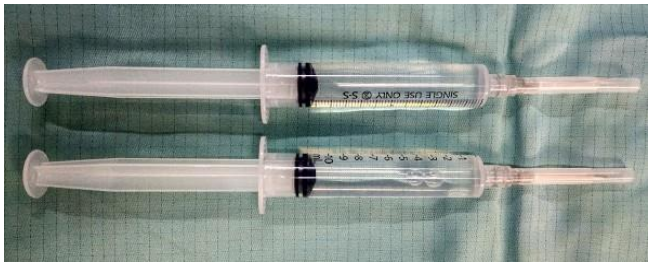

Figure 1: Solution after preparation

Wrist block was be given by injecting 5ml anaesthetic solution between FCR and PL at distal wrist crease, ulnar to FCU tendon, and in anatomical snuff box subcutaneously for median , ulnar nerve and radial nerve respectively. For palmar cutaneous nerve , dorsal cutaneous branch of ulnar nerve, 2-3 ml solution was injected subcutaneously at distal wrist crease between FCR and PL and subcutaneous border of ulna approx 4-6cm proximal to wrist joint. A total of 2 min was used for injecting the drugs.

Following injection, onset of anaesthesia was assessed with feeling of numbness on stimulation by an alcohol swab every 30 sec. After cold insensitivity pain was confirmed with needle prick. Pain was assessed (subjective and objective) using Visual

Analogue Scale (VAS) at the site of injection and surgical field [10]. Pain scores (1-10) was also taken at end of procedure. Patients were asked to note the time of return of sensation and pain for the first time. Patients were discharged on analgesics on as required doses.

Data collection and statistical analysis: The data were collected after inclusion of participants in the study by a nurse. After performing the procedure by the surgeon, the patients were followed up for 24 hrs and return of sensation and onset of pain was noted. Also, enquiry was made regarding any local reaction or adverse effects to drugs. All the analysis done using SPSS 20 version. Independent t-test was applied for normally distributed data where as Mann-Whitney U testwas applied when data were not normally distributed. p-value <0.05 considered as statistically significant.

The study obtained ethical approval from Institutional Review Committee of Phect Nepal. Consent was also taken from the patients.

RESULTS

According to zone of Injury case were distributed and is presented in figure 2. Of the 38 cases, males and females are equally distributed in both the groups and 1 case receiving buffered solution reported wrist swelling as a complication. The demographics of the patients of the study is presented in table 3.

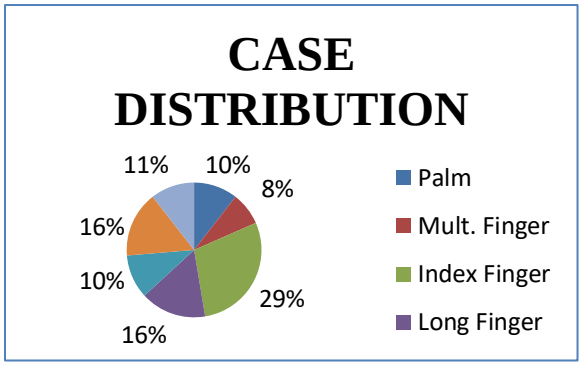

Figure 2: Case distribution based on zone of injury

There is a significant reduction in pain score while injecting buffered solution (p value = <0.0001) however, there is no significant difference between both groups in terms of onset of anaesthesia, duration of anaesthesia, return of pain sensation as seen in the table 4.

DISCUSSION

Doctors treating hand conditions usually use local anaesthetic (lignocaine with/without adrenaline, bupivacaine, prilocaine) for examining and performing any procedure. Pain while injecting these drugs and prolonged onset of action are invariably associated leading to anxiety and non-coperation by the patient for the procedure. Various modalities and drugs have been used to decrease pain associated with local anaesthetics. In our study, we have tried to compare the most commonly available local

Table 3: Demographic profiles of patients in Non Buffered and Buffered Group

		Group A (Non Buffered Solution)	Group B (Buffered Solution)
		n (%)	n (%)
Sex	Male	16(84.2%)	16(84.2%)
	Female	3(15.8%)	3(15.8%)
Age	Mean± SD	28.9±8.6	29.7.0±10.0
Side involved	Left	5(26.3%)	12(63.2%)
	Right	14(73.7%)	7(36.8%)

Table 4: Statistical Results in Non buffered and Buffered groups

S. N	Characteristics	Group A Mean± SD	Group B Mean± SD	p- value
1.	Onset of analgesia (min)	4.7± 0.96	4.7± 1.3	0.945*
2.	Duration of Anaesthesia (Hrs)	6.1±2.7	5.9±0.9	0.725*
3.	Return of pain sensation (Hrs)	7.2±3.1	6.8±1.3	0.576*
		Median (Range)	Median (Range)	
4.	Pain Score VAS	7 (4-9)	2 (1-5)	<0.001**
5.	Duration of procedure (min)	50 (10-120)	50 (20-140)	0.525**

* Independent t test
** Mann-Whitney U test

anaesthetic drug (lignocaine with adrenaline) in both buffered and non-buffered form in terms of pain associated with injection of the agent itself and anesthetic effectiveness.

Results of our study clearly show significant decrease in pain due to injection in patients receiving buffered solution as seen in other studies [9, 11, 12]. This study has used freshly prepared Lignocaine mixed with required amount of anrenaline, while most of the studies have used premixed lignocaine with adrenaline.[5,7,9,11,12] Best et al has shown that on alkalization, there is relatively higher increase in non-ionised fraction of local anaesthetic containing epinephrine. Ratios of lignocaine with adrenaline: sodium bicarbonate in 9:1 – 10:1 has been recommended to attain the physiological pH to decrease pain of injection and onset of time.[5,7] However, our study shows no significant decrease in onset of time of anaesthesia as seen in studies.[13,14] Studies done by Agrawal et al [12], shows decreased time of onset of anaesthetic action. There is no significant difference in duration of action of anaesthesia and return of pain sensation. Lingaraj has also shown no difference in onset and duration of action, however, he has shown that buffered solution has a faster onset of action in infected cases [9].

The major limitation of our study were that the data were collected over a two months period and limited number of cases. The surgeon was aware of the solution being given that could lead to some biasness. The age group involved in the study was 18-60 yrs, so, generalization cannot be made to pediatric age group who become anxious on separation from near ones or visualization of needle. Hence, larger age group needs to be covered to make generalization. Not even a single infected case was involved in the study. Males are more in number than females because more males work outdoor in the society and also females neglect their minor health problems. Follow up of the cases was done for 24 hrs only; longer duration follow up is required to know any long term effects of anesthetic solution.

CONCLUSION

It is conclude that lignocaine (1%) with adrenaline (1:1,00,000) in the ratio of 10: 1.2 buffered with sodium bicarbonate(7.5%) reduces the pain due to injection, however, we noticed no difference in onset, duration of action and return of pain sensation. Further studies are required to generalize the results.

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