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Efficacy of buffered local anaesthetics in head and neck infections

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Abstract

Lignocaine is one of the most commonly-used agents to anaesthetise an area preoperatively. It can, however, cause undesirable effects such as burning on injection, relatively slow onset, and unreliable, or lack of, numbness when injected into infected tissues as a result of the acidic pH of commercial preparations (the pH is between 3.5 and 7.0 compared with the physiological pH, which is between 7.35 and 7.45). The aim of this comparative study was to evaluate the efficacy of buffered local anaesthetic on infected areas by altering the pH with 8.4% sodium bicarbonate, to measure the pain before and after the injection, and to record the time of onset of anaesthesia. All 60 patients were given 2% lignocaine hydrochloride with adrenaline 1:80,000 and 30 patients were randomly allocated to have 10:1 dilution of 8.4% sodium bicarbonate (study group). Pain was assessed on a visual analogue scale and a verbal rating scale. There was a significant difference in the amount of pain between control and study groups ($p = 0.025$). The mean (SD) time (minutes) to onset of local anaesthesia in the study group was 1.06 (0.25) compared with 2.96 (0.81) in the control group ($p < 0.001$). Our results confirm the efficacy of the buffered local anaesthetic solution in reducing pain on injection and resulting in quicker onset of anaesthesia. Increasing the pH of lignocaine solutions with bicarbonate immediately before use, therefore, should be considered when treating various acute infections of the head and neck.

Keywords: Buffering local anaesthesia; Sodium bicarbonate; head and neck infections

Introduction

Successful pain control is an integral part of clinical practice, and anaesthetising an area of interest or teeth associated with infection can be challenging.[1] Clearly, this is an area that needs continuing research.

Local anaesthetics (LA) are agents that reversibly block nerve conduction when applied to a circumscribed area of the body to block the sensation of pain. Epinephrine is commonly given with lignocaine, and the addition of epinephrine potentiates and prolongs the action of lignocaine in a dose-related manner. In addition, the higher pH of the lignocaine-epinephrine solution could influence the amount of pain felt on injection.[2]

Many factors contribute to the reduction of clinical efficiency of LA, and these include the increased vascularity of the inflamed tissues. This removes the local anaesthetic effect almost immediately, thereby increasing the sensitivity of the tissues. It has also been reported that the pH of inflamed tissues is lowered slightly, which in turn interferes with the dissociation of local anaesthetics. When the pH of tissue fluids was measured in the presence of inflammation it was found to be lowered, the greatest change being in the presence of pus when it may be as low as 5.0.[3]

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Buffered local anaesthetics may be more efficient in controlling pain. The reason for buffering local anaesthetics is substantiated by the Henderson-Hasselbalch equation; if a local anaesthetic solution is buffered to a pH that is closer to its pKa, more of the free base form will be available on injection to enter the nerve sheath. This can be achieved by the addition of sodium bicarbonate ($NaHCO_3$), which will not only increase the pH of the solution but will also result in the production of carbon dioxide. There is overwhelming evidence that buffered local anaesthetics cause less pain during injection, and some patients have reported no pain at all.[4] We have therefore investigated whether pain is reduced as a result of buffering local anaesthetics in the management of various acute head and neck infections.

Patients and methods

We studied 60 patients who presented to the emergency and outpatient Departments of Oral & Maxillofacial Surgery, JSS Dental College and Hospital, Mysore, with acute head and neck infections. The ethics of the study protocol were approved by the Institutional Review Board, and written informed consent was taken from all the participants.

The physical condition of all patients was evaluated, and those with systemic diseases for which injections of lignocaine with adrenaline were contraindicated were excluded from the study. Patients were randomly assigned to have either buffered 2% local anaesthesia with 1:80,000 adrenaline and 8.4% sodium bicarbonate (group I, n = 30), or 2% lignocaine with 1:80,000 adrenaline alone (Group II, n = 30). All procedures were done by a single maxillofacial surgeon who was unaware of the LA given to the patient.

For group I, buffered local anaesthetic solution was freshly prepared just before the operation by adding 8.4% sodium bicarbonate 0.18 ml (Neon- Sodac Injection 8.4% w/v) in 2% lignocaine 1.8 ml with 1:80,000 adrenaline, which yields a 1:10 dilution, following which it was given at the desired site with all aseptic precautions. Patients in group II were given 2% lignocaine with 1:80,000 adrenaline, which was also given with all aseptic precautions.

Pain scales were assessed and recorded before the anaesthetic was given. The needle was inserted into the target site after negative aspiration, and the anaesthetic solution injected. The subjects ware asked to rate the pain after the needle had been withdrawn. The time of onset of anaesthesia was calculated from the point of retrieval of the needle after the injection. A Moon's probe was used to assess the onset of anaesthesia by inserting it in the gingival sulcus of the teeth in the area of anaesthesia at one-minute intervals. When anaesthesia had been confirmed, the operation was done.

Evaluation of pain

Pain was evaluated with a visual analogue scale (VAS) and a verbal rating scale (VRS).

Table 1
Initial pain ratings before injection. Data are number of patients.

	Group 1 (n = 30)	Group 2 (n = 30)	Total
No pain	1	0	1
Mild	3	1	4
Moderate	11	15	26
Severe	15	14	29

Group 1 = lignocaine and adrenaline buffered with sodium bicarbonate; group 2 = lignocaine and adrenaline alone.

A VAS consisted of a line, usually 10 cm long, the ends of which were labelled as the extremes of pain – "no pain" and "worst pain". A VAS may have specific points along the line that were labelled with an indication of the intensity. Patients were asked to rate their pain along the line that best indicated the intensity of their pain before and after the anaesthetic.

A VRS was recorded by asking the patient to rate his or her pain from 0 – 4, with the understanding that 0 is equal to no pain and 4 is equal to excruciating pain. The values were tabulated and the two groups compared.

Statistical analysis

All the data were transferred to Excel spreadsheets for ease of comparison, and statistical analysis was done with the help of IBM SPSS Statistics for Windows (version 20.0, IBM Corp). Descriptive statistics were given: mean (SD), and frequency. We used the *t* test for independent samples and repeated measures ANOVA to assess the significance of changes in VAS and VRS scores. Probabilities of less than or equal to 0.05 were accepted as significant.

Results

The minimum age of the 60 patients was 18, and the maximum 65, years. The mean (SD) ages for groups 1 and 2 were 34 (11) and 37 (13) years, respectively.

There were no significant differences in the mean initial pain scores using the VAS and the VRS ($p = 0.535$ and $p = 0.580$, respectively). Most of the subjects in both groups presented with moderate to severe pain (Table 1). The mean (SD) VAS score after the anaesthetic had been given in group 1 was 3.03 (1.62) and in group 2 was 4.40 (2.19). Fig. 1 shows the significant decrease in mean ratings when readings taken before and after anaesthetic were compared. There was a significant difference between the mean values of VRS in groups 1 and 2 before and after the anaesthesia had been given ($p = 0.025$) (Fig. 2). The mean (SD) time of onset of anaesthesia in the buffered group was1.06 (0.25) minutes, which was significantly less than that in the control group - 2.96 (0.81) minutes ($p < 0.001$).

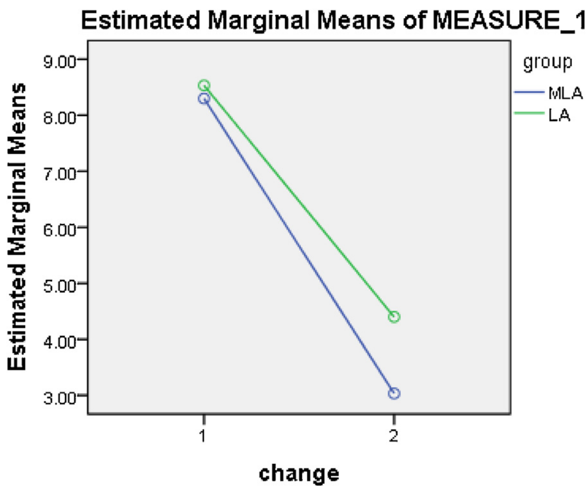

Fig. 1. Line diagram showing mean change in the visual analogue scale before and after anaesthesia in the two groups. Group 1 = lignocaine and adrenaline buffered with sodium bicarbonate; group 2 = lignocaine and adrenaline alone.

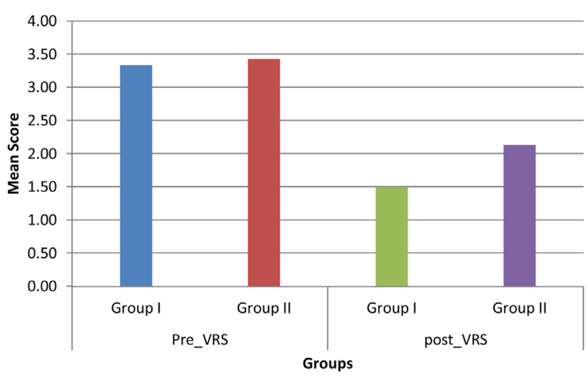

Fig. 2. Verbal rating scale before and after local anaesthetic had been given in the two groups. Group 1 = lignocaine and adrenaline buffered with sodium bicarbonate; group 2 = lignocaine and adrenaline alone.

Discussion

This study of 60 adult volunteers shows that there was a significant reduction in pain after anaesthesia in localised acute infections when we buffered the pH of the local anaesthetic towards a more physiological range of 7.0–7.4 without risk of precipitation or denaturing of the anaesthetic. Many of the subjects indicated that infiltration of the buffered solution was painless.

Some evidence supports the concept that there are age-related differences in the perception of pain. Gibson and Farrell[5] found that older patients tended to have a greater sensitivity to intense stimuli than younger patients. Because there were no significant differences in age between groups with regard to age ($p = 0.856$), it is unlikely that it would affect between-group comparisons when evaluating the pain of the injections and the operation.

Fitton et al[11] found that the addition of sodium bicarbonate 2.0 ml to 2% lignocaine 9 ml caused precipitation, while the addition of 0.5–1 ml of sodium bicarbonate to lignocaine 9 ml did not. In this study we used a 10:1 solution of 2% lignocaine with 1:80,000 epinephrine to 8.4% sodium bicarbonate. As a result, the buffered solution now contains 2% lignocaine 1.8 ml with 1:80,000 epinephrine and 8.4% sodium bicarbonate (0.18 mmol/L) for a total volume of 2 ml. This mixture contains less lignocaine than a standard 2% lignocaine with 1:80,000 epinephrine cartridge. Even though less lignocaine was given in the buffered formulation, the same success rate of anaesthesia was achieved as with the unbuffered lignocaine formulation.

Table 2
Initial pain assessment (n = 30 in each group).

	Mean (SD)
Before visual analogue scale:	
Group 1	8.30 (1.73)
Group 2	8.53 (1.11)
Before verbal rating scale:	
Group 1	3.33 (0.80)
Group 2	3.43 (0.57)

Group 1 = lignocaine and adrenaline buffered with sodium bicarbonate; group 2 = lignocaine and adrenaline alone.

We evaluated the initial pain on presentation (Table 2), and there were no significant differences between the groups using the VAS and VRS ($p = 0.535$ and $p = 0.580$). This is consistent with the idea that a patient typically presents with appreciable pain in addition to the other common symptoms of abscess and swelling.[6] The groups that we studied presented with moderate-to-severe initial pain as a result of an acute infection, and it was expected that these patients would have lowered pain thresholds as a result of inflammation (Table 1).

With an adequately buffered local anaesthetic solution it would be expected that the local anaesthetic would cause less pain on injection than a non-buffered local anaesthetic, because the consequences of injection of a solution of low pH are negated. Additionally, the onset of the anaesthetic is expected to be quicker, theoretically resulting in almost instantaneous anaesthesia at the site of injection. Kashyap et al[7] studied the effect of buffering lignocaine on the pain of injection and the speed of onset of anaesthetic, and found that the buffered solutions had a considerably faster time of onset than the non-buffered solutions (34.4 compared with 109.8 seconds). In maxillary infiltration, Brunetto et al[8] found that regardless of the volume of 2% lignocaine with 1:100,000 epinephrine that was infiltrated over the maxillary canine, onset of anaesthesia to the soft tissues was immediate. We found a significant difference in time of onset of anaesthesia between the two groups: in group 1 it was 1.06 minutes, which was less than that in group 2, which was 2.96 minutes.

Although many papers have concluded that buffered local anaesthetics result in less pain on injection, some authors have been unable to establish any significant difference in the pain of injection between buffered and non-buffered solutions. Gershon et al[9] studied 100 volunteers in a prospective, randomised, double-blind study, and found that there was no significant difference in pain scores between the two local anaesthetic solutions for either injection or catheterisation.

We found that the injection of a buffered local anaesthetic in group 1 was less painful than a standard, non-buffered local anaesthetic in group 2 using VRS ($p = 0.025$). These findings coincide with the findings of several other studies that investigated the pain of injection using buffered local anaesthetics. Metzinger et al[10] studied 40 patients who were given injections for blepharoplasty. Injections were given into the patients' eyelids and pain was rated. They found that the buffered solution was significantly less painful than the control ($p < 0.001$). Fitton et al[11] studied 40 patients in a randomised, double-blind, manner by injecting the anaesthesia into the ear, and concluded that the buffered solutions were significantly less painful on injection than the commercial lignocaine at both room ($p = 0.0001$) and body ($p = 0.01$) temperature. Curatolo et al [12] and Younis et al[13] both found that buffered local anaesthetics resulted in significantly improved anaesthesia.

Conclusion

Reduction of pain is a worthy goal, and painless infiltration may be achievable in cases of localised acute infections by the addition of sodium bicarbonate to local anaesthetics so that the resultant ratio of local anaesthetic to $NaHCO_3$ equals 10:1. In doing so, the efficacy of the local anaesthetic is not compromised. It is recommended that local anaesthetic buffering should be done immediately before the local anaesthetic is given, to eliminate concerns about the shortened shelf-life of the anaesthetic caused by the buffering. The results of this study confirm that the routine use of alkalinised local anaesthetic solution in cases of acute head and neck infections may improve patients' comfort and speed up the time of onset of anaesthesia. In conclusion, the use of sodium bicarbonate as an adjunct in local anaesthetics is convenient, safe, easy to dispense, and readily available.

Ethics statement/confirmation of patients' permission

All procedures in studies involving human participants were done in accordance with the ethical standards of the institutional and national research committees and with the 1964 Helsinki declaration and its later amendments, or with comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Conflict of interest

We have no conflicts of interest.

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