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Efficacy of sodium bicarbonate alkalinisation on three nerve blocks inferior alveolar, lingual, and long buccal on pain and onset of local anaesthesia

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Abstract

Background: Lignocaine injections used as a local anesthetic in oral and maxillofacial surgery can be unpleasant. Anaesthesia usually takes 3 to 5 minutes to kick in. Sodium bicarbonate has been utilized all throughout the world to decrease both of these injection disadvantages, making the operation more tolerable.

Aim: The goal of this randomized prospective experiment of 100 patients aged 18–55 years who had three nerve blocks (inferior alveolar, lingual, and long buccal) was to see how alkalinizing the lignocaine solution with sodium bicarbonate affected the results.

Method: All patients were given 2% lignocaine hydrochloride with a 1:80,000 adrenaline dose, and 50 patients were given 8.4 percent sodium bicarbonate in a 1/10 dilution at random. A visual analogue scale was used to assess pain (VAS).

Result: No patient who had the sodium bicarbonate injection complained of pain, compared to 39/50 (78%) who did not get the sodium bicarbonate injection ($p<0.0001$). In the sodium bicarbonate group, the mean (SD) time (seconds) to onset of local anaesthesia was 34.4 (9.8), compared to 109.8 (31.6) in the control group ($p<0.001$).

Conclusion: Our findings support the alkalinised local anaesthetic solution's effectiveness in decreasing discomfort during injection and resulting in a faster onset of anaesthesia.

Keywords: Lignocaine, oral and maxillofacial surgery, sodium bicarbonate, local anaesthesia

Introduction

One of the most common minor surgical procedures is the injection of local anaesthetic drugs into the skin and mucous membranes. It's frequently the only aspect of a dental operation that hurts. Even though the patient is assured that the injection would feel "like a mosquito bite," it is frequently considerably worse. 1 It is apparent that reducing the patient's suffering during a surgery benefits both the patient and the physician. The apparent discomfort of the injection of local anesthesia is intense enough for some patients to refuse future treatments under local anaesthesia, despite the fact that it is only temporary. Giving extra analgesics, sedatives, or both can be inconvenient and time-consuming; it can be contraindicated at times.

The acidity of the solution is considered to be one of the numerous causes of discomfort at the injection site. Nerve blocks can be made by neutralizing this with sodium bicarbonate. There is a lot of evidence that buffered local anesthetics produce less discomfort during injections, and some patients have even claimed no pain. [3]

We looked explored how adding sodium bicarbonate to the local anaesthetic solution affected the discomfort of injections as well as the time it took for anaesthesia to kick in.

Patients and procedures

The human studies review board authorized this prospective trial, and 100 healthy adult patients aged 18–55 years gave their written consent to participate. They were among the patients who will have operations in the mandibular area under local anaesthetic 1= (no behavioral symptoms and no response to questions). 2 = moderate discomfort (pain stated as a result of inquiry)

Assume that 80% of all patients who were administered local anaesthetics and had symptoms or discomfort reported spontaneously.

Painful anaesthetic injections, anticipating without asking), and 3 = extreme pain (loud vocalizations) a pain reduction of 75% when utilizing sodium-based treatments, or a reaction accompanied by grimaces, withdrawal bicarbonate, the sample size was determined such that the arm, or tears) would be covered.

The term "pain during injection" was used to describe the sensation of discomfort experienced during the have a certain level of the arm, or tears). Pain during injection was defined as pain that was described by the patient on a four-point Visual Analogue Scale (VAS) during injection of the solution and not on the needle-prick itself.

The time of onset of anaesthesia is defined as the first sensation of numbness or tingling in the anaesthetised region. It was calculated from the point of retrieval of the needle after the injection. A straight probe was used to assess the onset of anaesthesia by inserting it in the gingival sulcus of the teeth in the area of anaesthesia. The results were quantified and analysed. Data from the VAS were analysed using the chi square test, and times of onset of anaesthesia were analysed using Student’s t-test. Probabilities of less than 0.05 were accepted as significant.

The pH of both solutions were evaluated using a standard pH meter; 3.05 was the measured pH for 2% lignocaine with 1:80,000 adrenaline (Lignox 2% A, Warren Pharmaceuticals, India) and 7.38 for 2% lignocaine with 1:80,000 adrenaline with a 1/10 addition of 8.4% sodium bicarbonate.

Among patients given solutions without sodium bicarbonate, 11 experienced no pain, 31 mild pain, 8 moderate pain, and 0 severe pain during injection, from which can be deduced that 11 patients had no pain and the rest had pain. There was a significant difference between the control and the study group as none of those given local anaesthetic with sodium bicarbonate had any pain during injection (Table 1).

Table 1

Results (n = 50 in each group).

Variable	Lignocaine without sodium bicarbonate	Lignocaine with sodium bicarbonate	p value
Pain	39	0	<0.0001
No pain	11	50	
Mean (SD) onset of anaesthesia (s)	109.8 (31.6)	34.4 (9.8)	<0.001

Each group was given 2% lignocaine plus 1:80,000 adrenaline.

All patients given injections containing sodium bicarbonate had a more rapid onset of anaesthesia than the control group. The time to achieve anaesthesia was greatly reduced when buffered injections were given (Table 2).

Table 2

Comparison of onset of anaesthesia in the study groups.			
	Group I (patients receiving 2% lidocaine with 1:80,000 adrenaline solution)	Group II (patients receiving 2% lidocaine with 1:80,000 adrenaline solution alkalinised with sodium bicarbonate	*t** value Significance
	Mean ± SD	Mean ± SD	
Onset of anaesthesia (s)	109.76 ± 31.63	34.40 ± 9.82	16.08 $p < 0.001$ highly significant

*unpaired Student's t- test

Discussion

Pain: Pain is defined as an unpleasant emotional experience usually initiated by a noxious stimulus and transmitted over a specialised neural network to the central nervous system where it is interpreted as such.6 It is one of the most common symptoms in dentistry, and a serious concern for the dentist. The pain of the local anaesthetic injection has several causes, one being the acidity of the solution itself. The speed of injection also has an important role; pain is caused by the increase in volume in the tissues that causes pressure.7 Though painless injections can be given when the solution is injected slowly, acidity can be dealt with by altering the pH of the solution. There is a consensus that, for nerves with intact sheaths, local anaesthetics are more potent in alkaline, than in neutral or acid, conditions.8 This was achieved in the present study by adding sodium bicarbonate to the solution.[9]

Pharmacology of sodium bicarbonate

Sodium bicarbonate is a systemic alkalinising agent. It increases the plasma bicarbonate concentration, buffers excess hydrogen ions, and raises the pH of the blood, thereby reversing clinical signs of acidosis.[10] We used sodium bicarbonate to increase the pH of the local anaesthetic solution to a more physiological pH.[11]

Importance of pH of the local anaesthetic solution

Commercially available 2% lignocaine with 1:80,000 adrenaline solutions have a low pH (3.3).[12] Although reducing the pH extends the shelf life of the solution to around 36 months, and prevents the early oxidation of adrenaline, the solution is more likely to produce a burning sensation on injection and a slower onset of anaesthesia.[13]

Increasing the pH of the local anaesthetic solution speeds the onset of its action,[13] increases its effectiveness, and makes the injection more comfortable. Alkalinising or increasing the pH of the solution can be achieved by adding sodium bicarbonate. This increases the free base form of the lignocaine molecule and alkalinises the solution, thereby reducing the pain during injection.[13]

We added 8.4% sodium bicarbonate to local anaesthetic solution in a dilution of 1/10 (3 ml of sodium bicarbonate to 30 ml of local anaesthetic solution).[2,4] This reduced the pH from 3.05 to 7.38, which caused the availability of the lipophilic uncharged lidocaine molecules (RN), also called the base, to be more available for diffusion into the membrane of the nerve as the solution was close to the physiological tissue pH of 7.4. This reduced the pain caused by the injection itself.

When sodium bicarbonate is added it is also available in the tissues as bicarbonate ion, which alkalinises the extracellular pH. When extracellular pH is increased by the addition of bicarbonate, the decreased intracellular pH (through diffusion of carbon dioxide produced from the reaction of hydrogen and hydrogen carbonate in extracellular fluid) may also play a part in increasing the effect of the local anaesthetic block through protonation of intracellular free-base local anaesthetic (“ion trapping”) and increasing the concentration gradient for the free-base local anaesthetic across the plasma membrane (Fig. 1).[7]

No patient given local anaesthetic solution contain- ing sodium bicarbonate had any pain during injection. Erramouspe,[9] Martin,[14] Davies,[3] and Sarvela et al.[12] all concluded that using alkalinised solutions had obvious benefits in reducing the pain during injection of the local anaesthetic agent; our results confirmed this. However, Chow et al.[15] found no change in the intensity of pain using alkalinised solutions. The reduction in pain can also be attributed to the availability of the lipophilic uncharged molecule (RN) causing a faster onset of action of anaesthesia.

Onset of anaesthesia

The free base form of the local anaesthetic agent is more lipid-soluble, and so diffuses quickly into the membrane of the nerve. The cytoplasm was acidified by the membrane-permeating carbon dioxide leading to the intracellular “trapping” of the cationic form of the local anaesthetic agent (Fig. 1). Increasing the extracellular pH with a constant extracellular concentration of local anaesthetic results in a greater intracellular concentration of local anaesthetic and more complete inhibition of sodium currents, whether or not the intracellular carbon dioxide concentration or pH changes. When extracellular pH is increased by the addition of bicarbonate, decreased intracellular pH through diffusion of carbon dioxide may also have a role in increasing the local anaesthetic block. Sodium bicarbonate ions also non- specifically reduce the margin of safety for nerve conduction, and may have a direct action on the binding of the local anaesthetic to the sodium channel.

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