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Effect of local anaesthetic buffering on haemodynamic stability in normotensive patients undergoing routine dental extractions

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Abstract

Background

Alteration in haemodynamics with local anaesthetic (LA) buffering has not been confirmed. This was a double-blind randomised study conducted to compare the haemodynamic changes after administration of buffered and, non-buffered LA in inferior alveolar nerve block (IANB) for routine extractions of permanent mandibular molars.

Methodology

This study was carried out at Usmanu Danfodiyo University Teaching Hospital Sokoto from June 2020 to January 2022. After obtaining ethical approval from the ethics and research committee of the institution, all consented patients aged 18 years and above who met the selection criteria were randomized into Buffered and nonbuffered groups as A and B respectively. Baseline vital parameters were recorded after 5 minutes of patients settling down. Thereafter, the inferior alveolar nerve block was administered and vital parameters (SPB=systolic blood pressure, DBP= diastolic blood pressure, RR=respiratory rate, and, SPO2= oxygen saturation) were measured at 10minutes 20minute and, 30minutes. Data recorded were analyzed using SPSS version 21.

Results

There were 59 (54.6%) males and 49 (45.4%) females in the age range of 18 to 74 years with a mean±SD of 38.7±14.6 years. Both groups showed no significant difference in mean systolic blood pressure in assessing SBP10 (p=0.490) SBP20 (p=0.210) and, SBP30 (p=0.427). Similarly, a comparison of DBP, RR, and, SPO2 at 10 minutes, 20 minutes and, 30minutes yielded no statistically significant difference.

Conclusion

There was no significant difference in haemodynamic stability of participants when buffered and, non-buffered LA was compared. More clinical studies are required to draw clear conclusions.

Keywords: Local Anaesthetic, Haemodynamic Stability, Buffering

Introduction

There are many local anaesthetic agents used by both medical and dental practitioners. [1] They form the spine of pain control in dental practice and can be majorly grouped based on their chemical characteristics into two: Ester linked such as cocaine, procaine, tetracaine, and chloroprocaine and, Amide linked such as lignocaine, Etidocaine, Prilocaine, Ropivacaine, and Bupivacaine. [2] Lignocaine is an amide-linked local anaesthetic that is the most commonly used and, has become a gold standard against which all other local anaesthetic agents can be compared.[1] Lignocaine alone has an onset of 3 to 4 minutes and a duration of action of 3 to 4 hours. [2, 3] The addition of a vasoconstrictor such as Adrenaline or Levonordefrin prolongs the duration of the local anaesthesia, decreases the rate of absorption, and reduces localized bleeding at the site of administration. [4, 5]

Local anaesthetic solutions are usually stored and marketed in an acidic form. This is to maximize stability and water solubility; however acidic local anaesthetic solution has been associated with pain during its administration.[6] Pain associated with the administration of LA elicits fear and anxiety in some patients and, may manifest changes in haemodynamic parameters such as increased heart rate, and blood pressure due to the release of endogenous catecholamines.[7] These changes may also be related to the vasoconstrictive effect of adrenaline. However, sodium bicarbonate buffering of the local anaesthetic

solution has been documented to increase the pH of the local anaesthetic agents, making it closer to physiologic pH, and thereby improving some of its properties. [8] Extensive literature search suggests a paucity of information on this topic. Hence this study aimed to compare the haemodynamic changes following the administration of buffered and, non-buffered LA in IANB during routine extractions of permanent mandibular molars.

Methodology

This was a double–blinded control study carried out over a period of seven months (June 2020 to January 2022) at the Dental Surgery Clinic of Usmanu Danfodiyo University Teaching Hospital Sokoto. Ethical approval was obtained from the ethics and research committee of the institution with reference number (UDUTH/HREC/2019/NO.800). Included in this study are all consented patients (subjects) aged from 18years and above who presented for routine extraction of permanent mandibular molars that warrant inferior alveolar nerve administration irrespective of gender and, patients without any known co-morbidity that may affect their haemodynamic stability, pain perception, or healing. Excluded in the study were patients who had a history of allergy or hypersensitivity to any of the agents/drugs to be administered, pregnant, lactating mothers and, those on an oral contraceptive.

A simple random sampling technique was used in allocating the subjects into two groups (A and B) using a computer-generated table of random numbers. This was done by a well-trained research assistant who also prepare the drug solution. Subjects in Group A received sodium bicarbonate buffered 2% lignocaine with 1:100,000 adrenaline solution while those in Group B receive non-buffered 2% lignocaine with 1:100,000 adrenaline solution. The buffering was done using 0.18mls of 8.4% sodium bicarbonate which was added before the LA administration. Both the researcher and the subjects were however blinded regarding the type of LA administered to each subject

The study was conducted during morning clinic hours mostly between 8:00 am and 11:00 am. Subjects were comfortably seated in a semi-reclined position on a dental chair. Subjects' demographic variables were recorded and then primary vital parameters including subjects' pulse rate (PR), blood pressure (BP), respiratory rate (RR) and, peripheral oxygen saturation (SPO_2), were recorded after 5 minutes of sitting on the dental chair by the second research assistant. These values were labeled as the baseline(B) vital parameters (BPR, BBP, BRR, $BSPO_2$). Blood pressure was measured using a digital apparatus (Omron), pulse rate and partial pressure of oxygen (SPO_2) were measured using a pulse oximeter (Xuebox), and respiratory rate was measured manually by counting the number of breath cycles in one minute using a stopwatch (Kevin China). Thereafter, the inferior alveolar nerve was administered via the standard technique.

The second research assistant who recorded the initial primary vital parameters also recorded these vital parameters at 10 minutes, 20 minutes, and 30 minutes after the inferior alveolar nerve block (as, SBP10, SBP20, SBP30, DBP10, DBP20, DBP30, PR10, PR20, PR30, RR10, RR20, RR30, SPO_2 10, SPO_2 20, SPO_2 30).

Data obtained from the study were analyzed electronically using IBM SPSS version 21.0 software (IBM Corp., Armonk, NY, USA) and the results were presented using relevant tables. The age of the subjects in both the groups was expressed as mean (±Standard deviation) and, it was further categorised into 3 groups; ≤ 30 years, 31-60years, and > 60 years. The similarity of both groups in terms of age and gender was analyzed using Pearson's chi-square. A comparison of the mean value of haemodynamic parameters was done using an independent sample t-test. A p-value ≤ 0.05 was taken as statistically significant.

Results

There were 59 (54.6%) males and 49 (45.4%) females in the age range of 18 to 74 years with an overall mean±SD of 38.7±14.6 years. The age mean±SD for groups A and B was 37. 4±14.9 years and 40.1±14.4 years respectively. The ages of participants in the study were categorised into 3 groups; ≤ 30 years, 31-60years, and > 60 years and there was no statistically significant difference when tested using chi-square ($\chi2$=1.064, p=0.587), (Table 1). The gender distribution was also tested and no significant difference was found ($\chi2$=0.777, *p*=0.378) (Table 1).

The mean±SD values of haemodynamic parameters (systolic blood pressure, diastolic blood pressure, pulse rate, respiratory rate, and oxygen saturation) for groups A and B were compared. Both groups showed no significant difference in mean systolic blood pressure in assessing BSBP (p= 0.334), SBP10 (p=0.490) SBP20 (p=0.210) and, SBP30 (p=0.427) as depicted in Table 2. There was no statistically significant difference in mean diastolic blood pressure across the groups in assessing BDBP (p=0.831), DBP10(p=0.804), DBP20(p=0.698) and, DBP30(p=0.746) table 3. Both groups showed no statistically significant difference in mean pulse rate in assessing BPR(p=0.774), PR10(p=0.754), PR20(p=0.994) and, PR30(p=0.712) table 2.

Comparison of mean respiratory rate as BRR, RR10, RR20 and, RR30 yielded no statistically significant difference with BRR(p=0.852), RR10 (p=0.300), RR20 (p=0.428), and RR30 (p=0.411) respectively table 3. Both groups showed no statistically significant difference in mean $BSPO_2$ (p=0.440), SPO_2 10 (p=0.372), SPO_2 20 (p=0.371), and SPO_2 30 (p=0.606) table 2.

Table 1: Analysis of Demographic characteristics of the study population

Variable	Frequency		Test statistics	Level of significance
	Group A n (%)	Group B n (%)		
-Age ≤ 30 years 31-60years >60years	23(21) 25(23) 6(6) Total 108(100)	18(17) 30(28) 6(6)	$\chi2$=1.064	p=0.587
Gender **Male** **Female**	32(30) 22(20) Total 108(100)	27(25) 27(25)	$\chi2$=0.777	p=0.378

$\chi2$= Chi-square

Table 2: Comparison of Haemodynamic parameters between the study groups A and B

Variable	Group A Mean (±SD)	Group B Mean (±SD)	Test statistics	Level of significance
BSBP	121± (10.6)	118(±14.5)	t=0.970	p= 0.334
SBP10	123(±10.2)	121± (14.7)	t=0.693	p=0.490
SBP20	125(±13.1)	122(±12.1)	t=1.260	p=0.210
SBP30	124(±8.7	122(±12.5)	t=0.798	p=0.427
BDBP	76(±10.2)	76(±10.5)	t=-0.214	p=0.831
DBP10	76(±9.9)	76(±10.2)	t=-0.249	p=0.804
DBP20	78(±9.6)	79(±9.7)	t=-0.388	p=0.698
DBP30	79(±8.2)	79(±9.5)	t=0. 325	p=0.746
BPR	88(±15.7)	87(±12.9)	t=0.287	p=0.774
PR10	88(±14.3)	89(±12.6)	t=-0.314	p=0.754
PR20	89(±12.7)	89(±12.4)	t=-0.008	p=0.994
PR30	90(±12.7)	90(±11.2)	t=0.370	p=0.712
BRR	20(±2.7)	20(±3.4)	t=-0.187	p=0.852
RR10	20(±2.6)	20(±3.3)	t=-1.042	p=0.300
RR20	20(±2.7)	20(±3.1)	t=-0.796	p=0.428
RR30	20(±2.6)	20(±2.1)	t=-0.826	p=0.411
$BSPO_2$	98(±0.7)	98(±0.8)	t=0.775	p=0.440
SPO_2 10	99(±0.9)	98(±0.8)	t=0.896	p=0.372
SPO_2 20	98(±0.8)	98(±0.9)	t=0.232	p=0.871
SPO_2 30	98(±0.7)	99(±0.8)	t=-0.517	p=0.606

Keys: BSBP=Baseline systolic blood pressure, SBP10=Systolic blood pressure at 10minutes after inferior alveolar nerve block, SBP20=Systolic blood pressure at 20minutes after inferior alveolar nerve block, SBP30=Systolic blood pressure at 30minutes after inferior alveolar nerve block, BDBP=Baseline diastolic blood pressure, DBP10=Diastolic blood pressure at 10 minutes after the inferior alveolar nerve block, DBP20=Diastolic blood pressure at 20 minutes after the inferior alveolar nerve block, DBP30=Diastolic blood pressure at 30 minutes after the inferior alveolar nerve block, BPR=Baseline pulse rate, PR10= pulse rate at 10minutes after the inferior alveolar nerve block, PR20= pulse rate at 20minutes after the inferior alveolar nerve block, PR30= pulse rate at 30minutes after the inferior alveolar nerve block, BRR=Baseline respiratory rate, RR10=Respiratory rate at 10 minutes after the inferior alveolar nerve block, RR20=Respiratory rate at 20 minutes after the inferior alveolar nerve block, RR30=Respiratory rate at 30 minutes after the inferior alveolar nerve block, $BSPO_2$=Baseline partial pressure of oxygen, SPO_2 10=Partial pressure of oxygen at 10 minutes after the inferior alveolar nerve block, SPO_2 20=Partial pressure of oxygen at 20 minutes after the inferior alveolar nerve block, SPO_2 30=Partial pressure of oxygen at 30 minutes after the inferior alveolar nerve block.

Discussion

This study investigated the effect of local anaesthetic buffering on haemodynamic stability in normotensive patients undergoing routine dental extractions. There were more males than females in the age range of 18-74 years in this study and, the comparison of both the gender and age did not yield any statistically significant difference between the two research groups. This implied that the two groups ware comparable.

The present study demonstrated a slight increase in the value of the haemodynamic parameters (pulse rate, blood pressure, respiratory rate, and SPO2) related to baseline values in participants in both the buffered and non-buffered groups. This difference however was not statistically significant between the groups. Chumpitaz *et al.* [9] in a previous study also observed no statistically significant difference in haemodynamic parameters among the buffered and non-buffered groups. Changes in haemodynamic parameters related to routine dental extraction were not significant in a study done in Ibadan, Nigeria by Akinmoladun *et al*. [10] A review of English literature indicates that there are few studies on the effect of buffering of LA on haemodynamic parameters of participants. The slight increase in the values of haemodynamic parameters observed in most of the participants in both study groups could be attributed to anxiety commonly associated with tooth extractions. [10, 11, 12] This may lead to circulatory changes due to the secretion of endogenous catecholamines that causes psychological stress. The adrenaline present in both the two solutions could be responsible for the slight elevation in pulse rate and blood pressure. Although adrenaline incorporation into local anaesthetic has been reported safe in normotensive individuals, controversies still exist especially in patients with cardiovascular problems. [13] Some studies have suggested that while adrenaline is injected as a vasoconstrictor in local anaesthetics, it is associated with transient effects in normotensive patients. [14, 15]

None of the subjects in the present study showed any adverse reactions to buffered lignocaine. Previous studies have also reported an absence of adverse events or toxicity concerning buffered lignocaine, except for one isolated case, which reported hematoma formation. [16, 17] The long-term physical and chemical stability of buffered lidocaine is unclear. Although some studies have shown that solution of buffered lidocaine in glass vials can be stored for up to seven days and even up to 91 days. Prepared buffered lidocaine solution was used in this study to eliminate any disparities in the result. [18, 19] This could buttress the fact that sodium bicarbonate buffering of the LA may not be responsible for the slight elevation in the haemodynamic parameters. However, it may be difficult to reach a conclusion on the effect of sodium bicarbonate buffering of local anaesthetics on haemodynamic stability using the few studies available in the literature. More studies are needed in this area.

Conclusion

There was no significant difference in haemodynamic stability of participants when buffered and, non-buffered LA was compared. More clinical studies are required to draw a clear conclusion.

Conflict of interest: None declared.

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