Buffered Local Anaesthetic and Its Effects on Haemodynamic Stability during Conventional Root Canal Treatment in Normotensive Patients: A Comparative Analysis

*Amidu Omotayo **Sulaiman**, **Rufai **Jaafaru**, ***Mujtaba **Bala**, ***Ramat Oyebunmi **Braimah** ***Abdurrazaq Olanrewaju **Taiwo**, ****Mayana Sanusi **Abubakar**, *****Umar **Abdullahi**.
[Department of Restorative dentistry, University College Hospital, Nigeria.* ** Department of Restorative dentistry, Usmanu Danfodiyo University Teaching Hospital, Sokoto, Sokoto State, Nigeria, ***Department of Dental & Maxillofacial Surgery, Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria. **** Field office, World Health Organization, Kano State, Nigeria. ***** Department of Internal medicine, Federal Medical Centre Gusau].

Correspondence

Dr. Amidu Omotayo Sulaiman
Department of Restorative dentistry, University College Hospital, Nigeria
E-mail: tayooja@yahoo.co.uk

ABSTRACT

Background: The injection pain and ineffective local anaesthesia (LA) can be a source of anxiety during root canal therapy (RCT) and can alter haemodynamic parameters. Buffering of the local anaesthetic solution has been shown to shortens anaesthetic onset time and injection pain thereby providing more effective anaesthesia. The effect of local anaesthetic buffering on haemodynamic stability during RCT has not been widely explored. Hence this study aimed to investigate the effects of buffered and non-buffered LA on haemodynamic parameters in normotensive patients undergoing RCT.

Methods: This was a randomized controlled study conducted among 80 normotensive subjects undergoing RCT over 15 months (January, 2024 to March, 2025). After obtaining ethical approval from the research and ethic committee of the institution, subjects were randomized in to group A and B who received buffered and non-buffered LA respectively. Haemodynamic parameters (blood pressure, pulse rate, respiratory rate, SpO_2) were measured at presentation, 10, 20, and 30 minutes post drug administration. The data obtained was analyzed using IBM-SPSS (version 25).

Results: There were 39 (48.7%) males, 41(51.3) females in the age range of 19-69 years with a mean±SD of 38.34±13.44 years. No statistically significant difference was observed between the 2 groups in systolic and diastolic blood pressure, pulse rate, respiratory rate, or oxygen saturation at presentation, 10, 20, and 30 minutes post LA administration. ($p < 0.05$).

Conclusion: Buffered lignocaine with sodium bicarbonate was not found to significantly affect haemodynamic stability in normotensive patients when used during RCT, hence can be used safely.

Keywords: Buffered local anaesthetic, Haemodynamic stability, Root canal therapy

Amidu Omotayo Sulaiman
https://orcid.org/0000-0002-2988-5645
Rufai Jaafaru
https://orcid.org/0009-0005-4911-5591
Mujtaba Bala
https://orcid.org/0000-0003-1027-9175
Ramat Oyebunmi Braimah
https://orcid.org/0000-0002-8117-9393
Abdurrazaq Olanrewaju Taiwo
https://orcid.org/0000-0002-0699-7118Mayana Sanusi Abubakar
https://orcid.org/0000-0002-2311-4196
Umar Abdullahi
https://orcid.org/0000-0002-2311-4196
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INTRODUCTION

Root canal therapy (RCT) is a dental restorative procedure aimed at addressing issues related to the pulp of a tooth.[1] The goal is to alleviate pain by removing an infected or inflamed tissue from within a tooth.[2]A well root canal treated tooth is capable of receiving further conservative treatment vital for maintaining proper function and aesthetic form.[3] RCT is indicated in tooth with irreversible pulpitis, apical periodontitis, periapical abscess and dentoalveolar abscess.[4] However, pain stood as the most common reason for presentation to the dental clinic and this has been a source of anxiety to patients even during anaesthesia and dental treatment like extraction and root canal treatment.[5] Pain could elicit anxiety and was found to affect haemodynamic parameters like the pulse rate and blood pressure and as such it is crucial to obtain effective anaesthesia.[6]

As local anaesthetic solutions are usually stored and marketed in an acidic form to maximize stability and water solubility; it has been associated with pain during its administration.[6,7]To mitigate such an unwanted event, certain strategies have been employed as additives to local anaesthetic solution, this includes buffering of the local anaesthetic solution with sodium bicarbonate. Several double-blind randomized control trials have shown benefit in pain reduction when local anaesthetic solutions are buffered.[8-10] This particularly applies to the amide group of local anaesthetics such as lignocaine and bupivacaine. The addition of 8.4% sodium bicarbonate to local anaesthetic preparations regardless of the presence of adrenaline have been shown to improve the outcome of dental procedures.[11] Research has shown that the advantages of buffered local anaesthetics are still evident in terms of speed of onset, and reduction in pain of injection.[8,9] However, there is limited evidence in the effect of buffering on haemodynamic parameters.[12] More so, the safety of such intervention could be confirmed through the measurement of these parameters. Hence, this study aimed to investigate the effectiveness of buffered local anaesthetic on haemodynamic parameters in patients undergoing root canal treatment.

MATERIALS AND METHODS

This was a randomized controlled study conducted among 80 normotensive subjects undergoing RCT over 15 months (January, 2024 to March, 2025). After obtaining ethical approval (UDUTH/HREC/2019/NO.800) from the research and ethic committee of the institution, subjects who presented for with dental pathology indicated for root canal therapy were recruited and randomized in to group A and B who received buffered and non-buffered LA respectively. Excluded were hypertensive patients, anxious patients, those who were on medication known to alter threshold and those who did not gave consent.

A simple random sampling method was used and a minimum sample size of 80 (40 subjects in each group) was calculated using a similar study by Bala et al.[13] This study was carried out in the morning, between 8:00 a.m. and 11:30 a.m. Participants were seated comfortably in a semi-reclined position on a dental chair. After five minutes of rest in the chair, the second research assistant recorded the participants' primary vital signs, including pulse rate (PR), blood pressure (BP), respiratory rate (RR), and peripheral oxygen saturation (SPO_2). These measurements were documented as the baseline (B) vital parameters (BPR, BBP, BRR, $BSPO_2$). Blood pressure was assessed using a digital device (Omron), while pulse rate and oxygen saturation (SPO_2) were monitored using a pulse oximeter (Xuebox). Respiratory rate was manually counted using a stopwatch (Kevin China) by observing the number of breaths taken in one minute (figure 1). Following this,

the first research assistant provided either buffered or non-buffered local anesthetic solution to the researcher, depending on the participant's assigned group. The researcher then loaded it on a standard dental syringe with the given solution. Participants received either 2 ml of a freshly prepared solution containing 2% lignocaine with 1:100,000 adrenaline, buffered with 0.18 ml of 8.4% sodium bicarbonate (Group A), or 2 ml of unbuffered 2% lignocaine with 1:100,000 adrenaline (Group B). Those who required more than 2 ml of either formulation was excluded from the study but still received the necessary treatment. Any participants excluded during the procedure were replaced to maintain the intended sample size. The second research assistant, who recorded the initial baseline vital signs, also monitored these parameters at 10, 20, and 30 minutes following the inferior alveolar nerve block. These were recorded as SBP10, SBP20, SBP30, DBP10, DBP20, DBP30, PR10, PR20, PR30, RR10, RR20, RR30, and SPO2 10, SPO2 20, SPO2 30. The data obtained were analysed using statistical package for social sciences (IBM-SPSS) version 25. To assess changes in vital parameters over time within each group (baseline, 10, 20, and 30 minutes), repeated-measures analysis of variance (ANOVA) was applied.

RESULTS

A total of 40 subjects in each group were recruited, there were 39 (48.7%) males, 41(51.3) females (Figure 2) in the age range of 19-69 years with a mean±SD of 38.34±13.44 years. The distribution of the age category of the study participants include; ≤ 30 years 29(36.3%), 31-60years 46(57.4%) and >60years 5(6.3%) and there was no statistically significant difference when the age category was analysed against the study groups using chi-square ($\chi 2=2.749$, df=2, $p=0.256$) (Table 1).

The mean±SD values of haemodynamic parametres (systolic blood pressure, diastolic blood pressure, pulse rate, respiratory rate, and oxygen saturation) for groups A and B were compared. With analysis of variance (ANOVA), both groups showed no significant difference statistically in mean systolic blood pressure in BSBP (F= 0.006, p= 0.937), SBP10 (F=0.404, p=0.527) SBP20 (F=0.402, p=0.528) and, SBP30 (F=0.035, p=0.852) as depicted in Table 2. There was no statistically significant difference between mean diastolic blood pressure across the groups in BDBP (F=0.048, p=0.828), DBP10 (F=1.156, p=0.286), DBP20 (F=3.175, p=0.079) and, DBP30 (F=0.153, p=0.0696) (Table 2). Both groups showed no statistically significant difference in mean pulse rate BPR (F=1.210, p=0.275), PR10 (F=0.019, p=0.890), PR20 (F=0.045, p=0.832) and PR30 (F=0.320, p=0.573) (Table 2). Comparison of mean respiratory rate as BRR, RR10, RR20 and, RR30 was also not statistically different with BRR (F=0.382, p=0.538), RR10 (F=2.944, p=0.090), RR20 (F=2.204, p=0.142), and RR30 (F=1.864, p=0.176) respectively as shown in Table 1. Both groups showed no statistically significant difference in mean $BSPO_2$ (F=0.080, p=0.500), SPO_210 (F=0.014, p=0.907), SPO_2 20 (F=0.148, p=0.701), and SPO_2 30 (F=2.337, p=0.130) (Table 2).

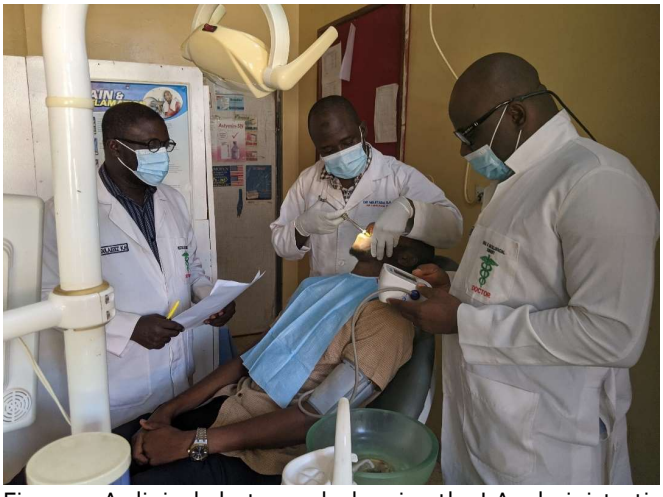

Figure 1: A clinical photograph showing the LA administration, and the data recording

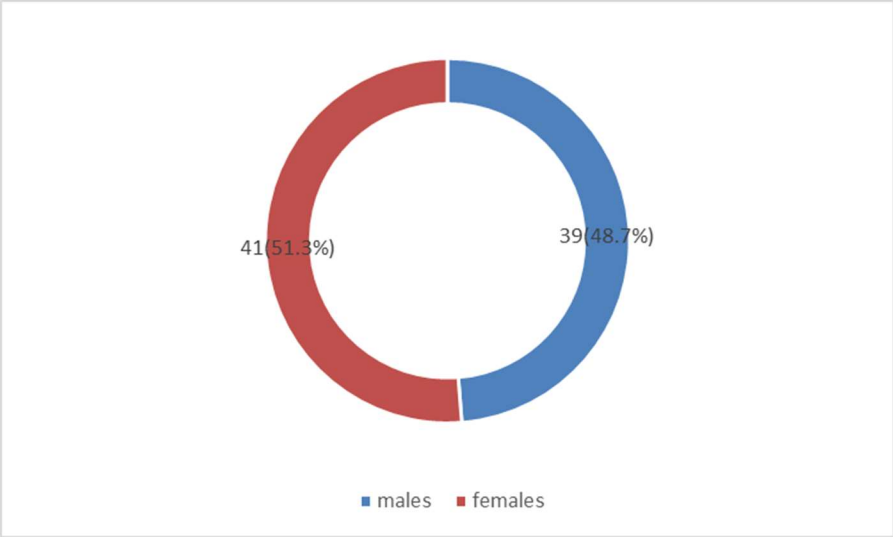

Figure 2: Gender distribution of the study participants

Table 1: Analysis of Demographic characteristics of the study population

Variables	Study group n (%)		Total	Test statistics	P value
	Group A	Group B	n (%)		
Age category					
≤ 30years	17(21.3)	12(15)	29(36.3)		
31-60years	22(27.5)	24(30)	46(57.5)	$\chi 2=2.749$, df=2	P = 0.253
>60years	1(1.2)	4(5)	5(6.2)		
Total	40 (50)	40(50)	80(100)		

Table 2: Comparison of Haemodynamic Parameters between the Study Groups (A and B) Using One-way ANOVA

ANOVA						
Variables		Sum of Squares	df	Mean Square	F	Sig.
Baseline systolic blood pressure	Between Groups	1.012	1	1.012	.006	.937
	Within Groups	12693.475	78	162.737		
	Total	12694.487	79			
Systolic blood pressure at 10 minutes	Between Groups	59.512	1	59.512	.404	.527
	Within Groups	11501.475	78	147.455		
	Total	11560.987	79			
Systolic blood pressure at 20 minutes	Between Groups	70.313	1	70.313	.402	.528
	Within Groups	13641.675	78	174.893		
	Total	13711.988	79			
Systolic blood pressure at 30 minutes	Between Groups	4.050	1	4.050	.035	.852
	Within Groups	8998.700	78	115.368		
	Total	9002.750	79			
Baseline diastolic blood pressure	Between Groups	5.513	1	5.513	.048	.828
	Within Groups	9004.175	78	115.438		
	Total	9009.688	79			

Diastolic blood pressure at 10 minutes	Between Groups	132.613	1	132.613	1.156	.286
	Within Groups	8947.875	78	114.716		
	Total	9080.488	79			
Diastolic blood pressure at 20 minutes	Between Groups	328.050	1	328.050	3.175	.079
	Within Groups	8059.150	78	103.322		
	Total	8387.200	79			
Diastolic blood pressure at 30 minutes	Between Groups	13.613	1	13.613	.153	.696
	Within Groups	6917.275	78	88.683		
	Total	6930.888	79			
Baseline pulse rate	Between Groups	6426.112	1	6426.112	1.210	.275
	Within Groups	414231.775	78	5310.664		
	Total	420657.888	79			
Pulse rate for patients at 10minutes	Between Groups	3.612	1	3.612	.019	.890
	Within Groups	14595.275	78	187.119		
	Total	14598.888	79			
Pulse rate for patients at 20minutes	Between Groups	7.200	1	7.200	.045	.832
	Within Groups	12378.350	78	158.697		
	Total	12385.550	79			
Pulse rate for patients at 30minutes	Between Groups	45.000	1	45.000	.320	.573
	Within Groups	10951.800	78	140.408		
	Total	10996.800	79			
Baseline respiratory rate	Between Groups	4.050	1	4.050	.382	.538
	Within Groups	825.900	78	10.588		
	Total	829.950	79			
Respiratory rate for patients at 10minutes	Between Groups	28.800	1	28.800	2.944	.090
	Within Groups	763.000	78	9.782		
	Total	791.800	79			
Respiratory rate for patients at 20minutes	Between Groups	20.000	1	20.000	2.204	.142
	Within Groups	707.800	78	9.074		
	Total	727.800	79			
Respiratory rate for patients at 30minutes	Between Groups	16.200	1	16.200	1.864	.176
	Within Groups	678.000	78	8.692		
	Total	694.200	79			
Baseline SPO2	Between Groups	.050	1	.050	.080	.778
	Within Groups	48.950	78	.628		
	Total	49.000	79			
SPO2 of patients at 10 minutes	Between Groups	.013	1	.013	.014	.907
	Within Groups	70.975	78	.910		

	Total	70.988	79			
SPO2 of patients at 20 minutes	Between Groups	.113	1	.113	.148	.701
	Within Groups	59.275	78	.760		
	Total	59.387	79			
SPO2 of patients at 30 minutes	Between Groups	1.513	1	1.513	2.337	.130
	Within Groups	50.475	78	.647		
	Total	51.988	79			

DISCUSSION

Anxiety surrounding root canal therapy is common and can emanate from various factors, including the fear of anaesthetic pain, unfamiliar sounds, and fear of the unknown. This can be mitigated by employing effective anaesthesia.[14] The aim of local anaesthetic buffering with sodium bicarbonate is to reduce the time of onset and injection pain, hence provide more effective anaesthesia leading to more a comfortable dental procedure like the root canal treatment.[15] Although buffering, increase the reliability of dental anaesthesia however, it doesn't eliminate the risk of systemic toxicity or other potential side effects associated with local anaesthetics.[16] Healthcare providers often monitor hemodynamic measures to assess a patient's response to treatment and identify potential side effects. If changes are significant or concerning, an intervention may be needed to manage the side effect. Arora et al.[17] highlighted the lack of side effect following local anaesthetic buffering. Bala et al.[13] also reported the absence of side effect with buffered local anaesthetic compared to non-buffered local anaesthetic.

This study compares the haemodynamic parameters such as blood pressure (pulse rate, blood pressure, respiratory rate, and SPO2). Overall, there is slight increase in the values of these parameters across the two groups related to the baseline parameters which was not significant. The slight increase in the values of haemodynamic parameters observed in most of the participants in both the study groups could be related to the anxiety commonly associated with root canal therapy. This may lead to circulatory changes due to the secretion of endogenous catecholamine that causes psychological stress rather than the components of the local anaesthetic. Although, adrenaline as a component of LA has been surrounded by controversies whether it alters haemodynamic stability but the current consensus is that adrenaline, when added to local anesthetics, can cause haemodynamic changes, the severity and potential for complications are generally considered low for most patients.[18] While some individuals, like those with cardiac conditions or uncontrolled hypertension, may be at higher risk, the use of local anesthetics with adrenaline is often considered safe and effective for many patients.[19]

This study corroborates the findings by Bala et al.[15] and Chumpitaz et al.[20], who reported no significant haemodynamic disturbances with buffered LA in dental procedures. Thus, buffered lignocaine can be considered safe for routine use during RCT, offering the additional benefit of reduced injection pain and faster onset without compromising haemodynamic stability.

CONCLUSION

Buffered lignocaine with sodium bicarbonate was not found to significantly affects haemodynamic stability in normotensive patients when used during RCT, hence can be used safely.

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