

ORIGINAL RESEARCH REPORT

# Hemodynamic response after injection of local anesthetics with or without adrenaline in adult Nigerian subjects undergoing simple tooth extraction

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## ABSTRACT

**Objective:** This study was conducted to determine the changes in the blood pressure (BP) and the pulse rate (PR) of normotensive patients having dental extraction under the administration of 2% lignocaine local anesthetic with or without adrenaline. **Materials and Methods:** This prospective study was carried out on 325 consecutive normotensive patients who presented at the exodontia clinic of the Lagos University Teaching Hospital (LUTH), Lagos, Yoruba State, Nigeria from December 2004 to August 2005 for simple tooth extraction. The patients were randomly allocated into two groups according to the type of anesthetic solution employed. Group A had tooth extraction done under the administration of 2% lignocaine with adrenaline (1:80,000) while group B had tooth extraction done under the administration of 2% lignocaine local anesthetic without vasoconstrictor (plain lignocaine). Each patient had single tooth extracted. The following parameters were monitored in each of the surgical interventions: systolic blood pressure (SBP), diastolic blood pressure (DBP), and PR. Measurements were taken in the waiting room before surgery, during the surgery after local anesthesia, during tooth extraction, and 15 min after tooth extraction. **Results:** The sample consisted of 176 females and 149 males. Age range of the patients was 18-89 years with the mean age of  $35.08 \pm 15.60$  years. The hemodynamic responses to lignocaine with adrenaline (1:80,000) and plain lignocaine essentially follow the same pattern in the study. There was no statistically significant difference between the measured parameters in the two groups after the administration of local anesthetics. **Conclusion:** This study, therefore, shows that there was no difference in the hemodynamic changes observed with the use of lignocaine with adrenaline or plain lignocaine during a simple tooth extraction in healthy adults.

**Key words:** Adrenaline, hemodynamic, lignocaine, local anesthetic, tooth extraction

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## INTRODUCTION

Safe and effective control of intraoperative pain is an intrinsic and important part of clinical dental practice.<sup>[1,2]</sup> This is commonly achieved with the use of local anesthetics, which are pharmacological agents that cause reversible interruption in the conduction of a nerve impulse to an anatomic part of the body.<sup>[1-4]</sup> The successful provision of many dental treatments including tooth extraction, therefore, depends on achieving excellent perioperative local anesthesia.<sup>[5,6]</sup> The vasoconstrictors and local

anesthetics commonly used in oral surgery can induce hemodynamic changes during tooth extraction in the same way as other factors such as patient anxiety or stress.<sup>[6,7]</sup> The adrenaline added to the anesthetic solution is used in oral surgery to increase the potency and duration of anesthesia, reduce the plasma concentrations of the anesthetic, and improve the local control of bleeding.<sup>[1,2,8]</sup> Adrenaline containing local anesthetic has been criticized due to the

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risk of possible massive systemic absorption of the drug, resulting in undesirable cardiovascular effects.<sup>[9,10]</sup> This risk is more likely in patients with cardiovascular disease and hypertension; an increase in blood pressure (BP) has also been reported after the injection of anesthetics even in normotensive patients.<sup>[5,11]</sup> It is also widely claimed that the use of local anesthetics with adrenaline predisposes to undesirable cardiovascular changes that may result in life-threatening medical complications, representing a risk to patients with heart disease, especially those previously undiagnosed.<sup>[11]</sup>

This study was, therefore, conducted to determine the changes in BP and pulse rate (PR) of apparently healthy patients having dental extraction under the administration of 2% lignocaine local anesthetic with or without adrenaline.

## MATERIALS AND METHODS

This prospective study was conducted at the exodontia clinic of the Department of Oral and Maxillofacial Surgery, Lagos University Teaching Hospital (LUTH), Idi-Araba, Lagos, Yoruba State, Nigeria, from December 2004 to August 2005. Approval was given by the Research and Ethics Committee of the hospital. Subjects included in this study were patients who presented at the clinic for intra-alveolar tooth extraction.

For each patient, a complete case history was compiled, including completion of a basic health questionnaire, to evaluate the patient's general condition. Patients with decompensated systemic diseases contraindicating or impeding dental treatment were excluded from the study, as were those who had arterial hypertension or were receiving medication capable of interacting with the drugs contained in the anesthetic solutions used.

All the selected patients required extraction of a fully erupted nonmobile premolar or molar tooth. The patients were randomly allocated into two groups (group A and group B) according to the type of anesthetic solution employed. One 68 patients from group A had their tooth extraction done under the administration of 2% lignocaine local anesthetic with adrenaline (1:80,000) while 157 from group B had their tooth extraction done under the administration of 2% lignocaine anesthetic without the vasoconstrictor (adrenaline). Only one tooth was extracted for each patient and two 1.8 mL cartridges (3.6 mL) of local anesthetic solution were injected. In all the subjects, the aspiration technique was used to prevent inadvertent injection of anesthetics into the vasculature and care was taken to ensure that the injection was as painless as possible. The anesthetic technique typically used for the extraction of a premolar and molar teeth was truncal block of the inferior alveolar and lingual nerves, with infiltration of the buccal nerve for the mandibular teeth

and for maxillary teeth; anesthesia was achieved through infiltration of the middle and posterior superior alveolar nerves and greater palatine nerve.

All the extractions were performed by oral surgery resident doctors while the hemodynamic readings were taken by another surgeon. Systolic blood pressure (SBP), diastolic blood pressure (DBP), and PR measurement were recorded with a precalibrated noninvasive electronic digital BP monitor (Mark of Fitness® model MF-61, Mark of Fitness Inc., shrews bury, NJ077702, Japan). Readings were taken first in the waiting room, then during the surgery 3-6 min after the local anesthetic injection, during the tooth extraction, and 15 min after the tooth extraction. All the patients who complain of pain after receiving a second cartridge of local anesthesia as well as those that required transalveolar approach to complete their tooth extraction were excluded from the study.

Data analysis was done using the Statistical Package for Social Sciences, SPSS® for Windows, version 11.0 (SPSS Inc., Chicago, IL, USA) statistical software package. Paired sample *t*-test was used to analyze the variation in parameters within the groups while independent sample *t*-test was used to compare the means of the two groups. To compare the frequency between the groups, Chi-square test was used. The critical level of significance was set at  $P < 0.05$ .

## RESULTS

A total of 325 subjects participated in the study. The age range of the subjects was 18-89 years with the mean age of  $35.1 \pm 15.6$  years [standard deviation (SD)]. The male-to-female ratio was 1:1.2.

One hundred and seventy five (57%) patients were below the age of 30 years while only 10 (3.1%) were above the age of 70 years [Figure 1]. One hundred and sixty eight patients in group A had their tooth extracted under the administration of 2% lignocaine local anesthetic with adrenaline (1:80,000) while 157 in group B had theirs done under 2% lignocaine local anesthetic without adrenaline. The trends in variation of SBP, DBP, and PR were similar

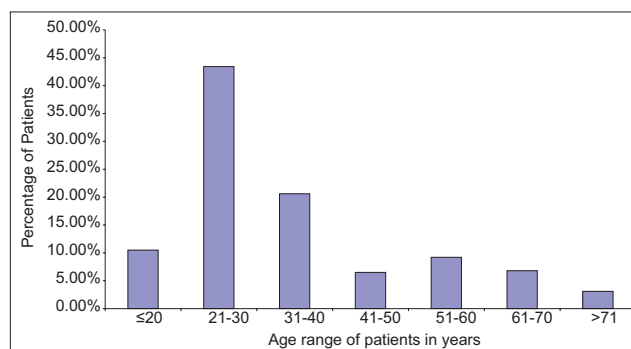


Figure 1: Age range distribution of patients

in the two groups. The hemodynamic responses of the patients in the two groups during the perioperative period are presented in Tables 1-3.

In group A, after the administration of 2% lignocaine anesthetic with adrenaline (1:80,000), the mean SBP increased by  $2.4 \pm 6.0$  mmHg from the baseline reading. Increase in the mean SBP was statistically significant [Table 1]. The greatest increase of 12.0 mmHg from the baseline reading was recorded during the tooth extraction. This was also statistically significant [Table 2]. After the tooth extraction, the SBP returned to the baseline value. The mean DBP unlike the SBP showed a decrease of  $2.0 \pm 9.2$  mmHg after the local anesthetic administration, which was also statistically significant [Table 1]. During tooth extraction, the mean DBP increased to 83.0 mmHg from a baseline value of 76.5 mmHg ( $P = 0.00$ ). After extraction, the mean DBP value however dropped by  $1.2 \pm 9.4$  mmHg below the baseline value of 76.5 mmHg ( $P = 0.09$ ). The PR showed no obvious changes following local anesthetic administration [Table 1]; however, there was a statically significant increase of an average of  $6.0 \pm 7.9$  beats/min during extraction [Table 2]. There was also a drop in the post-extraction reading to a level that was  $4.2 \pm 7.6$  bpm lower than the baseline reading. This was statistically significant when compared with the baseline reading.

In group B, following the administration of 2% lignocaine anesthetic without adrenaline, hemodynamic parameter changes similar to that of group A were observed [Tables 1 to 3]. There was a significant increase of mean SBP after the administration of local anesthetic, which further increased during extraction. After the extraction, there was a fall in the SBP but not in the baseline level. In contrast to the SBP, the mean DBP decreased significantly after the local anesthetic administration and increased significantly during extraction returned to the baseline level after the extraction [Tables 1 to 3]. The mean PR increased significantly ( $8.2 \pm 12.5$  bpm) during extraction and dropped to a lower level than the baseline after the extraction [Tables 1 to 3].

Table 4 compares the hemodynamic responses to 2% lignocaine local anesthetic with adrenaline to the responses to plain 2% lignocaine. The variations in the values of the SBP in the two groups follow the same pattern. A mean increase of  $2.4 \pm 6.0$  mmHg ( $P = 0.000$ ) and  $1.8 \pm 5.7$  mmHg ( $P = 0.001$ ) was observed in group A and group B, respectively, after local anesthesia administration. The highest increase from the baseline readings was recorded during the tooth extraction in the two groups;  $12.0 \pm 2.1$  mmHg in group A and  $16.1 \pm 3.3$  mmHg in group B. Statistical analysis showed that the increase in baseline readings during tooth extraction are statistically significant. The mean SBP returned to the baseline level of 122.5 mmHg in group A after the surgery while a reading of 125.3 mmHg as against the baseline of 123.6 mmHg was recorded

**Table 1: Hemodynamic alterations within the study groups after the local anesthetic injection (mean $\pm$ SD)**

Parameter	Group	Baseline	After local anesthesia	Md	P value
SBP	A	122.2 $\pm$ 14.6	124.6 $\pm$ 15.1	2.4 $\pm$ 6.0	0.000
	B	123.6 $\pm$ 12.3	125.5 $\pm$ 12.5	1.8 $\pm$ 5.7	0.001
DBP	A	76.5 $\pm$ 10.8	74.1 $\pm$ 11.4	-2.0 $\pm$ 9.2	0.001
	B	79.5 $\pm$ 9.8	77.3 $\pm$ 9.5	-2.1 $\pm$ 8.1	0.001
PR	A	81.1 $\pm$ 11.6	81.5 $\pm$ 11.9	0.4 $\pm$ 7.4	0.471
	B	78.7 $\pm$ 11.1	78.4 $\pm$ 11.7	0.9 $\pm$ 7.6	0.634

N Group A=168, Group B=157, Md=Mean difference

**Table 2: Hemodynamic alteration within the study groups during tooth extraction (mean $\pm$ SD)**

Parameter	Group	Baseline	During extraction	Md	P value
SBP	A	122.2 $\pm$ 14.6	134.2 $\pm$ 16.7	12.0 $\pm$ 9.4	0.000
	B	123.6 $\pm$ 12.3	139.7 $\pm$ 15.6	16.1 $\pm$ 10.8	0.000
DBP	A	76.5 $\pm$ 10.8	83.0 $\pm$ 13.3	6.4 $\pm$ 11.6	0.014
	B	79.5 $\pm$ 9.8	86.8 $\pm$ 12.1	7.3 $\pm$ 10.8	0.000
PR	A	81.1 $\pm$ 11.6	87.1 $\pm$ 13.49	6.0 $\pm$ 7.9	0.006
	B	78.7 $\pm$ 11.1	86.91 $\pm$ 13.6	8.2 $\pm$ 12.5	0.023

N Group A=168, Group B=157, Md=Mean difference

**Table 3: Hemodynamic alteration within the study groups after tooth extraction (mean $\pm$ SD)**

Parameter	Group	Baseline	After extraction	Md	P value
SBP	A	122.2 $\pm$ 14.6	122.5 $\pm$ 14.3	0.4 $\pm$ 7.8	0.518
	B	123.6 $\pm$ 12.3	125.3 $\pm$ 12.7	1.6 $\pm$ 7.6	0.067
DBP	A	76.5 $\pm$ 10.8	75.3 $\pm$ 11.2	1.2 $\pm$ 9.4	0.091
	B	79.5 $\pm$ 9.8	79.8 $\pm$ 10.1	0.3 $\pm$ 8.2	0.604
PR	A	81.1 $\pm$ 11.6	76.9 $\pm$ 12.1	-4.2 $\pm$ 7.6	0.002
	B	78.7 $\pm$ 11.1	74.4 $\pm$ 11.30	-4.3 $\pm$ 9.8	0.002

N Group A=168, Group B=157, Md=Mean difference

**Table 4: The comparison of the mean blood pressure and pulse rate between plain lignocaine and plain lignocaine with adrenaline groups**

Parameter	Measurement time	Mean $\pm$ SD		P value
		Group A	Group B	
SBP	Baseline	122.2 $\pm$ 14.6	123.6 $\pm$ 12.3	
	After local anesthesia	124.6 $\pm$ 15.1	125.5 $\pm$ 12.5	0.564
	During extraction	134.2 $\pm$ 16.7	139.7 $\pm$ 15.6	0.002
	After extraction	122.5 $\pm$ 14.3	125.3 $\pm$ 12.7	0.067
DBP	Baseline	76.5 $\pm$ 10.9	79.5 $\pm$ 9.8	
	After local anesthesia	74.0 $\pm$ 11.4	77.3 $\pm$ 9.5	0.065
	During extraction	83.0 $\pm$ 13.3	86.8 $\pm$ 12.1	0.027
	After extraction	75.3 $\pm$ 11.3	79.8 $\pm$ 10.1	0.081
PR	Baseline	81.1 $\pm$ 11.6	78.7 $\pm$ 11.1	
	After local anesthesia	81.5 $\pm$ 11.9	78.7 $\pm$ 11.7	0.069
	During extraction	87.1 $\pm$ 13.4	86.7 $\pm$ 13.6	0.856
	After extraction	76.9 $\pm$ 12.1	78.4 $\pm$ 11.3	0.062

in group B. The mean DBP shows a different pattern of changes from the SBP. There was a decrease of  $2.5 \pm 1.5$  mmHg in group A and  $2.2 \pm 0.3$  mmHg in group B after local anesthetic administration while during tooth extraction there was an increase of  $6.4 \pm 0.1$  mmHg in group A and

7.3 ± 2.3 mmHg in group B from the baseline level. The values, however, returned to the baseline value after the tooth extraction. These observed differences were not statistically significant. The mean PR remained unchanged after local anesthetic administration, which rapidly increased to statistically significant levels of 6.0 ± 1.8 bpm and 8.0 ± 2.7 bpm for groups A and B, respectively, during the tooth extraction. Following the extraction, there was a decrease in PR to 76.9 bpm, which is below the baseline value of 81.1 bpm for group A while the value for group B returned to 78.4 bpm.

## DISCUSSION

Several studies have been directed toward the systemic effect of exogenously administered adrenaline during dental local anesthesia with regard to potential medical risks.<sup>[11-16]</sup> The present study provided an overview of the effect of adrenaline contained in lignocaine solution on the BP and PR of adult normotensive subjects undergoing tooth extraction under local anesthesia. In this study, it was observed that there was a significant increase of 2.4 ± 6 mmHg in the mean SBP from the baseline readings in group A after the injection. This has been reported to be due to the  $\alpha$ -adrenergic effect of adrenaline on the receptors in the arteriole wall, leading to local arterial constriction that increases peripheral resistance and cause a resultant increase in SBP<sup>[12]</sup> Tolas *et al.*<sup>[8]</sup> and Brand<sup>[17]</sup> had previously observed that plasma adrenaline concentration increases twofold to tenfold few minutes after the injection of local anesthetic containing adrenaline. This increase was attributed to an expression of endogenous adrenaline release in response to the pain of the injection that is further augmented by the exogenous adrenaline in the local anesthetic solution. This similar finding was reported by Silvestre *et al.*<sup>[18]</sup> and Chohan *et al.*<sup>[19]</sup> but contrary to the reports of other investigators<sup>[3,20,21]</sup> who did not observe any alteration in BP after local anesthetic injection.

The DBP in group A and group B showed statistically significant reductions of 2.0 ± 9.2 mmHg and 2.1 ± 8.1 mmHg, respectively, from the baseline readings following the injection of the local anesthetic. This is possibly due to the  $\beta_2$  effect of adrenaline that produced a decrease in systemic arterial resistance following systemic absorption in low dose, thus confirming the findings of Tolas *et al.*<sup>[8]</sup> and Meechan *et al.*<sup>[5]</sup> that adrenaline has a number of hemodynamic responses that include decrease in DBP in adults.

Interestingly, the mean PR remained unchanged in both the lignocaine-adrenaline and plain lignocaine groups after local anesthetic injection but rapidly increased during the extraction and decreased below the baseline reading after the extraction. This finding is in contrast to that of the study conducted by Niwa *et al.*<sup>[3]</sup> and Meral *et al.*<sup>[21]</sup> who reported

a slight increase in the PR immediately after the injection of 2 mL (one cartridge) of 2% lignocaine local anesthetic with adrenaline in 1:100,000. This initial elevation of mean PR may be a result of the patients' anticipation of the treatment. Brand<sup>[22]</sup> and Jowett and Cabot<sup>[23]</sup> have earlier reported that increase in the mean PR is induced by the patient's anticipation of scheduled dental treatment; they also observed that anxious patients and dental phobics have an increase in heart rate prior to dental treatments. Kleinknecht and Alexander,<sup>[24]</sup> in a study on origins and characteristics of fear in dentistry, established that expectation of trauma from dentistry, previous painful dental work, and perceived ill treatment by dentists were some of the fear-eliciting stimuli. The recorded baseline reading seems to be an elevated figure since the mean PR value after the tooth extraction returned to a value below this level. Possibly, the patients were tachycardic in anticipation of a painful tooth extraction.

In group B patients, there was also an increase of 1.8 ± 5.7 mmHg in the mean SBP and slight decrease of 2.1 ± 8.1 mmHg in the DBP after local anesthesia injection. This could be attributed to the effect of endogenous adrenaline release in response to injection pain. These differences in the mean PR are similar to that obtained in group A. The observation is in agreement with the findings of Meral *et al.*,<sup>[21]</sup> which reveal that hemodynamic effect of lignocaine with adrenaline is not different from that of plain lignocaine.

There was no statistically significant difference in the hemodynamic parameters (SBP, DBP, and HR) of the two groups after the local anesthesia injection. This suggests that the recorded alteration in individual groups is possibly not due to the effect of the exogenously administered adrenaline. The highest mean value of all the hemodynamic parameters in the two groups was recorded during tooth extraction. These observations were similar to the findings of other authors<sup>[5,8,20,25]</sup> who deduced that tooth extraction is the most stressful part of the procedure. The observed increase can be attributed to factors such as psychological and physical stress, including that from painful stimuli, and patient anxiety.<sup>[12,17,24,26]</sup> This increase was significantly higher in the plain lignocaine group and was thought to be due to less effective anesthesia; this may likely be due to the absence of adrenaline that have been found to increase the potency and duration of anesthesia.<sup>[1,2,8]</sup> This observed increase in the measured parameters during tooth extraction can also be attributed to excessive release of endogenous adrenaline in response to pain-related stress (possibly from the less effective anesthesia) that has been identified by Tsuchihashi *et al.*<sup>[27]</sup> as a major determinant of the increment in BP level during the dental surgery. This finding is contrary to the findings of Beck and Weaver<sup>[28]</sup> and Meiller *et al.*<sup>[29]</sup> who observed no positive correlation between the baselines.

All the measured parameters in both groups A and B returned to the baseline measurement 15 min after the tooth extraction. This is possibly because the adrenaline must have been eliminated from the system and the effect of stress and anxiety is no longer present. This is in agreement with the findings of Abraham-Inpijn *et al.*<sup>[25]</sup> and Parameasvaran and Kingon,<sup>[30]</sup> which reveal that 10 min is sufficient for cardiovascular parameters to decrease to normal values after tooth extraction.

Some limitations of this study need to be acknowledged; the expected hemodynamic alterations are transient changes that need to be rapidly observed. It is possible that some of these transient changes in basic hemodynamic response that indicate an increased cardiovascular risk may have been masked by the discontinuous recording system that was used in the study, a continuous monitoring system may be more accurate.

## CONCLUSION

The hemodynamic responses to lignocaine with adrenaline (1:80,000) and plain lignocaine essentially follow the same pattern as was found in this study. There were no significant differences in the BP and PR alteration of apparently healthy adults following the injection of 2% lignocaine anesthetic with adrenaline (1:80,000) or without adrenaline. This study, therefore, shows that lignocaine with adrenaline may have no different hemodynamic effects in comparison to lignocaine alone during simple tooth extraction in healthy adults.

The observed hemodynamic changes are possibly due to other factors such as stress and patient's anxiety. Further studies to ascertain the role of these factors in hemodynamic changes during oral surgery procedures may be necessary.

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## Conflicts of interest

There are no conflicts of interest.

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James, *et al.*: Hemodynamic response during simple tooth extraction

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