Anaesthetic Effectiveness of Articaine and Lidocaine with Epinephrine and Cardio-respiratory Responses in Hypertensive and Normotensive Minor Surgical Patients

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INTRODUCTION

The goal of personalized medicine is to maximize the likelihood of therapeutic efficacy and minimize the risk of drug toxicity for an individual patient in all clinical situations (Xie & Frueh, 2005). One way to achieve this is through a systematic analysis of the prevailing clinical situation and the rational use of medicines. The rational use of medication implies the use of an appropriate medication, for the appropriate diagnosis or clinical situation, in an appropriate dose, for the appropriate person, through the appropriate route for an appropriate duration at the lowest cost for the individual and the community.

Whereas the safety and efficacy of a drug is evaluated according to strict regulatory guidelines, before the drug is marketed, it is however impossible that an approved drug becomes safe or effective for everyone. Interactions of genetic and environmental factors result in substantial variability in individuals' responses to available medications worldwide (Takahashi & Echizen, 2003; Xie & Frueh, 2005).

In choosing the appropriate medication from the available stock, efficacy and safety are of utmost importance. The task of choosing the appropriate medications is a complex one. This is because most drugs exert their effects in a multigenetic manner, showing complex interactions with the genes, environment, drugs, foods and even pathogens such as bacteria, parasites and viruses (Xie & Frueh, 2005). Today, in the practice of minor oral and maxillofacial surgery, there are many medications in varied concentrations, approved for the management of anxiety, bleeding, pain and secretions. With continuous advancement in pharmacotherapeutics, more medications are being introduced and approved for clinical use. The variety of these proprietary medications available to the clinicians poses real challenges to selecting the appropriate medications for a diagnosed clinical situation. This necessitates clinicians to constantly apprise themselves of the actions of medications available for their practice (Malhotra *et al.*, 2013).

Effective and safe control of pain is essential for the practice *m*OMS. Local anesthetic agents (LAAs) play fundamental role for pain-free surgeries. Local anesthesia (LA), sedation and general anesthesia (GA) are integral part of *m*OMS (ADA, 2007; 2012; 2016). Perhaps the most important skill required of all dental practitioners is the ability to provide effective and safe local anesthesia (Moore et al., 2010).

Local anesthesia is the reversible blockade of nerve conduction, resulting in temporary loss of sensation including pain in one part of the body produced by a topically-applied or injected agent, without depressing the level of consciousness (Ogle & Mahjoubi, 2012; AAPD, 2015; Kam et al., 2017). LAAs are the most commonly used drugs in *m*OMS (Malamed, 2004; Goyal, 2013). When given, LAAs prevent transmission of pain sensation during surgical procedures. LAAs are therefore essential for patients' comfort and cooperation during surgery (Malamed, 2006).

The protocol for effective and safe management of pain starts at the time of initial interview, before admission for surgery. This protocol involves appropriate composure and comportment of the surgeon and his team members, establishment of good rapport and adequate educations on the patients' expectations vis-à-vis the possible outcomes based on information available to the surgeon and team in the body of knowledge (Odai et al., 2013; Odai, 2014).

LAAs evokes local vasodilation. This enhances escape of LAAs into the systemic circulation, reduces the duration of action, increases the risk of toxicity and also aggravates bleeding during surgery. This associated vasodilation justified the introduction of vasoconstrictor agents into LAA preparations for oral surgery.

The vasoconstrictor counteracts the local vasodilation effect of the LAAs and delays their absorption into the cardiovascular system. The vasoconstriction is beneficial in increasing the duration of local anesthesia and diminishing the risk of toxicity. It also enhances hemostasis during surgery therefore reducing blood loss and creates clear operation fields for the surgeons to work (Haas, 2002; Abu-Mostafa et al., 2015).

Epinephrine is one of the most widely used vasoconstrictor in association with LAAs in *m*OMS (Haas, 2002; Figallo et al., 2012; Abu-Mostafa et al., 2015). This substance provokes vasoconstriction of the blood vessels in the mucosa and skin; favoring latency periods and reducing the dissemination of the LAAs due to its action on α_1-adrenergic receptors (Figallo *et al.*, 2012). However, binding to the β_1-adrenergic receptors can provoke an increase both in heart rate and blood pressure, while its binding to β_2-adrenergic receptors can cause vasodilation in muscles and internal organs (Haas, 2002; Serrera-Figallo et al., 2012). Pain during *m*OMS can also trigger the release of endogenous catecholamines, which, in turn, can give rise to hemodynamic changes, such as increase in blood pressure and heart rate, and may even produce arrhythmia (Abu-Mostafa *et al.*, 2015).

Some reports and anecdotal evidence in this study center show that most clinicians still prefer to use local anesthetics without vasoconstrictors in hypertensive patients due to the presumed negative effects of vasoconstrictors on cardiovascular system. Subsequently, hemodynamic aspects, like blood pressure and heart rate, in hypertensive patients come into prominence. Additional to these is myocardial ischemia which is also important in hypertensive patients (Ezmek et al., 2010).

Whereas some studies have shown that local anesthetics having vasoconstrictors can be safely used in *m*OMS amongst hypertensive patients, some controversies exist about this subject, with arguments for 'zero' epinephrine among the hypertensives (Gungormus & Buyukkurt, 2003; Malamed, 2004; Holm et al., 2006). Arguments for zero epinephrine do not take cognizance of earlier of Meyer that using anaesthetic solutions without vasoconstrictors increase the risk of hypertensive crisis due to the potential pain caused by insufficient intraoperative anesthesia (Meyer, 1986; Meyer, 1987).

This randomized clinical trial is therefore aimed to evaluate and compare the anaesthetic effectiveness and some of the cardio-respiratory effects of the articaine and lidocaine with varied concentrations of epinephrine among hypertensive and normotensive subjects planned for *m*OMS.

MATERIALS AND METHODS

Study Design and Setting: This randomized clinical trial was carried out on persons planned for intra-alveolar extraction of maxillary molars in the Department of Oral and Maxillofacial Surgery, University of Benin Teaching Hospital, Benin-City, Nigeria, over a 24-month period (May, 2017 to April, 2019 inclusive).

Study Location: The Study was carried out in the Department of Oral and Maxillofacial Surgery of the University of Benin Teaching Hospital, Benin-City, Edo state, Nigeria. The Department is part of the Dental Center of the University of Benin Teaching Hospital, a center that is accredited for the training of dental surgery personnel by the Nigerian University Commission (NUC), the Medical and Dental Council of Nigeria (MDCN), the National Postgraduate Medical college of Nigeria and the West African College of Surgeons.

The Department has dental chairs dedicated for diagnosis and minor oral surgical procedures, including the routine of intra-alveolar extractions, employed as the clinical model in this study.

Study Population: The study involved persons attending the dental center for intra-alveolar extraction of maxillary molar teeth. The age range of participants was eighteen (18) to fifty-five (55) years.

Cohorts and selection method: The study population was drawn from consecutive persons who presented for an extraction involving the maxillary molar teeth over a period of twenty-four months between May 2, 2017 and April 30, 2019.

The patients were divided into six cohorts A-100, A-200, L-0, L-80, L-100 and L-200. A-100 cohort received 1.8mls of 4% articaine + 1:100,000 adrenaline, A-200 cohort received 1.8mls of 4% articaine + 1:200,000 adrenaline both were bought from safco®, Safco Dental Supply Company, Buffalo Groove, IL 60089, USA), for their extraction.

L-0 cohort received 1.8mls of 2% lignocaine without adrenaline, L-80 cohort received 1.8mls of 2% lignocaine + 1:80,000 adrenaline, L-100 cohort received 1.8mls of 2% lignocaine + 1:100,000 adrenaline and A-200 cohort received 1.8mls of 4% articaine + 1:200,000 adrenaline for their extraction. The various L-cohorts were products of Zeyco®, Laboratorios Zeyco, S.A. DE C.V. Zapopan, Jalisco, Mexico.

All injection solutions were given by 27G, 25mm dental syringe product of Unoject®, Estrada do Guerengue 2059, Rio de Janeiro-RJ. The maxillary infiltration technique was used for delivering the LAAs. Metal aspirating dental syringes (Septodont®, United States of America) was used to deliver the various doses of the medicines.

The patient and the observer who notes and records the various parameter were blinded from the agents used for the procedure (double-blinded design).

Measurement of Cardio-Respiratory functions: Seated on the dental chair, a pulse oximeter (MASiMO SET® Radical-7 Pulse Oximeter) was applied to the right thumb of the patient. With this, the heart rate and oxygen saturation were recorded. Blood pressure was measured by an electronic sphygmomanometer (OMRON® MX3 Plus automatic blood pressure monitor) applied to the left arm. The respiratory rates were counted by a trained research assistant by observing chest movements. All the subjects had their pulmonary function parameters measured by a Hygeia® turbine spirometer.

Timing of the readings were as follows: $\mathbf{T_0}$, when the subject is seated and fully relaxed a the patients' waiting area(away from surgical room and equipment); $\mathbf{T_1}$, immediately following the administration of the LAA prescribed for the cohort to which the individual is allocated, with the subject seated and relaxed; $\mathbf{T_2}$, at the end of surgery, with the subject seated and relaxed and $\mathbf{T_3}$, , 60 minutes after administration of the LAAs and bleeding fully arrested and with the subject seated and relaxed (Kambalimath et al., 2013).

Inclusion criteria: Adults, between 18 and 55 years, presenting with an upper maxillary molar requiring extraction, meeting other set criteria and consenting for inclusion into the study.

Inclusion criteria for normotensive persons: Normotensive adults, between 18 and 55 years, presenting with an upper maxillary molar requiring extraction, meeting other set criteria and consenting for inclusion, systolic pressure less than 140mmHg and/or diastolic pressure less than 90mmHg (American Joint National Committee on Hypertension, 2018), were recruited into this study to represent normotensives.

Inclusion criteria for mildly hypertensive persons: Adults, between 18 and 55 years, presenting with an upper maxillary molar requiring extraction, meeting other set criteria and consenting for inclusion, systolic pressure systolic pressure of 140-159 mmHg and/or diastolic pressure of 90-99 mmHg (American Joint National Committee on Hypertension 2018), were recruited into this study to represent hypertensives. The study participants in this group are those that are not on any treatments for hypertension.

Exclusion criteria: The existence of acute infection and/or swelling at the time of surgery, systemic disorders, history of complications associated with local anesthetics, any treatment for hypertension and interventions in which time for the initial onset of anesthetic effects exceeded 10 minutes. Operations lasting more than 30 were also minutes excluded.

Data of interest: The data of interest in the study were biodata, onset of anesthesia, duration of anaesthesia, depth/quality of anaesthesia, heart rate, systolic blood pressure, respiratory rate, FEV_1 SPO_2, and degree of bleeding. EBL; Estimated blood loss at surgery. These estimates are made from the numbers of gauze used and the extent they are soaked. Number of gauze rolls used before haemostasis is achieved. 1 gauze roll is 2-ply gauze measuring 150mm x 200mm, and can hold about 5.0milliliters of blood.

Statistical analysis: Data was analyzed using SPSS version 20 (SPSS Inc., Chicago, IL). Findings were presented as bar charts and tables, p-values less than 0.05 were considered statistically significant.

Ethical consideration: The study was approved by the research ethics committee of UBTH (Ref: ADM/E 22/A/VOL. II/1486) and all participants were educated regards the research protocols, thereafter they gave informed consent before recruitment into the study. The data was analyzed with SPSS statistical software. The means of variable were compared between the different cohorts. P-values less than 0.05 were considered as significant and the results were presented as bar and pie charts, simple frequencies, tables and graphs.

RESULTS

The variations in the mean age between the cohorts are not statistically significant for both hypertensives and normotensives (df=5, F=1.609, P-value= 0.164 and df=5, F=2.107, P-value=0.065 respectively, N=358).

Table 1 shows the gender distribution of the study participants. For the hypertensives, n=108; there were 60 females and 48 males and for the normotensives, n=251; there were 136 females and 115 males. There were no statistically significance differences in their distribution among the cohorts; chi-square (p-value) are 2.140 (0.829) and 3.377 (0.642) respectively for hypertensives and normotensives.

The time (seconds) of onset of surgical anaesthesia effects of the commonly used LAAs in minor oral and maxillofacial surgery is as shown of table 2. A-100 and A-200 were ahead of the other LAAs in achieving surgical anaesthesia. The difference between articaine (A-100 and A-200) and Lidocaine (L-0, L-80, L-100 and L-200) was statistically significant (F=18.465, p= 0.000).

The duration of surgical anaesthesia within the cohorts is displayed on table 3. The L-0 cohort had the shortest mean (SEM) duration of 24.18(1.19) minutes and the cohort with the longest stimulation time, was the L-80 with mean (SEM) of 120.70 (2.20) minutes. The differences in the mean duration of surgical anaesthesia between the cohorts were statistically significant (F=223.957, p=0.000). The least blood was lost from the L-80 cohort while the most blood loss occurred in the L-0 cohort. df =5; F = 225.912; p = 0.000, (N = 359).

Table 1: Gender distribution within the cohorts for both hypertensive and normotensive study participants (N=359).

		Gender			
Cohorts		*Females n (%)*	*Males n (%)*	X^2	P-value
Hypertensives (n=108)	A-100	9 (8.3)	9 (8.3)	2.140	0.829
	A-200	9 (8.3)	8 (7.4)		
	L-0	14 (13.0)	8 (7.4)		
	L-80	8 (7.4)	10 (9.3)		
	L-100	10 (9.3)	6 (5.5)		
	L-200	10 (9.3)	7 (6.5)		
Normotensives (n=251)	A-100	23 (9.1)	24 (9.6)	3.377	0.642
	A-200	25 (10.0)	20 (8.0)		
	L-0	12 (4.8)	10 (4.0)		
	L-80	21 (8.3)	24 (9.6)		
	L-100	25 (9.9)	20 (8.0)		
	L-200	30 (12.0)	17 (6.7)		

Table 2: Time (seconds) for onset of surgical anaesthesia

	A-100	A-200	L-0	L-80	L-100	L-200	F	P
Mean time	134.04[a]	161.33[a]	240.00[b]	213.33[b]	218.67[b]	206.81[b]	18.465	0.000
SEM	±4.17	±8.27	±11.17	±10.19	±10.30	±9.27		

SEM=Standard Error of Mean

Table 3: Duration (minutes) of surgical stimulation

	A-100	A-200	L-0	L-80	L-100	L-200	F	P
Mean time	109.25[a]	92.71[b]	24.18[c]	120.70[d]	108.38[a]	93.20[b]	223.957	0.000
SEM	±1.51	±1.73	±1.19	±2.20	±1.82	±1.75		

SEM=Standard Error of Mean

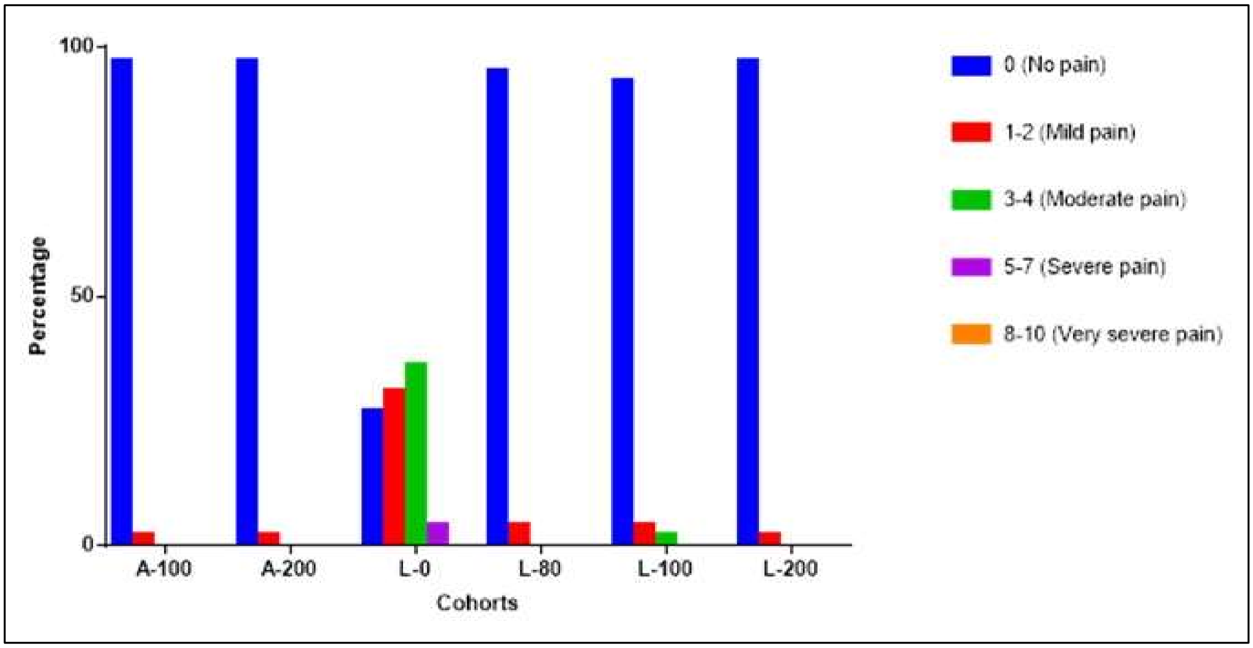

Figure 1: Evaluation of depth/quality of anaesthesia

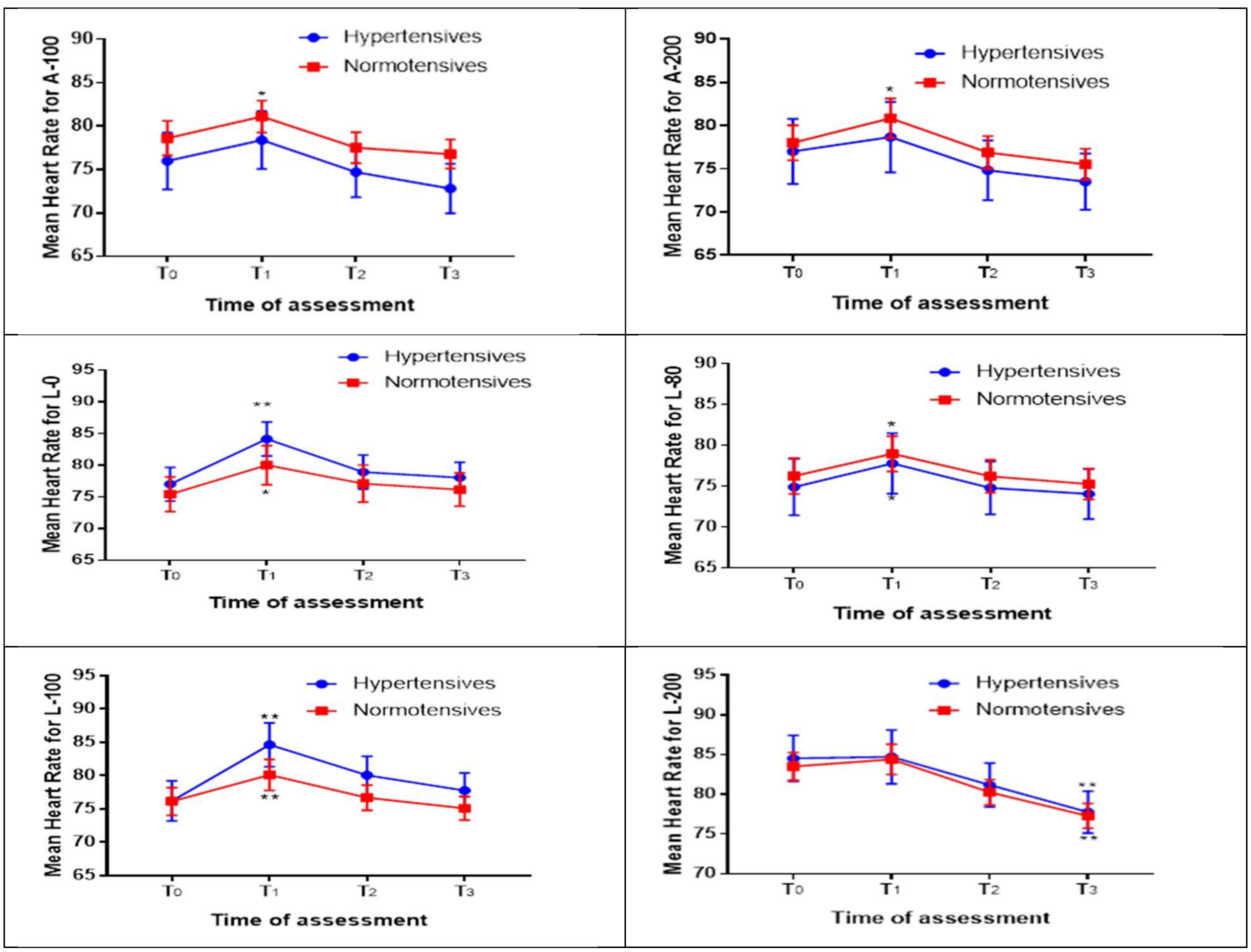

Figure 2: Comparison of mean heart rate for A-100, A-200, L-0, L-80, L-100 and L-200

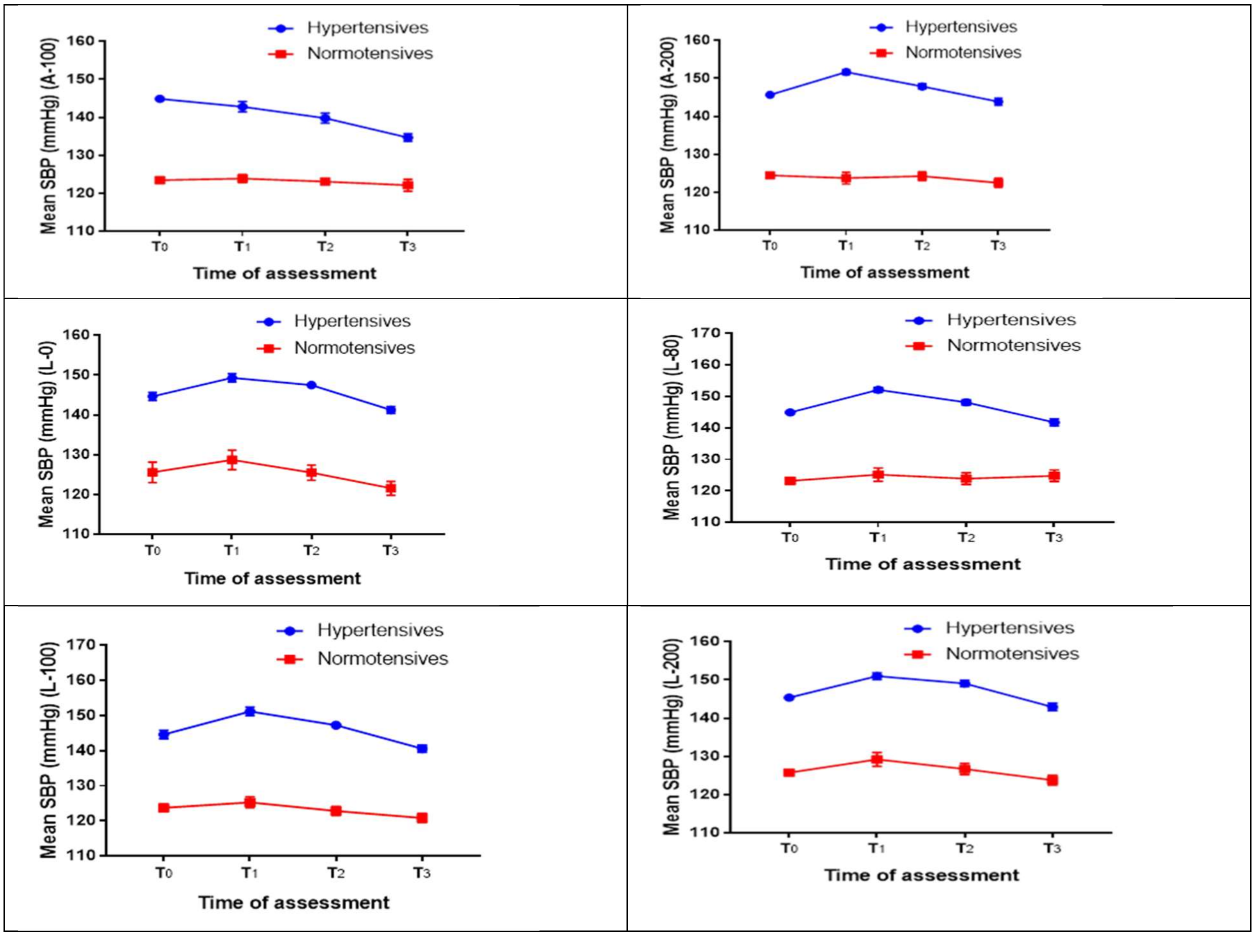

Figure 3: Comparison of mean systolic blood pressure for A-100, A-200, L-0, L-80, L-100 and L-200

DISCUSSION

The mean age of the study participants ranged from 34.78 to 46.12 years. The distribution among the cohorts were such that there are no significance differences in the age of the study participants in the cohorts (Table1; p=0.164). The different age groups were uniformly distributed among the different cohorts. This is another strength of this study.

More females participated in this study. This finding is similar to the finding of practically every other study in this area. The reason for this is probably because females are more likely to present to the hospital to seek help when they have health challenges. Furthermore, females are prone to give a listening ear. As such, they are more likely to oblige to a researcher, listen to and understand the study plans, give consent for enrollment into the study, and devote time to be part of the prescribed study protocols.

Onset of surgical anaesthesia: This is the interval between the injection of the LAAs and time the subject feels no pain when the periodontal ligament of the tooth to be extracted is probed. At this point surgical anesthesia is said to be achieved and therefore pain-free procedures can be done. Here, articaine was ahead of lidocaine and the difference was statistically significant (Table 2, p=0.000).

This trend is in consonance with the findings of Colombini et al., 2006, Potonick et al., 2006, Rebolledo et al., 2007; Kambalimath et al., 2013 where articaine achieved surgical anesthesia faster than lidocaine. Furthermore, the mean time of onset of surgical anesthesia for articaine in this study is 134.04 ± 4.17 seconds. This is also similar to 149.50 ± 14.29 seconds reported by Colombini and coworkers in 2006 but shorter than the 4.2 ± 2.8 minutes reported by Moore and coworkers in 2006.

The differences in the chemistry of the agents, clinical skill, study protocols, environment and genetics could be responsible for the reported differences in the results of these studies.

The patients' assessment of quality/depth of anesthesia can be deduced from a cursory look on the findings on figure 1 showed similarity in the excellent quality of anesthesia provided by articaine and lidocaine with epinephrine. This findings of comparable excellent performance of articaine and lidocaine with epinephrine is not in agreement with the account of Malamed in 2004, Srinivasan et al., 2009, and Yapp, Hopcraft and Parashos, in 2011. The account of these other workers suggests that articaine is superior to lidocaine whereas this study has found a similarity in their effectiveness in pain control.

This disagreement can be explained on a basis of the initial diagnosis before the onset of experiments in the studies. Whereas apical periodontitis is the initial diagnosis in this study, irreversible pulpitis was the initial diagnosis in the other studies comparing articaine and lidocaine. Teeth with irreversible pulpitis are perceived to be more difficult to anesthetize than those with normal pulps because nerves arising from inflamed tissue have altered resting potentials and decreased excitability thresholds (Wallace et al., 1985; Byers et al., 1990; Srinivasan et al., 2009 and Yapp, Hopcraft and Parashos, 2011).

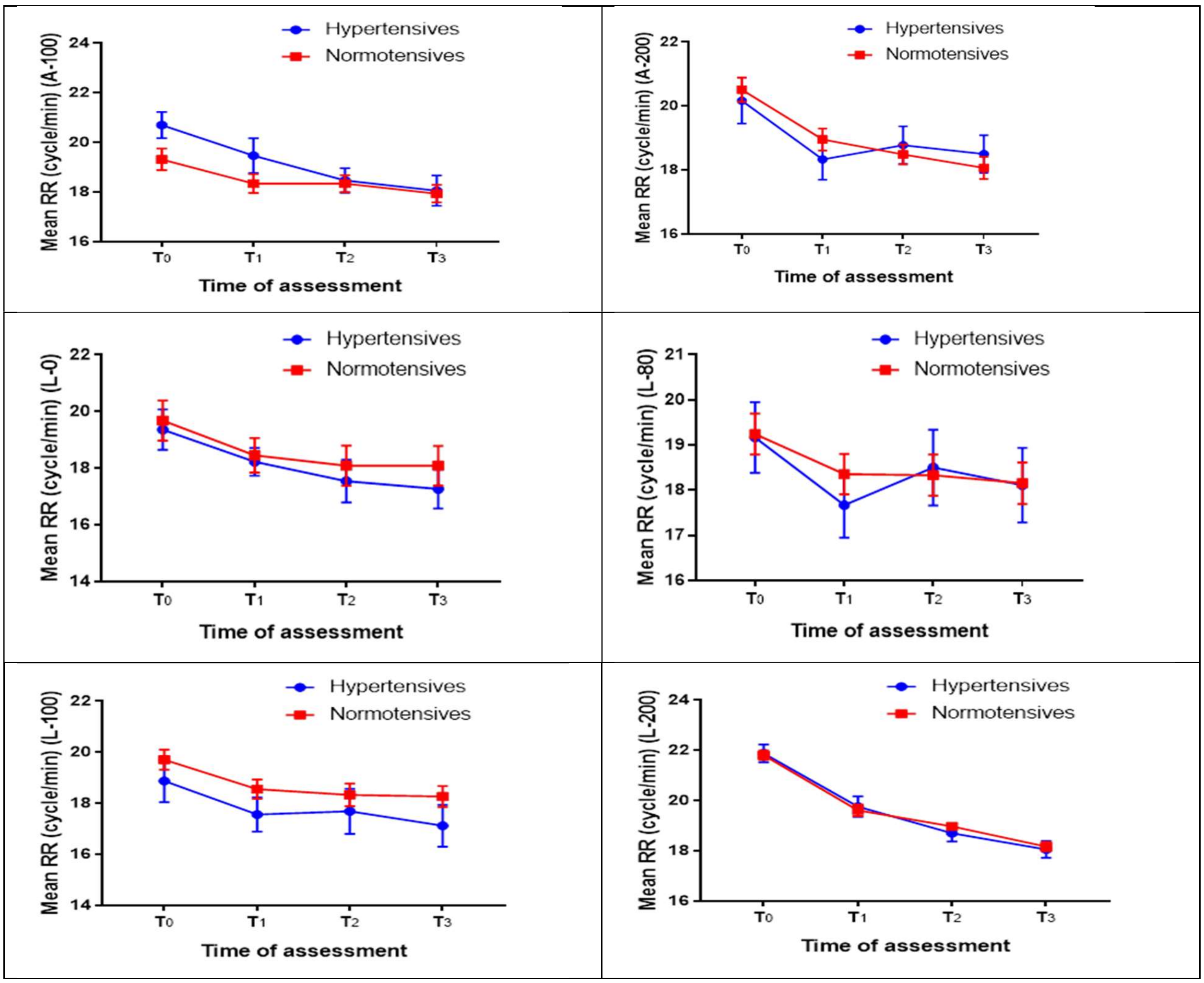

Figure 4: Comparison of mean respiratory rate for A-100, A-200, L-0, L-80, L-100 and L-200

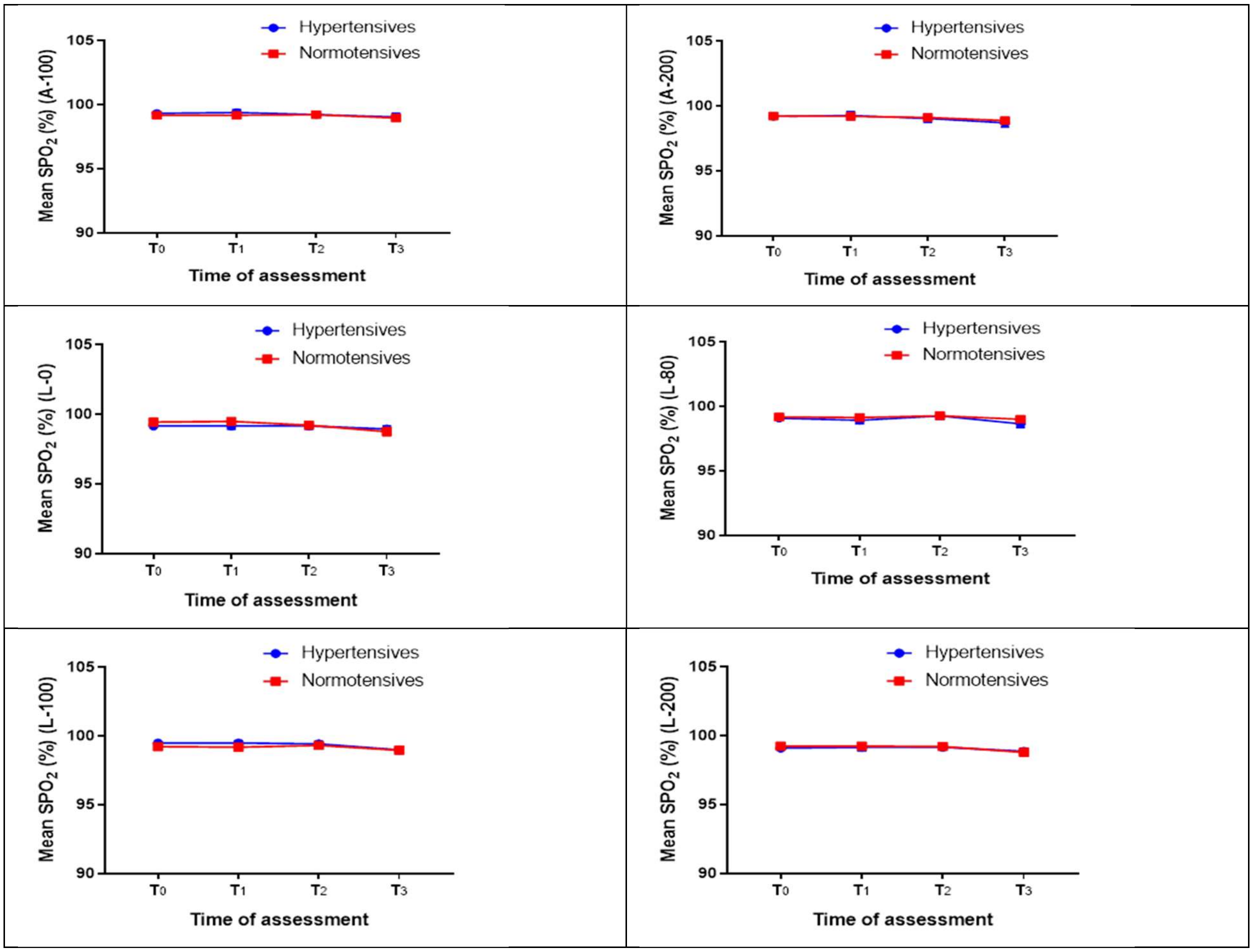

Figure 5: Comparison of mean SPO2 for A-100, A-200, L-0, L-80, L-100 and L-200

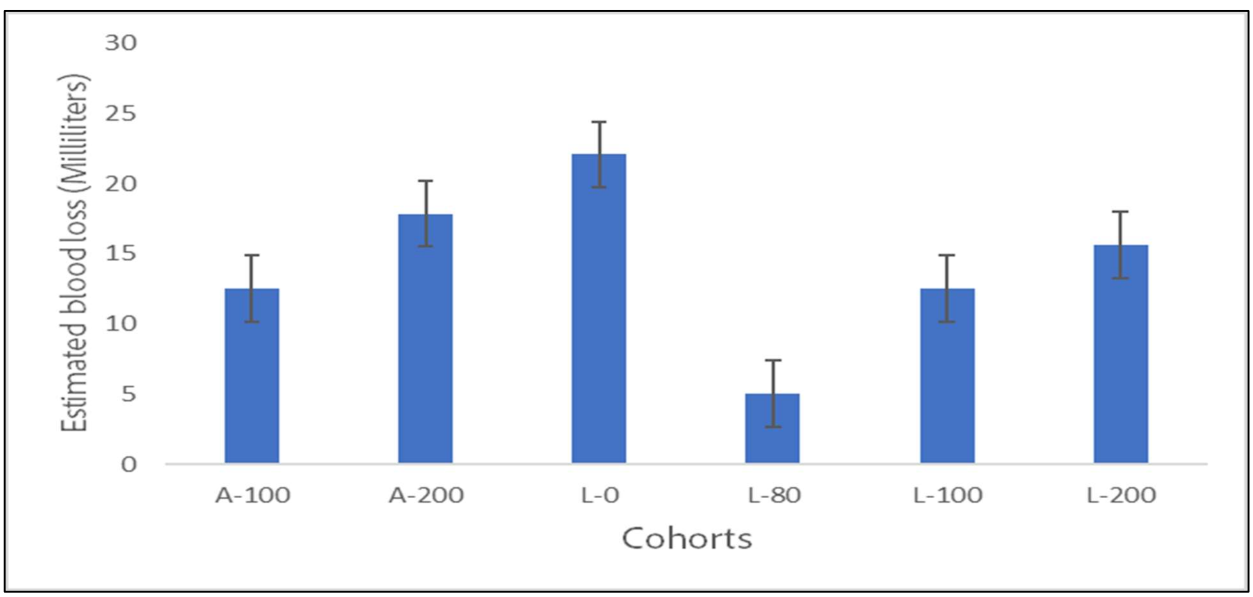

Figure 6: Bar charts displaying estimates of blood loss per cohorts:

The L-0 cohort showed a remarkable poor quality of anesthesia (Figure 1). This is probably because of the absence of the 'tourniquet effect' of epinephrine in the L-0 cohort. Thus, the LA is rapidly dissipated into the surrounding tissues, metabolized and inactivated.

The pattern of changes in the heart rates throughout the experiment were similar in both the hypertensive and the normotensive study participants (Figures 2). There were increase in HR following the injection of LAAs, subsequently the HR declined after extraction of teeth, and there was a further decline at the time the last readings were taken (60 minutes post injection of the LAAs).

The trend of increased heart rate following the injection of LAAs were very similar in both the hypertensive and normotensive study populations. There were significant increases (p=0.000) in the heart rate following injection of all the LAAs including L-0, which has zero-exogenous epinephrine (Figure 2). This trend is contradicting to the findings of James et al., who found no changes in the heart rates after LA injections as reported in 2015.

The finding in this study is similar to the findings of Niwa et al. in 2000, Jowett & Cabot in 2000 and that of Meral et al., in 2005. However, whereas Niwa et al. in 2000 and Meral et al., in 2005 reported only slight increases in HR following injection of there are significant increases in HR in this study for both the hypertensive and normotensive study populations.

A number of explanations are possible to account for the increase in heart rate recorded in this study. First is the result of patients' anticipation of treatment. Anxious patients and dental phobics are known to present with increased heart rates prior to treatments. A second reason why there could be an increased heart rate is an earlier painful dental experience. Thirdly, is an anticipation of painful treatment session. Fourthly, is some fear eliciting stimuli like sight of the armamentarium, perceived ill-treatment and so on (Kleinknecht et al., 1973; Niwa et al., 2000; Jowett & Cabot, 2000; Meral *et al.*, 2005; James *et al.*, 2015).

Lastly and about the most important reason for an increase in heart rate in that epinephrine is by right an ionotropic agent. The β_1-adrenergic effects of epinephrine on the cardiac musculature is known to increase both the rate and force of cardiac contractions. One will therefore want to know the reason for an increased heart rate noted for L-0, with no epinephrine (Figure 2). This increase is attributable to the expression of endogenous epinephrine released in response to the pain of injection.

The trends of the SBP in both the hypertensive and normotensive study participants were similar for A-200, L-0, L-80, L-100 and L-200 (Figures 3). These LAAs all precipitated an increase in the SBP, but the degree of increases was not statistically significant (p>0.05). This is in concordance with this finding of Santos *et al.*, in 2007 and that of de Morais *et al.*, in a series of comparatives studies they did in 2012.

However, the results for SBP differ from the findings of Abu-Mostafa et al. in 2015, who noted a significant rise in the SBP, following injection of the LAAs. An increase in SDP is expected following in injection of epinephrine, an agent known to cause vasoconstriction and increase the heart rate. One would have expected that L-0 to evoke no increase in SBP, but this is not so probably because of the endogenous expression of epinephrine in response to fear, fight or flight. In this case, it is in response to fear and pain.

The pattern of variation differed for A-100, between the hypertensives and the normotensives. Whereas the normotensive participants showed a slight increase following the injection of A-100, the hypertensive study participants unexpectedly, showed a decrease in SBP following the injection of A-100 (Figure 3). One can therefore assume that the elevated blood pressure may have been accentuated by fear and pain. Elimination of this factors by injection of LAA therefore brought about a decrease in the SBP.

The theory of accentuation of blood pressure above seems valid because for all the cohorts, extraction of the offending tooth further reduced the SBP. This reduction of the SBP is likely due to the elimination of fear, pain and reduction of the endogenous expression of epinephrine and the inputs for the sympathetic system.

The respiratory rate following the injection of the different LAAs are seen in figures 4. The general trend displayed is a decrease from the start of the experiment (T_0) to the end of the experiment (T_3). This falls in RR in the various study populations are however not statistically significant (p>0.05). The normotensive study population injected with A-200 showed an increase in the RR, between T1 and T2. This increase is also not statistically significant (p>0.05).

It has been established that a bidirectional relationship exists between pain and respiration. First, respiratory changes often occur in response to pain: An inspiratory gasp with a subsequent breathhold in response to sudden onset, acute pain, a sigh of relief when pain is removed, or hyperventilation in the presence of persistent and uncontrollable pain (Puntillo et al., 1997; Kabes et al., 2002; Ge´ linas & Johnston, 2007; Puntillo et al., 2009; Jafari et al., 2017).

It stands to reason from the foregoing therefore that the initial high rates of RR that were recorded were induced by the acute pain in the study populations. Following injection of LAAs and exodontia of offending, which abolishes the pain, the RR fall correspondingly, in both hypertensive and normotensive study population.

The SPO_2 when compared between the hypertensive and normotensive study participants showed a great similarity for both groups of study population (Figures 5). The values tend toward 100%, and this finding is very reassuring as the SPO_2 is not routinely measured during these minor surgeries. What can be deduced from this is that the atmosphere of the surgeries is healthy. Secondly, the study populations present optimal cardiorespiratory reserves which have not been affected in any adverse way by the LAAs or the study protocols, both in the hypertensive and normotensive study population.

The mean EBL is as displayed on figure 7; a little above 20.0 milliliters of blood was the mean EBL for the L-0, the LAA with most blood loss. Values below 5.0 0 milliliters of blood was the mean EBL for the L-80, the LAA with least blood loss. These differences were statistically significant (F=225.912; p=0.000).

This finding is in keeping with findings in the review of pharmacological considerations of local anesthetics by Becker & Reed in 2012. These researchers noted that higher concentrations of epinephrine in the LAAs infiltrated into the oral tissues will produce better hemostasis. The reason for this is because the tiny vessel of the oral mucosa and the surrounding is rich in α_1-adrenoceptors. These receptors mediate vasoconstrictions, in the small vessels, of the oral mucosa and surrounding tissues.

L-80 has the highest concentration of adrenaline among the LAAs investigated. From the findings here it has proven to be most effective in control of bleeding. This must be due to its pharmacological effect on α_1-adrenoceptors in the oral tissues, effectively evoking profound vasoconstriction. This counteracts the dilatation effects of the LAAs and controls bleeding.

It is logical from the finding above to suggest that this concentration of epinephrine be used in situations where excessive bleeding is likely, such as the excision of pyogenic granulomas, generalized gingivitis, pericoronitis, etc. It must be stated however that this is for normotensive individuals.

Considering the cardiac effects of epinephrine, lower concentrations (not zero epinephrine) should be used among hypertensive persons. The appropriate cardiovascular parameters should however be monitored and preferred doses be tailored according to the needs of the individual patients.

When compared with L-80 it can be concluded that L-0 literally encouraged bleeding. The reason is not far-fetched. LAAs are known to evoke vasodilation, opening up the vessels. Furthermore, the poor performance in pain control (figure 1) and attendant increase in HR (figure 2) and SBP (figure 3.), are all prerequisites for profuse bleeding. (Open vessels, increased heart rate, increased pressure).

CONCLUSION

We therefore conclude from our findings, that; both articaine and lidocaine are able to achieve effective surgical anesthesia for minor oral surgeries. But articaine showed superiority to lidocaine being significantly faster in onset of anesthesia and achievement of surgical anesthesia. Secondly, that the duration of surgical anesthesia is dependent on the tourniquet effect of epinephrine is in turn is a function of the amount of epinephrine in the LAA preparations. Thirdly, the quality of anesthesia produced by A-100, A-200, L-80, L-100 and L-200 are similar and can be described as excellent from the patients' ratings, but L-0 cohort presented very poor quality of anesthesia. And therefore, considered not ideal for use in minor oral and maxillofacial surgeries. Furthermore, the cardiorespiratory responses were similar in both hypertensive and normotensive study populations (with no statistically significance in any differences shown), using the available LAAs in minor oral and maxillofacial surgeries. Including the preparation with no epinephrine. Finally, that the use of L-0 is fraught with anesthetic ineffectiveness and complications and therefore not ideal for use in minor oral and maxillofacial surgery.

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Conflict of interest

The authors declare that they have no conflicts of interest.

REFERENCES

Abu-Mostafa N, Aldawssary A, Assari A, Alnujaidy S, Almutlaq A (2015). A prospective randomized clinical trial compared the effect of various types of local anesthetics cartridges on hypertensive patients during dental extraction. J Clin Exp Dent; 7(1): e84-e88.

Abu-Mostafa N, Al-Showaikha F, Al-Shubbar F, Al-Zawad K, Al-Banawi F (2015). Hemodynamic changes following injection of local anesthetics with different concentrations of epinephrine during simple tooth extraction: A prospective randomized clinical trial. J Clin Exp Dent; 7(4):e471-e476.

American Academy of Pediatric Dentistry (2015). Guidelines on use of local anesthesia for pediatric dental Patients. Clinical guidelines; 199-205.

American Joint National Committee on Hypertensionhttps://www.ajmc.com/journals/evidence-based-diabetes-management. Accessed on December 9th 2019.

Byers M, Taylor P, Khayat B, Kimberly C (1990). Effects of injury and inflammation on pulpal and periapical nerves. *J Endod*; 16: 78–84.

Colombini BL, Modena KCS, Calvo AM, Sakai VT, Giglio FPM, Dionísio TJ, Trindade AS, Lauris JRP Santo CF (2006). Articaine and mepivacaine efficacy in postoperative analgesia for lower third molar removal: a double-blind, randomized, crossover study. Oral Surg, Oral Med, Oral Pathol, Oral Radiol Endod; 102(2), 169-174.

Corbett IP, Ramacciato JC, Groppo FC, Meechan JG (2005). A survey of local anaesthetic use among general dental practitioners in the UK attending postgraduate courses on pain control. Br Dent J; 199:784-787.

Ge´ linas C, Johnston C (2007). Pain assessment in the critically ill ventilated adult: validation of the Critical-Care Pain Observation Tool and physiologic indicators. Clin J Pain; 23:497–505.

Goyal A, Jain G, Jain A, Ansari T, Bumb S (2013). A New Era of Local Anesthetic Agent: Centbucridine. Arch Cran Oro Fac Sc; 1(3):40-43.

Gungormus M, Buyukkurt MC (2003). The evaluation of the changes in blood pressure and pulse rate of hypertensive patients during tooth extraction. Acta Med Austriaca. ;30(5):127-129.

Haas DA (2002). An update on local anesthetics in dentistry. Journal of Canadian Dental Association; 68:546-551.

Holm SW, Cunningham LL Jr, Bensadoun E, Madsen MJ. Hypertension (2006). Classification, pathophysiology and management during outpatient sedation and local anesthesia. J Oral Maxillofac Surg; 64(1):111-121.

James O, Ladeinde AL, Ogunlewe MO, Ajuluchukwu JN, Adeyemo WL (2015). Hemodynamic response after injection of local anesthetics with or without adrenaline in adult Nigerian subjects undergoing simple tooth extraction. J Clin Sci; 12:90-95.

Jowett NI, Cabot LB (2000). Patients with cardiac disease: considerations for the dental practitioner. Br Dent J; 189:297-302.

Kabes AM, Graves JK, Norris J (2009). Further validation of the nonverbal pain scale in intensive care patients. Crit Care Nurse; 29:59–66.

Kambalimath DH, Dolas RS, Kambalimath HV, Agrawal SM (2013). Efficacy of 4 % Articaine and 2 % Lidocaine: A clinical study. J Maxillofac Oral Surg 12(1):3–10.

Kleinknecht RA, Klepac RK, Alexander LD (1973). Origin and characteristics of fear of dentistry. J Am Dent Assoc; 86:842-848.

Malamed S (2006). Local anesthetics: Dentistry's most important drugs, clinical update. J Calif Dent Assoc; 12(34):971-976.

Malamed SF (2004). Clinical action of specific agents. In: Malamed SF, ed. Handbook of local anaesthesia. 5th ed. St. Louis: Mosby; p.57-75.

Meral G, Tasar F, Sayin F, Saysel M, Kir S, Karabulut E (2005). Effects of lidocaine with and without epinephrine on plasma epinephrine and lidocaine concentrations and hemodynamic values during third molar surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endod; 100: e25-30.

Meyer FU (1986). Hemodynamic changes of local dental anesthesia in normotensive and hypertensive subjects. Internal J Clin Pharmacol Ther Toxicol; 24(9):477-481.

Meyer FU (1987). Haemodynamic changes under emotional stress following a minor surgical procedure under local anaesthesia. Int J Oral Maxillofac Surg;16(6):688-694.

Moore PA, Boynes SG, Hersh EV, De Rossi SS, Sollecito TP, Goodson JM Leonel JS, Floros C, Peterson C, Hutchenson M. (2006). The anesthetic efficacy of 4% Articaine 1:200000 epinephrine. J Am Dent Assoc; 137:1572–1581.

Moore PA, Hersh EV, Boynes SG (2010). Update of Dental Local Anesthesia. Dent Clin North Am; 54: xiii–xiv.

Niwa H, Satoh Y, Matsuura H (2000). Cardiovascular responses to epinephrine-containing local anesthetics for dental use: A comparison of hemodynamic responses to infiltration anesthesia and ergometer-stress testing. Oral Surg Oral Med Oral Pathol Oral Radiol Endod; 90:171-181.

Niwa H, Sugimura M, Satoh Y, Tanimoto A (2001). Cardiovascular response to epinephrine-containing local anesthesia in patients with cardiovascular disease. Oral Surg Oral Med Oral Pathol Oral Radiol Endod; 92(6):610-616.

Odai ED (2014). Comparative study of analgesic effectiveness of single doses of paracetamol and ibuprofen in a dental pain model. Dissertation written and defended for the award of Masters of Science Degree of the University of Benin, in Clinical Pharmacology and Toxicology.

Odai ED, Obuekwe ON (2016). Study of indications for disimpaction of mandibular third molar and the frequently associated complications following such treatments. Ann Med Surg Pract; 1(1):44-50.

Odai ED, Ozolua RI, Obuekwe ON (2013). Analgesic effectiveness of single doses of paracetamol and ibuprofen in a dental pain model. Nig Dent J; 21(2):61-69.

Ogle OE, Mahjoubi G (2012). Local anesthesia: agents, techniques and complications; Dent Clin North Am; 56(1): 133-148.

Puntillo KA, Miaskowski C, Kehrle K, Stannard D, Gleeson S, Nye P (1997). Relationship between behavioral and physiological indicators of pain, critical care patients' self-reports of pain, and opioid administration. Crit Care Med; 25:1159-1166.

Puntillo KA, Stannard D, Miaskowski C, Kehrle K, Gleeson S (2002). Use of a pain assessment and intervention notation (P.A.I.N.) tool in critical care nursing practice: nurses' evaluations. Heart Lung; 31:303-314.

Rebolledo AS, Molina ED, Aytes LB, Escoda CA (2007). Comparative study of the anesthetic efficacy of 4% Articaine versus 2% Lidocaine in inferior alveolar nerve block during surgical extraction of impacted lower third molars. Med Oral Patol Oral Cir Bucal 12: E139–E144.

Roden DM (2006). Antiarrhythmic drugs. Chapter 34, Goodman and Gilman's the pharmacological basis of therapeutics. 11th Ed. Editor, Brunton LL, Associate editors, Lazo JS and Parker KL. McGraw-Hill Publishers, United States of America.

Santos CF, Modena KC, Giglio FP, Sakai VT, Calvo AM, Colombini BL, (2007). Epinephrine concentration (1:100,000 or 1:200,000) does not affect the clinical efficacy of 4% articaine for lower third molar removal: a double-blind, randomized, crossover study. J Oral Maxillofac Surg; 65:2445-2452.

Serrera-Figallo MA, Velázquez Cayón RT, Lagares DT, Corcuera Flores JR, Machuca Portillo G (2012).

Srinivasan N, Kavitha M, Loganathan CS, Padmini G (2009). Comparison of anesthetic efficacy of 4% articaine and 2% lidocaine for maxillary buccal infiltration in patients with irreversible pulpitis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 107: 133–136.

Wallace J, Michanowicz A, Mundell R, Wilson E (1985). A pilot study of the clinical problem of regionally anesthetizing the pulp of an acutely inflamed mandibular molar. Oral Surg Oral Med Oral Pathol; 59: 517-521.

Xie HG, Frueh, FW (2005). Pharmacogenomics steps toward personalized medicine. Personalized Medicine, 2(4), 325–337.

Yapp KE, Hopcraft MS, Parashos P (2011). Articaine: a review of literature. Br Dent J; 210:323-329.