Evaluation of the Haemodynamic and Metabolic Effects of Local Anaesthetic Agent in Routine Dental Extractions

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Abstract

Introduction The systemic effects of adrenaline administered during dental local anesthesia have been the subject of many studies. The purpose of this study was to investigate the haemodynamic and metabolic effects attributable to adrenaline injected during local anesthesia in dental extraction patients.

Methods Apparently medically fit patients were included and randomized into two groups. Participants had breakfast before coming in for tooth extraction. The weight, height, blood pressure and pulse rate were measured and blood sample taken before administration of local anaesthetic injections. Blood pressure, pulse and blood sample were again taken at 15 and 30 min.

Results While the adrenaline group showed a modest increase between pre- and post-drug administration states, the control group showed no difference in median systolic blood pressures. Both groups showed a slight increase in diastolic blood pressure observed between pre- and post-

drug administration states. Also both groups showed no significant difference in median pulse rate throughout. Although blood glucose values were widely dispersed in the pre-drug administration state in both groups, the control group showed no difference in median values throughout. However, a modest increase was observed in the adrenaline group between pre- and post-drug administration states, which persisted beyond 30 min.

Conclusion The patients treated with local anesthesia with adrenaline showed a response similar to that observed in the control group.

Keywords Haemodynamic · Metabolic · Local · Anaesthetic · Tooth · Extractions

Introduction

The systemic effects of adrenaline administered during dental local anaesthesia have been the subject of many studies [1–3], though previous conclusions regarding safety and efficacy were based upon incomplete understanding, bias, and limited scientific and clinical data [4]. Relative to haemodynamic effects of adrenaline in local anaesthesia, little work has been carried out on the metabolic changes that the increase in circulating adrenaline might produce. It has been shown that adrenaline-containing dental local anesthetics, when injected in clinical doses, raise blood glucose concentrations in healthy volunteers [5, 6]. When the metabolic effects of adrenaline-containing and adrenaline-free local anaesthetics were investigated in unsedated patients having third molar surgery, differences between treatments were found in the changes from baseline plasma blood glucose concentrations [7, 8]. This could have consequences in the diabetic patient.

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It was the purpose of the present study to investigate, the haemodynamic and metabolic effects attributable to adrenaline in local anesthetics and to compare the results with earlier reports in the literature.

Materials and Methods

Apparently healthy adult patients who presented for tooth extraction at the oral surgery clinic of the Department of Oral and Maxillofacial Surgery, University College Hospital, Ibadan over a period of 2 years (November 2007–February 2010) were recruited for the study. Medical history was taken from each patient and those with known underlying medical problems were excluded. Also, individuals who refused to give their consent or individuals who did not consent were excluded. Participants were randomized into two groups namely the study group (adrenaline group) and the control group (adrenaline-free group). The two groups were age-matched. On the day of surgery, weight and height measurements were done. Baseline blood pressure, pulse rate and blood sample were taken from each patient before administration of either adrenaline-containing or adrenaline-free 2 % lidocaine 1:100,000 made by Hizon Inc., Philippines. Each patient received 3.6 ml of the solution. The blood pressure, pulse rate and blood samples were then taken at 15 and 30 min after the injection of the anaesthetic agents. Blood samples were immediately analyzed in the laboratory for estimation of blood glucose. Data obtained was analysed using *t* test by pooled variance to test significance of difference between mean values. Level of significance was set at 5 % or less than 0.05, Ethical approval was obtained from the state ethical review committee before study was commenced and informed consent obtained.

Results

Participants consisted of 36 males and 32 females. The ages ranged between 18 and 63 years with a mean of 32.1 ± 14.5 SD. There were 24 males and 12 females in the study group and 22 males and 10 females in the control group. The average age of the study group was 33.4 years while that of the control group was 31.2 years. The control group showed no difference in median systolic blood pressures while the study group showed a modest increase between pre-drug administration and post-administration states (Fig. 1). However both groups showed a slight increase in diastolic blood pressure observed between pre-drug administration and post-administration states (Fig. 2). Both control group and study groups showed no significant difference in median pulse rate between pre-drug administration and post-administration states (Fig. 3). The control group showed no difference in median blood

Fig. 1 The *boxplot* shows distribution of systolic blood pressures before drug administration, after administration and after procedure for both intervention and control groups

Fig. 2 The *boxplot* shows distribution of diastolic blood pressure before drug administration, after administration and after procedure for both intervention and control groups

glucose although values are most widely dispersed in the pre-drug administration state (Fig. 4). The study group showed a similar dispersion through the three time phases. However, a modest increase in blood glucose was observed between pre-drug administration and post-administration states, this increase persisted post-procedures.

Fig. 3 The *boxplot* shows distribution of pulse rate before drug administration, after administration and after procedure for both intervention and control groups

Fig. 4 The *boxplot* shows distribution of plasma glucose before drug administration, after administration and after procedure for both intervention and control groups

Discussion

Some of the systemic complications during dental treatments are caused by the local anaesthetic, and among these complications, the proportion of cases relating to the

circulatory system is the largest [9–12]. Endogenous catecholamines secreted in vivo, caused by psychological stress, accompanied by the injection pain and the added exogenous adrenaline in the local anaesthetic, which acts as a vasoconstrictor, are cited as the causes of these complications [9–12]. Although adrenaline is useful for extending the duration of local anaesthesia and for reducing bleeding, it could bring about undesirable effects, such as an increase in blood pressure, tachycardia and an increase in cardiac contraction [13–17].

Several haemodynamic studies have been carried out in patients subjected to local anaesthetic injection with a vasoconstrictor [18–20]. While some have reported no significant changes in either blood pressure (systolic and diastolic) or heart rate, others did and some authors have suggested that changes are dependent upon the injected vasoconstrictor dose [21]. Dionne et al. [22] found that after the administration of 5.4 ml of 2 % lidocaine with adrenaline 1:100,000, taking care to avoid intravascular injection, the heart rate was increased in 19 % of the cases, and cardiac output in up to 30 %. According to Silvestre et al. [23], the fact of using or not using a vasoconstrictor with the local anaesthetic solution exerts no effect upon blood pressure in normotensive patients—though a certain increase in systolic blood pressure was noted at the moment of tooth extraction and at the end of the procedure. This was attributed to increased patient anxiety during extraction, taking into account that the difference was comparatively greater between systolic blood pressure at the start of the procedure and at the actual moment of extraction.

Fellows et al. [24], using intravenous injections of adrenaline, recorded a 30 % increase in heart rate though the values returned to baseline levels after 15 min.

Some studies have suggested that while adrenaline injected as a vasoconstrictor is associated with transient effects in normotensive patients, hemodynamic complications could develop in uncontrolled hypertensive subjects, with possible cardiovascular accidents [25], though such problems would be related to the dose of vasoconstrictor administered, and to the local anaesthetic used [21]. The result from this study showed that the administration of 3.6 ml of lidocaine 1:100,000 did not result in a statistically significant increase in systolic blood pressure while diastolic pressure and heart rates were largely unaffected. The increases noted by some authors may have been transient as to have been missed in the current study at 15 min if indeed they occurred.

Variations in glucose plasma levels during dental treatment have been the subject of study and controversy in the literature [26–28]. Tily and Thomas [26] compared the effect of adrenaline administration in the dental local anaesthetic solution on blood glucose concentrations in

healthy and diabetic dental patients after extraction. They observed no significant differences in pre- and post-operative blood glucose levels. Nakamura et al. [27] investigated the changes in blood pressure, plasma catecholamines, glucose, and insulin concentrations in 11 normotensive patients during dental surgery and found that the administration of both local anaesthetics and tooth extraction activates sympathoadrenal outflow, resulting in increases of the systolic blood pressure, heart rate, plasma epinephrine, and serum glucose concentrations. They concluded that the adrenaline concentration increased and reached its peak just after the administration of local anaesthetics, yet the peak of adrenaline occurred within a time period similar to that of the increase of the serum glucose level, suggesting that there is a close relationship between the two variables. An increase in the mean glucose levels was observed in the adrenaline group in this study, it did not reach statistical significance both within and between the two groups. The increase in the glucose level may be small and transient for healthy patients due to compensatory and regulatory mechanisms of the body; this however may not be the case in a diabetic with an inherent defect in response and metabolism.

Conclusion

No significant changes were observed in any of the study parameters throughout in both groups. The patients treated with local anaesthesia with adrenaline showed responses similar to that observed in the control group. However, this may be different in hypertensives and diabetics where control is poor. Hence a prospective long-term protocol documenting pre-existing cardiovascular and metabolic diagnoses and medications in patients and the outcome or effect of local anaesthesia in dental treatment will be needed as a follow up to this study.

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References

- Glover J (1968) Vasoconstrictors in dental anaesthetics. Contra-indication—fact or fallacy? *Aust Dent J* 13:65–69
- Jastak JT, Yagiela JA (1983) Vasoconstrictors and local anesthesia: a review and rationale for use. *J Am Dent Assoc* 107:623–630
- Meechan JG, Rawlins MD (1987) A comparison of the effect of two different dental local anaesthetic solutions on plasma potassium concentration. *Br Dent J* 163:191–193
- Bader JD, Bonito AJ, Shugars DA (2002) A systemic review of cardiovascular effects of epinephrine on hypertensive dental patients. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 93:647–653
- Meechan JG, Rawlins MD (1987) The effect of adrenaline in lignocaine anaesthetic solutions on plasma potassium in healthy volunteers. *Eur J Clin Pharmacol* 32:81–83
- Jurevic R, Milgrom P, Karl HW (1998) Plasma levels of 2 % lidocaine with 1:100,000 epinephrine with young children undergoing dental procedures. *Anesth Prog* 45:87–90
- Tolas AG, Pflug AE, Halter JB (1982) Arterial plasma epinephrine concentrations and hemodynamic responses after dental injection of local anesthetic with epinephrine. *J Am Dent Assoc* 104:41–43
- Meechan JG, Rawlins MD (1992) The effects of two different local anaesthetic solutions administered for oral surgery on plasma potassium levels in patients taking kaliuretic diuretics. *Eur J Clin Pharmacol* 42:155–158
- Someya G (1999) Complications associated with local anesthesia. *J Jpn Dent Soc* 27:365–373
- Kubota Y (1994) Researches of systemic complications during dental treatment—a review of 30 year footsteps in the Department of Dental Anesthesiology. *J Oral Med Pathol* 61:197–206
- Yoshimura S (1983) The effects of vasoconstrictors contained in dental local anesthesia. *J Dent Med* 17:109–115
- Sano K, Nagoh T (1988) Vasoconstrictors in local anesthesia. *Dent Diam* 23:62–65
- Oohashi M, Sano K, Kanri T (1997) Effect of local anesthetics and vasoconstrictors on the clearance of ^{133}Xe in human oral mucosa. *J Jpn Dent Soc* 25:451–457
- Nagoh T, Sano K, Kanri T (1998) A study of localization to local anesthetics. Influence of concentration to epinephrine. *JSPA* 11:3–8
- Yamatsuta Y, Kanri T (1986) Influence of epinephrine on peripheral blood flow. *J Jpn Dent Soc* 17:479–489
- Uehara J (1983) A study on the vasoconstrictors contained in local anesthetics solution. Clinical safety dosage of epinephrine and norepinephrine. *J Jpn Dent Soc* 4:36–57
- Sasaki K (1979) A study on the vasoconstrictors contained in local anesthetic solutions. Clinically safe dosage of epinephrine in essential hypertension. *J Jpn Dent Soc* 7:320–343
- Viana AM, Campos AC, Morlin MT, Chin VK (2005) Plasma catecholamine concentrations and hemodynamic responses to vasoconstrictor during conventional or Gow-Gates mandibular anesthesia. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 100:415–419
- Cáceres MT, Ludovice AC, Brito FS, Darrieux FC, Neves RS, Scanavacca MI et al (2008) Effect of local anesthetics with and without vasoconstrictor agent in patients with ventricular arrhythmias. *Arq Bras Cardiol* 91:142–147
- Meechan JG, Parry G, Rattray DT, Thomason JM (2002) Effects of dental local anaesthetics in cardiac transplant recipients. *Br Dent J* 192:161–163
- Pérusse R, Goulet JP, Turcotte JY (1992) Contraindications to vasoconstrictors in dentistry: Part I. Cardiovascular diseases. *Oral Surg Oral Med Oral Pathol* 74:679–686
- Dionne RA, Goldstein DS, Wirdzek PR (1984) Effects of diazepam premedication and epinephrine-containing local anesthetic on cardiovascular and plasma catecholamine responses to oral surgery. *Anesth Analg* 63:640–646
- Silvestre FJ, Verdú MJ, Sanchís JM, Grau D, Peñarrocha M (2001) Effects of vasoconstrictors in dentistry upon systolic and diastolic arterial pressure. *Med Oral* 6:57–63
- Fellows IW, Bennett T, MacDonald IA (1985) The effect of adrenaline upon cardiovascular and metabolic functions in man. *Clin Sci* 69:215–222
- Pérusse R, Goulet JP, Turcotte JY (1992) Contraindications to vasoconstrictors in dentistry: Part II. Hyperthyroidism, diabetes, sulfite sensitivity, cortico-dependent asthma, and pheochromocytoma. *Oral Surg Oral Med Oral Pathol* 74:687–691

26. Tily FE, Thomas S (2007) Glycemic effect of administration of epinephrine-containing local anaesthesia in patients undergoing dental extraction: a comparison between healthy and diabetic patients. *Int Dent J* 57:77–83
27. Nakamura Y, Matsumura K, Miura K, Kurokawa H, Abe I, Takata Y (2001) Cardiovascular and sympathetic responses to dental surgery with local anesthesia. *Hypertens Res* 24:209–214
28. Meechan JG, Welbury RR (1992) Metabolic responses to oral surgery under local anesthesia and sedation with intravenous midazolam: the effects of two different local anesthetics. *Anesth Prog* 39:9–12