

Local anaesthetics in dentistry - Part 3: Vasoconstrictors in local anaesthetics

SADJ May 2017, Vol 72 no 4 p176 - p178

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INTRODUCTION

Vasoconstrictors like adrenaline in local anaesthetics are associated with more drug interactions than any other drug in Dentistry¹ with an incidence of adverse reactions ranging from 2.5%-11%.² Therefore, understanding the physiological and pharmacological effects, interactions with other drugs, and dosages are important in day to day dental practice.

Local anaesthetics are vasodilators, hence the addition of a vasoconstrictor like adrenaline provides the following advantages: improves the anaesthetic onset and duration, reduces bleeding, and decreases the systemic absorption rate of local anaesthetics by reducing the plasma concentration.^{2,3} However, adrenaline is unstable and therefore an antioxidant is added to prevent it oxidizing. Sodium bisulphite is the preservative most commonly added to local anaesthetics. Of course, patients allergic to sulphites will now react to a local anaesthetic containing sodium bisulphites.

DOSAGE

Calculating the dose of vasoconstrictor is different from ascertaining the local anaesthetic dosage in that vasoconstrictors are expressed as a dilution ratio and are not weight-dependent. In local anaesthetics, the adrenaline in dilution ratios of 1:80000 (Xylotox E80A, Adcock Ingram; Xylesthesin, 3M), 1:100 000 (Ubistesin forte, 3M; Septocaine, Septodont) and 1:200000 (Ubistesin 3M; Septocaine, Septodont) are generally the most commonly used concentrations in dentistry. Adrenaline concentrations are generally expressed as 1:1000 which is 1mg/ml. Therefore, a local anaesthetic with 1:100000 adrenaline concentration will translate to 0.01mg/ml resulting in a 1.8ml local anaesthetic cartridge containing 0.018mg adrenaline. A 1:200000 will therefore contain a concentration of 0.005mg/ml translating to approximately 0.01mg per cartridge of local anaesthetic. The maximum dose of adrenaline in healthy patients is 0.2mg per appointment (approximately 10 cartridges of 1:100000 local anaesthetic). However, in medically

compromised patients, such as those having cardiac risk, the recommended maximum dosage of adrenaline is 0.04 mg i.e. two cartridges of 1:1000000 local anaesthetic. The American Heart Association and the American Dental Association have stated "the typical concentrations of vasoconstrictors contained in local anaesthetics are not contraindicated in cardiovascular disease so long as preliminary aspiration is practiced, the agent is injected slowly, and the smallest effective dose is administered".⁴ Adrenaline 1:100,000 caused more sympathomimetic side effects than did 1:200,000 adrenaline concentration⁵ thus it is logical to use this lower concentration of adrenaline when possible. In several European and Asian countries, adrenaline concentrations of 1:300000 and 1:400000 are now available in dental cartridges.⁶ Furthermore, using a lower concentration of adrenaline like 1:200000 does not seem to compromise the anaesthetic efficacy of the local anaesthetic.⁷⁻⁹ In fact, 1:200000 solutions should be the preferred choice of adrenaline concentration in the absence of significant differences in performance with the 1:100000 solution.¹⁰ For patients undergoing periodontal surgery, 4% articaine with either adrenaline 1:100000 or 1:200000 concentration provides excellent surgical pain control. However, the 4% articaine 1:100000 adrenaline concentration has the additional advantage of providing better visualization of the surgical field because there is less bleeding.¹¹

ADRENALINE AND DRUG INTERACTION

Another problem associated with adrenaline is that it can interact with some of the drugs that the patient may be taking. In this instance the most commonly affected drugs are the non-selective beta blockers, some antidepressants and "street drugs" (Table 1).

NON-SELECTIVE BETA BLOCKERS

Non-selective beta blockers like propranolol (Inderal) and nadolol (Corgard) are used as anti-hypertensive drugs or to control migraines. Vasoconstrictors administered to patients on non-selective beta blockers can result in uncompensated peripheral vasoconstriction as a result of unopposed stimulation of alpha 1 receptors, leading to increase in blood pressure, bradycardia and headaches.^{4,12,13}

Cases have been recorded in both the dental and medical literature where the magnitude of the blood pressure

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increased was alarming and potentially life threatening.¹³ Therefore, in patients on non-selective beta blockers requiring simple restorative procedures, complete avoidance of adrenaline seems rational. For more complex procedures for which haemostasis or a more prolonged duration of local anaesthesia is required, the initial vasoconstrictor dose should be kept to an absolute minimum such as one-half of a dental cartridge with 1:100000 or preferably 1:200000 and injected carefully to avoid intravascular administration. The vital signs of the patient should be monitored before further administration. If there is no change in cardiovascular status, additional cartridges can be injected individually at five-minute intervals. Adrenaline containing retraction cord must be avoided in a patient taking a non-selective β -antagonist.

TRICYCLIC ANTIDEPRESSANTS

Tricyclic antidepressants like imipramine and amitriptyline inhibit the uptake of adrenaline at the neuronal level, resulting in increased concentrations of the catecholamines at the sympathetic neuronal junction.¹⁴ A maximum dose of 0.04 mg, (equivalent to two cartridges of 1:100000 local anaesthetic) of exogenous adrenaline is proposed for patients on tricyclic antidepressants.¹⁵ Using a lower concentration of 1:100000 or less, eg. 1:200000, is preferable and in a dosage which is no more than one-third the normal maximum which would be given, should preclude any problem that could arise from a tricyclic drug interaction.¹

The interactions of vasoconstrictors with general anaesthetics like halothane, thiopental and barbiturates can increase the dysrhythmic effects of dental vasoconstrictors. The clinician needs to inform the anaesthetist before administering a local anaesthetic with vasoconstrictor, and to restrict the dose to the limit recommended for the vasoconstrictor according to general anaesthetic procedures: halothane (2.2 μ g/kg for halothane, 3.5 μ g/kg for enflurane and 5.5 μ g/kg for isoflurane).¹⁵ A reported death under halothane anaesthesia caused by adrenaline in gingival retraction cord reinforces the need to adhere to recommended doses of adrenaline under general anaesthesia.

“STREET DRUGS”

Methamphetamines and cocaine have sympathomimetic effects and can interact with adrenaline in local anaesthetics. Vasoconstrictors in combination with cocaine or methamphetamines increase the risk of hypertensive crises, stroke and myocardial infarction.⁴ Elective dental treatment should be postponed for at least 24 hours after the last cocaine use to allow elimination of the drug.³

ADRENALINE AND THE MEDICALLY COMPLEX PATIENT

Adrenaline is both a hormone and a neurotransmitter belonging to sympathomimetic drugs that can mimic sympathetic nervous system mediators.⁶ It provides direct stimulation of the adrenergic receptors. Clinicians need to be aware of its effect on the sympathetic nervous system especially in medically compromised patients as certain modifications must be made (Table 1). A joint statement of the American Dental Association and American Heart Foundation on vasoconstrictors provides the following advice: “Vasoconstrictors should be used with extreme care to avoid intravascular injection. The minimum possible amount of vasoconstrictor should be used”.⁶

CARDIOVASCULAR DISEASES

In the presence of ischaemic heart disease, elective dental treatment is contraindicated in the following situations: patients with unstable angina, recent myocardial infarction (less than six months), recent coronary artery bypass surgery (less than three months).¹⁶

If emergency dental treatment is necessary, medical consultation is required and adrenaline dosages should be limited to one to two cartridges of 1:100000 solution (0.018 to 0.036 mg of adrenaline).^{16,17} Similarly, in patients with stable angina, vasoconstrictors should be limited to one to two cartridges.¹⁶ Vasoconstrictors are contraindicated in patients with severe arrhythmias.¹⁰ Digoxin, prescribed to increase the heart's contractile force, has a narrow therapeutic index and may precipitate a cardiac arrhythmia when used concurrently with vasoconstrictors.^{16,17}

STROKE

Use of adrenaline should be deferred for patients who have suffered a cerebrovascular accident, or stroke within the last six months. After that time, doses of adrenaline should be limited to less than 0.036 mg, equivalent to two cartridges of local anaesthetic with 1:100000 adrenaline concentration.^{16,17}

HYPERTHYROIDISM

The use of adrenaline in local anaesthetics should be avoided, or at least minimized to one to two cartridges, in the untreated or poorly controlled hyperthyroid patient.¹⁸ Although the theoretical risk of thyroxine - adrenaline potentiation is serious, no clinical case has been reported.¹⁰

Table 1: Precautions regarding adrenaline usage in local anaesthetics.

Contraindications to vasoconstrictors in dentistry	Precautions to the use of vasoconstrictors in dentistry
<ul style="list-style-type: none"> Heart diseases: Unstable angina, Recent myocardial infarction, Recent coronary artery bypass surgery, Refractory arrhythmias, Untreated or uncontrolled congestive heart failure. Untreated or uncontrolled severe hypertension, Uncontrolled hyperthyroidism Uncontrolled diabetes Sulphite allergies Steroid-dependent asthma Pheochromocytoma 	<ul style="list-style-type: none"> Patients taking tricyclic antidepressants Patients taking phenothiazine compounds Patients taking monoamine oxidase inhibitors Patients taking nonselective Beta-blockers Cocaine abusers Patients undergoing general anaesthesia with Halothane Patients taking Digoxin

CORTICOSTEROID-DEPENDENT ASTHMA

Administration of local anaesthetic with vasoconstrictors in cortico-dependent asthma patients may result in a higher risk of sulphite allergy. An anaesthetic without vasoconstrictor, and thus without bisulphite, is indicated.^{4,10,17}

PHEOCHROMOCYTOMA

A tumour of the adrenaline medulla, characterized by the presence of catecholamine-producing tissue, constitutes an absolute contraindication to the administration of vasoconstrictors.¹⁰

BONE IRRADIATION

It is desirable to avoid the use vasoconstrictors with a local anaesthetic when a patient is receiving irradiation of bone.¹⁰

CONCLUSION

A thorough understanding of the pharmacologic interactions between adrenaline and vasoconstrictors is important to avoid untoward reactions in patients.

A lower concentration like 1:200000 provides similar vasoconstriction and may be preferred especially for medically compromised patient.

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