

Use of Dexmedetomidine in Dentistry as an Additive to Local Anesthesia in Place of Adrenaline

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Abstract: *Introduction:* Dexmedetomidine as a newer or novel chemical tortoise with supposedly longer duration of action has been compared with the classical injection lignocaine with adrenaline in Dentistry. The present paper reports study comparing clinical efficacy and potency of this newer emerging drug in combination with lignocaine. *Materials and Methods:* Twenty five patients undergoing extraction were locally infiltrated with 2% lignocaine plus dexmedetomidine 1 µ/ml and 2% lignocaine plus adrenaline in 1:100,000 dilutions at two different appointments. The onset of action, duration of action, and pain threshold were assessed. *Results:* Onset of action was found to be faster with longer duration of action with the newer drug dexmedetomidine and lignocaine combination when compared with combination of lignocaine and adrenaline. *Conclusion:* The study demonstrated that the combination of dexmedetomidine with lignocaine enhances the local anesthetic potency of lignocaine without significant systemic effects when locally injected into oral mucosa.

Keywords: Dexmedetomidine, local anesthetic adjuvant

1. Introduction

Dexmedetomidine is a highly selective alpha₂ adrenoceptors (α₂-AR) agonist recently introduced to anesthesia practice. It produces dose-dependent sedation, anxiolysis and analgesia (involving spinal and supraspinal sites) without respiratory depression^[1]. Recently attention has been paid to dexmedetomidine as a possible additive for local anesthesia. Dexmedetomidine also has been reported to enhance central and peripheral neural blockade by local anesthesia. The effect of locally injected dexmedetomidine combined with lignocaine on local anesthesia has also been shown in the backs of guinea pigs. However, the effect of locally injected dexmedetomidine on the anesthetic action in humans has not fully been clarified. Furthermore, because the intravenously administered dexmedetomidine induces sedation in patients and occasionally influences the cardiovascular system, such as causing hypotension and bradycardia, the use of dexmedetomidine as an adjunct to local anesthetic may exert its effect with minimized systemic effects^[2].

The purpose of the present study was to evaluate the effect of dexmedetomidine in combination with lignocaine in patients undergoing extraction in terms of onset and duration of action and adverse effect if any when compared with injection of adrenaline with lignocaine.

2. Materials and Methods

A comparison study was undertaken in the Department of Oral and Maxillofacial Surgery. The procedure was performed in the operating clinic where all monitoring equipment was readily available.

Inclusion Criteria:

Twenty five healthy volunteers, aged between 10 and 25 years belonging to ASA class I of either gender, planned to undergo bilateral extraction with both teeth having the same reason for extraction were included in the study.

Exclusion Criteria

- Patients needing bilateral extraction having different reason for extraction.

- Patient with a history of an allergy or hypersensitivity to lignocaine or dexmedetomidine.
- Medically compromised patients.

3. Procedure

After explaining the study protocol, consent was taken from the patient or attendant as appropriate. Visual analog scale (VAS) score was explained tooth patient and recorded at baseline and during the procedure. Pulse rate (PR), noninvasive blood pressure, and peripheral saturation of oxygen (SpO₂) were monitored and recorded. Other parameters such as onset of action of drug and duration of action were evaluated. For the surgical procedure, test group patients received injection lignocaine plus dexmedetomidine (2% Lignocaine + dexmedetomidine 1 µ/ml) (study drug was prepared by addition of 30 µ of dexmedetomidine using appropriate dilution with insulin syringe to 30 ml vial of 2% lignocaine plain solution by an anesthesiologist) and injection lignocaine plus adrenaline (2% lignocaine in 1:100,000 adrenaline) for control group.

On the 1st day, thorough history and examination of all patients were done. Local anesthesia with injection lignocaine 2% plus dexmedetomidine was administered in the respective maxillary or mandibular tooth of right side in the first appointment, and 2% injection lignocaine plus 1:100,000 adrenaline (3 ml approximately) was administered in the left maxillary and mandibular tooth in the second appointment. Nerve block used in the maxillary anterior extraction procedure was infraorbital through premolar approach and nasopalatine nerve block and for maxillary posterior extraction was posterior superior alveolar and greater palatine nerve block for palatal anesthesia. Mandibular extraction nerve block given was classical inferior alveolar nerve block through premolar approach and lingual nerve block of corresponding side. Onset of action and duration of action was measured till patient felt no pain on probing.

Statistical Methods

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data

Volume 10 Issue 1, January 2021

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editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Data were expressed as Mean ± SD. Student's independent t-test was employed to compare onset of action and duration of action between two groups. A P-value of less than 0.05 was considered statistically significant.

Table 1: Comparison based on onset of action (minutes) in two groups

Onset of action (Minutes)	N	Mean	SD	Range	t-value	P-value
Test Group	25	2.4	0.399	1.8-3	6.174	<0.001*
Control Group	25	3.1	0.425	2.5-4		

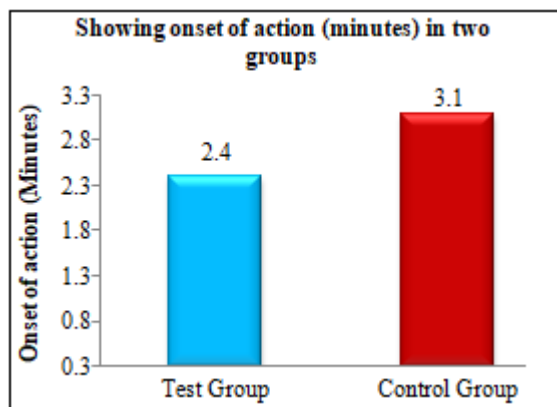
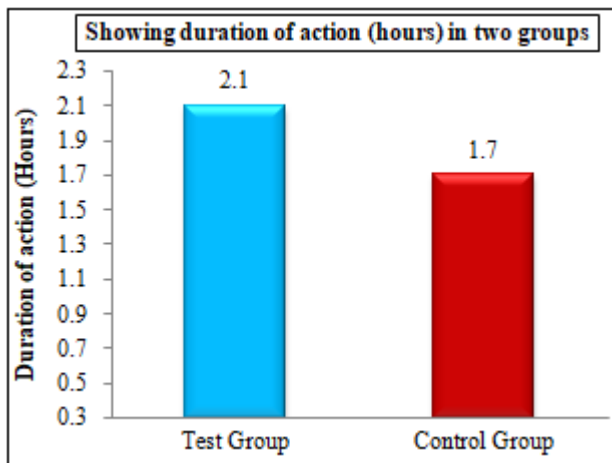


Table 2: Comparison based on duration of action (hours) in two groups

Duration of action (Hours)	N	Mean	SD	Range	t-value	P-value
Test Group	25	2.1	0.317	1.5-2.8	4.615	<0.001*
Control Group	25	1.7	0.308	1.2-2.5		



4. Results

A total of 25 healthy volunteers between age group 12 -35 years were included in the study. Onset of action was found to be shortened significantly for dexmedetomidine group with prolonged duration of action ($P < 0.05$). Pain threshold was noticeably increased after the injection of lignocaine plus dexmedetomidine solution than those with lignocaine plus adrenaline. There were no significant changes in the systolic blood pressure, diastolic blood pressure and heart rate from the baseline just before injection with either test solution.

5. Discussion

The invention of local anesthesia has made minor oral surgical procedures to be accomplished successfully with no or little pain, but all surgical procedures whether minor or major are invariably associated with stress, anxiety, and pain. There are some limiting factors for the use of local anesthetics. The most important is duration of action that is extended by addition of number of adjuvants. These adjuvants also help to reduce the dose of local anesthetic. Commonly used adjuvants include both non-opioids including epinephrine, alpha-2 agonist clonidine, nonsteroidal anti-inflammatory drugs, Mg²⁺, and NaHCO₃ and opioids such as fentanyl, sufentanil, and morphine. All are invariably associated with some adverse effects. However, attention has recently been paid to dexmedetomidine as a possible additive for local anesthesia [2].

Dexmedetomidine is a potent, highly selective α -2 adrenoceptors agonist, with sedative, analgesic, anxiolytic, sympatholytic, and opioid-sparing properties. It provides a unique type of sedation, "conscious sedation", in which patients appear to be sleepy but are easily aroused, cooperative and communicative when stimulated. It has a quick onset and a relatively short duration of action, characteristics that render dexmedetomidine suitable for a critical care unit, for postoperative cardiac and noncardiac patients, and for invasive and noninvasive procedures, because it can be easily titrated. Short-term sedation has been shown to be safe in some studies, although hypotension and bradycardia are the most significant side effects. Furthermore, it appears to have minimal respiratory depression and, thus, it can be used safely in both mechanically ventilated and spontaneously breathing patients. These properties make dexmedetomidine a useful agent in the current era of early extubation and fast track of postoperative cardiac patients. Overall, dexmedetomidine has a unique constellation of properties that make it an attractive agent for both anesthesiologists and critical care physicians. It is an excellent sedative and analgesic agent with opioid-sparing properties and minimal respiratory depression; does not decrease gut motility; prevents postoperative nausea, vomiting and shivering; and, at the same time, offers potential benefit towards neuroprotection, cardioprotection and renoprotection [3].

DEX provides analgesia by the activation of central α 2-adrenergic receptors in the locus coeruleus. Locus Coeruleus located at the brain stem is the area is believed to provide the sedative effects of DEX. So, incomparision with midazolam, DEX gives better sedation and analgesia during and after surgery [4].

Studies have shown that dexmedetomidine enhances the local anesthetic action and provides hemodynamic stability and preserves both the baroreceptor and heart rate response to a presser. These important aspects suggest that DEX provides an increased safety as an adjunct to local anesthetics in patients with cardiovascular disease in comparison with other vasoconstrictors.

In the present study, we have found that α_2 -adrenoceptors agonists' dose dependently enhances the local anesthetic action of lidocaine as well as prolonged its duration of action. Two possible theories have been demonstrated for this action, one is dexmedetomidine produces vasoconstriction around the site of injection, which causes a delay in the absorption of the local anesthetic thus prolongs the effect of local anesthetic.

DEX is a selective α_2 -adrenoceptor agonist and α_2 -Adrenoceptors can be subdivided into 4 subtypes: α_2A , α_2B , α_2C , and α_2D . The α_2A -, α_2B -, and α_2C -adrenoceptors have been well identified pharmacologically and have been shown to cause vasoconstriction hence it could be possible that the α_2 -adrenoceptors agonists interferes with the absorption of lidocaine injected via vasoconstriction. α_2 -Adrenoceptors play a role in the control of arterial blood pressure, and the other one that is nonselective α_2 -adrenoceptors agonists evokes a biphasic arterial blood pressure response: a short hypertensive phase followed by subsequent hypotension. So, the two different subtypes of α_2 -adrenoceptors provide two different action: the α_2B adrenoceptors is responsible for the initial hypertensive phase, whereas hypotension is carried out by the α_2A adrenoceptors. A study done in mice demonstrated that the vasoconstriction mediated by direct activation of vascular α_2 -adrenoceptors is due to α_2A subtype. Also, Masuki et al in his study in the human forearm has shown that dexmedetomidine induces vasoconstriction via α_2 -adrenoceptors.

The other possible theory for the direct enhancement and prolongation of the duration of action and onset of local anesthetic action by DEX is its direct effect on peripheral nerve activity. DEX has been shown to directly inhibit the nerve action peripherally. A study by Ouchi et al suggests that DEX enhances the local anesthetic action of lidocaine by vasoconstriction by way of α_2A -, α_2B -, and α_2C -adrenoceptors around the site of injection^[5,6].

Our results demonstrate that DEX enhances the onset and prolongs the duration of action of local anesthesia as compared with epinephrine and is safer in the patients with cardiovascular disease. So it has a potential as a new safety adjunct to local anesthetics. Furthermore, dexmedetomidine may also be useful in peripheral nerve blocks in patients with chronic pain because of its differential mechanism. The use of dexmedetomidine is expected for developing the reliability and efficacy of regional anesthesia

In conclusion, Dexmedetomidine, which produce sympatholytic, sedative, analgesic, antihypertensive and bradycardiac effects when combined with a local anesthetic agent, have been found to extend the duration of local anesthesia effect by causing local vasoconstriction.

The findings in our study suggest that dexmedetomidine is clinically useful as an additive to local anesthetics for enhancing local anesthesia in dentistry.

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