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Evaluation of Anesthetic Efficacy of 2% Lignocaine with 1:2,00,000 Adrenaline Among Smokers and Non-Smokers During Intra-Alveolar Mandibular Posterior Teeth Extraction

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Abstract

Introduction: Tooth extraction is one of the most frequently performed procedures by oral surgeons, and it cannot be successfully carried out without achieving adequate anesthesia. A patient-related factor hypothesized to affect anaesthetic efficacy is cigarette smoking. However, whether the anaesthetic effect of lignocaine is truly altered by cigarette smoking remains unclear. This uncertainty prompted us to evaluate the efficiency of 2% lignocaine with 1:200,000 adrenaline in both smokers and non-smokers during the extraction of mandibular posterior teeth.

Methods: This study included patients requiring extraction of mandibular posterior teeth. It was a single-blinded, prospective observational case-control study with a total sample size of 176 patients. Participants were categorized into two groups: the study group (Group A), comprising patients with a history of cigarette smoking, and the control group (Group B), consisting of patients with no history of smoking. Data collected included past

medical history, personal history (including smoking history), the volume of local anesthetic administered (in milliliters), the onset time of local anesthesia (in minutes), and pain scores.

Results: Of the 176 patients included in the study, the mean age of the patients in the study and control groups were 39 and 42 years, respectively. The mean time of onset of anesthesia in Group A and Group B was 3.53 ± 1.18 and 2.98 ± 1.006 minutes respectively. The mean volume of anaesthetic administered in Group A and Group B was 3.49 mL and 2.58 mL, respectively. A significant difference was observed in the time of onset of anesthesia between both the groups ($p < 0.05$), with smokers exhibiting a prolonged duration. Smokers report significantly higher pain scores compared to non-smokers ($p < 0.05$).

Conclusion: This study demonstrates an altered onset of action, increased volume requirement, and elevated pain scores indicative of reduction in the efficacy of local anesthetic utilised among individuals who are smokers. Additionally, histological studies are necessary to elucidate the findings of this study and to clarify the specific effects of lignocaine in smoker versus non-smoker populations.

Keywords: Tooth extraction, cigarette smoking, local anesthesia, lignocaine, anesthetic efficacy**.**

Introduction

Optimal treatment outcome in any oral surgical procedure depends mainly on adequate pain management[1]. This is brought about by injecting anaesthetic solutions in circumscribed areas thereby producing localised anesthesia. Local anaesthetics act by reducing the permeability of sodium channels in peripheral nerves and bind with calcium ions thereby disrupting the transmission of nerve impulses to the brain. The most commonly used local anesthetic for dental extractions is 2% lignocaine with adrenaline at a concentration of 1:200,000, owing to its excellent safety profile [2].

Cigarette smoking adversely affects all organs of the body, including the oral cavity. It contributes to a range of oral health issues. Various studies have shown that smoking is associated with both higher prevalence of dental caries, periodontal diseases, poor oral hygiene, premalignant lesions, and malignancies[3,4,5]. Particularly, nicotine in cigarettes affects the pharmacokinetics of many drugs including local anesthetics[6]. It has been shown to affect the protein-binding property of lidocaine and has a stimulatory effect on several sensory receptors in the peripheral nervous system[7].

This study aims to evaluate the effect of cigarette smoking on the onset of action and the volume of local anesthetic required during extraction of mandibular posterior teeth. Furthermore, it seeks to examine whether the timing of the last cigarette consumed influences the efficacy of local anesthesia in smokers.

Materials and Methods

This study was carried out in the Department of Oral and Maxillofacial Surgery, following approval from the Institutional Ethics Committee of Sri Ramachandra Institute of Higher Education and Research (SRIHER), under reference number IEC/22/FEB/169/20. The research was conducted in accordance with the ethical principles set forth in the Declaration of Helsinki.

Study Population and Sample Size

The study population comprised of patients who reported to the Department of Oral and Maxillofacial Surgery at Sri Ramachandra Institute of Higher Education and Research for extraction of mandibular premolars and molars. A sample size of 176 patients was needed to achieve 95% confidence interval and 90% power. The

case group included 88 smokers (Group A) and the control group included 88 non-smokers (Group B).

Inclusion and Exclusion Criteria

The study included patients over the age of 18 with ASA I classification who required extraction of asymptomatic mandibular molars and who demonstrated understanding of and willingness to comply with all study protocols. Patients with history any of systemic diseases and signs of active periapical pathologies were excluded from the study. A written informed consent was obtained from all the participants in the study. A well-designed case sheet was used to arrive at a diagnosis and to formulate a treatment plan.

Surgical Technique

The inferior alveolar nerve block (IANB) was performed by injecting 1.8ml of 2% lignocaine with a vasoconstrictor (adrenaline 1:2,00,000) near the mandibular foramen to numb the mandibular teeth and surrounding tissues. After aspiration to confirm the absence of blood, about 1.8 mL of anesthetic was slowly injected. (Figure 1).

Subjective assessment of time of onset of anesthesia was recorded (appearance of lip and tongue numbness perceived by the patient) (Figure 2).

Objective assessments of pain absence upon probing were conducted every 30 seconds, up to a maximum duration of 10 minutes. Absence of lip numbness and pain on probing after 10 minutes was taken as failure of anesthesia and supplemental anesthetic block was given to achieve clinically satisfactory local anesthesia.

The amount of local anaesthetic used was recorded in the case sheet. After achieving adequate anesthesia, tooth extraction was performed and the patient was asked to rate the pain response with help of Numerical rating scale (NRS) at the end of procedure.

Data Collection

The data collected were age, chief complaint, past medical history, past dental history, personal history which included smoking history (duration of smoking in years, consumption - number of cigarettes smoked per day and last consumption of cigarette prior to extraction procedure), amount of local anaesthetic used (in cartridges), time of onset of local anesthesia (in minutes), radiographic findings and diagnosis.

Statistical Analysis

Statistical analysis was done using IBM SPSS statistics (version 26.0). The mean value and standard deviation of data were recorded. Unpaired-T test was used to compare the difference between both the groups. The value of P <0.05 was considered statistically significant.

Results

1. **Demographic details and dental status of participants**

During the study period, 245 patients who required removal of mandibular molars were assessed. Of these, 69 patients who did not meet the inclusion criteria (n=42) and those who declined to participate (n=27) were excluded. Consequently, 176 patients were included in the study, all of whom were male. The average age of the participants in the study group was 39 years, while in the control group, it was 42 years. (Table 1).

2. **Amount of anesthetic administered in both groups**

This study found a statistically significant difference in the volume of anesthetic administered during the extraction procedure, with smokers requiring a greater volume compared to non-smokers. ($p < 0.001$) (Graph 1). The mean volume of anesthetic administered in Group A and Group B was 3.49 mL and 2.58 mL, respectively (Table 2).

3. **Assessment of signs of onset on anesthesia and pain scores among both the groups**

Both subjective and objective evaluations showed a statistically significant difference between smokers and non-smokers ($p < 0.05$), with smokers experiencing a longer duration of signs and higher pain scores compared to non-smokers ($p < 0.05$) (Table 3).

Discussion

The success of a dental extraction is primarily dependent on effective pain management. A 2% lignocaine solution with 1:200,000 adrenaline is commonly used due to its established safety and efficacy. Several factors may influence the efficacy of local anesthesia, including: presence of inflammation or infection, technique of administration, type and concentration of anesthetic, vascularity at the site of administration, patient anxiety, and repeated exposure to local anesthesia.

Additionally, patient-related factors such as smoking are theorized to reduce the efficacy of local anesthetics. Cigarette smoke contains over 5300 chemicals, some of which are known carcinogens[8] but the principal non-carcinogenic tobacco alkaloid with addictive property is nicotine[9]. After cigarette smoking, nicotine stays in the system for roughly 6-11 hours[10].

Nicotine, a tertiary amine present in tobacco, selectively binds to nicotinic cholinergic receptors (nAChRs). Upon inhalation of cigarette smoke, nicotine enters the arterial circulation and rapidly diffuses into brain tissue, where it interacts with nAChRs, which are ligand-gated ion channels. This interaction leads to opening of the channels permitting the influx of cations such as sodium and calcium [11].

Local anesthetics on the other hand primarily act by stopping the generation and propagation of electrical impulses in neurons by interfering with the sodium channels within the cell membrane. This paradoxical interaction between nicotine and lignocaine on sodium channel receptors has been suggested as a possible cause for reduced efficacy of lignocaine [12,13].

There is limited literature evaluating the efficacy of local anesthesia in healthy smokers compared to non-smokers. A previous study by Al-Noori NM et al. investigated the effect of cigarette smoking on the onset and volume of local anesthesia administered. The study concluded that smoker patients required a higher volume of local anesthetic compared to non-smokers, particularly in the presence of symptoms such as pain [14].

The technique of local anesthetic administration and the presence of active infections, may introduce bias and potentially influence the study's outcomes. Consequently, in this study, participants without any signs or symptoms of active periapical infections, who required extraction of mandibular posterior teeth, were selected.

There was a statistically significant difference in the onset time of local anesthesia, pain scores between smoker and nonsmoker patients. Smoking exerts a significant impact on circulation within the oral cavity. While systemic blood flow remains unaffected, vasoconstriction of the mucosal blood vessels occurs due to the effects of cigarette smoking [15]. Thus, the effect of lignocaine on gingiva, bone and teeth might be different from nonsmokers.

Moreover, there was a significant difference in the volume of anaesthetics utilized between the two groups. The inferior alveolar nerve block does not consistently achieve successful anesthesia, particularly in cases of irreversible pulpitis [16]. However, this discrepancy may not be sufficiently justified by our data regarding the influence of smoking, although it does provide stronger evidence and raises suspicion about its impact; therefore, further histological studies are necessary. Furthermore, intragroup analysis revealed no statistically significant

correlation between the duration, frequency, or timing of the last cigarette smoked prior to the procedure and the efficacy or volume of local anesthetic administered in the smoker group.

Conclusion

Thus, this study demonstrates an altered onset of action, increased volume requirement, and elevated pain scores indicative of reduction in the efficacy of local anesthetic utilised among individuals who are smokers. A key limitation of this study is that the sample consists exclusively of male patients due to cultural and societal factors, which restricts the generalizability of the findings to female populations.

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Legend Figures

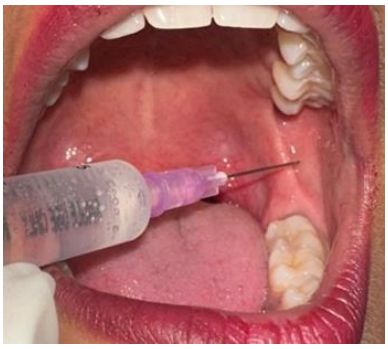
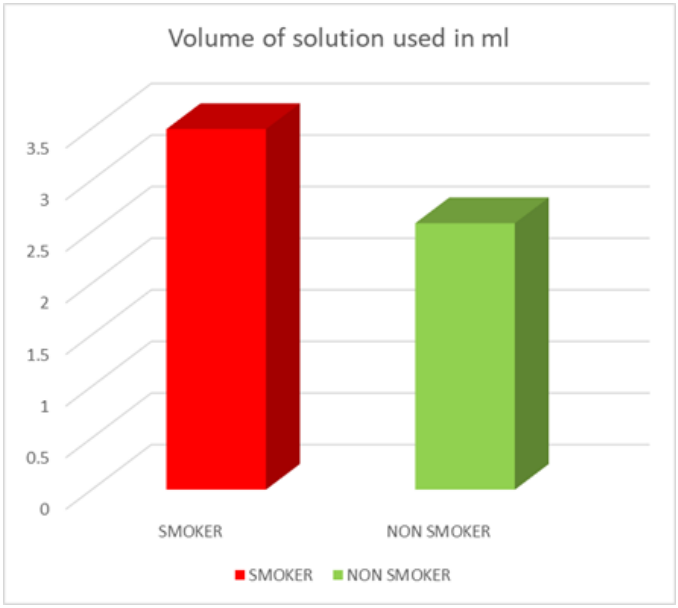


Figure 1: Administration of conventional IANB

Figure 2: Clinical Objective Assessment of Onset of Local Anesthesia



Graph 1: Bar graph depicting volume of anesthetic administered for both the groups

Table 1: Demographic data and dental status of the study participants

Parameter	Group A/B	N	Mean	Std. Deviation	P value
Age	A	79	39.22	12.85	0.199
	B	79	42.98	11.75	
Number of teeth extracted	A	79	1.29	0.580	0.893
	B	79	1.31	0.544	

Table 2: Volume of anesthetic administered among both groups

Parameter	Group A/B	N	Mean	Std. Deviation	P value
Volume of solution administered (in ml)	A	79	3.49	1.64	0.000
	B	79	2.58	0.96	

Table 3: Comparison of onset of local anesthesia and pain score between both the groups

Parameter	Group A/B	N	Mean	Std. Deviation	P value
Objective signs (in minutes)	A	79	3.53	1.18	0.011
	B	79	2.98	1.006	
Subjective signs (in minutes)	A	79	2.98	1.48	0.021
	B	79	2.96	1.15	
Pain score (0-10)	A	79	3.65	1.51	0.019
	B	79	3.11	1.17	