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ORIGINAL ARTICLE

The impact of cigarette smoking on the efficiency of local anesthesia during simple tooth extraction

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KEYWORDS

Cigarette smoking;
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Abstract Smoking is harmful to all organs of the human body and can affect nerve response to local anesthesia.

This study aimed to determine the effect of cigarette smoking on the amount and onset of local anesthesia, as well as the chief complaint (symptomatic and asymptomatic), number of cigarettes, and duration of smoking.

Materials and methods: A selective clinical case-control study carried out at the Oral Surgery Clinic of the Teaching Hospital at the College of Dentistry. One hundred and three male patients participated in the study, and they were divided into two groups (55 smokers and 48 nonsmokers). The patients received a local anesthetic agent (2% Lidocaine) in a 1.8 ml dental cartridge. The number of cartridges and the onset time of local anesthesia were detailed for each patient in a special case sheet prepared for this study.

Results: There was a statistically significant difference between the smoker and nonsmoker groups regarding the amount of local anesthetic solution ($p = .041$) with a higher amount needed in the smoker group; however, the onset of action showed no significant difference between the two groups ($p = 0.983$). The symptomatic cases in smokers needed a higher amount of local anesthesia than the asymptomatic cases with a statistically significant difference ($p = 0.002$). There was no

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relationship between daily cigarette consumption and the amount of local anesthetic solution ($p = .054$) and also the onset of local anesthesia ($p = .938$). The duration of smoking has no significant relationship with onset time ($p = .480$) and the amount of local anesthesia ($p = .418$).

Conclusion: The amount of local anesthesia used in smoker patients was higher than that in nonsmoker patients, especially if there were symptoms like pain. The duration of smoking and daily cigarette consumption had no effect on the amount and the onset of local anesthesia.

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1. Introduction

Smoking is harmful to all organs of the human body (Ozturka et al., 2017). The harmful effects of tobacco smoking on oral cavities are predictable. These effects range from common to exceptional disorders (Komar et al., 2018). Smoking affects the pharmacokinetics of numerous drugs, for example, local anesthetics (Furtado, 2002). Any local anesthetic agent adequate for neural block in the human body can be used for regional and infiltration anesthesia in the head and neck region, with lidocaine being the most common local anesthetic used in dentistry (Joseph et al., 2013). Lidocaine is a necessary medication used in surgery (Weinberg et al., 2015).

The role of lidocaine in the regional anesthesia is presented by its revocable blockade of impulse transmission in the nerve fibers. Part of the local anesthetic was attached to the tissue, and another part was moved out to circulation when the anesthetic was infiltrated close to a nerve (Weinberg et al., 2015). The rest of the anesthetic is attached to the sodium channel opening when it is activated or resting in an inactivated situation and it is impermeable to sodium (Fozzard et al., 2005). So, local anesthetics stop the creation and transmission of electrical impulses in neurons by interference to the sodium ion channel within the neural cell membrane (Sayhan et al., 2017). Nicotine in tobacco is selectively attached to "nicotinic cholinergic receptors" after inhalation of the smoke from a cigarette. Nicotine is then passed into the lungs, quickly transmitted into the circulation, and transported rapidly to the brain. Nicotine then attaches to "nicotinic cholinergic receptors". After binding to the channel, it is opened, allowing the entrance of cations, sodium, and calcium (Benowitz, 2009). A previous study found that nicotine could interrupt the activity of the sodium channel (Bigiani, 2016).

The study aims to compare the amount of local anesthesia and onset time between smoker and nonsmoker patients and also to evaluate the effect of cigarette consumption and duration of smoking on local anesthesia.

2. Materials and methods

2.1. Design

A selective clinical case-control study was carried out at the Oral Surgery Clinic of the Teaching Hospital at the College of Dentistry/ Mustansiriyah University, Baghdad- Iraq. The sample size was composed of 103 male patients who attended the clinic for dental extraction. Males with a history of any systemic disease were excluded. The control group included 48 nonsmoker male patients, and the case group included 55 smoker male patients. All patients completed a written consent form before participating in the study. A special case sheet for this study was filled with basic information, medical history, and case history followed by a clinical examination to reach a clinical diagnosis and to formulate a treatment plan. The clinical work started by injection of the local anesthesia: 1.8 ml of 2% lidocaine HCL (Huons Co., Ltd, Korea) with a vasoconstrictor (epinephrine 1:80,000), using a 27G needle measuring 35 mm in length (Biodent Co., Ltd. Korea) in order to anesthetize the tooth and the surrounding tissues before extraction either by infiltration or by nerve block. Then, the onset time of anesthesia was calculated (the onset of anesthesia was measured by calculating the time from the injection until numbness was felt by the patient and also by soft tissue testing). If a single cartridge is not adequate to ensure complete anesthesia to the area, then another one was injected. The numbers of cartridges were recorded in the case sheet.

2.2. The data collected

Age, chief complaint (symptomatic and asymptomatic), diagnosis (acute pulpitis, chronic pulpitis, etc.), systemic disease, past dental history (if there were any past problems with local anesthesia), smoking consumption (number of cigarettes smoked per day), duration of smoking in years, technique of local anesthesia (block and infiltration), amount of local anesthesia (number of cartridges), and onset time (by minutes).

2.3. Statistical analysis

IBM SPSS version 24 was used for statistical analysis. Mean value, range, and frequencies of data were recorded by descriptive analysis. T-Test was used to compare the difference between control and smoker groups. The relationship between variables was analyzed by chi-square test and Spearman's rho correlation. The value of $p < 0.05$ was considered significant.

3. Results

3.1. Statistics of patients and variables

3.1.1. Age

A total of 103 healthy adult male patients were included in this study with a mean age of 37.9 years and an age range of 19–67 years. The control group consisted of 48 non-smoker patients (with mean age 38.4 ± 13.9), and the smoker group consisted of 55 patients (with mean age 37.5 ± 12.0). There was no significant difference between the ages in each group.

3.1.2. Chief complaint and diagnosis

Regarding the chief complaint, out of 76 patients (40 control vs 36 smoker), 73.8% were asymptomatic; out of 27 patients (8 control vs 19 smoker), 26.2% were symptomatic (pain, swelling, etc.). The details of control vs smoker groups are explained in table 1.

The distributions according to diagnosis were 30 chronic periapical lesions, 23 for prosthetic purpose, 21 necrotic pulps, 17 chronic pulpitis, and 12 chronic periodontitis. The details of control vs smoker groups are explained in Table 1.

3.1.3. Amount and duration of smoking

The consumption of cigarettes ranged from 3 cigarettes per day to 120 cigarettes per day with a mean of 28.3 ± 21.6 while the duration of the smoking habit ranged from 1 year to 30 years.

3.2. Anesthesia

As for the local anesthesia, 65 patients had block anesthesia (inferior alveolar and lingual nerve block) and 38 patients had infiltration anesthesia. The amount of local anesthetic cartridge ranged from 1 to 5 cartridges per patient. The onset of local anesthesia ranged from 1 to 6 min, with a mean of 2.5 min.

3.2.1. Difference between the control and study group regarding amount and onset of anesthesia

There was a statistically significant difference between the control (1.4 ± 0.7) and the smoker groups (1.7 ± 0.9) on the amount of anesthesia (p = .041) while the onset time of anesthesia showed no statistically significant difference between the control (2.4 ± 1.5 min.) and smoker groups (2.3 ± 1.5 min.) (p = .983).

3.2.2. Difference within the same group (Table 2)

The nerve block technique showed a significantly higher number of local anesthetic cartridges than the infiltration technique smoker group (p = .002) but not a statistical difference in the control group (p = .073).

The number of local anesthetic cartridges in symptomatic patients was significantly higher than that in asymptomatic patients in the smoker group (p = .002); but in the control group, there was no statistical difference (p = .928).

Concerning the onset time of anesthesia, there was a statistically significant difference between block and infiltration within the smoker group (p = .041), but there were no differences between block and infiltration in the control group and in both groups regarding the chief complaint.

3.3. Cigarette consumption and duration of smoking

The amount of cigarette consumption had no relationship with the amount of anesthetic and the onset (rho = 0.261, p = .054) (rho = 0.011, p = .938) respectively.

The duration of smoking was not related to the amount of anesthetic needed (rho = 0.114, p = .418) and also to the onset (rho = 0.099, p = .480).

4. Discussion

4.1. Mechanism of action of local anesthesia and nicotine

This study was planned and conducted to explain the efficiency of lidocaine as a local anesthetic agent, whether it is affected by smoking or not.

The mechanism of action of local anesthesia and nicotine are paradoxical while lidocaine closes the channel and prevents the entry of sodium, and nicotine makes the channel open to the entry of sodium (Sayhan et al., 2017, Benowitz, 2009, Bigiani, 2016). This assumption supports the findings of this study that the smoker patients need more local anesthetic solution to reach effective anesthesia than the non-smoker patients.

4.2. Comparisons between this study and other studies

In the current study, there is no difference in the onset time of local anesthesia between smoker and nonsmoker patients and also between the duration of smoking and the onset time of the anesthesia. The rapidity of onset of lidocaine (1–5 min) for

Table 1 Chief complaint and diagnosis distribution in control and smoker groups.

			Diagnosis				
			Smoker group		Control group		
P value	df	Total	Percent	Frequency	Percent	Frequency	
0.007	5	17	23.6	13	8.4	4	chronic pulpitis
		21	29.1	16	10.4	5	necrotic pulp
		30	21.8	12	37.5	18	periapical lesion
		12	12.7	7	10.4	5	periodontitis
		23	12.7	7	33.3	16	prosthetic
		103	100	55	100	48	Total
			chief complaint				
0.04	1	76	65.5	36	83.3	40	Asymptomatic
		27	34.5	19	16.7	8	Symptomatic
		103	100	55	100	48	Total

Table 2 Comparison of the amount of local anesthesia and the onset time within each group.

Smoker (n = 55)						Control (n = 48)					
		Infiltration (n = 29)		Block (n = 26)				Infiltration (n = 36)		Block (n = 12)	
P value	Difference	SD	M	SD	M	P value	Difference	SD	M	SD	M	
0.002	0.271,1.193	0.5	1.3	1.1	2.1	0.073	−0.041, 0.874	0.6	1.3	0.9	1.7	**No. of cartridge**
0.041	−1.59433, 0.03410-	1.4	1.9	1.5	2.8	0.116	−1.83155, 0.20710	1.5	2.2	1.5	3.0	**Time of onset**
		Asymptomatic (n = 36)		**Symptomatic (n = 19)**				**Asymptomatic (n = 40)**		**Symptomatic (n = 8)**		
0.002	−1.275,−0.313	0.6	1.4	1.2	2.2	0.928	−0.526, 0.576	0.7	1.4	0.5	1.4	**No. of cartridge**
0.143	−1.45358, 0.21650	1.5	2.1	1.5	2.7	0.074	−2.24394, 0.10594	1.4	2.2	2.2	3.3	**Time of onset**

peripheral infiltration (5–15 min) and for nerve block and also the absorption of lidocaine are related to the total dose, the method of delivery and injection site blood supply (Weinberg et al., 2015). The effect of lidocaine on gingiva, bone and teeth might be different from the nonsmokers. Perhaps, the lack of difference cannot be explained with our data; therefore, further histological study should be conducted.

The result of this study found that more anesthetic solution is needed to achieve anesthesia with the block technique, regardless of smoking status. This is due to the nerve fiber of the inferior alveolar and lingual nerve being longer and having a larger diameter than the terminal branches of the superior alveolar nerve. The sensitivity of neural fibers to anesthesia is different in blocked formation and the transmission of electrical impulses; the smallest nerves have a tendency to anesthetize more easily than the larger one. In the same diameter of nerve fibers, myelinated nerves are obstructed faster than non-myelinated nerves (Becker and Reed, 2006).

In the current study, the number of cigarettes smoked per day and the duration of smoking had no relation with the amount and the onset of anesthesia.

In this study, we found that the extraction of symptomatic teeth in smoker patients needed more anesthesia than extractions of asymptomatic teeth. In cases of an active infection, there will be a change of the pH of the tissue to acidic, and the lidocaine with adrenaline (pKa = 7.9) prefers a basic environment for its action, which leads to increased demand for local anesthesia (Joseph et al., 2013, Patil et al., 2016). Furthermore, nicotine is regarded as a weak base (pKa = 8) that works in the basic area (Prochaska and Benowitz, 2019). A systematic review done by Milani et al. (2018) showed that doubling the dose of anesthesia increases the success of achieving anesthesia in the treatment of symptomatic teeth. But other studies found that there is no need for increasing the dose of anesthesia in symptomatic (Fowler and Reader, 2013) and asymptomatic cases (Wali et al., 2010).

The need for more anesthesia in the block technique than in the infiltration technique was reported in this study. Inferior alveolar nerve block does not constantly achieve success especially in irreversible pulpitis (Aggarwal et al., 2015). This finding was in contrast with another study that found no relation between increasing the amount of anesthetic solution and the success of anesthesia (Silva et al., 2019).

The basic limitation of this study is the shortage of prior studies on the subject, which made it challenging to interpret the results. Therefore, we need more in-depth studies in addition to histological studies on this subject.

Another limitation is that the sample is restricted to male patients for cultural and societal reasons; therefore, the results of the study cannot be generalized to females.

5. Conclusion

The amount of local anesthesia used in smoker patients was higher than in nonsmoker patients, especially if there were symptoms like pain. The duration of smoking and daily cigarette consumption had no effect on the amount and the onset of local anesthesia.

Further studies are needed on both male and female patients to assess any difference between the genders regarding the effect of smoking on the efficiency of local anesthesia. Also, histological studies are needed to further explain the findings of this study and the exact effect of lidocaine between smoker and nonsmoker patients.

Ethical statement

All procedures were performed in compliance with prevalent law and institutional guidelines and the institutional committees approved them.

The work described has been carried out with accordance with Code of Ethics of World Medical Association (declaration of Helsinki).

A written consent was obtained from all subjects.

CRediT authorship contribution statement

Noor Mohammed Al-Noori: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing - original draft, Writing - review & editing, Visualization, Project administration, Funding acquisition. **Noor Sahban Ibraheem:** Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing - review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Mohammed Majid Abdulmunem:** Conceptualization, Methodology, Validation, Investigation, Resources, Data curation, Writing - review & editing, Visualization, Project administration, Funding acquisition.

Declaration of Competing Interest

No Conflict of Interest

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