

Dental Practitioners' Knowledge, Behavior, and Attitude toward Safe Local Anesthesia Practice in Jeddah

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ABSTRACT

Objectives: This study aims to assess the knowledge level, behavior, and attitude of dental practitioners regarding the absolute maximum dose of local anesthetics, their MRD, and systemic complications.

Materials & Method: An electronic survey was distributed through social media platforms to dental practitioners in Jeddah. The survey consisted of 4 sections: demographic information, knowledge, behavior, and attitude. Cronbach's alpha was used to test for the validity 0.86.

Results: A total of 403 participants completed the questionnaire, with a response rate of 60%. Of all, 55.8% were females. The majority were undergraduate students 42.4%, and below the age of 25 44.9%. For the question "what is the MRD/kg for 2% lidocaine with Epinephrine?" we found a statistically significant difference between the professional rankings $p=0.001$. Although the undergraduate dentists were the least group to answer the questions "What does a 2% local anesthetic solution mean?", there was no statistically significant difference between those who answered correctly.

Conclusion: We found many of our participants to have false knowledge regarding the topics of LA, MRD/kg, and LAST. We believe that the current levels are not acceptable, and that more efforts must be made to raise the knowledge pertaining to this topic.

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INTRODUCTION

Local anesthetics are a category of drugs that were introduced initially back in the 19th century for the purpose of analgesia.¹ They are the most commercially used drugs by dentists; it was estimated that in the United States, more than 300 million cartridges are being annually used by dentists alone,² while another estimation stated that in Ontario, 13 million cartridges had been used in the year 2007.³ After being developed originally from Cocaine, in order to reduce toxicity many derivatives are being used daily nowadays, such as lidocaine and mepivacaine. The operating dentist now has the choice to use any of them basing their decision on multiple factors, such as procedure, cost, availability, and pharmacological characteristics.^{1, 4-7}

Proper dose calculation for local anesthetics is of critical importance as over-administration of local anesthetics could lead to serious complications. Local anesthetic systemic toxicity LAST is a severe, life-threatening complication when the local anesthetic agent being administered reaches a significant level in the systemic circulation.⁸ LAST most frequently occurs immediately after the administration of the drug, and recent data has shown that even delayed presentation may occur, up to several days after the administration.⁹ The primary feature of LAST is CNS toxicity 68-77%, presented as seizure activity.⁹ Local anesthesia-induced seizures are usually short-lived, and intervention with an anticonvulsant is rarely required. However, loss of consciousness and respiratory depression is likely to follow the seizure episode. Early recognition of this early manifestation allows for diagnosis and management early on, preventing the patient from going into cardiovascular collapse.^{9,10} Therefore, every dental practitioner must be able to recognize the initial manifestations of LAST. The leading causes of LAST include injection of the drug into a highly vascular area or directly into the bloodstream, incorrect calculation of the therapeutic dose MRD, and exceeding the absolute maximum.¹

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Prevention of LAST and most adverse reactions of local anesthesia is a multifactorial process; careful obtaining of the medical history, proper dose calculation, and having the adequate knowledge of the LA preparation being administered, such as its half-life, the concentration of the local anesthetic in the carpule, the presence of a vasoconstriction and how to minimize the LA systemic absorption, are important for the prevention of LAST.²

Practitioners' knowledge and awareness of the local anesthetics' calculations and LAST, and how it could be recognized and managed, is significant for patient safety. One of the earliest publications that touched on this topic was by Kirova et al.,⁷ and it assessed which LA is being used the most by dentists, as well as the management of medically-compromised patients. Throughout the following years, multiple studies were conveyed assessing similar parameters regarding the topic. Corbett et al. 2005 compared the knowledge and assessed the LA practice according to experience level.⁴ Gaffen et al.³ assessed the annual use of the different commercial local anesthetics, while Kaira et al.¹² went a step further and assessed the knowledge of the practitioners regarding how to calculate the MRDs. In India, Sagir et al.¹³ assessed the awareness level of the important aspects of LAST and its management. The assessment was concerned with teaching faculty members. On the other hand, Deluke et al.⁵ in the USA and Oliver et al.¹⁴ in the UK, aimed their efforts at assessing how the topics of LA and MRDs are being taught, and how the students are being evaluated. Locally, Khalil et al.⁶ assessed the practitioners' knowledge regarding the MRD calculation.

Bean et al. 2007 reported that from June 2005 to June 2006, a total of 26,882 procedures were performed by 264 undergraduate students with a rate of 655 procedures accomplished per day for all students.¹⁵ This example serves to emphasize the fact that it is vital to include undergraduate students when evaluating the usage of LA and the appropriate management of adverse events that may occur given their high exposure to procedures necessitating its use. To date, the Saudi literature is lacking enough publications investigating this area in the profession of dentistry. Therefore, this study aims to assess the knowledge level, behavior, and attitude of undergraduate dental students, as well as dental practitioners in both private and governmental clinics in the city of Jeddah, Saudi Arabia, regarding the absolute maximum dose of local anesthetics, their MRD, and systemic complications as well as to spread awareness and educate them on how to diagnose and manage LAST-related emergencies.

METHODOLOGY

Ethical Approval

The ethical approval for this survey based cross-sectional study was obtained from the Biomedical Ethics Committee at King Abdul-Aziz University in Saudi Arabia Faculty of Dentistry.¹⁸⁻¹¹⁻¹⁹

Population and sample

The survey used in this study targeted all dental practitioners and undergraduates. An electronic survey was distributed through social media channels to the target population living

and practicing in the city of Jeddah between August 2020 and January 2021.

Survey design

The survey was created based on the objectives of this cross-sectional study. A link to the online survey was distributed. First, the consent of all participants was obtained digitally, and complete anonymity was ensured. The survey was divided into 4 sections. The first section was concerned with the demographic data of our population. The second section was concerned with the knowledge and behavior. The third section was specific to the respondents that answered the question "Are you familiar with the term absolute maximum dose?" with yes. The fourth section was concerned with the attitude.

Assessment for the reliability and validity of the questionnaire was done using Cronbach's alpha test and the score was 0.86.

At the end of the questionnaire, there was an option for the participants to leave their email, which will be used later to send educational sources that will improve the knowledge and awareness regarding the topics of the calculation of LA maximum recommended dose, absolute maximum, and LAST.

Statistical analysis

All the responses were collected and coded. The data was then tabulated and analyzed by IBM SPSS Statistics version 23.0 IBM Corp., Armonk, N.Y., USA. Descriptive statistics were used to report frequency and percentages and Chi-square test was used to identify the correlation between independent and dependent variables. Mean and standard deviations were used to describe the continuous variables. $P \leq 0.05$ was considered statistically significant.

RESULTS

A total of 403 participants completed the questionnaire, with a response rate of 60%. Of all, 55.8% were females. The majority of the participants were undergraduate students 42.4% and 45% below the age of 25. Most of the participants 51.4% have participated in teaching, instructing, and mentoring students or residents. [Table 1]

Table 1: Demographic information

Variable		Frequency N= 403	Percentage
Gender	Male	178	44.2
	Female	225	55.8
Age group	Under 25	181	44.9
	25-35	155	38.5
	35-50	54	13.4
	Above 50	13	3.2
Specialty	Undergraduate student	171	42.4
	Postgraduate student	63	15.6
	General practitioner	74	18.4
	Nurse/assistant	1	0.2
	Specialist	33	8.2
	Consultant	61	15.1

Our cohort of participants mostly treated adult patients 79.7%, and the most popular LA solution used was lidocaine 2% with epinephrine 1:100,000 with a percentage of 74.9%. Half of the participants stated that they chose lidocaine because of its pharmacological characteristics and availability. The majority of the participants 86.6% used both infiltration and nerve block techniques when treating their patients. [Table 2]

Regarding the knowledge questions, the majority reported they were familiar with how to calculate the maximum recommended dose 70.2% and the term "absolute maximum dose of LA" 72%. However, only 25.6% and 32.3% participants answered correctly the questions "What does a 2% local anesthetic solution mean?" and "What is the absolute maximum dose for lidocaine?" respectively. While 42.7% knew the MRD/kg for lidocaine 2% with epinephrine. [Table 3]

Around 73% of the participants claimed knowledge about LAST signs and symptoms. Yet, merely 47% knew the correct initial manifestation which was "Seizure activity". Furthermore, half of our sample agreed that LAST could ensue without exceeding maximum recommended dose MRD. (Table 3)

As for behavior and clinical experience assessment, our participants rarely encountered or witnessed LAST in their practice 3.2%, and half reported that they always document the amount of LA given for each patient. However, only 25.6%

always calculated the maximum recommended dose before treating patients. While the majority 61.3% answered yes when asked "Do you always aspirate before injecting LA when performing inferior alveolar nerve block?". (Table 3)

Finally, the participants' attitude toward the awareness of MRD and LAST among dentists and dental students; their findings can be viewed in Table 4.

Regarding the knowledge of the participants and their different professional ranking, there was a statistically significant difference between the participants in correctly answering "What is the MRD/kg for 2% lidocaine with Epinephrine?" $p=0.001$. General dentists were the least group who correctly answered compared to all the other groups.

Undergraduate dentists were the least group to correctly answer "What does a 2% local anesthetic solution mean? e.g., 2% lidocaine" compared to others, yet there was no significant difference among those who answered correctly. As shown in Figure 1, the question answered mostly correctly in all specialties involved is "Can LAST occur without exceeding Maximum Recommended Dose MRD?", while the least correctly answered question is "What does a 2% local anesthetic solution mean? e.g., 2% lidocaine." The question "What is the MRD/kg for 2% lidocaine with epinephrine?" was answered most correctly by consultants compared to practitioners with lower experience.

Table 2: Experience and practice of the participants

Variable		Frequency N = 403	Percent
I have teaching experience	No	196	48.6
	Yes	207	51.4
I treat adult patients	No	321	79.7
	Yes	82	20.3
I treat pediatric patients	No	364	90.3
	Yes	39	9.7
I treat geriatric patients	No	394	97.8
	Yes	9	2.2
I treat special care patients	No	398	98.8
	Yes	5	1.2
I use Lidocaine	No	101	25.1
	Yes	302	74.9
I use Articaine	No	264	65.5
	Yes	139	34.5
I use Prilocaine	No	382	94.8
	Yes	21	5.2
I use Mepivacaine	No	255	63.3
	Yes	148	36.7
I use bupivacaine	No	389	96.5
	Yes	14	3.5
choice of the LA agent is based on	The pharmacological characteristics of the agent	205	50.9
	Availability	186	46.2
	Being unfamiliar with other agents	12	3
The technique I mostly use when giving LA is	Infiltration	44	10.9
	Nerve block	10	2.5
	Both	349	86.6

Table 3: Knowledge and behavior questions

I know how to calculate the maximum dose of LA	Yes	283	70.2
	Used to be	87	21.6
	No	33	8.2
What does a 2% local anesthetic solution mean? e.g., 2% Lidocaine	20 mg of Lidocaine in the carpule	60	14.9
	20 mg of Lidocaine in 1ml solvent	103	25.6
	20 mg of Lidocaine in 1.8 ml solvent	214	53.1
	I don't know	26	6.5
Do you know the signs and symptoms of Local Anesthetic Systemic Toxicity LAST?	Yes	293	72.7
	No	110	27.3
What is the initial manifestation of LAST?	Seizure activity	190	47.1
	Respiratory arrest	103	25.6
	Cardiac arrest	49	12.2
	I don't know	61	15.1
Can LAST occur without exceeding Maximum Recommended Dose MRD?	Yes	219	54.3
	No	144	35.7
	I don't know	40	9.9
Are you familiar with MRD/Kg for LA agents you use?	Yes	281	69.7
	No	122	30.3
What is the MRD/kg for 2% Lidocaine with Epinephrine?	4.4 mg/kg	155	38.5
	7 mg/kg	172	42.7
	6.6 mg/kg	25	6.2
	.5 mg/kg	16	4
	I don't know	35	8.7
Are you familiar with the term "absolute maximum dose of LA"?	Yes	290	72
	No	113	28
Where did you learn about it?	College undergrad	247	61.3
	College postgrad	32	7.9
	Self-taught	33	8.2
	Workplace	1	0.2
	Extracurricular programs lectures, conferences, etc.	7	1.7
	Other	23	5.7
	I'm not familiar with the term	60	14.9
Do you know the absolute maximum dose for the LA agents you use?	Yes	255	63.3
	No	148	36.7
What is the absolute maximum dose for Lidocaine?	90 mg	32	7.9
	500 mg	130	32.3
	400 mg	84	20.8
	I don't know	157	39
How often do you meet the absolute maximum limit?	Frequently	13	3.2
	Rarely	110	27.3
	Never did	125	31
	I don't know	155	28
Have you ever witnessed/experienced a patient with LAST?	Yes	58	14.4
	No	232	57.6
	I don't know	113	28
Are you able to recognize the signs and symptoms of LAST?	Yes	209	51.9
	No	81	20.1
	I don't know	113	28
	Yes, always	203	50.4
Do you always clinically document the amount of LA given at each procedure?	Only in critical cases	45	11.2
	Only when I meet the limit	4	1
	No	38	9.4
	I don't know	113	28
	Yes	103	25.6
Do you always calculate the number of carpules before treating a patient?	Only for pediatric patients	73	18.1
	No	114	28.3
	I don't know	113	28
	Yes	247	61.3
Do you always aspirate before injecting LA when performing inferior alveolar nerve block?	No	43	10.7
	I don't know	113	28

Table 4: Attitude questions

Variable		Frequency N=403	Percent
It is important for all dentists using LA to always know the MRD/kg for the LA agents they are using.	Strongly agree	282	70
	Agree	93	23.1
	Neutral	25	6.2
	Don't agree	2	0.5
	Strongly disagree	1	0.2
It is important for all dentists using LA to always know the absolute maximum dose for the agents they are using.	Strongly agree	255	63.3
	Agree	112	27.8
	Neutral	29	7.2
	Don't agree	5	1.2
	Strongly disagree	2	0.5
It is important to always aspirate before injecting LA when performing Inferior Alveolar Nerve Block IANB.	Strongly agree	290	72
	Agree	72	17.9
	Neutral	35	8.7
	Don't agree	5	1.2
	Strongly disagree	1	0.2
It is important for dentists dealing with LA to know the signs and symptoms of LAST.	Strongly agree	306	75.9
	Agree	84	20.8
	Neutral	10	2.5
	Don't agree	2	0.5
	Strongly disagree	1	0.2
It is important for dentists dealing with LA to know how to initially manage LAST.	Strongly agree	314	77.9
	Agree	74	18.4
	Neutral	10	2.5
	Don't agree	3	0.7
	Strongly disagree	2	0.5

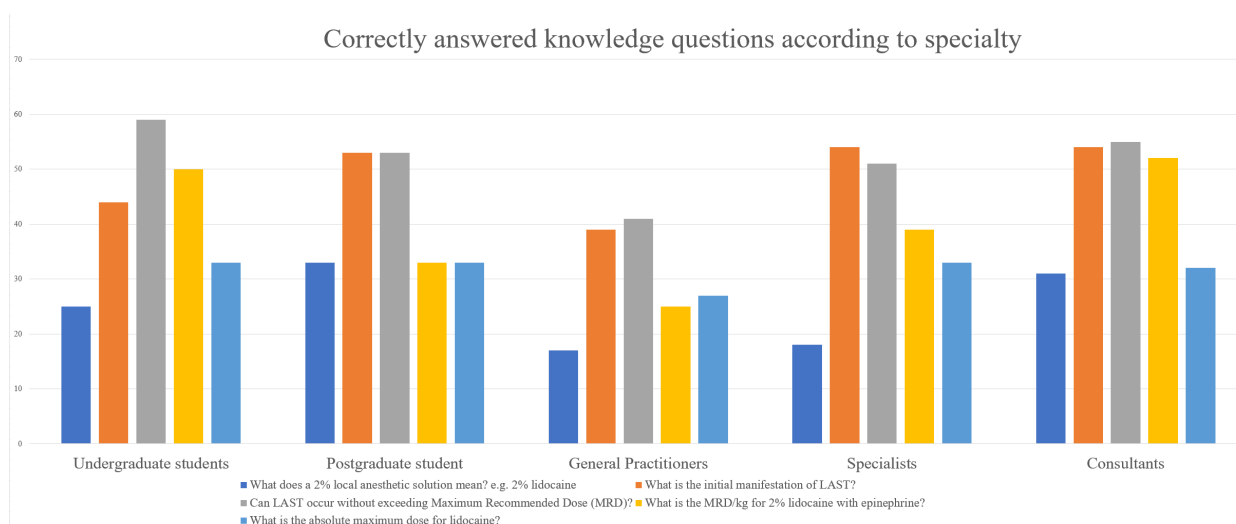


Fig. 1: Correctly answered knowledge questions according to specialty

DISCUSSION

In this survey-based cross-sectional study, the knowledge level, behavior, and attitude of dental students and dentists regarding Local Anesthetics absolute maximum dose, maximum recommended dose calculation and systemic complications were assessed. The survey was distributed through online channels including social media platforms and emails. This explains the high rate of dental students 42.4% in

our respondents' pool as this age group is more social media friendly.

Lidocaine was the mostly used local anesthetic 74.9%. The preference of lidocaine among dental practitioners comes in line with what was reported in previous literature, such as with Corbett and Gaffen [3, 4]. Many reasons make lidocaine the most commonly used local anesthetic; it has anti-inflammatory, antihyperalgesic properties and its safety profile

is convenient as it is considered a class B pregnancy category drug. Additionally, lidocaine is available in plain and with epinephrine formulation 1:50,000, 1:80,000, and 1:100,000 epinephrine. This gives the operator the ability to control the amount of vasoconstrictor administered to patients based on their medical history of cardiovascular disease without losing the benefits it brings to the table[2]. Nearly half of our respondents chose the local anesthetic based on its pharmacological characteristics 50.9%, while the other half chose it based on availability 46.2%.

Although 70.2% of the respondents said they know how to calculate the MRD for each patient, only 42.7% answered the question "What is the MRD/kg for 2% lidocaine with epinephrine?" correctly. MRD is calculated by multiplying the patient's weight by the fixed MRD specific to the local anesthetic agent, which differs in the presence of a vasoconstrictor depending on the agent. The MRD of lidocaine is 7 mg/kg when administered with epinephrine and 4.4 mg/kg when administered plain. Our results fall close form those reported by Kaira and Khalil, in which only 38% and 31% of their respondents answered a similar question correctly, respectively.

Subsequently, only 25.6% answered the question "what does a 2% local anesthetic solution mean?" correctly. Local anesthetics cartridges come in different capacities in terms of volume 1.7 ml, 1.8 ml, and 2.2 ml, the local anesthetic itself (lidocaine, mepivacaine, articaine, prilocaine), their concentration (2%,3% 4%), the presence and the concentration of the vasoconstrictor (1:50,000, 1:100,000, 1:150,000, 1:200,000). Each one of these factors plays a role in the calculation process of the maximum recommended dose of local anesthetic to be given to a patient. Knowledge of the practitioner regarding the content of the local anesthetic solution in the cartridges is vital in determining the maximum administrable number of cartridges in the dental setting and thus patient safety.^{2, 6, 12}

During the occurrence of LAST, the most common and usually earliest features are prodromal symptoms followed by more severe CNS toxicity manifestations 68-77%, mainly in the form of seizure activity. This is then followed by CVS toxicity symptoms and respiratory depression.⁹ When we asked the respondents if LAST could occur without exceeding the MRD, only 54.3% answered yes. Although LAST mainly manifests after exceeding the MRD, other factors could elicit LAST, such as direct injection into the bloodstream and getting very close to the MRD. Around 72.7% of our respondents believe they can recognize the signs and symptoms of LAST. However, this percentage is not validated as more than half of respondents failed to recognize LAST initial manifestations. Therefore, having 14.4% of our respondents say that they have witnessed episodes of LAST could be inflated and an overstatement. The incidence described in the literature is merely 0.03%.⁹

Our numbers fall short of those reported by Sagir, in which 81% and 51% were able to correctly identify the signs and symptoms of cardiotoxicity and neurotoxicity. We believe the main reason behind this difference is that is population involved medical personnel which included cardiology and neurology residents.¹³

Early recognition and management of patients undergoing LAST are key to prevent potential mortality. Prevention starts with

correct dose calculation and administration. Only 25.6% said they always calculate the dose before treating their patient, while 18.1% said they would do that only if the patient was a child. Additionally, only 61.3% aspirate before giving an inferior alveolar nerve block IANB. Added to the fact that 89.1% of our respondents give IANB, these numbers amplify the fact that proper and sufficient awareness must be spread between the dentists for the sake of our patients' wellbeing.

Majority of our respondents claimed to be familiar with the term "absolute maximum," which they learned mainly as undergraduate students during college. Similarly, they claimed to know the absolute maximum of the local anesthetic agents they regularly use; however, only a third of knew the absolute maximum limit of lidocaine yet it was the mostly used agent. We think this mismatch may be related to several factors; firstly, some dentists follow the recommendations of associations other than the U.S Food and Drug Administration FDA such as American Academy of Pediatric Dentistry AAPD and having more than one source for approved LA dosage will lead to confusion. Furtherly, DeLuke et al.⁵ reported lack of consistency in the teaching of MRD for local anesthetics among the U.S schools and they recommended reviewing the current guidelines to come up with common practice LA guidelines. Secondly, lack of knowledge of the absolute maximum concept in LA drugs and that each local anesthetic medication has its own unique absolute maximum dose. Thirdly, after graduation a lot of dentists don't practice calculating the MRD before providing treatment to patients. This justification is supported by our survey results where more than half of the population didn't follow that safety practice guideline. Lastly, inadequate continuous education touching on this topic post-graduation also plays a role.

The absolute maximum concept is a very important concept to understand for all healthcare providers who administer local anesthesia. As even if the patients weight permits giving a higher dose of the medication, the absolute maximum limit should never be exceeded. In the case of lidocaine, that is 500 mg. The dentist must not continue beyond that value; otherwise, signs of systemic toxicity may start to manifest, and the patient may require management in hospital setting.^{12, 9}

The attitude questions in our survey explored the population's mentality and feelings towards the established safety measures when dealing with local anesthetics. The majority of our population showed a positive attitude toward LA safety measures such believing in the importance of always aspirating before administering LA, MRD knowledge, absolute maximum knowledge, and being able to recognize LAST signs and symptoms. The question here is why the positive attitude didn't influence the behavior of our population? Unfortunately, our data and findings doesn't explain this inconsistency. The best way to explore it is through qualitative or mixed methods research.

Of the difficulties we have encountered is how to distribute our survey to insure a representative sample of our target population. Distribution of the research through social media platforms in the form of a digital survey exposes our results to bias and prevents us from having control over adequate representation of our population. We highly recommend applying the study on a wider geographic region with better

distribution of the population for better and more accurate representation of results.

CONCLUSION

We found that the majority of participants had false perception of their knowledge. This was evident in the very low rate of correct answers to our knowledge assessment questions. Additionally, the majority of people who said they knew what absolute maximum was didn't answer the absolute maximum related knowledge questions correctly. Our participants recognize that the topics of MRD/kg for LA and the absolute maximum dose to be of crucial importance, and strongly agree that all the practicing dentists must know those topics very well, in addition to LAST and its initial signs and symptoms, as well as its initial line of management. We believe the current levels of knowledge and behavior to be unacceptable, and we believe that more efforts must be put toward raising the awareness and knowledge surrounding the topics of LA and LAST.

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Conflict of interests

The authors of this paper declare no competing or conflict of interest and deny the presence of any financial or external affiliations regarding this paper.

Ethical approval

There is no need for ethical approval for this study.

Authorship contributions

The authors have the same contributions

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