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# Local anesthetics dosage still a problem for most dentists: A survey of current knowledge and awareness



Hesham Khalil \*

Department of Maxillofacial Surgery, College of Dentistry, King Saud University, Saudi Arabia

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## KEYWORDS

Lidocaine;  
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**Abstract** *Introduction:* Local anesthetics are the most commonly used drugs in dentistry. Although they are considered effective and safe in controlling pain during dental procedures, complications related to their use appear inevitable. Many dentists use these drugs routinely but are unaware of the dose calculations required and the maximum safe and effective dose of the drug. *Materials and methods:* The aim of this study was to determine the knowledge that general dental practitioners and dental specialists, in three different cities in Saudi Arabia, have regarding dose calculations and the maximum dose required of the most commonly used local anesthetics. A one page survey questionnaire was used in this study and data were analyzed using SPSS software. *Results:* The respondents comprised 51% general dental practitioners and 49% dental specialists, with ages ranging from 26–50 years; 58% of the total respondent was females and 42% males. A total of 69% of the respondents were unaware of the maximum recommended dose for use on adult, healthy patients and 85% were still confused about the maximum numbers of cartridges containing 2% lidocaine with adrenaline that can be given to a patient. A total of 53% of general dental practitioners and specialists do not perform aspiration when injecting local anesthetics, while only 43% performed the aspiration in inferior nerve block technique, while only 4% performed aspiration in all types of injection techniques. A high percentage of the dentists (87%) who responded are unaware of how to calculate the local anesthetic dose and 35% of them encountered complications during, or after, local anesthetic administration.

\* Address: Department of Maxillofacial Surgery, College of Dentistry, P.O. Box 60169, King Saud University, Riyadh 11545, Saudi Arabia. Tel.: +966 11 4677414.

E-mail address: [hkhalil@ksu.edu.sa](mailto:hkhalil@ksu.edu.sa)

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**Conclusion:** General practitioners and dental specialists appear to have an inadequate knowledge about local anesthetics maximum-dose and dose calculations; further educational courses are recommended to update them regarding such important aspects of dentistry.

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## 1. Introduction

Local anesthetics are the most commonly used drugs in clinical practice of dentistry. The use of such drugs aims to inhibit nerve conduction during a variety of dental procedures [1]. These drugs are classified as ester or amide type with short, intermediate or long acting action. In addition to the local anesthetic agent in the local anesthetic cartridge other constituents, such as vasoconstrictors are of great importance during the administration of local anesthetic [2]. During their routine work most dentists who use such drugs often ignore important aspects of drug administration, notably the maximum dose and the dose calculation which relate to the use of local anesthetics. Most dentists memorize the maximum number of cartridges and the total contents in milligrams of local anesthetic per cartridges [3]. The required dose of local anesthetic is based on many factors including age and weight, and medically compromised patients and children require special consideration when calculating the maximum dose of a local anesthetic or a vasoconstrictor [4]. Failure of anesthesia leads to more local anesthetic being administered in order to achieve the required effect, and toxic reactions to local anesthetics can occur when the local concentration of the drug in the blood stream becomes elevated over a short time period. High concentrations of the drug in the circulation may result from an inadvertent, rapid injection directly into a blood vessel, or to the use of repeated injections, and there is always a risk of intravenous administration when injections are made into a highly vascular area [5]. Although toxic reactions are more commonly encountered during the use of nerve block techniques than infiltrations, some authors recommend performing two negative aspirations even when infiltration technique is used. Dentists should be fully aware of the dose required and the dose calculations used for local anesthetics and should perform aspiration in all injections in order to avoid sudden intravascular injections which lead to drug toxicity. A 2% local anesthetic means that 2 grams of the drug is dissolved in 100 ml of solution, i.e., 20 mg per ml. Although these calculations look simple, many dentists are not confident doing them [6], and may be confused, in relation to the maximum dose to be given, when changing concentrations. The use of anesthetic cartridges in dentistry has unfortunately spawned carelessness regarding an appreciation of the amount of anesthetic that can be administered to the patient, and such attitudes continue to predominate even in many respected and well established institutes. The same problem arises in relation to the concentration of vasoconstrictors (used in concentrations such as 1:80,000 and 1:100,000). The presence of more than one drug in the dental anesthetic cartridge make the situation more complicated regarding calculations of the maximum dose for each drug, and it is important to respect local anesthetic as active pharmacological agents that can potentiate dose-related complications. The aim of this study was to investigate the awareness and knowledge of general dental practitioners and specialists regarding the maximum dose of the

commonly used local anesthetic drug lidocaine. The study also determined (a) the most commonly used local anesthetic drugs by dentists, (b) the most frequently encountered complications during, or after, local anesthetic administration and (c) whether or not aspiration is a common practice used by dentists working in Saudi Arabia.

## 2. Materials and methods

A one page questionnaire was designed, and used, to investigate the awareness of general dental practitioners and specialists working in Saudi Arabia regarding the maximum dose of the most commonly used local anesthetic, lidocaine. The questionnaire included questions relating to age, gender, rank and qualification, and investigated the practitioner's awareness of (1) the maximum dose of 2% lidocaine with adrenaline for adult healthy patients in terms of dose per kilogram, (2) the maximum number of cartridges that can be used for each patient and (3) the name of the most commonly used anesthetic drug used in the correspondents' clinic. The questionnaire also questioned awareness of the meaning of a 2% concentration in local anesthetic dose calculation. The questionnaire asked whether or not the dentist performs aspiration in different injection techniques and questioned the types of complications that the dentist had encountered during, or after, the administration of a local anesthesia. Questions relating to the maximum dose were based on the recommendations given in Malamed's *Handbook of Local Anesthesia* [7]. The research was approved by the College of Dentistry Research Center Ethics Committee, registration number FR0056. The dentists and specialists sampled included those working in both governmental and private practice in Saudi Arabia. The total number of questionnaires distributed was 600, although only 467 dentists replied and of these questionnaires, 431 were complete. The data were analyzed using SPSS software version 17 and presented using descriptive analysis.

## 3. Results

The response rate to our distributed questionnaires was 77% of which 92% were considered complete. Table 1 shows the descriptive information regarding the respondents. The responses from general dental practitioners reached 51%, compared to 49% for dental specialists; the age of respondents ranged from 26–50 years and 58% of the total were females

**Table 1** Details of respondents.

|                 | Male | Female | Total | Percentage |
|-----------------|------|--------|-------|------------|
| General dentist | 134  | 85     | 219   | 51         |
| Specialist      | 115  | 97     | 212   | 49         |
| Total           | 249  | 182    | 431   |            |
| Percentage      | 58   | 42     |       |            |

**Table 2** Answers to the question relating to the maximum dose in mg for 2% lidocaine with vasoconstrictor.

|                 | 2.4 mg/kg | 4.4 mg/kg | 6.4 mg/kg | 8.4 mg/kg | Total |
|-----------------|-----------|-----------|-----------|-----------|-------|
| General dentist | 23        | 56        | 66        | 74        | 219   |
| Specialist      | 27        | 77        | 50        | 58        | 212   |
| Total           | 50        | 133       | 116       | 132       | 431   |
| Percentage      | 12        | 31        | 27        | 30        |       |

and 42% males. Only 31% of all respondents gave the correct answer to the question regarding the maximum dose of 2% lidocaine with vasoconstrictor (Table 2). The ANOVA test showed no significant difference between general dental practitioners and specialists in relation to the correct answer. A total of 69% of the respondents were not aware of the maximum recommended dose for adult healthy patients. Table 3 shows the respondent's answers to the question regarding the maximum numbers of cartridges of 2% lidocaine, with adrenaline, that can be given to an adult healthy patient and only 15% of the general dental practitioners answered correctly the question regarding the maximum numbers of local anesthetic cartridges containing vasoconstrictor that can be safely given to patients. The remaining 85% of the respondents appeared confused about the maximum numbers of cartridges of the 2% lidocaine with adrenaline which can be administered.

Table 4 shows that lidocaine is the most frequently given local anesthetic given by dentists working in Saudi Arabia (73%), followed by articaine and mepivacaine. The results also show that fifty-three per cent of general dental practitioners and specialists do not perform aspiration when injecting local anesthetics, while only 43% perform aspiration in the inferior nerve block technique; 4% perform aspiration in all types of injection techniques Table 5. A high percentage of the responding dentists (87%) were unclear about correctly calculating the local anesthetic dose, (Table 6) and 35% of them encountered complications during, or after, the administration of local anesthetics (Table 7). The complications encountered by dentists in their clinics were mainly syncope (62%) followed by the failure of anesthesia to work (47%) (Table 8).

#### 4. Discussion

The results presented here show that the calculation of the local anesthetic maximum-dose and dose calculation present a problem for most dentists working in Saudi Arabia independent of whether they are general dental practitioners or specialists. Failure to appreciate the dose of local anesthetic that can be safely given to patients is a common problem for most dentists and even in well-established dental schools. Considering that the local anesthetic is the only daily injectable drug that the dentist can give their patients on a routine basis, this lack of awareness of the correct dose calculation is

**Table 4** The most commonly used local anesthetic agent.

|                 | Lidocaine | Articaine | Mepivacaine | Others | Total |
|-----------------|-----------|-----------|-------------|--------|-------|
| General dentist | 159       | 42        | 16          | 2      | 219   |
| Specialist      | 157       | 15        | 39          | 1      | 212   |
| Total           | 316       | 57        | 55          | 3      | 431   |
| Percentage      | 73        | 13        | 13          | 1      |       |

**Table 5** Results relating to aspiration.

|                 | Aspiration in IANB | Aspiration in all injections | No aspiration | Total |
|-----------------|--------------------|------------------------------|---------------|-------|
| General dentist | 100                | 15                           | 104           | 219   |
| Specialist      | 84                 | 4                            | 124           | 212   |
| Total           | 184                | 19                           | 228           | 431   |
| Percentage      | 43                 | 4                            | 53            | 100   |

IANB = inferior alveolar nerve block.

**Table 6** Familiarity with local anesthetic-dose calculation.

|                 | Yes | No  | Total |
|-----------------|-----|-----|-------|
| General dentist | 27  | 192 | 219   |
| Specialist      | 29  | 183 | 212   |
| Total           | 56  | 375 | 431   |
| Percentage      | 13  | 87  |       |

obviously worrying and it appears that the local anesthesia procedure has become a technical matter, rather than a medical procedure. As a result, it has proved worthwhile to check the knowledge of dental health providers in Saudi Arabia regarding the maximum dose and dose calculation of the commonly used local anesthetic, lidocaine. A questionnaire was developed here in which most of the questions were designed as closed and pre-coded with all options already set, or with two options provided, such as yes or no, in order to make the questionnaire as simple as possible to complete. Only 31% of the general dental practitioners and specialists correctly answered the question regarding the maximum dose of 2% lidocaine with vasoconstrictor and no significant difference arose between the two groups in relation to the answer to this question. These results show that most dentists use local anesthetic routinely to perform their various dental procedures without giving attention to the importance of the dosage used. A number of complications can arise from the incorrect administration of local anesthetic injections, some of which are permanent and can damage patients or even be life threatening [8–12]. The maximum numbers of cartridges of 2% lidocaine with adrenaline that can be given to an adult healthy patient is calculated according to the percentage and the

**Table 3** Answers to the maximum numbers of local anesthetic cartridges.

|                 | 6 Cartridges | 8 Cartridges | 12 Cartridges | 14 Cartridges | Total |
|-----------------|--------------|--------------|---------------|---------------|-------|
| General dentist | 9            | 24           | 147           | 39            | 219   |
| Specialist      | 8            | 40           | 141           | 23            | 212   |
| Total           | 17           | 64           | 288           | 62            | 431   |
| Percentage      | 4            | 15           | 67            | 14            |       |

**Table 7** Number and percentage of respondents encountering complications during or after injections.

|                 | Yes | No  | Total |
|-----------------|-----|-----|-------|
| General dentist | 72  | 147 | 219   |
| Specialist      | 79  | 133 | 212   |
| Total           | 151 | 280 | 431   |
| Percentage      | 35  | 65  |       |

**Table 8** Types of complications encountered by dentists.

| Complication          | General dentist | Specialist | Total | Percentage |
|-----------------------|-----------------|------------|-------|------------|
| Syncope               | 141             | 127        | 268   | 62         |
| Needle Breakage       | 1               | 0          | 1     | 0.2        |
| Hematoma              | 8               | 10         | 18    | 4.2        |
| Anaphylaxis           | 1               | 2          | 3     | 0.7        |
| Failure of anesthesia | 114             | 90         | 204   | 47         |
| Trismus               | 8               | 13         | 21    | 4.8        |
| Total                 | 273             | 242        |       |            |

maximum recommend dose for this drug. Only 15% of the general dental practitioners correctly answered the question regarding the maximum numbers of cartridges that can be given to an adult healthy patient. The remaining 85% of the respondents are still clearly confused about the maximum numbers of cartridges of the 2% lidocaine with adrenaline. Such confusion may become especially problematic when anesthetics are administered to medically compromised patients or children, where doses of local anesthetics and vasoconstrictors differ than in normal patients [9,13–15]. The accidental intravascular injection of local anesthetics may occur following any injection procedures. This study showed that 53% of general dental practitioners and specialists do not perform aspiration when injecting local anesthetics, while only 43% perform aspiration in the inferior nerve block technique and 4% perform aspiration in all types of injection techniques. Some authors recommend performing at least two negative aspirations before depositing local anesthetics [16,17], and it seems that dentists often fail to appreciate the importance of applying such procedures to all injection events. This is especially worrying since, high levels of toxicity can be achieved by the accidental intravascular injection of local anesthetics.

This study showed that lidocaine (73%) is the local anesthetic most commonly used by dentists in Saudi Arabia, followed by articaine and mepivacaine. Lidocaine also remains the most commonly used local anesthetic in the United States [3]. Many factors can affect the selection of local anesthetics such as duration of action, efficacy and toxicity and a high percentage of the responding dentists (87%) were shown in this study to be unaware of how to calculate the local anesthetic dose. The volume of local anesthetic cartridges used in Saudi Arabia is set at 1.8 ml. In order to simplify dose calculations Becker and Reed recommended that this volume be regarded as being 2 ml, thereby leading to an over estimate of the amount of local anesthetic that is given to the patient [3], and as a result automatically introducing a safety margin.

Thirty-five percent of dentists questioned in this study encountered complications during or after local anesthetic administration. The complications encountered by dentists in their clinics were mainly syncope (62%) followed by failure

of anesthesia to work (47%). Syncope may be related to the fear of the dental injection and anxiety related events. Failure of local anesthetics to be effective is related to many factors such as, inaccurate anatomical deposition of the local anesthetic solution or the use of inadequate amounts of solution. The determination of local anesthetist dosage and dose calculations remains a problem for most of the dentists sampled here. The inability to understand and manipulate such important issues in dentistry is of considerable concern as it is likely to render dentists unsafe health providers.

## 5. Conclusions

In conclusion, the knowledge of general practitioners and dental specialists concerning the local anesthetics maximum-dose and dose calculations appears inadequate and worrying, especially since systemic toxicity of local anesthetics is dose dependent. It is recommended that further educational courses are provided in order to update both general dental practitioners and specialists regarding the correct application of these critically important aspects in dentistry.

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