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Original Research

Evaluating Dentists' Knowledge and Practices in the Use of Local Anesthetics and Unintended Effects in Pediatric Patients

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This study was presented as an oral presentation at the 2nd NEU International Dentistry Congress held in Konya on 1-3 October 2022 (https://www.erbakan.edu.tr/en/dishekimligi/haber/500254/2-uluslararasi-dis-hekimligi-kongresi-ve-fuari).

ABSTRACT

Objective: This cross-sectional study aimed to evaluate a group of Turkish dentists' awareness, preparedness, and competence regarding the unintended effects of LAs in pediatric patients.

Methods: In this study, the questionnaire form titled ' Evaluation of the Knowledge Level of Dentists Regarding the Use of Local Anesthesia and its Unintended Effects in Pediatric Patients' prepared in a digital environment was sent to dentists via Google survey application. The study investigated dentists' awareness and knowledge of the maximum dose of local anesthetic (LA) drugs. The most commonly used LA drugs and the most common complications related to these anesthetics were also determined.

Results: According to the results obtained, the dentists' most frequently preferred LA substances were Articaine+Adrenaline (A+A) and Lidocaine+Adrenaline (L+A). It was found that 91% of the participants performed aspiration before LA applications. It was found that 74% of the dentists participating in the study did not calculate the maximum dose per kilogram when performing local anesthesia in pediatric patients. The three complications encountered by the participating dentists during local anesthesia were found to be anesthetic failure (73%), facial paralysis (26%), and syncope (19%), respectively. In addition, 90% of the dentists who were asked about the first drug they would prefer in anaphylaxis answered adrenaline. When asked about the route of adrenaline injection, the majority of the dentists (64%) responded intramuscularly.

Conclusion: Although the occurrence of anaphylaxis during dental procedures is rare, when it does occur, it can lead to severe complications that may result in death. Dentists should be familiar with the signs of systemic complications that may arise from using LAs. When these findings are encountered after anesthesia, it should be considered that a systemic complication may have occurred, and urgent intervention should be performed. Any delay may cause consequences that may threaten the patient's life. This subject, which is of critical importance in dentistry, should be considered more in undergraduate and postgraduate education, and the level of knowledge should be increased by providing further training courses to update the information.

Keywords: survey, local anesthesia, complications, maximum dose

INTRODUCTION

Local anesthetic (LA) drugs have been primary agents for pain control in dentistry for year. There have been some concerns associated with them, including anesthesia-related complications. Therefore, dentists must precisely understand LA drugs' application method and dosage to minimize complications [1].

LA drugs primarily act by reducing the permeability of ion channels to Na+ ions on the nerve membrane [2]. The nerve cell membrane consists of lipid layers, which are hydrophobic barriers, and drugs with high lipid solubility have longer durations of action, potential, and rapid onset compared to those with low lipid solubility [3]. The concentration of anesthetic agents in nerve fibers also affects anesthesia efficacy. LA drugs are primarily classified as ester and amide according to their chemical structure. In the field of dentistry, amide-based anesthetics (Lidocaine, Mepivacaine, Bupivacaine, Articaine, and Prilocaine) are used extensively [4]. Lidocaine is particularly notable for its safety profile and high tolerability, and dentists also prefer articaine in Türkiye. Having comprehensive knowledge of the usage, pharmacokinetics, contraindications, and possible side effects of local anesthetics is crucial. It is equally important to keep this information up-to-date.

As with any invasive procedure, side effects can occur during local anesthesia applications [5]. These reactions can vary from local blanching to severe reactions such as anaphylactic shock and systemic toxicity [6]. Life-threatening hypersensitivity reactions are infrequent and are known to occur in less than 1% of cases [7]. In dentistry, LA drugs are primarily used with the addition of a vasoconstrictor. Severe and life-threatening toxic reactions result due to relatively high doses of LAs or the vasoconstrictor agent. Such reactions can be prevented with proper patient assessment and following dosage protocols before administering the LA agent [8]. LAs used in dentistry are minimal in dosage, and systemic effects after absorption are rare.

Main Points;

- Local anesthetics are the most used drugs in dentistry.
- Dentists may encounter various complications related to the use of local anaesthetics.
- Dentists should have adequate knowledge of local anesthetics, appropriate dose calculation, and management of complications.
- This subject is critical to dentistry and should be emphasized more in undergraduate and postgraduate education, with further training courses provided to update dentists' knowledge.

However, toxic effects may occur due to incorrect vascular injection and rapid increases in blood levels, especially in the pediatric population [9]. For this reason, the correct use of LA agents in dental clinics is crucial. Any dentist using an anesthetic agent must have sufficient knowledge about the dosage and content of the anesthetic used [8]. It is crucial for dentists to be aware of the possible permanent side effects of local anesthesia and have the necessary equipment to handle them [10].

Therefore, this cross-sectional study aimed to evaluate a group of Turkish dentists' awareness, preparedness, and competence regarding the unintended effects of LAs in pediatric patients. This study aims to assess dentists' knowledge of LA treatment protocols (e.g. dosage, complications), LA preference, experience with adverse events, and proficiency in managing anaphylactic attacks in pediatric patients.

MATERIAL AND METHODS

The ethical approval for the research was obtained from Selcuk University Faculty of Dentistry (Decision No: 2020/02, dated 13.02.2020). The digitally prepared questionnaire titled "Evaluation of the Knowledge Level of Dentists Regarding the Use of Local Anesthesia and its Unintended Effects in Pediatric Patients" was sent to participants via the Google Forms application. The volunteers participating in the study were evaluated anonymously, and no fee was requested from the participants. The questionnaire consisted of 16 questions. The first three questions represent "demographic" data, such as the age, gender, and title of the individuals filling out the questionnaire. The continuation of the questionnaire covers 13 questions related to local anesthesia application methods and complications (Table 1). The questions were prepared in multiple-choice or yes/no format. The survey was piloted on six dentists. Their feedback helped us to change some questions. Individuals who graduated from the dental faculty and voluntarily agreed to participate were included in the study. The participation period of the study was between 15.02.2020 and 03.11.2020.

The IBM SPSS 20.0 package program was used for statistical data analysis. Descriptive statistics were presented in terms of frequency and percentage values. Pearson's Chi-square Test or

Table 1. Survey Questions and Answers

QUESTIONS	ANSWERS
1-Gender?	**o Male** **o Female**
2-Age?	**o 23-30** **o 31-40** **o 41-50** **o 51 and over**
3-Title?	**o General Dentist** **o Pediatric Dentistry Resident** **o Pediatric Dentistry Specialist**
4-How many anesthetic syringes do you use maximum for local anesthesia in pediatric patients??	**o 1** **o 2** **o 3** **o 4**
5- Which local anesthetic do you most frequently use in the clinic?	**o Lidocaine+ Adrenaline** **o Articaine+ Adrenaline** **o Prilocaine** **o Others**
6-Do you aspirate before administering local anesthesia?	**o Yes** **o No**
7- Do you calculate the maximum local anesthetic dose/kg before administering in pediatric patients?	**o Yes** **o No**
8- Have you experienced any complications during local anesthetic applications?	**o Syncope** **o Needle breakage** **o Hematoma** **o Anaphylaxis** **o Facial Paralysis** **o Anesthetic insufficiency** **o Trismus** **o Others**
9- Do you inquire about any medication allergies your patient may have? *	**o Yes** **o No**
10- Do you ask your patient if she/he has had local anesthesia administered before?	**o Yes** **o No**
11- Do you perform a test dose of local anesthetic in your routine procedures?	**o Yes** **o No**
12- Have you experienced systemic toxicity due to local anesthetic administration?	**o Yes** **o No**
13- Which of the following symptoms would suggest systemic toxicity of local anesthetic?	**o Nausea-vomiting** **o Skin rash** **o Sweating** **o Hypotension** **o Respiratory distress**
14- Which of the following medications are available in your clinic?	**o Adrenaline** **o Antihistaminics** **o Steroids** **o Glucagon** **o Salbutamol**

15- Which is the first-choice medication for anaphylaxis?	**o Adrenaline** **o Antihistaminics** **o Steroids** **o Glucagon** **o Salbutamol**
16- Which route do you use for adrenaline injection?	**o Intramuscular** **o Intravenous** **o Subcutaneous** **o I do not know.**

Fisher's Exact Chi-square Test was used to compare variable groups. The significance level was accepted as α=0.05.

RESULTS

214 volunteer dentists, comprising 48 men and 166 women, participated in the study. 56% of the participants were general dentists (GD) (n = 120), 27% were pediatric dentistry residents (PDR) (n = 58), and 17% were pediatric dentistry specialists (PDS) (n = 36). The number of female participants in all groups was statistically significantly higher (GD: %68.3/31.7, PDR: %94.8/5.2, PDS: %80.6/19.4). The participants were divided into four age groups: 23-30, 31-40, 41-50, and ≥51. Their tenure was also categorized into 1-5 years, 6-15 years, and more than 16 years.

The comparison between groups regarding age and tenure revealed statistically significant differences ($p < 0.001$). The tenure of pediatric dentist specialists differed from that of other groups. Approximately 80% of specialists had a tenure of 6 years or more, while 87.5% of general dentists and 82.8% of residents had a tenure of at most five years.

Based on the survey results, the majority of participants preferred Articaine+Adrenaline (A+A) (64%) or Lidocaine+Adrenaline (L+A) (33%) for local anesthesia. (Figure 1). It was observed that there were proportional differences in the A+A preferences of dentists with different titles. Specifically, 82.8% of PDRs, 69.4% of PDSs, and 52.5% of GDs preferred A+A. Furthermore, the difference between the A+A preference of PDRs and GDs was found to be statistically significant ($p = 0.001$).

Most participants (60%) stated they used a maximum (max) of two ampoules of LAs for pediatric patients. This answer is not statistically significant between titles and groups. When asked about aspiration before local anesthesia, more than 90% of the participants reported that they aspirated. Again, the differences between titles and age groups regarding whether aspiration was performed before local anesthesia were not statistically significant.

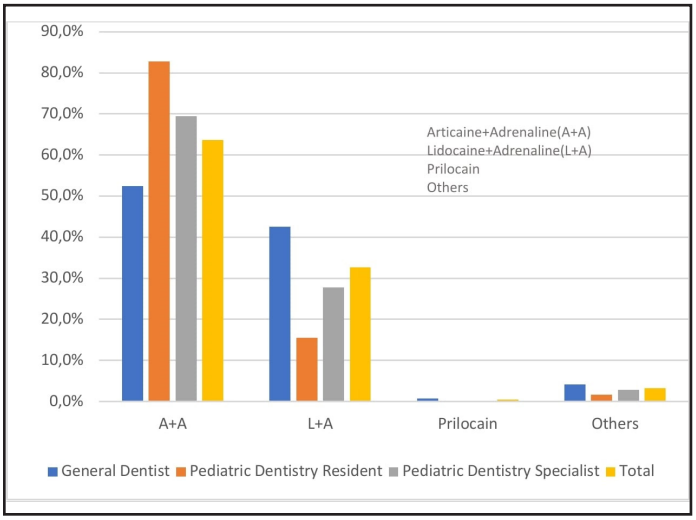

Figure 1. Local Anesthetics preference according to the titles

Most participants (74%) stated they did not calculate the dose per kilogram when performing local anesthesia. Response differences between all title groups were statistically insignificant ($p=0.138$). However, when we reduce the title groups to "PDS" and "Other Dentists," the difference between these two new groups becomes statistically significant, although it is very close to the limit value ($p = 0.047$). Accordingly, 39% of PDS state that they calculate the max dose per kilogram when applying local anesthesia to a pediatric patient, while this rate is 23% for other participants (Figure 2).

Most clinicians (96%) reported inquiring about drug allergies in patients before treatment. Participants were asked whether they question patients' previous local anesthesia experience, and 82% responded positively. The difference between dentists who asked their patients about their previous experience with local anesthesia was found to be statistically significant, with a p-value of 0.048. Interestingly, general dentists showed a 23% "No" response to this question, which was different from the responses

Table 2. Answers to the complications during local anesthesia applications.

Complications experienced during local anesthesia applications	The Whole Answers	PDS	PDR	GD
Anesthesia Failure	%73,0	%69,4	%86,2	%68,3
Facial paralysis	%25,6	%36,1	%36,2	%17,5
Syncope	%19,1	%25,0	%15,5	%19,2
Hematoma	%10,7	%25,0	%5,2	%9,2
Trismus	%5,1	%8,3	%5,2	%4,2
Emphysema	%0,9	-	-	%1,7
Angioedema on the lip	%0,5	%2,8	-	-
Urticaria	%0,5	%2,8	-	-
Short-term epileptic seizure-style convulsions	%0,5	%2,8	-	-
Redness	%0,5	-	%1,7	-
Paresthesia	%0,5	-	-	%0,8
Epileptic seizure	%0,5	-	-	%0,8
I did not experience any complications	%7,9	-	%3,4	%12,5

Pediatric Dentistry Specialists (PDS), Pediatric Dentistry Residents (PDR), General Dentists (GD)

of other groups (Figure 3).

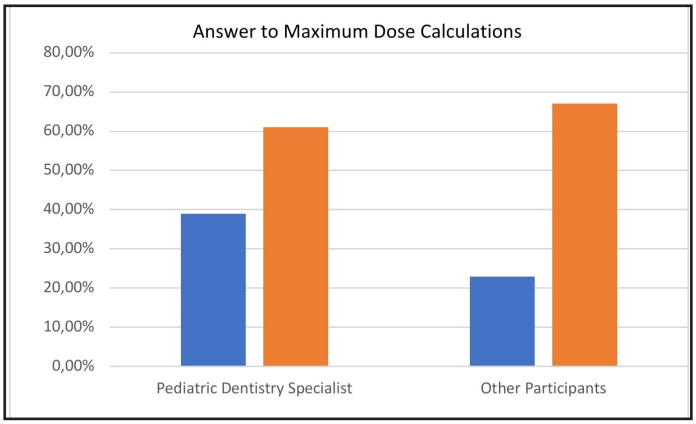

Figure 2. Answer to Maximum dose calculation rates for local anesthesia (p=0.047)

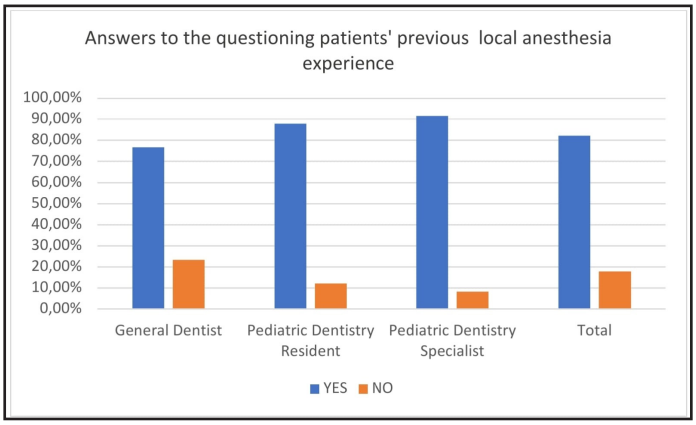

Figure 3. Answers to the questioning patients' previous local anesthesia experience (p=0.048).

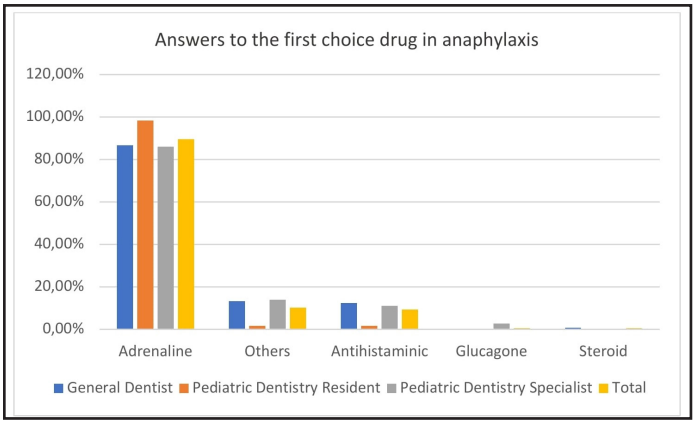

Figure 4. Answers to the first-choice drug in anaphylaxis (p=0.022)

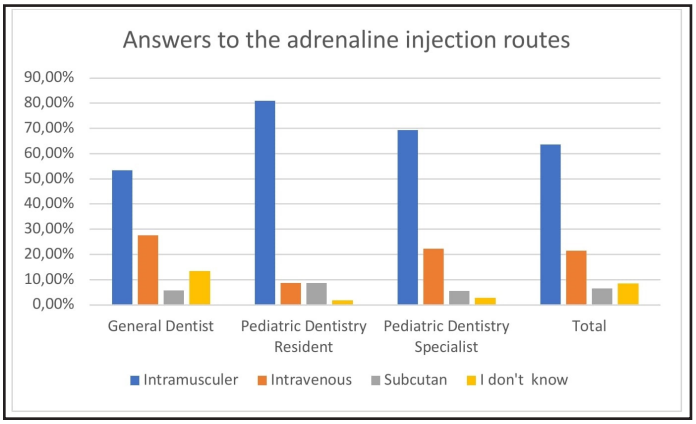

Figure 5. Answers to the adrenaline injection routes

Almost all (98%) participants answered 'No' to whether they performed LA test doses in their routine practice. Nearly all participants (99%) answered 'No' to the question about experiences with systemic toxicity due to LAs.

When asked about the first- line drug of choice for participants in anaphylaxis, the primary (90%) answer was 'adrenaline.' 10% of participants prefer different drugs as the first choice in anaphylaxis (9% Antihistaminic, 0.5% Glucagon, 0.5% Steroid). The preference for adrenaline was almost unanimous (98%) among PDR dentists, leading to a statistically significant difference in drug preference (p=0.022) (Figure 4).

When the question of what route they use for adrenaline, 63.6 % intramuscular (IM), 21.5 % intravenous (IV), and 6.5 % subcutaneous (SC), 8.4 of the participants marked the option of 'I do not know.'. Despite the IM response of 53.3 %of GD, PDR is 81.0 %, and PDS is 69.4 %. The difference between the answers given by dentists in different titles regarding the route used for adrenaline injection is statistically significant (p = 0.002). (Figure 5).

Participants were asked about the complications they encountered during local anesthesia applications. As a result of the answers, the three most common complications are anesthesia failure (73%), facial paralysis (26%) and syncope (19%). (Table 2) Another question asked what the symptoms suggestive of LA systemic toxicity were, and the answers were as follows: respiratory distress (72%), nausea-vomiting (69%), sweating (55%), hypotension (54%), and skin rash (40%). General dentists preferred the 'respiratory distress' most (76%), PDS preferred nausea and vomiting the most (72%), and likewise, PDR preferred nausea and vomiting the most (83%) (Figure 6).

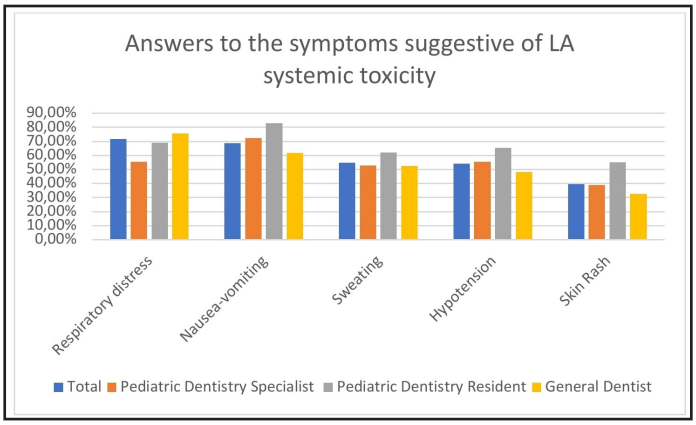

Figure 6. Answers to the symptoms suggestive of local anesthetic systemic toxicity

DISCUSSION

This survey study examined a group of Turkish dentists' knowledge of LA dosage, side effects, and managing side effects in pediatric patients.

A total of 214 volunteer dentists who are treating pediatric patients participated in our study. Bani-Hani et al. conducted a survey study to evaluate the use of LAs in pediatric dentistry. The study collected answers from 72 PDSs. The results showed that Lidocaine with 2% Adrenaline was the most used LA drug among the participants, with 72.2% of them using it. The second most frequently used drug was Articaine with 4% Adrenaline, used by 54.2% of the participants [11]. Ezzeldin et al [12], another survey study collected from 61 PDS, found that the most frequently used LAs were Lidocaine and Articaine. The reason for having more participants in our study might be due to the relatively fewer questions in our survey and the fact that we sent the survey to PDSs and dentists treating pediatric patients. In many studies, Articaine was found to be more effective than lidocaine in terms of anesthetic efficacy in dentistry [13, 14]. When the results found in our study are compared with the literature, it is like the results that Articaine is preferred more than Lidocaine. A reported study has found that newly qualified dentists more commonly use Articaine [15]. This may be due to the recent adoption of Articaine during undergraduate education in universities in Türkiye, as well as the fact that 82% of the participants in the study were between the ages of 23 and 30. Based on these results, it is seen that the differences in the guidelines adopted in different dental schools and in the professional periods between the dentists are effective in the selection of LAs. In a survey study, the maximum number of cartridges used by dentists was questioned, and it was reported that most dentists (87%) could not calculate the correct anesthetic dose [16]. In a survey conducted by Ngan et al., almost half of the respondents (49%) reported using full body weight to determine LA dosage. 44% of respondents reported using the estimated size of the patient, 2% the age of the patient, and 5% other methods such as 'one cartridge anesthetic dose to all patients [17]. In our study, 74% of the dentists surveyed do not calculate the dose per kilogram. The proportion of dentists who calculated the dose was 39% among PDS and 23% among other dentists. These results show similar results to other survey studies, revealing that dentists have insufficient knowledge about dose calculation when applying local anesthesia.

Baluga et al. reviewed 5018 case reports of dental treatment under local anesthesia. The study reported that local anesthesia-

related side effects were observed in only 25 cases (0.5%), and allergic reactions were observed in only two of these cases [18]. Cağıran et al. [19] reported that only one of 30 patients in whom allergy consultation was requested before intervention because of a history of atopic disease or drug allergy had a positive test result. Although rare in the literature, allergic reactions following LA injections may develop due to preservatives (methylparaben) or antioxidants (sulfites) in the solution [4]. If a patient describes a reaction that is at least clinically consistent with allergy, the dentist should refrain from using the offending substance until an allergist has assessed it. In this study, 96% of dentists stated that they asked their patients whether they had drug allergies before treatment. All PDS (100%), 97% of PDR, and 94% of GD responded positively to this question. Although cases of allergy due to local anesthesia are rare, it is essential to ask about allergy status during anamnesis before treatment, considering that complications that may develop may be fatal.

Aspiration before administration reduces the incidence of side effects of LAs. Accidental IV injection may cause acute overdose reactions [20]. According to Malamed, the inferior alveolar nerve block is the technique with the highest risk of positive aspiration [21]. Al-Wattar et al. [22] reported that 90% of the dentists participating in their survey study did not perform aspiration. Lipp et al. showed in their study that more than 60% of dentists were unaware of the toxicity that may occur due to positive aspiration [23]. This study found that 91% of dentists performed aspiration before LA applications. This higher aspiration rate than previous studies is due to dentists' increased knowledge and awareness.

In this study, the most common complication encountered by dentists was an anesthetic failure (73%). The causes of anesthesia failure include anesthetic technique and patient-specific factors. Failure to detect symptoms within 10-15 minutes after administration is considered anesthesia failure [24]. A double or bifid inferior alveolar nerve may be a possible cause of anesthetic failure [25]. Pulpitis or apical periodontitis can lead to anesthetic failure [26]. Infection lowers pH levels, affecting anesthetic dissociation, whereas inflammation heightens patient sensitivity by triggering a primary region of hyperesthesia [27]. According to Potonick and Bajrovic, inflammation causes anesthetic failure in 30-45% of cases, even when the technique is performed correctly [28]. Repeated anesthesia should be avoided in cases of inflammation and infection; repeated anesthetic applications may cause tachyphylaxis [29]. Many authors attribute the failure of LA to the need for more knowledge or experience from dentists. This situation can be prevented by correct anatomical knowledge and learning application techniques. In this study, most participants (73%) reported anesthetic failure. To solve this problem, dentists in Türkiye should be trained in anatomy and the correct application of LAs during their undergraduate and specialty education, and in-service training should be provided regularly throughout their careers.

LAs, frequently used in dentistry, account for most medical emergencies in the clinic. 70% of these are due to fear and stress, and 50% of the reported emergencies are syncope [21]. Das et al. [30] found 49% hematoma, 38% syncope, and 16% anesthetic failure as the most common complications after LA injection. According to the results of a study by Girdler and Smith, the most common emergency encountered by dentists was vasovagal syncope. Among the respondents, 63% reported that their patients had syncope in the last year [31]. In our study, syncope ranked third among the most common complications in the responses of PDS and PDR.GD reported syncope as the second most common complication. Although these results show a lower rate than previous studies, they clearly show that syncope is one of the most common complications.

Another complication frequently encountered by dentists in this study was facial paralysis. Temporary facial paralysis is usually caused by LA entering the capsule of the parotid gland at the posterior border of the mandibular ramus. Temporary facial paralysis after local anesthesia in this area will equal the duration of drug-related soft tissue anesthesia [32]. In this study, 26% of all dentists who participated encountered facial paralysis. The fact that facial paralysis, a preventable complication, occurs so frequently suggests that it is due to a lack of knowledge and attention.

In this study, dentists found trismus to be the fifth most common complication. The leading cause of trismus is trauma to muscles or blood vessels in the infratemporal space following dental anesthetic injections. This complication can be prevented by using short needles for posterior maxillary injections and avoiding multiple injections. Once acute trismus has developed, progression to chronic hypomobility can be prevented by a rapid treatment combination of heat, analgesics, muscle relaxants, and vigorous physiotherapy [33].

Adrenaline is the most essential drug in the treatment of

anaphylaxis. According to the guidelines published by the European Resuscitation Council (ERC) in 2015, side effects are rare when correct IM doses are used [34]. If the patient's condition does not improve within 5 minutes, the IM dose of adrenaline should be repeated. Dentists should be able to recognize and initiate the treatment of anaphylaxis. However, numerous studies in different countries show that most dentists cannot adequately identify and treat anaphylaxis [35]. In developed countries, the incidence of anaphylactic reactions to local anesthesia following dental procedures ranges from 1 in 3,500 to 1 in 13,000 [36]. Although rare, dentists should have the necessary knowledge and equipment to manage allergic reactions, as the consequences can be severe. In a study conducted by Krishnamurthy et al., it was learned that only 62% of dentists had emergency medicine kits in their clinics. According to the results, although 68% of dentists knew that epinephrine was the preferred treatment option for anaphylaxis, only 28% were aware of the route of administration [37]. In our study, 90% of the dentists who were asked about the first drug they would prefer in anaphylaxis answered adrenaline. When asked about the route they used for adrenaline injection, the majority (64%) responded intramuscularly. These results are also compatible with the literature.

The responses to the symptoms suggestive of LA systemic toxicity in our study were respiratory distress (72%), nausea and vomiting (69%), sweating (55%), hypotension (54%), and skin rash (40%). In a study of 593 cases of anaphylaxis, the most common symptoms were urticaria and angioedema (87%), shortness of breath/wheezing (59%), and hypotension (33%) [38]. Mortality in anaphylaxis most commonly occurs due to respiratory failure or cardiovascular collapse [39].

CONCLUSION

Although anaphylaxis during dental procedures is rare, it can lead to severe complications that may even result in death. Therefore, it is crucial for dentists to be familiar with the signs of systemic complications that may arise from using LAs. If such findings are encountered after anesthesia, it should be considered that a systemic complication may have occurred, and urgent intervention should be performed without any delay to prevent consequences that may threaten the patient's life. This subject is of critical importance in dentistry and should be emphasized more in undergraduate and postgraduate education, with further training courses provided to update the knowledge of dentists.

This study was presented as an oral presentation at the 2nd NEU International Dentistry Congress held in Konya on 1-3 October 2022 (https://www.erbakan.edu.tr/en/dishekimligi/haber/500254/2-uluslararasi-dis-hekimligi-kongresi-ve-fuari).

Conflict of interest: The authors deny any conflicts of interest related to this study.

Informed Consent: Informed consent form was obtained from the participants.

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Ethical Approval: The ethical approval for the research was obtained from Selcuk University Faculty of Dentistry (Decision No: 2020/02, dated 13.02.2020).

Author Contributions:

Şükran ÖZ: Data Collection (%40) Data Analysis (%40).

Funda ARUN: Design of the Study | Study Design (%100) Data Collection (%60) Data Analysis (%60) Writing the Article | Writing (%50) / Article Submission and Revision (%50).

Enes Mustafa AŞAR: Writing the Article | Writing (%50) Submission and Editing (%50) .

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