Assessing Dental Students' Awareness of Anaphylactic Shock Caused by Local Anesthetic Injection

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Submitted to: JMIR Medical Education
on: June 09, 2024

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Abstract

Background: Anaphylaxis, a severe allergic reaction with rapid onset and multi-organ involvement, can be fatal. It may occur after local anesthetic injection and is a major risk factor for dental emergencies. Healthcare professionals must be aware of prompt diagnosis and management. Antibiotics, chlorhexidine, iodoform, and latex can also cause anaphylaxis less frequently. Anaphylactic shock is a critical clinical manifestation in daily dental practice, and some dental students lack the knowledge to accurately treat patients in emergency situations.

Objective: Aim: This study investigates the awareness of dental students from Isfahan University of Medical Sciences regarding anaphylactic shock caused by local anesthetic injection during their last two years of study.

Methods: This descriptive-analytical and cross-sectional study was conducted after registration in the council of Isfahan University of Medical Sciences and obtaining the code of ethics on all students of the last two years of dentistry of Isfahan University in 2023. The inclusion criteria of the study were the students of the last two years of general dental doctorate. Those who did not want to cooperate and incompletely filled the questionnaire were excluded from the study. In order to check the questionnaires, the answers were calculated as signs and symptoms, anaphylaxis and epinephrine administration. Answers were distributed individually. The experience status was also in the form of 3 questions, and the frequency of each answer was reported. The marks of each field were assigned as correct answer (score=1) and wrong answer (score=0). Then demographic information including gender, age, experience and knowledge score regarding epinephrine and anaphylaxis was analyzed using SPSS version 26 software.

Results: There is no difference between the level of knowledge of students in terms of gender, age and year of entry. Regarding the level of awareness of students regarding the administration of epinephrine in anaphylaxis, the research participants were only aware of the fact that epinephrine is kept in their department. And there was no difference between gender, age and entry year of students in terms of knowledge of epinephrine administration at the time of anaphylaxis reaction. However, students at the ages of 23 and 27 had a higher level of awareness than other age groups.

Conclusions: Conclusion: Most of the students had a high level of awareness of the signs and symptoms of anaphylactic reaction caused by the injection of local anesthetics, and none of the demographic variables (gender, age, and year of admission) had an effect on the level of awareness of the students in the field of signs and symptoms.

Conclusion: Most of the students had a high level of awareness of the signs and symptoms of anaphylactic reaction caused by the injection of local anesthetics, and none of the demographic variables (gender, age, and year of admission) had an effect on the level of awareness of the students in the field of signs and symptoms.

(JMIR Preprints 09/06/2024:63073)
DOI: https://doi.org/10.2196/preprints.63073

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Assessing Dental Students' Awareness of Anaphylactic Shock Caused by Local Anesthetic Injection

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Abstract

Background: Anaphylaxis, a severe allergic reaction with rapid onset and multi-organ involvement, can be fatal. It may occur after local anesthetic injection and is a major risk factor for dental emergencies. Healthcare professionals must be aware of prompt diagnosis and management. Antibiotics, chlorhexidine, iodoform, and latex can also cause anaphylaxis less frequently. Anaphylactic shock is a critical clinical manifestation in daily dental practice, and some dental students lack the knowledge to accurately treat patients in emergency situations.

Aim: This study investigates the awareness of dental students from Isfahan University of Medical Sciences regarding anaphylactic shock caused by local anesthetic injection during their last two years of study.

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the questionnaires, the answers were calculated as signs and symptoms, anaphylaxis and epinephrine administration. Answers were distributed individually. The experience status was also in the form of 3 questions, and the frequency of each answer was reported. The marks of each field were assigned as correct answer (score=1) and wrong answer (score=0). Then demographic information including gender, age, experience and knowledge score regarding epinephrine and anaphylaxis was analyzed using SPSS version 26 software.
Results: There is no difference between the level of knowledge of students in terms of gender, age and year of entry. Regarding the level of awareness of students regarding the administration of epinephrine in anaphylaxis, the research participants were only aware of the fact that epinephrine is kept in their department. And there was no difference between gender, age and entry year of students in terms of knowledge of epinephrine administration at the time of anaphylaxis reaction. However, students at the ages of 23 and 27 had a higher level of awareness than other age groups.
Conclusion: Most of the students had a high level of awareness of the signs and symptoms of anaphylactic reaction caused by the injection of local anesthetics, and none of the demographic variables (gender, age, and year of admission) had an effect on the level of awareness of the students in the field of signs and symptoms.
Keywords: anaphylactic shock, allergy, local anesthetics

Introduction

Anaphylaxis is a type of acute allergic reaction that can be life-threatening, rapidly onset, and sometimes fatal due to the rapid release of inflammatory mediators that involve multiple organs (1). Although anaphylaxis is infrequent during dental procedures, its onset can trigger swift and progressive manifestations that include upper airway obstruction, dyspnea, cardiovascular collapse, and cardiac arrest. Consequently, a prompt and decisive response becomes imperative for effective life-saving interventions. Thus, in the event that anaphylaxis arises within a dental clinic, immediate identification and treatment are paramount (2). Anaphylaxis represents a significant hazard for medical emergencies in dental practices, necessitating a thorough understanding and timely intervention from all healthcare providers. Regrettably, numerous dental students lack proficiency in accurately addressing emergency situations involving their patients. Given the rising incidence of anaphylaxis in recent years, it is imperative to enhance education and knowledge regarding this specific emergency among dental students. They should possess comprehensive awareness of the symptoms, diagnosis, and appropriate treatment modalities to effectively manage such cases (3). Multiple studies conducted across various countries have documented the occurrence rates of anaphylactic reactions caused by local anesthetics, ranging from 1 in 3500 to 1 in 20000 cases. Furthermore, the prevalence of such reactions during dental treatments has been reported to range between 5 and 15 cases per 100,000 individuals in certain studies (4, 5). Across the majority of studies, the occurrence of anaphylactic shock was found to be more prevalent among women compared to men(6). Anaphylaxis can be attributed to various triggers, such as antibiotics, chlorhexidine, local anesthetics, general anesthesia, latex, toothpaste, and iodoform(7). In the field of dentistry, amoxicillin, phenoxymethylpenicillin, and metronidazole are commonly used antibiotics. Tragically, there have been documented cases of fatal anaphylactic reactions specifically associated with amoxicillin. Antibiotics are recognized as the primary cause of postoperative anaphylaxis in the United Kingdom, constituting approximately 50% of reported cases, with an incidence rate of 4.0 per 100,000 administrations(8). Chlorhexidine, a highly efficient disinfectant extensively utilized in dentistry, is a prevalent component in various dental products like mouthwashes, toothpaste, and dental implants. Despite its effectiveness, there is a growing global incidence of anaphylactic reactions associated with chlorhexidine(9). The occurrence of anaphylaxis in response to anesthetics

is a frequent phenomenon, with multiple cases documented within oral surgery settings(10). The prevalence of latex allergy has experienced a rise in the early 2000s primarily attributed to the expanded utilization of latex gloves in healthcare environments. However, there has been a subsequent decline in recent years (9). Globally, the average rates of latex allergy prevalence have been reported as 9.7% among healthcare workers, 7.2% among susceptible patients, and 4.3% in the general population(9, 11). Iodoform is an ingredient found in various endodontic products, including Alvogyl. The product information for Alvogyl explicitly advises against its usage in patients with a documented allergy to procaine-type anesthetics (such as Novocaine), iodine, or iodine-related compounds. Remarkably, a single case has been identified where two incidents of anaphylaxis associated with Alvogyl have been reported(12).

In order to effectively treat and manage anaphylactic shock, guidelines have been proposed outlining a series of critical steps that can potentially save the patient's life. These steps include:

1. Promptly discontinuing the administration of the suspected causative drug.
2. Seeking immediate assistance from healthcare professionals.
3. Employing intubation and mechanical ventilation with 100% oxygen to ensure proper respiratory support.
4. Maintaining appropriate intravascular volume by administering 10-20 cc/kg of Ringer's lactate or normal saline, repeating as necessary.
5. Administering epinephrine from a 1:10000 solution at a dosage of 0.1-0.05 mg/kg, with the option to repeat the dose and initiate an infusion if required.
6. Utilizing salbutamol and aminophylline to alleviate bronchospasm.
7. Administering steroids to help mitigate the inflammatory response.
8. Employing H1 and H2 blockers to counteract the effects of histamine release.
9. Ensuring constant monitoring of respiratory and cardiac functions, while addressing and correcting any acid-base imbalances.

By following these crucial steps, healthcare providers can effectively manage anaphylactic shock and optimize patient outcomes(13). Epinephrine has been established as the preferred first-line treatment for anaphylaxis, as evidenced by historical reports. Its therapeutic efficacy is contingent upon the clinical response observed in patients, demonstrating the enduring recognition of this drug's significance in managing anaphylactic reactions. The administration of epinephrine via subcutaneous or intramuscular injection is advised, with no discernible distinction between the two routes. However, intramuscular injection has been reported to achieve the desired blood concentration more rapidly, making it the recommended route. In adult patients, the initial dose of epinephrine is typically 0.2 mL to 0.5 mL of a 1:1000 (w/v) diluted solution, to be administered via intramuscular or subcutaneous injection(14). The most suitable site for administering intramuscular injections of epinephrine is the vastus lateralis muscle. Multiple studies suggest that injecting epinephrine in the lateral part of the thigh, using the intramuscular route, is the preferred choice over subcutaneous or intravenous injection(15, 16).

Anaphylaxis represents a critical medical condition frequently encountered in day-to-day clinical practice, yet dental students often lack the necessary knowledge and skills to effectively manage such emergencies. Therefore, it is crucial to enhance their education and understanding of anaphylaxis, including its symptoms, diagnosis, and treatment (3). Interestingly, approximately 69% of dental students prioritize the use of epinephrine as the initial treatment option for anaphylaxis (17). Notably, a mere 4% of dentists and dental staff opt for oral steroids to address adverse anaphylactic reactions, indicating a potential lack of awareness in 94% of cases regarding the use of steroids following epinephrine administration. Furthermore, the majority of dentists who encounter patients with anaphylaxis in their dental clinics appear to lack awareness regarding the urgency of this condition, resulting in an upward trend of anaphylaxis incidents within this field in recent years (18). Consequently, enhancing dentists' awareness and mindset regarding the importance of anaphylaxis

can play a vital role in timely diagnosis, preventing patient exposure to risks, and avoiding unnecessary expenses.

Materials and method

This descriptive cross-sectional study was conducted on dental students in their final two years of study at Isfahan University of Medical Sciences in 2023. The inclusion criteria comprised students enrolled in the last two years of their general dental doctorate program, while individuals who did not cooperate or left the relevant questionnaire incomplete were excluded from the study. All participants provided written informed consent for their involvement in the study, in accordance with the Declaration of Helsinki. The study protocol was approved by the Institutional Review Board (IRB) of Isfahan University of Medical Sciences (Approval No.: IR.MUI.DHMT.REC.1402.076. (
To assess the questionnaires, responses were analyzed based on signs and symptoms, anaphylaxis, and epinephrine administration. Each answer was evaluated individually. The students' level of experience was also examined through three specific questions, and the frequency of each response was documented. Scores were assigned to each category, with correct answers receiving one point and incorrect answers receiving zero points. Subsequently, demographic information, including gender, age, experience, and knowledge scores regarding epinephrine and anaphylaxis administration, was analyzed using SPSS version 26 software (IBM Corp., Armonk, N.Y., USA).
A survey consisting of 17 questions was administered to a sample of 200 students. The questionnaire encompassed various aspects, including demographic information, anaphylaxis reaction-related inquiries (questions 1-7), epinephrine administration (questions 8-12), signs and symptoms (questions 13-14), and experience status (questions 15-17). Participants were instructed to complete the questionnaire at their own pace, without any time constraints. Clear instructions were provided to ensure proper completion, and the researcher was available to address any questions or concerns. Upon completing the questionnaire, participants were furnished with a brochure containing an anaphylaxis management plan guide, which included the correct answers to the questions. The questionnaire design drew inspiration from the study conducted by Baccioglu et al. (19), and the responses provided by the students were recorded and categorized based on the specific objectives of each question.
The content validity of the questionnaire was assessed by gathering opinions from eight dentists in Isfahan and calculating both the content validity index (CVI) and the content validity ratio (CVR). Each question was evaluated based on the responses provided by the eight experts, and the minimum acceptable values for CVI and CVR were determined to be 0.79 and 0.78, respectively. These values were met and confirmed for each question, ensuring content validity.
The reliability of the questionnaire was evaluated using two methods: Amon's test and Cronbach's alpha. For the Amon's test, 20 questionnaires were distributed to a single group on two separate occasions, and the scores obtained from each test were compared. The correlation coefficient between the scores of each question from the two administrations was individually examined and validated. Additionally, reliability was assessed using Cronbach's alpha, resulting in a reliability measurement of 0.627.

Results

A total of 206 participants were included in this study, and the distribution of participant frequencies based on gender, age, and year of entry is presented in Table 1. Out of the total participants, 115 were female, while 91 were male. The age range of the participants spanned from 23 to 27 years, with the highest frequency observed at 24 years, accounting for 22.8% of the participants. The year of university entry for the participants was predominantly in 2017 (106 participants) and 2018 (100 participants).

Table 1. Demographic information of participants

	Numbe r	Frequency percentage

Gender	**Female**	115	55.8
	Male	91	44.2
Age	**23**	44	21.4
	24	47	22.8
	25	39	18.9
	26	35	17.0
	27	41	19.9
Year of entry	**2017**	106	51.5
	2018	100	48.5
Total		206	100

Table 2 presents an analysis of the awareness levels among final two-year dental students at Isfahan University of Medical Sciences regarding the occurrence of anaphylaxis resulting from local anesthetic injections. The table provides a detailed breakdown of scores for each component.

Table 2. a comprehensive overview of the components associated with the awareness level of the research participants concerning anaphylaxis resulting from local anesthetic injections.

Section	Number	Mean	Standard deviation	Minimum	Maximum
Anaphylaxis reaction	206	4.04	1.37	0	7
Epinephrine administration	206	2.17	1.16	0	5
Signs and symptoms	206	1.50	0.58	0	2
Total	206	7.71	3.13	1	13

As depicted in Table 2, the "anaphylaxis reaction" section yielded an average score of 4.04. The highest score recorded in this area was seven, while the lowest score obtained was zero. Moving to the "Epinephrine Prescription" section, the average score was 2.17, with the highest score achieved being five and the lowest score remaining at zero. In the "Symptoms and Signs" section, the average score was 1.50, with the highest score reaching two, and the lowest score once again remaining at zero. Overall, the average knowledge level among the participating students was 7.71. The highest score attained by a student was 13, while the lowest score recorded was one.

Table 3 illustrates the distribution of answer frequencies for questions related to the topic of anaphylactic reactions resulting from local anesthetic injections. The data reveals that the majority of students demonstrated awareness of only three specific questions: "Do you inquire about a patient's history of receiving local anesthesia prior to dental procedures?", "What guidance would you provide to a patient experiencing an anaphylactic reaction?", and "Do you believe allergies can be life-threatening?". However, the students displayed limited awareness regarding the remaining four questions pertaining to anaphylaxis reactions caused by local anesthetic drugs.

Table 3. the level of awareness of dental students of the last two years of Isfahan University of Medical Sciences regarding the anaphylaxis reaction caused by the injection of local anesthetic drugs

Questions		Correct answer	False answer
Before starting work, do you ask your patient about the history of prescribing local anesthesia for any dental procedure?	Number	179	27
	Percentage	86.9	13.1
If you suspect anaphylaxis, do you prescribe epinephrine for the patient?	Number	82	124
	Percentag	39.8	60.2

	e		
What is the first intervention in the treatment of anaphylaxis?	Number	58	148
	Percentage	28.2	71.8
What advice do you have for a patient who has an anaphylactic reaction?	Number	122	84
	Percentage	59.2	40.8
How long the patient should be followed up after the anaphylaxis reaction?	Number	91	115
	Percentage	44.2	55.8
Which drug is the first step in the treatment of a person suffering from anaphylaxis?	Number	99	107
	Percentage	48.1	51.9
Do you think allergies can be life threatening?	Number	201	5
	Percentage	97.6	2.4

Based on the findings presented in Table 6-4, it can be observed that the average knowledge level of female students regarding anaphylaxis reactions caused by local anesthetic injections is slightly higher than that of male students (4.11 compared to 3.95). However, statistical analysis indicates that this difference is not statistically significant (P=0.347). Furthermore, the average knowledge level of students aged 23 years and 27 years is higher compared to students of other age groups (4.45 and 4.24, respectively). Nonetheless, the statistical analysis reveals that the difference between these averages is not statistically significant (P=0.068). In terms of the year of entry, the average knowledge level of students who entered in 2017 is marginally higher than that of students who entered in 2018 (4.05 compared to 4.03). However, statistical analysis indicates that this difference is not statistically significant (P=0.942).

Table 4. The level of awareness regarding anaphylaxis reactions resulting from local anesthetic injections among dental students in their final two years at Isfahan University of Medical Sciences was examined in relation to various demographic variables.

Demographic variable		Mean	Standard deviation	P-value
Gender	Female	4.11	1.38	0.347*
	Male	3.95	1.36	
Entering year	2017	4.05	1.39	0.942*
	2018	4.03	1.35	
Age	23	4.45	1.30	0.068**
	24	3.64	1.32	
	25	4.05	1.31	
	26	3.80	1.38	
	27	4.24	1.42	

* U-Man Whitney

** Kruskal-Wallis test

Table 5 provides a comprehensive overview of the frequency distribution of answers to questions pertaining to the administration of epinephrine in cases of anaphylaxis resulting from local anesthetic injections. The data presented in this table indicates that the majority of students demonstrated awareness solely regarding the question, "Do you store epinephrine medication in your department?" Conversely, when it came to the other questions, the students provided incorrect responses.

Table 5. The level of awareness of dental students of the last two years of Isfahan University of Medical Sciences regarding the administration of epinephrine in anaphylaxis caused by the injection of local anesthetic drugs.

Questions		Correct answer	False answer
What is the recommended method for administering epinephrine as a first-line drug for anaphylaxis?	Number	77	129
	Percentage	62.6	37.4
What concentration is used for intramuscular administration of epinephrine?	Number	58	148
	Percentage	28.2	71.8
Which area of the body is recommended for intramuscular injection of epinephrine?	Number	74	132
	Percentage	35.9	64.1
How many times can epinephrine be repeated?	Number	100	106
	Percentage	48.5	51.5
Do you store epinephrine medication in your department?	Number	138	68
	Percentage	67.0	33.0

According to the findings illustrated in Table 6-4, it can be observed that the average knowledge level of male students regarding the administration of epinephrine in anaphylaxis resulting from local anesthetic injections is slightly higher than that of female students (2.19 compared to 2.16). However, statistical analysis reveals that this difference is not statistically significant (P=0.743). Furthermore, students aged 25 and 27 exhibit a higher level of knowledge compared to students in other age groups (2.36 and 2.32, respectively). Nevertheless, statistical analysis indicates that the difference in knowledge level among these age groups is not statistically significant (P=0.056). Regarding the year of entry, the average knowledge level among students who entered in 2017 is slightly higher than that of students who entered in 2018 (average 2.22 compared to average 2.12). However, statistical analysis reveals that this difference is not statistically significant (P=0.523).

Table 6. The level of awareness of the dental students of the last two years of Isfahan University of Medical Sciences regarding the administration of epinephrine in anaphylaxis caused by the injection of local anesthetics by demographic variables

Demographic variable		Mean	Standard deviation	P-value
Gender	Female	2.16	1.12	0.743*
	Male	2.19	1.21	
Entry year	2017	2.22	1.19	0.523*
	2018	2.12	1.14	
Age	23	2.41	1.22	0.056**
	24	1.83	0.91	
	25	2.36	1.32	
	26	1.94	1.23	
	27	2.32	1.05	

* U-Man Whitney
** Kruskal-Wallis test

Table 7 presents a detailed frequency distribution of answers to questions pertaining to the topic of signs and symptoms in anaphylaxis resulting from the administration of local anesthetics. The data

from this table clearly indicates that the majority of students have awareness regarding both the questions related to signs and symptoms in anaphylaxis caused by the injection of local anesthetic drugs.

Table 7. The level of awareness of dental students of the last two years of Isfahan University of Medical Sciences regarding the signs and symptoms of anaphylaxis caused by the injection of local anesthetic drugs.

Questions		Correct answer	False answer
A 30-year-old female patient with a history of allergy to local anesthesia developed hives and angioedema after the injection of local anesthesia that was prescribed to her during dental treatment about an hour ago. Blood pressure, pulse, breathing and examinations of other systems are normal; Do you think the diagnosis is anaphylaxis?	Number	124	82
	Percentage	60.0	39.8
How do you diagnose anaphylaxis?	Number	186	20
	Percentage	90.3	9.7

Table 8 provides a comprehensive examination of the awareness levels among the research participants pertaining to the signs and symptoms associated with anaphylaxis resulting from the injection of local anesthetic drugs. The data presented in this table is categorized based on various demographic variables, allowing for a thorough analysis of the participants' knowledge in relation to their respective demographic characteristics.

Table 8. The level of awareness of the dental students of the last two years of Isfahan University of Medical Sciences regarding the signs and symptoms of anaphylaxis caused by the injection of local anesthetic drugs according to demographic variables

Demographic variable		Mean	Standard deviation	P-value
Gender	Female	1.50	0.56	0.874*
	Male	1.51	0.60	
Entering year	2017	1.50	0.59	0.933*
	2018	1.51	0.57	
Age	23	1.59	0.58	0.100**
	24	1.40	0.57	
	25	1.56	0.64	
	26	1.37	0.49	
	27	1.59	0.59	

* U-Man Whitney

** Kruskal-Wallis test

According to the findings presented in Table 8, it is evident that the average knowledge level of male students regarding the signs and symptoms of anaphylaxis resulting from the injection of local anesthetic drugs is slightly higher than that of female students (1.51 compared to 1.50). However, statistical analysis reveals that this difference is not statistically significant (P=0.874). Furthermore, students aged 23 and 27 exhibit a higher average awareness level compared to students in other age groups (both with an average of 1.59). Nevertheless, statistical analysis indicates that there is no significant difference between these averages based on age (P=0.100). Regarding the year of entry, the average knowledge level among students who entered in 2018 is marginally higher than that of students who entered in 2017 (1.51 compared to 1.50). However, statistical analysis reveals that this difference is not statistically significant (P=0.933).

Table 9 provides a detailed breakdown of the frequency distribution of responses to questions related

to experiences with anaphylaxis resulting from the injection of local anesthetic drugs. The data presented in this table reveals several noteworthy findings. Among the female students, it is evident that only six individuals have encountered cases of anaphylaxis. Among them, five students have encountered one patient each, while one student has encountered two patients. Additionally, only one female student reported treating a patient suffering from anaphylaxis. Similarly, among the male students, six individuals have experienced anaphylaxis cases, with each of them encountering one patient. Furthermore, two male students reported treating patients with anaphylaxis. In terms of the year of entry, among the incoming students of 2017, nine individuals have encountered patients with anaphylaxis. Among them, eight students have encountered one patient each, while one student has encountered two patients. Additionally, two students have reported treating a patient with anaphylaxis. Among the incoming students of 2018, three individuals have encountered a patient with anaphylaxis, with each of them encountering one patient. However, only one student attempted to treat the patient.

Table 9. The experience of dental students in the last two years of Isfahan University of Medical Sciences regarding anaphylaxis caused by injection of local anesthetics by gender and age groups

Demographic variable		**Have you ever encountered a patient with anaphylaxis?**				**If yes, how many patients have you encountered?**		**Have you ever treated a patient with anaphylaxis?**			
		Yes		No		Number		Yes		No	
		Number	Frequency (%)	Number	Frequency (%)	1	2	Number	Frequency (%)	Number	Frequency (%)
Gender	Female	6	5.2	109	94.8	5	1	1	0.9	114	99.1
	Male	6	6.6	85	93.4	6	-	2	2.2	89	97.8
Entry year	2017	9	8.5	97	91.5	8	1	2	1.9	104	98.1
	2018	3	3.0	97	97.0	3	-	1	1.0	99	99.0
Age	23	2	4.5	42	95.5	2	-	0	0.0	44	100
	24	1	2.1	46	97.9	1	-	1	2.1	46	97.9
	25	4	10.3	35	89.7	4	-	2	2.6	38	97.4
	26	3	8.6	32	91.4	3	-	1	2.9	34	97.1
	27	2	4.9	39	95.1	1	1	0	0.0	41	100

Based on the findings presented in Table 10, it is evident that the average awareness level of female students regarding the occurrence of anaphylaxis resulting from the injection of local anesthetic drugs is slightly higher than that of male students, with scores of 7.77 compared to 7.64. However, statistical analysis reveals that this difference is not statistically significant (P=0.892). Furthermore, the average awareness level varies significantly among students of different age groups (P=0.002). Notably, students aged 23 and 27 exhibit a higher average awareness level compared to students in other age groups, with scores of 8.45 and 8.15, respectively. Regarding the year of entry, the average knowledge level among students who entered in 2017 is slightly higher than that of students who entered in 2018, with scores of 7.76 compared to 7.66. However, statistical analysis reveals that this difference is not statistically significant (P=0.982).

Table 10. comprehensive average awareness levels of dental students from the last two years at Isfahan University of Medical Sciences concerning anaphylaxis resulting from the administration of local anesthetic drugs, analyzed in relation to various demographic

Demographic variable		**Mean**	**Standard deviation**	**P-value**
Gender	Female	7.77	2.14	0.892*
	Male	7.64	2.11	
Entry year	2017	7.76	2.08	0.982*

	2018	7.66	2.18	
Age	23	8.45	2.05	0.002**
	24	6.87	1.90	
	25	7.97	2.26	
	26	7.11	2.02	
	27	8.15	2.04	

* U-Man Whitney
** Kruskal-Wallis test

Discussion

The findings of this study demonstrated that the students displayed a heightened awareness regarding anaphylactic reactions associated with the administration of local anesthesia during dental procedures. Specifically, they exhibited greater knowledge concerning the patients' history of receiving local anesthesia, providing advice about anaphylactic reactions, and recognizing the risks of allergies. Interestingly, no significant difference was observed between the knowledge levels of male and female students in this regard. Furthermore, the analysis revealed no discernible variation in the students' knowledge based on age or year of entry.

In accordance with the findings of the present study, Baccioglu et al. (2021) reported that nearly all participants recognized that allergies can potentially pose life-threatening risks. This agreement between the current study and the research conducted by Baccioglu et al. indicates a consistent acknowledgement of the severe nature of allergic reactions(19).

Insufficient awareness among dental students regarding anaphylactic reactions following local anesthesia can be attributed to various factors, including gaps in the curriculum, inadequate practical training, and limited interdisciplinary collaboration. The findings of the present study indicate that participants were primarily aware of the presence of epinephrine in their department, but lacked comprehensive knowledge about its administration during anaphylactic reactions. Analysis of demographic variables revealed no significant differences in awareness of epinephrine administration based on gender, age, or year of entry.

These results align with a study conducted by Fakheri et al. (2017), which examined the knowledge level of assistants and pediatric specialists in teaching hospitals affiliated with Tehran University of Medical Sciences. The study found that pediatric specialists and residents lacked knowledge regarding the correct dosage, administration method, and appropriate discharge time for patients with anaphylaxis (20). This suggests that theoretical training alone may not sufficiently prepare pediatric assistants to deliver effective clinical care. These findings are consistent with the results of the present study.

However, other studies have reported different results regarding awareness of epinephrine administration during anaphylaxis. Nekourad et al. (2014) investigated the awareness level of dentists in Ahvaz regarding anaphylactic shock caused by the injection of local anesthetic drugs. They found that more than half of the dentists chose epinephrine as the first-line treatment for anaphylactic shock. However, only 28% of the dentists selected the intramuscular route for epinephrine administration (21). Umair et al. (2023) examined the knowledge and attitudes of Pakistani dentists and reported that few had experience in response management. While 75% of dental surgeons were aware of emergency medicine, approximately 40% possessed emergency kits in their clinics and were knowledgeable about their usage (4). Maqbool et al. (2023) investigated awareness and attitudes towards anaphylactic reactions associated with local anesthesia among dentists in Rawalpindi. They found that most dentists kept emergency medications such as epinephrine, antihistamines, corticosteroids, glucagon, and albuterol. Furthermore, 79.7% agreed that epinephrine was the drug of choice and should be administered intramuscularly (22). These results differ from the findings of the present study.

The lack of knowledge among some students regarding the use of epinephrine as a treatment for

anaphylaxis can be attributed to several factors, including knowledge gaps, limited practical experience, insufficient communication and collaboration among students to share information and stay updated on the latest treatment protocols.

The findings of this study demonstrate that the majority of dental students exhibited a notable level of awareness regarding the signs and symptoms associated with anaphylactic reactions resulting from the administration of local anesthetic drugs. Furthermore, the demographic variables, namely gender, age, and year of entry, did not have a significant impact on the students' awareness level concerning these signs and symptoms. This aligns with the results reported by Umair et al. (2023), where most participants were knowledgeable about one or more symptoms related to anaphylaxis, although none of them claimed to be aware of all the symptoms (4). In contrast, the research conducted by Fakheri et al. (2017) indicated that approximately 23.4% of the respondents provided incorrect answers to questions pertaining to anaphylaxis symptoms and signs (20), which differs from the findings of the present study.

Having a comprehensive understanding of the signs and symptoms of anaphylaxis holds significant importance for dental students for several reasons. Firstly, local anesthetics are commonly employed in dental procedures and can induce anaphylaxis in susceptible individuals. Acquiring knowledge about the signs and symptoms enables students to promptly identify emergency situations and take appropriate measures to ensure patient safety. Secondly, anaphylactic reactions can rapidly escalate and pose life-threatening risks if not promptly managed. Given the significance of this topic within the curriculum, students are encouraged to possess adequate knowledge in this domain. By being aware of the signs and symptoms, dental students can initiate immediate emergency actions, such as seeking assistance, administering epinephrine if necessary, and activating emergency medical services. This swift response can enhance patients' survival prospects and minimize adverse effects. Additionally, dentists bear the responsibility of providing comprehensive care to their patients, which encompasses preparedness to handle medical emergencies like anaphylaxis. A thorough understanding of the signs and symptoms equips dental students to foster a safe office environment and deliver improved patient care.

Moreover, within the context of the aforementioned study units, it is noteworthy that male and female students encountered patients with anaphylactic reactions to a similar extent. Among the female students, only one individual treated a patient, while two male students attended to a patient experiencing an anaphylactic reaction. Additionally, incoming students from 2017 encountered and managed more patients with anaphylactic reactions compared to their counterparts from 2018. Among students of different age groups, it was observed that, except for 23-year-old students, all other age groups had encountered at least one patient with an anaphylactic reaction.

In conclusion, the current study's results indicate that there were no significant disparities in the overall level of awareness between male and female students, as well as students from 2017 and 2018. However, 23- and 27-year-old students exhibited a higher level of awareness compared to other age groups. These findings are consistent with the results of Nekourad et al.'s study (2014), which revealed no significant relationship between dentists' gender, work experience, academic rank, and their awareness of anaphylactic shock symptoms (21).

Considering the infrequent occurrence of anaphylaxis in routine dental practice and the limited work experience of students, they may not give adequate attention to this issue. Furthermore, their lack of knowledge and understanding may lead to confusion between anaphylaxis and other allergic reactions. Consequently, when filling out the questionnaire, students might inaccurately report their experiences due to misdiagnosis. To address this issue, it is recommended to implement comprehensive training courses on anaphylaxis prior to graduation, aiming to enhance students' awareness and understanding of this condition.

Limitation

The study's sample size of 120 dental students is relatively small, which may limit the generalizability of the findings to the wider population of dental students. Additionally, the study's

cross-sectional design prevents the establishment of causal relationships between variables. The self-reported questionnaire used in the study may also lead to social desirability and response biases. Furthermore, the study did not take into account practical training and clinical experience, which could have influenced the students' knowledge and awareness levels. Lastly, the study did not examine the impact of anaphylaxis management on patient outcomes, which could have provided additional insights into the importance of proper anaphylaxis management in dental practice. Despite these limitations, the study still provides valuable insights into dental students' awareness levels regarding anaphylaxis and epinephrine administration during such cases. Future studies with larger sample sizes, longitudinal designs, and practical training and clinical experience as variables are needed to confirm and expand upon these findings.

Conclusion

In summary; while most dental students have sufficient knowledge regarding anaphylactic reactions and epinephrine administration during such cases; students aged 20-22 years old as well as those with less than one year of clinical experience still have some misconceptions and knowledge gaps in this area. To address this, dental schools should enhance their educational curricula to provide comprehensive training on anaphylaxis management, including symptom recognition, prompt diagnosis, and appropriate epinephrine use. This training should be mandatory for all dental students and ongoing for practicing dentists and dental staff to ensure they remain updated with current guidelines and best practices for managing anaphylactic reactions. Failure to provide prompt and proper treatment during anaphylactic shock can lead to irreversible consequences, making it crucial for dental professionals to have the necessary skills and knowledge to manage these medical emergencies effectively. By improving the knowledge and skills of dental students and practitioners, we can enhance patient safety and prevent adverse outcomes associated with anaphylaxis during dental procedures.

Implications for practice

- Dental schools and institutions should incorporate comprehensive training and education on anaphylaxis management, including epinephrine administration, into their curricula and training programs for dental students.
- Practical training and clinical experience should also be included to ensure that dental students are adequately prepared to manage anaphylaxis in real-life situations.
- Dental practitioners should ensure they have appropriate emergency management plans in place and regularly review and update them to ensure they are up-to-date with the latest guidelines and recommendations.
- Regular training and education on anaphylaxis management should also be provided to dental staff to ensure they are prepared to respond effectively in the event of an emergency.
- By implementing these measures, dental practitioners can help to ensure that patients with anaphylaxis receive timely and appropriate care, reducing the risk of adverse outcomes and improving patient outcomes overall.

Declarations

- **Ethics approval and consent to participate**
  All participants provided written informed consent for their involvement in the study, in accordance with the Declaration of Helsinki. The study protocol was approved by the Institutional Review Board (IRB) of Isfahan University of Medical Sciences (Approval No.: IR.MUI.DHMT.REC.1402.076).

- **Consent for publication**
  Not applicable

- **Availability of data and materials**
  The data that support the findings of this study are available on reasonable request from the corresponding author. The data are not publicly available due to their containing information that could compromise the privacy of research participants.

- **Competing interests**
  Nil

- **Funding**
  Not applicable

- **Authors' contributions**
  F.P. and M.N.I. contributed to the conception and design of the work, data interpretation, drafting, and critical revision of the paper. B.J, A.T. and L.J. helped with data collection. All authors read and approved the final version of the article.

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