

Imaging and Oral Diagnostics

Study of sensitization to dental haptens in dental students and thermovision analysis of the positive skin-allergic reactions

Stanev E.¹, M. Dencheva²

Проучване на сенсibiliзацията към дентални хаптени при студенти по дентална медицина и термовизионен анализ на положителните кожно-алергичните реакции

Станев Е.³, М. Денчева⁴

Summary

Dental students are exposed to various dental materials (haptens) during their studies.

Aim: To study sensitization to dental haptens in dental medicine students and to compare data from standard reading and imaging.

Material and Methods: 76 students of dental medicine at FSM-Sofia were surveyed. Epicutaneous testing was performed in accordance with the principles of the European Contact Dermatitis Society, and the international standards of ICDRG (International contact dermatitis research group) were met. Allergens of the company - Chemotechnique Diagnostics and Bulgarian series of allergens manufactured by NCIPD have been used. Standard reporting is complemented by FLIR A320 thermal imaging.

Results: Slightly positive (+) reactions at early reading are 15 (19.7%) with allergic inflammation (AB) at an average temperature of -0.5 to 0.8 °C and a maximum of -0.4 to 0.9 °C. Strongly positive reactions (++) at early reading are 9 (11.8%) and have AB at an average temperature of 1 to 2.7 °C and a maximum of 1.2 to 2.8 °C. Slightly positive (+) reactions at late reading are 8 (10.5%), with AB at an average temperature of 0.1 to 0.4 °C and a maximum of 0.1 to 0.5 °C. The highly positive (++) reactions at late reading are 9 (11.8%) and have AB at an average temperature of 0.2 to 1.9 and a maximum of 0.1 to 2.0 °C.

Conclusion: The incidence of allergic reactions to the tested haptens is similar to that found in other studies. A thermovision examination shows that allergic inflammation in highly positive (++) reactions is greater than in mildly positive (+) and there are temperature indicators that may support standard reading.

Key words: Patch- test, thermovision, dental materials

¹ PhD student - Medical University of Sofia, Faculty of Dental Medicine, Department of Imaging and Oral Diagnostics

² Assoc. prof. - Medical University of Sofia, Faculty of Dental Medicine, Department of Imaging and Oral Diagnostics

¹ Редовен докторант – Медицински университет – София, Факултет по дентална медицина, Катедра Образна и орална диагностика

² Доцент – Медицински университет – София, Факултет по дентална медицина, Катедра Образна и орална диагностика

Резюме

Студентите по дентална медицина са изложени на контакт с различни дентални материали (хаптени) по време на своето обучение.

Цел: Да се изследва сенсibiliзацията към дентални хаптени при студенти по дентална медицина и да се сравнят данните от стандартното отчитане и термовизионното заснемане.

Материал и методи: Изследвани са 76 студенти по дентална медицина във ФДМ-София. Епикутанното тестване е проведено съгласно принципите на Европейското дружество по контактен дерматит, а при отчитането са спазени международните стандарти на ICDRG (International contact dermatitis research group). Използвани са алергени на фирмата - Chemotechnique Diagnostics и Българска серия алергени произведени от НЦЗПБ. Стандартното отчитане е допълнено с термовизионно заснемане с камера FLIR A320.

Резултати: Слабо позитивните реакции (+) при ранно отчитане са 15 (19,7%) с алергично възпаление (AB) на средна температура от -0,5 до 0,8 °C и максимална от -0,4 до 0,9 °C. Силно позитивните реакции (++) при ранно отчитане са 9 (11,8%) и са с AB на средната температура от 1 до 2,7 °C и максимална от 1,2 до 2,8 °C. Слабо позитивните реакции (+) при късно отчитане са 8 (10,5%), с AB на средната температура от 0,1 до 0,4 °C и максимална от 0,1 до 0,5 °C. Силно позитивните реакции (++) при късно отчитане са 9 (11,8%) и са с AB на средната температура от 0,2 до 1,9 и на максималната т 0,1 до 2,0 °C.

Заключение: Честота на алергични реакции към изследваните хаптени е подобна на установяваната при други изследвания. Термовизиографското изследване показва, че алергичното възпаление при силно позитивните реакции (++) е по-голямо от това при слабо позитивните (+) и съществуват температурни показатели, които могат да подпомогнат стандартното отчитане.

Ключови думи: Patch-тест, термовизия, дентални материали

Introduction

Dental training requires both theoretical knowledge and practical experience. Students' contact with dental materials begins in the first year in the Dental Material Science course. In the second and third year students work in technical halls with materials for making dentures and metal crowns. After the students pass the fourth year, practical training in clinical disciplines begins. This includes working with patients as well as working in a dental laboratory.

We have selected four allergens to be included in the study that are known to have been in contact with each of the students for a different period of time. In our study, we examine the sensitization of fourth-year students to four dental materials. These substances are inferior allergens (haptens) - low molecular weight - up to 1000 Da (daltons). We also use thermal imaging of reactions as an innovative method to supplement standard reporting.

Syed et al. summarize 71 scientific articles with studies on allergy to dental materials. The

results show the most common reactions to latex, acrylates, formaldehyde metal alloys containing nickel. [1] Aalto-Korte et al. examine the presence of acrylate allergy among dental staff. More common allergies to acrylates are found than in the general population. [2] These substances are part of Duracryl plastic. Lyapina and count. found that dental students were at increased risk of sensitization by methyl methacrylate and formaldehyde. [3] Foredent duct filling is one of the sources of formaldehyde. Thyssen et al. investigate allergy to metals and found that 17% of women and 3% of men are hypersensitive to nickel, and 1-3% are allergic to cobalt and chromium. [4]

In 2018, Anzengruber et al. make thermal imaging of the Patch test, which takes into account the capabilities of the method in distinguishing between different reactions. They only examine the average temperature of the reactions at early reading [5]. In response to their study, Hamann et al. note the need for late reporting of results, both in standard reading and in thermal imaging

and analysis. [6]

In accordance with these requirements and with the requirements of the European Contact Dermatitis Society in our study, we make an early reading - at the 48th hour after the allergen is applied and late - at the 7th day after its placement.

In our previous study, we found the difference between the absolute temperature of the different reactions, while comparing the allergic inflammation (AB) of the positive reactions here. [7]

Aim

To study sensitization to dental haptens in dental medicine students and to compare data from standard reading and imaging.

The following tasks were identified in relation to the stated aim:

1. To study sensitization to dental haptens in dental medicine students
2. To perform thermovisigraphic analysis of reactions after epicutaneous testing.

Material and methods

Material - 76 students: 25 men and 51 women aged 23 ± 2 years, students at the Faculty of Dental Medicine at Medical University - Sofia. All students studied are eligible for Complex Oral Outbreaks and Allergic Diagnostics accepted by the Department of Imaging and Oral Diagnostics.

One of the allergens (dental materials) used in the study is the Dental Materials - Patients DMP-1000 series from Chemotechnique Diagnostics, Sweden:

1. N-002A Nickel (II) sulfate hexahydrate 5.0% five. Nickel is one of the proven metal allergens, so it is tested independently. It is also included in the DMP-100 (series of dental allergens).

We investigate 3 allergens from the Bulgarian Allergens Series (NCSPB 2019):

2. Duracryl - Plastic for removable prosthetics.
3. Heranium-P - metal alloy for fixed pros-

thetic structures containing chromium and cobalt.

4. Foredent - root canal obturation material containing formaldehyde.

Methods - The methods of testing are in accordance with the complex oral and allergic diagnostics, accepted in the Department of Imaging and Oral Diagnostics of the Faculty of Pedagogical Sciences - Sofia. They are applied in all research and development.

Questionnaire method: It is used for taking an allergy-focused history and includes questions about past allergic reactions and evidence of suspected or established sensitization to different allergen groups (pollen, household, animal, etc.). During the anamnesis, questions were asked about: 1. Hereditary burden and atopy; 2. For established or suspected allergy to dental materials; 3. For established or suspected allergy to concomitant allergens (bacteria, food, pollen).

Clinical examination: A clinical examination has been performed to identify intraoral and extraoral signs of a hypersensitivity contact reaction such as: single or multiple abrasive units with discoloration, relief and volume of the oral mucosa, tissues and organs of the oral, oral and neck, as well as all over the body.

Epicutaneous test: The patch test is a method for examining sensitization to haptens. [8] The standard reporting of its results is made according to the ICDRG (International Contact Dermatitis Research Group) criteria of 2015. It determines sensitization to several degrees, depending on the strength of the reaction to an allergen. [9]

Allergens are placed in IQ Ultimate™ patch cells. The nickel allergen is made by the company Chemotechnique Diagnostics and the rest are standardized by NCIPD. (Figure 1) The allergen patch is applied to the skin area without hair, skin irritation and pigmentation. He stayed there for 48 hours. After this period it is removed. The results were counted 2 times - on the day that the patch was removed (early reading) after passing the irritation and on the 7th day (late reading).



Figure 1. *Epicutaneous testing allergens*

The criteria were adopted by the ICDRG:

- Negative reaction (-) - no skin changes in the area
- Suspicious reaction (? +) - only mild erythema
- Slightly positive (1st degree reactions (+) - erythema, infiltration, papules possible
- Highly positive (2nd degree reactions) (++) - erythema, infiltration, papules, vesicles
- Extremely Positive (Grade 3 Reactions) (+++) - Intense erythema, infiltration and fusion vesicles

Allergic inflammation, which is observed in positive reactions, is also associated with a change in the temperature of the skin area, so the reading of the results can be supplemented by a thermal imaging examination.

Thermovigraphic examination - This is a safe, non-invasive, non-contact method for determining skin temperature. It is used in various fields of general and dental medicine. Grozdanova uses thermal imaging to diagnose inflammatory reactions and confusion fields [10]. In allergy, it is used in the diagnosis of various allergic diseases and in addition to skin allergy tests, to determine the temperature of the reactions and, therefore, to judge the intensity of the inflammation. It has also been successfully used in determining the strength of reactions in the Patch test [11].

In terms of thermal imaging, the requirements described in R. Grozdanov's dissertation are observed. [10] The FLIR A320 camera (Figure 2) and the Flir Reporter Professional software 2013 image processing software are used. Capture is taken just before the early and late reporting of reactions. A fine plastic frame is used to help accurately locate reactions to the thermal imaging. It analyzes the mean and maximum temperature response with those of a patient's skin area at a distance of 1 cm from the site of the patch as control. When the temperature of the control (T_{contr}) is subtracted from the reaction temperature (T), the value of allergic inflammation (AB) is obtained with the corresponding equation:

$$AB = T - T_{\text{contr}}$$



Figure 2. *Thermal imaging camera*

Statistical processing was performed with SPSS software 17.0.

Results

Results for Task 1:

Results of the survey:

24 (32%) of the students reported having allergic reactions in the past or evidence of allergic reactions in the past; 3 (4%) reported allergic diseases in the family. No one submitted documents related to allergic tests and did not take medicines related to allergic diseases.

One female student reported an allergy to gold and precious metals; 4 of the students re-

Table 1 Results from standard reporting

allergen	Allergic reaction	Early assessment (48 hour)		Late assessment (7 day)	
		Number(n)	%	Number(n)	%
Nickel(II)sulfate	(++)	5	6.6%	5	6.6%
	(+)	5	6.6%	5	6.6%
	(-)	66	86.8%	66	86.8%
Duracryl	(++)	1	1.3%	1	1.3%
	(+)	3	3.9%	1	1.3%
	(-)	72	94.7%	74	97.4%
Heranium-P	(++)	1	1.3%	1	1.3%
	(+)	5	6.6%	1	1.3%
	(-)	70	92.1%	74	97.4%
Foredent	(++)	2	2.6%	2	2.6%
	(+)	2	2.6%	1	1.3%
	(-)	72	94.7%	73	96.1%

ported being allergic to nickel and base alloys. There was no history of allergy to plastics and sources of formaldehyde in the study group.

Clinical examination results: Clinical findings in the oral cavity, which may be due to allergic reactions, were identified in 19 (25%) of the patients studied.

Results of the Epicutaneous Test:

Early reading revealed 9 strongly positive (++) and 15 slightly positive (+) reactions to the allergens tested. The results for each of them are presented in Table. 1.

In 7 (46%) of the poorly positive early reading skin reactions were late negative (-). In accordance with the requirements of the ICDRG, they were included in the adverse reaction group (-). No extremely positive reaction was detected in the studied patients (Figure 3).

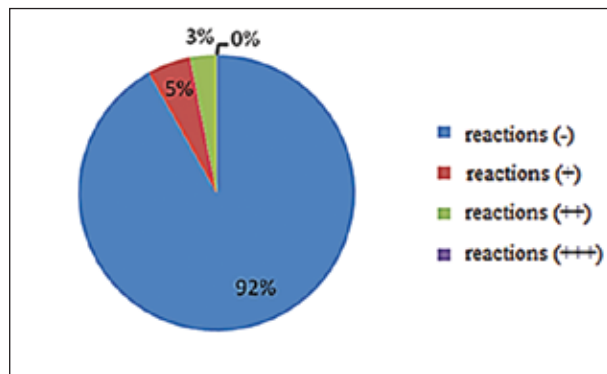


Figure 3. Frequency of various severe allergic reactions

Following standard reporting of results, it was found:

Nickel sensitization in 10 (13%) students. In the men studied 1 highly positive reaction (++); 9 positive reactions (4 strongly positive (++) and 5 slightly positive (+)) in the women studied.

Sensitization to Duracryl plastic in 2 (3%) women - 1 strongly positive and 1 slightly positive reaction.

Sensitization to Heranium-P alloy in 2 (3%): 1 woman with a strong positive reaction (++) and 1 man with a weak positive reaction.

Sensitization to Foredent canal filling material with 3 (4%) -1 strongly positive (++) response in males and 1 strongly positive (++) and 1 weakly positive (+) response in females.

Task 2 results:

Differences in both visual and thermal imaging are observed between the slightly positive (+) and strongly positive (++) reactions (Fig. 4).

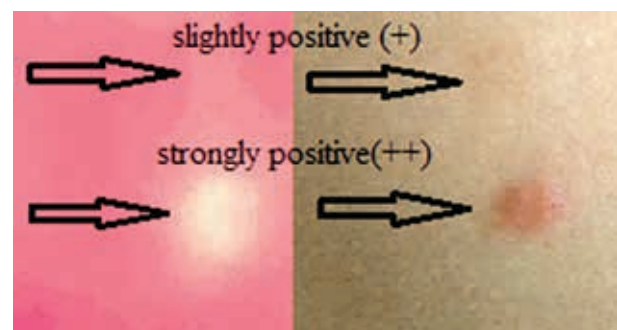


Figure 4. Thermal and visual representation of reactions after an epicutaneous test

Table 2. Mean, minimum and maximum values for allergic inflammation (AB)

Early reading				Late reading			
Average temp.		Maximum temp.		Average temp.		Maximum temp.	
Slightly positive reactions	Highly positive reactions	Slightly positive reactions	Highly positive reactions	Slightly positive reactions	Highly positive reactions	Slightly positive reactions	Highly positive reactions
AB= 0,35 ± 0,35 min -0,5 max 0,8	AB = 1,4 ± 0,5 min 1,0 max 2,7	AB = 0,37 ± 0,36 min -0,4 max 0,9	AB = 1,48 ± 0,5 min 1,2 max 2,8	AB = 0,23 ± 0,13 min 0,1 max 0,4	AB = 0,87 ± 0,59 min 0,2 max 1,9	AB = 0,26 ± 0,16 min 0,1 max 0,5	AB = 0,93 ± 0,56 min 0,1 max 2,0

Table 2 presents information on allergic inflammation (AB).

In the early reading, several reactions with a negative AB value were observed. In these, the temperature of the control region is higher than the reaction temperature. In the late reading of slightly positive reactions (+), completely positive values of AB, both at average and maximum temperatures, are observed.

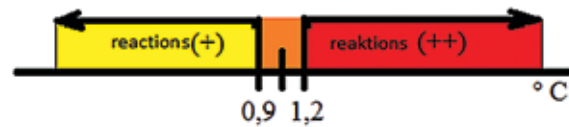
The data for positive reactions show the following limit values for allergic inflammation (AB) - Table 3.

The results presented in Table 3 are crucial for distinguishing between weakly positive (+) and strongly positive (++) reactions.

In the early reading of average temperatures, there is an interval of 0.8 to 1 degree, which distinguishes the weakly positive (+) from the strongly positive (++) reactions. If the patient's reaction is at a temperature within this range, it is to be considered doubtful.



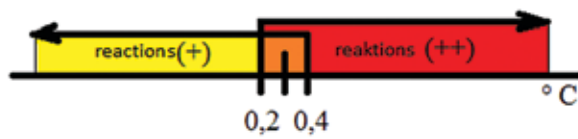
In the early reading of maximum temperatures, there is an interval of 0.9 to 1.2 degrees, which distinguishes between slightly positive (+) and strongly positive (++) reactions. If the patient's reaction is at a temperature within this range, it is to be considered doubtful.



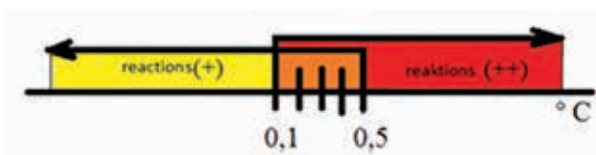
In the late reading of average temperatures, there is an interval of 0.2 to 0.4 degrees, which distinguishes between slightly positive (+) and strongly positive (++) reactions. If the patient's reaction is at a temperature within this range, it is to be considered doubtful.

Table 3. Allergic inflammation (AB) values at both readings

Early reading:	Late reading:
<u>Average temperatures:</u>	<u>Average temperatures:</u>
Slight positive reactions: up to 0,8	Slight positive reactions: up to 0,4
Highly positive reactions: over 1.0	Highly positive reactions: over 0.2
<u>Maximal temperatures:</u>	<u>Maximal temperatures:</u>
Slight positive reactions: up to 0,9	Slight positive reactions: up to 0,5
Highly positive reactions: over 1.2	Highly positive reactions: over 0.1



In the late reading of maximum temperatures, there is an interval of 0.1 to 0.5 degrees, which distinguishes between slightly positive (+) and strongly positive (++) reactions. If the patient's reaction is at a temperature within this range, it is to be considered doubtful.



Discussion

The epicutaneous test is a classic method of contact hypersensitivity testing. It has a number of positives: allergens are standardized, patches are specially made for the needs of the study, patients meet certain conditions. On the other hand, accounting for skin reactions is a subjective process. Despite the criteria to be met (Figure 5), the dentist must be experienced.

Student results show the most allergic reactions (low positive (+) and highly positive (++)) to nickel - 13% (n = 10) in men (n = 1) 1% and in women (n = 9) 12%. The incidence is less than the reported data in literature. The incidence of positive reactions to other allergens is consistent with that in similar studies. [1,4]

Strongly positive (++) and weakly positive (+) reactions in late reading are more equal, while in early reading the low positive (+) are greater. This confirms the need for delayed response in patients to make a more accurate diagnosis. In cases where patients' reactions are completely negative (-) at first reading, there is no need to do so late. In our study, we did not find any response to be reported as negative (-) at early reading and as positive at late reading.

The first studies on the impact of the work environment during student learning are from 2012. We build on these results and complement the study with thermoviographic reporting. [13]

In the study of Anzengruber et al. 480 positive allergic reactions were monitored after the Patch test and thermoviographic imaging. Despite the large sample size of the study, it has received some criticism. [6] Anzengruber et al. take the cutoff between low positive (+) and high positive (++) reactions at early reading, an allergic inflammation of 0.4 °C with respect to maximum temperatures. In the case of weakly positive (+) reactions at early reading, the authors establish an AB of 0.54 °C ± 0.47, and at strongly positive (++) 0.96 °C ± 0.67. [5]

In our study, these values are 0.35 °C ± 0.35 and 1.44 °C ± 0.50, respectively. The other three temperature indicators related to AB that we present have not been studied by Anzengruber et al.

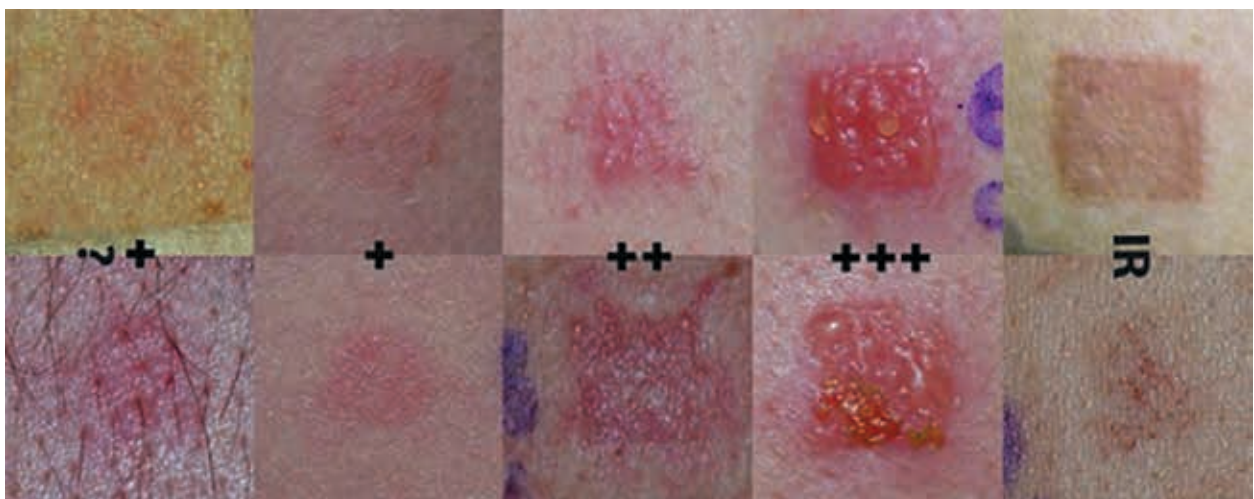


Figure 5. Scale for response response after epicutaneous test [12]

Conclusions:

1. The incidence of sensitization to tested hapten in dental students is similar to that found in previous studies. [1,13]. The sensitizing potential of the allergens tested is confirmed. [1,13] The study should be repeated at the end of their training to determine if there is a change in their allergic status.
2. Allergic inflammation (AB) values above 1.0°C at early reading and above 0.5 °C at late reading are characteristic of highly positive reactions (++); below 0.8 °C at early reading and below 0.1 °C at late reading are characteristic of slightly positive reactions (+). Thermographic imaging data can help distinguish reactions after an epicutaneous test.

*Application***Questionnaire****for patients who will be tested for allergy:**

1. **Name, Surname, Family name:**

2. **Age:**

3. **Tel. number:**

4. **Address:**

5. Have you had an allergic disease and what type?
.....

6. Are there any relatives with allergic diseases and what type(s)?
.....

7. Have you been examined for the disease?
.....

8. Have you been taking/currently taking medications for allergic illnesses or changes in your body's immune response? When was the last intake (less than seven days; more than seven days; more than a month)?
.....

9. Are you allergic to dental supplies and medication?
.....

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Address of correspondence:

Dr. Evgeni Stanev

Bulgaria, Sofia,

1431, Georgi Sofiisky 1 str., Faculty of dental medicine,

Тел/Tel: +359 988811648

Email: stanev242@gmail.com