

**THERMOVISIOGRAPHIC STUDY OF EPICUTANEOUS
TESTING WITH DENTAL HAPTENS IN DIFFERENT
CONCENTRATIONS**

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Abstract

Dental haptens are used to study sensitization to their respective dental materials. The concentration of haptens is important for the diagnostic process, as different concentrations lead to different severity of skin reactions. The aim of the study was to examine the dermal reactivity to 15 dental haptens in two different concentrations after the Patch test, by thermal imaging and calculating the temperature parameters of the respective reactions. The present study included 15 haptens from five different categories of dental materials, each with two different concentrations, with the objective to examine the results ensuring the Patch test. Thirty-three patients were included in the study. A total of 990 skin reactions were observed. They were subject to standard and thermal imaging evaluation. Approximately 5% of reactions were positive. The thermovisiographic indicator 'dT' confirms the results of the standard readings, as its values vary from 0 to 0.8 °C in the case of positive reactions. The study observed no significant differences in the results based on gender, both in the standard and in the thermal imaging examination. The study also confirms that it is necessary to apply certain concentrations of each hapten depending on its nature.

Key words: dental materials, concentrations of haptens, thermocamera, allergy, thermovision, Patch test

Introduction. Dental haptens are applied in the epicutaneous testing method in order to evaluate the body's sensitization to dental materials. The

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dental haptens were sourced from complete dental products and are the result of generations of research and labour of Bulgarian scientists. They consist of a multicomponent dispersed system of specific types of dental material and Vaseline. The classification of dental haptens of groups is only indicative and supports the methodology of epicutaneous testing. The concentrations of the substances from whole dental products according to utility model No 3493/23.01.2020 are determined by the group: intracanal endodontic obturation materials 1–5 wt.%, Metal alloys 3–7 wt.%, Composite materials (cold-curing, light-curing and heat-curing) 2–4% by weight, but may vary within their specified range. Their use in everyday dental allergology practice is justified by the need for more reliable criteria to establish the etiological factor of various pathologies such as oral allergic syndrome, idiopathic urticaria, burning mouth syndrome, oral lichenoid lesions, and others. In addition to the standard reporting of the epicutaneous test according to the ICDRG criteria, we proposed a method for further evaluation and examination of the skin reaction with conjunction of thermal imaging diagnostics, which ultimately yields to increased information and scientific data regarding the dermal reactions (outside the scope of the visible criteria) [1]. The latter method was evaluated and defended in a PhD thesis, and it is based on a study of temperature changes in the skin ensuing the epicutaneous testing [2].

The aim of the study was to examine the dermal reactivity to 15 dental haptens in two different concentrations after the Patch test, by thermal imaging and calculating the temperature parameters of the respective reactions.

1. Epicutaneous testing of 33 patients and standard reporting of results according to the ICDRG criteria [1]. Skin reactions are: Extremely positive (erythema papules and single vesicles); Highly positive (erythema, papules and vesicles); Slightly positive (erythema and infiltration); Suspicious (weak erythema); Negative.
2. Thermal imaging of the results.

Materials and methods. The study included a group of 33 people with a mean age of 23 ± 2 years, dental students ($n = 9$ (30%) men and $n = 24$ (70%) women) who underwent an epicutaneous test. Students in this specialty are exposed significantly more to dental materials and therefore have increased exposure to some of their components [3].

Inclusion criteria: patients over 18. Exclusion criteria: Patients with skin allergies and patients participating in anti-allergic or immunosuppressive therapy as a result of other pathologies. Epicutaneous testing with the following dental haptens equivalents of the listed dental materials (Table 1).

The haptens presented are in the process of having their concentrations definitively established within the limits of utility model No 3493/23.01.2020. The haptens are divided into test groups according to their purpose in dental practice.

T a b l e 1

Representatives of the groups that are equivalent to the respective dental materials

1. Hydrocal – 2% and 4%	Intracanal endodontic obturation materials
2. Acroseal – 2% and 4%	
3. Endomethason N – 2% and 4%	
4. Duracryl – 2% and 4%	Acrylics used in prosthetic treatment
5. Duracryl (colourless) – 2% and 4%	
6. Meliodent – 2% and 4%	
7. Signum – 2% and 4%	Composite materials used in dental fillings
8. Charisma – 2% and 4%	
9. Adhesor ZnPO4cement – 2% and 4%	Dental cements
10. Cement Imicryl Nova glassLC – 2% and 4%	
11. CetacCem – 2% and 4%	
12. Crystalloy C – 4% and 6%	Metal alloys used in prosthetic treatment
13. Crystalloy N – 4% and 6%	
14. Maranium – 4% and 6%	
15. Wiron 250 – 4% and 6%	

Technique: The haptens are placed in the indentations (chambers) of IQ Ultra™ polyethylene patches. They are taped to the skin of the patient's back, removed after 48 hours and the result is evaluated according to the ICDRG criteria [1].

Thermal imaging: thermal photographs are taken once with a Therma Cam A 320 camera and FLIR Reporter Professional 2013 software, and again 30 minutes after removing the patches. The difference between the maximum temperature of each positive reaction and its corresponding control is investigated (dT). Elevated skin temperature is one of the signs of allergic inflammation (calor), which is not included in the results evaluated as per the standard reporting protocol, but provides important information about the intensity of the reaction [1, 4].

Results from the standard reading. Of the 990 reactions studied, $n = 50$ (5.1%) reactions were defined as positive with varying intensities (from doubtful to extremely positive). The results from the standard reading and percentage relationships between the total positive reactions is: extremely positive $n = 0$, highly positive $n = 2$ (4% of all positive reactions), slightly positive $n = 45$ (90% of all positive reactions), slightly positive $n = 3$ (6% of all positive reactions) and 940 negative reactions.

The ratio between the different positive reactions shows that the largest occurrences were the weakly positive $n = 45$ (90%), while strongly positive are only $n = 3$ (4%), extremely positive were not reported. The number of doubtful reactions is $n = 3$ (6%).

Distribution of allergic reactions by sex. In the study, the number of women (70%) is more than twice as high as that of men (30%). The results for

men are: Extremely positive $n = 0$; highly positive $n = 0$; slightly positive $n = 17$ (38% of all slightly positive reactions); suspicious $n = 3$ (67% of all suspicious reactions) and 251 negative (27% of all negative reactions).

The results for women are: extremely positive $n = 0$; highly positive $n = 2$ (100% of all highly positive reactions); slightly positive $n = 28$ (62% of all slightly positive reactions); suspicious $n = 1$ (33% of all suspicious reactions) and negative $n = 689$ (73% of all negative reactions).

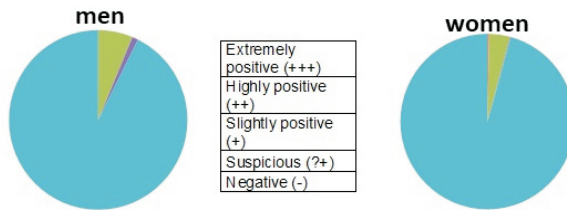


Fig. 1. Relationship between different reactions in men and women

Distribution of different strengths in men and women. Figure 1 shows the similarity between the distribution of the different reaction intensities in men and women. Weakly positive reactions are a slightly higher percentage in men than in women. Highly positive and doubtful are a very small percentage of the total number of reactions. In men, very positive reactions are not observed, and in women there are almost no doubtful reactions.

There were no statistically significant differences in the percentage of positive reactions between men and women, but in men they had weaker skin manifestations than in women.

Distribution of reactions to the different equivalents of the respective dental materials. The data in Table 2 show that the allergen concentration is of importance in epicutaneous testing. Only from $n = 4$ of all allergens (Nos 10, 13, 14, 15) one case of positive reaction was found at both low and high allergen concentration.

From $n = 5$ of the allergens (Nos 2, 3, 7, 8, 11) all observed positive reactions were found at one of the two concentrations. In allergens Nos 2, 3, 8, 11 reactions are observed only in high concentrations, while in allergen No 7 only at low concentrations.

In Group 1 (endodontic intracanal obturation materials) the hapten needed to be in a higher concentration to provoke a reaction, with the exception of calcium preparations. In Group 2 (acrylics for prosthetic treatment) the hapten should be in the lower concentration. In Group 3 (composites for dental fillings) Signum gives positive reactions at low concentration, while Charisma – at high. In Group 4 (dental cements) the hapten should be in higher concentrations. In Group 5 (metal alloys) should also be in high concentrations, with the exception of Crystalloy C.

Table 2

Distribution of positive reactions depending on the concentration of allergens

1		2	3	4	5	6	
Haptens Dental materials equivalents		N positive reactions	Patients with reactions only at low allergen concentrations	Patients with reactions only at high allergen concentrations	Patients with reactions to both allergen concentra- tions in the same patient	% of positive reactions at low concentrations	% of positive reactions at high concentrations
1. Hydrocal – 2%	4	4	2	0	66%	33%	
1. Hydrocal – 4%	2						
2. Acroseal – 2 %	0	0	3	0	0%	100%	
2. Acroseal – 4 %	3						
3. Endomethason N – 2%	0	0	1	0	0%	100%	
3. Endomethason N – 4%	1						
4. Duracryl – 2%	5	5	2	0	71%	29%	
4. Duracryl – 4 %	2						
5. Duracryl (colourless) – 2%	2	2	1	0	66%	33%	
5. Duracryl (colourless) – 4%	1						
6. Meliodent – 2%	1	1	1	0	50%	50%	
6. Meliodent – 4%	1						
7. Signum – 2%	2	2	0	0	100%	0%	
7. Signum – 4%	0						
8. Adhesor ZnPO4 – 2%	0	0	1	0	0%	100%	
8. Adhesor ZnPO4 – 4%	1						
9. Cement Imicryl – 2%	1	1	2	0	33%	66%	
9. Cement Imicryl – 4%	2						
10. CetacCem – 2%	2	1	1	1	25%	25%	
10. CetacCem – 4%	2						
11. Charisma – 2%	0	0	2	0	0%	100%	
11. Charisma – 4%	2						
12. Crystalloy C – 4%	3	3	1	0	75%	25%	
12. Crystalloy C – 6%	1						
13. Crystalloy N – 4%	1	0	3	1	0%	75%	
13. Crystalloy N – 6%	4						
14. Maranium – 4%	1	1	3	1	0%	66%	
14. Maranium – 6%	3						
15. Wiron 250 – 4%	1	0	1	1	0%	33%	
15. Wiron 250 – 6%	2						

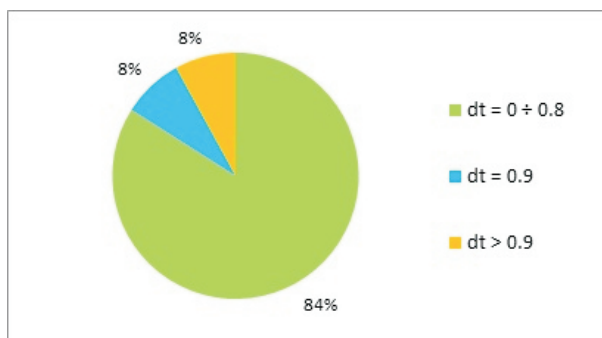


Fig. 2. Difference in the temperature of the skin reaction and the corresponding control area

Results of thermal imaging research. At $n = 42$ (84%) of the positive reactions, the difference between the reaction temperature and that of the control region was between 0 and 0.8°C (Fig. 2). In $n = 4$ (8%) of the reactions it is 0.9°C , and in others $n = 4$ (8%) it has a higher value. The data coincides with our previous studies, which showed that in positive reactions, the values of the indicator are in the range from 0 to 0.8°C [2, 3, 5].

Reactions that give higher values (above 0.8°C) are observed in allergens Nos 9, 12, 14, and 15. Reactions with a value of 0.9°C are found in allergens Nos 14 and 15. Of the reactions with value above 0.9°C , one is for allergen No 9 – Cement Imicryl (2.9°C) and allergen No 12 – Crystalloy C (3.4°C).

Results of thermal imaging examination for men is Extremely positive $n = 0$; highly positive $n = 0$; slightly positive $n = 17$ (mean value of $dT = 0.5$); suspicious $n = 3$ (mean value of $dT = 0.5$) and total 19 (mean value of $dT = 0.5$).

The results for women are: extremely positive $n = 0$; highly positive $n = 2$ (mean value of $dT = 0.65$); slightly positive $n = 28$ (mean value of $dT = 0.66$); suspicious $n = 1$ (mean value of $dT = 0.3$) and total $n = 31$ (mean value of $dT = 0.65$).

In the different positive reactions, both in men and women, the value of dT is similar, a little higher for the women. The data from our previous studies confirm that the dT index is independent of the sex of the patient [2].

It is noteworthy that the doubtful reactions noted in the standard reading are in the temperature range of the positive reactions recorded thermally.

Discussion. For the first time in Bulgaria happens with different concentrations are compared and the standard reading is combined with thermal imaging. The percentage of positive reactions is similar to that in similar studies in patients without a history of allergy [1, 3, 4, 6]. There were no statistically significant differences between men and women in terms of the percentage of positive reactions. The data shows that the concentration of the allergen is important for the occurrence of a skin reaction in the case of standard reading.

In Group 1 the hapten should be in the higher concentration (4%), with the exception of calcium preparations, for which it is better to use the lower concentration (2%). In Group 2, the hapten should be in the lower concentration (2%). In Group 3, Signum shows positive reactions at low concentration (2%), while Charisma – at high concentration (4%). In Group 4, the hapten should be in higher concentrations (4%). In Group 5, it should also be in high concentrations (6%), with the exception of Crystalloy C.

The results of the standard reading, although similar to previous studies of dental haptens, indicate that the development of each new hapten must be individualised and it is normal for the concentration to vary [2–4]. It is also of importance that in the case of a skin reaction to sensitization, it can be reported by some of the used methods – standard or thermal imaging.

The results of the thermal imaging report confirm that the indicator dT gives reliable information about the strength of the temperature reaction, as in weakly positive and doubtful reactions, it is in the range 0–0.8 °C [2, 3]. The hypothesis that dT values do not depend on the patient's gender is confirmed [2, 4]. Thermovision examination of skin allergy samples complements the standard reading made at 48 hours.

For future studies, the thermal skin response on day 3 or 7 of patch removal in doubtful and mildly positive reactions, would be of interest.

Conclusion. The concentrations of the substances from whole dental products according to utility model No 3493/23.01.2020 are determined by the group: intracanal endodontic obturation materials 1–5 wt.%, Metal alloys 3–7 wt.%, Composite materials (cold-curing, light-curing and heat-curing) 2–4% by weight, but may vary within their specified range. This will increase the clinical value of the study. On the other hand, the reporting of the results is supplemented with a thermal imaging test, which gives objective data on the temperature of the examined skin area. The result of the test is not influenced by the sex of the patient.

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