



Article

Occupational Methacrylate Allergy in Dental Personnel

Norma Cameli ¹, Maria Mariano ^{1,*}, Flavia Pigliacelli ¹, Martina Silvestri ² and Antonio Cristaudo ¹

¹ San Gallicano Dermatological Institute, IRCCS, 00144 Rome, Italy; norma.cameli@ifogov.it (N.C.); pigliacelliflavia@gmail.com (F.P.); antonio.cristaudo@ifogov.it (A.C.)

² Unit of Dermatology, Department of Health Sciences, Magna Graecia University, 88100 Catanzaro, Italy; martinaeg@hotmail.it

* Correspondence: maria.mariano@ifogov.it; Tel.: +39-065-266-6025

Abstract: Purpose of the article: Acrylate and methacrylate (MA) use in the dental industry is widespread, being utilized in dental prostheses and composite resins, dentin bonding materials, and glass ionomers. However, occupational methacrylate allergy in dental personnel is a growing phenomenon. The aims of this retrospective observational study are to evaluate the risk of occupational contact dermatitis following exposure to methacrylates in dental personnel and to identify possible preventive measures. Materials and Methods: A total of 126 subjects exposed to acrylic and methacrylic resins in their professional context and who reported clinical manifestations were included from our outpatient department database. These were subdivided into two groups: 81 dental technicians and 45 dental hygienists. All the subjects had undergone patch testing with a “methacrylate series” (FIRMA) and readings were taken after 2 days (D2), 4 days (D4), and 7 days (D7). Results: A significantly higher incidence of methacrylate allergy was found in the dental technician group compared to the dental hygienists. Among the dental technicians, 40.7% of the subjects presented skin manifestations. The hands were the most frequently affected sites. Conclusion: Our results confirm the high sensitizing potential of MA in the workplace for dental personnel and in particular an increased professional risk in work where the hands are directly involved (dental technicians). Patch testing as an integrated part of a screening tray is needed for a complete evaluation of occupational skin allergy due to MA in dental personnel. The adoption of proper primary preventive measures, including gloves, protective eyewear, face shields, and disposable gowns, can be useful in preventing new cases of contact dermatitis, which may lead to a change of occupation in dental personnel.

Keywords: dental hygienists; dental technicians; (meth)acrylic resins; methacrylate; occupational contact dermatitis; patch test; skin allergy



Citation: Cameli, N.; Mariano, M.; Pigliacelli, F.; Silvestri, M.; Cristaudo, A. Occupational Methacrylate Allergy in Dental Personnel. *Allergies* **2021**, *1*, 123–127. <https://doi.org/10.3390/allergies1020010>

Academic Editors: Pierre Rouge, Antonella Tosti and Enzo Berardesca

Received: 19 March 2021

Accepted: 1 June 2021

Published: 7 June 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Acrylates and methacrylates (MA) are different types of chemical products deriving from the esterification of acrylic and methacrylic acids. Their reactivity varies according to the type of acid used for the esterification process. Acrylic monomer use is widespread, being used in dental prostheses and composite resins, dentin bonding materials, and glass ionomers [1–4]. Dental personnel are at risk of developing acrylate and methacrylate allergy [5]. Classically, acrylate allergy is characterized by a facial and/or eyelid rash, eczematous finger pulp fissuring (pulpitis), nail dystrophy, and/or periungual dermatitis [6,7]. Sensitized patients may have complications with dental work [8]. Acrylates and MA can also be responsible for occupational asthma [9,10].

The aims of this study are to evaluate the risk of skin allergy following exposure to MA in dental technicians and dental hygienists and to identify the allergens responsible for allergic contact dermatitis and possible preventive measures.

2. Material and Methods

In this retrospective observational study, data were obtained from our outpatient department database and included patients that had been evaluated using patch testing for allergic contact dermatitis from January 2017 to December 2018. In particular, we considered dental technicians and dental hygienists exposed to acrylic and methacrylic resins in their professional context referring clinical manifestations. The most commonly reported dermatological manifestations were facial and/or eyelid dermatitis, eczematous finger pulp fissuring (pulpitis) and nail dystrophy.

The study population was divided into two groups: 81 dental technicians and 45 dental hygienists for whom it was possible to assume an allergic reaction to MA. In all the subjects, patch tests with a “methacrylate series” (FIRMA) (Table 1) with Finn Chambers® (SmartPractice) on Scanpor® tape (Norgesplaster, Vennessla, Norway) were performed and readings were taken after 2 days (D2), 4 days (D4), and 7 days (D7). The readings were always carried out by the same dermatologist trained in the field. Descriptive statistics were used to describe the patients’ characteristics.

Table 1. Localization of allergic contact dermatitis skin manifestations in dental technician and dental hygienist groups.

Variables	Dental Technicians (33) N (%)	Dental Hygienists (13) N (%)
Site		
Hands	19 (57.6)	6 (53.8)
Forearms	8 (24.2)	4 (23.1)
Neck and face	4 (12.1)	2 (15.4)
Other	2 (6.1)	1 (0)

The non-parametric Mann–Whitney U test was used to compare the groups. The association between categorical variables was estimated with a chi square test or Fisher exact test. However, when needed, the odds ratios (OR) and their relative 95% confidence intervals (CI 95%) were calculated using a univariate logistic regression model. SPSS statistic software (version 21) was used to perform the statistical analysis.

3. Results

Of the 81 dental technicians (67 males, 14 females; median age 35.7), 33 (40.7%) presented localized dermatitis, respectively, in: the hands (57.6%), forearms (24.2%), neck, and face (12.1%) (Table 1). Of the 45 dental hygienists (12 males, 33 females; median age 23.5), 13 (28.8%) showed clinical features of dermatitis; the most frequently affected sites were the hands (53.8%), forearms (23.1%), head, and neck (15.4%) (Table 1).

Patch tests were positive for at least one allergen in 37 individuals: 30 dental technicians (37%) and 7 dental hygienists (15.6%) (Table 2).

Table 2. Methacrylate series (FIRMA) patch test positivity for at least one allergen in dental technician and dental hygienist groups.

Patch Test Positivity (N = 126)	Dental Technicians (81 pts) N (%)	Dental Hygienist (45 pts) N (%)	p Value
Yes (N = 37)	30 (37.0)	7 (15.6)	0.01
No (N = 89)	51 (63.0)	38 (84.4)	

In 21 of these, the positive patch tests were multiple. The most frequently positive allergens were: 2-hydroxyethyl methacrylate (2-HEMA), ethylene glycol dimethacrylate (EGDMA), methyl methacrylate (MMA), and 2-hydroxypropyl methacrylate (2-HPMA) (Table 3).

Table 3. Methacrylate series (FIRMA) patch test-positive allergens.

Name	% FIRMA
1,3-butanediol dimethacrylate	2
Butyl acrylate	1
Butyl methacrylate	2
<i>N,N</i> -dimethylaminoethyl methacrylate	0.2
1,6-hexanediol diacrylate	0.1
Ethyleneglycol dimethacrylate	2
2-ethylhexyl acrylate	0.5
2-hydroxyethyl methacrylate	2
Hydroxypropyl methacrylate	2
Methyl methacrylate	5
Tetraethylene glycol dimethacrylate	2
Tetrahydrofurfuril methacrylate	2
Triethyleneglycol dimethacrylate	2
Dimethacrylate diurethane	2

As previously described by Koppula et al. [11], the cross-reactivity of methacrylates is based on their chemical structure. In particular, they hypothesized that the acrylates with the carboxy ethyl side group react with receptors on antigen-presenting cells to generate antigenically identifiable residues.

The odds ratio for the professional risk of exposure was OR = 3.19 (CI 95%, 1.27–8.04; $p = 0.02$) in dental technicians vs. dental hygienists, showing an increased professional risk in the first group.

4. Discussion

The results of our study confirm the high incidence of occupational allergy to MA and the growing phenomenon of allergy to acrylates and MA in dental technicians and dentists; these data are in accordance with the scientific literature [5,6,10,12,13]. In our study, the higher incidence was found in the dental technician group, due to the predominant use of the hands, which caused an increased exposure to the substances (21% positive patch tests in the dental technician group vs. 13.3% in the dental hygienist group). This group of workers was exposed to the monomeric form of MA during the preparation of the dental resins. Acrylates and MA are important compounds in dental prosthetic work, so it was not surprising that a greater reactivity in dental technicians was found compared to dental hygienists.

The most commonly positive acrylic monomers were EGDMA, 2-HEMA, and 2-HPMA. Animal studies have shown strong cross-reactivity between these three methacrylates [14]. Stevenson, in 1941, reported the first case of acrylate allergy in a patient with an allergy to methyl MA [15]. Therefore, sensitized individuals are often multiallergic and, accordingly, it is difficult to reach definitive conclusions regarding cross-allergy, because concomitant exposure to several acrylic monomers and multiple sensitization could be an alternative explanation [10]. Additionally, the presence of impurities in denture acrylate components, which may contain a variable proportion of other (meth)acrylates than those officially declared, should be considered [16].

Skin manifestations usually involve directly exposed areas that are not covered by clothes or individual protection devices. The typical clinical signs involve the hands; however, facial involvement has also been described. In our patients, neck and face manifestations were also observed. The causes include contamination by hands to the face and airborne allergenic material [17]. In fact, during their professional activity, personnel use

cutters which produce dust, thus favoring the possibility of an airborne dermatitis that involves the skin of the neck and face. In fact, following exposure to MA suspended in air, professionals show symptoms even if such areas have not been in direct contact with acrylates.

Our results confirm the high sensitizing potential of MA in the workplace for dental personnel, and in particular, an increased professional risk due to the predominant use of the hands for dental technicians. Allergic contact dermatitis caused by MA involves directly exposed areas that are not covered by clothes or individual protection devices and can be correlated with a lack of or inadequate use of personal protective equipment.

In order to avoid contact dermatitis, health practitioners should recognize possible occupational hazards in dentistry and should adopt preventive measures.

The preventive measures should include the proper use of personal protective equipment, including gloves, protective eyewear, face shields, and disposable gowns.

No-touch techniques are important in order to avoid skin exposure to these chemicals [18]. The nitrile rubber gloves provide better protection against permeation by MA with higher resistance to permeation and a lower permeation rate of the monomers [19]. Moreover, gloves should be changed frequently. The adoption of such primary preventive measures can be useful in preventing new cases of contact dermatitis, which may lead to a change of occupation.

Patch testing is needed for a complete evaluation of occupational skin allergy due to MA in dental personnel.

The principles of the 1975 Declaration of Helsinki revised in 2013 were followed in this study.

Author Contributions: N.C.: supervision; study design; conceptualization; methodology; writing—original draft; database strategy research; and acquisition of data. M.M.: conceptualization; writing—original draft; methodology; and data curation. F.P.: review and editing; visualization; critical revision of the manuscript; and writing. M.S.: review and editing; visualization; and critical revision of the manuscript; A.C.: resources; study design; conceptualization; methodology; supervision; and data curation. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethical review and approval were waived for this study because it was a retrospective study performed on a database.

Informed Consent Statement: Patient consent was waived because it was a retrospective study performed on a database.

Data Availability Statement: Data is contained within the article.

Conflicts of Interest: The authors declare that they have no competing financial interests or other potential conflict of interest.

References

1. Lyapina, M.; Dencheva, M.; Krasteva, A.; Tzekova, M.; Kisselova-Yaneva, A. Concomitant contact allergy to formaldehyde and methacrylic monomers in students of dental medicine and dental patients. *Int. J. Occup. Med. Environ. Health* **2014**, *27*, 797–807. [[CrossRef](#)] [[PubMed](#)]
2. Luo, S.; Liu, F.; He, J. Preparation of low shrinkage stress dental composite with synthesized dimethacrylate oligomers. *J. Mech. Behav. Biomed. Mater.* **2019**, *94*, 222–228. [[CrossRef](#)] [[PubMed](#)]
3. Rodrigues, S.B.; Petzhold, C.L.; Gamba, D.; Leitune, V.C.B.; Collares, F.M. Acrylamides and methacrylamides as alternative monomers for dental adhesives. *Dent. Mater.* **2018**, *34*, 1634–1644. [[CrossRef](#)] [[PubMed](#)]
4. Fugolin, A.P.; Dobson, A.; Mbiya, W.; Navarro, O.; Ferracane, J.L.; Pfeifer, C.S. Use of (meth)acrylamides as alternative monomers in dental adhesive systems. *Dent. Mater.* **2019**, *35*, 686–696. [[CrossRef](#)]
5. Rolls, S.; Rajan, S.; Shah, A.; Bourke, J.; Chowdhury, M.; Ghaffar, S.; Green, C.; Johnston, G.; Orton, D.; Reckling, C.; et al. (Meth)acrylate allergy: Frequently missed? *Br. J. Dermatol.* **2018**, *178*, 980–981. [[CrossRef](#)]
6. Ramos, L.; Cabral, R.; Gonçalo, M. Allergic contact dermatitis caused by acrylates and methacrylates—A 7-year study. *Contact Dermat.* **2014**, *71*, 102–107. [[CrossRef](#)] [[PubMed](#)]

7. Muttardi, K.; White, I.R.; Banerjee, P. The burden of allergic contact dermatitis caused by acrylates. *Contact Dermat.* **2016**, *75*, 180–184. [[CrossRef](#)]
8. Lazarov, A. Sensitization to acrylates is a common adverse reaction to artificial fingernails. *J. Eur. Acad. Dermatol. Venereol.* **2007**, *21*, 169–174. [[CrossRef](#)] [[PubMed](#)]
9. Walters, G.I.; Robertson, A.S.; Moore, V.C.; Burge, P.S. Occupational asthma caused by acrylic compounds from SHIELD surveillance (1989–2014). *Occup. Med.* **2017**, *67*, 282–289. [[CrossRef](#)]
10. Aalto-Korte, K.; Henriks-Eckerman, M.-L.; Kuuliala, O.; Jolanki, R. Occupational methacrylate and acrylate allergy—cross-reactions and possible screening allergens. *Contact Dermat.* **2010**, *63*, 301–312. [[CrossRef](#)] [[PubMed](#)]
11. Koppula, S.V.; Fellman, J.H.; Storrs, F.J. Screening allergens for acrylate dermatitis associated with artificial nails. *Am. J. Contact Dermat.* **1995**, *6*, 78–85. [[CrossRef](#)]
12. Aalto-Korte, K.; Alanko, K.; Kuuliala, O.; Jolanki, R. Methacrylate and acrylate allergy in dental personnel. *Contact Dermat.* **2007**, *57*, 324–330. [[CrossRef](#)]
13. Goon, A.T.; Isaksson, M.; Zimerson, E.; Goh, C.L.; Bruze, M. Contact allergy to (meth)acrylates in the dental series in southern Sweden: Simultaneous positive patch test reaction patterns and possible screening allergens. *Contact Dermat.* **2006**, *55*, 219–226. [[CrossRef](#)]
14. Rustemeyer, T.; De Groot, J.; Von Blomberg, B.; Frosch, P.; Scheper, R. Cross-Reactivity Patterns of Contact-Sensitizing Methacrylates. *Toxicol. Appl. Pharmacol.* **1998**, *148*, 83–90. [[CrossRef](#)] [[PubMed](#)]
15. Stevenson, W. Methyl methacrylate dermatitis. *Contact Point.* **1941**, *18*, 171.
16. Henriks-Eckerman, M.L.; Suuronen, K.; Jolanki, R.; Alanko, K. Methacrylates in dental restorative materials. *Contact Dermat.* **2004**, *50*, 233–237. [[CrossRef](#)]
17. Isaksson, M.; Zimerson, E.; Svedman, C. Occupational airborne allergic contact dermatitis from methacrylates in a dental nurse. *Contact Dermat.* **2007**, *57*, 371–375. [[CrossRef](#)]
18. Thomas, S.; Padmanabhan, T.V. Methyl methacrylate permeability of dental and industrial gloves. *N. Y. State Dent. J.* **2009**, *75*, 40–42.
19. Lönnroth, E.-C.; Wellendorf, H.; Ruyter, E. Permeability of different types of medical protective gloves to acrylic monomers. *Eur. J. Oral Sci.* **2003**, *111*, 440–446. [[CrossRef](#)] [[PubMed](#)]