

Occupational dermatitis in dental personnel: contact dermatitis with special reference to (meth)acrylates in 174 patients

K. WRANGSJÖ^{1,2}, C. SWARTLING¹ AND B. MEDING^{1,2}

¹Occupational and Environmental Dermatology, Department of Medicine, Karolinska Institutet and Stockholm County Council, Stockholm, Sweden

²Occupational Dermatology, National Institute for Working Life, Stockholm, Sweden

Between 1995 and 1998, 174 dental personnel were referred as patients to the Department of Occupational and Environmental Dermatology, Stockholm. After clinical examination, 131 were patch tested with the Swedish standard series and 109 with a dental screening series. Furthermore, 137 were tested for IgE-mediated allergy to natural rubber latex (NRL). Hand eczema was diagnosed in 109/174 (63%), 73 (67%) being classified as irritant contact dermatitis and 36 (33%) as allergic. Further diagnoses included other eczemas, urticaria, rosacea, psoriasis, tinea pedis, bullous pemphigoid or no skin disease. 77/131 (59%) had positive reactions to substances in the standard series and 44/109 (40%) to substances exclusive to the dental series. 24/109 (22%) patients had positive reactions to (meth)acrylates, the majority with reactions to several test preparations. Reactions to HEMA (2-hydroxyethyl methacrylate), EGDMA (ethyleneglycol dimethacrylate) and MMA (methyl methacrylate) were most frequent. 9 of the 24 were positive only to (meth)acrylates, the remaining 15 also had reactions to allergens in the standard series. 23 of these had hand eczema and 1 facial eczema. In 17 of the 24 allergic to (meth)acrylates, the dermatitis had started in 1995 or later, in 15 within the previous 12 months. Of 8 who had been sick-listed, 7 also had a history of atopy and 6 were allergic to nickel. The most frequent allergens besides (meth)acrylates were nickel, cobalt, palladium, fragrance mix, colophonium and thiuram mix. Allergy to natural rubber latex was diagnosed in 14/137 (10%). In conclusion, irritant hand dermatitis was the dominant diagnosis. Contact allergy to (meth)acrylate was seen in 22% of the patch tested patients, with reactions to 3 predominant test substances. 1/3 of the patients with allergy to (meth)acrylates had been sick-listed for dermatitis, but in all these cases the (meth)acrylate allergy was seen together with atopy and/or further contact allergies.

Key words: contact dermatitis; dentistry; hand eczema; (meth)acrylates; patch testing; occupational; atopy. © Munksgaard, 2001.

Accepted for publication 10 May 2001

Dental professionals risk contracting occupational skin diseases. Frequent hand washing, prolonged glove use and exposure to skin irritating and sensitizing chemicals, in particular (meth)acrylate monomers, are recognised as risk factors for hand eczema (1–5). Glove intolerance and IgE-mediated allergy to natural rubber latex (NRL) are also reported as health hazards in dentistry (6).

Acrylate-containing systems have largely replaced amalgam as dental restorative material in Sweden, and since 1996, the regulations on thermosetting resins, issued by the Swedish National Board for Occupational Safety and Health, have also included dental personnel (7). These regulations prescribe medical examination of personnel

who occupationally handle 100 g or more of thermosetting plastic materials per year. Personnel must be examined before start of the exposed work and also if they develop eczema or asthma.

The inclusion of dental personnel in the regulations led to examination of the majority of Swedish dental personnel by the occupational health services during a rather short period. In Stockholm, it contributed to a rapid increase of referrals to the Department of Occupational and Environmental Dermatology. Skin complaints from dental professionals also showed temporarily an increased proportion of notified occupational skin diseases 1996–97 (8).

These signs of occupational skin health hazards

in dentistry were the background to this study. Its aim was to establish diagnoses and to investigate the occurrence of contact allergy and IgE-mediated allergy to NRL in dental personnel referred for examination at an occupational dermatology department.

Subjects, Methods and Materials

Subjects

174 patients, all dental personnel with skin disease possibly related to exposure in their working environment, were, during 1995 to 1998, referred to the Department of Occupational and Environmental Dermatology, Stockholm. In 1995–6, 32 patients were examined and in 1997–8, 142 patients.

The group consisted of 141 women and 33 men (32 dentists and 1 dental technician). The mean age was 45 years (range 25–68). 79 dentists, 85 dental nurses, 8 hygienists and 2 technicians were included. After history and clinical examination, 137 patients were patch tested, 131 with the Swedish standard series and 109 with a dental screening series. Also 137 were tested for IgE-mediated allergy to NRL, 118 with CAP-RAST, and 79 with prick test.

Clinical records

Clinical data from the patients' records were compiled retrospectively. Information was collected concerning medical examinations, diagnoses, history of hand eczema and atopy, test reactions and sick-leave due to skin disease. Notes were made if change of occupation or occupational tasks had been brought up for discussion. Patients with previous or current atopic dermatitis, allergic rhinitis/conjunctivitis or allergic asthma were classified as atopics.

In cases of hand eczema, a main diagnosis of either allergic contact dermatitis or irritant contact dermatitis was made, depending on the overall information on history, morphology, localization, time course, exposure and results of patch testing. The diagnosis of allergy to NRL required a positive prick test and/or positive CAP-RAST to NRL allergens. Other skin diagnoses were registered according to criteria presented in dermatological textbooks.

Patch testing

Patch testing was performed with the Swedish standard series and a dental screening series including 11 acrylate test preparations supplied by Chemotechnique Diagnostics AB, Sweden. 2 additional allergens were included, glutaraldehyde

and metol, both supplied by Chemotechnique. Finn Chambers (Epitest Ltd Oy, Finland) and Scanpor tape (Norgesplaster A/S, Norway) were used for allergen application. The application time was 2 days and readings were done 3 or 4 days after application, and if possible, also after 5–7 days. The test results were classified according to established methods (9).

Prick testing and serum analyses

Prick tests were performed on the forearm, with a commercial NRL extract (Stallergènes, Antony, France). Histamine dihydrochloride 10 mg/ml and saline were used as positive and negative controls. Prick test responses were regarded as positive if the wheal mean diameter was at least 1/2 that of the histamine wheal and there was no reaction to the negative control. Blood samples were collected and specific IgE antibody measurements were made to NRL (CAP RAST k82 Pharmacia). Specific IgE-concentrations of ≥ 0.35 kU/l were regarded as positive.

Results

Diagnoses

Hand eczema was diagnosed in 109/174 (63%) of the patients examined: of these, 73 (67%) were classified as irritant contact dermatitis and 36 (33%) as allergic. The occupational distribution in the hand eczema group was 44 dentists, 62 dental nurses and 3 hygienists. In the 65 patients without hand eczema, the following diagnoses were represented: other eczemas 31 (atopic, seborrhoeic, facial, nummular, unspecified, or contact allergic without hand eczema), urticaria 12 (including dermographism, contact urticaria). Other diagnoses were; rosacea, psoriasis, tinea pedis, bullous pemphigoid, palmar erythema and pruritus. 14 cases had no skin disease.

Patch testing

77/131 (59%) presented at least 1 positive patch test reaction to substances in the standard series and 44/109 (40%) to substances exclusive to the dental series. In the standard series, 161 positive reactions were found and in the dental series 112. All positive patch test reactions from the two series are presented in Table 1. The most common allergen was nickel 37%, (females 44%, males 8%). Further, the allergens most frequently seen positive in the standard series were; cobalt 17%, fragrance mix 12%, colophonium 8% and thiuram mix 8%.

24/109 (22%) patients tested with the dental series had positive reactions to (meth)acrylates, the

Table 1. % of positive patch test reactions to substances in the standard series; $n=131$ (24 male, 107 female) and the extended dental series $n=109$ (20 male, 89 female)

Substance	Concentration (%)	Total (%)	Male (%)	Female (%)
<i>Standard series</i>				
nickel sulfate	5.0	37	8	44
cobalt chloride	0.5	17	4	20
fragrance mix	8.0	12	8	13
colophonium	20.0	8	8	8
thiuram mix	0.25	8	8	8
balsam Peru (Mytoxylon Pereirae resin)	25.0	6	0	7
potassium dichromate	0.5	5	0	7
formaldehyde	1.0	4	4	4
quaternium-15	1.0	2	4	2
PPDa rubber mix	0.6	2	4	2
primin	0.01	2	0	3
diazolidinyl urea	2.0	2	4	2
4-para-phenylenediamine	1.0	2	0	3
lichen acid mix	0.1	2	0	3
tosylamide/formaldehyde resin (TSA)	10.0	2	0	3
neomycin sulfate	20.0	2	0	2
epoxy resin	1.0	2	4	1
Cl+Me-isothiazolinone (Kathon CG)	0.02	2	0	2
sesquiterpenlactone mix	0.1	1	0	1
4-tert-butylphenol formaldehyde resin	1.0	1	0	1
ethylendiamine dihydrochloride	1.0	1	0	1
Amerchol L-101	50.0	1	0	1
caine mix II	10.0	1	0	1
budesonide	0.1	1	4	0
<i>Dental series</i>				
2-hydroxyethyl methacrylate (HEMA)	2.0	21	25	20
ethyleneglycol dimethacrylate (EGDMA)	2.0	18	20	18
methyl methacrylate (MMA)	2.0	15	15	15
palladium chloride	2.0	11	0	13
tetrahydrofurfuryl methacrylate (THFMA)	2.0	7	10	7
triethylenglycol dimethacrylate (TREGDMA)	2.0	7	10	7
gold sodium thiosulfate	0.5	6	0	8
mercury	0.5	6	0	7
1,4-butanediol dimethacrylate (BUDMA)	2.0	6	5	6
N,N-dimethylaminoethyl metacrylate	0.2	4	5	3
glutaraldehyde*	0.2	3	0	3
urethane dimethacrylate (UEDMA)	2.0	2	0	2
2,2-bis-(4-(2-hydroxy-3-methacryloxypropoxy)BIS-GMA)	2.0	2	0	2
methylhydrokinon	1.0	2	0	2
metol*	1.0	2	0	2

Petrolatum was used as vehicle for all substances except formaldehyde, germall II and Kathon CG, where water was used.

* Additional allergens.

majority reacting to several test preparations. Reactions to HEMA, EGDMA and MMA were the most frequent. The pattern of positive test reactions to (meth)acrylates is shown in Table 2. 9 of these 24 patients were positive to (meth)acrylate substances only, the remaining 15 having further contact allergies (13 to nickel and/or cobalt). 2 of 11 acrylates in the dental screening series did not elicit any positive reactions, BIS-MA (2,2bis(4-(methacryloxy)phenyl)propane) and HDDA (1,6-hexanediol diacrylate). In the extended dental series, reactions were also seen to gold sodium thiosulfate 6%, mercury 6%, glutaraldehyde 3% and metol 2% (Table 2).

Prick testing and serum analyses

Allergy to NRL was diagnosed in 14/137 patients examined (10%): 6 dentists, 6 nurses, and 2 hygienists. 12/79 had a positive prick test and 6/118 had a positive CAP-RAST to NRL.

Clinical data and consequences of skin disease

History of previous and/or current atopic diseases was found in 43 (39%) patients with hand eczema. Clinical information about the 24 patients with acrylate allergy is summarized in Table 2. 23 of these were diagnosed with hand eczema, all but 1 involv-

Table 2. Positive patch test reactions and clinical data in 24 dental personnel with contact allergy to (meth)acrylates, 23 with hand eczema and 1 with facial eczema*

Age (years) sex	2-HEMA	EGDMA	MMA	TREDGMA	THFMA	BUDMA	N,N-Dimethyl- aminoethyl methacrylate	UEDMA	BIS-GMA	Other positive patch test reactions	Duration of eczema (years)	Atopy history	Sick-leave
<i>Dentists</i>													
49/f	pos	pos	pos				pos			Ni, thiuram mix, ethylenediamine, metol	<1	+	+
64/m	pos	pos	pos	pos						Ni, PPDa, epoxy	31	-	-
52/f*								pos		Ni, caine mix II, metol	<1	-	-
63/f	pos	pos	pos							Ni, Co	<1	-	+
40/f	pos	pos								Co, fragr.mix	<1	-	-
43/f	pos	pos								mercury	<1	+	-
61/m	pos	pos	pos	pos	pos	pos					6	-	-
60/m	pos	pos	pos	pos							<1	+	+
60/m	pos	pos	pos	pos							2	-	-
37/f	pos	pos	pos					pos	pos		<1	-	-
39/m	pos	pos	pos								<1	-	-
<i>Dental nurses</i>													
36/f	pos	pos								Ni, Co, fragr.mix, colophonium, palladium	<1	-	-
41/f	pos	pos	pos							Ni, fragr.mix, Kathon CG, Amerchol L-101	25	+	+
25/f	pos	pos	pos	pos	pos					Ni, Co, mercury, glutaraldehyde	2	-	-
50/f	pos	pos	pos							Ni, Co, fragr.mix	<1	-	-
49/f	pos	pos	pos	pos	pos	pos	pos			Ni, colophonium, balsam of Peru	5	+	+
43/f	pos	pos	pos	pos	pos	pos				Ni, Co, methylhydrokinon	4	+	+
63/f	pos	pos	pos	pos	pos	pos				Ni, Co	<1	+	+
50/f	pos	pos	pos	pos	pos	pos				Ni, Co	<1	-	-
54/f	pos	pos	pos							TSA	10	+	+
57/f	pos	pos	pos					pos			3	+	-
51/f	pos	pos	pos	pos	pos	pos					<1	+	-
44/f	pos	pos	pos	pos	pos	pos	pos				<1	+	-
40/f	pos	pos	pos		pos	pos					<1	-	-

* Facial eczema.

ing the fingers, and 1 had facial eczema. In 17 patients, the dermatitis had started in 1995 or later, in 15 within the previous 12 months. In the 48 patients allergic to nickel, 34 had a history of hand eczema and 14 had ongoing hand eczema at examination.

Of the 174 patients, 16% had been sick-listed for skin disease: 10 dentists, 16 nurses and 2 hygienists. Among these, 8 patients were allergic to (meth)acrylates, 14 to nickel and 6 to both. 7/8 patients allergic to (meth)acrylates who had been on sick-leave also had a history of atopy, and 6 were allergic to nickel (Table 2). Notes on discussion of occupational changes were found in the records of 23 patients (4 dentists, 18 nurses, 1 hygienist). In this group, 10 had contact allergy to (meth)acrylates and 6 of these had also a history of atopy.

Among the 14 patients sensitized to NRL, atopic history was found in 8, and hand eczema in 7. One was also patch test positive to thiuram rubber chemicals. 2/14 patients allergic to NRL had been on sick-leave and 5 had discussed change of tasks/occupation.

Discussion

Hand eczema classified as irritant in origin was the most common diagnosis, as also seen in previous studies of Swedish dentists (4). Contact allergy to (meth)acrylates was found in 24 (22%) of the patients tested and IgE-mediated allergy to NRL in 14 (10%). Hand eczema, however, the main expression of occupational contact dermatitis, was diagnosed in only 63% of the patients. When occupational health services are screening for occupational skin diseases, a mixture of patients are referred to specialist departments. This was also found in our study: several patients lacked signs of occupational skin disease, and thus there was no reason for patch testing.

In the pattern of contact allergies, we found the majority of reactions to contact allergens in the standard series and almost 2/3 of the (meth)acrylate-allergic patients had concomitant allergy to such allergens, mainly nickel.

Several studies of contact allergy to acrylates in dental professionals have been published (1, 4, 10–13). The prevalence among dentists has been estimated to be less than 1% up to 2% (3, 4). In previously tested Swedish populations of dental personnel with reported skin symptoms, contact allergy to acrylates has been verified in 5%–10% by patch testing (4, 10). We found 22%, probably because many of our patients had been actively referred for significant clinical symptoms.

Whether the increased use of (meth)acrylates in dentistry has really led to an increased incidence of contact sensitization is not possible to calculate

from our study. In the Stockholm area, around 2,000 dentists and 3,500 dental nurses are estimated to be in clinical work. During the 4 years, we diagnosed 24 cases of allergy to (meth)acrylates, 17 with a history of skin symptoms starting between 1995–1998, the vast majority within the year before referral. Since we can assume that not all dental personnel with skin symptoms were referred to our department, only a cautious estimation can be made of a minimum incidence figure of around 1/1000 persons per year.

The Register of Occupational Diseases in Finland shows dentists to have the highest risk of developing allergic contact dermatitis compared to the general working population (12) and the risk may be increasing. Our findings support the suspicion of an increasing incidence, though from a low level.

How far sensitization to dental (meth)acrylates influences dental professionals' working ability is incompletely known. In a previous Swedish study of an unselected population of dentists, contact allergy to (meth)acrylate had no serious medical, social or occupational consequences (4). A different picture of the influence on working ability of sensitization to dental composite resins is given in a Finish study, in which 6/7 dental personnel could not continue in clinical dentistry (11). In our study, only 1/9 patients who were sensitized only to (meth)acrylates had been on sick-leave, compared to 7/15 patients with further contact allergies. Furthermore, history of atopy seemed to influence the need for sick-leave in the (meth)acrylate-sensitized group: 7/10 patients with a history of atopy had been on sick-leave but only 1/14 in the nonatopic group. Our findings thus indicate that contact sensitization to (meth)acrylates alone will not unconditionally lead to occupational disability in dental personnel.

Nevertheless, the importance of skin protection by gloves, no-touch product packaging and careful work techniques is unquestionable. What types of protective glove should be recommended in dentistry is not clear, though, since medical gloves for single use are not impermeable to various acrylate monomers (14–16). The breakthrough times for typical gloves of NRL or polyvinyl chloride are usually less than 10 min (16). In experimental settings, double gloves increase the breakthrough times considerably (16). In a recent study, the combination of a thin copolymer glove under a medical glove for single use offered the best protection (17).

How to patch test with acrylates has long been under discussion. Cross-reactivity between different (meth)acrylate monomers, concomitant sensitization, as well as impurities with undeclared mixtures of monomers in preparations used at work and in

test substances, make accurate mapping of contact sensitization difficult (1, 18, 19). Initially, patch-test sensitization also constituted a problem (20), but this has now been diminished by lowering the patch test concentrations (1). Still, it remains desirable to minimize exposure on patch testing. In our study as well as in several previous ones (4, 11, 13), multiple, often strongly-positive patch test reactions are found. We would have identified all 23 (meth)acrylate-allergic patients with hand eczema had we tested with HEMA. HEMA may therefore be the main candidate for screening dental professionals for sensitization to (meth)acrylates.

Contact allergy to nickel was found at an astonishingly high rate, 44% in the females. One possible explanation could be that the majority of patients tested were referred at a health check-up, which may favour referrals of patients who themselves suspect contact allergies and therefore want to be patch tested. This may be the case in nickel-allergic females. Nickel also is found in dental instruments and tools and may initiate hand eczema in nickel-sensitized individuals as a cause of the referral to our department.

IgE-mediated allergy to NRL was found in 10% of the patients examined. This figure may reflect a low prevalence in the population of dental professionals in Stockholm (21), but may also reflect that these patients were referred to our department to trace those at risk of or with contact allergy to (meth)acrylates.

In conclusion, irritant hand dermatitis was the dominant diagnosis in referred dental personnel. Contact allergy to (meth)acrylate was seen in around 20% of the tested patients, with allergy to 3 predominant test substances, HEMA, EGDMA and MMA. 1/3 of the patients allergic to (meth)acrylates had been on sick-leave for dermatitis, but in all these cases, the (meth)acrylate allergy was seen together with atopy and/or further contact allergies.

Acknowledgements

We thank Marie Gidlund and Alkistis Nalbanti for epidemiological assistance, and Gunborg Lindahl for assistance with data processing.

References

1. Kanerva L, Estlander T, Jolanki R. Occupational skin allergy in the dental profession. *Dermatologic Clinics* 1994; 12: 517–532.
2. Örtengren U, Andreasson H, Karlsson S, Meding B, Barregård L. Prevalence of self-reported hand eczema and skin symptoms associated with dental materials among Swedish dentists. *Eur J Oral Sci* 1999; 107: 496–505.
3. Munksgaard E C, Hansen E K, Engen T, Holm U. Self-reported occupational dermatological reactions among Danish dentists. *Eur J Oral Sci* 1996; 104: 396–402.

4. Wallenhammar L M, Örtengren U, Andreasson H, Barregård L, Björkner B, Karlsson S, Wrangsjö K, Meding B. Contact allergy and hand eczema in Swedish dentists. *Contact Dermatitis* 2000; 43: 192–199.
5. Burke F J T, Wilson N H F, Cheung S W. Factors associated with skin irritation of the hands experienced by general dental practitioners. *Contact Dermatitis* 1995; 32: 35–38.
6. Hamann C P, Turjanmaa K, Rietschel R, Siew C, Owensby D, Gruninger S E, Sullivan K M. Natural rubber latex hypersensitivity: incidence, prevalence of type I allergy in the dental professional. *JADA* 1998; 129: 433–454.
7. Arbetarskyddstyrelsens kungörelse med föreskrifter om hårdplaster samt allmänna råd om tillämpningen av föreskrifterna. *AFS* 1996; 4.
8. Börje Bengtsson, personal communication. Statistics Division, Swedish Work Environment Authority.
9. Wahlberg J E. Patch Testing. In: Rycroft R J G, Menné T, Frosch P J (eds.): *Textbook of contact dermatitis*, 2nd edition. Berlin: Springer-Verlag, 1995: 237–268.
10. Lindberg M, Silverdahl M. The use of protective gloves and the prevalence of hand eczema, skin complaints and allergy to natural rubber latex among dental personnel in the county of Uppsala, Sweden. *Contact Dermatitis* 2000; 43: 44–48.
11. Kanerva L, Estlander T, Jolanki R. Allergic contact dermatitis from dental composite resins due to aromatic epoxy acrylates and aliphatic acrylates. *Contact Dermatitis* 1989; 20: 201–211.
12. Kanerva L, Lahtinen A, Toikkanen J, Forss H, Estlander T, Susitaival P, Jolanki R. Increase in occupational skin diseases of dental personnel. *Contact Dermatitis* 1999; 40: 104–108.
13. Kiec-Swierczynska M. Occupational allergic contact dermatitis due to acrylates in Lodz. *Contact Dermatitis* 1996; 34: 419–422.
14. Munksgaard E C. Permeability of protective gloves to (di)methacrylates in resinous dental materials. *Scand J Dent Res* 1992; 100: 189–192.
15. Munksgaard E C. Permeability of protective gloves by HEMA and TEGDMA in the presence of solvents. *Acta Odont Scand* 2000; 58: 57–62.
16. Mäkelä E A, Väänänen V, Alanko K, Jolanki R, Estlander T, Kanerva L. Resistance of disposable gloves to permeation by 2-hydroxyethyl methacrylate and triethyleneglycol dimethacrylate. *Occupational Hygiene* 1999; 5: 121–129.
17. Boman A, Rönndell E, Sandborgh-Englund G, Wiater-Adamczak E, Lidén C. *Contamination and protection during dental work*. 12th International Contact Dermatitis Symposium, 15–18 October 1999, San Francisco, CA, USA.
18. Rustemeyer T, De Groot J, Von Blomberg B M E, Frosch P J, Scheper R J. Cross-Reactivity Patterns of Contact-Sensitizing Methacrylates. *Toxicology and Applied Pharmacology* 1998; 148: 83–90.
19. Kanerva L, Jolanki R, Estlander T. 10 years of patch testing with the (meth)acrylate series. *Contact Dermatitis* 1997; 37: 255–258.
20. Kanerva L, Estlander T, Jolanki R. Sensitization to patch test acrylates. *Contact Dermatitis* 1988; 18: 10–15.
21. Warshaw E M. Latex allergy. *J Am Acad Dermatol* 1998; 39: 1–24.

Address:

K. Wrangsjö
Occupational and Environmental Dermatology
Department of Medicine
Karolinska Institutet
Stockholm
Sweden