

Case report

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Allergic contact gingivostomatitis from a temporary crown made of methacrylates and epoxy diacrylates

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methacrylate; stomatitis; temporary crown.

Occupational allergic contact dermatitis caused by (meth)acrylates is common in dental personnel, whereas dental acrylic fillings and crowns have rarely been reported to cause problems in dental patients. Here we report on a 48-year-old woman who developed gingivitis, stomatitis, and perioral dermatitis after a temporary crown made of restorative, two-component material had been inserted. The manufacturer stated that the temporary crown base paste and catalyst contained three (meth)acrylates, namely, a proacrylate, which is a modification of 2,2-bis[4-(2-hydroxy-3-methacryloxypropoxy)phenyl]propane (BIS-GMA); a tricyclate, which is a saturated, aliphatic, tricyclic methacrylate; and urethane methacrylate. The manufacturer refused to give more exact information on the (meth)acrylates. Patch testing revealed that the patient was highly allergic to BIS-GMA, other epoxy diacrylates, and (meth)acrylates, as well as to the base paste and catalyst of the temporary crown. Accordingly, it was concluded that the allergic reaction was caused by BIS-GMA, or a cross-reacting (meth)acrylate, or other (meth)acrylates in the temporary crown.

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Occupational allergic contact dermatitis caused by (meth)acrylates is often reported in dental personnel (1–3), whereas dental acrylic fillings and crowns have rarely caused problems in dental patients (4–9). Here we report on a 48-year-old woman who developed gingivitis, stomatitis, and perioral dermatitis after an acrylate-based temporary crown had been inserted.

Case report and Material and methods

The upper front tooth of a 48-year-old female patient, who was highly allergic to (meth)acrylates and epoxy acrylates (9), split down to the root. The tooth had to be removed, and a temporary crown made of restorative, two-component material was inserted. Within half an hour, the patient felt thickness in her throat, and the next day her upper lip and gum started to swell. We saw her the next day when her upper lip was considerably swollen, exhibiting stomatitis and vesicular eczema. She also had perioral dermatitis, angular cheilitis, gingivitis, and macular erythema on the cheeks and the neck. Peroral corticosteroid therapy was started, but the swelling increased and the temporary crown had to be removed. Her symptoms then subsided.

Patch testing and scoring were performed, as previously described (9, 10), with the (meth)acrylate series (Chemotechnique Diagnostics AB, Malmö, Sweden). They showed the patient's extreme sensitivity to several epoxy di(meth)acrylates, which gave 3+ allergic reactions even with very low patch test concentrations (down to 0.001%, Table 1). Prick tests with a series of (meth)acrylates were negative.

The dentist had used the two-component Protemp Garant® base paste and catalyst (Espe Dental-Medizin GmbH, Germany) for the patient's temporary crown. The base and catalyst also gave very strong patch test reactions (Table 1, Fig. 1). According to the Finnish material safety data sheet (MSDS), the base paste was acrylate-based, but no hazardous components were declared. The manufacturer then informed us that the base paste contained "bismethacrylates, tertiary amines, polymers, strontium glass silanized, silicic acid, stabilizers, and pigments", whereas the catalyst paste contained "Z-acetate, peroxide, strontium glass silanized, and silicic acid".

As this information was unsatisfactory, we requested more exact data (Table 2). The organ matrix was now reported to be a combination of three comonomers: "(a) a proacrylate, a modification of the Bowen resin, in which the hydrophilic hydroxyl groups are replaced, (b) a tricyclate, a saturated, aliphatic, tricyclic methacrylate, and (c) urethane methacrylate."

We then asked for more exact chemical names and CAS numbers of the above (meth)acrylates, but the manufacturer informed us that "we cannot provide more information on the substances used in Protemp Garant® as you already received the composition and our product dossier. Because of know-how-reasons it is not possible to reveal the chemical structure and the CAS numbers."

Discussion

From the above information, we could assume that the patient's reaction to the temporary crown was caused by her allergy to (meth)acrylates and/or epoxy diacrylates in the temporary crown. According to the manufacturer, the crown contained a modification of Bowen's resin, 2,2-bis[4-(2-hydroxy-3-methacryloxypropoxy)phenyl]propane (BIS-GMA), to which the patient was extremely allergic. As the patient developed allergic symptoms from the first contact with Protemp Garant, it is likely that the "modification of Bowen's resin" contained BIS-GMA, a product that cross-reacted with BIS-GMA, or with BIS-GA or BIS-EMA, which had provoked allergic patch test reactions in our patient (Table 1). On patch testing, our patient did not react to urethane (meth)acrylates. We do not have details of the third methacrylate; namely, "the tricyclate, a saturated, aliphatic, tricyclic methacrylate". In conclusion, it was apparent that the strong allergic reaction was caused, at least partly, by BIS-GMA and/or other epoxy diacrylates.

Acrylics are strong occupational sensitizers, especially for dental personnel (1), but sensitization of patients to dental acrylics other than conventional dental prostheses (11–14) is rare (4–9). Our patient had earlier been shown to have extreme sensitivity to epoxy diacrylates; e.g., BIS-GMA. Nevertheless, her symptoms after visits to her dentist had earlier been mild, even though she was exposed to (meth)acrylates (9). Apparently, the dentist therefore thought that he could use restorative materials containing acrylates. Furthermore, the MSDS that the dentist had at his disposal declared no harmful components.

BIS-GMA is the most widely used epoxy di(meth)acrylate in dental resins (10, 16). Other epoxy di(meth)acrylates, such as 2,2-bis[4-(2-methacryloxyethoxy)phenyl]propane (BIS-EMA), 2,2-bis[4-(methacryloxy)phenyl]propane (BIS-MA), and 2,2-bis[4-(3-methacryloxypropoxy)phenyl]propane (BIS-PMA), are also used in dental composite resins (16, Fig. 2). New epoxy di(meth)acrylates, e.g., *n*-tolylglycine glycidyl methacrylate, CAS 133736-31, and biphenyl dimethacrylate, CAS 125086-31-9 (ALL-BOND®, Bisco, Itasca, IL, USA), have also been used but have not been reported as allergenic. Patients allergic to BIS-GMA have shown allergic patch test reactions to other epoxy di(meth)acrylates (10), possibly due to cross-reactivity (1, 17).

Agner & Menné (6) had a patient who developed edema, erythema, and ulceration of the mucosa of the upper lip after a dentist used acrylates to fill her front teeth. Patch testing with BIS-GMA was negative, whereas strong reactions were

Table 1. Patient's patch test reactions to (meth)acrylates series (Chemotechnique Diagnostics AB, Malmö, Sweden), "own" methacrylate compounds (Protemp Garant), and diglycidyl ether of bisphenol A epoxy resin (summarized from four patch test sessions). Scoring scheme: –, negative; ?+, doubtful reaction; +, weak (nonvesicular) reaction; ++, strong (edematous or vesicular) reaction; +++, extreme (bullous or ulcerative reaction). ?+ is faint or macular erythema and was not interpreted as proven allergic reaction; ++++ reactions were interpreted as allergic reactions

(Meth)acrylate series	Abbreviation	Patch test concentration (%) (w/w) (all allergens in petrolatum)	Patch test reaction
Ethyl acrylate	EA	0.1	–
Butyl acrylate	BA	0.1	–
2-Ethylhexyl acrylate	2-EHA	0.1	–
2-Hydroxyethyl acrylate	2-HEA	0.1	–
2-Hydroxypropyl acrylate	2-HPA	0.1	–
Methyl methacrylate	MMA	2	–
Ethyl methacrylate	EMA	2	–
<i>n</i> -Butyl methacrylate	BMA	2	–
2-Hydroxyethyl methacrylate	2-HEMA	2	3+
2-Hydroxypropyl methacrylate	2-HPMA	2	2+
Ethyleneglycol dimethacrylate	EGDMA	2	1+
Triethyleneglycol dimethacrylate	TREGDMA	2	?+
1,4-Butanediol dimethacrylate	BUDMA	2	–
Urethane dimethacrylate	UDMA	2	–
2,2-bis[4-(2-methacryloxyethoxy)phenyl]propane	BIS-EMA	1	3+
2,2-bis[4-(2-methacryloxyethoxy)phenyl]propane	BIS-EMA	0.01	2+
2,2-bis[4-(2-methacryloxyethoxy)phenyl]propane	BIS-EMA	0.003-0.001	?+
2,2-bis[4-(2-methacryloxyethoxy)phenyl]propane	BIS-EMA	0.0003-0.00001	–
2,2-bis[4-(methacryloxy)phenyl]propane	BIS-MA	2	?+
2,2-bis[4-(2-hydroxy-3-methacryloxypropoxy)phenyl]propane	BIS-GMA	2–0.001	3+
2,2-bis[4-(2-hydroxy-3-methacryloxypropoxy)phenyl]propane	BIS-GMA	0.0003	2+
2,2-bis[4-(2-hydroxy-3-methacryloxypropoxy)phenyl]propane	BIS-GMA	0.00001	1+
2,2-bis[4-(2-hydroxy-3-methacryloxypropoxy)phenyl]propane	BIS-GMA	0.00003–0.00001	–
1,6-Hexanediol diacrylate	HDDA	0.1	–
Diethyleneglycol diacrylate	DEGDA	0.1	–
Tripropyleneglycol diacrylate	TPGDA	0.1	–
Trimethylolpropane triacrylate	TMPTA	0.1	–
Pentaerythritol triacrylate	PETA	0.1	–
Oligotriacrylate 480	OTA 480	0.1	–
Epoxy diacrylate=2,2-bis[4-(2-hydroxy-3-acryloxypropoxy)phenyl]propane	BIS-GA	0.5–0.003	3+

Table 1. Continued

(Meth)acrylate series	Abbreviation	Patch test concentration (%) (w/w) (all allergens in petrolatum)	Patch test reaction
Epoxy diacrylate = (2, 2-bis[4-(2-hydroxy-3-acryloxypropoxy)phenyl] propane	BIS-GA	0.001	2 +
Epoxy diacrylate = (2, 2-bis[4-(2-hydroxy-3-acryloxypropoxy)phenyl] propane	BIS-GA	0.0003	? +
Epoxy diacrylate = (2, 2-bis[4-(2-hydroxy-3-acryloxypropoxy)phenyl] propane	BIS-GA	0.0001–0.000 01	–
Urethane diacrylate (aliphatic)	al-UDA	0.1	–
Urethane diacrylate (aromatic)	ar-UDA	0.05	–
Triethyleneglycol diacrylate	TREGDA	0.1	–
<i>N,N</i> -Methylenebisacrylamid	MBAA	1	–
Tetrahydrofurfuryl methacrylate	THFMA	2	–
Glycidyl methacrylate	GMA	0.1	–
<i>N,N</i> -Dimethylaminoethylmethacrylate	DMAEMA	0.2	–
Ethyl cyanoacrylate	ECA	2	–
Diglycidyl ether of bisphenol A epoxy resin	DGEBA-ER	1–0.003	3 +
Diglycidyl ether of bisphenol A epoxy resin	DGEBA-ER	0.001–0.0003	2 +
Diglycidyl ether of bisphenol A epoxy resin	DGEBA-ER	0.0001–0.000 01	–
Protemp Garant base paste		1–0.03	3 +
Protemp Garant base paste		0.01	2 +
Protemp Garant base paste		0.003–0.001	? +
Protemp Garant base paste		0.0003–0.000 01	–
Protemp Garant catalyst paste		1–0.03	3 +
Protemp Garant catalyst paste		0.01	2 +
Protemp Garant catalyst paste		0.003–0.0001	1 +
Protemp Garant catalyst paste		0.000 03–0.000 01	? +

induced by 2-hydroxyethyl methacrylate (2-HEMA; 3 +) and triethyleneglycol dimethacrylate (TREGDMA, 2 +).

Fissure sealants containing acrylics (e.g., Delton[®]) have been reported to cause asthmatic reactions and urticaria (18), but it is also possible that these symptoms were caused by components other than the acrylics. Nathanson & Lockhart (4) presented a patient with a measles-like rash and hives on the chest, arms, and legs. Patch testing with cured composite dental materials (Adaptic, Johnson & Johnson, East Windsor, NJ, USA; Nuvafile, L.D. Caulk Co., Milford, DE, USA) gave a positive reaction, but the components were not tested. BIS-GMA from dental acrylics was considered a possible cause of the symptoms. Hutchinson (19) reported on a patient who developed an allergic reaction shortly after the placement of Edgewise stainless-steel orthodontic brackets with Unite, a composite bonding agent. Patch testing revealed that he was allergic to the set composite and the catalyst paste. When the brackets were replaced by

stainless-steel orthodontic bands cemented with Poly F Zinc polycarboxylate cement, the patient became symptomless. The causative chemical was not identified.

Table 2. Composition of Protemp Garant temporary crown base paste and catalyst according to manufacturer

Base paste	% per weight
Bifunctional (meth)acrylate	70
Inorganic fillers	25
Vinyl copolymers	4
Initiators, stabilizers, and pigments	1
Catalyst	
Bifunctional (meth)acrylate	40
Inorganic fillers	56
Initiators and stabilizers	4
Filler components of Protemp Garant: strontium glass (50% < 4 µm; 100% < 12 µm); highly dispersed silicon dioxide.	

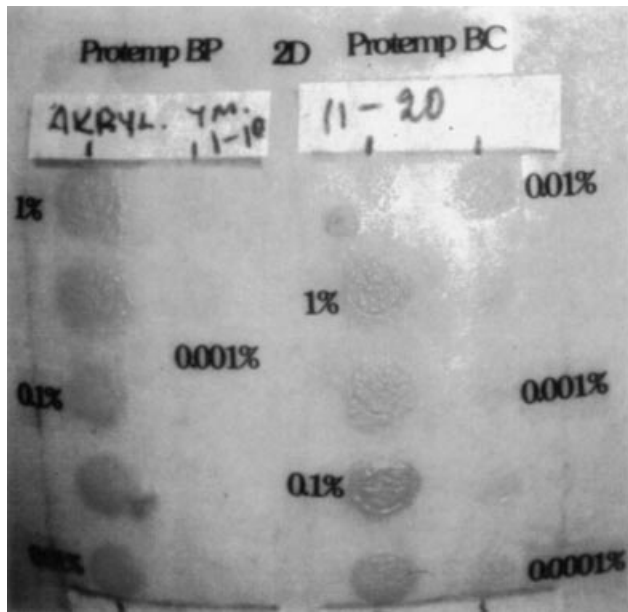
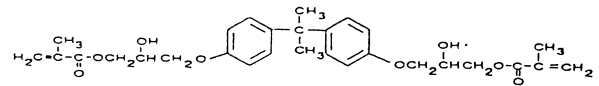


Figure 1. Allergic patch test reactions to components of patient's temporary crown at 2-day reading. Positive reactions were provoked by Protomp Garant base paste (Protomp BP) down to 0.001% and by Protomp Garant catalyst paste (Protomp BC) down to 0.0001%.

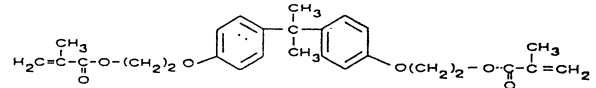
(Meth)acrylates have caused immediate allergic reactions in our clinic (20, 21), and our patient had her first symptoms already within half an hour after the restorative, two-component material was inserted. She was negative on prick testing with (meth)acrylates like more than 20 previous patients with occupational asthma from (meth)acrylates (20, 21). At a recent conference in Sweden, a patient with immediate reactions to epoxy diacrylates was reported to have had an allergic prick test reaction from BIS-GMA (unpublished). We are not aware of other patients who would have shown an allergic prick test reaction to (meth)acrylates, and the diagnosis of immediate allergy from (meth)acrylates requires other tests in addition to skin prick tests (19, 20). Recently, Bauer & Wollina claimed that they had a patient with an IgE-mediated acrylate reaction to a dental prosthesis, but they performed no prick tests or *in vitro* radioallergo-sorbent or other tests to show type I sensitization (22).

Our patient had extremely strong allergic reactions also to diglycidyl ether of bisphenol A epoxy resin (DGEBA-ER; Table 1). Earlier, several patients with occupational allergy to epoxy di(meth)acrylates have also had allergic patch test reactions to DGEBA-ER (8, 10). It is possible that DGEBA-ER and epoxy di(meth)acrylates cross-react (8). Some animal studies have indicated cross-reactivity (23), while others have not (24). On the other hand, dental acrylics contain minute amounts of DGEBA-ER as impurities (25–27), and the impurities could induce concomitant sensitization to DGEBA-ER and epoxy di(meth)acrylates.

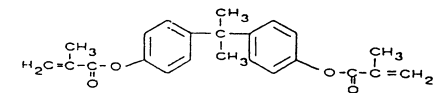
2,2-bis[4-(2-hydroxy-3-methacryloxypropoxy)phenyl]propane (BIS-GMA)



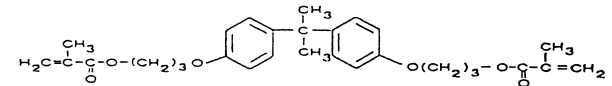
2,2-bis[4-(2-methacryloxyethoxy)phenyl]propane (BIS-EMA)



2,2-bis[4-(methacryloxy)phenyl]propane (BIS-MA)



2,2-bis[4-(3-methacryloxypropoxy)phenyl]propane (BIS-PMA)



2,2-bis[4-(2-hydroxy-3-acryloxypropoxy)phenyl]propane (BIS-GA)

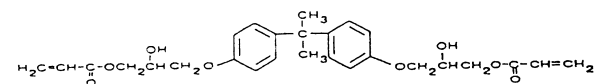


Figure 2. Chemical structure of epoxy di(meth)acrylates based on bisphenol A or epoxy resin.

Complex legal consequences can arise if patients occupationally sensitized to epoxy resin (e.g., DGEBA-ER) cannot use dental acrylics, and therefore need much more expensive dental devices. Should the insurance company covering the costs of the occupational disease caused by epoxy resin also be responsible for the costs if dental “nonacrylic” devices are necessary?

It has been shown that (meth)acrylates such as TREGDMA, hydroxyethyl methacrylate (2-HEMA), bisglycidyl methacrylate, and benzoyl peroxide can move into an aqueous medium from resin-based materials which are applied to teeth (28), and, accordingly, can induce both local and systemic side-effects in the patient. Therefore, we find it unacceptable that manufacturers of dental products refuse to give exact data on harmful agents. It cannot be acceptable to treat patients with dangerous chemicals and not disclose the data on the pretext that they are “trade secrets”. A sensitized patient also needs exact information on safe alternative materials for dental restoration without frustrating and expensive “trial-and-error” processes.

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