

ORIGINAL ARTICLE

Sensitization to acrylates is a common adverse reaction to artificial fingernails

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Keywords

acrylates, adverse reaction, allergic contact dermatitis, artificial nails, methacrylates

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Received: 19 December 2005,
accepted 3 April 2006

DOI: 10.1111/j.1468-3083.2006.01883.x

Abstract

Background Although precise figures for adverse reactions to nail-care products are not available, it is thought that one of the main risks from artificial nails (ANs) is contact allergy.

Objective To evaluate the role of allergic contact dermatitis (ACD) as a cause of adverse reactions related to the use of ANs.

Method A 4-year retrospective study of patients with suspected ACD from ANs was conducted. Patients tested with the methacrylate artificial nail (MAAN) series were evaluated clinically and patch test results were analysed.

Results ACD to components of ANs may be a frequent cause of hand eczema, as observed in more than one-third of our patients (38.2%). About half of the patients were beauticians specializing in nail sculpturing who developed occupationally related ACD. All patients had involvement of the hands and fingers. Paronychia, nail dystrophy and onycholysis were less frequent. Dorsal hands and fingers, forearms and distant sites (face and neck) were more frequently affected in patients with occupational ACD (OACD). Typical clinical features were those of chronic dermatitis but atypical forms such as lichenoid and psoriasiform ACD were also observed. Mucosal erythema and oedema developed in two patients with ACD due to MAAN, after application of dental crowns with an acrylate-based cement. The most frequent allergens triggering ACD were 2-hydroxyethyl methacrylate (2-HEMA) and 2-hydroxypropyl methacrylate (2-HPMA) (17.5% each), followed by ethyleneglycol dimethacrylate (EGDM; 13.4%). A quarter of the patients tested with ethyl cyanoacrylate (ECA), a component of nail glue, had positive results.

Conclusions Acrylic monomers used when sculpturing ANs are important contact and occupational sensitizers that can produce cross-reactions with other acrylic compounds and trigger allergic reactions when re-exposure occurs in a different setting.

Introduction

The use of artificial nails (ANs) as part of nail-care cosmetics has gained much popularity in developed countries. The various types of ANs include sculptured nails, preformed ANs (press-on nails) and nail wrapping (silk nails). Sculptured nails are the product of coatings that polymerize, whereas press-on nails and silk nails have to be glued on to the

natural or pre-existing artificial nails. Thus adverse reactions from contact with ANs can be related to allergic and irritant reactions to acrylates in the sculptured nails, to the glue used in the preformed nails and wrappings and to the top coating of nail varnishes. Although precise figures for the number of adverse reactions related to the use of nail-care products are not available,¹ it is thought that one of the main risks from ANs is contact allergy.²

Clinical diagnosis	No. of patients	Percentage
Irritant contact dermatitis (ICD)	19	34.5
Allergic contact dermatitis (ACD)	11	20
Occupational allergic contact dermatitis (OACD)	10	18.2
Occupational irritant contact dermatitis (OICD)	4	7.3
Atopic dermatitis	6	10.9
Dyshidrotic eczema	5	9.1
Total	55	100

Table 1 The dermatological diagnoses of our patients

To evaluate the role of allergic contact dermatitis (ACD) as a cause of adverse reactions related to the use of ANs, a retrospective study of patients with suspected ACD from ANs was conducted.

Patients and methods

All patients who had been tested with the methacrylate artificial nail (MAAN) series during a period of 4 years (2001–2004) and who were referred to our patch test clinic for investigation of ACD were included in this study. The patients were evaluated clinically and were patch tested with the European standard series, the MAAN series and additional allergens in personal cosmetics, including nail lacquer and ethyl cyanoacrylate, where appropriate. The nail lacquer was placed 'as is' on IQ chambers (Chemotechnique Diagnostics, Malmö, Sweden) and left to dry for at least 30 min before testing. Two patients with positive reactions to the MAAN series were also patch tested with the dental series.

Patch testing was performed using the IQ Chambers. The methodology of the procedure was in accordance with the International Contact Dermatitis Research Group (ICDRG) guidelines,³ with an application time of 2 days and readings performed on the second and third day after application. The clinical relevance of the positive reactions was evaluated. A positive reaction was considered to have current clinical relevance if the patient had cutaneous exposure to a product known to contain the allergen to which the patient reacted. The exposure assessment was based on information from packages and safety data sheets when available. Data were recorded on a standardized computer entry form and analysed statistically.

Results

The study was conducted on 55 female patients aged 20–68 years (mean age 44.5 years). Sixteen of the these patients suffered from seasonal rhinitis and/or asthma. All patients had been in contact with different types of ANs. Thirty-nine patients wore acrylic sculptured nails in which a monomer liquid and polymer powder are mixed

on the nail plate. Eight wore photo-bonded ('gel') nails that are applied as an ordinary nail lacquer and polymerization starts by means of a photo-bonding technique using a weak ultraviolet source. Only three of the patients had nail wraps (silk nails). The patients had been referred mainly because of hand eczema, which had been present for an average of six and a half months prior to consultation. Table 1 presents the dermatological diagnoses that were established after clinical examination and patch testing.

Of the 55 patients diagnosed with hand eczema, ACD to allergens from the MAAN series was observed in 21 (38.2%). Occupational allergic contact dermatitis (OACD) was diagnosed in 14 patients (25.5%), all of whom were professional beauticians specializing in nail sculpturing. Eleven of them were exposed to ANs only through their work while three wore ANs and applied them to others as well. Ten of the 14 (71.4%) had OACD and four (28.6%) had occupational irritant contact dermatitis (OICD). Three of the patients with OACD had pre-existing asthma, which had been exacerbated after the onset of the ACD.

All patients had involvement of the hands and fingers, with fingertip dermatitis being very common (fig. 1). Paronychia and involvement of the periungual area was seen in four of the patients (7.3%) and nail changes, including nail dystrophy and onycholysis, was present in five of them (9.1%). Patients with OACD had more frequent involvement of the lateral and dorsal hands and fingers and forearms than the non-occupational patients. Distant sites, namely the face and neck, were affected mainly in the occupational group (three of the 10 patients) (fig. 2). One of them had hand dermatitis and disseminated nummular-like lesions on the trunk and extremities, which completely involuted after stopping the contact with the artificial acrylic nails. In the non-occupational group, some atypical locations were observed to be affected, apart from hand dermatitis. These locations included the scalp and the vulva, for example.

The typical clinical features were those of chronic dermatitis. Erythematous-squamous patches with hyperkeratosis and fissures affecting the pulps of the fingers were much more common in the occupational-related group (five of 10) than in the non-occupational (two of 11)



fig. 1 Fingertip dermatitis: typical presentation of allergic contact dermatitis (ACD) from artificial nails (ANs).

patients. One patient from the occupational group had hand eczema that worsened and developed into a severe lichenoid eruption. Patch testing in the same patient produced a lichenoid eruption at the site of the positive reactions. Another patient diagnosed by her dermatologist as having palmo-plantar psoriasis was referred for investigation and treatment. The psoriasiform lesions appeared first on her palms and subsequently on her soles after having reapplied the acrylic nails, which she had been using for several months. After discontinuation of the acrylic nails and treatment with systemic steroids, the psoriasiform lesion disappeared and did not recur.

Painful mucosal erythema and oedema developed in two patients, one with OACD and another with ACD to MAAN, after application of dental crowns attached with an acrylate-based cement containing 2-hydroxyethyl methacrylate (2-HEMA).

Table 2 shows the patch test results of patients tested with the MAAN. Positive patch test reactions to allergens

from the MAAN series in the occupational and non-occupational groups are presented in Table 3. There were no differences in the frequency of sensitization in both the occupational and non-occupational groups. Strongly positive reactions were observed mainly in the OACD patients (fig. 3). Additional testing with ethyl cyanoacrylate (ECA) resulted in two positive reactions from the eight patients tested. One of 10 patients tested with their own nail varnish had positive reactions. Patch testing with the European standard series produced the following results: five positive reactions to nickel sulfate (41.7%), three to fragrance mix (25%) and two to cobalt chloride and isothiasolinone (16.7%). Patch testing with the dental series and MAAN series in two patients is presented in Table 4. None of the patients tested had positive reactions to 2, 2-bis (4-(2-hydroxy-3-methacryloxy-propoxyphenyl) propane (BisGMA) and 2, 2-bis (4-(2-methacryloxyethoxy) phenyl) propane (Bis-MA). All positive patch test reactions from the MAAN series, ECA and nail varnish had current clinical relevance in the patients with ACD and current occupational relevance in patients with OACD.

Discussion

ACD to components of ANs may be a frequent cause of hand eczema, as observed in more than one-third of our patients. OACD is common, accounting for about half of all patients with ACD to acrylates in ANs.

Adverse reaction to ANs may be present at a variety of sites including the site of application (the nail), the periungual area, and pulps of the fingers and hands, as observed in all of our patients with ACD. With respect to the occupational group, the lateral and dorsal parts of the hands were typically affected, most probably because of the contact of the hands with the surfaces of tables contaminated with acrylic allergens. Ectopic reactions, where the hand transfers small amounts of nail cosmetics to other areas of the skin, are not as common. Distant areas,



fig. 2 Distant sites of involvement in occupational allergic contact dermatitis (OACD).

Table 2 Patch test results with allergens from the MAAN series

Allergen in petrolatum	Abbreviation	Positive reactions	Percentage
Butyl acrylate 0.1%	BA	1	1.0
Ethylmethacrylate 2.0%	EMA	9	9.3
n-Butylmethacrylate 2.0%	BMA	3	3.1
2-Hydroxyethyl methacrylate 2.0%	2-HEMA	17	17.5
2-Hydroxypropyl methacrylate 2.0%	2-HPMA	17	17.5
Ethyleneglycol dimethacrylate 2.0%	EGDMA	13	13.4
Triethyleneglycol dimethacrylate 2.0%	TREGDMA	8	8.2
1,6-Hexanediol diacrylate 0.1%	HDDA	2	2.0
Trimethylolpropane triacrylate 0.1%	TMPTA	3	3.1
Tetrahydrofurfuryl methacrylate 2.0%	THFMA	6	6.2
Ethyl acrylate 0.1%	EA	8	8.2
2-Hydroxyethyl acrylate 0.1%	2-HEA	8	8.2
Triethyleneglycol diacrylate 0.1%	TREGDA	2	2.1
Total		97	100

Table 3 Comparison of patch test results with allergens from the MAAN series in occupational and non-occupational induced ACD

Allergen*	No. of positive reactions in the occupational cases	No. of positive reactions in the non-occupational cases
BA	0	1
EMA	3	6
BMA	3	0
2-HEMA	8	9
2-HPMA	9	8
EGDMA	7	6
TREGDMA	4	4
HDDA	1	1
TMPTA	1	2
THFMA	3	3
EA	4	4
2-HEA	4	4
TREGDA	0	2
Total	47	50

*See Table 2 for expansion of abbreviations.

such as the face and the neck, were affected in about one-third of the patients from the occupational group. This is most probably because of hand transferral as well as possible airborne dissemination of the allergen during the work process. In the non-occupational group, the distant sites included the scalp and the vulva in patients with pre-existing skin pathology in these areas. Generalized disseminated reaction after the development of periungual dermatitis and hand eczema may be present in some severe cases of occupational-related exposure.

Although the main clinical manifestation is that of chronic dermatitis, the severity of the disease was more prominent in the occupational group in whom erythema,

hyperkeratosis and deep fissures were observed. Atypical clinical manifestations of ACD to acrylates in ANs include lichenoid dermatitis of the hands and palmo-plantar psoriasisiform eruptions.

The most frequent allergens to trigger ACD were 2-HEMA and 2-hydroxypropyl methacrylate (2-HPMA) (each triggering 17.5% of the cases) followed by ethyleneglycol dimethacrylate (EGDM) (13.4%) and ethylmethacrylate (EMA) (9.3%). Butylmethacrylate (BMA), butyl acrylate (BA), hexanediol diacrylate (HDDA) and trimethylolpropane triacrylate (TMPT) were the least common allergens present in our series and correspond to the acrylics eliminated from the new screening series for ANs as proposed by Constandt *et al.*² 2-HEMA was present in 17 of 21 cases, failing to affect four patients in whom allergic sensitization to other AN methacrylates existed. From our experience, 2-HEMA is one of the two most frequent allergens responsible for contact allergy to ANs. However, using it as the sole screening allergen, as suggested,² would have resulted in the loss of positive results. Our study is one of several that demonstrates that the use of ECA is of great importance in detecting allergy to a variety of nail glues.^{2,4,5} In our series, a quarter of the cases would have resulted in loss of positive results if ECA had been omitted from the series.

The results of our study demonstrate that the acrylic monomers used when sculpturing ANs are important occupational sensitizers that can lead to the development of OACD and the appearance or exacerbation of asthma. We found that one-third of the beauticians with OACD had exacerbation of pre-existing asthma during exposure to acrylates.

Cross-reactions of acrylic monomers, namely allergic sensitization induced by one acrylic compound that extends to one or more other acrylic compounds, is a well-known phenomenon.^{6,7} Therefore, sensitized indi-



fig. 3 Strong positive reactions to the methacrylate artificial nail (MAAN) series.

Table 4 Two cases of patch testing with the dental series and with MAAN series

Allergen*	Case 1: OACD		Case 2: ACD	
	MAAN	Dental	MAAN	Dental
BA			+	
EMA	+		+	
BMA				
2-HEMA	+	+	+	+
2-HPMA	+		+	
EGDMA	+	+		+
TREGDMA	+			+
HDDA				
TMPTA			+	
THFMA	+	+	+	+
EA	+		+	
2-HEA	+		+	
TREGDA		+		
Dental series (additional allergens to the methacrylates used in the MAAN)				
MM		+		+
BisGMA		–		–
Bis-MA		–		–
Urethane dimethacrylate		+		+
N,N-dimethyl-4-toluidine		–		–
2-Hydroxy-4-methoxy-benzophenone		+		
Cobalt chloride		+		+
Nickel sulfate		+		+

*See Table 2 for expansion of abbreviations. MM, methylmethacrylate; BisGMA, 2, 2-bis (4-(2-hydroxy-3-methacryloxy-propoxyphenyl) propane; Bis-MA, 2, 2-bis (4-(2-methacryl-oxymethoxy) phenyl) propane.

viduals are often multiallergic and, accordingly, cannot be exposed to any of the compounds. Severe contact allergy to acrylates in dental materials can occur in previously sensitized patients after exposure to ANs. This was demonstrated by our two patients with OACD and ACD to ANs and allergic stomatitis following the use of a 2-HEMA-containing dental bonding. A similar case was reported by Jung *et al.*⁸ Both of our patients were sensitized to 2-HEMA, which is the most frequent methacrylate in the bonding materials, and lacked allergic sensitivity to BIS-

GMA, which is one of the most frequently used methacrylates in composite resins.⁹

The expanding application of methacrylates in cosmetics such as ANs is likely to lead to an increase in allergic contact dermatitis and stomatitis related to their use. Patients with suspected ACD to ANs should therefore be examined thoroughly, using the MAAN series as well as additional allergens such as ECA and the nail lacquer used by the patient.

Most of the patients with allergic reactions to 2- HEMA will not be able to continue using sculptured acrylic nails.

These patients can safely use silk nails if they are not allergic to ECA, which is present in all nail glues. According to Constandt *et al.*,² some acrylic nails do not contain 2-HEMA on their list of ingredients, so certain acrylic nails can still be recommended (although these lists of ingredients cannot always be relied on). Patients allergic to ECA and not to acrylates can use acrylic nails, in the event that no repair of broken nails is performed with glues.

Professional beauticians specializing in nail sculpturing who have developed OACD and are allergic to 2-HEMA should be able to continue to work without touch techniques and with nitrile gloves that have to be changed frequently – many times a day. An alternative solution would be to limit the range of products applied and to use only silk nails. Patients with previous sensitization to acrylates in ANs may experience severe allergic reactions when re-exposed to acrylates during dental treatment. These patients should therefore be advised to consult their dentist about the choice of appropriate restorative materials.

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