

Screening for contact allergy to artificial nails

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27 patients (26 women and 1 man), all in contact with artificial nails, were tested for acrylic compounds, known to be present in nail cosmetics. The patch test results obtained in these patients demonstrated that 2-hydroxyethyl methacrylate and ethyl cyanoacrylate were the only 2 allergens needed to diagnose contact allergy to acrylic-containing nail cosmetics, except for 1 patient who reacted only to her nail preparation used and in which we were unable to identify the allergen. This concerns clearly a limited number of patients. The purpose was, however, to detect the most valuable allergen(s) to be used in a dermatologist's practice, in which not all possible allergens can be tested, in order to diagnose such cases.

Key words: acrylates; acrylics; artificial nails; contact dermatitis; cyanoacrylate; (meth)acrylates; nail cosmetics. © Blackwell Munksgaard, 2005.

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The main risk from artificial nails is contact allergy. Our first aim was to determine, based on a retrospective study, a screening series (as limited as possible) in order to diagnose contact allergy to artificial nails in a dermatologist's practice. Secondly, we wanted optimize an acrylic series for advising an allergic patient who wants to continue applying artificial nails. This series is compared with 2 other screening series for artificial nail allergy, previously proposed in the literature.

Various Types of Nails

Normally the customer knows which type of artificial nails has been applied: tips, silk, acrylic or gel. However, it is important to realize that various types of artificial nails are usually combined and that nail tips and glue are nearly always needed.

The preformed nail: a plastic tip (press-on nail)

Nail tips are preformed pieces of plastic to be glued on a broken, previously applied artificial nail. They, thus, have a repair function. Normally, only a small piece of plastic covers the distal part of the natural nail. Further finishing with nail lacquer or with silk and cyanoacrylate glue is needed, because the unfinished colourless plastic does not have a beautiful appearance.

There also exists another type of nail tips that are 'trendy' and more appreciated by the younger

people; they are sold as a 'do-it-self kit', which contains 10 nail tips, a glue and a cleaning agent. This type of 'glue-and-go-nails' allows the customer to apply the nails at home in a very easy and cheap way. They are coloured (usually with oil paints or with nail lacquer) and do not need further finishing. After 2 or 3 D, they are removed by applying acetone or another solvent. As the solvent destroys the plastic, the tips cannot be re-used. This type of disposable artificial nail is not useful, if the customer wants to wear permanent artificial nails. Indeed, repeated application of glue and solvent every 2 or 3 D is too damaging to both the nails and the skin. Moreover, the permanent occlusion by a piece of plastic of the full length of the natural nail irritates and is able to destroy the nail plate. For permanent artificial nails, the customer should choose sculptured nails.

Dermatological complications of nail tips are rare. Contact allergy to tricresyl ethyl phthalate in the plastic is exceptional (1).

Nail wrap (silk nail)

A nail wrap is a piece of silk (less often cotton or fibre) that is glued on the natural nail. Its first aim is to strengthen the nail plate, but by using a disposable shield, one can also lengthen the nail. The sculptured silk nail needs finishing, mostly with nail lacquer.

Silk nails do not cause contact allergy and are an excellent alternative for the patient who is allergic to acrylic compounds. The only condition is that the patient is not sensitive to cyanoacrylate nor to tosylamide/formaldehyde resin.

The application of silk nails is not easy and some experience in the case of the beautician is needed. This is the reason why they are not as popular as acrylic nails.

Nail glue

Nail glue is an important accessory to all applied artificial nails. In the past, phenol-formaldehyde resins were used and did cause contact allergy (1, 2), but nowadays the main component is ethyl cyanoacrylate (more than 90%); other ingredients are hydroquinone and organic sulfonic acid. Contamination with monomers of other acrylics is possible. Contact allergy to cyanoacrylate is more common than that hitherto believed, as it was seldom considered for patch test and thus not included in test series. The clinical symptoms include periungual and (severe) onychodystrophy, as well as ectopic contact eczema. Onycholysis and paraesthesia are rare. Ethyl cyanoacrylate does not cross-react with (meth)acrylates (3).

Sculptured nails

Acrylic nail (powder + liquid). A monomer liquid and polymer powder are mixed on the nail plate, from which polymerization starts in the presence of hydroquinone and normal daylight. Using a disposable shield, the artificial acrylic nail can be sculptured, lengthening the natural nail. Acrylic nails are more 'trendy' than they used to be, because they smell less, are less heavy than earlier and have a nicer shine than gel nails. They are, however, less flexible and not useful while doing manual or wet work.

Photobonded nail ('gel' nail). Acrylic gel nails are the newest type of artificial nails and are applied as an ordinary nail lacquer. Polymerization starts by means of a photobonding technique in the presence of a weak ultraviolet source, with benzophenone-3 and -4 as light-absorbing activators (this is similar to restorative dental bonding). Various layers of gel are needed: the nail is lengthened by using a builder gel on a disposable shield; the sculptured gel nail is coloured by means of a colour gel or normal nail lacquer; finally, a gloss gel layer is applied (Fig. 1). Each layer needs separate polymerization for some minutes (the application of 10 new gel nails takes about 2 hr). The acrylic compounds in gel nails are similar to



Fig. 1. Application of gel nails.

those used in acrylic nails, except for 2-HEMA (2-hydroxyethyl methacrylate), which is not present in all acrylic nails.

Patients, Materials and Methods

The population tested comprised 27 patients (26 women and 1 man), all in contact with artificial nails. Of them, 16 were professional beauticians – all had contact with nail tips, gel and/or acrylic nails, glue and nail lacquer. 11 were customers – some had used only gel nails, some only acrylic nails, whereas others had used both types. Only one of the 27 patients had used silk wraps.

Most of the patients had fingertip and/or nailfold dermatitis, sometimes accompanied by serious nail destruction (Fig. 2). Of the 27 patients, 4 had onycholysis, 6 had onychodystrophy, 3 had a nail infection (1 proven *Pseudomonas aeruginosa*, others not identified), 8 with periungual eczema and 8 with fingertip eczema. Some of them also had lesions elsewhere: 7 with eczema on the fingers, 6 of 27 patients (5 of them were



Fig. 2. Severe nail dystrophy because of sculptured artificial nails (powder + liquid).

professionals) with hand eczema and 2 professionals with eczema on the forearms; from the 9 who presented with facial dermatitis, particularly on the eyelids, 8 were professionals. In the clients, dermatitis could have been because of transfer of the allergen (ectopic dermatitis) or, as with the professionals, of airborne contact with the dust released when polishing the nails. This was certainly also the case for 5 patients (4 professionals) who had presented with lesions on the cheeks, tip of the nose and the chin, and 4 professionals had lesions on the neck also. There was no widespread eczema; 2 patients (1 professional and 1 client) complained of paraesthesia.

All patients were patch-tested in Ghent or Leuven with the Belgian standard series, including tosylamide/formaldehyde resin, with acrylic compounds and, if indicated, also with a cosmetic and hairdresser series.

Table 1 summarizes the acrylics tested. 12 patients were tested with various substances, 9 with the complete Chemotechnique (Malmö, Sweden) printing series (24 acrylic compounds), 7 with ethyl cyanoacrylate, 5 with a small series of 5 acrylics (MMA, 2-HEMA, EGDMA, BIS-GMA and UEDMA;

Table 1) and 1 with 2-HEMA only. 20 patients were also tested with their own nail preparations in a semiopen method (4); this consists of applying with a Q-tip of a minute amount of the preparation directly on the skin (1 cm²), leaving it to dry completely and then covering it with acrylic tape.

The patch tests were applied with van der Bend patch test chambers (van der Bend, Brielle, the Netherlands) applied on the back with Micropore (3M Health Care, Neuss, Germany) and fixed with Mefix (Mölnlycke Health Care, Göteborg, Sweden) or Hypafix (BSN Medical, Hamburg, Germany) as adhesive tape. The patch test chambers were removed at D2. Readings (ICDRG guidelines) were performed on D2 and D4 (exceptionally on D3), and sometimes later. If relevant, prick test with a latex extract (Stallergènes, Antony, France) was also performed (4 patients).

Results

Table 1 summarizes the concentrations and vehicles of the acrylics tested (with their abbreviations), as well as the patch test results.

Table 1. Patch test results with (meth)acrylates

(Meth)acrylates	Abbreviation	Patch test concentration (percentage of petrolatum)	Positive/tested in petrolatum
Ethyl acrylate	EA	0.1	5/10
2-ethylhexyl acrylate	2-EHA	0.1	0/6
2-hydroxyethyl acrylate	2-HEA	0.1	10/12
2-hydroxypropyl acrylate	2-HPA	0.1	7/9
Methyl methacrylate	MMA	2.0	4/21
Ethyl methacrylate	EMA	2.0	2/13
n-butyl methacrylate	BMA	2.0	0/12
2-hydroxyethyl methacrylate	2-HEMA	2.0	25/27
2-hydroxypropyl methacrylate	2-HPMA	2.0	6/11
Ethylene glycol dimethacrylate	EGDMA	2.0	20/26
Triethyleneglycol dimethacrylate	TREGDMA	2.0	3/12
2,2-bis[4-(2-methacryloxyethoxy)phenyl]propane	BIS-EMA	1.0	0/7
1,4-butanediol diacrylate	BUDA	0.1	4/8
1,6-hexanediol diacrylate	HDDA	0.1	2/8
Diethyleneglycol diacrylate	DEGDA	0.1	7/9
Tripropyleneglycol diacrylate	TPGDA	0.1	0/6
Trimethylolpropane triacrylate	TMPTA	0.1	0/10
Pentaerythritol triacrylate	PETA	0.1	0/7
Oligotriacrylate 480	OTA 480	0.1	0/8
Epoxy acrylate	–	0.5	0/10
Urethane diacrylate (aliphatic)	al-UDA	0.1	0/8
Urethane diacrylate (aromatic)	ar-UDA	0.05	0/8
Triethyleneglycol diacrylate	TREGDA	0.1	5/10
N,N-methylene bis-acrylamide	MBAA	1.0	0/1
Urethane dimethacrylate	UEDMA	2.0	2/20
Tetrahydrofurfuryl methacrylate	THFMA	2.0	1/4
N,N-dimethylaminoethyl methacrylate	–	0.2	0/1
2,2-bis [4-(methacryloxy)phenyl]propane	BIS-MA	2.0	0/7
2,2-bis [4-(2-hydroxy-3-methacryloxy-propoxy)phenyl]propane	BIS-GMA	2.0	0/16
Ethyl cyanoacrylate	ECA	10.0	1/7

From the 2 of 27 patients not reacting to 2-HEMA, 1 reacted solely to her own nail products, whereas the other patient was the only one reacting to ethyl cyanoacrylate. The 3 patients of 12 tested who reacted to TREGDMA gave also a positive reaction to EGDMA, whereas 6 of the 9 negatives to TREGDMA did react to EGDMA. 4 of the 6 patients reacting positively to 2-HPMA were also positive to 2-HPA, whereas 3 of 5 patients who reacted negatively to 2-HPMA were positive to 2-HPA. 14 of 17 patients tested (semiopen) reacted positively to at least 1 of their own acrylic nail products (gel, acrylic liquid or acrylic powder); for 1 patient who was tested with an extensive acrylic series, they constituted the only positive tests. 3 patients tested with nail glue (semiopen) were negative. There were no reactions to nail lacquers nor to tosylamide/formaldehyde resin. Prick test with latex was positive in 1 of the 4 patients tested.

Discussion

In our experience, in order to detect contact allergy to acrylic-containing nail cosmetics, only 2 allergens, i.e. 2-HEMA and ECA, are sufficient. Only 1 patient, reacting to her own nail preparation, did not react to any of the acrylics tested. Testing with the nail product itself can, thus, also be useful (14 of 17 patients reacted), but it should only be performed in the semiopen way (4) in order to avoid irritancy and active sensitization on patch testing (5).

However, in order to advise patients allergic to certain acrylic compounds about alternative products to use, a more extensive test series is needed. Indeed, taking into account our patch test results as well as the ingredients labelled on the packaging or mentioned on the material safety data sheets (MSDS), as far as they can be relied on (6), and taking into account the ingredients mentioned by Kanerva (7), we suggest patch testing 10 acrylics (Table 2).

There are other screening series that have previously been suggested. Koppula et al. (8) proposed a selection of the following 5 acrylics – EA, 2-HEA, EGDMA, ECA and TREGDA – because they are the most frequently used in nail preparations. Besides, they belong to the group of the 10 acrylics that most often produce positive tests in patients wearing artificial nails (EA, 2-HEMA, 2-HEA, DEGDMA, EMA, EGDMA, 2-HPMA, 2-HPA, ECA and TREGDA (8). 2-HEMA has not been considered to be used frequently in nail-product manufacturing, which is in contrast to our experience. Especially in gel products, 2-HEMA is

a constant ingredient; hence, it needs to be tested in a screening series.

In the artificial nail series of Chemotechnique (Table 3), there are 13 acrylics, from which we eliminated 5 – TREGDMA (all were detected with EGDMA), BMA, BA, HDDA and TMPTA – because of the lack of positive results to these. Of course, if these compounds are labelled as ingredients of a patient's product, they can still be tested. We did add 2 acrylics, i.e. ECA to which contact allergy has been seldom described but, as is MMA, is frequently mentioned as an ingredient of nail products. We replaced 2-HPMA by 2-HPA in our series, because we found it to be a better screening agent.

With regard to the advice to the allergic patients, all our patients (except 1) were positive to 2-HEMA, and thus could not continue to apply gel nails, except for IBD Dual Advantage Gel[®] (International Beauty Design INC, Gardena, CA, USA), which does not contain 2-HEMA. It is a colourless gel that needs finishing with normal nail lacquer and is manufactured by IBD for the 'allergic' patient. It is not clear which other acrylics might be present, but 3 patients with 2-HEMA positive, who had reacted positively (semiopen) to their own gel products, remained negative to it. This alternative gel is useful only for individual customers because of the disadvantage that it cannot be combined with any other type of bonder gel or builder gel that contain 2-HEMA. The allergic beautician cannot limit her 'palette' offer to this one product, which is also of inferior quality compared to the other gels.

In our experience, some acrylic nails did not contain 2-HEMA on their ingredient list. For these patients, it is useful to test the screening series with the 10 acrylic compounds. Depending on the test results, certain acrylic nails can still be recommended, although one cannot always rely on the ingredients listed.

Table 2. New screening series for artificial nails

(Meth)acrylates		Patch test concentration (percentage of petrolatum)
1.	2-Hydroxyethyl methacrylate	2.0
2.	Ethyl cyanoacrylate	10
3.	Ethylene glycol dimethacrylate	2.0
4.	2-Ethylhexyl acrylate	0.1
5.	Triethyleneglycol diacrylate	0.1
6.	Ethyl acrylate	0.1
7.	Ethyl methacrylate	2.0
8.	Methyl methacrylate	2.0
9.	Tetrahydrofurfuryl methacrylate	2.0
10.	2-Hydroxypropyl acrylate	0.1

Table 3. Artificial nails series of Chemotechnique

	(Meth)acrylates	Patch test concentration (percentage of petrolatum)
1.	Butyl acrylate	0.1
2.	Ethyl methacrylate	2.0
3.	n-Butyl methacrylate	2.0
4.	2-hydroxyethyl methacrylate	2.0
5.	2-hydroxypropyl methacrylate	2.0
6.	Ethylene glycol dimethacrylate	2.0
7.	Triethylene glycol dimethacrylate	2.0
8.	1,6-hexanediol diacrylate	0.1
9.	Trimethylolpropane triacrylate	0.1
10.	Tetrahydrofurfuryl methacrylate	2.0
11.	Ethyl acrylate	0.1
12.	2-hydroxyethyl acrylate	0.1
13.	Triethylene glycol diacrylate	0.1

The best alternative is to apply silk nails, provided that the patient is not sensitive to ECA, which, according to our experience, is present in all nail glues. Many customers are very pleased with this solution and some beauticians, having learnt the application technique, have even decided to offer only this type of artificial nails to their customers. Allergic beauticians who want to continue their job as before have to be advised to use no-touch techniques and to wear nitrile gloves that have to be changed at least every half an hour.

The patient allergic to ECA and not to other acrylics can still use gels and acrylic nails, provided that no tips to repair broken nails nor full tips are glued. There might be glues based on other acrylics or epoxy resin, but in our experience, all nail glues are based on ethyl cyanoacrylate.

Conclusion

The main risk from artificial nails is contact allergy. Both customers and professionals should be aware of the sensitizing capacity of acrylics present in them and for which cross-sensitivity varies greatly between people. Other side effects, such as nail dystrophy, onycholysis, permanent loss of fingernails, paraesthesia, transmission of infection and Raynaud's phenomenon, are less frequent (9).

The patch test results obtained in 27 patients demonstrated 2-HEMA and ECA to be the only allergens needed to diagnose contact allergy to acrylic-containing nail cosmetics, except in the case of 1 patient who reacted only to her nail preparation used; we were not able to identify the allergen. For practising dermatologists, these 2 substances, thus, seem indicated to screen for such reactions. With regard to the advice to be given to allergic patients who want to continue with nail cosmetics, i.e. artificial nails, a series of 10 acrylics is needed – 2-HEMA, ECA, EGDMA, 2-HEA, TEGDA, EA, EMA, MMA, THFM and 2-HPA.

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