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The burden of allergic contact dermatitis caused by acrylates

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Acrylates and methacrylates are esters of acrylic acid and methacrylic acid, respectively, that polymerize either spontaneously or on ultraviolet (UV) light exposure to form products that are commonly used in adhesives in healthcare settings, and in plastics and textiles (1). They were commonly considered to be occupational contact allergens, particularly in dentists and orthopaedic surgeons, owing to the use of (meth)acrylates in dental materials and bone cement (2).

However, more recently, the demand for long-lasting cosmetic nails has led to the widespread use of gel nails and acrylic nails. Gel nails are methacrylate-based gel varnishes that rely on UV curing to form a hard nail-coating colour that lasts for up to 2 weeks. This has led to an occupational shift in (metha)crylate allergy, with a rise in incidence among beauticians and nail technicians using these products (1, 3–5). In addition, with home use UV-curing kits now readily available, there is a further shift of contact allergy to consumers.

Our aim was to characterize the cases of allergic contact dermatitis caused by meth(acrylates) and cyanoacrylates in our large regional patch testing centre. Because of its significant occupational and health-related sequelae, we highlight the current burden of the serious allergy to these compounds.

Patients and Methods

A retrospective observational study on 241 consecutive patients patch tested with meth(acrylates) and cyanoacrylates between January 2012 and February 2015 was conducted.

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Table 1. Mini-acrylate series used to screen for meth(acrylate) and cyanoacrylate allergy (6)

Acrylate	Concentration in pet. (%)
Bisphenol A-glycidyl methacrylate	2
1,6-Hexanediol diacrylate	0.1
Ethyl cyanoacrylate	10
2-Hydroxypropyl acrylate	2
2-Hydroxyethyl methacrylate	2
Ethyleneglycol dimethacrylate	2

Demographic data and clinical information, including site of eczema and history of atopy, were obtained for each patient. Occupational history, including the use of gel nails, was assessed. In patients with no occupational exposure, the use of eyelash glues, acrylic nails and gel nails was considered.

All patients were tested with an extended European baseline series [Allmiral (Trolab), Reinbek, Germany] and mini-acrylate or extended acrylate series (Chemotechnique Diagnostics, Vellinge, Sweden) by the use of Finn Chambers® on Scanpor® tape. The mini-acrylate series is our main screening tool (6) (Table 1). Readings were performed on day (D)2 and D4, and scored in accordance with European Society of Contact Dermatitis guidelines. Only readings of + and above on D4 were included. Patients with multiple acrylate allergies were analysed.

Results

Approximately 1500 patients are patch tested by us annually. Between January 2012 and February 2015, 241 patients were tested with the mini-acrylate or extended acrylate series. Sixteen patients with a positive patch test reaction to a (meth)acrylate or cyanoacrylate were identified. Their age ranged from 14 to 62 years (mean 36 years), and there was a female predominance (male/female ratio of 1:15). Nine (56%) patients had a history of atopy.

All reactions were deemed to be relevant. Eight of 16 patients had an occupational acrylate exposure identified. Of those, 6 were beauticians/nail technicians, 1 was a dental nurse, and 1 was an electrician. All beauticians/nail technicians had multiple acrylate allergies to meth(acrylates). However, it is important to note that 2 of the beauticians were also users of gel nails, and may therefore have been sensitized by personal use of these products.

Of the patients who were exposed from a non-occupational route, 1 was sensitized from an acrylic polymer-based clamp used to treat hypertrophic scars on her earlobe, 1 was sensitized from cyanoacrylate in false nail glue, 2 were sensitized from cyanoacrylate in false eyelash glue, 2 were sensitized from acrylate in surgical drapes, and 2 were sensitized from personal use of gel/acrylic nails.

Most patients (9/16) presented with eczematous finger pulp fissuring 'pulpitis'. Four of 16 had nail and periungual changes, including onycholysis. Five of 16 had facial eczema; 2 of these cases were related to false eyelash use. None of our patients had respiratory symptoms, despite this being reported in the literature (7).

Eight patients had allergic contact dermatitis caused by other allergens. Four of 8 had allergy to nickel. Two of 8 had allergy to *p*-phenylenediamine. Other allergens include caine mix, fragrance mix I, thiuram mix, potassium dichromate, and colophonium.

Overall, 2-hydroxyethyl methacrylate (2-HEMA) was the most common allergen; allergy to this was found in 12 patients (Table 2). Ethyleneglycol methacrylate (EGMA) and 2-hydroxypropyl acrylate (2-HPA) were the second most common allergens. Eleven patients were allergic to more than one acrylate. Seven patients were allergic to 2-HEMA, EGMA and 2-HPA simultaneously; this was the most prevalent combination of acrylate reactions. Most of the patients with multiple acrylate allergies had an occupational cause of their contact allergy (Table 2).

Six of 16 patients were allergic to ethyl cyanoacrylate (ECA) (Table 2), and half of these had isolated ECA allergy. These patients were those with exposures related to false eyelashes or false nail glues. However, the other half, who had an ECA allergy and a coexistent meth(acrylate) allergy, had exposures related to perioperative glues in surgical adhesives and construction adhesive.

Discussion

Acrylate allergy was initially described in the healthcare setting, predominantly affecting dentists and orthopaedic surgeons. However, more recently, gel and acrylic nails have become a well-documented source of acrylate and

methacrylate allergy (3–5, 7, 8). The true incidence of acrylate allergy is unknown, but is estimated to be ~1% of all patients patch tested (1), and our figures are consistent with this.

Once sensitized, individuals may be unable to protect themselves adequately, as (meth)acrylates can permeate readily through latex gloves (7). This may have significant occupational consequences. Furthermore, sensitization can occur through the airborne route, which makes prevention more difficult in certain settings. It is also important to remember the health implications of such an allergy, owing to the orthopaedic and dental requirements of an ageing population.

Our results show that, although (meth)acrylate allergy is still mostly occupational, it is now more prevalent in younger women, with the most common occupational groups affected being beauticians and nail technicians (Table 2). These results are mirrored in similar studies across Europe (3, 4, 8). Furthermore, a recent study showed that (meth)acrylates are now the most common allergens found among beauticians, followed by fragrance substances and rubber chemicals (5). This shift in the occupation affected can be explained by the increasing use of gel and acrylic nails, which constitute the main source of exposure in this group. This is further confounded by the lack of regulation in the beauty industry, and often a lack of training and awareness of the risk of allergy among both employees of the industry and consumers (7).

Once polymerized, (meth)acrylates are relatively inert. Sensitization is thought to occur because of incomplete curing of the monomers, and now, with the availability of light-emitting diode home-curing kits without any equilibration or servicing advice, this is a potential avenue for consumer sensitization.

Patients can present with a variety of complaints, but the most common are eczema and painful fissuring of the finger pulps, termed 'pulpitis' (Fig. 1). Most of our patients presented with this. Cases of fingertip numbness and decreased dexterity have also been reported (9), but we did not directly ask our patients about dysaesthesia. Other presentations include painful dermatitis around fingernails, leading to onycholysis and, in severe cases, nail shedding (3–5, 7, 8). Four of our 16 patients had periungual dermatitis and nail changes. There are also reports in the literature of permanent nail loss and abnormal regrowth. Facial dermatitis and respiratory symptoms in patients with (meth)acrylate allergy are also well documented, with most of these cases being secondary to airborne sensitization (3, 4, 7, 8).

Table 2. Table showing the breakdown patch test results of 16 patients with contact allergy to (meth)acrylates and ethyl cyanoacrylate in our centre

Patient number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Age (years) /sex	40/F	23/F	37/F	56/F	24/F	47/F	40/F	47/F	34/F	62/M	37/F	21/F	14/F	31/F	45/F	17/F
Atopy	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	No	Yes	Yes	No
Occupation	Housewife	Speech therapy	IT	Dental nurse	Public relations	Beautician	Nail technician	Beautician	Beautician	Electrician	Beautician	Dental nurse	Student	Carer	Courier	Nail technician
Presentation	Facial	Postoperative rash	Nail changes and hands	Eyelids	Hands	Fingertips	Fingertips	Hands	Nail changes and hands	Hands, arms, and face	Nail changes and hands	Fingertips	Face	Face	Face	Fingertips and peringual changes
Allergy to acrylate/methacrylate	ECA	2-HEMA	2-HEMA, EGDMA, 2-HPA	2-HEMA	ECA	EGDMA, HDDA, 2-HPA	2-HEMA, EGDMA, 2-HPA	ECA, 2-HEMA, 2-HPA, 2-HPMA, diethylene glycol diacrylate, 1,6-hexanediol diacrylate	2-HEMA, 2-HPA, EGDMA, 2-HPMA	ECA, 2-HEMA, EGDMA, 2-HPA	2-HEMA, EGDMA, 2-HPA, 2-HMA	2-HEMA, EGDMA, 2-HPA	2-HEMA, EGDMA	ECA	ECA, 2-HEMA	2-HEMA, EGDMA, 2-HPA
Exposure	False eyelashes	Adhesive drape	False nails	False nails	False nails	Gel nails	Gel nails	Gel nails	Gel nails	Superglue™ and Loctite™ sealant	Gel nails	Dental	Earlobe clamp	False eyelashes	Operative drape	Gel nails
Other allergies	-	Nickel	Potassium dichromate	Caine mix	Colophonium, 2-ethoxyethyl p-methoxy cinnamate	-	-	-	-	p-Phenylenediamine, fragrance mix I, perfume, Myroxylon peregrinae	-	-	Nickel, thiuram mix	Nickel	Nickel, p-phenylenediamine	-

ECA, ethyl cyanoacrylate; EGDMA, ethyleneglycol dimethacrylate; F, female; HDDA, Hexanediol diacrylate; 2-HEMA, 2-hydroxyethyl methacrylate; 2-HMA, 2-hydroxy methyl methacrylate; 2-HPA, 2-hydroxypropyl acrylate; 2-HPMA, 2-hydroxypropyl methacrylate; M, male.

Most patients were young female nail technicians/beauticians. The most common allergy was to 2-HEMA, being found in a total of 12 (75%) patients. Some cases had multiple acrylate allergies, as shown.



Fig. 1. Nail technician presenting with fissuring of the finger pulp ('pulpitis') and periungual eczema resulting from methacrylate allergy.

Eleven patients were allergic to more than one acrylate. Simultaneous 2-HEMA, EGMA and 2-HPA allergy was the most prevalent combination. Multiple acrylate allergy is well described in the literature (10, 11). Cross-reactions among (meth)acrylates are well documented, and explain the similar patterns of multiple allergy seen in patch test-positive patients. There is also some concern about cross-sensitization (10), and some centres therefore screen for acrylate allergy by using only 2-HEMA, which has previously been found to have a sensitivity of 96% (1, 6). However, more recent evidence from a large study has shown that a panel screening tool and the addition of acrylates to the baseline series should be considered in many more centres, to avoid missing a large proportion of acrylate-allergic patients (6).

It has also been suggested that multiple acrylate allergy occurs as a result of meth(acrylate) cross-contamination and the presence of various undisclosed acrylate contaminants in products (10, 11). These additional compounds are not always disclosed on gel nail material safety data sheets. These factors may therefore explain multiple reactions to acrylates related to nail occupations.

Owing to the permeation through latex gloves, precautions such as double gloving and the use of nitrile

gloves should be considered in the industry. These can provide up to 60 min of protection. The most protective gloves are tri-laminated polyethylene gloves, which have been shown to provide up to 4 h of protection from acrylate exposure, but these are non-elastic and thus poorly fitting, and are hence not very practical for occupations requiring manual dexterity. However, as mentioned previously, airborne sensitization can also occur. Furthermore, with the advent of gel nail home use kits and over-the-counter eyelash and nail glues, the frequency of acrylate allergy among consumers of these products is increasing (8).

Six of the 16 patients studied were allergic to ECA. This is still found in adhesives for false eyelashes and false nails, and also in skin glue closure systems (12, 13), which are very widely used in the healthcare setting. Despite these glues being described as less volatile than (meth)acrylates, cases of contact allergic dermatitis caused by ECA in skin glues are being increasingly reported.

Furthermore, exposures to (meth)acrylates in the healthcare setting aside from bone cement should not be overlooked. Two of our acrylate allergy cases resulted from exposure to the glue of surgical drapes. Other cases reported in the literature include contact allergic dermatitis caused by (meth)acrylates in transcutaneous electrical nerve stimulation units, electrocardiogram electrodes, and dental composites (14–16).

Conclusion

(Meth)acrylate allergy is uncommon but important; it has undergone an occupational shift towards the beauty industry, and is increasing in prevalence. We predict that this allergy is at risk of undergoing transition from an occupational allergy to one that affects consumers of gel nails/acrylic nails. Improved regulatory control and public education are needed.

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