Tackling Acrylate Allergy: The Sticky Truth

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PRACTICE **POINTS**

- Acrylates are thermoplastic resins used in a variety of products ranging from cosmetics to adhesives and industrial materials. Acrylic monomers are strong contact allergens, whereas fully polymerized forms are inert, provided they are completely cured.
- The use of home gel nail kits may increase the risk for sensitization to acrylates, which are the most common modern nail cosmetic allergens.
- When patch testing for suspected acrylate allergy, 2-hydroxyethyl methacrylate (HEMA) is the most important screening allergen. Expanded testing to additional acrylates should be considered depending on the clinical scenario.

Acrylates are synthetic thermoplastic resins used in numerous industries since their discovery in the mid-19th century. Known for their versatility in formulating various consumer, health care, and industrial products, acrylates also have come under scrutiny for their potential to cause allergic contact dermatitis (ACD). Allergic contact dermatitis to acrylates previously was largely occupational in nature, but the expanded use of acrylates in products ranging from nail cosmetics to medical devices has increasingly brought this allergy to the general population. Herein, we discuss the chemistry and allergenicity of acrylates and highlight common sources of exposure, clinical presentations, pertinent considerations for patch testing, and tips for the management/prevention of acrylate ACD. We hope to emphasize the shifting trend of exposure sources from the workplace to consumers, underlining the need for increased vigilance from physicians. Collaborative efforts among health care providers and patient education about allergen avoidance strategies are essential to mitigate potential complications arising from acrylate sensitization.

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Acrylates are a ubiquitous family of synthetic thermoplastic resins that are employed in a wide array of products. Since the discovery of acrylic acid in 1843 and its industrialization in the early 20th century, acrylates have been used by many different sectors of industry.[1] Today, acrylates can be found in diverse sources such as adhesives, coatings, electronics, nail cosmetics, dental materials, and medical devices. Although these versatile compounds have revolutionized numerous sectors, their potential to trigger allergic contact dermatitis (ACD) has garnered considerable attention in recent years. In 2012, acrylates as a group were named Allergen of the Year by the American Contact Dermatitis Society,[2] and one member—isobornyl acrylate—also was given the infamous award in 2020.[3] In this article, we highlight the chemistry of acrylates, the growing prevalence of acrylate contact allergy, common sources of exposure, patch testing considerations, and management/prevention strategies.

Chemistry and Uses of Acrylates

Acrylates are widely used due to their pliable and resilient properties.[4] They begin as liquid monomers of (meth)acrylic acid or cyanoacrylic acid that are molded to the desired application before being cured or hardened by one of several means: spontaneously, using chemical catalysts, or with heat, UV light, or a light-emitting diode. Once cured, the final polymers (ie, [meth]acrylates, cyanoacrylates) serve a myriad of different purposes. Table 1 includes some of the more clinically relevant sources of acrylate exposure. Although this list is not comprehensive, it offers a glimpse into the vast array of uses for acrylates.

Acrylate Contact Allergy

Acrylic monomers are potent contact allergens, but the polymerized final products are not considered allergenic, assuming they are completely cured; however, ACD can occur with incomplete curing.[6] It is of clinical importance that once an individual becomes sensitized to one type of acrylate, they may develop cross-reactions to others contained in different products. Notably, cyanoacrylates generally do not cross-react with (meth)acrylates; this

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TABLE 1. Common Products Containing Acrylates[4,5]

Home and consumer products	Medical products	Industrial goods
Super glues	Adhesive tapes	Adhesives
Nail cosmetics	Wound dressings	Coatings
Eyelash glues	Liquid tissue adhesives	Sealants
Hair extension glues	Bone cements	Paints
Disposable diapers	Dental fillings, adhesives, and prostheses	Lacquers
Sanitary and incontinence pads	Electrocardiogram electrodes	Paper products
In-ear headphones	Intraocular contact lenses	Printing inks
	Diabetes devices (eg, insulin pumps, glucose monitors)	Floor polishes
	Hearing aids	

has important implications for choosing safe alternative products in sensitized patients, though independent sensitization to cyanoacrylates is possible.[7,8]

Epidemiology and Risk Factors

The prevalence of acrylate allergy in the general population is unknown; however, there is a trend of increased patch test positivity in studies of patients referred for patch testing. A 2018 study by the European Environmental Contact Dermatitis Research Group reported positive patch tests to acrylates in 1.1% of 18,228 patients tested from 2013 to 2015.[9] More recently, a multicenter European study (2019-2020) reported a 2.3% patch test positivity to 2-hydroxyethyl methacrylate (HEMA) among 7675 tested individuals,[10] and even higher HEMA positivity was reported in Spain (3.7% of 1884 patients in 2019-2020).[11] In addition, the North American Contact Dermatitis Group (NACDG) reported positive patch test reactions to HEMA in 3.2% of 4111 patients tested from 2019 to 2020, a statistically significant increase compared with those tested in 2009 to 2018 (odds ratio, 1.25 [95% CI, 1.03-1.51]; P=.02).[12]

Historically, acrylate sensitization primarily stemmed from occupational exposure. A retrospective analysis of occupational dermatitis performed by the NACDG (2001-2016) showed that HEMA was among the top 10 most common occupational allergens (3.4% positivity [83/2461]) and had the fifth highest percentage of occupationally relevant reactions (73.5% [83/113]).[13] High-risk occupations include dental providers and nail technicians. Dentistry utilizes many materials containing acrylates, including uncured plastic resins used in dental prostheses, dentin bonding materials, and glass ionomers.[14] A retrospective analysis of 585 dental personnel who were patch tested by the NACDG (2001-2018) found that more than 20% of occupational ACD cases were related to acrylates.[15] Nail technicians are another group routinely exposed to acrylates through a variety of modern nail cosmetics. In a 7-year study from Portugal evaluating acrylate ACD, 68% (25/37) of cases were attributed to occupation, 80% (20/25) of which were in nail technicians.[16] Likewise, among 28 nail technicians in Sweden who were referred for patch testing, 57% (16/28) tested positive for at least 1 acrylate.[17]

Modern Sources of Acrylate Exposure

Once thought to be a predominantly occupational exposure, acrylates have rapidly made their way into everyday consumer products. Clinicians should be aware of several sources of clinically relevant acrylate exposure, including nail cosmetics, consumer electronics, and medical/surgical adhesives.

A 2016 study found a shift to nail cosmetics as the most common source of acrylate sensitization.[18] Nail cosmetics that contain acrylates include traditional acrylic, gel (shellac), dipped, and press-on (false) nails.[19] The NACDG found that the most common allergen in patients experiencing ACD associated with nail products (2001-2016) was HEMA (56.6% [273/482]), far ahead of the traditional nail polish allergen tosylamide (36.2% [273/755]). Over the study period, the frequency of positive patch tests statistically increased for HEMA (P=.0069) and decreased for tosylamide (P<.0001).[20] There is concern that the use of home gel nail kits, which can be purchased online at the click of a button, may be associated with a risk for acrylate sensitization.[21,22] A recent study surveyed a Facebook support group for individuals with self-reported reactions to nail cosmetics, finding that 78% of the 199 individuals had used at-home gel nail kits, and more than 80% of them first developed skin reactions after starting to use at-home kits.[23] The risks for sensitization are thought to be greater when self-applying nail acrylates compared to having them done professionally because individuals are more likely to spill allergenic monomers onto the skin at home; it also is possible that home techniques could lead to incomplete curing. Table 2 reviews the different types of acrylic nail cosmetics.

Medical adhesives and equipment are other important areas where acrylates can be encountered in abundance.

TABLE 2. Common Types of Artificial Nails and Associated Acrylates[5,24,25]

Acrylate category	Product (synonym[s])
(Meth)acrylates	Acrylic nails (porcelain nails), gel nails (long-lasting or semipermanent nails)
Cyanoacrylates	Dipped nails (powder nails), nail wraps (preformed nails), press-on nails (fake, false, or stick-on nails)

A review by Spencer et al[18] cautioned wound dressings as an up-and-coming source of sensitization, and this has been demonstrated in the literature as coming to fruition.[26] Another study identified acrylates in 15 of 16 (94%) tested medical adhesives; among 7 medical adhesives labeled as hypoallergenic, 100% still contained acrylates and/or abietic acid.[27] Multiple case reports have described ACD to adhesives of electrocardiogram electrodes containing acrylates.[28-31] Physicians providing care to patients with diabetes mellitus also must be aware of acrylates in glucose monitors and insulin pumps, either found in the adhesives or leaching from the inside of the device to reach the skin.[32] Isobornyl acrylate in particular has made quite the name for itself in this sector, being crowned the 2020 Allergen of the Year owing to its key role in cases of ACD to diabetes devices.[3]

Cyanoacrylate-based tissue adhesives (eg, 2-octyl cyanoacrylate) are now well documented to cause postoperative ACD.[33,34] Although robust prospective data are limited, studies suggest that 2% to 14% of patients develop postoperative skin reactions following 2-octyl cyanoacrylate application.[35-37] It has been shown that sensitization to tissue adhesives often occurs after the first application, followed by an eruption of ACD as long as a month later, which can create confusion about the nature of the rash for patients and health care providers alike, who may for instance attribute it to infection rather than allergy.[38] In the orthopedic literature, a woman with a known history of acrylic nail ACD had knee arthroplasty failure attributed to acrylic bone cement with resolution of the joint symptoms after changing to a cementless device.[39]

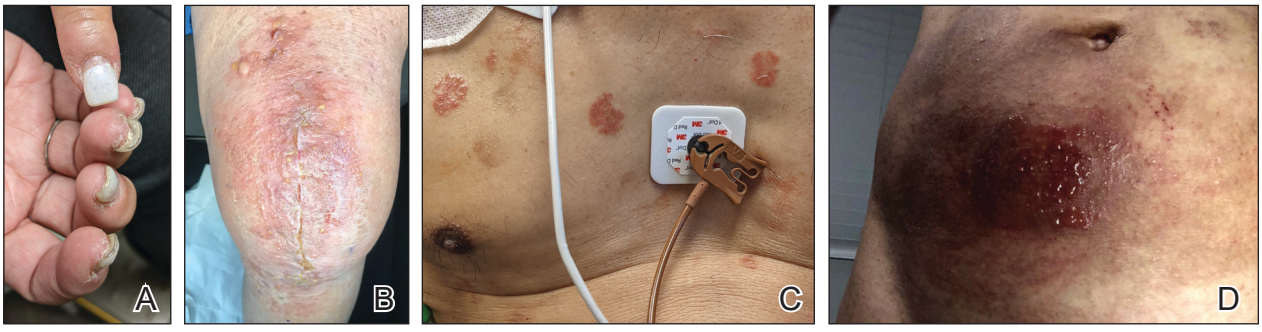
Awareness of the common use of acrylates is important to identify the cause of reactions from products that would otherwise seem nonallergenic. A case of occupational ACD to isobornyl acrylate in UV-cured phone screen protectors has been reported[40]; several cases of ACD to acrylates in headphones[41,42] as well as one related to a wearable fitness device also have been reported.[43] Given all these possible sources of exposure, ACD to acrylates should be on your radar.

When to Consider Acrylate ACD

When working up a patient with dermatitis, it is essential to ask about occupational history and hobbies to get a sense of potential contact allergen exposures. The typical presentation of occupational acrylate-associated ACD is hand eczema, specifically involving the fingertips.[5,24,25,44] Acrylate ACD should be considered in patients with nail dystrophy and a history of wearing acrylic nails.[45] There can even be involvement of the face and eyelids secondary to airborne contact or ectopic spread from the hands.[24] Spreading vesicular eruptions associated with adhesives also should raise concern. The Figure depicts several possible presentations of ACD to acrylates. In a time of abundant access to products containing acrylates, dermatologists should consider this allergy in their differential diagnosis and consider patch testing.

Patch Testing to Acrylates

The gold standard for ACD diagnosis is patch testing. It should be noted that no acrylates are included in the thin-layer rapid use epicutaneous (T.R.U.E.) test series. Several acrylates are tested in expanded patch test series including the American Contact Dermatitis Society Core Allergen series and North American 80 Comprehensive Series. 2-Hydroxyethyl methacrylate is thought to be the most important screening allergen to test. Ramos et al[16]



Allergic contact dermatitis to acrylates. A, Periungual dermatitis and onychodystrophy due to long-term use of acrylic nails. B, A vesicular eruption with crusting around a postoperative total knee arthroplasty incision site due to cyanoacrylate-based surgical glue. C, Discrete vesicular plaques on the chest from contact with acrylate-based electrocardiogram electrodes. D, A spreading vesiculobullous eruption around the site of a continuous glucose monitor on the abdomen. Photographs courtesy of Brandon L. Adler, MD.

reported a positive patch test to HEMA in 81% (30/37) of patients who had any type of acrylate allergy.

If initial testing to a limited number of acrylates is negative but clinical suspicion remains high, expanded acrylates/plastics and glue series also are available from commercial patch test suppliers. Testing to an expanded panel of acrylates is especially pertinent to consider in suspected occupational cases given the risk of workplace absenteeism and even disability that come with continued exposure to the allergen. Of note, isobornyl acrylate is not included in the baseline patch test series and must be tested separately, particularly because it usually does not cross-react with other acrylates, and therefore allergy could be missed if not tested on its own.

Acrylates are volatile substances that have been shown to degrade at room temperature and to a lesser degree when refrigerated. Ideally, they should be stored in a freezer and not used beyond their expiration date. Furthermore, it is advised that acrylate patch tests be prepared immediately prior to placement on the patient and to discard the initial extrusion from the syringe, as the concentration at the tip may be decreased.[46,47]

With regard to tissue adhesives, the actual product should be tested as-is because these are not commercially available patch test substances.[48] Occasionally, patients who are sensitized to the tissue adhesive will not react when patch tested on intact skin. If clinical suspicion remains high, scratch patch testing may confirm contact allergy in cases of negative testing on intact skin.[49]

Management and Prevention

Once a diagnosis of ACD secondary to acrylates has been established, counseling patients on allergen avoidance strategies is essential. For (meth)acrylate-allergic patients who want to continue using modern nail products, cyanoacrylate-based options (eg, dipped, press-on nails) can be considered as an alternative, as they do not cross-react, though independent sensitization is still possible. However, traditional nail polish is the safest option to recommend.

The concern with acrylate sensitization extends beyond the immediate issue that brought the patient into your clinic. Dermatologists must counsel patients who are sensitized to acrylates on the possible sequelae of acrylate-containing dental or orthopedic procedures. Oral lichenoid lesions, denture stomatitis, burning mouth syndrome, or even acute facial swelling have been reported following dental work in patients with acrylate allergy.[50-53] Dentists of patients with acrylate ACD should be informed of the diagnosis so acrylates can be avoided during dental work; if unavoidable, all possible steps should be taken to ensure complete curing of the monomers. In the surgical setting, patients sensitized to cyanoacrylate-based tissue adhesives should be offered wound closure alternatives such as sutures or staples.[34]

In patients with diabetes mellitus who develop ACD to their glucose monitor or insulin pump, ideally they should be switched to a device that does not contain acrylates. Problematically, these devices are constantly being reformulated, and manufacturers do not always divulge their components, which can make it challenging to determine safe alternative options.[32,54] Various barrier products may help on a case-by-case basis.[55]

Preventative measures should be implemented in workplaces that utilize acrylates, including dental practices and nail salons. Acrylic monomers have been shown to penetrate most gloves within minutes of exposure.[56,57] Double gloving with nitrile gloves affords some protection for no longer than 60 minutes.[6] 4H gloves have been shown to provide true protection but result in a loss of dexterity.[58] The fingerstall technique involves removing the fingers from a 4H glove, inserting them on the fingers, and applying a more flexible glove on top to hold them in place; this offers a hybrid between protection and finger dexterity.[59]

Final Interpretation

In a world characterized by technological advancements and increasing accessibility to acrylate-containing products, we hope this brief review serves as a resource and reminder to dermatologists to consider acrylates as a potential cause of ACD with diverse presentations and important future implications for affected individuals. The rising trend of acrylate allergy necessitates comprehensive assessment and shared decision-making between physicians and patients. As we navigate the ever-changing landscape of materials and technologies, clinicians must remain vigilant to avoid some potentially sticky situations for patients.

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