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The Dermatologic Hazards of Nail Product Usage

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ABSTRACT

The major dermatologic adverse effect of nail polish that has been reported is an allergic contact dermatitis. This can be within the ungual and periungual region, but it can also be diffuse and spread along the face, chest, trunk, and arms. The purpose of this paper is to explore the dermatologic impacts, especially allergic contact dermatitis, secondary to nail product use. This paper aims to increase awareness of possible dermatologic risks of nail product use and encourage consumer safety.[1]

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INTRODUCTION

Allergic contact dermatitis is a type IV delayed hypersensitivity. It is triggered by contact with an allergen by individuals who have been previously sensitized via allergen-specific T cell activation. If the allergen triggering allergic contact dermatitis is not found and eliminated, the dermatitis can become chronic, which can significantly decrease the patient's quality of life. For example, allergic contact dermatitis can lead to long term workplace leaves of absence, negatively impacting the socioeconomic state of the patient. Ultraviolet nail light radiation exposure and damage to the nail bed itself are also dermatologic concerns of nail product use.[1]

Composition of Nail Polish: Toxic Ingredients and Their Potential Effects

2-hydroxyethyl methacrylate (HEMA) → Binding agent	Acetone → Nail polish removal	Acrylic acid → Adhesive
Dibutyl phthalate (DBP) → Improve nail polish flexibility	Formaldehyde → Nail hardening	Metals → Metallic finish
Methyl Methacrylate (MMA) → Binding agent	N-methylpyrrolidone (NMP) → Solvent and surfactant	
N,N-Dimethyl-p-toluidine (DMPT) → Solvent	Toluene → Solvent	Triphenyl phosphate (TPHP) → Plasticizer

Dermatological Impacts of Nail Polish

Allergic contact dermatitis is the most studied adverse effect from nail polish. This has been documented as early as the 1940s and 1950s. Symptoms include paronychia, subungual swelling, severe pruritus, nail dystrophy, scaling, vesicular dermatitis,[1] thickened and dried nail plates, and hemorrhagic onycholysis with complete nail detachment.[2] Additionally, allergic contact dermatitis can lead to fingertip eczema, onychodystrophy, onycholysis, and leukonychia. Allergic contact dermatitis secondary to nail product use can also be seen in other anatomic locations including the dorsum of the hands, face, eyelids, and trunk[3] due to hand transfer. In fact, a study on periorbital eczema found that 4% of the patients studied had periorbital dermatitis due nail polish use. Allergic contact dermatitis usually presents 7-10 after current exposure. Patch testing is the standard diagnostic and confirmatory test for allergic contact dermatitis-causing allergens.[2]

Allergic contact dermatitis from traditional nail polish may be due to the toluene/formaldehyde resin, formaldehyde, polyester resin, pigments, or nitrocellulose. The most common allergen is tosylamide/formaldehyde resin.[3] In fact, 4% of positive patch tests involve sensitivity to toluene/formaldehyde resin.[2] Allergic contact dermatitis due to toluene/formaldehyde resin can involve the head, neck, nose, ears, and eyelids. Allergic contact dermatitis secondary to phthalic and trimellitic anhydride/glycols copolymer, which is present in traditional nail polish, typically presents on the head and neck; but there are cases of the dermatitis affecting the face, neck, and periorbital area as well as swelling of the eyelids that can last several months.[3] Additionally, allergic contact dermatitis is the most common cause of eyelid dermatitis, causing 46-74 cases of eyelid dermatitis.[4]

Methyl Methacrylate (MMA) is the monomer used with acrylic nails, but MMA has been found to cause severe contact dermatitis as well.[1] In fact, there has been a global allergic contact dermatitis from (meth)acrylic monomers (ACDMA) epidemic over the past 10 years, and nail polish has been identified as a trigger for this epidemic. Nail technicians, nail salon patrons, and at home nail product users have been identified as having ACDMA. Methacrylates are also present in dental materials, prostheses,

and glucose sensors; and while data on the immediate and long term ACDMA prognosis are severely limited, there are well reported data on allergic reactions to methacrylates in a variety of other sources in people who had been sensitized previously through nail product exposure.[5] Additionally, distant cases of dermatitis can be explained due to the volatility of nail polish leading to manipulation of unpolymerized acrylates and spreads via hand contact or airborne spread of the allergen.[4] Because methacrylate is a volatile compound, there have been numerous cases of patients with eyelid dermatitis secondary to methacrylate allergy with no nail manifestations.[6] Acrylates are volatile and rapidly degrade upon air exposure.[7] Compounds such as formaldehyde, toluene, DBPs, ethyl acetate, butyl acetate, and methyl ethyl ketones are also considered to be volatile or semivolatile.[8] There is risk for dermal absorption of nail product volatile organic compounds (VOC) via direct contact and glove permeation, and less often via inhalation.[9]

Furthermore, the most frequently found molecule in a patch tested tray of methacrylates is 2-hydroxyethyl methacrylate (HEMA). HEMA has been included in the North American Contact Dermatitis Group's screening tray since 2007. Between 2007 and 2014, the prevalence of sensitization to HEMA in North America has been consistently between 2% and 2.6%. However, between 2015 and 2016, the rates grew to 3.4% and to 3.2% between 2019 and 2020. Recent studies show that more than 80% of these sensitizations are due to nail products. In a 2019 Danish study, it was found that 100% of patients testing positive for HEMA sensitization have a history of using UV nail polish.[10] The average time between HEMA exposure and symptom development is 24 months for nail professionals and 34 months for consumers.[11] Additionally, HEMA has been found to be one of the 15 most common acrylate allergens implicated in eyelid contact dermatitis as well.[12]

In a study of 55 females with exposure to artificial nails as consumers and employees, allergic contact dermatitis was found to involve forearms, dorsal hands and fingers, and face and neck. Women with occupational exposure were also more likely to have chronic dermatitis as well as lichenified and psoriasiform dermatitis.[1] Some other atypical dermatologic manifestations of HEMA allergy include lichen planus of the nail, lymphomatoid papulosis, and systemic contact dermatitis.[1,10] Additionally, cases of paronychia, nail dystrophy, onycholysis, pruritic vesicular to lichenified scaling plaques of eczema, and hand fissures have also all been reported with monomer use.[10]

In addition to allergic contact dermatitis, methacrylates also have high reactivity. They are used in dentistry and orthopedics, and once one is sensitized through one means, they can have hypersensitivity reactions when exposed through another means. If a patient had been previously sensitized, it is unlikely for them to have symptoms due to cured acrylic resin not containing enough reactive monomers. However, when curing is incomplete or improperly done, residual monomers may be present in the final product, which can lead to contact dermatitis.[10] A retrospective study found that of 87 patients who worked as nail technicians, 47.1% reacted to at least one methacrylate. Also, 21 out of 908 patients who tested positive for acrylates allergy used nail related cosmetics and 53 patients had exposure through working at nail salons.[1] It is concerning that the use and efficacy of medical devices with acrylates have been impinged by the use of methacrylates for cosmetic purposes. The use of methacrylates for solely cosmetic purposes can have significant negative impacts on patients who rely on medical devices containing acrylates.[10]

In terms of damage to the actual nail itself, distal nail plate thinning has also been associated with artificial nails. Nail polish has also been linked to yellow-orange discoloration of the superficial nail, which usually resolves within a few weeks of nail polish removal if the nail polish was only on for a week. If the nail polish was used for a longer period of time, it can lead to a deeper penetration of the dye and this will only resolve with growing out of the nail.[1]

Also, keratin degranulation can occur with repetitive application, binding, and removal of nail polish. With the repetitive degranulation and exfoliation, the nail plate can develop pseudo leukoplakia with white patches and lines on the nail. This pattern can be confused for superficial white onychomycosis.[1] Additionally, onycholysis and subungual hyperkeratosis can also be manifestations of allergies to artificial nails. This can also be difficult to distinguish from nail psoriasis or onychomycosis. Paresthesia, nail infection, and superinfection of eczematous tissue have also been reported.[1]

There are also dermatologic concerns over the UV light used to cure gel nails. Gel nails use a gel nail varnish that is applied like a normal nail polish. It then needs to be polymerized through photo bonding under a UV light source. Gel nails require several layers of polish to be applied and each layer needs to be polymerized with UV light. UV lamps emit mainly UVA rays with a wavelength of 100-400nm with the majority between 350-400nm. There have been case reports of women with extensive histories of UV nail light exposure developing in situ squamous cell carcinoma of the dorsum of the hands. On the other hand, there have been some studies disproving the risk of skin cancer due to UV nail lights.[1] In one study, the UV nail irradiation was compared to the UV dose in a narrow band UVB light. It was found that over 10,000 ten minute sessions of UV nail light would be needed to equal the UVB exposure with one course of narrow band UV light (15-30 treatments over 5-10 weeks). Another study looked at the UVA irradiance and found it to be variable depending on the brand of UV nail light being used. The UVA exposure associated in a single manicure was found to

not cause DNA damage. However, it is estimated that between 8-208 UV nail light visits are needed to reach the 600 kJ/m2 threshold energy density to cause DNA damage.[1] Another study found that the total energy nails were exposed to during the recommended curing time was between 285-386 J/m2, which is the daily recommended limit for irradiation for outdoor workers. As seen here, the data on UV exposure risk with gel manicures are conflicting and more research needs to be done to analyze the safety profile and risk of skin cancer associated with UV nail lights.[1]

CONCLUSION

In conclusion, nail product usage has the potential to cause significant, chronic, dermatologic disease. The chemicals used within nail products can be hazardous to the skin and nails, leading to allergic contact dermatitis, destruction of the nail itself, and potentially skin cancer due to UV radiation in nail salons. More research needs to be conducted to further evaluate these hazardous chemicals and their dermatologic impact to promote consumer safety. Dermatologists, being the experts in skin and nails, should be well aware of these potential risks and be able to counsel their patients accordingly.

DISCLOSURES

The authors do not have any conflicts of interest to disclose.

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