

NAIL COSMETICS

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For many centuries, nails have been recognized as important not only in their physiologic role but even more so for cosmetic purposes. One author has found evidence of long, manicured nails in early Chinese art indicating this ancient culture as the possible origin of current Western nail styles. In some of this art, nails are depicted as having grown very long, indicating the relative priority of form over function.¹ Much in the way that a multimillion dollar enterprise has been established on the beautification and styling of hair, so has the nail cosmetic business become a significant market share of the cosmetic industry. It was estimated by American Salon Magazine that in 1988, over one and a half billion dollars was spent on combined nail services and products. The typical simple manicure takes about half an hour and costs from \$10 to \$20. More time consuming procedures like acrylic nails may cost upwards of \$50.

Aside from its cosmetic importance, the nail unit serves both structural and functional roles by assisting in fine motor tasks, augmenting the sensation of touch, and providing a protective covering for the fingertips.² It also furnishes a unique diagnostic window to underlying physical and psychological conditions. For example, the distally buffed nail of the atopic can indicate prolonged scratching, while the dyschromic nail may herald toxic metal ingestion or use of certain drugs. Nail surface abnormalities may suggest psoriasis, alopecia areata, lichen planus, Darier's disease, iron deficiency anemia, or may date severe illness (Beau's lines). Onychophagia and onychotillomania may allude, in a similar manner to trichotillomania, to an underlying psychological disorder or psychosocial problem. This article will review the basic nail cosmetics, implements, accessories, their uses as treatment of a variety of nail deformities, and their adverse reactions.

Many people have their nails manicured professionally or do it themselves. The basic manicure begins by removing old nail enamel with *nail enamel removers*. Next, the nail plate is *cut* to the proper length and *filed*

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Figure 1. Contact dermatitis of the nail unit with onycholysis due to toluene-sulfonamide formaldehyde resin.



Figure 2. Contact dermatitis at a distant site due to toluene-sulfonamide formaldehyde resin.

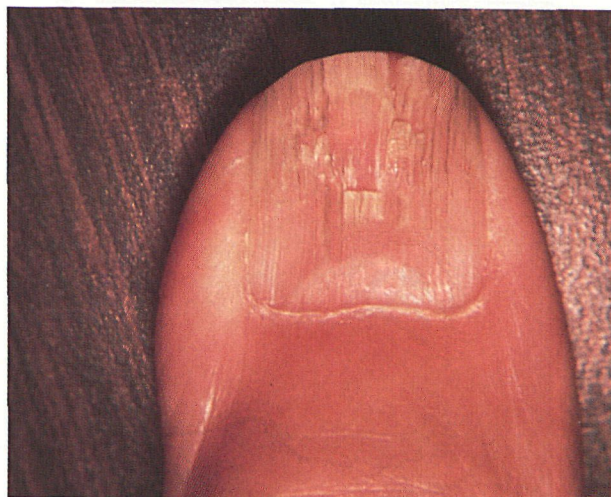


Figure 3. Dehydrated nail plate with splitting and peeling due to over-frequent removal and reapplication of nail enamel.



Figure 4. Severe contact dermatitis from formaldehyde in a nail hardener.

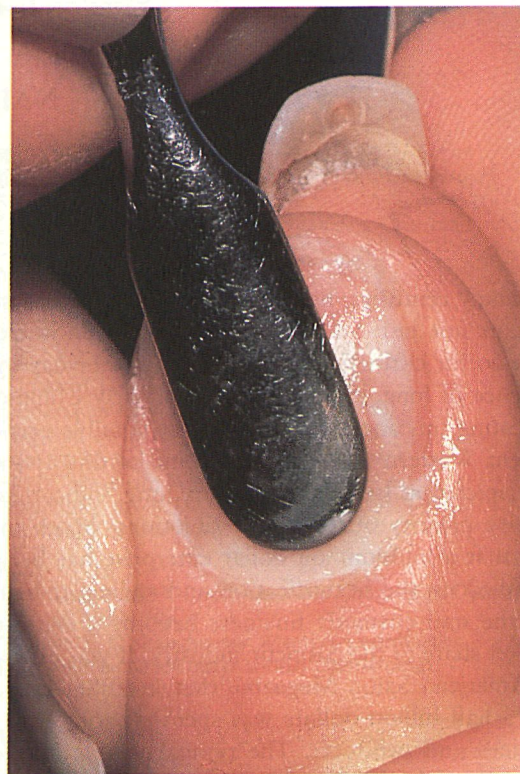


Figure 7. Metal spatula being used to push back cuticle away from the nail plate.



Figure 5. Onychodystrophy with dehydration of the nail plate and surrounding nail folds from prolonged application of cuticle remover.



Figure 8. Transverse striate leukonychia due to nail matrix injury secondary to vigorous pushing back of the cuticle.



Figure 6. Paronychia and contact dermatitis with partial loss of the nail plate due to acrylic monomer.



Figure 9. Candidal paronychia resulting from the use of an improperly sterilized cuticle nipper.

to the desired contour with either a diamond dust file or fine sandpaper file. The strongest configuration is to shape the sides of the nail plate straight with the tops gently rounded.³ *Cuticle removers*, comprised of a variety of detergents may be applied to dissolve the cuticle and allow its removal by trimmers. Finally, the *nail enamel* is applied to the surface of the nail plate and allowed to dry. Additionally, an acrylic overcoat may be added to increase strength, particularly if the nails will be worn long.

COSMETIC PREPARATIONS

Nail cosmetics can be generally categorized into enamels (polishes), hardeners (strengthen), moisturizers/conditioners, and prostheses (Table 1). Nail *enamels*, which may be used as basecoats and topcoats, are made of five basic ingredients in varying proportions.⁴ The *film former* is made of nitrocellulose, and, in addition to being non-sensitizing, it is hard, stable, and waterproof. The *thermoplastic resin* is most commonly toluene-sulfonamide/formaldehyde resin, but may also be alkyd resins, acrylates, vinyls, or polyesters.⁵ These chemicals improve adhesion, gloss, hardness, and flow of the enamel. Toluene-sulfonamide/formaldehyde resin is a potent sensitizer and cause of allergic contact dermatitis. Typical sites of involvement are distant from the

nail unit (Fig. 1) and include the cheeks, eyelids (Fig.2), sides of neck, and genitalia. Less commonly, the nail unit itself may be involved. Rarely, a generalized eruption has been noted.⁵ Of particular importance is that the resin is only sensitizing when not fully dry. Therefore, as long as allergic individuals are careful not to let wet enamel touch the skin, they can continue to use these products without ill effect. It has been suggested that sensitive individuals allow the enamel to dry for a minimum of 15 minutes followed by testing the surface with a cotton tipped applicator to assure that no polish comes off on the swab.⁶ Although a small amount of free formaldehyde is in the resin, it is normally the resin that is the cause of the reaction although both may be allergenic. Alkyd resins, used in hypoallergenic enamels, while being less sensitizing, often chip, peel, and wear poorly.^{4,5} Even these hypoallergenic products have been reported to cause contact dermatitis. A case of such a reaction to a resin containing trimellitic anhydride, adipic acid, neopentyl glycol, and cyclohexanedimethanol 70% in normal butyl acetate has been reported.⁷ Certain nail enamels do not contain toluene-sulfonamide/formaldehyde resin.⁸

Dibutylphthalate and camphor comprise the group of chemicals called *plasticizers*. Plasticizers provide flexibility, minimize shrinkage, enhance adhesion, and prolong wear by softening and plasticizing the nitrocellulose film former to prevent wrinkling and distortion of the enam-

Table 1. Nail Cosmetics and Preparations

<i>Cosmetics and Preparations</i>	<i>Principal Ingredients</i>	<i>Primary Irritant of Sensitizing Potential</i>	<i>Purpose and General Remarks</i>
Enamels	Quaternary ammonium compounds, nitrocellulose, toluene sulfonamide, solvent-extenders, and pigment colorants	Allergic sensitization mainly from toluene sulfonamide, less from nitrocellulose, least from others; primary irritancy mainly from the solvent extenders	Principal cosmetic for nails
Undercoats (basecoats)	Higher resin, lower nonvolatile content than enamel	Like those of enamels	Promote adherence; add gloss and luster; prevent chipping, cracking, and peeling
Topcoats	Higher nitrocellulose and plasticizer content than enamel; lower resin		
Buffing creams	Waxes and finely ground pumice	Practically none	Enhance shine and smooth enamels
Hardeners	Formerly formaldehyde, now polyesters, acrylics, and polyamides	Sensitization rarely occurs	Act as a good basecoat for binding enamel to nail plate
Enamel removers	Ethyl acetate, sometimes ketones	Primary irritant when application is prolonged	Permit new application of enamels or cleanse off old
Cuticle removers	Sodium or potassium hydroxide	Primary irritant when application is prolonged	Dissolution of excess cuticular tissue on nail plate
Conditioners	Protein or lipid substances	Practically none	Strengthen nails and fill in imperfections
Press-on nails	Resins and acrylic glues	Acrylic glues may sensitize	Prosthetic
Sculptured nails	Methyl and polymethyl methacrylate	The monomer is highly sensitizing, the polymer weakly so	Prosthetic
Nail wrapping	Tissue paper, high-solids enamel; may have acrylic adhesive	Acrylic adhesive may sensitize; it is also an eye irritant	Repair fractured nail plates

From Scher RK.⁴

el.¹⁵ None of these chemicals have been reported to be sensitizing. *Solvent extenders*, which make up 75% of the nail lacquer, are volatile organic solvents, usually toluene, butylacetate, ethyl acetate, or isopropanol. They maintain liquidity of the other components; and although they may act as contact irritants due to their dehydrating properties (Fig. 3), they are rarely sensitizers. *Pigment-colorants* give the products color. Additional, usually insoluble, particles may be added to impart glitter, shine, or fluorescence. Common colorants include a variety of D and C reds and yellows as well as Lithol Ribin B, tartrazine yellow, and Alizuroil Purple. Other additives may include bentonites, which are naturally occurring clays used to improve pigment suspension and enamel flow; crystalline guanine or titanium dioxide coated mica used for pearl essence; and fluorescents that contain eosin, erythrosin, fluorescein, or rhodamine B, which may be photosensitizing.⁴

Whether a product will be used as a basecoat, enamel, topcoat, or hardener depends on the proportion of the five basic components. In general, the basecoat has increased resin concentration to improve adhesion to the nail plate, while the topcoat has increased amounts of nitrocellulose and plasticizers to enhance gloss and abrasion resistance.⁵ *Nail hardeners* are used to strengthen the nail plate and are applied in much the way enamels are. Polyesters, acrylics, and polyamides are used.⁴

Infrequently, nickel mixing beads may be included in bottles of enamel, which may be responsible for nickel dermatitis.⁹ Although now banned from nail preparations in the United States, products with high concentrations of formaldehyde (>5%) may still be found in other parts of the world. In this concentration, formaldehyde may cause subungual hemorrhage, onycholysis, subungual hyperkeratosis, bluish discoloration of the nail plate, and dehydration of the nail plate resulting in cracking and splitting. Scaling and contact dermatitis of the skin with intense throbbing pain has also been described (Fig. 4). These reactions may persist for years after discontinuation of the product.^{4,10} Pterygium inversum unguis, a painful thickening of the hyponychium whereby the distal part of the nail bed remains adherent to the ventral surface of the nail plate, has been reported in association with nail hardeners.¹¹ Yet despite all of the potential adverse reactions to nail enamels and hardeners, a relatively small number of such reactions have been reported given their wide use. In a study of 1781 patients with contact dermatitis seen over 6 years during the early 1980s, only 4.2% had allergy to cosmetic products; and of these, only 8% were attributed to nail cosmetics.¹² Another study found that out of 119 patients with cosmetic related contact dermatitis, 13% could be attributed to nail hardener and/or lacquer, making skin care products more commonly responsible, and perfumes, hair cosmetics, and deodorants less commonly responsible than nail cosmetics.¹³

For the non-dermatologist, it should be borne in mind that pulse oximetry, used for the determination of oxygen saturation in a wide variety of in hospital settings, is predicated on the transmission of light through the skin. While some of these sensors are attached to the ear, many are fastened to the fingertip. The presence of black, blue, and green nail polish has been shown to lower oximeter readings of oxygen saturation significantly.¹⁴

Nail conditioners soften and moisturize the nail plate thereby improving strength and flexibility much in the way that hair conditioners and creme rinses work for dry hair. These products are hydrophobic emulsions, which contain proteins, oils, fatty acids, lanolin, or petrolatum. Additives are common including natural herbs and extracts as well as preservatives and the newer liposome delivery systems. Any of these may be potential sensitizers to the surrounding skin. Conditioners are typically applied with a brush or rubbed on, but newer applicators, which look like a highlighter pen, are being sold.¹⁵

Nail enamel removers are organic solvents such as acetone or acetates. Because they often cause nail plate dehydration leading to brittle nails and local irritation of the perionychial area, many preparations include oils. Scents (commonly lemon) and colors may also be added.

Cuticle removers contain 2 to 5% sodium or potassium hydroxide. They break the disulfide bonds of keratin. Once applied, the cuticle is softened or dissolved, making manual removal with cuticle clippers or other implements easier. These products may act as primary irritants causing chemical paronychia, and subsequent fungal or bacterial infection may ensue. In addition, overuse may result in considerable dehydration of the nail plate and perionychial skin (Fig. 5). Like nail enamel removers, cuticle removers should not be used for closed patch testing.⁵

Preformed plastic nails are nail look-alikes that are glued with an acrylic-based cement to the nail plate to lengthen short nails or cover the entire nail plate. These products are marketed heavily for home use and are available at cosmetic counters and on supermarket shelves. Although the acrylic cement has been reported to be sensitizing in some,¹⁶ their major danger is onycholysis and onychodystrophy brought about by leaving these prostheses in place for prolonged periods of time (>18 hours). Because they are nonporous, no air can reach the nail plate, and because the glue is strong, improper removal may cause onychoschizia.^{4,17-19}

Sculpted nails are formed *in vivo* with the use of a template, which is placed over the nail unit. An acrylic paste is applied, and then when dry, the form is removed and the resulting nail trimmed, filed, and polished like a natural nail plate would be. Additionally, acrylic can be painted over a weak nail to impart strength alone and not length. Liquid ethyl or isobutyl-methacrylate monomer is combined with powdered

polymethyl-methacrylate polymer and allowed to polymerize. Then, in the presence of benzoyl peroxide (an accelerator), the acrylic nail is shaped over the natural nail plate, producing a long, smooth, attractive nail. It has been reported that these monomers are sensitizing (Fig. 6), and that they cross-react with methyl- and N-butyl methacrylate, which has been removed from the U.S. market because of its potent sensitizing properties. Products such as dental plates, orthopedic surgical cement, contact lenses, sealants, and others often contain acrylic and, therefore, may be the initial sensitizers.^{5,15,20} The polymer has mild sensitizing ability and may cause onycholysis, permanent loss of the nail plate, onychoschizia, paronychia, and paresthesias of the fingertips. One case has been reported in which paresthesia of the fingertips, caused by acrylic nails, did not resolve with their removal, but persisted for years.^{21,22} Numerous reports of fatal and nonfatal ingestion of acetonitrile-containing acrylic nail removers have recently appeared in the literature. When acetonitrile, the main ingredient in these products, is inhaled or ingested, it is metabolized to cyanide. The effects, which include severe metabolic acidosis, vomiting, seizures, shallow respirations, and death, begin after a latent period of approximately 12 hours. Treatment is with activated charcoal, sodium nitrite, sodium thiosulfate, and hemodialysis. Sodium bicarbonate may be needed to correct the metabolic acidosis.²³⁻²⁷ Methemoglobinemia and resultant cyanosis may follow ingestion of N,N-dimethyl-p-toluidine, a component used in the fabrication of artificial nails.²⁸

Sculpted nails have traditionally been acrylic, but recently a new *gel* preparation has been marketed with the promise of easier application, faster drying, longer life, and easier removal with less weakening of the natural nail plate. They are versatile, because the gel may be used as a wrap, tip overlay, strengthener, or lengthener. The word *gel* applies to the form of the product, and not to the product itself; as these systems may be either acrylic or cyanoacrylate-based.²⁹ The gel is composed of a resin, resin monomer, and photoinitiator. It is applied to the nail plate with a brush and is cured (polymerized) with UV light, visible light, or with a chemical activator, which is brushed or sprayed on. The viscosity of a gel is determined by the proportion of the resin to resin monomer: higher concentrations of resin thicken the gel. Although gels are designed to remain on the nail plate for long periods of time, improper technique may cause premature peeling, shrinkage, or popping off of the entire gel. Should contact dermatitis occur, gels may be removed by filing the top of the nail to break the seal, followed by soaking in gel remover solution, which is usually acetone based. The price for a full set of gels averages \$39.²⁹

Nail wrapping is the technique of applying tissue paper, cotton, wool, nylon, or silk to the nail plate, especially at the free edge, to repair onychoschizia or

strengthen the nail plate. After placement of the mesh on the nail plate, enamel, acrylic, or gel is applied as a glue. Potential for contact dermatitis is based on the glue used.⁵

IMPLEMENTS

Nail implements are tools used in the manipulation of the nail plate and surrounding structures of the nail unit. Nail clippers cut the nail plate to the desired length, while files smooth and shape the distal edge. For the best results, a fine file such as a diamond dust file or very fine sandpaper file should be used instead of an emery board.³ Using coarser materials leave the free edge rough, permitting catching on material and objects predisposing to tears or nicks of the nail. The cuticle may be mechanically removed by cutting with a diagonal cutter or pushed back with a porcelain spatula, orange wood stick, or metal spatula (Fig. 7). Any of these activities run the risk of injury to the nail matrix resulting in temporary or permanent scarring and deformity. Such damage may be manifested by transverse ridging, punctate and transverse leukonychia (Fig. 8), or in more serious cases, longitudinal ridging and splitting indicating permanent matrix scarring.^{30,31} Additionally, improperly sterilized instruments may transmit a variety of infectious diseases, the most common of which is fungal disease leading to onychomycosis (Fig. 9). Because there may be bleeding during a manicure, it is particularly important in this era of viral disease to ensure that adequate and effective sterilization techniques are followed.

ACCESSORIES

Nail accessories refer to jewelry and appliques (decals and paints), which are applied to the nail plate at the end of the manicure. Many are glued to or painted onto the nail plate, while others are attached by a post inserted through a hole drilled in the nail plate much in the way an earring is affixed to a pierced earlobe. More elaborate nail art is fashioned with airbrushes, stencils, and fine brushes. With the exception of possible contact sensitization to the paints and glues similar to those described with nail enamel, nail accessories as a group do not have adverse reactions.

COSMETIC THERAPY FOR ABNORMAL NAILS

Of first and foremost consideration in the cosmetic treatment of abnormal nail plates is to bear in mind that the treatment is only a cover-up of the underlying disease process. Proper diagnosis remains essential before therapy is instituted. A thorough history and physical examination of the nail unit and skin are the minimum.

Augmentation with fungal or bacterial cultures, blood assays, bone x-rays, or nail biopsy may be necessary. This is particularly true of *nail dyschromia*, which may be secondary to bacterial or fungal infection, medications, endogenous or exogenous chemicals, underlying systemic disease, or malignant melanoma. Whether pigment is endogenous or exogenous may be clinically suspected based on the orientation of the pigment in relation to the proximal nail fold (Fig. 10). If in doubt, especially with dark pigmentation, it is wise to perform a biopsy before covering up a potentially serious condition. Once the etiology of the dyschromic condition has been diagnosed as benign, covering with an opaque lacquer or prosthetic nail allows for camouflage.

Onychomycosis should be diagnosed with potassium hydroxide preparation and confirmed by culture. With the exception of white superficial onychomycosis where superficial scrapings will yield the diagnosis, most fungal nail involvement is subungual and therefore scrapings for diagnosis must be taken from the underside of the nail using either a small curette or cupped burr, or by clipping the nail back and scraping the hyperkeratotic nail bed. Therapy with topicals is usually inadequate, making oral preparations the necessary approach. During therapy there is no harm in buffing the nail plate to an even surface and applying nail enamel, or prosthetic nails. Indeed, this may be quite appreciated by the patient because a cure takes months of therapy. One relative exception to this camouflage is candidal nail infection with paronychia, which may be additionally irritated by topically applied cosmetics. Likewise, it is probably safest to leave bacterially infected nails unoccluded.

Surface defects such as pits, horizontal or vertical depressions, and the delling of koilonychia may be remedied by buffing the surface of the nail plate and then applying a prosthetic acrylic or gel nail. Cosmetic treatment may be time limited, since one time insults will eventually grow out and underlying disease may be treated successfully.

Longitudinal splitting of the distal nail plate and *onychoschizia*, a condition in which the distal nail plate splits along a plane that divides the thickness of the nail plate into the superficial one third and the deep two thirds, are both caused by chronic dehydration and rehydration of the nail plate. Therapy involves the frequent and religious application of moisturizers and conditioners. This may be augmented by nightly 15 minute soaks in water followed by liberal application of thick moisturizer such as petrolatum. Moist occlusive technique is then used. Additionally, keeping the free edge of the nail buffed and smooth using a file will decrease trauma thereby avoiding further deformity. Gloves should be worn during any activity that requires immersion of the hands in water. Moisturizer should be applied after each contact with water. Nail enamel and acrylics may be used to fill

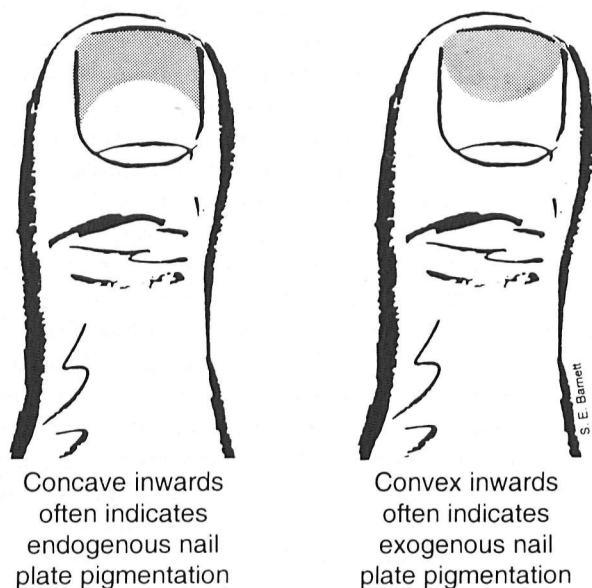


Figure 10. Whether pigment is endogenous or exogenous may be clinically suspected based on the orientation of the pigment in relation to the proximal nail fold.

gaps or strengthen the nail plate, but their removal with acetone based enamel removers may cause further dehydration. Nail wrapping of the distal free edge may be useful, especially in onychoschizia.² Ideally, trimming should take place only when the nail is well hydrated or covered with hardened enamel.

Therapy for *soft nails*, which bend easily or split at the free edge,¹⁸ includes nail fortification with hardener or wrapping, or application of plastic nails. *Hard, thick nails*, as seen in pachyonychia congenita, must be soaked in warm water before they can be cut to prevent irregular chipping.

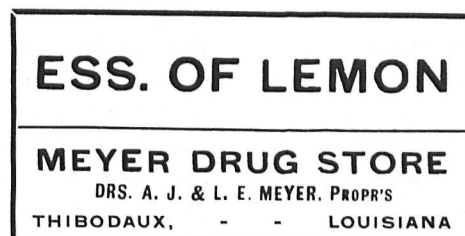
Rough nails may arise primarily as a congenital anomaly, be secondary to psoriasis, alopecia areata, ichthyosis, lichen planus, or chemicals, or have no demonstrable cause.¹⁸ The hallmarks of this disorder are a rough, brittle nail surface with gray opacities and frequent splitting of the distal edge of the nail plate. Therapy is directed at treatment of the underlying disease process, and application of nail conditioners. Buffing and wrapping offer additional modalities of cosmetic treatment.²

CONCLUSIONS

A knowledge of nail cosmetics allows the dermatologist additional breadth in his differential diagnosis of diseases of the nail unit as well as when considering the etiology of dermatitis occurring at a distance from the nail. Cosmetic techniques may be of great benefit when therapy of nail disease will take a long time or when no effective medical or surgical therapy is available.

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