



Review

Nail health in women

Jessica K. Reinecke^a, Molly A. Hinshaw, MD, FAAD^{b,*}^a University of Wisconsin-Madison, Madison, WI, United States^b Department of Dermatology, University of Wisconsin-Madison, Madison, WI, United States

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ABSTRACT

Healthy nails are functionally and cosmetically important to the daily work of women. The globally increasing market for nail cosmetics reflects the importance of the appearance of nails. This article details the composition of a healthy nail, diagnosis and treatment of nail disorders, use of nail cosmetics and their risks, the impact of the aging process on nails, and the relative risks to nail salon workers. Knowledge of these issues will prepare health care providers and patients to maintain healthy nails throughout their lives.

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* Corresponding author.

E-mail address: mhinshaw@dermatology.wisc.edu (M.A. Hinshaw).

Introduction

Healthy nails help women accomplish the work and joy of their busy lives. Unfortunately, according to the American Academy of Dermatology, 99% of people will experience a nail disorder during their lifetime (Crutchfield, 2013). Many of these disorders will require medical intervention. Nail disorders are the chief complaint in 10% of all medical visits to dermatology specialists in the United States (Leone and Schupbach, 2017) and are a substantial health care burden given that there were approximately 25.3 million visits to dermatologists in 2006 in the United States (Pal, 2009). Women seek medical intervention for nail disorders, some of which are due to nail cosmetics, complications of nail grooming, and the aging process.

This review describes a healthy nail and the best approach to maintain its health and discusses nail disorders caused by nail grooming and cosmetics as well as age-related nail disorders in women.

Global attention to nail health and esthetic appearance

Throughout history, women have enhanced their beauty with nail cosmetics. The use of nail cosmetics dates to 5000 BC when

women in India, China, and Egypt used henna to dye their fingernails (Shafer, 1993; Tsatalis et al., 2018). Currently, 85% to 90% of women worldwide use nail care products (Goldstein Research, 2018).

Nail cosmetics including nail polish, acrylics, silks, gels, and extensions, are a global, multibillion-dollar industry, the primary consumers of which are woman. In 2018, nail cosmetics became an \$8.36 billion industry in the United States (Mazareanu, 2019). Globally, the retail market for nail polish increased from \$3 billion in 2007 to \$45 billion in 2012 (Sun, 2014).

Clearly, the esthetic appearance of nails is important to women. Awareness of how to maintain a healthy nail, safe practices for the use of nail cosmetics, and the early identification and treatment of nail disorders should help patients use nail cosmetics and maintain functional nails throughout their lives.

Healthy nails

Healthy nails are shiny, smooth, and uniform in consistency on both the surface and free-margin views (Fig. 1A, B, and C; Draelos, 2013). They have attached cuticles, nail folds, and nail plates (Draelos, 2013). Healthy nails are not cracked, rigid, or broken (Draelos, 2013). The visible nail bed is pink, and the free margin is

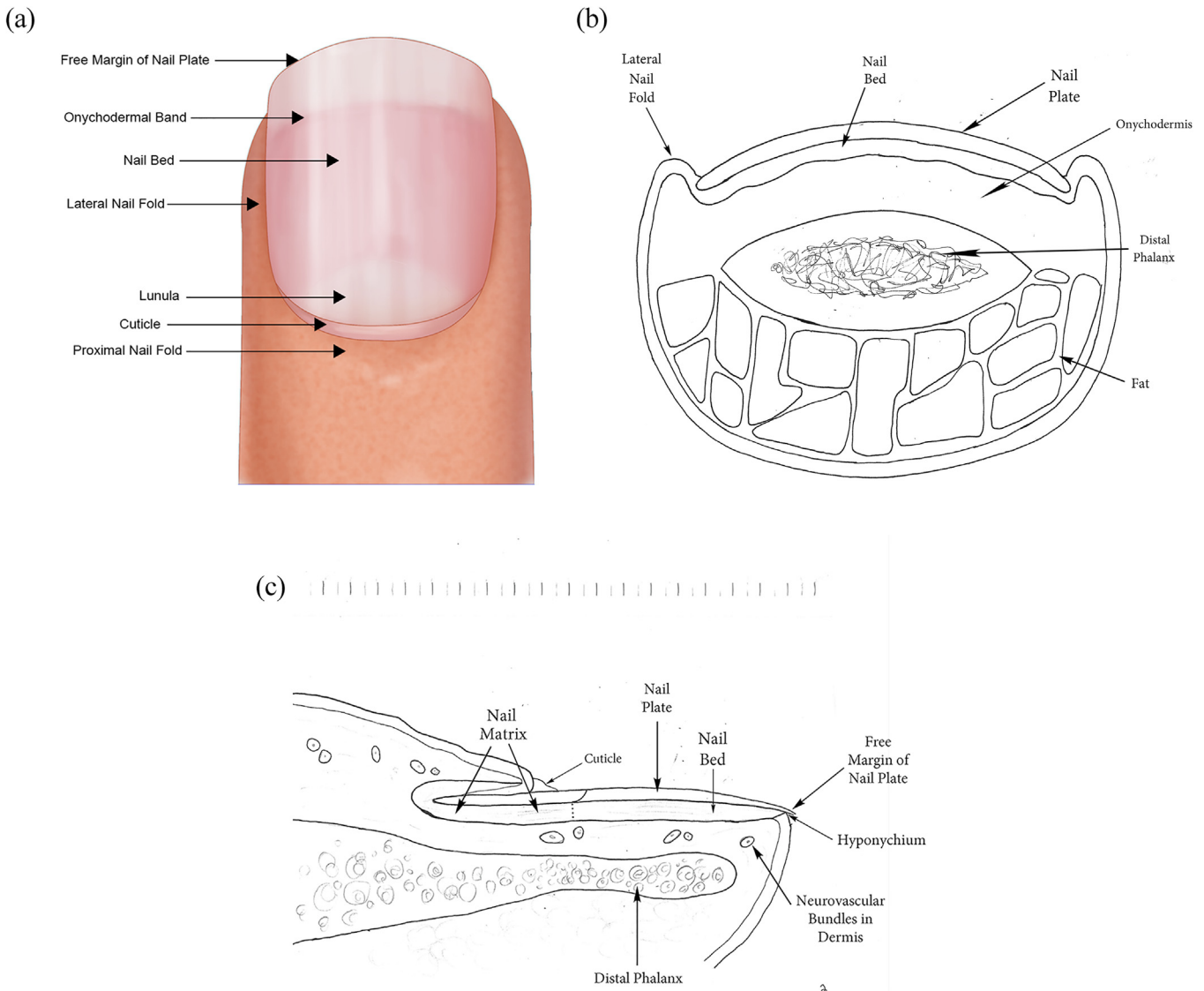


Fig. 1. Healthy nail with normal anatomic structures in place. (A) Surface view. (B) Free-margin view. (C) Longitudinal view; the vertical dotted line represents the junction of nail matrix and nail bed, which corresponds to the distal margin of the lunula.

white (Madnani and Khan, 2012). Other desirable characteristics of nails include a free edge that extends beyond the nail bed, a shiny surface, and a slight curve on the free-margin view. Many available over-the-counter products claim to improve nail health. However, there is little evidence that these products actually improve nail quality or provide any benefit beyond a cosmetic one (Haneke, 2006).

Healthy grooming habits include cutting fingernails straight across and rounding the edges. However, rounding the edges of toenails more than slightly may increase the risk of ingrowing nails and should therefore be avoided. Cuticles should be left in place, not cut or pushed back, because they serve to keep out pathogens. The nail surface should not be filed because this thins the nail plate and makes it prone to splitting. Sharp objects should not be placed under the nails because this may breach the onychodermal band (Fig. 1A), causing onycholysis and increasing the risk of infection with bacteria and fungi.

Nail disorders in women

Paronychia

Paronychia is the inflammation of the nail fold(s). It can be acute or chronic and may present in isolation or coincide with an ingrown nail (Lomax et al., 2016). Acute paronychia consists of painful swelling with pus that affects the nail fold(s). It is caused by trauma including cuticle abrasion during nail filing or cuticle trimming (Baran, 2002). When the seal between the nail fold and nail plate is breached, a pathway is made for infectious agents (Lomax et al., 2016). *Staphylococcus aureus* is the most commonly isolated infectious organism in acute paronychia and may be acquired from contaminated nail grooming instruments (Brook, 1993; Lomax et al., 2016).

Chronic paronychia is inflammation and swelling of the nail folds, often with loss of the cuticle (Fig. 2). The pathogenesis is debatable, but at least a substantial component is an irritant or, less often, allergic contact dermatitis (ACD; Shemer and Daniel, 2013). Treatment includes gentle nail care and the application of corticosteroids until the inflammation is resolved. Of note, a comprehensive treatment plan for chronic paronychia involves avoidance of irritants and moisture and the use of light cotton gloves under vinyl gloves for wet work; this should continue indefinitely, particularly for patients with recurrent paronychia.



Fig. 2. Chronic paronychia. Surface view of nail showing redness and swelling of the proximal nail fold in association with loss of cuticle. Nail plate Beau's lines appear as transverse ridges as a result of trauma to the nail matrix, which occurs when the cuticle is repeatedly pushed back.

Green nail

Green nail syndrome (GNS) is a term used to describe a greenish discoloration of the nail, often in association with onycholysis (Fig. 3; Bae et al., 2014; Geizhals and Lipner, 2019; Greene et al., 1984). *Pseudomonas aeruginosa* is a gram-negative coccobacillus that is the most common cause of bacterial infections of the nail and is known to cause GNS by the production of the blue-green pigment pyocyanin (Muller et al., 2014; Nenoff et al., 2014). GNS is a colonization of the nail by *Pseudomonas* as opposed to a true infection, which would have associated signs such as pus. Risk factors for the development of GNS include chronic paronychia, trauma to the nail or perionychium, and prolonged exposure to water. Prevention of GNS therefore relies on avoidance of these environmental factors and on maintenance of healthy nails.

The treatment of GNS has not been well studied but includes avoidance of predisposing factors, avoidance of prolonged exposure to water, and clipping back any onycholytic nail. Use of topical agents is also beneficial. *Pseudomonas* is naturally resistant to a variety of antibiotics and may develop new resistance through the modification of porin (Bae et al., 2014). Therefore, any treatment with antibiotics is ideally guided by bacterial culture and sensitivities. Topical antibiotics including quinolones, aminoglycosides, and silver sulfadiazine have all demonstrated efficacy. In a recent case series, 100% of patients with GNS who completed treatment (21 of 21 patients) had complete clearance after 3 months of nightly application of ophthalmic 0.3% gentamicin topical solution used as monotherapy (Geizhals and Lipner, 2019). Case reports on the efficacy of antiseptics such as acetic acid and sodium hypochlorite exist; if using these agents, caution is advised because they may cause irritation of the surrounding skin. Systemic therapy may be necessary in refractory cases.

Onycholysis

Onycholysis is separation of the nail plate from the nail bed. Causes of onycholysis include trauma, irritants, subungual tumors, primary nail disorders such as psoriasis, and infections including onychomycosis.



Fig. 3. Pseudomonal nail (green nail syndrome). Green chromonychia due to staining of the nail plate by pyocyanin produced by *Pseudomonas aeruginosa*. In addition, onycholysis is present.

Onycholysis can be inflammatory or noninflammatory and usually causes temporary throbbing pain (Helsing et al., 2007). Patients who wear acrylic nails are predisposed to onycholysis because the adhesive that bonds the extension to the nail is stronger than the natural bond of the nail to the nail plate (Draeos, 2000). Acrylic nails lead to traumatic onycholysis when extensions lever the nail plate from the bed or when the wearer uses sharp instruments to clean under the nails (Dinani and George, 2019). Acrylic nails also reduce evaporation of water from the nail, which causes the nail and nail bed to be excessively hydrated and makes the nail bed more likely to separate from the nail plate (Baran, 2002).

Nail hardeners are another potential cause of onycholysis because they may contain up to 5% formaldehyde, which can cause inflammatory and painful onycholysis (Helsing et al., 2007). Treatment of onycholysis involves gentle nail care and identification and treatment of any associated nail disorders, such as onychomycosis.

Onychomycosis

Onychomycosis is the most common nail disease and accounts for up to 50% of all nail disorders (Fig. 4; Faergemann and Baran, 2003). Onychomycosis is most commonly caused by dermatophytes, specifically *Trichophyton rubrum*, but in some series up to 30% to 40% of onychomycosis is due to nondermatophyte molds and yeast (Lipner and Scher, 2019). Men, the elderly, and those with immunosuppression, tinea pedis, diabetes mellitus, or peripheral vascular disease are all at increased risk of onychomycosis (Hanna et al., 2018).

Transmission of dermatophytes into the nail is thought to begin with tinea pedis in the setting of a dystrophic nail, thus facilitating penetration of fungi into the nail. In addition, fungi may gain access to the nail through contact with contaminated objects, including nail grooming instruments (Klafke et al., 2018). The sanitization of nail tools is therefore important in preventing the spread of onychomycosis. Cuticle abrasion, paronychia, and contact dermatitis can also provide a point of entry for fungi. One study found that 67 of 68 female patients with a nail concern after the removal of artificial nails were diagnosed as having a fungal infection (Shemer et al., 2008). Another study found that a typical nail polish top coat can act as fomite and therefore be a nidus for onychomycosis (Klafke et al., 2018).



Fig. 4. Onychomycosis. Xanthonychia and hyperkeratosis of third toenail typical of onychomycosis. Note that associated tinea pedis as is routinely present.

The gold standard for treatment of onychomycosis remains oral terbinafine. Multiple topical antifungals and other oral antifungals agents are also available by prescription. Fingernails grow more quickly (approximately 3 mm/month) than toenails (approximately 1 mm/month), and the duration of antifungal therapy is typically shorter for fingernails than for toenails. Prevention of onychomycosis includes gentle nail care, use of clean instruments during nail care, and early treatment of tinea pedis for toenails.

Brittle nails

Brittle nails are a common problem in women and are characterized by excessive longitudinal ridging, horizontal lamellar splitting (onychoschizia), and irregularity of the free margin of the nail plate (Lubach et al., 1986; Singh et al. 2005). Environmental triggers that exacerbate brittle nails include filing the surface of the nail, trauma, and dehydration of the nail due to excessive water exposure or use of solvents such as cuticle or nail polish removers. Management of brittle nails is difficult, but interventions that may help include limiting trauma, using moisturizing creams/ointments/oils, wearing gloves to avoid contact with irritants such as water and chemicals and avoiding filing the surface of the nail (Chang et al., 2007; Haneke, 2006).

Oral supplementation with biotin (2.5–10 mg orally per day) has been used to improve the quality of nails, but the need for supplementation is unclear because biotin is synthesized to a great degree by intestinal bacteria (Haneke, 2006). Biotin is important for carboxylation and stimulates the synthesis of lipid molecules, which bind the nail plate's keratinocytes (Iorizzo, 2015).

Marked biotin deficiency is associated with poor nail quality (Haneke, 2006). A study by Colombo et al. (1990) documented a 25% increase in nail thickness in women who took biotin supplementation for 6 to 9 months. Another study by Hochman et al. (1993) concluded that although biotin supplementation is not consistently effective among all patients, there is a trend toward being beneficial to nail health. There may be a role for biotin in nail health, but additional studies, including investigation of dosages and the effect of biotin on brittle nails, are needed.

Risks of biotin supplementation include the Food and Drug Administration's warning that supplementation may interfere with laboratory testing (eg, tests for troponin levels, thyroid-stimulating hormone, and parathyroid hormone) and lead to incorrect diagnoses (John and Lipner, 2019). However, this warning applies to high-dose biotin supplementation, and some suggest there is no need to discontinue biotin before laboratory testing when patients are taking biotin at dermatologic doses of 5 mg per day (Piraccini, 2018).

Effect of nail cosmetics on women's health

Women wear nail cosmetics to enhance their esthetic appearance. Ironically, nail cosmetics may lead to substantial and sometimes permanent nail changes that worsen the esthetic appearance of the nail. Knowledge of these potential complications may help avoid or at least expeditiously diagnose and treat them.

Nail polish

One potential health risk from standard nail polish is ACD. The most well-known nail polish allergen is tosylamide/formaldehyde resin (Atwater and Reeder, 2019). Recognition of this frequent sensitizer has led to the current availability of many tosylamide/formaldehyde resin-free nail polishes and thus a reduction in patch-test positivity to this allergen (DeKoven et al., 2018; Zug et al., 2009).

Gel polish (ultraviolet light–curable nail lacquer)

Unlike standard nail polish, gel polish (also known as ultraviolet [UV] light–curable nail lacquer) requires photocuring. Gel polish has gained popularity because it is long-lasting, resistant to chipping and scratching, and easy to apply (Cervantes et al., 2018). Shellac (CND, San Diego, CA) and OPI gel polishes are examples of gel polish. Gel polish contains photoinitiators that are photocured with either a UV (typical wavelength of 340–380 nm; Shihab and Lim, 2018) or a light-emitting diode (LED) lamp, and some are formulated to be used with either type of lamp. LED lamps accomplish photocuring more quickly because they emit a narrower spectrum of light. However, UV lamps are less expensive and are therefore more routinely used in the photocuring process.

A newly recognized complication of UV light–cured polish is pterygium. Pterygium inversum unguis (PIU) is the adherence of the hyponychium to the nail plate, which causes morbidity and pain especially during cutting or filing of the nails. Cervantes et al. (2018) reported a case series of 17 patients who all developed PIU after 2 to 5 years of gel polish application. In 9 of these 17 patients, both LED and UV-A light had been used. Of the remaining 8 patients, 5 had used only LED light and 3 did not know or could not recall which type of light they used. All but 2 patients had resolution within a few weeks of switching from gel to normal nail polish. Patients and providers should be educated about this potential complication so they can recognize it early and stop gel manicures immediately, thereby hopefully leading to resolution of PIU.

Gel polishes are not only available in professional nail salons but are also available for purchase online for home use. At-home gel polish kits using UV light pose a significant health threat because they are unregulated, and users are untrained (Gatica-Ortega et al., 2018). Consumers who use these nail kits tend to increase the duration of contact with irritants found in nail cosmetics (Chang et al., 2007). A 2016 study of 65 consumers who developed side effects from at-home gel polish kits found that the most common complaint was painful, pruritic periungual eczematous dermatitis. Other side effects included onycholysis, lesions under the nail plate, and weak or brittle nails (Dahlin et al., 2016).

Sculptured nails

Sculptured nails are applied as acrylic or gel nails, both of which contain acrylates. Acrylic nails are made by the spontaneous polymerization of acrylate or methacrylate (referred to here as [meth]-acrylate) monomers (Dinani and George, 2019). Acrylic nails traditionally include the use of a nail extension and do not require the use of UV light. Gel nails are created from a mixture of liquid acrylate monomers applied either directly to the nail plate or to a plastic tip and polymerized with UV light.

Acrylate-based nail products are inducers of ACD (Fig. 5A and B) and distant dermatitis (Baran, 2002). Signs of allergy to nail products include pruritic eczematous dermatitis of the fingers, hands, and wrists, although up to 10% of patients may have dermatitis localized only to the face or neck (Gonçalo et al., 2018). Of note, acrylates are not a component of the thin-layer rapid-use epicutaneous patch test (SmartPractice). Instead, patients suspected of having an acrylate allergy should be patch tested to the acrylate series used with the chamber method. Some authors recommend an initial screening with 2-hydroxyethylmethacrylate (HEM) and ethyl cyanoacrylate, followed by extended acrylate testing if both are negative (Atwater and Reeder, 2019; Gonçalo et al., 2018).

Nail hardeners

Nail hardeners are another potential cause of ACD and distant dermatitis (Mestach and Goossens, 2016). The active ingredient in nail hardeners is up to 5% formaldehyde. In sensitized individuals, a concentration of formaldehyde as low as 0.006% can trigger ACD (Mestach and Goossens, 2016). Products that contain formaldehyde should be completely avoided.

Nail cosmetics and skin cancer

Many artificial nail applications require the use of a UV lamp. These UV light lamps use UV-A to photocure, harden, and dry the nail cosmetics (Wang et al., 2018). These lights are available for purchase for at-home use, and consumers may be unaware of the potential risk of carcinogenesis (Wang et al., 2018).

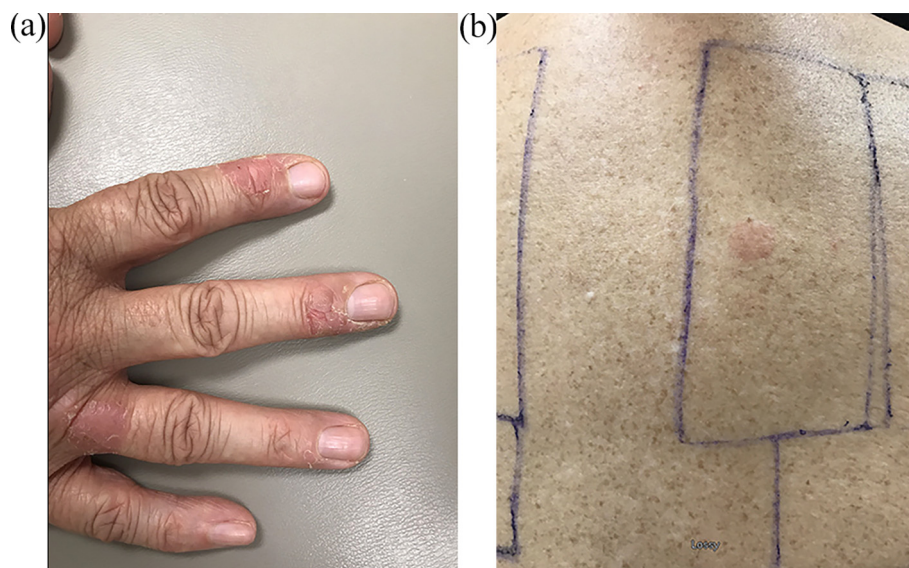


Fig. 5. Allergic contact dermatitis to acrylate. (A) Eczematous dermatitis of the nail folds with extension to the dorsal fingers and hands. (B) Positive patch test confirming allergy to 2-hydroxyethylmethacrylate (Photo courtesy of Margo Reeder, MD, Department of Dermatology, University of Wisconsin School of Medicine and Public Health).

UV-A radiation is a known carcinogen (Shihab and Lim, 2018). The time of exposure to these UV lamps during usual photocuring of nail polish ranges from 3 to 5 minutes and is commonly repeated every 2 to 4 weeks (McConnell, 2008; Shihab and Lim, 2018). A study by MacFarlane and Alonso (2009) found that the amount of UV-A radiation exposure from a UV nail lamp is as damaging as spending an additional of 1.5 to 2.7 minutes in sunlight each day for 2 weeks. MacFarlane and Alonso (2009) reported on two female users of UV lamps who developed squamous cell carcinoma on their hands in the absence of a personal or family history of skin cancer. Other studies have found that the risk associated with these lamps is low. Nonetheless, the current recommendation by the Skin Cancer Foundation is to avoid the use of UV lamps. If patients are going to use photocured polishes, then the use of a broad-spectrum sunscreen or nitrile gloves before exposure is recommended (Wang et al., 2018).

Lastly, it is important to discuss that the use of nail adornments obscure the nail unit and therefore may lead to a delay in diagnosis of malignancies. Delay in diagnosis of malignant melanoma has been reported in a patient who routinely wore nail polish (Goldman and Rich, 2001). The patient was aware that 30 years earlier, she had developed a pigmented streak in the nail, but she was not concerned about the appearance because she covered the streak with polish. At diagnosis, the patient's nail was polished, and the atypical pigmented lesion was noted at the hyponychium. Her melanoma measured to a Breslow thickness of 0.42 mm and lacked a Hutchinson's sign.

Risks to nail salon employees

A discussion of nail health in women would not be complete without a discussion of the health of nail salon workers. According to the Centers for Disease Control and Prevention (CDC; CDC, 2018), 96% of nail salon workers are women, and 63% of these women are minority workers (CDC, 2018). This vulnerable group is potentially exposed to numerous chemicals during a routine workday. Nail salon workers are exposed for much longer periods to these chemicals and are therefore more affected than consumers. Many publications have discussed the possible associations between nail cosmetic exposures and the respiratory, neurologic, and musculoskeletal health of these female workers (Cogliano et al., 2005; Quach et al., 2015; Swan, 2006; 2008; Swan et al., 2005).

ACD is also a serious risk for these workers. For the last 10 years, nail technicians have been the primary occupation experiencing acrylate allergy (Gonçalo et al., 2018), which most frequently presents in this group as pulpitis and fissures (Gonçalo et al., 2018). Acrylate allergy in nail salon workers may also present as onycholysis, onychodystrophy, subungual hyperkeratosis, paresthesia, urticarial, and upper respiratory tract symptoms (Gatica-Ortega et al., 2017; Gonçalo et al., 2018).

Nail salon workers' exposure to the chemicals found in nail cosmetics can be regulated by enforcing required licensing and certifications, disclosing product dangers (translated into a language each nail technician can understand), improving ventilation systems, and following the restrictions of prohibited ingredients (Zhong et al., 2019). One recent study found that intervention with appropriate training for nail salon owners and workers effectively improved the condition of the workplace and decreased the exposure of nail salon workers to workplace chemicals (Quach et al., 2018).

Age-related nail changes

Age-related nail changes occur in women and may be confused with pathological conditions that require medical attention.

Throughout the normal aging process, nails become more brittle and slow in their rate of growth (Maddy and Tosti, 2018). Starting at the age of 25 years, a person's nail growth rate decreases by 0.5% each year (Cohen and Scher, 1992). The aging nail may appear pale, dull, or opaque (Singh et al., 2005).

Neapolitan nails is an age-related change in which nails are opaque distally, normal pink centrally, and white proximally (Horan et al., 1982). The changes in color occur without abnormalities in the liver or kidneys, as would be expected with Terry's or half-and-half nails (Saraya et al., 2008). The etiology of these age-related changes is unclear but may be due to impaired blood flow to the nail unit. A complete review of symptoms and, if warranted, screening laboratory studies for thyroid, kidney, and liver function should be reassuringly normal.

Importantly, the risk of onychomycosis, paronychia, and onycholysis increases with age (Singh et al., 2005). The prevalence of onychomycosis in children aged <16 years is 0.2% to 2.6% and increases with age, reaching a prevalence of 20% in patients aged >60 years (Singh et al., 2005; Solis-Arias and Garcia-Romero, 2017; Totri et al., 2017). This increased incidence may be related to the decrease in nail growth rate with age (Maddy and Tosti, 2018). Gait abnormalities and changes in anatomy increase with age (eg, hallux valgus), predisposing toenails to trauma, which is a risk factor for the progression of tinea pedis to tinea unguium.

Brittle nails also increase with age, affecting 19% of patients aged <60 years and 35% of the population aged >60 years (Lubach et al., 1986). Postmenopausal women are particularly predisposed to nail brittleness, which may due in part to a decrease in cholesterol sulfate in the nail plate (Iorizzo, 2015; Maddy and Tosti 2018). See Brittle Nails for a more comprehensive discussion of the etiology and treatment of this common nail disorder.

Conclusion

Nail health in women is important for daily function and cosmesis. Maintaining healthy nails is accomplished by the use of safe grooming practices. The plethora of nail cosmetics used worldwide has the potential to compromise nail health. It is important for women and their health care providers to be aware of such potential complications so that they can be avoided or at least diagnosed early and treated.

In addition, the normal aging process in women leads to nail changes that may impair function if not addressed. In collaboration with her health care provider, a woman should be able to maintain healthy, functional nails throughout her life.

Conflict of Interest

Dr. Molly A. Hinshaw is tri-founder, tri-owner, and board member of Accure Medical, LLC.

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None.

Study Approval

The author(s) confirm that any aspect of the work covered in this manuscript that has involved human patients has been conducted with the ethical approval of all relevant bodies.

Appendix A. Supplementary material

For patient information on this Nail Health In Women, please click on Supplemental Material to bring you to the Patient Page.

Supplemental Material (Patient Page) to this article can be found at <https://doi.org/10.1016/j.ijwd.2020.01.006>.

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