

Tattoo Hypersensitivity Reactions: Inky Business

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PRACTICE POINTS

- Temporary tattoo pigments include red henna, black henna, and jagua.
- Black henna tattoos contain paraphenylenediamine, the most common allergen in temporary tattoos.
- Modern permanent tattoo ink components include metals, carbon, azo, diketopyrrolopyrrole, quinacridone, anthraquinone, dioxazine (purple), or quinophthalone (yellow) dyes.
- Patch testing for tattoo contact allergy is complex and challenging.

Hypersensitivity reactions can occur in both temporary and permanent tattoos. Traditional temporary tattoos consist of red henna or black henna; paraphenylenediamine is the most common allergen and usually is present in black henna. Contact allergy to genipin in jagua temporary tattoos also has been reported. Permanent tattoo inks traditionally contain black pigment of amorphous carbon or black iron oxides or metals. Modern permanent tattoo ink is a blend of pigments, including metals, as well as carbon, azo, diketopyrrolopyrrole, quinacridone, anthraquinone, dioxazine (purple), or quinophthalone (yellow) dyes. Patch testing for temporary and permanent tattoos is complex and challenging.

Cutis. 2020;106:64-67.

Sometimes regrettable yet increasingly common, tattoos are an ancient art form used in modern times as a mark of artistic and cultural expression. Allergic contact dermatitis (ACD) to tattoo ink is

rare, but the popularity of tattoos makes ACD an increasingly recognized occurrence. In a retrospective study of 38,543 patch-tested patients, only 29 (0.08%) had tattoo-related ACD, with the majority of patients being female and young adults. The most common contact allergy was to paraphenylenediamine (PPD), which occurred in 22 (76%) patients.¹ In this article, we will walk you through the rainbow of tattoo ACD, covering hypersensitivity reactions to both temporary and permanent tattoo inks.

Temporary Tattoo Inks

Henna is the most common temporary tattoo ink. Derived from the plant *Lawsonia inermis*, henna is an orange dye that has been used in many parts of the world, particularly in Islamic and Hindu cultures, to dye skin, hair, and fabrics. Application of henna tattoos is common for weddings and other celebrations, and brides may wear elaborate henna patterns. To create these tattoos, henna powder is mixed with water and sometimes essential oils and is then applied to the skin for several hours. After application, the henna pigment lawsone (2-hydroxy-1,4-naphthoquinone) interacts with keratin and leaves a red-orange stain on the skin²; longer application time leads to a deeper color. Most traditional cutaneous henna designs fade in 2 to 6 weeks, but some last longer. Red henna generally is considered safe with low incidence of contact allergy. What is referred to as black henna usually is red henna mixed with PPD, a black dye, which is added to deepen the color. Paraphenylenediamine is highly sensitizing; patients can become sensitized to the PPD in the tattoo itself.² One

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Dr. Atwater received an Independent Grant for Learning and Change from Pfizer, Inc. Dr. Bembry reports no conflict of interest. Dr. Reeder is a site investigator for AbbVie.

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study confirmed the presence of PPD in black henna tattoos, with chemical analysis of common preparations revealing concentrations ranging from less than 1% to 30%.² Patients who undergo patch testing for tattoo reactions often are strongly positive to PPD and have concomitant reactions to azo dyes, black rubber, and anesthetics. Other aromatic amines including aminophenols have been identified in black henna tattoo ink, and these chemicals also may contribute to ACD.³ Less common sources of contact allergy from temporary black henna tattoos include resorcinol,⁴ para-tertiary butylphenol formaldehyde resin,⁵ and fragrance.⁶

Clinically, ACD to PPD in temporary tattoos presents 1 to 3 days after application if the patient is already sensitized or 4 to 14 days if the patient is sensitized by the tattoo ink.² Most patients notice erythema, edema, vesicles, papules, and/or bullae, but other less common reactions including generalized dermatitis, systemic symptoms, urticaria, and pustules have been described.² Postinflammatory hypopigmentation or hyperpigmentation also can occur.

Because of the sensitizing nature of black henna tattoos, consumers are turning to natural temporary tattoos. Jagua temporary tattoos, with pigment derived from the sap of fruit from the *Genipa americana* tree, have been associated with ACD.⁷ This black dye is applied and washed off in a similar fashion to henna tattoos. Importantly, a recent analysis of jagua dye identified no PPD. In one case, a patient who developed ACD to a jagua tattoo was patch tested to components of the dye and had a positive reaction to genipin, a component of the fruit extract.⁷ Thus, jagua tattoos often are marketed as safe but are an emerging source of contact dermatitis to temporary tattoos.

Permanent Tattoo Inks

Permanent tattoos are created by injecting small amounts of ink into the dermis. As the name suggests, these tattoos are permanent. Tattoos are common; nearly one-third of Americans have at least 1 tattoo.¹ Historically, tattoos were created using black pigment composed of amorphous carbon or black iron oxides.^{8,9} Metallic pigments (eg, mercury, chromium, cobalt, cadmium) were once used to add color to tattoos, but these metals are now only rarely used; in fact, a 2019 study of tattoo ink components identified 44 distinct pigments in 1416 permanent inks, with an average of 3 pigments per ink.⁸ Of the 44 pigments, 10 had metallic components including iron, barium, zinc, copper, molybdenum, and titanium. The remaining 34 pigments contained carbon, azo, diketopyrrolopyrrole, quinacridone, anthraquinone, dioxazine (purple), or quinophthalone (yellow) dyes. The authors noted that nearly one-quarter of the tattoo pigments identified in their study had been reported as contact allergens.⁸

Typically, reactions to permanent tattoo inks manifest as an eczematous dermatitis occurring weeks to years

after tattoo application.^{9,10} The dermatitis usually is locally confined to the tattoo and may be limited to particular colors; occasionally, a new tattoo reaction may trigger concurrent inflammation in older tattoos. Many tattoo reactions occur as a response to red pigment but also have occurred with other tattoo ink components.⁹ Many researchers have speculated as to whether the reaction is related to the ink component itself or from the photochemical breakdown of the ink by exposure to UV radiation and/or laser therapy.⁹

Red Pigment—Red ink is the most common color reported to cause tattoo hypersensitivity reactions. Historically, red tattoo pigments include mercuric sulfide (vermilion, cinnabar), scarlet lake, cadmium red, carmine, and cochineal,¹¹ but today's tattoo inks primarily are composed of other pigments, such as quinacridone and azo dyes.¹² Several cases of red tattoo ink hypersensitivity reactions exist in the literature, many without completion of patch tests or without positive patch tests to relevant red pigments.¹¹⁻¹⁵

Black Pigment—In general, reactions to permanent black tattoo ink are rare; however, a few case reports exist. Black pigment can be created with India ink (carbon), logwood (chrome), iron oxide, and titanium.^{16,17} Shellac can be used as a binding agent in tattoo ink; there is at least one report of a reaction to black tattoo ink with a positive patch test to shellac and the original black ink.¹⁸

Metals—When utilized in tattoos, metals can create a variety of colors; several have been reported to cause ACD. There has been at least one reported case of a tattoo hypersensitivity reaction to a gold tattoo, with positive patch testing for gold sodium thiosulfate.¹⁹ Green tattoo inks also have been confirmed to contain metal. One case of nickel allergy from a green tattoo has been reported, with a positive patch test for nickel sulfate and tissue confirmation of the presence of nickel with micro X-ray fluorescence and laser ablation inductively coupled plasma mass spectrometry.²⁰ Another case series described 3 patients with pruritus and chronic dermatitis associated with green tattoos who had positive patch tests to potassium dichromate, and the green tattoo pigment flared during patch testing. Chromium oxide was presumed to be present in the green tattoo pigment, and potassium dichromate avoidance in products and food improved both the pruritus and dermatitis.²¹

Azo Pigments—Azo pigments frequently are used in modern tattoos due to their vibrant colors. One case of hypersensitivity to azo pigment involved an eczematous ulcerated plaque overlying yellow, red, and green ink in a recently applied tattoo. Patch testing with the inks originally used in the tattoo was negative. The authors noted that the 3 problematic ink colors all contained pigment yellow 65—an azo pigment—and attributed the reaction to this dye.²² In another azo reaction, a patient had erythema and pruritus overlying a tattoo applied 1 month prior. Patch testing was positive for aminoazobenzene,

an azo pigment that was present in the orange ink of the tattoo.²³

Management of Tattoo Hypersensitivity Reactions

Hypersensitivity reactions to temporary tattoos are just that—temporary. Topical steroids and time generally will allow these reactions to resolve. In the setting of vigorous reactions, patients may develop postinflammatory hypopigmentation or hyperpigmentation that may last for months. Unfortunately, bullous tattoo reactions can lead to scarring and keloid formation, requiring more aggressive therapy.

Management of reactions to permanent tattoos is more challenging. High-potency topical steroids under occlusion or intralesional corticosteroid injections may aid in treating pruritus or discomfort. For severe reactions, oral corticosteroids may be required. Patients also may consider laser tattoo removal; however, providers should be aware that there have been rare reports of systemic lenticular reactions from this procedure.^{24,25} Obviously limited by location and size, excision also may be offered.

Patch Testing for Tattoo Ink Contact Allergy

When patients present for evaluation and management of tattoo ACD, it is important to also consider other causes, including granulomatous tattoo reaction, pseudolymphoma, and lichenoid tattoo reaction. A biopsy can be helpful if the diagnosis is in question.

Patch testing for contact allergy to temporary tattoo inks should include PPD, fragrance, aminophenols, resorcinol, para-tertiary butylphenol formaldehyde, and essential oils. Jagua currently is not available for commercial purchase but also should be considered if the patient has the original product or in research settings. If the individual tattoo ingredients can be identified, they also should be tested. In this scenario, recall reactions may occur; testing with the tattoo paste should be avoided if the prior reaction was severe. Importantly, patients with a PPD allergy should be counseled to avoid hair dyes that contain PPD. Many patients who are sensitized to PPD have strong reactions on patch testing and are at risk for severe reactions if PPD or PPD-related compounds are encountered in hair dye.

Patch testing for ACD to permanent tattoos is complex. In most cases, patch testing is of limited utility because many of the chemicals that have been reported to cause ACD are not commercially available. Additionally, a 2014 study of 90 patients with chronic tattoo reactions found that the majority had negative patch testing to the European baseline series (66%), disperse dyes (87%), and tattoo inks (87%–92%). The investigators theorized that the allergens causing tattoo reactions are formed by haptenization of “parent” chemicals in the dermis, meaning application of chemicals present in the original tattoo ink may not identify the relevant allergen.²⁶ If patch

testing is performed, it is most ideal if individual pigment ingredients can be identified. Allergens to be considered for testing include azo dyes, aromatic amines, iron oxide, barium, zinc, copper, molybdenum, titanium, gold sodium thiosulfate, nickel sulfate, carbon, shellac, diketopyrrolopyrrole, quinacridone, anthraquinone, dioxazine (purple), quinophthalone (yellow) dyes, mercuric sulfide (vermillion, cinnabar), scarlet lake, cadmium red, carmine, and cochineal, many of which are not commercially available for purchase.

Final Interpretation

As tattoos become increasingly trendy, tattoo ACD should be recognized by the astute dermatologist. The most common allergen associated with tattoo ACD is PPD, but other potential allergens include azo dyes and newer pigments. Unlike tattoos of the past, today’s inks are unlikely to contain toxic metals. Diagnosing ACD caused by permanent tattoo inks requires a high degree of suspicion, as patch testing may be of limited utility.

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