

Clinical Patterns of Hand and Foot Dermatitis: Emphasis on Rubber and Chromate Allergens

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KEYWORDS

- Rubber • Thirumam • Carbamates • Chromate
- Hand dermatitis

HAND AND FOOT DERMATITIS *Hand and Foot Versus Hand or Foot*

Pattern of presentation can offer important diagnostic clues that guide the physician when obtaining history to evaluate dermatitis. Pattern of dermatitis also must correlate with history of exposure in order for a positive patch test to be considered relevant.

Hand dermatitis without foot dermatitis, especially if there is involvement of the face or neck, is more likely to be because of allergic contact, as opposed to hand dermatitis presenting with foot dermatitis. Hand dermatitis presenting with foot dermatitis is more likely to be a result of a systemic, “endogenous” cause.

Contactants for hands are many and include occupational exposures, personal care products, and hobby exposure, whereas contactants for feet are usually limited to footwear and medications; therefore there are few common exposures. Sometimes, hand and foot dermatitis occur together because of medications applied to both. Alternatively, when hand and foot dermatitis occur together, there may be a common allergen, such as mercaptobenzothiazole, with occupational hand exposure to corrosion inhibitors and/or nitrile gloves and feet exposure to mercaptobenzothiazole in rubber shoe components (**Figs. 1–3**).

More commonly, hand and foot dermatitis presenting together are because of an endogenous process such as dietary metal sensitivity (**Fig. 4**). The article on chronic vesicular hand dermatitis

in this issue further discusses the endogenous dermatoses.

Hand and foot dermatitis resulting from contact allergy may not occur synchronously given the different routes of exposure (**Figs. 5 and 6**). Because hands are also subject to irritation from wet/dry cycles during handwashing and wet work and sometimes from patients picking or paring away scales, *irritant dermatitis* can also be superimposed upon another primary dermatosis, such as psoriasis or dermatomyositis. Irritant dermatitis can appear spongiotic histologically, such that skin biopsy from the hands and feet must be interpreted with caution.

Allergic contact dermatitis resulting from medication may be limited to hands and feet (**Fig. 7**) in patients with disorders such as underlying tinea or palmar/plantar psoriasis. The presence of spongiosis prevents histological diagnosis of psoriasis in most of these cases. When hands and feet are the only affected areas, the clinician should maintain diagnostic suspicion for underlying psoriasis, dermatomyositis, chronic hyperkeratotic hand dermatitis, or chronic vesicular dermatitis.

Chronic hyperkeratotic hand dermatitis is symmetrically located on the middle portion of the palms and/or soles with painful fissures.¹ A 10-year follow-up study of 32 adults with hyperkeratotic dermatitis of the palms revealed that only 1 developed psoriasis during the decade of follow-up, and that the patient developed only a plaque on the elbow. There was no increased

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Fig. 1. Hand dermatitis due to mercaptobenzothiazole in corrosion inhibitors at work and subsequent use of nitrile gloves containing mercaptobenzothiazole.



Fig. 3. Shoe dermatitis in same patient as in Fig. 1; relevant to thioureas and/or mercaptobenzothiazole in shoe insoles.

prevalence of family history of psoriasis, and all of the 9 patients who underwent skin biopsy of the palm showed spongiotic dermatitis.² This diagnosis does not respond well to treatment and tends to be stable and chronic.

Frictional hand dermatitis also often involves the palms, but it is directly a result of chronic rubbing, usually of an occupational contactant, and has a good prognosis when the friction is eliminated. Antiimpact gloves have been reported to be of benefit for this condition.³ Grenz ray treatment was reportedly successful in a single case of a dermatological surgeon with frictional hyperkeratotic hand and foot dermatitis, who had failed topical and systemic corticosteroids, topical tacrolimus, calcipotriene, and bexarotene gel.⁴

Other Affected Areas in Addition to Hand or Foot

The pattern of hand dermatitis with forearm or with facial dermatitis can suggest the causative

allergen. Allergic contact dermatitis resulting from sticky substances, such as acrylate nail products, or other resins, such as plant resin or colophony, often involves the fingertips and facial skin (Fig. 8). Allergy to preservatives in personal care products often involves the hands with a more generalized distribution of skin affected; if occupational biocides are the only exposure to these chemicals, dermatitis is usually limited to the hands and forearms. These allergens are discussed in other articles in this issue.



Fig. 2. Shoe dermatitis in same patient as in Fig. 1; positive patch tests to mercaptobenzothiazole and potassium dichromate, both likely relevant; also positive patch test to mixed dialkyl thiourea.

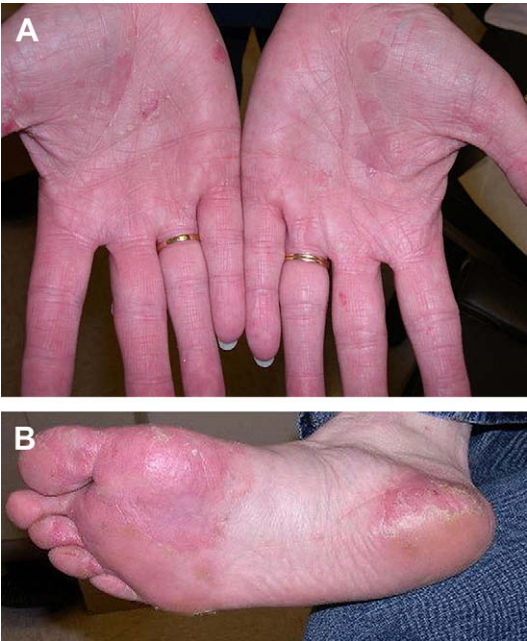


Fig. 4. (A, B) Hand and foot dyshidrotic eczema as a result of systemic nickel dermatitis in a candy maker.



Fig. 5. Allergy due to foam rubber glove insert on palm.

This article focuses on allergic contact dermatitis of the hands and feet resulting from rubber and chromate; dermatitis from these allergens almost always involves the hands or feet. For patients with positive patch tests to rubber chemicals, 78% have hand dermatitis.⁵ Rubber and chromate sensitization often coexist in construction workers, with 67% of rubber-allergic patients also sensitized to chromates in a 1991 study.⁵

RUBBER CHEMICALS

In addition to allergy to natural rubber latex discussed in the section on glove pattern dermatitis, allergy to chemicals used to accelerate the vulcanization of natural latex or synthetic rubber or to reduce degradation of rubber is common. There



Fig. 6. Same patient as in Fig. 5, after 5 years, with dermatitis due to rubber in shoes during episode of increased perspiration. Cleared entirely with avoidance of rubber, despite psoriasiform appearance.



Fig. 7. Dermatitis caused by medicament: positive relevant patch tests to econazole nitrate, lanolin, and iodopropynyl butyl carbamate.

is an overlap between the products where these chemicals are used, but some patterns emerge and are described here for each of the common rubber allergens.

Hand/Foot Dermatitis Due to Black Rubber

Black rubber mix (*N*-isopropyl-*N*-phenyl-4-phenylenediamine and *N*-cyclohexyl-*N*-phenyl-4-phenylenediamine and *N*, *N*-diphenyl-4-phenylenediamine) is a patch test screen for paraphenylenediamine-related antioxidants used in making black or gray rubber. Black rubber is frequently used in occupational personal protective equipment (**Fig. 9**). Cross-reaction with 4-phenylenediamine base can occur, but most patients allergic to *N*-isopropyl-*N*-phenyl-4-phenylenediamine-type antioxidants do not react to paraphenylenediamine.



Fig. 8. Allergy to nail polish and ethylcyanoacrylate (Superglue) used to treat fissures on fingers, with ectopic dermatitis on face.



Fig. 9. Allergy to black rubber apron and gloves in a worker with hand, forearm, and neck dermatitis, who tested positive to black rubber mix.

Palmar/Grip Pattern

Black rubber is used to make solid objects that are often present in an industrial environment. Tire workers sensitized to *N*-isopropyl-*N*-phenyl-4-phenylenediamine and its related chemicals often have dermatitis on the palms and extensor wrists.⁶ Related antioxidants are the most common causes of allergic contact dermatitis in tire workers.

Other devices made of black rubber can cause occupational dermatitis. Hyperkeratotic palmar dermatitis, worse on the right hand, was reported to occur from handling an egg stamper made of black rubber.⁷

Nonoccupational allergic contact dermatitis due to black rubber mix usually occurs as a palmar “grip pattern”, as the most common sources are grips on exercise equipment or orthopedic assistive devices, such as canes and wheelchairs. Hard rubber that has a gray color is often manufactured with these antidegradant chemicals.

Black rubber on an escalator handrail caused palmar and perioral contact dermatitis in 1 case report.⁸

Hand/Foot Dermatitis Due to Thiurams and Carbamates

Thiuram is tested as a mix of tetramethylthiuram monosulfide, tetramethylthiuram disulfide,

tetraethylthiuram disulfide, and dipentamethylene-thiuram disulfide because these components do not always cross-react. Carba mix contains *N*, *N*-diphenylguanidine (a cross-reacting noncarbamate), zinc diethyldithiocarbamate, and zinc dibutyldithiocarbamate. Thiurams are the most common causes of contact dermatitis to rubber gloves.⁹ Many patients are patch test positive to thiuram and carba mixes; 92% of patients with a positive patch test to dithiocarbamates also react to thiurams.⁹ Even if carba mix patch tests are negative, patients with positive patch tests to thiuram mix may be intolerant of gloves containing carbamates.¹⁰

Whenever allergens are tested as a mix, the concentration of the individual allergens may be too low and cause a false-negative reaction. Therefore, if there is a high degree of suspicion of rubber allergy, a rubber series containing the individual allergens and testing with thin pieces of the suspect rubber should be performed.⁶

Dorsal Hand and Finger Dermatitis with Cut-off at Wrist

Many patients with this pattern are allergic to rubber chemicals in gloves, especially thiuram and carbamates. Many patients have dermatitis of the thenar and hypothenar eminence also. Vinyl gloves are an acceptable substitute for most patients allergic to rubber gloves. The American Contact Dermatitis Web site offers members a database of gloves free of various rubber accelerators for sterile and nonsterile use.

Allergy to natural rubber latex can also cause glove dermatitis, but there is usually a history of urticaria immediately after donning the gloves. Immediate hypersensitivity to latex was a common problem in the late 1980s and 1990s, when adoption of universal precautions suddenly increased usage of gloves and possibly led to decreased quality of manufacturing. Work-up for patients with a history of urticaria from gloves should include a radioallergosorbent test to the latex protein, *Hevea brasiliensis* (which is not entirely sensitive because of differences in the latex proteins from different sources), and testing of pieces of the glove. Prick or scratch testing should be performed only with the presence of appropriate emergency assistance because of the risk for anaphylaxis.¹¹

Atopic dermatitis patients often react to occlusion with inflammatory response¹² and may exhibit the same pattern of dermatitis as do patients with glove allergy. This diagnosis must be considered in the atopic dermatitis patient with negative patch tests to an extended screening series. To improve

the dermatitis, patients should wear thin cotton gloves under occlusive gloves to prevent perspiration from irritating the skin and to prevent maceration of the skin, which causes fissuring due to rapid drying upon removal of the gloves in low humidity conditions.

Eyelid Dermatitis

Eyelid dermatitis may result from use of rubber cosmetic applicators or removal pads and the edge of eyelash curlers. Airborne patterns of dermatitis occasionally result from nonrubber exposures to thiurams in insecticides and fungicides.⁶

Pattern of Shoe Dermatitis

Thiuram, carbamate, meracapo, and thiourea are chemicals that can all cause shoe dermatitis. **Figs. 10A, B** show the typical pattern of dermatitis due to rubber or rubber adhesives in the soles of shoes with sparing of the instep and the interdigital webs. The dorsum of the foot under the tongue of the shoe is often involved as well.

Hand/Foot Dermatitis Due to Mercaptobenzothiazole

Mercaptobenzothiazole is a common cause of shoe dermatitis. Mercaptobenzothiazole is tested on the standard series alone and as part of the mercapto mix along with *N*-cyclohexylbenzothiazyl sulfenamide, dibenzothiazyl disulfide, and morpholinylmercaptobenzothiazole.

Dorsal Hand/Foot Sparing Webspace Pattern

Mercaptobenzothiazole is frequently found in shoes, but it is sometimes detected in rubber gloves also.¹³ Use of mercaptobenzothiazole-related chemicals in gloves increased in the late 1990s.⁹ In this investigator's experience, mercaptobenzothiazole is the rubber allergen most likely responsible for allergic contact dermatitis affecting the hands and feet. A predisposing occupation may be mechanics and machinists, who are exposed to mercaptobenzothiazole in corrosion-inhibiting fluids. Nitrile gloves are often provided to protect the worker from these fluids, and the gloves themselves often contain mercaptobenzothiazole. Sensitized workers may then develop shoe dermatitis from mercaptobenzothiazole in work boots or athletic shoes (see **Figs. 1–3**).

Hand Dermatitis Involving Webspace

If the hand dermatitis is due to mercaptobenzothiazole in a corrosion inhibitor, there may be

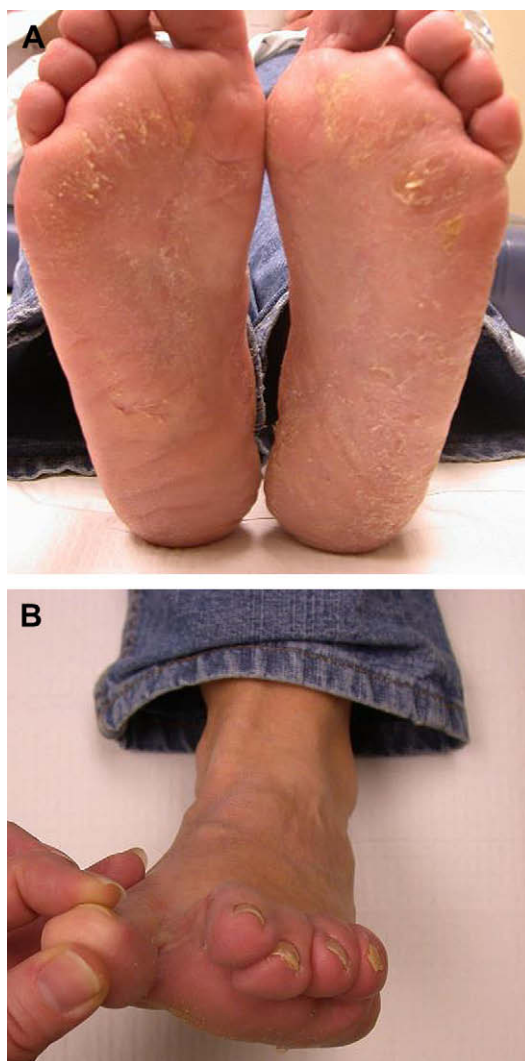


Fig. 10. (A, B) Shoe dermatitis usually spares the interdigital webs and plantar arch with involvement of the remainder of the plantar aspect and often the dorsal foot under the tongue of the shoe. This patient was allergic to thiuram mix.

patchy dermatitis with webspace involvement rather than the glove pattern.

Nonrubber dermatitis due to mercaptobenzothiazole is also rarely described from flea and tick powders for pets.

Hand/Foot Dermatitis Due to Thioureas

Thioureas are accelerators most often tested as a mix containing diethyl thiourea and dibutyl thiourea. Thioureas are often used in neoprene orthopedic braces and wetsuits. Similar to mercaptobenzothiazole, dibutyl thiourea can be used as an anticorrosive, or they may be used in

paint and adhesive removers and may cause hand dermatitis.⁶

Sole of Foot/Glove Pattern Hand Dermatitis

Thioureas are often used in insoles that patients insert into shoes after purchase. This may lead to a chronic, scaly plantar dermatitis. Thioureas are also occasionally used in neoprene gloves.

CHROMATE ALLERGY

Chromate frequently causes chronic hand dermatitis in metal workers and construction workers.¹⁴ Men are more likely to be sensitized than women.¹⁵ Hexavalent and trivalent chromium can cause allergy. Hexavalent chromium is more irritating, and in the 1980s, Scandinavian countries mandated adding ferrous sulfate to construction cement to cause reduction of hexavalent to trivalent chromium. Incidence of chromate dermatitis decreased after this initiative, but there is debate regarding whether the use of ferrous sulfate was of benefit or whether reduced usage of chromate and industrial hygiene played a role.¹⁶ Hexavalent chromium is more likely to be systemically absorbed than trivalent, and a study in Taiwan that compared urinary chromium levels in cement workers before and after introduction of ferrous sulfate to cement in 2004 showed that systemic absorption was significantly reduced in workers after ferrous sulfate was added, especially those workers with hand dermatitis.¹⁷ However, there was no difference in prevalence of hand dermatitis 3 months after addition of ferrous sulfate was instituted.

Cobalt is a common cosensitizer in chromium-allergic patients, especially those sensitized from cement.¹⁵ Thiuram is the next most common cosensitizer as discussed in a previous section.

Pattern of Hand/Foot Dermatitis Due to Chromates

Allergic contact dermatitis resulting from chromates in cement occurs on the hands and wrists, especially the back of the dominant hand.¹⁶ Cement is a common irritant; irritant dermatitis due to cement is more likely to be limited to the hands, whereas allergic dermatitis to cement may also affect the forearms, feet, and face.¹⁷ Because chromates are used to tan leather, use of leather gloves can cause hand dermatitis. Allergy to leather can also cause hand and foot pattern dermatitis because of exposure to leather gloves and shoes. Hand dermatitis alone is the most common pattern of presentation of chromate allergy, accounting for about 35% of cases,

followed by hand with foot dermatitis in 15%, generalized pattern in 20%, and feet only in about 6%.¹⁵

Hyperkeratotic lesions on the elbow are reported in patients with dyshidrotic hand eczema to nickel and chromate. These lesions demonstrate dermatitis rather than psoriasis on biopsy, and usually flare with dietary metal exposure.¹⁸

Dietary Exposure Patterns in Chromate Allergy

Chromate-allergic patients may develop vesicles with experimental immersion of a finger into a metal solution more consistently than cobalt- or nickel-allergic patients.¹⁹ Dietary ingestion of metals is often implicated in chronic vesicular hand dermatitis and is discussed in another article in this issue. A few patients with nonvesicular hand dermatitis, with or without positive patch tests to chromate, may flare with oral chromate challenge.²⁰ Dietary metal restriction is a low-risk therapeutic option in patients with recalcitrant hand dermatitis, especially men who have risk factors for occupational chromate sensitization.

MANAGEMENT OF DERMATITIS DUE TO RUBBER AND CHROMATES

Glove manufacturers report the types of chemicals used in published sources.²¹ Vinyl gloves are a safe alternative for rubber-allergic patients, but they are not appropriate for all occupational hazards.

Shoe dermatitis poses a more difficult problem, as there is usually no way to determine the rubber chemicals used in shoes. Some patients improve with control of pedal hyperhidrosis, as perspiration permits leaching of rubber and chromates from footwear. Application of aluminum chloride hexahydrate to the feet to decrease perspiration lessens shoe dermatitis in some patients. Purchase of new socks is recommended, as rubber chemicals from previous shoes²² or from previously applied allergenic medicaments may be retained in socks even after laundering.

Vinyl work boots are available. Also, insoles free of rubber chemicals can be used to replace existing insoles. Finally, custom shoemakers can create shoes free of specified allergens. Scheman et al²¹ provide specific sources for these alternatives.

SUMMARY

Rubber chemicals and chromates, along with medicaments and adhesives, are common causes of dermatitis of the hands and feet. Patch testing to an extended standard series, shoe series,

including rubber chemicals and textile dyes, and an extended medicament series is the best way to diagnosis allergic contact dermatitis of the hands and feet. When hand and foot dermatitis occur together, investigation for a primary systemic cause, such as psoriasis or chronic vesicular hand dermatitis, is indicated.

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