DIAPER DERMATITIS IN THE INFANT-TODDLER

The broad category of diaper dermatitis encompasses a variety of skin conditions.

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Allergic contact dermatitis (ACD) is an important disease, which notably affects 14.5 million Americans each year.[1] The economic impact of this disease is high in terms of both patient morbidity and loss of income, school and work, not to mention significant expenditures for visits to healthcare providers and for medicaments.[1] Once patch testing is performed and a culprit has been identified, education becomes the critical intervention to ensure adherence to an avoidance regimen. With allergen avoidance, remission of the dermatitis ensues. If patients are unable to comply with the avoidance regimen, they become at risk for recurrent or sustained dermatitis or progression to a systematized presentation.[2,3] In fact, education of the patient often begins before the diagnostic patch test is ever placed, to ensure that the patient has an appropriate understanding of potential outcomes, and their central role in both their disease and treatment.

At the initial consultation patients are often taught about the pathophysiology of ACD: its delayed presentation; its relationship with the immune system (sensitization to a chemical and then elicitation of a dermatitis with re-exposure) and that it can occur at any point in time, even to something that the patient has been using regularly for a short period of time or intermittently for years. In certain cases, the topics of the other key players, such as irritant contact dermatitis (ICD) and contact urticaria, may be explained, as history (not patch testing) can point to these as the correct diagnosis for the patient. It is important to note that ICD, the most prevalent form of contact dermatitis, can at times precede or be a concomitant diagnosis with ACD.[4,5] Unlike ACD, ICD occurs secondary to contact with an irritating or abrasive substance. Contact urticaria (wheal and flare reaction), on the other hand, represents the least prevalent form of ACD. It is an immune-mediated phenomenon whose hallmark is an IgE and mast cell-mediated immediate-type hypersensitivity reaction. We acknowledge this form of hypersensitivity due to the severity of the potential deleterious anaphylactic type reactions and direct the reader to key sources.[6-8]

In this article, we highlight ACD and explore top relevant allergens, regional-based dermatitis presentations, topic-based dermatitis presentations and clinical tips and pearls for diagnosis and treatment.

DIAPER DERMATITIS: IMPORTANCE OF HISTORY

Diaper dermatitis is a very broad term, encompassing a variety of skin conditions and is one of the most common cutaneous disorders of infancy. In general, the overall incidence is between 7% and 35% with a peak at 9 to 12 months of age.[9] An infant's anatomy can be a predisposing risk factor in and of itself, as the many folds and creases constitute areas of difficulty for cleansing and contribute to a moist environment.[10] A thorough patient history is a key component in making the proper diagnosis.[11] The physical construct of the diapers used is a vital element in the patient's exposure history (ie, dispos-

able vs cloth and dye vs dye-free). For instance, disposable diapers may have the advantage of preventing irritant diaper dermatitis by reducing wetness via an absorbent gelling material; whereas, cloth diapers may not be as effective at wicking away moisture.[10,12] That being said, white cotton cloth diapers in particular do have their advantage of reducing exposure to potential allergens, such as dyes and fragrances.

While an in depth discussion of the differential diagnoses is beyond the scope of this article, it is important to consider, as diaper dermatitis can be multifactorial (**Table 1**). For example, a history of exposure to high humidity and heat (eg, warm weather) or the infant being overdressed can contribute to intertriginous candidiasis, as can recent antibiotic use. When taking the patient's history, it is important to elicit whether there has been painful or difficult urination, as this could indicate Jacquet's dermatitis, which presents with punched out erosions of the diaper region. Likewise, a history of Hirschsprung disease, encopresis or urinary incontinence can be associated with perianal pseudoverrucous papules and nodules and/or granuloma gluteale infantum, which exists on the spectrum.[13]

Diarrhea can be a trigger for developing diaper dermatitis, despite the very best efforts, as the skin's pH is elevated due to the formation of ammonia, which is produced upon exposure of feces to ureases in urine. Proteases and lipases within the feces are then activated, which can damage the stratum corneum along with the moist environment that contributes to maceration.[9,10] In addition, diarrhea with failure to thrive and alopecia could indicate a nutritional dermatosis, such as acrodermatitis enteropathica. When considering the differential diagnosis, Langerhans cell histiocytosis should be considered if lymphadenopathy, anemia and hepatosplenomegaly are present. This article specifically focuses on ACD in the diaper region.

DIAGNOSTIC STUDIES

In regards to ACD, patch testing is the gold standard for diagnosis, with positive reactions graded from macular erythema to either 1+, 2+ or 3 + intensity, indicated by erythema, induration, papules or vesicles at the site of the patch test application.[11] There is a commercially available Thin-layer Rapid Use Epicutaneous Test (Mekos Laboratories ApS, Hillerod, Denmark) which is an FDA-approved (in adults) patch test device consisting of 3 panels of allergens which contain some of the allergens frequently associated with diaper dermatitis; however, comprehensive extended panel and product patch testing may be needed to determine the culprit. Products to be tested would include the diaper, along with the creams, salves and powders which have historically also been used in the affected region.[11]

The most important management strategy for ACD-associated diaper dermatitis is identification of causative allergens and subsequent prevention by avoidance. Fragrance-free personal care products and diapers, dye-free diapers and cloth (white cotton) diapers are potential alternative options.

ETIOLOGY AND PATHOPHYSIOLOGY

Understanding the potential causes or predisposing factors leading to diaper dermatitis is key to prevention and treatment. ACD is a delayed type IV hypersensitivity immunologic reaction that is the second most common form of contact dermatitis, with ICD being the most common.[4]

Risk factors for ICD include prolonged exposure to urine or feces, skin wetness and biochemical irritants.[10] Risk factors for ACD include prolonged exposure to potential allergens under occlusion in a moist region containing thin skin, whose barrier function may be defective due to concomitant atopic dermatitis.[12]

IMPORTANT ALLERGENS IN DIAPER ACD

As alluded to earlier, sensitization to allergens in diapers and products used in the diaper area has been reported to a number of chemicals (**Table 2**). For example, disperse dyes, specifically red 1/17, disperse blue 106/124 and disperse orange have been described to elicit dermatitis in this setting.[14,15] Disperse dyes are used on synthetic fabrics, and therefore, are easily leached out onto skin in the presence of moisture and friction. Fragrances, such as fragrance mix 1 and balsam of Peru, have also been associated with ACD, as they are used in both the diapers and in topical skincare products that are used to treat and prevent diaper dermatitis.[16,17] Notably, balsam of Peru (a marker for fragrance allergy) is the active ingredient in some healing salves for bottoms. Moreover, reactions have been noted to the emulsifier, sorbitan sesquioleate, which is included in many topical creams and some ointments, including medicaments.[11,18] Preservatives have also been implicated in diaper region ACD, specifically iodopropynyl butylcarbamate and bronopol, which are used in baby wipes, along with fragrances.[11,19]

Interestingly, ACD due to rubber additives, such as rubber accelerators (mercaptobenzothiazole), which are found in the elastics at the waist and legs of disposable diapers, as well as p-tert-butylphenol formaldehyde, a resin that is used in diaper adhesives, has been termed "Lucky Luke'" dermatitis in the late 1990's.[11,20,21] This name is based on the characteristic distribution of the dermatitis being located on the infant or child's hips and outer buttocks, which resembles a cowboy's holster.

TREATMENT OPTIONS

The most important management strategy for ACD-associated diaper dermatitis is identification of causative allergens and subsequent prevention by avoidance.[11] Fragrance-free personal care products and diapers, dye-free diapers and cloth (white cotton) diapers are potential alternative options. Cloth diapers may pose a challenge, however, as disposable diapers have the advantage of superior absorption and prevention of ICD and/or candidiasis; therefore, frequent diaper changes are encouraged to help prevent chafing and ICD. Some diapers also contain petrolatum to prevent

Table 1. DIAPER DERMATITIS: DIFFERENTIAL DIAGNOSIS AND CHARACTERISTIC FINDINGS ON PHYSICAL EXAMINATION[9, 11,12,25]

Condition	Characteristics
Classic dermatitides/ papulosquamous	
Chafing dermatitis	Recurrent mild erythema and scaling, appearing in areas of friction, ie, abdomen, inner thighs, buttocks and genitalia
Atopic dermatitis (AD)	Acute: erythematous, scaly papules and plaques, often pruritic and excoriated Chronic: thickening, hyperpigmentation and lichenification
Irritant contact dermatitis	Erythema and scaling of the diaper region Diagnostic key: routinely spares the intertriginous creases
Allergic contact dermatitis	Erythema, scaling, papules and/or vesicles, often with geometric patterns consistent with distribution of the contactant, but often spreads beyond; may also include the creases
Seborrheic dermatitis	Yellowish, scaly, greasy plaques, which tend to involve the intertriginous creases and may also be found on the scalp, face and neck
Napkin psoriasis	Maceration in the flexures and intertriginous areas, accompanied by persistent erythematous, well-demarcated plaques with dry, silvery scale elsewhere on the body Scalp may be the primary site of involvement; also may be accompanied by nail changes Diagnostic clue: family history
Infection/infestation	
Candidiasis	"Beefy" red erythema with a raised, white scaly, sharply demarcated edge; oral thrush may also be present Diagnostic hallmark: presence of satellite lesions, both pustules and vesicles
Intertrigo	Bright red erythema with a potential overlying white to yellow exudate Diagnostic clue: predilection for creases, such as inguinal and thigh, as well as the intergluteal cleft; anterior neck fold and axillae may also be affected
Bacterial dermatitis	Edema, erythema, tenderness to palpation and possible purulent drainage
Syphilis	Reddish-brown papules present in the diaper area, with possible desquamation of palms and soles, appearing symmetrically
Scabies	Acute onset of pruritic, often excoriated, erythematous papules, vesicles, and/or burrows that favor the intertriginous regions, ie, inguinal folds, axillae and web spaces Diagnostic clue: infants may display acropustulosis (palms and soles) and scalp involvement as well
Perianal Distribution	
Perianal streptococcal dermatitis	Pruritic, sharply demarcated erythema and edema of perianal region, sometimes also involving the vulva, vagina or penis
Perianal pseudoverrucous papules and nodules	May also occur in the suprapubic region
Miscellaneous	
Acrodermatitis enteropathica	Erythematous, pustular or erosive dermatitis appearing in intertriginous and/or acral sites and may appear in a periorificial pattern, including the perioral face Clue: a zinc level <50 mcg/dL
Jacquet's dermatitis (dermatitis syphiloids posterosiva)	Ulcerated papules and nodules that can affect the glans penis and urinary meatus in males and can be present in females as well
Langerhans cell histiocytosis	Yellowish to red-brown papules, resembling seborrheic dermatitis, but with possible development of erosions, purpura and hemorrhage, unresponsive to any treatment Diagnostic consideration: look for additional areas of involvement, such as the scalp and retroauricular areas; the infant may also clinically have diarrhea. This disease can be fatal.
Granuloma gluteale infantum	Purple-red nodules located on the lower abdomen, groin and inner thighs that can resolve spontaneously after a few months
Miliaria	Pruritic, discrete, erythematous papules, vesicles or pustules found in the diaper distribution, but also may be present on the face, neck and axillae

Table 2. IMPORTANT ALLERGENS ASSOCIATED WITH ACD OF THE DIAPER REGION[11, 14-17, 19-21]

Bronopol (formaldehyde-releasing preservative)
Disperse dyes: red 1/17, blue 106/124 and orange
Fragrance mix 1 and 2 and balsam of Peru (fragrances)
Iodopropynyl butylcarbamate (preservative)
p-tert-butylphenol formaldehyde (adhesive resin)
carbamate, mercaptobenzothiazole, thiuram (Rubber accelerators)
Sorbitan sesquioleate (emulsifier)

Table 3. EXAMPLES OF DIAPERS AND BABY WIPES

Diapers: Free of Phthalates, Dioxins, Chlorine and Dyes	Baby Wipes: Free of Formaldehyde, Formaldehyde-Releasing Preservatives, and Iodopropynyl Butylcarbamate
Bambo Nature*	BabyGanics Thick n' Kleen Ultra Sensitive Baby Wipes
Earth's Best	Johnson & Johnson Baby Hand & Face Wipes
Honest* Plant-based	Procter + Gamble Luvs Ultra Clean Wipes
Huggies Pure and Natural*	Procter + Gamble Pampers Sensitive Baby Wipes
Nature Babycare	Seventh Generation Free & Clear Baby Wipes including New! Thicker & Softer
Pampers	
Seventh Generation Free & Clear*	

*Denotes fragrance-free by the manufacturer

ICD, while others are designated "chlorine-free" to suggest a safer product.[10] Scientific evidence of the effect of chlorine inclusion (in diapers) on microbial growth on the skin to our knowledge is not available. Furthermore, a review of the literature demonstrated no published head-to-head trials showing an association between chlorine inclusion and increased prevalence of diaper ICD.

While disposable baby wipes have also been implicated in ACD due to preservatives and/fragrances, there are advantages over washcloths both hygienically and mechanically, as the cloths may contribute to irritation, especially in already compromised skin.[10] Some disposable wipes are also formulated with a pH buffering system to allow for maintenance of skin's normal physiologic pH after cleansing.[10] Despite these benefits, in the infant with sensitization to fragrances, additives (chamomile, aloe, panthenol)[10] or preservatives (bronopol, iodopropyl carbamate, sodium hydroxymethylglycinate and quaternium 15), caution must be used when selecting wipes and complete avoidance may be necessary. In fact, many providers recommend that soap and water be used within the home and wipes only when washing is not easily performed.

In addition to avoidance strategies, which may be challenging, topical barriers are vital at each diaper change, preferably when dermatitis is at bay, and even more so when it is present. Recommended "protectant" salves include those containing zinc oxide, medical grade beeswax, glycerin, mineral oil, dimethicone, petrolatum preparations, as well as vitamin A&D ointments.[9,10,22] In addition to topical barriers, preparations that are formulated to restore epidermal barrier function utilizing ingredients such as lanolin (which may cause sensitization in some children), ceramides and cod liver oils also are available.

Additional topical treatment modalities include low potency, non-fluorinated corticosteroids, such as 1% hydrocortisone, applied 2 to 3 times per day, usually no longer than 2 weeks, but this is dependent on the healthcare provider's evaluation. Moreover, one's healthcare provider may choose to prescribe a short course of mid-potency corticosteroids for severe involvement, but caution is advised because the affected area would be occluded by the diaper, causing increased absorption and potentially predisposing to yeast overgrowth. Potential risks involved with topical corticosteroids in the diaper area include cutaneous atrophy, striae, telangiectasia and changes in pigmentation.[14] In order to avoid the above concerns, steroid-sparing agents, such as calcineurin inhibitors (tacrolimus or pimecrolimus), might be prescribed.[18]

PEARL: EVERY DOSE COUNTS

A person might be exposed to and subsequently sensitized to a particular allergen for days to years before actually developing ACD. Exposures can be additive, eventually causing one's immune system to cross a metaphorical "threshold," at which time a cutaneous response is elicited.[4,23] Just as it required contact with many items over time to produce a response, it will then require avoidance of several exposures over time to induce remission. Avoidance creativity, however, is necessary by utilizing alternatives, such as cloth, "plant-based" or "natural" conventional-type diapers (**Table 3**).

As discussed, many personal care products used on infants and young children contain potential allergens in the form of fragrances and preservatives. Unfortunately, searching for these chemicals on a product ingredient list can prove to be a tedious task. For this reason, there are programs available to aid in this endeavor. Both the Contact Allergen Management Program, a service offered through the American Contact Dermatitis Society[24] and the Contact Allergen Replacement Database, developed by Mayo Clinic,[25] allow for a provider to enter a patient's known contact allergens and produce a "shopping list" of products void of those particular chemicals. The technology also can exclude cross-reactors, so one is not inadvertently exposed to a harmful substance. While baby wipes are also included in these databases, diapers are not at this time. ■

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