Scalp involvement in patients referred for patch testing: Retrospective cross-sectional analysis of North American Contact Dermatitis Group data, 1996 to 2016

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Background: Scalp conditions are often multifactorial.

Objective: To characterize patients with scalp involvement and patch-testing outcomes.

Methods: Retrospective cross-sectional analysis of North American Contact Dermatitis Group data (1996-2016). Study groups included patients with scalp involvement (≤3 anatomic sites coded) with or without additional sites.

Results: A total of 4.8% of patients (2331/48,753) had scalp identified as 1 of up to 3 affected anatomic sites. Approximately one-third of "scalp-only" individuals had a specific primary diagnosis of allergic contact dermatitis (38.6%), followed by seborrheic dermatitis (17.2%) and irritant contact dermatitis (9.3%). When adjacent anatomic sites were affected, allergic contact dermatitis was more frequently identified as the primary diagnosis (>50%). The top 5 currently clinically relevant allergens in scalp-only patients were *p*-phenylenediamine, fragrance mix I, nickel sulfate, balsam of Peru, and cinnamic aldehyde. Methylisothiazolinone sensitivity was notable when adjacent anatomic sites were involved. The top 3 specifically identified sources for scalp-only allergens were hair dyes, shampoo/conditioners, and consumer items (eg, hair appliances, glasses).

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Limitations: Tertiary referral population.

Conclusion: Isolated scalp involvement was less likely to be associated with allergic contact dermatitis than when adjacent anatomic sites were involved. Overlap with multiple diagnoses was frequent, including seborrheic dermatitis, irritant dermatitis, other dermatoses, or all 3. *p*-Phenylenediamine was the most common allergen. (J Am Acad Dermatol 2021;84:977-88.)

Key words: allergic contact dermatitis; dermatitis; irritant contact dermatitis; itch; North American Contact Dermatitis Group; patch testing; *p*-phenylenediamine; pruritus; scalp; seborrheic dermatitis.

INTRODUCTION

The differential diagnosis of itching, erythema, erosions, and scaling of the scalp is broad and includes various dermatoses (eg, psoriasis, lupus, dermatomyositis, alopecia, scalp dysesthesias, rosacea, cutaneous T-cell lymphoma, dermatitis herpetiformis), infections (eg, tinea capitis, secondary syphilis), and eczematous conditions (eg, allergic contact dermatitis, irritant contact dermatitis, lichen simplex chronicus, seborrheic dermatitis, atopic dermatitis).[1-4] Previous data suggest that allergic contact dermatitis may occur less commonly on the scalp compared with other areas of the body, possibly because of increased skin thickness, protective sebum, and moderation by hair follicle regulatory T-cells that promote tolerance.[5-8] Allergic contact dermatitis may occur from contact with allergens on a normal scalp or after application of allergens on a scalp with preexisting skin disease (eg, psoriasis, seborrheic dermatitis, alopecia).[9-14]

Hair dye is the most documented cause of scalp allergic contact dermatitis.[5,9,15,16] Other contactants include shampoos, conditioners, hair-styling agents, topical medicaments, head wear (eg, hats, headsets), glasses, and hair accessories.[6,9,17-19] Allergic contact dermatitis to scalp/hair products commonly presents on surrounding skin, especially the hairline, forehead, eyelids, neck and ears (retroauricular area), and back,[5,6,9,20-22] where hair care product residue persists.[23] In severe eruptions, contact allergy may lead to temporary hair loss.[20] Inflammation resulting from allergic contact dermatitis or irritant contact dermatitis may cause telogen effluvium,[20,24,25] alopecia (some involving hyperpigmented patches and others with generalized dermatitis incorporating the scalp),[10,26] or accelerated female-pattern hair loss.[27]

CAPSULE SUMMARY

- Scalp signs/symptoms are prevalent.
- Allergic contact dermatitis is more common when anatomic sites adjacent to the scalp are involved; hair dye is the most frequent source. Patch testing for scalp signs/symptoms should be considered for individuals with a suggestive history (dye use) or involvement of adjacent anatomic areas.

Few studies have investigated scalp involvement in patch-tested patients. Hillen et al[9] reviewed records of greater than 100,000 patch-tested patients; 1320 (<1.3%) had current scalp involvement, and constituents of hair-coloring products (eg, *p*-aminoazobenzene, *p*-phenylenediamine, toluene-2,5-diamine) were common allergens. Aleid et al[6] reviewed patch-test records of 1015 patients and found that 226 (22.3%) had scalp symptoms or clinical signs (of those, 41.0% had involvement of additional anatomic sites); common allergens in these patients included nickel, cobalt, and balsam of Peru (*Myroxylon pereirae*). Ojo et al[5] reviewed records of 2373 patch-tested patients; 182 (7.7%) had scalp involvement, and common allergens in these patients included *p*-phenylenediamine, benzoic acid, fragrance mix I, and balsam of Peru. Only 1 of the above-mentioned studies reported involvement of additional anatomic sites (in scalp patients)[6] and none reported clinical relevance of allergens specific to scalp signs/symptoms.

This study describes the frequency of scalp involvement in patients referred for patch testing, describes final diagnoses, and, in the case of allergic contact dermatitis, identifies common relevant allergens and sources.

MATERIALS AND METHODS

The North American Contact Dermatitis Group database

This analysis of deidentified data was approved by the Minneapolis Veterans Administration Medical Center's Subcommittee on Human Studies. We included data on individuals tested by the North American Contact Dermatitis Group from 1996-2016.

During that time, the group's screening series consisted of 50 to 70 allergens (Chemotechnique Diagnostics AB, Malmo, Sweden; allergEAZE SmartPractice, Calgary, Canada). North American Contact Dermatitis Group methods for patch testing and coding have been previously described.[28] Collected data included demographic information (age, sex, race, occupational relevance, and atopic history), up to 3 anatomic sites of dermatitis (generalized, hand, foot, face, lips, nose, eyelids, eyes, ears, scalp, neck, arm, leg, trunk, anal/genital, most exposed areas, only under clothing, erythroderma, and other), up to 3 final diagnoses, and relevant allergens/irritants, as well as their sources. For each allergen, reading strength at 48-hour and final visits was coded (negative, irritant, doubtful, + [erythema, infiltration, papules], ++ [edematous or vesicular], or +++ [spreading, bullous]). In addition, a final interpretation code of allergic (positive) or not allergic (negative/irritant) was determined for each allergen, depending on morphology, history, and reactions to related allergens. For all allergic reactions, clinical relevance was coded as unknown, past, or current (definite, probable, or possible).

Study population and subgroups

The study focused on individuals who had "scalp" coded as 1 of up to 3 sites. In addition, we were interested in individuals with scalp plus involvement of surrounding areas. Therefore, several subgroups were defined: scalp only (scalp as the only anatomic site coded); scalp plus face/ear/neck (scalp plus any of [but limited to] the following codes: eyelids, eyes, lips, face, ears, or neck); scalp plus face/ear/neck/arms/trunk (scalp plus any of [but limited to] the following codes: eyelids, eyes, lips, face, ears, neck, trunk, and arms); scalp plus any site(s) other than face, ears, neck, arms, or trunk; and scalp not specifically coded as a site. These subgroups were mutually exclusive. Each subgroup was further divided into currently relevant positive reactions or no currently relevant positive reactions, which included both reactions coded as "not allergic" or positive reactions with past or unknown clinical relevance.

Data management and analysis

North American Contact Dermatitis Group data were entered and analyzed with Access or Excel (Microsoft, Redmond, WA) and checked for quality assurance at a central location. Counts and proportions were determined for demographic and allergen-related data. Pearson χ^2 tests were used for categoric variables (SAS version 9.2, SAS Institute, Inc, Cary, NC). In total, 24 comparisons were made and a cutoff of $P < .05$ was used for statistical significance.

RESULTS

Patient characteristics

Of 48,753 individuals patch tested, 4.8% (n = 2,331) had scalp identified as 1 of up to 3 affected anatomic sites, of whom 505 (21.7%) had involvement of scalp only, 883 (37.9%) had involvement of scalp plus face/ear/neck, 388 (16.6%) had involvement of scalp plus face/ear/neck/arms/trunk, and 555 (23.8%) had involvement of scalp plus any site(s) other than face, ears, neck, arms, or trunk. Within each group, the proportions with currently relevant positive reactions were as follows: scalp only, 45.9% (n = 232); scalp plus face/ear/neck, 66.8% (n = 590); scalp plus face/ear/neck/arms/trunk, 61.3% (n = 238); and scalp plus any site(s) other than face, ears, neck, arms, or trunk, 64.8% (n = 360).

In pairwise comparisons with the group with scalp not specifically coded as a site, all scalp groups (scalp only, scalp plus face/ear/neck, scalp plus face/ear/neck/arms/trunk, and scalp plus any site(s) other than face, ears, neck, arms, or trunk) were significantly more likely to be women (all $P < .001$) and this relationship was strongest for the scalp-only group (Table I).[29] Similarly, all scalp groups were more likely to be older than 40 years ($P < .001$) and less likely to have occupationally related dermatitis ($P < .001$). Patient-reported history of atopic dermatitis was inversely associated with scalp-only and scalp plus face/ear/neck/arms/trunk groups compared with the no scalp group ($P \leq .03$).

Other anatomic sites associated with scalp dermatitis

For each of the 3 scalp groups with additional anatomic sites, approximately half had scalp as the primary site (scalp plus face/ear/neck = 52.4%, scalp plus face/ear/neck/arms/trunk = 56.2%, and scalp plus any site(s) other than face, ears, neck, arms, or trunk = 45.4%) (Table II). For the group with scalp plus any site(s) other than face, ears, neck, arms, or trunk, common associated sites beyond face, ear, neck, arm, and trunk included hand (n = 229), scattered/generalized (n = 149), and leg (n = 106).

Final diagnoses among scalp dermatitis groups

Approximately one-third of scalp-only individuals had a primary diagnosis of allergic contact dermatitis (38.6%), followed by seborrheic dermatitis (17.2%), other dermatoses (16.4%), other dermatitis (13.5%), and irritant contact dermatitis (9.3%) (Table II). The frequency of allergic contact dermatitis as a primary

Table I. Demographics (Male, Occupation, Atopic dermatitis history, Hand, Leg, Face, Age >40 years [MOAHLFA Index][29]) of study patients

	Study groups, no. (%)					Comparisons of study groups *P* value RR (95% CI)			
	Scalp only (N = 505)	Scalp + face, neck, or ear (N = 883)	Scalp + face, neck, ear, arm, or trunk (N = 388)	Scalp + any other site (N = 555)	Not scalp (N = 46,422)	Scalp only vs not scalp	Scalp + face, neck, or ear vs not scalp	Scalp + face, neck, ear, arm, or trunk vs not scalp	Scalp + any vs not scalp
Men	63 (12.5)	136 (15.4)	99 (25.5)	108 (19.5)	15,915 (34.3)	<.001 0.36 (0.29−0.46)	<.001 0.45 (0.38−0.52)	<.001 0.74 (0.63−0.88)	<.001 0.57 (0.48−0.67)
Related to occupation*	0	14 (1.6)	7 (1.8)	31 (5.6)	6513 (14.0)	n/a	<.001 0.11 (0.07−0.19)	<.001 0.13 (0.06−0.27)	<.001 0.40 (0.28−0.56)
History of atopic dermatitis	67 (13.3)	181 (20.5)	68 (17.5)	117 (21.1)	10,323 (22.2)	<.001 0.60 (0.48−0.75)	.22 0.92 (0.81−1.05)	.03 0.79 (0.63−0.98)	.51 0.95 (0.81−1.11)
Hand†	0	0	0	229 (41.3)	13,408 (28.9)	n/a	n/a	n/a	<.001 1.43 (1.29−1.58)
Leg†	0	0	0	106 (19.1)	5122 (11.0)	n/a	n/a	n/a	<.001 1.73 (1.46−2.06)
Face†	0	589 (66.7)	98 (25.3)	87 (15.7)	9814 (21.1)	n/a	<.001 3.16 (3.00−3.32)	.05 1.19 (1.01−1.42)	.002 0.74 (0.61−0.90)
>40 y	416 (82.4)	668 (75.7)	317 (81.7)	408 (73.5)	30,820 (66.4)	<.001 1.24 (1.19−1.29)	<.001 1.14 (1.10−1.18)	<.001 1.23 (1.17−1.29)	<.001 1.11 (1.05−1.16)
White	415 (82.2)	732 (82.9)	333 (85.8)	480 (86.5)	39,928 (86.0)	.01 0.96 (0.92−1.00)	.008 0.96 (0.94−0.99)	.92 1.00 (0.96−1.04)	.75 1.01 (0.97−1.04)

CI, confidence interval; *MOAHLFA Index*, Male, Occupational, Atopic dermatitis, Hand, Face, Leg, Age (>40 y) Index; *RR*, relative risk.

*Overall occupationally related skin condition.

†Any of up to 3 sites.

Table II. Other body sites and final diagnoses for scalp dermatitis groups

	Scalp only	Scalp + face, neck, or ear	Scalp + face, neck, ear, arm, or trunk	Scalp + any other site	Scalp only	Scalp + face, neck, or ear	Scalp + face, neck, ear, arm, or trunk	Scalp + any other site
	Primary site*				Nonprimary sites†			
	N = 505	N = 883	N = 388	N = 555	N = 505	N = 883	N = 388	N = 555
Scalp	505 (100)	463 (52.4)	218 (56.2)	252 (45.4)	0	420 (47.6)	170 (43.8)	303 (54.6)
Face, NOS	n/a	282 (31.9)	47 (12.1)	30 (5.4)	n/a	307 (34.8)	51 (13.1)	57 (10.3)
Eyelids	n/a	71 (8.0)	10 (2.6)	9 (1.6)	n/a	49 (5.5)	2 (0.5)	8 (1.4)
Neck	n/a	27 (3.1)	14 (3.6)	3 (0.5)	n/a	364 (41.2)	75 (19.3)	37 (6.7)
Ears	n/a	26 (2.9)	5 (1.3)	3 (0.5)	n/a	91 (10.3)	6 (1.5)	12 (2.2)
Lips	n/a	11 (1.2)	2 (0.5)	1 (0.2)	n/a	12 (1.4)	2 (0.5)	3 (0.5)
Eyes	n/a	3 (0.3)	0	2 (0.4)	n/a	10 (1.1)	0	1 (0.2)
Trunk	n/a	0	73 (18.8)	17 (3.1)	n/a	0	244 (62.9)	37 (6.7)
Arm	n/a	0	19 (4.9)	17 (3.1)	n/a	0	96 (24.7)	42 (7.6)
Hand	n/a	0	0	137 (24.7)	n/a	0	0	92 (16.6)
Generalized	n/a	0	0	24 (4.3)	n/a	0	0	125 (22.5)
Leg	n/a	0	0	17 (3.1)	n/a	0	0	89 (16.0)
Anal/genital	n/a	0	0	14 (2.5)	n/a	0	0	29 (5.2)
Other	n/a	0	0	11 (2.0)	n/a	0	0	12 (2.2)
Only under clothing	n/a	0	0	8 (1.4)	n/a	0	0	5 (0.9)
Foot	n/a	0	0	7 (1.3)	n/a	0	0	24 (4.3)
Most exposed areas	n/a	0	0	3 (0.5)	n/a	0	0	4 (0.7)
Nose	n/a	0	0	0	n/a	1 (0.1)	0	0

	Primary diagnosis				Nonprimary diagnoses†			
	N = 505	N = 883	N = 388	N = 555	N = 505	N = 883	N = 388	N = 555
Allergic contact dermatitis	195 (38.6)	526 (59.6)	201 (51.8)	299 (53.9)	37 (7.3)	64 (7.2)	37 (9.5)	61 (11.0)
Seborrheic dermatitis	87 (17.2)	92 (10.4)	20 (5.2)	19 (3.4)	21 (4.2)	35 (4.0)	14 (3.6)	15 (2.7)
Other dermatoses	83 (16.4)	45 (5.1)	35 (9.0)	46 (8.3)	11 (2.2)	28 (3.2)	14 (3.6)	18 (3.2)
Other dermatitis	68 (13.5)	66 (7.5)	67 (17.3)	58 (10.5)	8 (1.6)	23 (2.6)	14 (3.6)	28 (5.0)
Irritant contact dermatitis	47 (9.3)	50 (5.7)	10 (2.6)	28 (5.0)	13 (2.6)	37 (4.2)	16 (4.1)	37 (6.7)
Psoriasis	14 (2.8)	38 (4.3)	25 (6.4)	53 (9.5)	5 (1.0)	19 (2.2)	10 (2.6)	26 (4.7)
Atopic dermatitis	9 (1.8)	57 (6.5)	20 (5.2)	39 (7.0)	5 (1.0)	25 (2.8)	12 (3.1)	31 (5.6)
Contact urticaria	1 (0.2)	5 (0.6)	0	2 (0.4)	0	6 (0.7)	2 (0.5)	0
Photo dermatitis	1 (0.2)	3 (0.3)	3 (0.8)	3 (0.5)	1 (0.2)	0	2 (0.5)	1 (0.2)
Nummular eczema	0	1 (0.1)	7 (1.8)	5 (0.9)	0	0	0	3 (0.5)
Stasis dermatitis	0	0	0	2 (0.4)	0	1 (0.1)	0	4 (0.7)
Pompholyx	0	0	0	1 (0.2)	0	1 (0.1)	0	0

Data are presented as No. (%).
NOS, not otherwise specified.
*No patients had "erythroderma" listed as primary/secondary site.
†Percentages do not equal 100% because patients could have up to 2 nonprimary sites coded.

diagnosis was higher for scalp plus face/ear/neck (59.6%), scalp plus face/ear/neck/arms/trunk (51.8%), or scalp plus any site(s) other than face, ears, neck, arms, or trunk (53.9%). Other top 5 primary diagnoses for the groups with scalp plus other site included psoriasis (scalp plus face/ear/neck/arms/trunk, and scalp plus any site(s) other than face, ears, neck, arms, or trunk) and atopic dermatitis (scalp plus face/ear/neck, scalp plus face/ear/neck/arms/trunk, and scalp plus any site(s) other than face, ears, neck, arms, or trunk). Common secondary diagnoses among all groups were allergic contact dermatitis, seborrheic dermatitis, irritant contact dermatitis, atopic dermatitis, and psoriasis.

Currently relevant positive reactions

The top 10 allergens in scalp-only patients were *p*-phenylenediamine, fragrance mix I, nickel sulfate, balsam of Peru, cinnamic aldehyde, methylisothiazolinone, iodopropynyl butylcarbamate, gold sodium thiosulfate, fragrance mix II, and oleamidopropyl dimethylamine (Table III). The top 10 allergens in the other 3 subgroups were similar, with the notable addition of dimethylaminopropylamine and amidoamine in involvement of scalp plus face/ear/

Table III. Top 25 currently relevant* positive reactions

	S-only			S + FEN			S + FENAT			S + any		
Allergen	Rank	No. CRPR/no. patients tested (%)	No. CRPR/no. patients with ACD listed as 1 of up to 3 final diagnoses (%)	Rank	No. CRPR/no. patients tested (%)	No. CRPR/no. patients with ACD listed as 1 of up to 3 final diagnoses (%)	Rank	No. CRPR/no. patients tested (%)	No. CRPR/no. patients with ACD listed as 1 of up to 3 final diagnoses (%)	Rank	No. CRPR/no. patients tested (%)	No. CRPR/no. patients with ACD listed as 1 of up to 3 final diagnoses (%)
p-Phenylenediamine (1.0% pet)	1	68/504 (13.5)	68/232 (29.3)	1	263/882 (29.8)	263/590 (44.6)	1	63/388 (16.2)	63/238 (26.5)	2	90/554 (16.2)	90/360 (25)
Fragrance mix I (8.0% pet)	2	41/502 (8.2)	41/232 (17.7)	3	73/883 (8.3)	73/590 (12.4)	5	40/388 (10.3)	40/238 (16.8)	4	56/555 (10.1)	56/360 (15.6)
Nickel sulfate (2.5% pet)	3	32/504 (6.3)	32/232 (13.8)	4	72/879 (8.2)	72/590 (12.2)	3	46/388 (11.9)	46/238 (19.3)	3	82/552 (14.9)	82/360 (22.8)
Balsam of Peru (25% pet)	4	30/505 (5.9)	30/232 (12.9)	5	57/883 (6.5)	57/590 (9.7)	4	43/388 (11.1)	43/238 (18.1)	5	48/555 (8.6)	48/360 (13.3)
Cinnamic aldehyde (1.0% pet) (1996-2000; 2003-2016)	5	18/463 (3.9)	18/219 (8.2)	16	23/827 (2.8)	23/560 (4.1)	24	10/358 (2.8)	10/225 (4.4)	19	16/513 (3.1)	16/338 (4.7)
Methylisothiazolinone (0.2% aq) (2013-2016)	6	5/136 (3.7)	5/68 (7.4)	2	33/288 (11.5)	33/201 (16.4)	2	22/129 (17.1)	22/89 (24.7)	1	28/151 (18.5)	28/105 (26.7)
Iodopropynyl butylcarbamate (0.5% pet) (2005-2016)	7	11/348 (3.2)	11/165 (6.7)	12	22/653 (3.4)	22/452 (4.9)	16	11/285 (3.9)	11/184 (6.0)	23	9/383 (2.3)	9/260 (3.5)
Sodium gold thiosulfate (0.5% pet) (1996-2004)	8	4/154 (2.6)	4/67 (6.0)	8	9/228 (3.9)	9/138 (6.5)	6	5/103 (4.9)	5/54 (9.3)	10	8/172 (4.7)	8/100 (8)
Fragrance mix II (14% pet) (2007-2016)	9	8/299 (2.7)	8/143 (5.6)	9	23/575 (4.0)	23/394 (5.8)	7	14/250 (5.6)	14/168 (8.3)	21	9/324 (2.8)	9/224 (4.0)
Oleamidopropyl dimethylamine (0.1% aq) (2009-2016)	10	6/239 (2.5)	6/115 (5.2)	6	24/491 (4.9)	24/336 (7.1)	8	11/201 (5.5)	11/136 (8.1)	11	14/266 (5.3)	14/185 (7.6)
MDBGN/PE (2.5% pet in 96-98; 2% pet in 1998-2016)	11	11/502 (2.2)	11/232 (4.7)	23	16/883 (1.8)	16/590 (2.7)	20	12/386 (3.1)	12/238 (5.0)	15	19/555 (3.4)	19/360 (5.3)
Dimethylaminopropylamine (1.0% aq) (2009-2016)	12	5/239 (2.1)	5/115 (4.4)	7	22/491 (4.5)	22/336 (6.6)	18	8/201 (4.0)	8/136 (5.9)	12	14/266 (5.3)	14/185 (7.6)
MDBGN/PE (1% pet in 96-98; 0.4% pet in 1998-2002)	13	2/102 (2.0)	2/45 (4.4)	47	1/143 (0.7)	1/85 (1.2)	33	1/62 (1.6)	1/33 (3.0)	80	0/116	0/66
Amidoamine (0.1% aq) (1998-2016)	14	9/503 (1.8)	9/232 (3.9)	10	31/882 (3.5)	31/590 (5.3)	21	12/388 (3.1)	12/238 (5.0)	26	11/555 (2.0)	11/360 (3.1)
Carmine (2.5% pet) (2011-2012)	15	1/55 (1.8)	1/28 (3.6)	15	3/102 (2.9)	3/71 (4.2)	72	0/41	0/26	31	1/59 (1.7)	1/38 (2.6)
Lanolin alcohol (30% pet 96-10; 50% pet 2011-2016)	16	7/505 (1.4)	7/232 (3.0)	14	28/883 (3.2)	28/590 (4.8)	26	10/388 (2.6)	10/238 (4.2)	27	11/555 (2.0)	11/360 (3.1)
MCI/MI (0.01% aq)	17	6/500 (1.2)	6/232 (2.6)	13	29/882 (3.3)	29/590 (4.9)	12	18/388 (4.6)	18/238 (7.6)	7	43/555 (7.7)	43/360 (11.9)
Quaternium-15 (2.0% pet)	18	6/504 (1.2)	6/232 (2.6)	20	19/883 (2.2)	19/590 (3.2)	23	11/387 (2.8)	11/238 (4.6)	6	45/554 (8.1)	45/360 (12.5)
Cobalt chloride (1.0% pet)	19	6/502 (1.2)	6/232 (2.6)	21	18/882 (2.0)	18/590 (3.1)	17	14/388 (3.6)	14/238 (5.9)	13	24/554 (4.3)	24/360 (6.7)

Propylene glycol (30% aq) (1996-2016)	20	6/503 (1.2)	6/232 (2.6)	26	15/883 (1.7)	15/590 (2.5)	35	7/388 (1.8)	7/238 (2.9)	16	19/555 (3.4)	19/360 (5.3)
Tixocortol-21-pivalate (1.0% pet)	21	6/503 (1.2)	6/232 (2.6)	48	7/883 (0.8)	7/590 (1.2)	66	1/387 (0.3)	1/238 (0.4)	36	8/555 (1.4)	8/360 (2.2)
Cocamidopropyl betaine (1.0% aq) (2001-2016)	22	5/441 (1.1)	5/200 (2.5)	17	19/796 (2.4)	19/535 (3.6)	15	13/355 (3.7)	13/218 (6.0)	18	16/481 (3.3)	16/316 (5.1)
Ylang ylang oil (2.0% pet) (2001-2016)	23	5/441 (1.1)	5/200 (2.5)	72	2/796 (0.3)	2/535 (0.4)	52	3/355 (0.8)	3/218 (1.4)	32	8/481 (1.7)	8/316 (2.5)
Bacitracin (20% pet)	24	5/502 (1.0)	5/232 (2.2)	24	16/882 (1.8)	16/590 (2.7)	27	9/387 (2.3)	9/238 (3.8)	17	19/554 (3.4)	19/360 (5.3)
Thimerosal (0.1% pet) (1996-2002)	25	1/102 (1.0)	1/45 (2.2)	85	0/143	0/85	34	1/63 (1.6)	1/33 (3.0)	81	0/116	0/66
Formaldehyde (1.0% aq)	27	4/505 (0.8)	4/232 (1.7)	19	20/883 (2.3)	20/590 (3.4)	19	13/387 (3.4)	13/238 (5.5)	8	35/555 (6.3)	35/360 (9.7)
Decyl glucoside (5.0% pet) (2009-2016)	28	2/239 (0.8)	2/115 (1.7)	30	7/491 (1.4)	7/336 (2.1)	50	2/201 (1.0)	2/136 (1.5)	22	7/266 (2.6)	7/185 (3.8)
Formaldehyde (2.0% aq) (2013-2016)	31	1/136 (0.7)	1/68 (1.5)	11	10/288 (3.5)	10/201 (5.0)	9	7/129 (5.4)	7/89 (7.9)	9	10/151 (6.6)	10/105 (9.5)
Bronopol (0.5% pet)	37	3/502 (0.6)	3/232 (1.3)	52	6/883 (0.7)	6/590 (1.0)	46	4/388 (1.0)	4/238 (1.7)	20	16/555 (2.9)	16/360 (4.4)
Glyceryl thioglycolate (1.0% pet) (1996-2010)	49	1/310 (0.3)	1/136 (0.7)	46	4/493 (0.8)	4/318 (1.3)	49	2/218 (0.9)	2/123 (1.6)	24	7/344 (2.0)	7/217 (3.2)
N-isopropyl-*N*-phenyl-*p*-phenylene-diamine (0.1% pet) (1996-2000)	61	0/63	0/32	18	2/87 (2.3)	2/55 (3.6)	79	0/33	0/20	86	0/74	0/44
Ammonium persulfate (2.5% pet) (2015-2016)	62	0/74	0/39	22	3/154 (1.9)	3/105 (2.9)	38	1/61 (1.6)	1/41 (2.4)	25	2/88 (2.3)	2/63 (3.2)
Budesonide (0.01% aq) (2003-2006)	63	0/101	0/44	25	3/165 (1.8)	3/111 (2.7)	80	0/75	0/37	50	1/115 (0.9)	1/70 (1.4)
Propylene glycol (100%) (2013-2016)	65	0/136	0/68	27	5/288 (1.7)	5/201 (2.5)	31	3/129 (2.3)	3/89 (3.4)	14	6/151 (4.0)	6/105 (5.7)
Diphenylguanidine (1.0% pet) (2013-2016)	69	0/136	0/68	39	3/288 (1.0)	3/201 (1.5)	13	6/129 (4.7)	6/89 (6.7)	63	1/151 (0.7)	1/105 (1.0)
Shellac (20% alc.) (2009-2012)	70	0/103	0/47	40	2/203 (1.0)	2/135 (1.5)	14	3/72 (4.2)	3/47 (6.4)	34	2/115 (1.7)	2/80 (2.5)
Majantole (5.0% pet) (2009-2012)	75	0/103	0/47	64	1/203 (0.5)	1/135 (0.7)	25	2/72 (2.8)	2/47 (4.3)	88	0/115	0/80
BHA (2.0% pet) (1996-1998)	86	0/26	0/13	86	0/32	0/21	10	1/19 (5.3)	1/13 (7.7)	90	0/35	0/21
Benzalkonium chloride (0.1% aq) (2001-2002)	87	0/41	0/13	87	0/56	0/30	11	1/30 (3.3)	1/13 (7.7)	91	0/42	0/22
Chlorhexidine digluconate (1.0% aq) (2015-2016)	88	0/74	0/39	88	0/154	0/105	22	2/61 (3.3)	2/41 (4.9)	92	0/88	0/63

ACD, allergic contact dermatitis; *alc*, alcohol; *aq*, aqueous; *BHA*, butylated hydroxyanisole; *CRPR*, currently relevant positive reactions; *MCI/MI*, methylchloroisothiazolinone/methylisothiazolinone; *MDBGN/PE*, methyldibromoglutaronitrile/phenoxyethanol; *pet*, petrolatum; *S+any*, scalp plus any sites other than face, ears, neck, arms, or trunk; *S+FEN*, scalp plus face/ear/neck; *S+FENAT*, scalp plus face/ear/neck/arms/trunk; *S-only*, scalp only.

*Current relevance = definite, probable, possible (excludes past/unknown relevance); relevance can only be linked to site in scalp-only group.

neck; formaldehyde (2.0% aqueous) and butylated hydroxyanisole in involvement of scalp plus face/ear/neck/arms/trunk; and quaternium-15, methylchloroisothiazolinone/methylisothiazolinone, and 2 concentrations of formaldehyde (1.0% and 2.0% aqueous) in involvement of scalp plus any site(s) other than face, ears, neck, arms, or trunk. Clinical relevance for the top 15 allergens in scalp groups are detailed further in Table IV.

Allergen sources

In scalp-only involvement, the top 5 specifically identified sources for the above-mentioned currently relevant positive reactions allergens were hair dyes, shampoo/conditioners, hair-styling products, miscellaneous consumer items (eg, hair appliances, jewelry, glasses), and medications (Table V).

DISCUSSION

Main findings

This analysis found that 4.8% of patch-tested patients (n = 2331) had scalp coded as 1 of 3 anatomic sites of involvement; 1.0% (n = 505) had scalp as the only site identified. Patients with scalp involvement were significantly more likely to be women, to be older than 40 years, and to have nonoccupational dermatosis. In addition to allergic contact dermatitis, other important final diagnoses for scalp patients included seborrheic dermatitis, irritant contact dermatitis, psoriasis, and atopic dermatitis. The most prevalent currently relevant allergens among scalp-only allergic contact dermatitis patients were *p*-phenylenediamine, fragrance mix I, nickel sulfate, balsam of Peru, and cinnamic aldehyde. Significant sources for scalp contact allergy included hair dyes, shampoos/conditioners, glasses/jewelry, medications, and hair-styling products.

Epidemiology

Comparison of our results with those of other studies is difficult because of differences in study design and variables. Reported frequencies of scalp symptoms/signs in patch-tested patients include 1.3% (N >100,000; Germany/Austria; 1993-2003),[9] 7.7% (N = 2373; Miami, FL; 2012-2016),[6] and 22.3% (N = 1015; Cleveland, OH; 2003-2018).[5] Our frequency of 4.8% (2331/48,753) is consistent with results of the 2 larger studies. Because not all patients who were patch tested had reactions or clinically relevant reactions, the frequency of confirmed allergic contact dermatitis of the scalp was lower. Clinical relevance is critically important for describing epidemiology of patients with allergic contact dermatitis, allergens to a specific anatomic location, or both. For example, a positive reaction to nickel may only be of past relevance (ie, historical umbilical dermatitis from belt buckles) and not currently relevant to the patient's scalp dermatitis. Even if currently relevant, if multiple anatomic sites are affected, a currently relevant positive reaction to nickel may be related only to current umbilical dermatitis or present as a generalized dermatitis (if involving a systemic nickel allergy) but not specifically result in scalp dermatitis (eg, if no metal contactants can be identified contacting the scalp). In the current study, we attempted to account for these possibilities by including only currently relevant positive reactions and by presenting several groups of scalp dermatitis patients according to the presence of additional anatomic sites of dermatitis; frequency of currently relevant positive reactions and scalp dermatitis (n = 1420) was 2.9% and that of currently relevant positive reactions in scalp-only patients (n = 232) (ensuring association with anatomic site) was 0.5%.

Patch-test patients with scalp involvement were significantly more likely to be women than those with no scalp involvement (74.5%-87.5% versus 65.7%). This finding is similar to those of other studies: 64.4% (Miami, FL; 2012-2016),[5] 78.0% (Germany/Austria; 1993-2003),[9] and 90.1% (Cleveland, OH; 2003-2018).[6] The frequency of individuals older than 40 years in our study was 73.5% to 82.4%, which was significantly higher than that of individuals with scalp not specifically coded as a site (66.4%) and also higher than that reported in other studies (69.1% [Cleveland, OH; 2003-2018][6]; and 62.8% [Germany/Austria; 1993-2003]).[9] Previous studies established an increased prevalence of female-pattern hair loss,[30-32] symptomatic scalp,[33,34] and dermatomyositis[35-37] among women in middle and advanced ages (typically >40 years).

It is not surprising that occupational skin disease was not associated with scalp involvement in our study. Hillen et al[9] also found that occupational relevance was lower in patch-tested patients with scalp signs/symptoms (1.8% vs 15.1% nonscalp). Several previous studies of occupationally related skin disorders noted that anatomic sites in direct contact with occupational exposures, especially hands/arms, are most frequent.[38-42]

Here, common associated sites with scalp involvement were nearby/runoff locations such as the face, neck, arms, and trunk. These results were consistent with those of a study by Aleid et al,[6] in which 92 of the 226 patients (40.7%) with suspected scalp dermatitis (with or without positive reactions) reported other body sites affected by dermatitis; the most common were runoff areas, including the face (16.4%), trunk (11.0%), extremities (8.4%), and neck

Table IV. Clinical relevance for top 15 allergens in scalp groups*

	S-only					S + FEN					S + FENAT					S + any				
Allergen	**R**	**D**	**Pr**	**Po**	**T**	**R**	**D**	**Pr**	**Po**	**T**	**R**	**D**	**Pr**	**Po**	**T**	**R**	**D**	**Pr**	**Po**	**T**
p-Phenylenediamine	1	10	48	10	68	1	20	184	59	263	1	2	47	14	63	2	2	72	16	90
Fragrance mix I	2	1	17	23	41	3	2	30	41	73	5	0	21	19	40	4	0	19	37	56
Nickel sulfate	3	0	12	20	32	4	1	19	52	72	3	2	11	33	46	3	1	28	43	82
Balsam of Peru	4	1	11	18	30	5	2	25	30	57	4	0	20	23	43	5	1	10	37	48
Cinnamic aldehyde	5	0	10	8	18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Methylisothiazolinone	6	0	3	2	5	2	1	20	12	33	2	0	18	4	22	1	1	20	7	28
Iodopropynyl butylcarbamate	7	0	4	7	11	12	1	6	15	22	—	—	—	—	—	—	—	—	—	—
Sodium gold thiosulfate	8	0	1	3	4	8	0	5	4	9	6	1	2	2	5	10	0	3	5	8
Fragrance mix II	9	0	6	2	8	9	0	10	13	23	7	0	5	9	14	—	—	—	—	—
Oleamidopropyl dimethylamine	10	0	3	3	6	6	1	4	19	24	8	0	2	9	11	11	0	2	12	14
MDBGN/PE (2.0%—2.5% pet)	11	0	2	9	11	—	—	—	—	—	—	—	—	—	—	15	0	3	16	19
Dimethylaminopropylamine	12	0	2	3	5	7	1	10	11	22	—	—	—	—	—	12	1	4	9	14
MDBGN/PE (0.4%—1.0% pet)	13	0	0	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Amidoamine	14	0	1	8	9	10	1	12	18	31	—	—	—	—	—	—	—	—	—	—
Carmine	15	0	0	1	1	15	0	1	2	3	—	—	—	—	—	—	—	—	—	—
Formaldehyde (2% aq)	—	—	—	—	—	11	0	1	9	10	9	0	5	2	7	9	0	3	7	10
MCI/MI	—	—	—	—	—	13	3	13	13	29	12	0	13	5	18	7	1	28	14	43
Lanolin alcohol	—	—	—	—	—	14	2	16	10	28	—	—	—	—	—	—	—	—	—	—
BHA (2% pet)	—	—	—	—	—	—	—	—	—	—	10	0	0	1	1	—	—	—	—	—
Benzalkonium chloride	—	—	—	—	—	—	—	—	—	—	11	0	0	1	1	—	—	—	—	—
Diphenylguanidine	—	—	—	—	—	—	—	—	—	—	13	0	1	5	6	—	—	—	—	—
Shellac	—	—	—	—	—	—	—	—	—	—	14	0	3	0	3	—	—	—	—	—
Cocamidopropyl betaine	—	—	—	—	—	—	—	—	—	—	15	0	5	8	13	—	—	—	—	—
Quaternium-15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	1	16	28	45
Formaldehyde (1% aq)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	1	5	29	35
Cobalt chloride	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13	0	5	19	24
Propylene glycol (100%)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14	0	4	2	6

Dashes indicate that the allergen wasn't a top 15 allergen within that scalp group.
aq, aqueous; *BHA*, butylated hydroxyanisole; *CRPR*, currently relevant positive reactions; *D*, definite; *MCI/MI*, methylchloroisothiazolinone/methylisothiazolinone; *MDBGN/PE*, methyldibromoglutaronitrile/phenoxyethanol; *pet*, petrolatum; *Po*, possible; *Pr*, probable; *R*, rank; *S+any*, scalp plus any sites other than face, ears, neck, arms, or trunk; *S+FEN*, scalp plus face/ear/neck; *S+FENAT*, scalp plus face/ear/neck/arms/trunk; *S-only*, scalp only; *T*, total.
*Not all allergens were tested in all cycles; rank is listed by percentage of CRPR reactions.

(4.9%). Because rinse-off products contact other locations, sensitization to products used on the hair or scalp would likely affect them.

Final diagnoses

In the current study, final diagnoses of scalp patients included allergic contact dermatitis, seborrheic dermatitis, irritant contact dermatitis, psoriasis, and atopic dermatitis; multiple diagnoses were common. Scalp conditions are often multifactorial because conditions can coexist, and have similar symptoms and clinical features.[1] Additionally, scalp signs/symptoms are prevalent; a previous US Procter and Gamble survey of 735 adults found that 39% reported scalp flaking and almost 50% complained of scalp itch.[43] Aleid et al[6] noted that greater than 80% of their patch-tested scalp patients had preexisting scalp conditions such as androgenetic alopecia (34.5%), telogen effluvium (acute 9.7%; chronic 8.4%), seborrheic dermatitis (6.2%), or alopecia areata incognita (4.9%). In the current study, 38.6% of scalp-only dermatitis patients had a final primary diagnosis of allergic contact dermatitis; the highest frequency (59.6%) of allergic contact dermatitis occurred in the scalp plus face/ear/neck group, consistent with the closest sites for hair product runoff.[21]

Allergens

Our top 5 currently relevant positive reactions in the scalp-only group were *p*-phenylenediamine, fragrance mix I, nickel sulfate, balsam of Peru, and cinnamic aldehyde. These allergens are commonly found in scalp/hair contactants such as hair dye (*p*-phenylenediamine), hair care products (fragrances), and hair accessories (barrettes, pins, and headbands) or glasses (nickel). Although tested from only 2013-2016, methylisothiazolinone ranked number 6 for scalp-only patients and number 1 or 2 for all other scalp groups, underscoring its importance.

Table V. Currently relevant allergen sources in scalp patients (2001-2016)

Source category	S-only	S + FEN	S + FENAT	S + any
Personal care products	239	721	302	438
Hair care products	125	428	120	191
Hair dye	59	250	58	84
Shampoo/conditioner	36	130	46	84
Hair spray/gel	7	10	3	9
Permanent wave	0	1	1	5
Hair care product, NOS	23	37	12	9
Other personal care products, NOS	114	293	182	247
Consumer items (hair appliances, glasses, jewelry)	22	73	51	79
Medications	17	53	19	55
Other	12	41	54	65
Total allergen sources*	290	888	426	637

Currently relevant scalp-only allergens in top 5 specific sources†

	Associated allergen	No. pts with allergy
Hair dyes	*p*-Phenylenediamine	58
	Other	1
	Total	59
Shampoo/conditioners	Fragrance mix I	6
	Methylisothiazolinone	5
	MCI/MI	4
	Balsam of Peru	3
	Amidoamine	3
	Oleamidopropyl dimethylamine	3
	Cocamidopropyl betaine	2
	Dimethylaminopropylamine	2
	Other	8
	Total	36
Miscellaneous consumer items, glasses, jewelry	Nickel sulfate	17
	Cobalt chloride	3
	Sodium gold thiosulfate	2
	Total	22
Medications	Tixocortol-21-pivalate	5
	Clobetasol-17-propionate	3
	Neomycin sulfate	3
	Bacitracin	3
	Propylene glycol	2
	Other	1
	Total	17
Hair-styling products	Lanolin alcohol	2
	Fragrance mix I	2
	Other	3
	Total	7

MCI/MI, methylchloroisothiazolinone/methylisothiazolinone; *NOS*, not otherwise specified; *S+any*, scalp plus any sites other than face, ears, neck, arms, or trunk; *S+FEN*, scalp plus face/ear/neck; *S+FENAT*, scalp plus face/ear/neck/arms/trunk; *S-only*, scalp only.
*Excludes unknown sources; multiple sources/allergens could be coded per patient but only 1 source per allergen could be coded.
†Specific allergens with 1 reaction listed under "other."

Methylisothiazolinone is a notorious sensitizer[44-49]; although rinse-off products are less likely to cause primary sensitization, previously sensitized individuals will develop allergic contact dermatitis to rinse-off products containing their allergens.[50] Methylisothiazolinone is a common component of hair dyes and hair products. According to a May 2020 search, approximately two-thirds of hair dyes (68.2%, 60/88) and half of shampoos (47.7%, 216/453) and conditioners (44.2%, 134/303) listed in the American Contact Dermatitis Society's Contact Allergen Management Program contain methylisothiazolinone or cross-reactors.[51] Although primary sensitization to methylisothiazolinone in rinse-off products is unlikely, elicitation may occur in individuals previously sensitized.[50]

Hillen et al[9] and Ojo et al[5] also found that *p*-phenylenediamine was the most common allergen in patch-tested patients (11.8%, 15.0%). Patients in the study by Hillen et al[9] were also tested for sensitivity to other hair dye allergens, with frequent positive reactions to *p*-aminoazobenzene 24.0%, toluene-2,5-diamine 15.9%, *p*-aminophenol 8.3%, 3-aminophenol 5.9%, and pyrogallol 5.4%. Aleid et al[6] found that fragrances (balsam of Peru 18.2%; fragrance mix 14.4%) and nickel (23.8%) were common allergens in their patients; these frequencies are similar to those of general patch-test populations.[52] Clinical relevance to scalp symptoms/signs was not reported in these studies.

Sources

For scalp-only patients, hair dye was the most common source of currently relevant positive reactions (20.3% of allergic contact dermatitis reactions). This is consistent with findings of *p*-phenylenediamine sensitivity in the studies by Hillen et al[9] and Ojo et al,[5] and exemplifies the important potential clinical sequelae from dyeing one's hair. Greater than 75% of US women use a hair-coloring agent, and the North American hair color market will generate a predicted $9.3 billion between February 2020 and the end of 2024.[53] Because hair coloring continues to expand globally, a larger portion of the population will be at risk for sensitization. Fortunately, *p*-phenylenediamine–free hair dye alternatives exist.[51,54]

LIMITATIONS

This study involved 48,753 patients patch tested at tertiary referral centers and therefore may not be generalizable to the general population, general hair disorder population, or general dermatology population. The database allows entry of lists up to 3 anatomic sites but does not link sites specifically to allergens, sources, or diagnoses, so we used several anatomic groupings to address associations.

CONCLUSION

Isolated allergic contact dermatitis of the scalp is uncommon, and multiple associated conditions, including seborrheic dermatitis, psoriasis, irritant contact dermatitis, and other dermatoses, are common. Scalp allergic contact dermatitis is most commonly due to *p*-phenylenediamine. Allergic contact dermatitis of the scalp plus adjacent anatomic sites is also highly associated with methylisothiazolinone. Hair care products and metals used in hair accessories, glasses, and jewelry are common sources of allergens.

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