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Allergic Contact Dermatitis of the Scalp: Analysis of Allergen Profiles

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Abstract: Background: Allergic scalp contact dermatitis (ASCD) is a delayed type of hypersensitivity from contact with a specific allergen to which the patients has developed a specific sensitivity. The aim of the study was to evaluate the results of patch testing with standard series of contact allergen in patients suspected to have ASCD. Methods: 112 cases of scalp contact dermatitis were included in the study. Test substances were applied on the upper part of the patient's back, on clinically uninvolved and untreated skin. The patch test was removed and reaction were evaluated after 48 h and 72 h. The grading of negative (-) to positive (+ to ++++) patch test was done in accordance with the International Contact Dermatitis Research Group. Results: Among the 112 cases, 83 patients were female (74.1 %) and 29 were male (25.9 %). The age of participants spanned 17 to 72 years. The commonest age group affected was 41-50 years. The most common positive reactions were recorded to nickel sulphate 22 (26.2%), cobalt chloride 18 (21.4%), fragrance mix 16 (19%), balsam of Peru 14 (16.7%), carba mix 8 (9.5%) and paraphenylenediamine 5 (5.9%). Females were more likely to show a positive response to two or more allergens. Scalp itching or burning were reported as the most common symptom. Conclusions: Scalp ACD predominantly affects middle-aged women. Our results suggest that nickel sulphate and cobalt are the predominant allergens responsible for the induction of ASCD. These findings are crucial in the treatment, long term management, and education of patients with ASCD.

Keywords: allergen, allergic scalp contact dermatitis, patch test

INTRODUCTION

Allergic contact dermatitis (ACD) is a very common type of skin disorders seen among patients attending dermatology clinics. The prevalence of this disease in the general population ranges from 20% to 28% and is increasing [1,2]. It is a delayed type of hypersensitivity from contact with a specific allergen to which the patients have developed a specific sensitivity. When the antigen contacts the skin, it is processed and presented with HLA-DR on the surface of Langerhans cells, which act as antigen presenting cells in the skin [3]. These cells migrate to the regional lymph nodes and the allergen is subsequently processed by the T-lymphocytes. It leads to proliferation of specific T-cell clones that recirculate through the body and return to the skin. Upon re-exposure of the allergen, CD8+ T-cells response is mediated by the CD4+ T-cell subset. Skin penetration of allergens is facilitated by skin barrier impairment due to dermatitis or trauma. Disruption of the integrity of the epidermal barrier appears to be the first step in the events following contact with allergen [4]. Clinically, acute ACD is characterized by erythema, swelling and blisters while the more chronic reaction features epidermal reactive changes including

lichenification, thick scale and fissuring. Allergic contact dermatitis is less frequent on the scalp than at other anatomical sites; it is underdiagnosed due to overlapping dermatoses and remains understudied.

Epicutaneous patch tests are tools used in the identification of the etiological agents of allergic contact dermatitis. It is a scientific method of investigation, with internationally defined rules and well-established foundations. The function of the patch test is to produce, in a controlled manner, the elicitation phase of ACD, and thus determine the etiological agent of this dermatitis [5]. It has been recommended that all patients with chronic dermatitis must be patch tested, keeping in view the indefinite course of disease [6]. Therefore, the aim of the study was to evaluate the results of epicutaneous patch testing with standard series of contact allergen in patients suspected to have ASCD.

PATIENTS AND METHODS

This was a descriptive case study carried out at the Department of Dermatology in a tertiary care centre. A total of 112 patients clinically diagnosed with scalp contact dermatitis were included in the study. After informed consent, relevant history was taken and clinical examination was performed. The following factors were considered: gender, age, duration of disease, morphology of the lesion and anatomical site of areas affected that showed evidence of dermatitis in addition to the scalp. Patients with any other pre-existing skin disorders, on immune suppressive therapy and pregnant women were excluded from the study. Only patients with scalp signs or symptoms that suggested a possible contact dermatitis were referred for patch testing.

Table 1: The series of allergens used for patch testing

Allergen	Dilution (%) vehicle	Allergen	Dilution (%) vehicle
Acid chromici	1.0 aqua	Epoxy resin	1.0 vaseline
Cobalt chlorid	1.0 vaseline	Colophony	20.0 vaseline
Asepsol	0.5 aqua	Quaternium	1.0 vaseline
Potassium dichromate	0.5 vaseline	PPD-black rubber mix	0.1 vaseline
Resorcini	2.0 vaseline	Balsam of Peru	25.0 vaseline
Lidocain	1.0 vaseline	Fragrance mix	8.0 vaseline
Nickel sulfate	5.0 vaseline	Paraben mix	15.0 vaseline
Paraphenylenediamine	0.5 vaseline	Ammonium persulfate	2.5 vaseline
Terpentini	10.0 vaseline	Thimerosal	0.1 vaseline
Carba mix	3.0 vaseline	Neomycin sulfate	20.0 vaseline
Mercapto mix	2.0 vaseline	Formaldehyde	1.0 aqua
Thiuram mix	1.0 vaseline	Vaseline	As it is

Each patient was patch tested with allergens of European Baseline Series (Table 1), manufactured by Chemotechnique Diagnostics, Vellinge, Sweden.

Test substances were applied on the upper part of the patient's back, on clinically uninvolved and untreated skin with adhesive strips for patch test (Curatest, Lohmann Rauscher, Germany). The patch test was removed and reaction were evaluated after 48 h and 72 h. Patients were instructed to wear the patch for 48 hours without removing it and to avoid contact with water. Grading of negative (-) to positive (+ to +++) patch test was done according to the International Contact Dermatitis Research Group Criteria [7]. An irritant response was interpreted as a negative response. Positive patch test results were presented by frequency and percentage.

RESULTS

Among the 112 cases, 83 patients were female (74.1%) and 29 were male (25.9%). The youngest patient was aged 17 and the oldest was 72. The most affected age group was 41 – 50 years. The minimum disease duration recorded in our study was less than 4 weeks with the maximum duration of 3 years. The majority of the patients had the disease for 2 to 6 months. Scalp erythema was reported in 81 (72.3%) cases. Concomitant involvement of other anatomical sites was observed in 55 (49.1%) patients, specifically the face, neck, trunk and limbs. The predominant symptoms were scalp pruritus (91%) and burning (65%), while hair shedding and thinning were reported by 55% of the cohort.

Positive patch test results with at least one allergen were obtained for 84 (75%) patients, more frequently in women than in men. The most common positive reactions were recorded to nickel sulphate 22 (26.2%), cobalt chloride 18 (21.4%), fragrance mix 16 (19%), balsam of Peru 14 (16.7%), carba mix 8 (9.5%) and paraphenylenediamine 5 (5.9%). Reactivity against the rest of the panel was not remarkable.

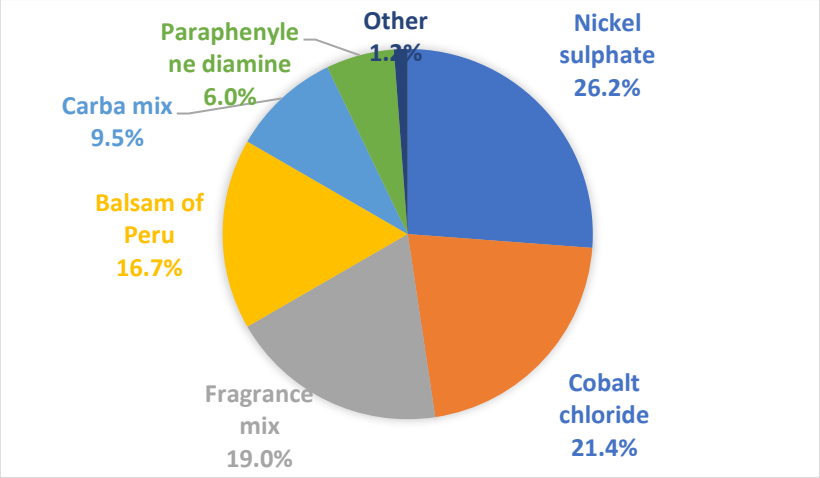

Chart 1: Positive reactions by allergen.

Regarding patch test reactivity, most of the patients had 2+ degree of reaction. Females were more likely to show a positive response to two or more allergens. Neither age nor disease duration significantly influenced patch test outcomes. Adverse reactions included pruritus and tape erythema.

DISCUSSION

Allergic scalp contact dermatitis is an uncommon form of dermatosis of the scalp caused by an allergic reaction. Warshaw *et al*. found that only 4.8% of patients presenting with dermatitis had the scalp as one of their areas of concern [8]. This low occurrence may be explained by the huge number of pilosebaceous units, whose sebum acts as natural barrier from possible allergens [9]. However, certain demographics, particularly women and patients over 40 years old are more susceptible to scalp dermatitis [10]. Women are at increased risk due to more frequent use products that directly contact the scalp, while older patients are more vulnerable due to age-related thinning of the scalp epidermis [8]. The typical clinical presentation includes erythema, scales and unrelenting pruritus as principal symptom. Characteristic eczematous lesions may be seen at the hairline, on the ears, in the retroauricular region and on the neck. Scalp ACD can also present as hair thinning and hair loss, which can negatively impact patients' quality of life.

A detailed allergy history is essential when scalp ACD is suspected. In this context, the patch test is an indispensable tool, which helps to identify the correlated allergen and to aid in diagnosis [11].

Today, about 3000 antigens are known to act as contact allergens [12]. Based on the patch test results, our study identified metals as the most common allergens. In addition to metals, the other common allergens identified included paraphenylenediamine, fragrance mix and balsam of Peru. The frequency of positive patch test results in the patients (75%) as well as clear predominance of women are within the range of results available in literature [13]. ASCD disproportionately affects women more, potentially due to increased exposure to allergenic substances in hair products, treatments, and accessories.

Nickel is ubiquitous metal used in a wide variety of products and is the most common allergen encountered worldwide [14]. Dermatitis due to contact with nickel was initially described among workers in the nickel-plating industry and was documented as an allergic response in 1925 [15]. Frequency of nickel allergy is reported to be continuously increasing in several countries, and represents a major health and socioeconomic problem [16]. In our study, 22 (26.2%) patients showed an allergic response to nickel, making it the most prevalent of the allergens identified in this study. Nickel is a metal commonly used in many consumer hair products and devices, including hair clasps, hairpins, brushes, combs and jewellery. This wide use of nickel in many items contributes to it being one of the most common skin allergens Nickel salts being soluble in water and sweat easily cause sensitisation. Patch test studies show that 15 to 24% of patients with scalp dermatitis have a positive patch test for a nickel allergy [13, 17]. Another study demonstrated that 19.3% of adult hair clasps and 79.4% of children's hair clasps could release large amounts of nickel onto the skin [18]. In addition, oral/intestinal exposure to sufficient doses of nickel ions may trigger systemic allergic dermatitis, with large inter-individual variations related to the elicitation threshold [19]. European Union Nickel directive [20] has passed certain legislation with the intention of controlling the use of nickel releasing objects in contact with the skin.

The second most common allergen identified in our series was cobalt. Cobalt is a metal found in nature. It is commonly used with nickel for metal plating, and added to alloys to make more robust tools and parts. Cobalt is another metal shown to cause scalp ACD, especially as it is one common compound added in light hair dyes. Cobalt can also be found in other hygienic products such as detergents, soaps, and antiperspirants. Studies have

shown a positive patch test to cobalt in 6 to 21% of patients with scalp dermatitis, with significantly more women sensitized to it compared to men [13, 17]. Positive reaction to this allergen occurred in 18 (21.4%) of people tested, and this percentage was greater than in other European countries [21]. Most patients with positive cobalt chloride tests also had allergies to nickel and potassium dichromate. Approximately 80% of individuals with cobalt sensitivity have co-sensitivity to other metals, with the predominant co-sensitivity being nickel [22]. It has been postulated that nickel sensitisation and preexisting dermatitis are often prerequisites for cobalt sensitisation.

A mix of eight common fragrances, Fragrance Mix, is commonly used for testing fragrance contact allergy. The mix consists of the cinnamic aldehyde and alcohol, eugenol and isoeugenol, geraniol, hydroxycitronellal, amyl cinnamaldehyde, and oak moss [23]. Fragrance mix can be found in many products such as shampoos, hair conditioners, tonics, oils and hair gels. In our study, ACD to fragrance mix was seen in 16 (19%) cases. A study conducted in Denmark on about 10 000 patients with eczema showed that 5.5% of responders reported positive reaction after exposure to the mix [24]. Aleid *et al*. reported that one-third of patients had allergic reaction to at least 1 of 3 fragrances [13].

Balsam of Peru is the aromatic resinous balsam derived from the tree Myroxylon balsamum that grows in Central and South America. It is a complex substance that contains many potential allergens such as benzoic acid, benzyl acetate, benzyl benzoate, vanillin, nerolidol, and cinnamic acid among others. Balsam of Peru is also the addition of fragrance in many cosmetics, and its use is wide due to fixative properties. Patients should be suspicious of aromatherapy products, scented oils, candles, air fresheners, deodorizers, and incense with a cinnamon, vanilla or clove aroma [13]. In addition to its use in fragrances, balsam of Peru can also be found in foods, drinks and medicines. Among our patients positive patch test with balsam of Peru were found in 14 (16.7%) of patients. Most patients with positive balsam of Peru tests also had allergies to fragrance mix.

Carba mix was the fifth most common allergen in our study, with a positive reaction observed in 8 (9.5%) patients. The prevalence of carba mix sensitisation has also been reported from other countries and have ranged between 2.2 % to 11.6 % [13, 25]. Carba mix serves as a rubber accelerator added to natural rubber to speed its polymerisation. It is commonly found in women's personal care products such as shampoos, soaps and disinfectants. In addition, carba mix may also be found in hairbrushes, bathing caps, rubber hair nets, hat bands, fungicides and pesticides.

Paraphenylendiamine (PPD) is an oxidizing agent frequently used as an ingredient in hair dyes and henna tattoos. Because of its potent allergenic properties, hairdressers or consumers of hair dye products can develop ACD. A positive test to PPD was seen in 5 patients (5.9%). Hillen *et al* [17] identified hair dyes as the most common products associated with scalp ACD, with 11.8% patients testing positive for PPD. Another study found PPD-related dermatitis prevalence to be 4% in Europe, 4.3% in Asia, and 6.2% in North America [13, 18].

ASCD is a chain of complex processes of the immune system with response to chemical substances present in the environment. The clinical relevance of positive tests is important in interpreting patch test results, as this enables the differentiation of ASCD and contact sensitisation. Furthermore, monitoring patients after patch testing is essential for determining clinical relevance and evaluating treatment outcomes.

CONCLUSIONS

Our results indicate that metals such as nickel and cobalt along with fragrances, balsam of Peru, carba mix and PPD were the most common allergens responsible for induction of ASCD. Patch tests are essential for the diagnosis of contact sensitisation. Despite improvements in cosmetics and hair product safety, the literature reports a continued association between these allergens and scalp dermatitis [26]. The most common sources of allergens are hair dyes, shampoos and conditioners, but wigs, headbands, hats, hair clasps, hairpins, brushes, combs and jewellery, and spectacles may also be allergenic [27].

Our findings may help clinicians identify potential allergens responsible for scalp dermatitis and provide guidance on allergen selection for patch testing. These results are essential for the treatment, long-term management and education of patients with scalp ACD. Given that more than one-quarter of the general population is allergic, improvements in the primary prevention of contact allergy must be strengthened.

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Author contribution: Each author participated in each step of research. Article was revised and final approval for publishing was given.

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