

# Occupational Eczema and Asthma in a Hairdresser Caused by Hair-Bleaching Products

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**Occupational allergic contact eczema and asthma caused by bleaching agents is seen in hairdressers. Bleaching agents contain persulfate salts, which are known to induce immediate reactions such as rhinitis, asthma, contact urticaria, and anaphylaxis. The immunologic mechanism is not, however, fully understood. The specific inhalation challenge test is considered to be the gold standard for diagnosing occupational asthma and rhinitis. However, this test is not always accessible. Therefore, the diagnosis of occupational allergic asthma caused by persulfate salts is made by combining a clinical history, a diagnosis of asthma, and a positive skin prick test (SPT). Standardized methods for performing SPT with persulfate salts are warranted. A case of a young hairdresser with occupational asthma and hand eczema caused by persulfate salts is presented, and the procedure for performing the SPT with ammonium persulfate and potassium persulfate is described in detail.**

**P**ERSULFATE SALTS exist in hair-bleaching products. They are highly reactive low-molecular-weight chemicals capable of causing contact urticaria, rhinitis, asthma, and even anaphylaxis.<sup>1-4</sup> Irritant and allergic contact dermatitis is also commonly induced by persulfate salts.

Hairdressers are exposed to persulfate salts when mixing bleaching powder with hydrogen peroxide. Dust powder is wheeled into the air and easily inhaled and distributed to the nose, eyes, and lungs. In addition, the skin is exposed when the hairdressers perform highlights and full hair bleaching or afterward when the hair is rinsed from bleaching product—especially if they are not wearing gloves.

Skin prick test (SPT) with persulfate salts has been performed since 1963.<sup>5</sup> Reactions to both ammonium persulfate,<sup>5-16</sup> potassium persulfate,<sup>6-8,11-13,17,18</sup> and sodium persulfate<sup>17,18</sup> have been described. Ammonium persulfate, sodium persulfate, and potassium persulfate exist in hair bleaching products.<sup>1</sup> Various procedures for performing SPT with persulfate salts have been described, but validation and standardization is still lacking.

In the following, a case report of a hairdressing apprentice with occupational hand eczema and asthma will be described, and the procedure for performing SPT will be described in detail.

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## CASE REPORT

An 18-year-old previously healthy hairdressing apprentice presented with occupational-related hand eczema and asthma. She had been in apprenticeship for 2 years. After 4 to 5 months, where the patient had been almost exclusively involved with hair washing, she had developed bilateral hand eczema. This was seen by her general practitioner and was treated as irritant contact eczema with local corticosteroids and moisturizing cream with good results.

After 15 months of apprenticeship, she developed a vesicular hand eczema bilaterally on the dorsal side of her hands and fingers and interdigitally. At this time, the patient was exposed to all kinds of hairdressing work. When on vacation, the hand eczema improved. Patch tests with a standard series and a hairdressing series showed positive reactions to ammonium persulfate. No other allergies were proven. The patient was therefore diagnosed with allergic contact dermatitis caused by hair-bleaching products.

At the same time as the allergic contact eczema developed, the patient was diagnosed with asthma by her general practitioner. According to the history, the patient had never previously had asthma or atopic dermatitis but had a clear family history of atopy.

Subjective symptoms of asthma improved on weekends and holidays. She was treated with daily inhalations of corticosteroids and instructed in the use of a peak flow meter for daily measurements. The results revealed a significant decline in lung function after days of working with hair-bleaching products.

Occupational asthma was suspected, and the patient was referred to the Department of Dermato-Allergology, Copenhagen University Hospital, Gentofte, Denmark, to have SPT with potassium persulfate and ammonium persulfate performed.

**Preparation guide for skin prick test material****Ammonium persulfate:**

2 % solution:

100 mg of ammonium persulfate is added to 5 ml of sterile water.

2 ml is transferred to a cryotube

1 % solution:

1 ml of 2 % ammonium persulfate solution is added to 1 ml of sterile water.

0,1 % solution:

0,2 ml of 1 % ammonium persulfate solution is added to 1,8 ml of sterile water.

**Potassium persulfate:**

2 % solution:

100 mg of potassium persulfate is added to 5 ml of sterile water.

2 ml is transferred to a cryotube

1 % solution:

1 ml of the 2 % potassium persulfate solution is added to 1 ml of sterile water.

0,1 % solution:

0,2 ml of the 1 % potassium persulfate solution is added to 1,8 ml sterile water.

**Reagents**

1. Ammonium persulfate 99,99 %, Sigma-Aldrich, 43,153-2
2. Potassium persulfate 99,99 %, Sigma-Aldrich 379824-5G

Persulfate solutions are prepared freshly on the day the skin prick test is performed.

Date of manufacture and patient name is applied to the prepared solutions.

**Figure 1.** Preparation guide for SPT material.

Our standard procedure for performing the test is that, on the day of testing solutions of 0.1%, 1.0% and 2.0% are freshly prepared by adding sterile water. See Figures 1 and 2.

Because anaphylactic reactions toward persulfate salts have been reported,<sup>2,19–21</sup> we recommend performing SPT stepwise with increasing concentrations to minimize the risk. First, solutions of ammonium and potassium persulfate at 0.1% concentration are used. If no reaction occurs in 15 minutes, continuation with 1.0% should be performed. If no reaction occurs in 15 minutes, finally 2% solutions can be used. Histamine (10 mg/L) serves as a positive control, and saline solution, as a negative control (ALK Abelló A/S). The test is performed on the volar side of the forearm. Reactions are considered to be positive when resulting in a wheal size of 3 mm or more.

The patient had positive reactions to both potassium persulfate and ammonium persulfate at 1.0% concentration. Immediate-type allergy toward ammonium persulfate and potassium persulfate was concluded, and the patient was diagnosed with *allergic* occupational asthma (OA) caused by persulfate salts on the basis of a diagnosis of asthma, clinical history of work-related symptoms, results from the peak flow measurements, and a positive SPT to persulfate salts. Entitlement to compensation for industrial injury and vocational

rehabilitation was given. The patient experienced a substantial improvement in her hand eczema and asthma after she ceased to work as a hairdresser.

## DISCUSSION

The mechanism by which persulfate salts induce the immediate reactions leading to asthma, rhinitis, contact urticaria, and anaphylaxis remains to be fully elucidated. The mechanism might be different for the various diseases, and in addition, persulfate salts seem to be capable of causing both allergic and irritant reactions.

With regard to asthma, some authors report immunologic mechanisms, IgE mediated<sup>6,13</sup> and non-IgE mediated,<sup>9</sup> whereas others believe that persulfate salts act directly on mast cells, thereby releasing histamine.<sup>8</sup>

Only 2 studies<sup>11,22</sup> have succeeded in reporting positive results from immunospot and radioallergosorbent test in proving the existence of specific IgE toward ammonium persulfate and potassium persulfate. This might be because specific IgE toward persulfate salts does not exist, or it might be that levels are too low to detect. Finally, an explanation could be that the test for detecting these haptenized persulfate salts lack standardization.

### Skin prick testing hairdressers with persulfates ( hair bleaching products)

**Indication:** suspicion of type 1 reaction towards hair bleaching products (persulfates).

Eg. urticaria, rhinitis, prolonged cough or breathing problems/asthma in relation to hair bleaching. If patient history reveals severe asthmatic reactions or anaphylaxis, consult a doctor, prior to performing the test.

**Procedure:** Skin prick testing is performed with increasing concentrations of both ammonium and potassium persulfate separately.

Thus, the first prick is performed with:

0,1% ammonium persulfate and

0,1% potassium persulfate

Observation and reading after 15 min. If negative, continue with:

1% ammonium persulfate and

1% potassium persulfate

Observation and reading after 15 min. If negative, continue with:

2% ammonium persulfate

2% potassium persulfate

Observation and reading after 15 min

At the same time as the first prick is made, a positive control (histamine) and a negative control is done.

After performing the test, encourage the patient to seek medical attention if symptoms occur after leaving the hospital.

**Figure 2.** Skin prick testing hairdressers with persulfates (hair-bleaching products).

When performing SPT, it is always important to bear in mind that it could potentially, although rarely, cause anaphylactic or severe asthmatic reactions.<sup>20</sup> To reduce the risk, thorough history to assess previous reactions to persulfate exposure is advised. If a history of severe reactions exists, the SPT could instead be performed as a prick-to-prick test.<sup>2</sup> Frequent monitoring of the patient during the SPT is advised. If symptoms of asthma or anaphylaxis occur during the procedure, treatment of these conditions according to local guidelines should be performed. After performing the test, the patient is encouraged to seek medical attention if further symptoms occur upon leaving the hospital.

In Denmark, a diagnosis of allergic OA caused by persulfate salts requires objective test in proving sensitization toward persulfate salts. The risk of performing the SPT with persulfate salts is outweighed by the benefit of receiving compensation and vocational rehabilitation.

Ideally, the hairdresser from the case report should have had the specific inhalation challenge with persulfates or hair-bleaching

products performed because this test is considered “gold standard” for diagnosing OA<sup>23</sup>; however, as in many other countries, this test is not yet available in Denmark, and SPT still play an important role in diagnosing OA caused by persulfate salts and identifying the cause of sensitization among multiple relevant agents in a hairdressing salon.

Patients with asthma caused by persulfate salts are advised to discontinue their work as a hairdresser to avoid further exposure and thereby for asthma to deteriorate.<sup>23</sup> However, a case has been reported<sup>14</sup> where a patient was sensitized to ammonium persulfate but not to potassium persulfate in SPT and therefore, in theory, would be able to work with bleaching agents containing only potassium persulfate. In addition, exposure to the persulfate-containing dust can be minimized if the salon substitutes the powdered form of hair bleach with granular formulations.

It is important to emphasize the importance of using proper protective equipment when working with hair-bleaching products containing persulfate salts. This means using protective gloves both when performing highlights and when rinsing them out

again to avoid skin contact, having proper ventilation in the salon, and mixing the hair bleach with hydrogen peroxide in designated area to minimize the distribution of the product in the salon or at the hairdressing school.

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