

The Fine Scratches of the Spectacle Frames and the Allergic Contact Dermatitis

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Background: Spectacle contact allergy is not infrequent. The fine scratches on the spectacle frames which may play a role in the sensitization to the potential allergenic components have not been studied. **Objective:** We sought the relationship between the scratches on the spectacle frames and the allergic contact dermatitis (ACD) in the Republic of Korea. **Methods:** A total of 42 Korean patients with ACD at the spectacle contact sites were enrolled. Their spectacle frames were examined with the dimethylglyoxime (DMG) test and analyzed by the scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS). Patch tests (thin-layer rapid use epicutaneous test [TRUE tests]) were performed to identify the skin allergens. **Results:** The DMG-positive spectacle frames were identified in 78.5% of the frames. The SEM results showed that there were more scratches on the skin-contacting parts of the spectacle frames than the non-skin-contacting parts of the same frames. In the EDS findings, the mean nickel content (weight, %) of the spectacle frames was 15.7 ± 5.5 , and the mean chromium content was 20.3 ± 3.4 at the skin-contacting parts. In the TRUE tests, nickel sulphate was the most common allergen (31 cases, 73.8%), and potassium dichromate was the second (9 cases, 21.4%). Three patients presented simul-

taneous positive reactions with nickel sulphate and potassium dichromate. **Conclusion:** Minor visible and non-visible fine scratches on the spectacle frames may present the provocation factors of the ACD. Nickel sulphate was the most common allergen suspected of provoking the spectacle frame-induced ACD, followed by potassium dichromate. (*Ann Dermatol* 25(2) 152~155, 2013)

-Keywords-

Allergic contact dermatitis, Fine scratch, Spectacle frame

INTRODUCTION

Allergic contact dermatitis (ACD) is a common cutaneous disorder presenting pruritus, erythema, and edema of the skin¹. There are many kinds of allergens (substances causing skin allergy), such as nickel, chromium, fragrances, and preservatives^{2,3}. Among these, nickel and chromium are the major metals that cause ACD. Especially, nickel has a wide use and can be found in trouser buttons, watches, and the spectacle frames⁴.

Spectacle allergy is associated with various parts of eyeglasses, such as the dyes, rubber, frame, and plastic additives. Among its many potential allergic components, the frame is thought to be the most important and common allergen in ACD from the spectacles. It is concerning that many spectacle frames marketed to the optical professions as 'hypoallergenic' are potentially far from it. Recent examples of allergens include Monel, which consists primarily of nickel, and some of the 'titanium memory alloys,' which can also have a nickel content of 40% or more⁵. Plating gives a surface with the microscopic imperfections through which nickel can penetrate when

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dissolved in sweat⁶. In spectacle frames, the fine numerous scratches which may damage the plated frames are easily seen. It may be hypothesized that nickel and chromium may more easily evoke ACD through these scratches. In this pilot study, we investigated the relationship between the fine scratches in spectacle frames and ACD.

MATERIALS AND METHODS

Between October 2008 and October 2010, a total of 42 Korean patients diagnosed with ACD at the spectacle contact site were enrolled in the pilot study. None of the patients had any types of metal induced ACD prior to developing spectacle dermatitis. They had not been wearing the same makes of the spectacle frames, but all of the spectacles consisted of Ni/Cr plated frames.

The mean age of the volunteers was 32.7 ± 8.0 years, ranging from 21 to 44 years old. The male-to-female ratio was 1:2 (fourteen males and twenty eight females). The mean onset duration was 4 ± 1.5 days. The mean duration of the spectacle use which evoked ACD was 2.5 ± 4.5 years.

We set out to dimethylglyoxime (DMG) test 42 pairs of spectacle frames. The test solutions were 1% DMG in alcohol and 10% ammonium hydroxide in water. We examined only the temples of the spectacle frames that potentially came in direct and prolonged skin contact. The test was administered by placing two drops of each solution in succession on a white cotton-wool-tipped applicator which was rubbed for up to 20 seconds against the test object. A positive reaction was indicated by a pink or a red color of the applicator, whereas a negative reaction was registered when no color change was observed. Doubtful reactions were retested, and if the reaction remained uncertain it was considered negative⁷.

These spectacle frames were analyzed via scanning electron microscopy and energy-dispersive X-ray spectroscopy (SEM-EDS) to identify the surface topography and metal components. The SEM-EDS investigations were carried out using a scanning electron microscope JSM-7000F (JEOL Ltd., Peabody, MA, USA). In order to minimize variation, the procedure was always conducted by the same operator.

Patch testing was performed in a standard manner by using panel 1 and 2 of the standardized ready-to-apply thin-layer rapid use epicutaneous test (TRUE test) (SMART-PRACTICE DENMARK Aps, Hillerød, Denmark). The reactions were recorded by two dermatologists according to the International Contact Dermatitis Research Group (ICDRG) scoring system⁸. The patch test panels were applied to the patient's upper back and left for 48 hours.

They were read and photographed at 49 and 96 hours. In case of doubtful reactions, the test was repeated. For the study purpose, reactions were considered to be positive if they were scored as a 1+, 2+ or 3+ using the ICDRG scoring system.

RESULTS

The DMG testing was positive in 33 (78.5%) of 42 pairs of the spectacle frames: 10 (71.4%) of male's and 23 (82.1%) of female's. The SEM results showed that there were more scratches on the skin-contacting parts of the spectacle frames than the non-skin-contacting parts (Fig. 1). Although minor scratches were also found in the other non-skin-contacting parts of the spectacle frames, the degree of scratches was significantly more severe in the skin-contacting and allergy-provoked parts of the spectacle frames compared to the non-skin-contacting parts. The frame coating was damaged at the scratched sites. In the EDS findings at the skin-contacting parts, the mean nickel content (weight, %) of the spectacle frames was 15.7 ± 5.5 , and the mean chromium content was 20.3 ± 3.4 (Fig. 2).

In the TRUE tests, nickel sulphate was found to be the most common allergen (31 cases, 73.8%), followed by potassium dichromate (9 cases, 21.4%). During the study period A, only 4 (9.5%) had a positive patch test result for potassium dichromate. During period B, 9 (21.4%) had positive reactions ($p < 0.05$). Nickel allergy was more common in female patients (82.1%) than in the male

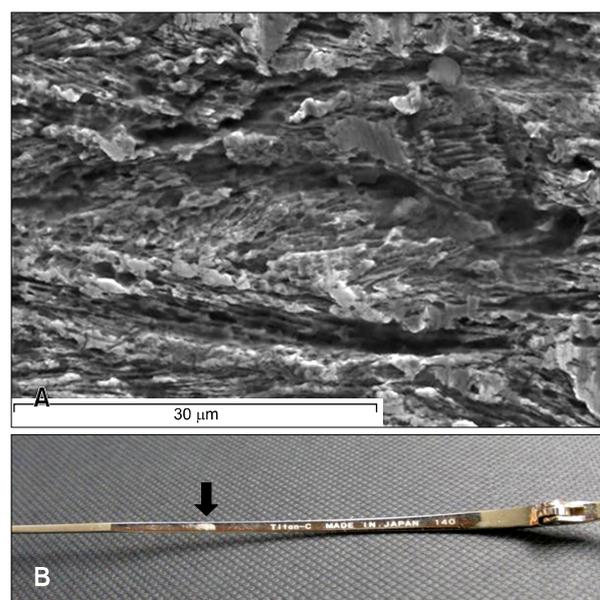


Fig. 1. (A) Scratches on the skin-contacting parts of the spectacle frames analyzed by scanning electron microscopy (SEM). (B) Black arrow indicates the skin-contacting part.

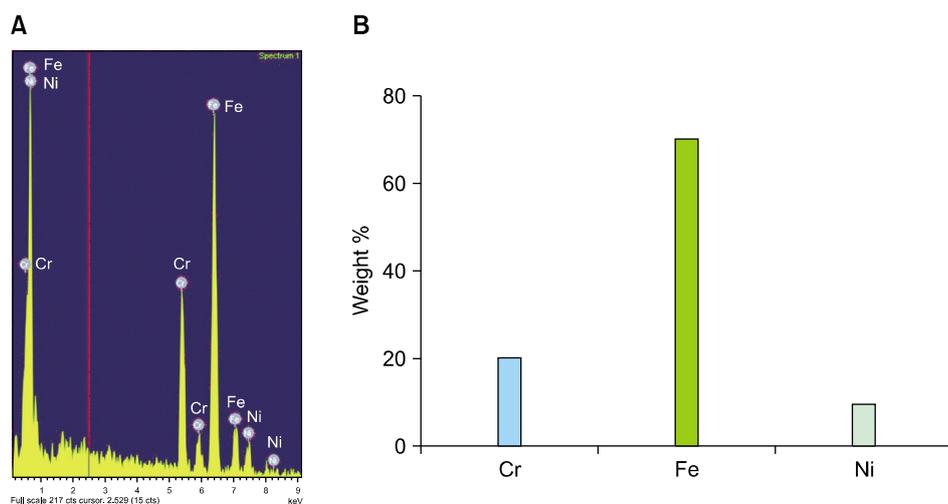


Fig. 2. Energy-dispersive X-ray spectroscopy (EDS) imaging: (A) Nickel and chromium components at the skin-contacting parts of the spectacle frames. (B) The mean nickel content (weight, %) was 15.7 ± 5.5 , and the mean chromium content was 20.3 ± 3.4 at the skin-contacting part of the spectacle frames.

Table 1. The most common positive patch test

Allergens	Number of positive patch test at 49 h			Number of positive patch test at 96 h			p-value
	Male	Female	Total	Male	Female	Total	
Nickel sulfate	8	22	30 (71.4)	8	23	31 (73.8)	NS
Potassium dichromate	2	2	4 (9.5)	4	5	9 (21.4)	<0.05

Values are presented as number or number (%). NS: non-significant.

patients (57.1%) (Table 1). Three patients presented simultaneous positive reactions to nickel sulphate and potassium dichromate.

DISCUSSION

Various kinds of metals are used in the spectacle frames, including copper, nickel, chromium, cobalt, titanium, palladium, aluminum, silver, gold, platinum, and alloys. Among the material, nickel and chromium are the most common ACD metal allergens in a normal environment, although different concentrations of these metals exist in spectacle frames, according to the manufacturer⁹.

These metals, when included in spectacle frames, come in contact with the skin for an extended period. Nickel is scarcely used in its pure form in the spectacle frames, except as a material for plating to improve the bond between the outer layer and the main frame¹⁰. It may be exposed to the surface, however, due to the wear and tear of the spectacles owing to a long-time use and may be in contact with the skin, thus causing ACD¹¹. People with nickel-induced ACD sometimes present relatively higher positive allergic reactions to chromium¹⁰. Chromium is also used for plating frames and as the base in metal alloys, especially the stainless-steel alloy. It is a safer alloy compared to other metal alloy combinations.

In the development of ACD owing to spectacle frames, a sensitization period and a sufficient amount of metal release are required. In this pilot study, the mean duration of wearing the spectacles was 2.5 ± 4.5 years. The European "CE mark" requires the spectacle manufacturers to abide by the EC Nickel Directive, which prohibits the use of noticeable free-surface nickel for two years¹¹. During this period, the spectacle frames can be scratched by ring, watches, nails, and eyeglass holders, and the plating of the frame may cause maceration. Our study shows the similar positive nickel sulphate results between the DMG test (78.5%) and the TRUE test (73.8%), where nickel sulphate was found to be the most common allergen.

The frames may also be weakened by tears, sweat, ultrasonic devices for eyeglass cleaning, and various potential accidents. Two years is considered a sufficient time to sensitize the skin for the development of ACD owing to the spectacle frames. As such, the coating needs to prevent allergens for minimum 2 years, which is to be noted by the ACD patients when purchasing new eyeglasses.

It is currently not known if the scratches on the spectacle frames that come in contact with the preauricular skin may deteriorate ACD, but it may be presumed that the physical factors like scratches, pressure, rubbing, and maceration play a role in the development of ACD. This hypothesis is supported by the findings in this pilot study

that there are more scratches on the skin-contacting parts of the subjects' spectacle frames than on the non-skin-contacting parts.

With EDS, we can map out the nickel and chromium contents from the scratched sites of the spectacle frames (Fig. 2A). Interestingly, the main component of the non-skin-contacting part was mostly gold (as plating material), and no nickel and chromium were detected (Fig. 2B). This suggests that the scratches on the spectacle frames may play a role in the development of ACD, which is mainly due to the contact with the nickel and chromium alloy contents of spectacle frames, as well as the plating. To determine the potential roles of these spectacle frame scratches, further studies with control subjects are required.

There were some limitations that may affect the accuracy of the results. The SEM-EDS analyzed site may be biased by reaching the content value as discussed before. This may be overcome by analyzing two consecutive SEM-EDS. We also did not quantify the amount of scratching. Based on this pilot study, further evaluations with a larger number of patients, and a quantitative analysis to evaluate the amount of scratching are necessary.

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