

ORIGINAL ARTICLE

Solvent Orange 60 is a potent contact sensitizer in occupational and everyday life

Kotryna Linauskienė^{1,2}  | Erik Zimerson¹ | Annarita Antelmi¹  | Magnus Bruze¹  |
Lina Hagvall³  | Nils Hamnerius¹  | Inese Haukssohn¹ | Kristina Ryberg⁴ |
Marléne Isaksson¹

¹Department of Occupational and Environmental Dermatology, Lund University, Skane University Hospital, Malmö, Sweden

²Clinic of Chest Diseases, Immunology and Allergology, Vilnius University, Faculty of Medicine, Institute of Clinical Medicine, Vilnius, Lithuania

³Department of Occupational Dermatology, Sahlgrenska Academy at University of Gothenburg, Gothenburg, Sweden

⁴Department of Dermatology, Uddevalla Hospital, Uddevalla, Sweden

Correspondence

Kotryna Linauskienė MD, Vilnius University, Faculty of Medicine, Institute of Clinical Medicine, Clinic of Chest Diseases, Immunology and Allergology, 08661 Vilnius, Lithuania
Email: kotryna.lin@gmail.com

Background: Solvent Orange (SO) 60 is a perinone-type dye that is often used in plastic materials such as spectacle frames and has been shown to cause contact allergy. The first case of SO 60 allergic contact dermatitis caused by spectacle frames was reported in 1999, and the second in 2011. We have recently seen 10 patients, of whom 6 developed dermatitis in the retroauricular/temporal area after wearing plastic spectacles.

Objectives: To report the cause of the dermatitis in the 10 patients and to describe our first case with occupational SO 60 contact allergy.

Methods: In this retrospective study, patch test results of 10 patients, tested with the Swedish baseline series and our specific spectacle and/or plastic series, including SO 60 1.0% pet., in 2011–2017, were analysed and compared with data published earlier.

Results: Ten patients, 2 males and 8 females, aged 43 to 71 years, reacted positively to SO 60 1.0% pet., namely, 4 pensioners, 2 nurses, 1 office worker, 1 teacher, 1 shop assistant, and 1 unemployed person. Four of the patients had an atopic history. Patch test reactions varied from + to +++; some had spread >20 cm outside the test area, and consisted of erythematous, infiltrated skin with papules. Retesting of patient no. 1 with serial dilutions of SO 60 in acetone to pinpoint his level of reactivity showed positive reactions down to 1 ppm. Three patients reacted to the extracts of their earpieces. Gas chromatography-mass spectrometry was used to confirm the presence of SO 60 in 2 earpieces.

Conclusions: SO 60 should be included in any spectacle patch test series that may be used. If there is a strong suspicion of contact allergy to SO 60 before patch testing, lowering the test concentration from 1.0% to 0.01% should be considered.

KEYWORDS

chemical analysis, contact allergy, hearing aid, occupational contact allergy, patch testing, spectacle frames, ultrasonic bath extract, CAS no. 6925-69-5

1 | INTRODUCTION

Solvent Orange (SO) 60 (CAS no. 6925-69-5) is a perinone-type dye that is often used in plastic materials such as spectacle frames and hearing aids, and has been shown to sensitize and cause allergic contact dermatitis. The first case of SO 60 allergic contact dermatitis caused by spectacle frames was reported in 1999,¹ and the

second was reported in 2011;² recently, another 4 Japanese cases were reported.³ We have seen 10 patients with contact allergy to SO 60, 6 of whom developed dermatitis in the periauricular or temporal area. Of the 10, 6 had dermatitis after wearing plastic spectacles. Two of these patients (nos. 1 and 10) were presented at the ESCD congress in 2012.⁴ The aim of this retrospective study was to summarize the history and test results.

2 | METHODS

The patients' test results were retrieved from our registration system DALUK. Patch testing was performed between 2011 and 2017 with the Swedish baseline series and, in some patients, also a plastic series (Chemotechnique Diagnostics, Vellinge, Sweden), supplemented with an in-house test preparation of SO 60 1.0% pet. In some patients, an in-house spectacle series, which also included a test preparation of SO 60 1.0% pet., was used. SO 60 1.0% pet. was added to both series on June 30, 2011. Patch testing and readings were performed according to ICDRG guidelines, with Finn Chambers (diameter, 8 mm; Smart-Practice, Phoenix, Arizona) on Scanpor tape (Norgesplaster, Vennesla, Norway). The dose for the pet. preparations was 20 mg,⁵ and that for the liquid preparations was 15 µL, for a Finn Chamber.⁶

Serial dilutions of SO 60 in acetone were patch tested in patient no. 1, and ultrasonic acetone/ethanol or acetone extracts of earpieces from patient nos. 1, 6 and 10 were patch tested in patient nos. 1, 6 and 10, respectively. The chambers were applied and left on the back for 48 hours, and readings were performed on day (D) 3 and D7. Reactions from + to +++ were classified as positive, and negative, irritant or doubtful reactions were classified as non-positive. Atopy was defined according to the nomenclature of the European Academy of Allergy and Clinical Immunology.⁷ Gas chromatography-mass spectrometry (GC-MS) was performed on extracts from the earpieces of patient nos. 1 and 6.

3 | RESULTS

Ten patients, 2 males and 8 females, aged 43–71 years, reacted positively to SO 60 1.0% pet. Four of the patients had a history of atopy. Patch test reactions varied from + to +++. In 2 patients (nos. 1 and 10), the test reaction had spread >20 cm outside the test area as erythematous, infiltrated skin with papules (Figure 1). Patient no. 1 was retested with serial dilutions of SO 60 in acetone from 0.001% to 0.000001% to determine his level of reactivity, and this showed positive reactions down to 1 ppm (Figure 2). Three patients reacted to ultrasonic bath acetone/ethanol or acetone extracts (Figure 2) of the respective earpieces from these patients. GC-MS identified 0.01% of SO 60 in the earpieces



FIGURE 1 Infiltrated, erythematous patch test reaction with multiple papules spreading from the strong allergic reaction to Solvent Orange 60 (in the middle) out to a 20 × 20-cm area

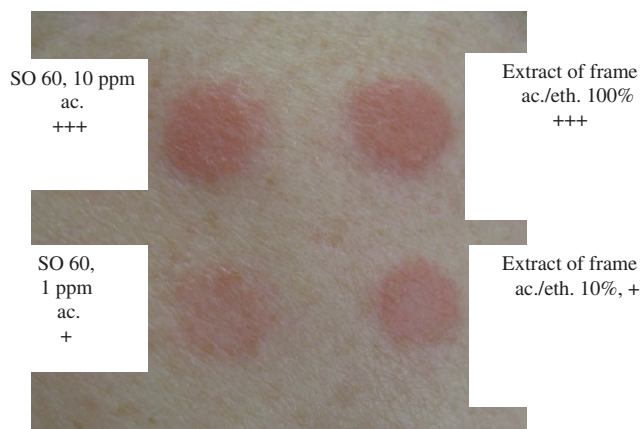


FIGURE 2 Positive patch test reactions to tested dilutions of Solvent Orange (SO) 60 in acetone (ac.) down to 1 ppm and ultrasonic bath ac./ethanol (eth.) extracts of frames (100% and 10%) in patient no. 1. The ac./eth. extracts (50:50 vol/vol) were made so that the concentration of SO 60 in them would correspond to the respective dilution of SO 60 in acetone

of patient nos. 1 and 6 (Figure S1). The demographics and test results of the patch tested patients are summarized in Table 1.

4 | DISCUSSION

Solvent Orange 60 is a dye used worldwide, and has been produced in Japan since the 1960s. It is used in orange automobile lights, automotive lenses and in household electronic appliances. All but 1 of the previously published SO 60 contact allergy cases^{1–3} were associated with spectacle frames, and the causative dye was confirmed by patch testing and chemical analysis with thin-layer chromatography and high-performance liquid chromatography. SO 60 produces colours ranging from pink to brown, and the dye is used in different plastic materials; it is known as a high-performance dye because of its desirable properties such as transparency, heat stability, excellent colour strength, ease of dispersion, and good light-fastness in transparent colours. The spectacle frames and hearing aids are made of cellulose acetate or propionate resins, which rarely cause allergic contact dermatitis. When they do, the main sensitizers identified have been plasticizers, ultraviolet light stabilizers, antioxidants, solvents, polishes, and colours.¹ The cellulose, after being esterified, is mixed with a plasticizer, a stabilizer, and a colouring agent. The entire mass is then heated to increase mixing of the components. As the chemical components are not bound to each other, they may leach out.²

In 2011, Yeo et al² published a report of a woman working in a plant manufacturing polyamide plastic helmets who developed wrist, finger and face dermatitis. She had a positive patch test reaction to SO 60, making this the first published occupational case. Since 1999, 12 cases of contact allergy to SO 60 have been reported from Japan, the main causes being spectacle frames. The plastic plates containing SO 60 used for the manufacture of frames were made in Japan, China, and Korea. In 6 of our patients (nos. 1, 3, 5, 6, 9, and 10), contact allergy caused by their glasses was suspected, and a relevant contact allergy to SO 60 was found. One had a history of allergy to plastic earrings, and was to have a plastic hearing aid (no. 4). In the remaining patients,

TABLE 1 The demographics and patch test results of the patch tested Solvent Orange (SO) 60-positive patients

No.	Sex	Occupation	Age (years)	Atopy	Localization of dermatitis	Patch test with SO 60 1% pet.		Tested eyeglass materials from patients and dilutions of SO 60	Relevant contact allergy to SO 60
						Day 3	Day 7		
1	Male	Pensioner, formerly a plumber	68	-	Retroauricular	+++	+++	Dilutions of SO 60 in acetone 0.001% +, 0.0001% +; Ultrasonic bath acetone/ethanol extract of patient's eyeglass frame, 100% +, 10% +	Yes
2	Female	Nurse	69	+	Fingers	?+	+	-	Uncertain. Patient herself suspected plastic allergy
3	Male	Pensioner	71	+	Face, temporal area	+	+	Scrapings from dried glue on the frame tested "as is" ++/++	Yes
4	Female	Unemployed, formerly nurse	64	+	None	+	ND	-	Uncertain. History of allergy to plastic earrings. Was to have a hearing-aid
5	Female	Pensioner, formerly office worker	67	-	Retroauricular	?	+	Scrapings from the frames "as is" -	Yes
6	Female	Pensioner, formerly shop assistant	64	-	Retroauricular	++	+	Ultrasonic bath acetone extract of patient's glasses ++; Scrapings from eyeglasses "as is" ++	Yes
7	Female	Food shop assistant	60	+	Face, neck, eyelids	+	ND	Scrapings from eyeglasses "as is" -	Uncertain
8	Female	Office worker	43	-	Face	++	++	-	Uncertain
9	Female	Nurse	44	-	Retroauricular	+++	ND	-	Yes
10	Female	Teacher	67	-	Retroauricular	+++	+++	Ultrasonic bath acetone/ethanol extract of patient's glasses + Ultrasonic bath hexane extract of patient's glasses +; Scrapings from earpieces "as is" ++; Solvent Red 179 +	Yes

ND, not done.

relevance was uncertain (Table 1). One (no. 10) had also reacted to Solvent Red 179, which has been reported to cross-react with SO 60.

Our first case (not included in Table 1) concerning SO 60 contact allergy had already been diagnosed in 1996, but it was not until 2003 that we could show that SO 60 was the culprit allergen. A woman working in a plant manufacturing orange plastic chainsaw bodies complained of work-related hand dermatitis. Testing with the Swedish baseline and the plastics and glue series gave negative results. The chainsaw bodies were injection-moulded from orange polyamide pellets. The patient reacted positively to used form oil collected from the mould. The used form oil had been coloured orange by the heated polyamide. Also, ethanol and acetone extracts of the used polyamide pellets (Figure S2) gave positive reactions, whereas patch testing with the fresh and non-coloured form oil gave negative results. At that time, the manufacturer of the plastic gave no information on the additives used in the pellets, but, several years later, the new owner revealed the composition of the polyamide pellets, and we could patch test the patient with all of the raw materials and additives used. The patient reacted positively only to SO 60 at the concentrations 1.0% (++) and 0.10% pet. (++) (unpublished data, E. Zimerson). This patient was not tested with lower concentrations of SO 60. Twenty controls were patch tested with SO 60 0.1% pet., with negative results. Type I allergy testing was also performed with 0.1% SO 60 in pet., with a negative result in the patient. The presence of SO 60 in 1 of the polyamide pellet extracts that had given a positive test reaction was confirmed by GC-MS analysis.

Testing with common commercial patch test series may be insufficient for correct diagnosis in many cases. In the cases reported here, the actual causative agent would have been missed if we had not tested with SO 60. Moreover, SO 60 is a very potent sensitizer, as the 0.01% concentration found in the spectacle frame caused the eczematous reaction in patient nos. 1 and 6. At present, SO 60 is not commercially available as a patch test preparation, and this may lead to cases being misdiagnosed.

5 | CONCLUSIONS

SO 60 should be included in any commercially available spectacle patch test series. If there is a strong suspicion of contact allergy to SO 60 before patch testing, lowering the test concentration from 1.0% to 0.01% pet. should be considered.

Conflict of interest

The authors declare no potential conflict of interests.

ORCID

Kotryna Linauskienė  <http://orcid.org/0000-0002-4693-0436>

Annarita Antelmi  <http://orcid.org/0000-0002-5067-2564>

Magnus Bruze  <http://orcid.org/0000-0002-2919-3227>

Lina Hagvall  <http://orcid.org/0000-0002-9141-9215>

Nils Hamnerius  <http://orcid.org/0000-0001-5188-7711>

REFERENCES

1. Shono M, Kaniwa MA. Allergic contact dermatitis from a perinone-type dye C.I. Solvent Orange 60 in spectacle frames. *Contact Dermatitis*. 1999;41:181-184.
2. Yeo L, Kuuliala O, White IA, Alto-Korte K. Allergic contact dermatitis by Solvent Orange 60 dye. *Contact Dermatitis*. 2011;64:353-356.
3. Shono M, Numata M, Sasaki K. Allergic contact dermatitis caused by Solvent Orange 60 in spectacle frames in Japan. *Contact Dermatitis*. 2018;78:83-84.
4. Isaksson M, Helwig H, Zimerson E, et al. Allergic contact dermatitis from solvent orange 60 in spectacle frames. *Contact Dermatitis*. 2012; 66(Suppl. 2):77.
5. Bruze M, Isaksson M, Gruvberger B, Frick-Engfeldt M. Recommendation of appropriate amounts of petrolatum preparation to be applied at patch testing. *Contact Dermatitis*. 2010;63:284-288.

6. Johansen JD, Aalto-Korte K, Agner T, et al. European Society of Contact Dermatitis guideline for diagnostic patch testing—recommendations on the best practice. *Contact Dermatitis*. 2015;73:195-211.
7. Johansson SGO, Hourihane JOB, Bousquet J, et al. A revised nomenclature for allergy. An EAACI position statement from the EAACI nomenclature task force. *Allergy*. 2001;56:813-824.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

How to cite this article: Linauskienė K, Zimerson E, Antelmi A, et al. Solvent Orange 60 is a potent contact sensitizer in occupational and everyday life. *Contact Dermatitis*. 2018;1–4. <https://doi.org/10.1111/cod.13022>

Figure S1. Smarteyewear spectacle earpieces containing SO 60.



Figure S2. Orange polyamide pellets used for chain saw body covers.

