

Disproportionated Rosin Dehydroabiatic Acid in Neoprene Surgical Gloves

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Background: Allergic contact dermatitis (ACD) is a well-recognized immune-mediated disease often associated with the use of vulcanization accelerator-containing latex and nitrile gloves. Potential contact allergens in neoprene (polychloroisoprene, polychloroprene) gloves have not been reported.

Objective: The objective was to analyze extracts of neoprene surgical and examination gloves for potential contact allergens.

Methods: Four different brands of neoprene-type gloves were purchased, and dichloromethane extracts were derivatized and assayed by gas chromatographic mass spectrometry. A latex surgical glove was used as a negative control.

Results: Chemical species consistent with the composition of disproportionated rosin (dehydroabiatic acid [DHA], didehydroabiatic acid, and other pimaric or isopimaric species) were identified in dichloromethane extracts of neoprene gloves. Levels of DHA, a type IV prohaptan that can be air oxidized to an active allergen, ranged from 7 to 31 mg/g of glove. A leaching study of DHA was conducted, and small amounts of DHA leached from the glove materials into artificial sweat. DHA oxidation products were not observed in any of the gloves assayed.

Conclusion: DHA exposure may occur from neoprene-type glove use, although a potential association with glove ACD has not been established.

COLOPHONY (also called rosin) is a complex mixture derived from plant resins and is a common cause of allergic contact dermatitis (ACD). Limited data on the prevalence of colophony ACD in the general population are available. Nielsen and Menne reported 1.0% and 0.4% prevalences of colophony allergy in Danish adult women and men, respectively.¹ The reported rates in selected populations are usually higher. Hogeling and Pratt found that 6% of children who were patch-tested between 1996 and 2006 had a positive reaction to colophony.² Bajaj and colleagues found a similar rate (5.7%) among patients from their clinic who had signs or symptoms of suspected

ACD.³ Additionally, 11.6% of 155 patients with footwear dermatitis were allergic to colophony.⁴

It is generally accepted that the allergenic components are air-oxidation products of rosin acids.⁵ The most abundant rosin acids in colophony are abiatic acid and dehydroabiatic acid (DHA). Disproportionation of rosin results in an exchange of hydrogen between molecules and a shift in abiatic-type acids to DHA, didehydroabiatic acid, and dihydropimaric- and dihydroisopimaric-type acids. Disproportionated rosins are more resistant to air oxidation and are therefore used commercially in synthetic rubber, paints, inks, adhesives, and paper production.

The major contact allergens identified in synthetic rubber medical and surgical gloves include zinc diethyldithiocarbamate (ZDEC), zinc dibutyldithiocarbamate (ZDBC), and 2-mercaptobenzothiazole (MBT).^{6,7} These chemicals are used as vulcanization accelerators in both latex and nitrile gloves. They are also commonly listed as potential constituents of neoprene-type (polychloroprene or polyisoprene) gloves. Recent studies have also noted the absence of thiurams from recently manufactured gloves. Disproportionated rosins are also added to synthetic rubber as emulsifiers and softening agents. We report here the presence of disproportionated rosin in neoprene-type gloves that were tested.

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Methods

Extraction

Four different brands of neoprene-type medical gloves were purchased from commercial vendors; three of these were surgical gloves and one was an examination glove. In addition, a latex surgical glove was purchased as a control. Glove sections were taken from the palm area of each glove. Sections were cut to approximately 1 × 1 cm pieces. The glove pieces (1.5 g each) were placed in a clean amber glass jar with a polytetrafluoroethylene-lined lid. Glove pieces were extracted with dichloromethane (10 mL/g of glove) at room temperature for 18 hours. Eight milliliters of each extract was recovered, filtered, and evaporated to dryness under nitrogen.

Analysis

The samples were reconstituted in 1 mL of dichloromethane (DCM) for analysis un-derivatized and after derivatization with N-methyl-N-trimethylsilyltrifluoroacetamide and 1% trimethylchlorosilane (product #48915, Thermo Scientific, Rockford, IL) for quantitative analysis. Samples were analyzed with an Agilent 6890 gas chromatograph coupled to an Agilent 5975C mass spectrometer (MS) using a 30 m HP5MS column (Agilent Technologies, Santa Clara, CA). Samples were injected (1 µL) at a 20 : 1 split injection ratio into a 300°C inlet. Analytes were eluted from the column by using 1.0 mL/min helium and an oven temperature profile as follows: the initial oven temperature was 50°C with a 5.0 minute hold, and the temperature was then ramped up at 5.0°C per minute to a final temperature

of 300°C; the MS source temperature was 230°C, and the quadrupole temperature was 150°C. The detector was in scanning mode. Quantification was performed against DHA standard material (catalog #201167, lot #7901H; MP Biomedical, Solon, OH) adjusted for observed standard material purity from in-house analysis.

All gloves were assayed for the presence of zinc dithiocarbamates (including ZDEC and ZDBC) and for MBT as described elsewhere.⁸

Potential leaching of DHA into sweat was examined by placing 1.5 g of glove material into 150 mL of artificial sweat. The artificial sweat, containing 20 g/L sodium chloride (NaCl), 17.5 g/L ammonium chloride (NH₄Cl), 5 g/L acetic acid, and 15 g/L lactic acid, was adjusted to a hydrogen ion concentration (pH) of 4.7 with sodium hydroxide (NaOH). After 18 hours at room temperature, 140 mL of artificial sweat was recovered and extracted with 150 mL of DCM. The glove extracts were evaporated to dryness under nitrogen, reconstituted to 0.1 mL of DCM, and derivatized and assayed as described above.

Results

The level of DHA in each glove is presented in Table 1. Total extractable levels ranged from 7 to 31 parts per thousand by weight in the neoprene-type gloves. A small proportion of the DHA was found to be extractable with an artificial sweat (see Table 1). Disproportionated rosin DHA was not detected in the latex glove. Didehydroabiatic acid and other pimaric and isopimaric species were observed to be in all extracts containing DHA. This is consistent with the composition of disproportionated rosin. A latex glove that did not contain DHA was used as an assay control. We have not found DHA in latex or nitrile gloves assayed by gas

Table 1. Dehydroabiatic Acid Content of Neoprene-Type Gloves

Glove Brand	Manufacturer (Lot No.)	DHA Concentration	
		DCM Extract (mg/g)	Artificial-Sweat Leachate (µg DHA per liter sweat per 10 g glove)
Biogel 30490 latex general surgery glove (assay negative control)	Mölnlycke Health Care, Norcross, GA (05J1444)	ND	—
Duraprene 2D72A3I synthetic surgical glove	Allegiance Health Care Corp., McGaw Park, IL (TS08090109)	22	394
Neolon 2G polychloroprene surgical glove	Medline Industries, Mundelein, IL (TN8905580)	31	707
Biogel 30860 nonlatex surgical glove	Mölnlycke Health Care (09A117)	7	65
Micro-Touch Affinity latex-free neoprene examination glove	Ansell Healthcare Products LLC, Red Bank, NJ (09013631EQ)	10	129

DCM = dichloromethane; DHA = dehydroabiatic acid; ND = not detected.

chromatographic mass spectrometry (GC-MS) to date, but this does not preclude the possibility that it may be added to some brands. Abietic acid was not detected nor were any of the oxidation products noted to be the ultimate allergenic forms of the above. Of note, the DHA standard material had a supplier-stated purity of greater than 90%. Our analyses showed a DHA purity of approximately 65% by percent of the total rosin species' ions identified. Similar chemical species were observed in our standard material. In addition, our standard material contained approximately 1 to 2% 7-oxydehydroabietic acid. An alternate standard supplier for DHA within the United States was not found.

Discussion

Currently, there is debate as to the true sensitization potency of rosins.⁹ Underlying this debate is the understanding that rosin acids require oxidation (ie, prehapten) to be allergenic. The disproportionated rosin found in neoprene gloves is reported to be more resistant to air oxidation and under normal conditions may be less allergenic than colophony. It is not known if neoprene-type gloves can elicit ACD in colophony-sensitive individuals (with or without air oxidation). Five different DHA oxidation products have been identified as potential allergens.⁵ In the health care setting, oxidants such as chlorine, iodine, and peroxide are commonly used and may facilitate the oxidation of prehapten to their antigenic form. None of the five glove brands assayed for this study had detectable levels of ZDEC, ZDBC, or MBT, but these allergenic vulcanization accelerators are often used in the manufacture of neoprene-type synthetic gloves. DHA has antimicrobial properties and is cytotoxic to mammalian cells.^{10–12} This toxicity is thought to be partly mediated by the amphiphilic nature of DHA, enabling DHA to become concentrated in lipid membranes and disrupting ion transport. The potential effect of co-exposure to DHA along with other allergenic accelerators has not been evaluated.

Conclusion

High concentrations of disproportionated rosin dehydroabietic acid were found in neoprene medical and

examination gloves from four manufacturers. Dermatologists might consider patch-testing glove allergic contact dermatitis patients with (oxidized) colophony or disproportionated rosin in addition to previously recognized allergenic accelerators if those patients are using neoprene-type synthetic gloves.

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