ALLERGEN Focus

Focus on T.R.U.E. Test Allergen #14:

Epoxy

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Allergic contact dermatitis is an important disease with a high impact both in terms of patient morbidity and economics. The contact dermatitides include allergic contact dermatitis, irritant contact dermatitis and contact urticaria.

Irritant contact dermatitis, the most common form, accounts for approximately 80% of environmental-occupational based dermatoses.

Contact urticaria (wheal and flare reaction) represents an IgE and mast cell-mediated immediate-type hypersensitivity reaction that can lead to anaphylaxis, the foremost example of this would be latex hypersensitivity. While this is beyond the scope of this section, we acknowledge this form of hypersensitivity due to the severity of the potential reactions and direct the reader to key sources.[1,2]

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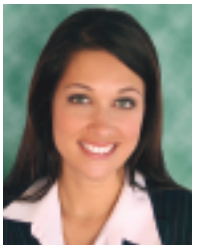

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Allergic contact dermatitis, on the other hand, is a delayed type IV hypersensitivity reaction. The primary focus of this section is to highlight the educational component of allergic contact dermatitis.

CLINICAL ILLUSTRATION

A woman with facial erythema and telangiectasia presented to the contact dermatitis clinic for post patch test counseling. She had been diagnosed with a positive reaction to the epoxy resin by T.RU.E testing.

EARLY COMPOSITE BUILDING MATERIALS

The utilization of composite (glue) systems dates back to ancient times. Moses' basket, for example, was an ark of bulrushes and pitch (a petroleum-based plant biodegradation product), and the Tower of Babel's bricks were laid with bitumen (a naturally occurring tar compound).[3]

Geography and the availability of natural resources played an important role in the development of composite building materials. In Ancient Greece, for example, amber resins had been readily available. Pliny The Elder, a Greek naturalist, stated that even the mesh "used for restraining wild animals" was made with amber.[4]

As supplies dwindled and traveling the Amber Road to the North trade route became more and more perilous, the need for newer composite materials became apparent.

Early Africans had been among the first to compound albumen (derived from cattle blood) and mud as a composite building material.[5] Yet, it wasn't until 1848 that Francois Lepage popularized this formulation in his trendy *Bois Durci* Architectural Hardware, a symbol of elevated social status.

In fact, casings of Thomas Edison's early phones were made from *Bois Durci*.

In 1877, W.H. Dibble patented hemacite doorknobs utilizing the *Bois Durci* technology. These hydraulic-pressure-hardened doorknobs of animal blood and sawdust were thought to be so indestructible, that they came with a lifetime guarantee.[5]

BUILDING MATERIALS TO HOSIERY

Innovations in composite materials brought previously inaccessible items to the masses, and allowed for the cultivation of pastimes and hobbies.

For example, gutta percha, a milky resin from a Malaysian palm tree, clearly transformed the game of golf in the 1850s. The gutta resin could be quickly molded into relatively inexpensive, readily available, rock-hard balls. Prior to gutta, golf balls had been custom made small leather bags hand stuffed with boiled goose feathers.[6]

The advent of the new mass producible golf ball created a major social rift between the nouveau gutta lovers and the upper class feather ball traditionalists.[6] An effort to keep up with the demand of this ever popular sport led to the harvested depletion of the Malaysian palm, which is now included on the endangered list.[7]

Today's golf balls are a technologic wonder — they're composed of a core with an optional intermediate layer and an aerodynamic dimpled cover. Acrylonitrile-butadiene, styrene copolymers, polyureas, and epoxy resins are interchangeably used in the ball cover construction and vary by manufacturer. This wide variety of available plastic polymers is owed to the "plastics craze" that began in the 1920s.

In search of the ideal plastic tablecloth, Jacques E. Brandenberger discovered cellophane in 1908.[8] Although it did not make for a good-quality tablecloth, the potential uses for this new synthetic were limitless.

When DuPont bought the exclusive rights to cellophane and created a waterproofed formulation, it changed the face of the food packaging industry forever.

Around this same time, Wallace Hume Carothers, a Harvard chemist working for DuPont, developed what would become the company's most notorious innovation: Fiber 66 (a.k.a. Nylon). Nylon's rapid replacement of silk in the women's hosiery market allowed for mass production of panty hose.[9] When nylon's availability became scant during World War II, riots broke out. The newspaper headlines read "Women Risk Life and Limb in Bitter Battle over Nylons".[9]

The vast popularity of DuPont's Fiber 66/Nylon incited a polymer research frenzy that soon resulted in the discovery of polyethylene, polyfluoroethylene, and polyepoxide. Dr. Pierre Castan of Switzerland and Dr. S.O. Greenlee of the United States separately discovered *polyepoxide* (a.k.a. epoxy). ***(See Table 1.)*** Although Dr. Castan's innovation came out earlier in 1936, Dr. Greenlee actually patented the ingredients that are still used today to formulate epoxy.

A HARVARD CHEMIST WORKING FOR DUPONT DEVELOPED WHAT WOULD BECOME THE COMPANY'S MOST NOTORIOUS INNOVATION: FIBER 66 — A.K.A. NYLON. THIS [INVENTION] ALLOWED FOR MASS PRODUCTION OF PANTY HOSE.

Manufacturers were quick to realize the great potential of this new thermosetting-composite-polymer, both as a glue and surface protectant. For example, the addition of epoxy to glass fibers (a.k.a. fiberglass) revolutionized the transportation industry. Faster boats and cars were constructed, with improved ability to resist corrosion. Longer suspension bridges, including the bridge that spans the Straits of Gibraltar, were now possible to build. Equivalent suspension bridges made of steel would have collapsed under their own weight.[10]

Epoxy innovated design on the home improvement front as well.

Formica (a composite of an epoxy binder and quartz) furnishings became the rage of the '50s. The formica-surfaced kitchen cabinets and tables were durable and easily cleaned of grease. Attractive and practical kitchens were now accessible to the middle classes.

Flooring in the American household also underwent the epoxy revolution. Previously, terrazzo floors had been a fad of the wealthy. Fifteenth century terrazzo floors were created by repetitively hand-rubbing marble floors with stones and goat's milk to achieve the shined finish.[11] Epoxy took terrazzo floors to the next level by creating a non-labor-intensive shine, while adding a hardened protective finish.

A. Alfred Taubman, founder of the shopping mall, believed that the success of the shopping mall was due to the epoxified terrazzo floors, which allowed for easy gliding through the malls. "Women, especially, tend to have thin soles," he said. "We found that they are very sensitive to the surface, and when they get on one of those terrazzo floors it's like a skating rink."[12]

FASHION-FORWARD EPOXIFIED PLASTICS

With the rising environmentalist movement of the '70s came an aversion to man-made products. For the first time, epoxified plastics sales slumped and consumers returned to natural products such as cotton and leather.[13]

Interestingly, the late '70s sparked an anti-commercialist movement, epito-

TABLE 1

EPOXY SYNONYMS

Bisphenol A [2,2-bis(4-hydroxyphenyl)propane] (diphenylpropane)
Diglycidyl ether
Epichlorohydrin (1-chloro-2,3-epoxypropane) (8-chloropropylene oxide)
4,4'-Isopropylidenediphenol-epichlorohydrin

Source: Reference 21.

mized by The Sex Pistols. Members of this anarchist punk band notoriously spiked their hair, wore metal studs and finished off their look with, of all things, epoxy jewelry![14]

In the '80s, Lipstick Rockers and Madonna set their own new trends sporting spandex onstage, while their fans embraced epoxy jelly bracelets and shoes.

Allergies to these products were rare since the epoxy was usually hardened (cured) when it reached the consumer.

This was not always the case though with all epoxy-based products. Sears, Roebuck and Co. Toughskin & Roughhouser epoxy-fixed knee patch jeans had to be replaced with a non-epoxy adhesive after an outbreak of allergic contact dermatitis in children.[15]

EPOXY AND THE SPACE SHUTTLE DISASTER

The last two decades have further broadened the utilization of epoxy by bringing the must-have electronics to the consumer markets. Cell phones, game boys, laptops, and iPods, for example, have become household items.

Epoxies can be found as integral components in a wide range of products including airplanes, automobiles, bikes, golf clubs and balls, skis, snow boards, and electrical system wiring insulation *(see Table 2)*. Furthermore, epoxy is used as an internal coating on canned food tins (to prevent rusting from acidic foods) underscoring the worldwide broad utilization.[16]

The world's attention turned to epoxy in 2003, with the tragic loss of the space shuttle, Columbia. Columbia's lost tile and the subsequent re-entry explosion were both blamed on the epoxy glue that had not been given enough time to cure.[17]

No chances were taken in 2005, when a small piece of projecting epoxy grout was encountered on the space shuttle Discovery, National Aeronautics and Space Administration (N.A.S.A.) initiated an intra-mission rescue operative. Imaging specialists, shuttle tile engineers, aerodynamicists and spacewalk planners worked relentlessly to direct the removal of the extruding filler. Astronaut Stephen Robinson removed the filler and averted the potential disruption of the aerodynamic flow on re-entry, as millions of television viewers looked on.[18]

TABLE 2

EPOXY RESIN USES

Adhesives and Glues
Dental Bonding Agents
Electrical Encapsulators
Eyeglass Frames
Flooring
Handbags
Hemodialysis Equipment
Laminates
Microscopy Immersion Oil
Pacemakers
Paints and Inks
Plastic Necklaces
Vinyl Gloves

OCCUPATIONAL EXPOSURES

Since most consumers are only exposed to the post-manufacturing cured resins, allergy rates are low. Occupational exposures to epoxy raw materials, such as epichlorohydrin and bisphenol-A, however, result in a high incidence of sensitization in factory laborers.

Dermatitis from epoxy systems can occur from the uncured epoxy or the catalytic agents, the fillers, the pigments and other parts of the resin system. According to the Canadian National Occupational Health and Safety Resource, the professionals most at risk include artists, sculptors, electricians, jewelers, mechanics, office workers, and painters.[19,20] *(See Table 3)*. It is important to realize that any person who handles uncured epoxy from golf clubs to household glues to synthetic asphalt is at risk for sensitization.

TESTING FOR EPOXY SENSITIVITY

Patch testing for epoxy allergy can be screened with the commercially available Thin-layer Rapid Use Epicutaneous (T.R.U.E.) test (site #14). Comprehensive patch testing compounds for epoxy allergy include epoxy (1% in petrolatum), bisphenol A (1% in acetone or petrolatum) and epichlorohydrin (0.1% to 0.3% in petrolatum). In addition, chemicals used in conjunction with epoxy systems are also available for testing, such as the amine hardeners and reactive diluents.

THE VALUE OF THIS PATIENT CASE

In most cases of epoxy allergy, the allergen is encountered through an occupational exposure. We were not able to determine a relevant epoxy exposure in this patient. Avoidance counseling and safe alternatives were prescribed, such as switching to non-epoxy adhesives and using nitrile gloves, rather than vinyl gloves, which may contain epoxy. The facial erythema and telangiectasia, however, did not improve until rosacea therapy was initiated.

This patient underscores two important aspects of patch testing: the value of a careful history and the significance of

TABLE 3

OCCUPATIONS AT HIGH RISK FOR EPOXY EXPOSURE

Aircraft Assemblers
Automobile Industry Workers
Artists
Bookbinders
Cabinetmakers, Carpenters
Cement Workers
Construction Workers
Dental Workers
Electronics Workers/Electricians
Floor Layers
Jewelers
Mechanics
Medical Workers
Paint and Glue Workers
Printers
Textile Workers
Shoemakers

Source: References 19 and 20.

determining relevance — the latter of which can be the more difficult part of patch testing. In the words of Donald Belsito, ". . . the mystery remains unsolved until the allergen has been relevantly linked to the patient's present dermatologic problem(s)".[22]

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DESCRIPTION

CLINICAL PHARMACOLOGY

INDICATIONS AND USAGE

CONTRAINDICATIONS

PRECAUTIONS

ADVERSE REACTIONS

OVERDOSAGE

DOSAGE AND ADMINISTRATION

HOW SUPPLIED

Rx Only