Cobalt

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Cobalt has been a recognized allergen capable of causing contact dermatitis for decades. Why, therefore, has it been named 2016 “Allergen of the Year”? Simply put, new information has come to light in the last few years regarding potential sources of exposure to this metallic substance. In addition to reviewing some background on our previous understanding of cobalt exposures, this article will highlight the recently recognized need to consider leather as a major site of cobalt and the visual cues suggesting the presence of cobalt in jewelry. In addition, a chemical spot test for cobalt now allows us to better identify its presence in suspect materials.

Metals in general are the most common causes of allergic contact dermatitis (ACD). Nickel, gold, chromium, palladium, and cobalt all rank highly in lists of positive patch test reactions from studies around the world. Although cobalt has always been recognized as a common allergen, several new features of cobalt allergy have recently been elucidated (Table 1).

Cobalt (atomic number 27) is a shiny gray, magnetic, brittle metal, which in the earth, is often found with nickel and copper, with almost half coming from nickel ores. It is produced primarily in Australia, Zaire, Canada, China, Congo, Morocco, and Zambia. Cobalt was discovered by Georg Brandt in the 1730s in Sweden. The name comes from the German word kobald meaning goblin or evil spirit.

The metal is commonly used as an alloy in steel that requires high strength and endurance, such as for tools, vehicle engines, magnets, and orthopedic and other medical devices. It is also found in a number of other metal items; in ceramics, cement, and other construction materials; in some plastics; in leather tanning; and in a number of other metal items; in ceramics, cement, and other construction materials. In addition to reviewing some background on our previous understanding of cobalt exposures, this article will highlight the recently recognized need to consider leather as a major site of cobalt and the visual cues suggesting the presence of cobalt in jewelry. In addition, a chemical spot test for cobalt now allows us to better identify its presence in suspect materials.

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another cause. A patient with chronic ACD reported symptoms after using a leather sofa and was positive on patch testing to cobalt but not chromium. No other exposure source was found, and the leather from the sofa was found to contain cobalt.12 This finding led to a search for more cases of leather as a cause of ACD from cobalt. Researchers identified 183 patients positive to cobalt but not chromium. Leather was the single most likely exposure causing ACD.13 This research was performed in Scandinavia, but presumably, leather goods from other countries may be expected to also contain cobalt. Leather exposure now must be considered an important source of cobalt allergy.

Cobalt in Jewelry

Perryman and Fowler14 tested 28 patients with known cobalt allergy to a jewelry alloy (containing platinum and cobalt). The manufacturer felt the alloy would bind the cobalt tightly and thus be “hypoallergenic.” In fact, only five (18%) reacted to a patch test with a disc of the alloy applied for 7 to 8 days continuously. This novel alloy is felt likely to be tolerated by most cobalt-allergic patients. It has been suggested that jewelry containing cobalt will tend to have a dark silver appearance, in contrast to the more shiny appearance of jewelry without cobalt.15 By appearance alone, therefore, a jewelry buyer may be able to determine whether it is likely that a piece contains cobalt. In addition, a spot test for cobalt has been developed by Thyssen and colleagues16 that is similar in concept to the dimethylglyoxime spot test for nickel. Cobalt may be detected (in the presence of 1000 times as much nickel) by using a 1% aqueous solution of 2-nitroso-1-naphthol-4-sulfonic acid at pH 7 to 8. Instead of the pink color given by the nickel test, the cobalt spot test gives a yellow-orange color in the presence of cobalt.

A report from Thailand, which has no legislative controls regarding nickel or cobalt content of jewelry, found 37% of 551 jewelry items positive on the cobalt spot test. More expensive items (>US $20) were less likely to release cobalt, whereas items that were gray, brass, or pink-gold in color commonly were positive.17

Cobalt in Children’s Toys

Jensen and colleagues18 tested 212 toys purchased in Denmark or the United States. None was positive on the cobalt spot test.

Cobalt in Orthopedic and Other Implanted Devices

Allergy to orthopedic implants, especially artificial hip and knee joints, has been proposed as a possible cause of both skin disease (mostly dermatitis) and problems with the implant (pain, loosening, delayed healing).19 An illustrative case was reported from Australia of an 84-year-old woman who developed an intractable generalized dermatitis after a hip implant. The dermatitis began at the site of the implant. She had a positive cobalt patch test, and serum cobalt level was highly elevated (approximately 50-fold over normal). Within several months after replacement of the prosthesis with a titanium device, her dermatitis cleared.20 In contrast is the case report of a patient with metal allergy who unintentionally received a total knee replacement with a cobalt chromium alloy in 1 knee and a titanium alloy in the other knee. The patient did not experience any adverse effects despite being allergic to cobalt and chromium.21

Other metallic implants such as vascular stents, pacemakers, and medication pumps are also of concern. The major potentially allergenic metals in these devices include cobalt, chromium, and nickel.22 Jakobsen and colleagues23 tested 52 removed hip components and found cobalt in 44% of the implants on x-ray analysis. Only 4 items gave a positive cobalt spot test, but this test may underestimate in vivo release.

Although there is no question that occasional patients with allergy to cobalt and/or other metals can develop allergy-related complications from implanted devices, it seems likely that the majority of people with metal allergy will tolerate these implants. Schalock and colleagues24 suggest patch testing only those “reporting a history of metal sensitivity of a magnitude sufficient to cause concern to the patient or a healthcare provider.”

Vitamin B12 and Cobalt Dermatitis

Cyanocobalamin is essential for life. Allergy to the cobalt contained in it is likely to be exceedingly rare but has been reported. Allergy to vitamin B12 (cyanocobalamin) was recognized in 2 patients shown to be sensitive to cobalt on patch testing by Rostenberg and Perkins25 and Fisher.26 One case of recurrent cheilitis was in a patient who was found to be allergic to cobalt and who ingested vitamin B12 tablets regularly. The patient later developed stomatitis of the hard palate when her dentist unwittingly made her a denture out of a cobalt alloy.
Fisher reported 1 cobalt-allergic patient that correlated with an allergic reaction to an injectable vitamin B12. (One mL of the injection contained more than 43 mg of cobalt.) This patient had a positive patch test to both 2% aqueous solution of cobalt chloride and the vitamin B12 in the strength of 100 and 1000 mg/mL. In addition, there were positive delayed scratch and intradermal reactions to the vitamin B12. The patient noted that, after each injection of vitamin B12, the injected area became red, tender, and pruritic but not eczematous. Oral ingestion of vitamin B12 produced similar flares. The patient also had an intractable hand eczema. In another case, there was a delayed allergic reaction to intradermal injection, but not to subcutaneous and intramuscular injections, of vitamin B12.

Anaphylaxis and urticaria have been reported in 2 patients from intramuscular B12 injections with positive intradermal testing to the preparations.

Kalenský and Schwank described hypersensitivity to cobalt in a cream used for hyperhidrosis. Patch tests were positive to cobalt, and in 1 patient, vitamin B12 produced positive epicutaneous and intradermal test reactions.

OTHER CAUSES OF COBALT DERMATITIS

Metals in Heavy Industry

As noted in Skog, cobalt is used as a binding agent to make “hard” metal, which consists of metal carbides and a binding agent that are presented and sintered into plates. Wolfram carbide (a tungsten compound) and the carbides of titanium, nobilium, and tantalum are frequently used. Hard metal is characterized by a high degree of wear resistance. Consequently, it is used for rock drills, cutting tools, drawing, pressing and stamping tools, and mechanical parts exposed to heavy strain.

Fischer and Rystedt reported that “hard metal” contains approximately 10% cobalt. Eight hundred fifty-three hard-metal workers were examined and patch tested with substances from their environment. Initial patch tests with 1% cobalt chloride showed 62 positive reactions. Allergic reactions to cobalt were reproduced in 9 men and 30 women by means of secondary serial dilution tests. Hand etching and hand grinding, often associated with hand trauma, involved the greatest risk of cobalt sensitization. Twenty-four women had cobalt allergy and also nickel allergy.

Alloys containing cobalt include alnico, duralumin, nobilium, permalloy, stellite, ticonium, and vitallium. Allergic dermatitis in workers making alloys of cobalt has been shown by patch tests to be due in some instances to the dust of metallic cobalt. The dust also has been reported as causing asthma. It is believed that a dusty atmosphere containing metallic cobalt particles favors a sensitization to cobalt.

Figure 2. Color is more intense with increasing cobalt level (photograph provided by Jacob P. Thyssen).

Figure 3. “Dark” metal jewelry is more likely to contain cobalt (photograph provided by Jacob P. Thyssen).
Polyester Resin and Plastics Manufacturing

Cobalt naphthenate is commonly used in the manufacture of polyester resin. Several instances of ACD were encountered in Great Britain that were attributed to workers handling cobalt naphthenate in polyester synthesis. Cobalt-containing catalysts may be used in plastics manufacturing. Allergy to cobalt in workers has been reported. Cobalt naphthenate has been reported to cause ACD, with a negative patch test to cobalt chloride.

Paints

Cobalt siccatives or driers, which are present in certain paints, have been reported as producing allergic contact sensitivity in paint factory workers. These are organic cobalt naphthenate or cobalt resinate based on linseed oil.

Cement and Related Materials

Although the cobalt content of cements may be low (<0.01%), cement workers may become sensitized to cobalt. Cobalt and chromate sensitivity may coexist in cement workers. Because these patients have positive patch test reactions to both chromate and cobalt, it is difficult to determine what role the cobalt hypersensitivity played in the production of the cement dermatitis. In a 5-year study of 449 construction workers, cobalt was the second most common allergen (20.5%) after chromate (42.1%).

Camarasa found that a high percentage of bricklayers in Barcelona showed hypersensitivity to both chromium and cobalt, but he noted that hypersensitivity to cobalt does not appear as commonly in patients allergic to chromium and working in other occupations. Müller and Breucker found that, in most of their 79 cobalt-sensitive patients, the most frequent cause of dermatitis was cement (29%) and that, when these patients showed reactions to chromium and nickel, the sensitization was due to simultaneous exposure to the 3 metals.

Dermitis from exposure to wet clay containing cobalt may occur. Cobalt dermatitis from dry clay or finished wares is rare. Cobalt may be added to clay to neutralize the yellow color produced by impurities. Cobalt is present in some pigments used for painting of pictures, china, and enameling.

Miscellaneous Exposures to Cobalt

Cobalt is used extensively in the carbide, glass, ceramic, enamel, electrical, and pigment industries. It may also be used in printing inks and in animal feeds. Cobalt in animal feeds has caused allergy in a Finnish pig farmer and an English animal feed worker. Cobalt-2-ethylhexoate caused hand dermatitis in an offset printer. Two of the ink driers he worked with contained this chemical. Inks, paints, oils, and varnishes may contain cobalt and other heavy metal catalysts, which help speed the drying process. Cobalt was reported to be present in belt buckles, much less commonly than nickel. In a survey of 701 buckles from either China or the United States, only five released cobalt, whereas approximately 55% to 60% released nickel on spot testing.

Cobalt in Tattoos

In the form of cobalt blue (azure blue and cobaltous aluminate), cobalt has been reported as causing a sarcoidal allergic reaction in areas in which it was used as a light blue tattoo pigment. A patch test with cobalt was positive, and cobalt was demonstrated in the pathologically altered parts of the tattoo. A tattoo test with cobalt blue elicited an inflammatory tissue reaction.

Photosensitization Dermatitis due to Cobalt

Camarasa and Alomar reported a bricklayer with a chronic and severe eczema, combined with a chronic papular dermatosis in sun-exposed areas, associated with multiple sensitivities. Several other allergens were positive on patch testing, but cobalt produced a reaction only on photo patch testing. This suggests that individuals
having dermatitis in areas exposed to sunlight and having likely cobalt exposure should be considered for photo patch testing.

Romaguera and colleagues found that 4 patients with chronic photocontact dermatitis were sensitive to cobalt salts. They presented as cases of contact dermatitis from cement or pig fodder with persistent lesions on exposed areas. Only two of them had standard patch test reactions to cobalt, but all showed positive photo patch tests to cobalt.

**Patch Testing With Cobalt**

A “reaction” peculiar to cobalt patch tests has been described by Storrs and White. This consists of a “cayenne pepper” speckled appearance of the patch site without edema or uniform erythema, apparently due to a poral reaction. This is not an allergic reaction but rather an irritant reaction specific to cobalt. Testing with a lower concentration of cobalt is not recommended, as Allenby and Baskette found that, of 6 cobalt-allergic patients who reacted to cobalt chloride 1% aqueous, only one reacted to 0.1% aqueous. As long as the poral reaction is kept in mind, testing at 1% would seem reasonable. Cobalt sulfate 2.5% is also commercially available for testing.

**SUMMARY**

Cobalt has been known as an allergen for many years, but recently, we have realized several previously unrecognized features of cobalt allergy and potential exposure. Although, in the past, it was often thought that ACD to cobalt was incidentally due to concomitant exposure to both cobalt and nickel, now we understand that exposure to cobalt independent from exposure to nickel is often important.

**REFERENCES**


