

CASE REPORT

Handheld x-ray fluorescence spectroscopy evaluation of leather chromium and cobalt

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Summary We present a 29-year-old non-atopic male apprentice power lineman and recreational cowboy with a case of allergic contact dermatitis due to both occupational and recreational exposure. He presented with a 4-month history of a pruritic, steroid-responsive, intermittent hand, foot and leg dermatitis. Patch testing was positive for chromium, cobalt and a piece of leather from his cowboy boots. His leather work gloves, inner lining of work harness, work boots and cowboy boots were assessed for chromium and cobalt content with handheld fluorescence x-ray spectrometry. Upon replacement of all leather items including the items tested and his leather cowboy saddle, the rash resolved. This case demonstrates the clinical relevance of using a handheld fluorescence x-ray spectrometer to assess for chromium and leather content.

Key words Allergic contact dermatitis; occupational; patch testing; recreational.

Background

Ninety per cent of work-related dermatological disorders can be attributed to occupational contact dermatitis [1]. The two types of occupational contact dermatitis can be divided into irritant contact dermatitis and allergic contact dermatitis (ACD), which is responsible for about 20% of occupational contact dermatitis cases [1]. ACD is a cell-mediated immune reaction and is usually suspected after a thorough history and physical exam, often with additional testing such as patch testing [1]. Avoidance of exposure to the identified allergen is the treatment for ACD [2].

Case Presentation

A 29 year-old non-atopic male apprentice power lineman and recreational cowboy presented for patch testing due to a 4-month pruritic, steroid-responsive, intermittent hand, foot and leg dermatitis. He had no relevant past medical history and took no medications. He was patch tested to T.R.U.E. Test®, a modified American Contact Dermatitis Society (ACDS) core series, and patient products (including pieces of his leather gloves, leather work boots, leather cowboy boots). The results at 96 h

post-patch test application included: potassium dichromate (+1), cobalt dichloride (+1) and a piece of leather from his cowboy boots. Although weak positives, these results are clinically relevant because the items testing positive correlated with the distribution of the rash. The pieces from his leather gloves and leather work boots were negative. The patch test used came with a patch containing 15.7 mcg of chromium at a dose of 54 mcg/cm². There was no mention of the concentration on the reference manual.

Our clinic has a hand-held Bruker S-1 Sorter handheld fluorescence x-ray spectrometer unit (Bruker Bioscience Corporation, Billerica, MA, USA) which has been used to screen for cobalt content in leather [3]. This analysis is predominantly qualitative, rather than quantitative but we find it useful for patient counselling, particularly for patients who have numerous leather exposures that are required for work. In this case, the patient's job as a power lineman establishing and maintaining power lines required him to wear multiple pieces of work equipment made of leather. The patient brought his work attire to the clinic for a follow-up appointment during which his work gloves, inner lining of his work harness, work boots, cowboy boots and belt were all found to contain chromium with the x-ray spectrometer (Figure 1). No

Key learning points

What is already known about this subject:

- Existing methods of identifying chromium and cobalt content in leather can be expensive, time-consuming or damaging to leather products.
- The treatment for allergic contact dermatitis is avoidance of the allergen.

What this study adds:

- This study identifies a quick, effective and non-damaging in-office method of testing leather items.
- Allergic contact dermatitis can be caused by multiple factors. Consider recreational exposures in addition to occupational exposures.
- Occlusive environments such as gloves or boots can worsen occupational allergic contact dermatitis.

What impact this may have on practice, policy or procedure:

- Clinical relevance of leather items may be assessed quickly and in the office with handheld x-ray fluorescence spectrometry to evaluate chromium and cobalt content. Providers can consider using this method to more quickly identify allergens in the items of their patients.



Figure 1. Photo of harness and handheld fluorescence x-ray spectroscopy showing chromium content piece of leather on work harness.

workplace assessment was conducted. Cobalt content has been reported in leather shoes/gloves [4], but none of his leather products contained cobalt. Interestingly, his harness was made of different types of leather and the thinner top-grain inner lining contained chromium, but the outer full-grain leather did not. He was advised to replace the chromium-containing leather personal protective gear for work in favour of non-leather or vegetable-tanned leather items.

Interestingly, he did not bring in his cowboy saddle for evaluation but complained that inner thigh dermatitis was particularly bothersome, making this an interesting case of both occupational and non-occupational chromium ACD. The patient reports that his symptoms resolved with switching all materials to vegetable-tanned leather and non-leather items. This includes all work leather items tested and all recreational items such as his leather saddle.

Discussion

Cr(III), which is less allergenic than Cr(VI), is used in leather tanning for consumer use by binding to collagen in raw leather to stabilize it [5]. Small amounts of Cr(VI) are also formed in this process via oxidation of Cr(III) [5] and may be present in consumer leather. There are alternative methods to tan leather such as vegetable-tanning, but these are typically more expensive [6]. One study showed that patients allergic to chromium-tanned leather did not react to vegetable-tanned leather [6], suggesting it is may be a reasonable alternative for our patients.

Gloves and boots induce perspiration and create an occlusive environment [7]. A previous case report demonstrated long-term occupational exposure to chromium-containing leather gloves in a golf professional as a cause contact dermatitis of the hands [7]. Since Cr(VI) has poorer protein binding, it is more likely to be leached from leather with sweating in gloves. The occlusive environment increases the penetration of Cr(VI) into the skin [5]. Upon penetration into the skin, Cr(VI) is reduced to Cr(III), which is the actual allergen by which sensitization occurs [5].

This particular patient has a physically demanding occupation often working in the Arizona heat, increasing his perspiration and enhancing Cr(VI) absorption into his skin, not only through his gloves and boots but also through his belt and harness while perspiring at work and throwing his harness over his arms and shoulders.

The only other method of detecting chromium in leather items in clinic is the diphenylcarbazide (DPC) spot test. This is a valid, quick and inexpensive method of detecting the release of chromium(VI) ions from leather and metal articles. However, this test is destructive and can damage leather items [8].

We conclude that clinical relevance of leather items may be assessed with handheld x-ray fluorescence spectrometry evaluation of chromium and cobalt content. This test can be done quickly in office, and it is easier than the DPC spot test and non-destructive to leather items. There is no comparison available between the spot test and in-lab X-ray fluorescence. Additionally, occlusive, sweaty environments may increase risk for ACD in occupational and non-occupational exposure to leather-associated allergens.

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Competing interests

D.H. is an employee and first-degree relative of the owner of SmartPractice, a company that sells dermatologic diagnostic products, including patch test supplies.

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