

## REVIEW ARTICLE

### Why Hair Turns Green

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#### REVIEW

The problem of a green discoloration of hair, sometimes referred to as chlorotrichosis, has been addressed in the past in several reports. In most cases, deposition of exogenous copper through both occupational and vocational activities has been identified as the cause of this disorder.

Originally, green hair was reported among copper workers, the first reports dating back as early as 1654 (1). More recent cases occurred at the end of the last century (2–6) and (a few) quite lately (7–9).

Nowadays, a common source of exogenous copper is tap or swimming pool water. In the first case, the metal is released from copper fittings by the acidic pH of the water (9–14), according to one report after fluoridization of drinking water (15), or after addition of copper-based algicides to or chlorination of swimming pool water (16–22).

There are single reports of green hair by copper deposition from other sources than those mentioned so far. They describe hair discoloration at the temples due to wearing metal spectacles (23, 24) and use of a copper-containing henna shampoo (25) (*Cassia obovata* (Caesalpinaceae)).

However, other causes of green hair than exogenous copper deposition have been reported as well. Use of tar shampoo (26), industrial exposure to cobalt, chromium and nickel (27) are described, as well as topical treatment of tinea capitis with yellow mercuric oxide (28). In two cases, green discoloration of hair seemed related to metabolic disorders. In the first one (10), hypothyroidism may have been involved but did not, however, play a crucial role. In the other, green hair was observed in a patient with phenylketonuria (29). Exposure to exogenous copper from the above-mentioned sources and other causes have not, however, been evaluated in this report. Altogether, green discoloration of hair may be regarded as a cosmetic disorder, which is not accompanied by other health hazards (30).

In most cases, patients with light blond hair are affected. Other predisposing factors have to be present as well for green discoloration to occur (31). These include previous hair damage (9, 17), either mechanically or by sun or peroxide bleaching, dyeing, frequent contact with chlorinated water (21, 32) or use of an alkaline shampoo (14).

A number of studies have further examined the course and

location of copper depositions in the hair (7, 10–12, 17, 32, 33, 35). Copper content was elevated in all cases as compared to normal hair and deposited predominantly at the hair tips. When the hair is in contact with copper-containing water, the metal is absorbed into the hair and cannot easily be desorbed again (12, 17, 32–35). Ultrastructurally and by x-ray examination, the metal could be found in the outer hair sheath, but not in the inner parts (7, 10–12, 17, 32–34). At the same time, trauma such as disrupted cuticulae could be demonstrated (10, 11, 17). Interestingly, systemic uptake of copper results in increased copper content, though not in a green discoloration (36).

Several remedies for this cosmetically disturbing, but otherwise harmless disease have been suggested. These include the use of hot vegetable oil (18), 3% hydrogen peroxide (18), penicillamine- (22) or EDTA- (21) containing shampoo, aqueous solution of 1, 5% 1-hydroxyethyl diphosphonic acid (31) or commercial decolorizers for overcolored hair (18).

We have recently seen a 25-year-old female patient in our outpatient department who complained of progressively green discoloration of her originally light blond scalp hair for the past 9 months. Eleven months earlier, she had moved to a recently remodelled home, where new copper warm water pipes had been installed. Whereas her husband, having dark brown hair, did not undergo a change of hair color, neighbors with light blond hair living in the same house complained of a greenish tint in their hair as well. Our patient had never had her hair colored artificially; it had, however, been permanently waved at regular intervals of about 4–5 months for several years.

On examination, the outer layers of the scalp hair had a distinct greenish tint at their distal end which was most prominent at the back of the head. The discoloration of hair adjacent to the skull was only faint. No further dermatological disorders could be found.

All laboratory parameters were normal, including serum-coeruloplasmin, serum copper and liver function tests.

Copper content of tap water and scalp hair was tested by atomic absorption spectrometry. After washing in a 1% aqueous Triton solution followed by acetone, the hair sample was allowed to dry and weighed. Thereafter it was dissolved by heating in 65% nitric acid in a teflon vial. The copper content of the patient's tap water revealed considerably elevated levels with 1.43 mg/l and a pH of 5.5. The outer layers of the scalp hair contained 164.2 µg/g copper, whereas the inner layers demonstrated 101.2 µg/g hair (normal values 10.0–70.0 µg/g) (37, 38) only.

The fact that overlying hair appeared distinctly more tinted than deeper hair and was shown to contain higher levels of copper may be explained by increased mechanical and solar

damage resulting in increased absorption of copper (12, 32, 35). Using commercial decolorizers for overcolored hair, normal status could be regained. Thus, our report demonstrates that exogenous copper still has to be taken into account in cases of hair discoloration.

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