Pigment disorders of the skin: causes and remedies

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No matter whether dark or light skin – our skin colour is genetically determined. However there are other factors too that influence the complexion such as UV radiation or cosmetics.

With the exception of albinism, pigment disorders show up with blotchy skin. Hyperpigmentations appear as darker spots on lighter skin; hypopigmentations occur as lighter spots on darker skin. Such alterations can be of temporary or permanent nature and have various origins. Temporary light spots, for instance, can be caused by unwanted impact of oxidizing household chemicals that contain hydrogen peroxide (e.g. mold removers) or through partial peelings and dermabrasion.
Reversible dark spots are caused by post-inflammatory hyperpigmentation (PIH) after inflammatory injuries. Laser- and IPL treatments with certain wave lengths can also stimulate the formation of melanin. Freckles appear as a seasonal phenomenon particularly on Celtic skin. Longer lasting dark spots on undressed skin areas are triggered by photosensitizations. Potential causes are, among others, oral hypericum preparations (alias St.John's wort, amber) (hypericin), adverse effects of pharmaceutical drugs, skin contact with cartwheel flowers (alias giant hogweed, giant cow parsley) or cow parsnip and others (grass dermatitis) but also photosensitizing components of essential oils.
Rather persistent are age spots consisting of oxidised protein-lipid-complexes (lipofuscin) or sugar-protein-agglomerates, also called advanced glycation end products (AGE). The Maillard reaction known from the brown colouration during baking and from self-tanning products is involved in AGE-formation. In this process carbohydrates react with amino acids and proteins and form melanoidins of various structure. Oxidative processes are also involved herein. Unlike the superficial tanning caused by self-tanning products, the age-induced deposits are deeply anchored in the cells and difficult to remove. Persistent lighter spots develop on scars if the scar tissue has no melanocytes. This also applies to stretch marks (striae) that first appear with a blue-reddish tint and later on turn into light spots. Fair spots also appear as symptoms of Pityriasis alba which is a post-inflammatory hypopigmentation showing areas with less melanin-content on the cheeks. In the case of Pityriasis versicolor the skin is infected with Malassezia yeast fungi and also develops fairer spots on darker surrounding skin; in the case of very fair surrounding skin, the infected areas seem lightly dark.

Vitiligo – a skin depigmentation

Rather eye-catching are the symptoms of vitiligo which is a rather frequent but painless skin disease. It appears as a skin depigmentation which starts with small white spots, and then gradually is involving larger areas of the skin. Hair can also be affected. Because of the deficiency of tyrosinase, the responsible enzyme for the formation of melanin, and a lack of melanocytes, the melanin formation during sun radiation cannot be stimulated. One of the frequently discussed causes is the disordered hydrogen peroxide balance of the skin. Hydrogen peroxide is an intermediary natural component of the body which is eliminated by the enzyme catalase. In case of a catalase deficiency or even a local lack of catalase, the hydrogen peroxide level increases and leads to an endogenous bleaching effect. There are various hypotheses on the triggering of this disease ranging from adverse effects of pharmaceutical drugs up to severe mental experiences.
Besides oxidants such as hydrogen peroxide that act upon already formed melanin, most of the antioxidants impede the formation of melanin by inhibiting the enzyme tyrosinase. Based on the amino acid tyrosine and an oxygen-consuming process it forms the pigments eumelanin (brown-black) and pheomelanin (yellow-reddish). One of the most effective substances to suppress pigmentation is the phosphoric acid ester of vitamin C (INCI: Ascorbyl Phosphate). In liposomal form it is effective even in very low dosage and by contrast to solutions of free ascorbic acid it is resistant to oxidation during storage. In the case that besides preventing a pigmentation also the existing pigmentation should be reduced, it

is recommended to take accompanying measures such as peelings, microdermabrasion or keratolytic active agents – e.g. salicylic acid, higher doses of vitamin C (fruit acid effects) and vitamin A (formation of regenerating retinoic acid). In the case that also erythema should be reduced, tranexamic acid is an effective active agent to inhibit melanin formation and stabilise the capillary blood vessels with its anti-fibrinolytic activity. Since vitamin B_3 (niacinamide) intervenes in the melanosomes transport of the skin, combinations of tranexamic acid and niacinamide are very effective.

The role of polyphenols

Polyphenols still are used as antioxidants and tyrosinase inhibitors. Belonging to this substance group are some synthetic but more often extract-based substances such as rucinol (resorcin derivative) catechins, flavones, isoflavones and gallates. After potential adverse effects of kojic acid have been discussed for years, it is again classified as safe for use today. Regarding arbutin however, a glucoside of hydroquinone and glucose, there are more concerns today due to the assumed release of hydroquinone which has been banned from cosmetic applications. Also glabridin (liquorice extract) is less used in skin-whitening preparations today. Many polyphenols become darker after oxidation, a fact that for instance can be observed with freshly brewed black tea. Dark coloration of black tea can be reversed by adding lemon juice as it contains vitamin C which is an antioxidant.

If it is persistent

As already mentioned above, photosensitizations and particularly age spots can be very persistent. Besides avoiding the triggers and taking preventive measures only the above-mentioned abrasive and keratolytic treatments and, where applicable, also medical-, chemical peelings or laser therapies are successful remedies. In this context, pre- and after-treatments with low-dosed liposomal vitamin C phosphate are recommended in order to exclude a treatment-related melanin formation. Since the skin is not protected after the treatment and reacts particularly sensitive to sun radiation, an effective light protection product should be applied. A high sun protection factor initially is required as everything depends on the quantum efficiency of the filters due to the absence of melanin. Just to state an example for comparison: SPF 10 converts 90 % of the UV-B radiation into heat, with SPF 30 it is still 96.7 % and 98 % with SPF 50. The prescribed protection against UV-A radiation has to be graduated accordingly.

In the case of hypopigmentations priority should also be given, if possible, to a causal treatment, as e.g. by treating the fungal skin infections. Vitiligo cases are more complicated, but there are also alternatives here:

- Peroxide-forming substances such as polyethylene glycols (PEG) including the antioxidants (tyrosinase inhibition!) for their protection are counterproductive – unless the still pigmented skin areas should be bleached to minimise the contrast to de-pigmented areas. In this case, all the above-mentioned antioxidants as well as abrasive and keratolytic treatments can be applied.
- To achieve, vice versa, a recovery and pigmentation of the white spots several medical approaches have been started – although it should be mentioned that so far the approaches have not been resoundingly successful. In this context it has been tried to imitate the missing catalase by a so-called pseudocatalase consisting of manganese salts in combination with UV radiation. The mechanism of action consists of intermediary developing manganese dioxide that breaks down surplus cutaneous hydrogen peroxide into oxygen and water. Own developments consist of transforming manganese dioxide into a nanoparticular skin-barrier-penetrating form in order to enable a convenient long-term treatment in the hope that melanocytes of the surrounding skin areas slowly migrate into the de-pigmented skin.
- The amino acids of the Natural Moisturizing Factor (NMF) form a natural non-selective protective barrier against exogenous radicals and thus have supportive effects.
- Beta-carotene preparations lead to a yellowish up to reddish colouring of the white areas. Deeply penetrated beta-carotene is metabolized into regenerative vitamin A and retinoic acid.

Minimising contrasts

Measures against diverse pigment disorders are focused on minimising the contrasts and consist of applying the following preparations:

- Self-tanning preparations, although they do not protect against UV-radiation. In the case of sun exposure longer than the natural self-protection time, an adequate sun screen has to be applied just as on the untreated skin. Potentially forming formaldehyde traces during the storage of DHA-containing self-tanners usually are below

the legal threshold. These traces can completely be avoided by adequate storage at a temperature of 5-20 °C.

- Camouflage that should be smear-resistant and waterproof. Since the application of camouflage involves occlusive conditions that are counterproductive for the regeneration of the skin, it should not be used constantly. Self-tanning products and camouflage can also be combined.

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