Achromotrichia due to hypocupremia in a dog

Achromotrichiose door hypocupremie bij een hond

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ABSTRACT

A five-year-old, intact, female, brown Labrador retriever was presented for loss of hair color (achromotrichia). Clinical and blood examinations revealed no significant abnormalities, except for a considerably reduced serum copper measurement. This has been described in dogs and cattle as achromotrichiosis due to hypocupremia. Interference of intestinal copper absorption due to an increased lead concentration in the drinking water was assumed to be the cause. The dog's haircoat became brown again after serving tap water as drinking water and adding a copper supplement.

SAMENVATTING

Een vijf jaar oude, intacte, vrouwelijke, bruine labrador retriever werd bij de dierenarts aangeboden wegens verlies van haarkleur (achromotrichia). Het klinisch onderzoek en bloedonderzoek leverden geen significante afwijkingen op, behalve dat serumkopermeting beduidend verlaagd was. Dit is beschreven bij runderen en honden als achromotrichiose door hypocupremie. De vermoedelijke oorzaak werd toegewezen aan een interferentie van de intestinale koperabsorptie met een verhoogde loodconcentratie in het drinkwater. Deze hypothese werd bevestigd door het opnieuw bruin kleuren van de vacht na vervanging van het drinkwater door leidingwater en kopersupplementatie.

INTRODUCTION

Copper deficiency occurs when the diet contains an abnormally low amount of copper (primary copper deficiency) or when copper absorption or metabolism is adversely affected by antagonistic or synergistic interactions (secondary copper deficiency) (Maas and Smith, 1990; Harraki et al., 1995; Goldhaber, 2003). If inadequate amounts of copper are available to tissues in the form of essential metalloenzymes, signs of copper deficiency (hypocupremia) may occur (Muller et al., 1989; Maas and Smith, 1990). Clinical signs in dogs include poor hair coat quality, abnormal color; deficient erythropoiesis and skeletal abnormalities (Zentek and Meyer, 1991; Quist-Rybachuk et al., 2012). In large animals, diarrhea, decreased weight gain, unthrifty appearance, anemia, changes in coat color (achromotrichia) or wool quality, spontaneous fractures, lameness, and demyelination have been reported (Maas and Smith, 1990). Secondary copper deficiency is associated with high dietary levels of molybdenum, sulfates, zinc, iron, or other divalent cations, resulting in limited intestinal copper absorption or competition for copper in biochemical mechanisms (Maas and Smith, 1990; Flora et al., 2012). This leads to nutritional deficiencies or toxicities from these environmental metals (Abdel-Mageed et al., 1990). For example, zinc absorption in the small intestine is decreased by calcium, phosphate and copper (Willis et al., 2005). On the other hand, excess of zinc ingestion and short-term exposure to lead have been described as causes of copper deficiency (Willis et al., 2005, Dobrakowski et al., 2017).

In the present case, hypocupremia is described likely due to an excess of lead in drinking water.

CASE REPORT

A five-year-old, intact, female, brown Labrador retriever, weighing 25kg and having a BCS of 6/9, was presented at the veterinarian for loss of hair color: i.e. the brown hair coat had become a beige hair coat (Figure 1). Clinical examination revealed no abnormalities, except achromotrichia. A complete blood count and general biochemical profile were analyzed at Medlab Bruyland. This panel was expanded with copper, iron and zinc because of achromotrichia. Hematologic examination revealed no abnormalities. Biochemistry analysis revealed low serum copper (39 µg/dL - ref. 95 - 125) and high albumin (45.4 g/L - ref. 28 - 38) levels. Serum levels of zinc and iron were within the reference ranges.

The dog had been fed a commercial diet (Royal Canin Labrador Retriever, adult) for years, according to the manufacture's recommended amount, without any problem. The dog had not been receiving any other food, medication and/or supplementation and its weight had been stable for several years. For the last six months, the dog had been drinking water originating from a lead-plumbed water reservoir. Since high iron intake and short-term exposure to lead can be a cause of hypocupremia, analysis for iron and lead concentrations in the drinking water were additionally performed. These analysis revealed an iron and lead concentration of <0.08 mg/L and 14 µg/L, respectively. The cut-off reference for lead in human drinking water is <10 µg/L (Roelof Demerie, personal communication).

As no other possible cause was detected, the excess of lead in the drinking water was assumed to be the main cause of hypocupremia. The dog's treatment included the replacement of the drinking water by tap water and, aiming to speed up the recovery of the serum copper level, an oral copper supplement was given (Biotics Cu-zyme, 20µg/kg of body weight; Biotics Research Corporation, Rosenberg, Texas, USA). Two months later, a significant improvement in the dog's hair color was noticed, slowly returning to its normal brown pigmentation.

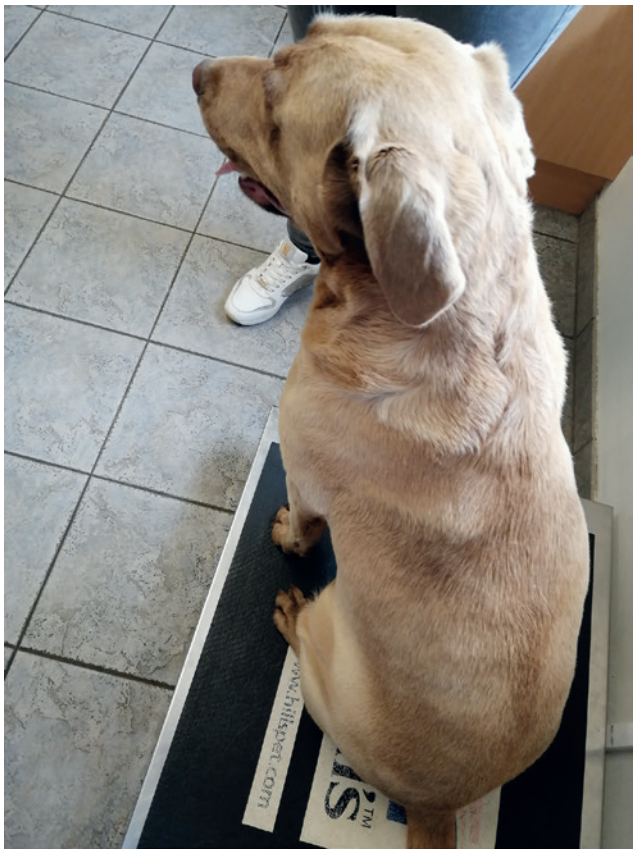

Figure 1. Photograph of the patient taken at the time of the diagnosis of hypocupremia. The achromotrichia can be noticed by the beige hair coat instead of its normal brown color.

DISCUSSION

Copper is necessary for enzymes that convert L-tyrosine to melanin and for the follicular cells in the conversion of prekeratin to keratin. Copper deficiency is manifested by hypopigmentation and faulty keratinization of the skin and hair follicles. The hair becomes dull and rough, with patchy alopecia and loss of normal hair color (Muller et al., 1989). This 'washed out' aspect of the coat was also present in the current case.

Over the years, copper deficiency in dogs has been reported in the literature. However, in none of these reports, the drinking water of the dogs had been evaluated. Inadequate dietary copper intake in times of high energy needs, results in deficient erythropoiesis, leukotrichia and skeletal abnormalities (Zentek and Meyer, 1991; Quist-Rybachuk et al., 2012). Yamaguchi (1996) showed that high serum levels of zinc reduce the hepatic copper in healthy adult Beagle dogs. In other reports, decreased serum copper levels have been described; however, it was not conclusive that copper deficiency was the cause of the clinical disease (Gumbrell, 1972; Hartley et al., 1963). Lethal acrodermatitis in bull terriers (Uchida et al., 1997) and chondrodysplasia in (dwarf) Alaskan malamutes (Brown et al.,1997) have been suggested as possible syndromes of genetic copper deficiency.

Naturally occurring copper deficiency has not been identified as a cause of disease in dogs. This probably relates to the monogastric digestive system of the dog and the ubiquitous distribution of copper in foodstuffs. Commercial pet foods are supposed to have adequate copper levels; therefore, supplementation of copper is generally not recommended (Muller et al., 1989). The dog in the present case received the same commercial pet food for several years without presenting any clinical abnormalities.

Lead is one of the ubiquitous pollutants, and exposure to it is a global concern. There is no known physiological value of lead, and there is no safe level

of exposure to this xenobiotic (Dobrakowski et al., 2017). Essential metals, like calcium, magnesium, iron, zinc, copper, and selenium, are coactivators of several important enzymes, including antioxidant enzymes, and proteins which are necessary for health maintenance (Flora et al., 2012). Therefore, their interactions with lead may affect various fundamental biological processes, including intra- and intercellular signaling, cell adhesion, protein folding and maturation, apoptosis, ionic transportation, enzyme regulation, and release of neurotransmitters (Flora et al., 2012). It has been shown that the level of plasma copper is significantly decreased after short-term exposure to lead (Dobrakowski et al., 2017). In the current case report, an excess of lead was present in the lead-plumbed water reservoir. Although the authors were not able to analyze the concentration of lead in the blood of the dog, the excess of lead in the drinking water was assumed to be the cause of the severely decreased copper level in the dog's serum. The hair coat color changed remarkably after replacing the drinking water by tap water and giving an additional oral copper supplement. However, it could not be stated that the improvement of the dog's hair color was only attributed to the change of the water source, since the dog simultaneously received copper supplementation. The dog remained on tap water and the copper supplementation was ceased once serum copper levels were within normal rates and the hair coat returned to its normal brown color.

In conclusion, it should be kept in mind that deficiency of a divalent cation may be caused by either a dietary deficiency, limited absorption, or adversely affected by antagonistic/synergistic interactions of other divalent cations. As the dog in this case report was an owner's dog and not a dog in a controlled research study, limitations in data acquisition and follow-up examinations were inevitable. However, despite its limitations, this case report offers valuable insights to veterinarians, who should not only check the diet of the patients, but also their source of water in case of achromotrichia.

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