Hyperthyroidism in dogs caused by consumption of thyroid-containing head meat

F. K. Zeugswetter[1], K. Vogelsinger[2], S. Handl[3]

[1]Clinical Department for Small Animals and Horses, University of Veterinary Medicine Vienna, Vienna,
[2]Praxis für Kleintiere, Gmünd, [3]Department for Farm Animals and Veterinary Public Health, University of Veterinary Medicine Vienna, Vienna, Austria

Summary

Two female spayed dogs belonging to the same owner were admitted for further examinations because of clinical signs and laboratory values compatible with hyperthyroidism. Sonography of the ventral aspect of the neck revealed small thyroid glands in both dogs. The hypothesis that the dogs suffered from alimentary hyperthyroidism caused by feeding head meat containing thyroid gland tissue was confirmed by consultation of the slaughtering plant, determination of iodine concentrations in deep-frozen samples and hormone measurements in 5 other dogs receiving head meat from the same supplier. After changing the diet, thyroxine concentrations declined and clinical signs were no longer observed.

Keywords: dog, hyperthyroxinemia, polydipsia, alimentary hyperthyroidism, head meat

Hyperthyreose bei Hunden verursacht durch die Aufnahme von schilddrüsenhaltigem Kopffleisch

Zwei weiblich kastrierte Hunde einer Besitzerin mit auf Hyperthyreose hindeutenden klinischen Symptomen und Laborbefunden wurden zur weiteren Abklärung überwiesen. In der sonographischen Untersuchung des ventralen Halses konnten bei beiden Hunden kleine Schilddrüsen dargestellt werden. Die Hypothese dass die Hunde an einem alimentären Hyperthyroidismus litten, der durch die Verfütterung von schilddrüsenhaltigem Kopffleisch ausgelöst wurde, konnte durch eine Kontaktaufnahme mit dem Fleischhauer, Jodmessungen in eingefrorenen Futterproben und durch Hormonbestimmungen bei 5 anderen Hunden die mit Kopffleisch vom gleichen Lieferanten gefüttert wurden, bestätigt werden. Nach einer Futterumstellung sanken die Schilddrüsenwerte und klinische Symptome konnten nicht mehr beobachtet werden.

Schlüsselwörter: Hund, Hyperthyroxinämie, Polydipsie, alimentäre Hyperthyreose, Kopffleisch

Introduction

Canine hyperthyroidism is exceptionally rare and typically results from thyroid carcinomas producing excessive amounts of thyroid hormones (Mooney and Jones, 2004). Sporadic cases associated with a functional adenoma have been reported (Lawrence et al., 1991; Itoh et al., 2007). Elevations of thyroid hormones are usually modest and clinical signs are mild (Meuten, 2002). Other published causes of elevated thyroxine concentrations (hyperthyroxinemia) in dogs include excessive levothyroxine treatment (Feldman and Nelson, 2004, Fine et al., 2010), discontinuation of the administration of substances blocking T_4 synthesis (Frank et al., 2005) and thyroid trauma (Rau et al., 2007). Spuriously elevated thyroxine concentrations are possible in case of anti-thyroxine antibodies interfering with specific immunological assays (Choi et al., 2006) and prolonged storage of serum at high temperatures (Behrend et al., 1998).

Recently Köhler et al. (2012) described a possible new cause of hyperthyroxinemia in 12 dogs in a retrospective study. Eight of these dogs were fed the "bones and raw food" (BARF) and 4 a commercial diet. In the latter, dried gullet was added to the feed on an almost daily basis. Six dogs showed clinical signs including weight loss, restlessness, aggressiveness, tachycardia and panting. As

150 Fallberichte/Case reports

clinical signs disappeared after changing the diet, the authors speculated that hyperthyroxinemia was most likely caused by the feeding of fresh or dried thyroid tissue from animal origin. The present case report describes alimentary hyperthyroidism in 2 dogs with polyuria and polydipsia as the leading symptoms, caused by the consumption of head meat containing thyroid gland tissue.

History

Two female spayed Rhodesian Ridgeback dogs with 11 and 13 years of age belonging to one of the authors were admitted to the Clinic for Companion Animal Medicine (University of Veterinary Medicine Vienna) because of clinical signs and laboratory values compatible with hyperthyroidism.

The dogs, living in the same house-hold, had a history of gradually worsening polydipsia, polyuria, excessive panting and restlessness. Appetite was good and weight loss had not been observed. Recently one of the dogs had collapsed during a walk, and despite intensive examinations including cardiac and abdominal ultrasonography, no underlying disease had been identified. Sinus tachycardia was the only abnormality detected.

Results of complete blood counts were unremarkable. Except for slightly elevated liver enzymes (alanine amino transferase: 168 U/l, norm. < 55 U/l; aspartate aminotransferase: 36 U/l, norm. < 25 U/l) in the younger dog, plasma biochemical parameters were within reference limits. Urine of both dogs was isosthenuric and contained no active sediment. The urinary protein to creatinine ratio, measured in the older dog, was 0.02 (norm. < 0.5). Hormone measurements, performed with a chemiluminescence immunoassay (Immulite, Siemens Medical Solutions, Flanders, U.S.A.), included thyroxine (193 nmol/l in both dogs, reference range 17 to 58 nmol/l, Fig. 1, dogs 1 and 2), free thyroxine (8.4 and 13.8 pmol/l; reference range 7.7–48 pmol/l) and thyroid stimulating hormone measurements ([TSH] 0.03 ng/ml in both dogs, reference range < 0.6 ng/ml).

Further anamnesis revealed that one year before, the owner had started with a homemade raw food diet including ~ 300–500 grams of ground head meat per day. Meat was stored in the deep freezer at − 20 °C. The dogs had no access to thyroid medication.

Ultrasonography

Sonographic examination of the ventral aspect of the neck revealed normal shaped thyroid glands with a total volume of 485 mm3 in the older and 235 mm3 in the
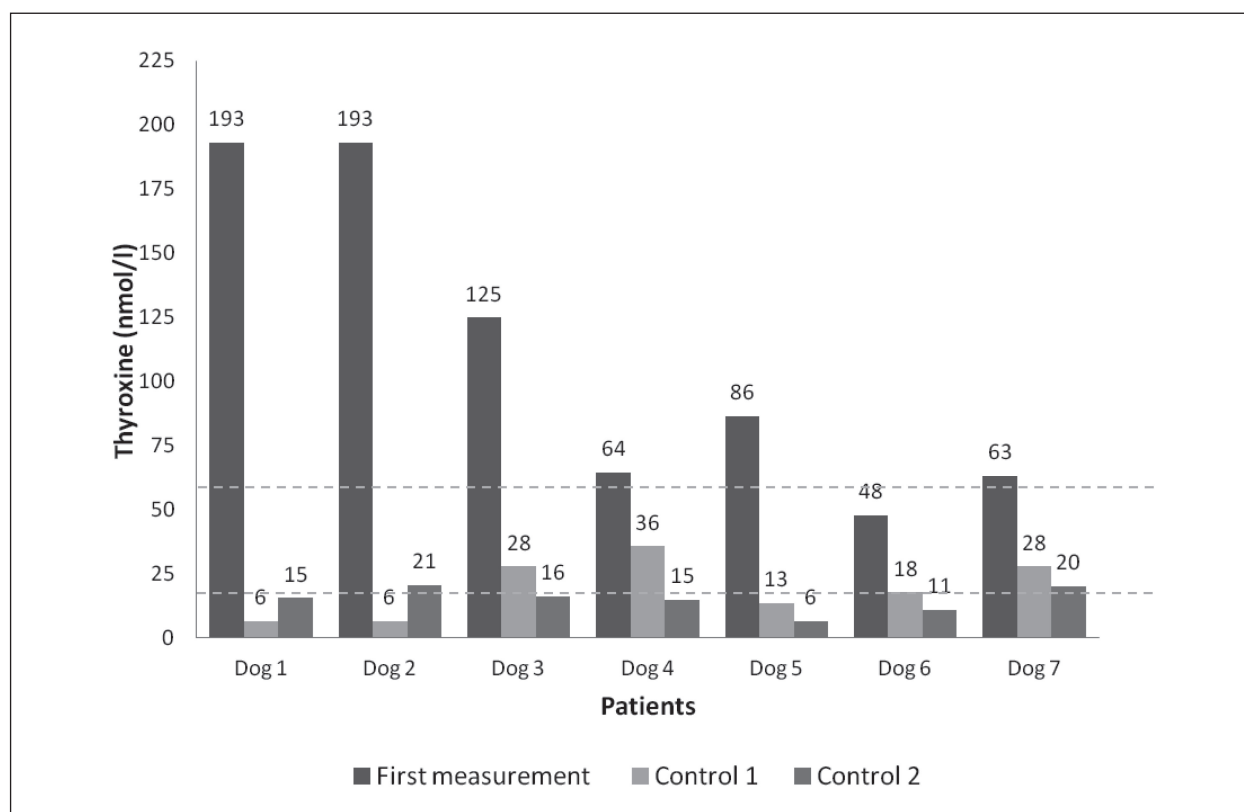
Figure 1: Total thyroxine concentrations in 7 dogs fed with thyroid-containing head meat. In dogs 1 and 2 the head meat was eliminated immediately after the first measurement, whereas a reduction to 50 % (control 1) and 30 % (control 2) of the original amount was fed in dogs 3 to 7. Dashed horizontal lines denote upper and lower reference limits. Data below the detection limit of the assay are given as 6 nmol/l.

younger dog (no breed specific references available, normal volume [mean ± SD] in Akitas: 987.4 ± 420.1mm³, Golden Retrievers: 947.6 ± 311.7; Brömel et al., 2006). The total thyroid volume was calculated by summation of volumes of the right and the left thyroid glands. Thyroid volume was determined with the formula π/6 x (length x height x width). A 1 x1 cm hypoechogenic round structure, was detected in the cranial part of the left thyroid gland caudal to the parathyroid gland in the older dog. The sonographic appearance of this cystic structure remained unchanged during the follow up of 4 months. Biopsy was not performed.

Laboratory analysis

Thyroglobulin-, triiodothyronine- and thyroxine autoantibodies, measured at the Institute of Immunology (Department of Pathobiology, University of Veterinary Medicine Vienna) using an enzyme immunoassay developed and validated for canine serum (Patzl and Möstl, 2003), were not detectable.

Frozen ground-beef samples were sent to the Austrian Agency for Health and Food Safety (Linz, Austria) for iodine determination. Iodine was measured using inductively coupled plasma mass spectrometry (ICP-MS) after alkaline extraction. The analysis revealed iodine concentrations (mean ± SD) of 9.43 ± 2.36 mg/kg (average iodine of muscle tissue ~ 0.02 – 0.15 mg/kg; Flachowsky et al., 2007). After selective removal of visible thyroid tissue during neck trimming, iodine concentrations dropped below the detection limit of 0.08 mg/kg. Thyroxine was additionally measured in 5 other dogs fed with head meat from the same supplier. This group consisted of 4 female Rhodesian Rhidgebacks [Fig.1 dogs 3 – 6] and one female Miniature Pinscher [Fig. 1 dog 7], ranging in age from 1 – 6 years. Four of these dogs also showed hyperthyroxinemia (Fig 1, dogs 3, 4, 5 and 7), but only 2 had shown mild clinical signs (restlessness and aggressiveness). TSH was below the detection limit of 0.03 ng/ml in all dogs.

Follow up

Hormone concentrations were monitored in all 7 dogs after eliminating (dogs 1 and 2) or reducing (dogs 3 – 7) the allotment of the specific head meat from the diet (Fig.1). Thyroxine and TSH values were determined on days 2 and 12 in dogs 1 and 2, and on days 6 and 19 in dogs 3 to 7. TSH concentrations stayed low throughout the observation period in all dogs.

Discussion

To the authors' knowledge, this is the second report of food induced hyperthyroidism in dogs. The first publica-

tion, a retrospective study from 2006 to 2011, appeared during the writing of this paper and described 12 dogs with hyperthyroxinemia most likely caused by feeding thyroid tissue from animal origin (Köhler et al., 2012). Thyroid hormones are orally active and feeding fresh thyroid glands was one of the first effective treatments of hypothyroidism in human patients (Mackenzie, 1892). Thus it is not surprising that the consumption of thyroid containing ground beef can cause hyperthyroxinemia. In fact, two large outbreaks of alimentary hyperthyroidism in the United States in 1984 and 1985 (Hedberg et al., 1987) resulted in the prohibition of gullet trimming by the United States Department of Agriculture. Since then sporadic cases from Canada (Parmar and Sturge, 2003) and the Netherlands (Hendriks and Looij, 2010) have been reported.

In contrast to the recent publication of Köhler et al. (2012) polyuria and polydipsia were the most conspicuous clinical signs in the dogs of this study and in combination with excessive panting and restlessness prompted the referring veterinarian to measure thyroid hormones. These signs are consistent clinical findings in dogs with functional thyroid tumors (Meuten, 2002) and are typically observed in dogs with levothyroxine intoxication (Feldman and Nelson, 2004). After receiving the laboratory results showing very high thyroxine concentrations in both dogs, the simultaneous occurrence of functional thyroid neoplasia was considered. Although the finding of small thyroid glands in a dog with hyperthyroxinemia, absence of detectable thyroxine antibodies and no access to thyroid medication would normally result in further examinations e.g. pertechnetate thyroid scan, the existence of ectopic thyroid tissue in two dogs of the same owner was considered very unlikely. A causative relationship with the feeding protocol was taken into consideration. The hypothesis that clinical signs were caused by "alimentary hyperthyroidism" was substantiated by the fact that the butcher had not removed the thyroid glands when harvesting meat from the neck (personal communication) and that the iodine concentrations in the ground head meat were very high. In fact daily iodine intake of the 2 dogs was at least 247 µg/kg$^{0.75}$ compared to the recommended allowance of 29.6 µg/kg$^{0.75}$ (kg$^{0.75}$ = metabolic body weight; National Research Council, 2006). Finally, 4 of 5 other dogs receiving the same feed had hyperthyroxinemia, and eliminating the ground beef from the diet normalized thyroid hormone concentrations in all dogs. Whether hyperthyroidism was caused by excessive iodine or thyroxine in the ground meat was not determined. Although healthy thyroids have regulatory mechanisms to keep thyroid hormones within physiological ranges even in the presence of iodine excess, iodine-induced hyperthyroidism is a well described phenomenon in humans with underlying thyroid diseases (Roti and Uberti, 2001). As histopathology was not performed in the dogs of this study preexisting thyroid pathology cannot be excluded. Nevertheless the simultaneous occurrence in 6 dogs im-

152 Fallberichte/Case reports

plicates that hyperthyroidism was caused by the ingestion of authentic thyroxine. It has to be determined whether alimentary hyperthyroidism is exclusively caused by the consumption of "raw" thyroid gland tissue. This seems unlikely as thyroxine is not destroyed by cooking and outbreaks of thyrotoxicosis in humans were caused by the consumption of fried ground beef (Hedberg et al., 1987). Possible causes of collapse, as reported in one of the dogs include cardiovascular manifestations of hyperthyroidism (Fine et al., 2010) and thyrotoxic hypokalemic paralysis (Kung, 2006).

Conclusion

The work-up of dogs with elevated thyroxine concentrations should include a thorough investigation of feeding habits, as hyperthyroidism with or without clinical signs can be caused by the consumption of thyroid-containing head meat.

References

Behrend E. N., Kemppainen R. J., Young D. W.: Effect of storage conditions on cortisol, total thyroxine and free thyroxine concentrations in serum and plasma of dogs. J. Am. Vet. Med. Assoc. 1998, 212: 1564–1568.

Brömel C., Pollard R. E., Kass P. H., Samii V. F., Davidson A. P., Nelson R. W.: Comparison of ultrasonographic characteristics of the thyroid gland in healthy in healthy small-, medium-, and large-breed dogs. Am. J. Vet. Res. 2006, 67: 70–77.

Choi E. W., Shin I. S., Bhang D. H., Lee D. H., Bae B. K., Kang M. S., Kim D. Y., Hwang C. Y., Lee C. W., Youn H. Y.: Hormonal changes and cytokine mRNA expression in peripheral blood mononuclear cells during the development of canine autoimmune thyroiditis. Clin. Exp. Immunol. 2006, 146: 101–108.

Feldman E. C., Nelson R. W.: Hypothyroidism. In: Canine and Feline Endocrinology and Reproduction, Saunders, St.Louis, 2004, 86–151.

Fine D. M., Tobias A. H., Bonagura J. D.: Cardiovascular manifestations of iatrogenic hyperthyroidism in two dogs. J. Vet. Cardiol. 2010, 12: 141–146.

Flachovsky G., Berk A., Meyer U., Schoene F.: Iodine transfer from feed into meat and other food of animal origin (article in German) Fleischwirtsch. 7, 2007: 83–87.

Frank L. A., Hnilica K. A., May E. R., Sargent S. J., Davis J. A.: Effects of sulfamethoxazole-trimethoprim on thyroid function in dogs. Am. J. Vet. Res. 2005, 66: 256–259.

Hedberg C. W., Fishbein D. B., Janssen R. S., Meyers B., McMillen J. M., MacDonald, K. L. White K. E., Huss L. J., Hurwitz E. S., Farhie J. R., Simmons J. L., Braverman L. E., Ingbar S. H., Schonberger L. B., Osterholm M. T.: An outbreak of thyrotoxicosis caused by the consumption of bovine thyroid gland in ground beef. N. Engl. J. Med. 1987, 316: 993–998.

Hendriks L. E. L., Looij B. J.: Hyperthyroidism caused by excessive consumption of sausages. Neth. J. Med. 2010, 68: 135–137.

Itoh T., Kojimoto A., Nibe K., Uchida K., Shii H.: Functional thyroid gland adenoma in a dog treated with surgical excision alone. J. Vet. Med. Sci. 2007, 69: 61–63.

Köhler B., Stengel C., Neiger R.: Dietary hyperthyroidism in dogs. J. Small Anim. Pract. 2012, 53: 182–184.

Kung A. W. C.: Clinical review: thyrotoxic periodic paralysis: a diagnostic challenge. J. Clin. Endocrinol. Metab. 2002, 91: 2490–2495.

Lawrence D., Thompson J., Layton A. W., Calderwood-Mays M., Ellison G., ManellaC.: Hyperthyroidism associated with a thyroid adenoma in a dog. J. Am. Vet. Med. Assoc. 1991, 199: 81–83.

Macckenzie H. W. G.: A case of myxoedema treated with great benefit by feeding fresh thyroid glands . Brit. Med. J. 1892, 2: 940–941.

Meuten D. J.: Tumors, hyperplasia, and cysts of thyroid follicular cells. In: Tumors of Domestic Animals. 4th edn. Iowa State Press, Ames, 2002, 638–657.

Mooney C. T., Jones B. R.: Unusual thyroid disorders. In: BSAVA Manual of Canine and Feline Endocrinology. 3rd edn. Eds. C.T. Mooney and M.E. Peterson. BSAVA, Gloucester, 2004, 193–199.

National Research Council (NRC): Nutrient requirements of dogs and cats. National Academies Press, Washington, 2006.
Parmar M.S., Sturge C.: Recurrent hamburger thyrotoxicosis. Can. Med. Assoc. J. 2003, 169: 415–417.

Patzl M., Möstl E.: Determination of autoantibodies to thyroglobulin, thyroxine and triiodothyronine in canine serum. J. Vet. Med. A. 2003, 50: 72–78.

Rau S., Reese S., Brühschwein A., Dorsch R., Neuerer F.: Schilddrüsenwerterhöhung bei einem Hund infolge eines Dachsbisses. Tierärztl. Prax. 2007, 35: 345–350.

Roti E., Uberti E.: Iodine excess and hyperthyroidism. Thyroid 2001, 11: 493–500.

Corresponding author

Dr. med. vet. Florian K. Zeugswetter
Clinical Department for Small Animals and Horses
University of Veterinary Medicine Vienna
Veterinärplatz 1
1210 Vienna
Austria
Tel.: +43 (0)1/25077/5137
Fax: +43 (0)1/25077/5190
Florian.Zeugswetter@vetmeduni.ac.at