Detailed Information About Thyroid Hormones

1. Definition T4, fT4, T3, TSH

T4, fT4 (free T4) und T3 are hormones produced in the thyroid gland with **TSH** as activator of the production.
Thyroid hormones contain four iodine molecules after their complete synthesis (**T4**). In the thyroid gland as well as in tissues one iodine molecule is separated which produces **T3**. Within the blood stream thyroid hormones are coupled to transport proteins. There is a small fraction of T4 which is not coupled to transport proteins but is free (**fT4**).

2. Which conditions lead to changes in thyroid hormone concentrations?

Concentrations of thyroid hormones (T4, fT4, T3) can either be

- increased (*Hyperthyroidism, Hyper* = too much, *thyreos* = „thyroid gland“),
- decreased (*Hypothyroidism, hypo* = too little) or
- within normal limits (*euthyroid*).

Dog:

In **dogs hypothyroidism** is often present (diminished thyroid function). Patients gain weight, are lethargic/ sleepy and may show dermal problems. Main reason for hypothyroidism is diminished production of thyroid hormones due to inflammation of the thyroid gland. Important differential diagnoses for diminished thyroid hormone concentrations are **non-thyroidal illnesses**. These can be endocrinologic diseases like Diabetes („sugar disease“), hyperadrenocorticism/ Cushing’s disease (too many glucocorticoids within the blood) or renal-, liver- disease or other pronounced, severe illnesses and infections. Drugs may also lead to lower concentrations of thyroid hormones.

If the thyroid gland is diseased and the body senses lower thyroid hormone concentrations, TSH is released. TSH subsequently increases production of thyroid hormones. As dogs with **hypothyroidism** have a diseased thyroid, the gland is however unable to increase their hormone production. In the laboratory analysis the typical picture of an **increased TSH** concentration as well as a **lower T4, fT4 (T3)** concentrations.

Cats:

Cats may suffer from **hyperthyroidism**. Affected cats are mostly 12-13 years old, show weight loss, polyphagia (increased appetite and food consumption), as well as increased physical activity. Reason is an increased production of thyroid hormones from thyroid gland.

3. When do you examine which parameter?

3.1. Analysis of T4

If hypothyroidism in a dog is suspected first step is evaluation of **T4** concentration. Reference laboratories evaluate T4 using i.e. a radioimmunoassay (RIA).

a) T4-concentration normal:

If T4-concentration is within normal limits, probability is high that the patient does not have hypothyroidism.

In 2-10% of cases with thyroid inflammation production of autoantibodies against T4 may occur. In case of RIA analyses these may lead to falsely high T4 concentrations. Patient display T4 values within normal limits although they are hypothyroid. If T4 concentration of the patient is normal but the vet still has the strong suspicion of hypothyroidism a confirmatory test is needed.

There are two possibilities:

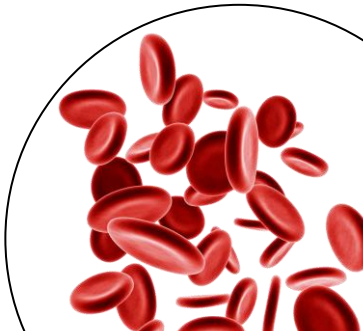
- Evaluation of **TSH**: in case of hypothyroidism TSH concentration should be increased
- Detection of **fT4**: fT4 is analysed via equilibrium dialysis. Thereby fT4 passes a fine membrane and is then detected. Autoantibodies against T4 are captured at the membrane and thereby cannot interfere with the analysis, making fT4 analysis a good confirmatory test. Patients with hypothyroidism have low fT4 concentrations.

b) T4-concentration low:

In case of diminished T4-concentration the patient may have hypothyroidism or non-thyroidal illness. Drugs (especially glucocorticoids/ cortison) may also influence T4 production and may lead to lower T4 concentration.

Non-thyroidal illnesses should be treated. In case of amelioration of disease T4 shall be reanalysed. Drugs which may influence T4 concentration have to be discontinued prior to analysis. Detection of T4 can then be done 1-2 weeks later.

A confirmatory test (TSH or fT4) or a therapeutical trial may be performed to assure that the patient really suffers from hypothyroidism.



c) T4-concentration high:

The patient is hyperthyroid. This is a very rare event in dogs but is often noticed in cats. Cats with increased T4 concentrations have hyperthyroidism.

As thyroid hormone concentration in case of hyperthyroidism is increased, concentration of TSH is within or even below normal limits in the blood. In cats TSH analysis is of no further value and species specific tests seldom available.

3.2. Detection of TSH

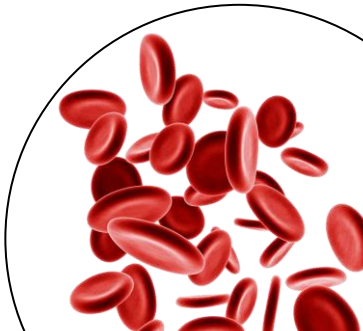
TSH serves as a confirmatory test in case of hypothyroidism in dogs with a low/ low normal T4 concentration. Hypothyroid dogs often show an increased TSH concentration.

3.3. Detection of fT4

Free T4 is also used as confirmatory test in the event of normal T4 concentration but strong clinical suspicion of hypothyroidism. If antithyroid antibodies would have interfered with T4 analysis, fT4 should give the exact result.

3.4. Detection of T3

T3 analysis does not show an advantage over detection of T4 or fT4. Therefore, T4 is normally evaluated instead of T3.



4. Further laboratory changes

Hypothyroidism dog

- Mild anemia (hematocrit, RBC, hemoglobin slightly low)
- Anemia non regenerative = no reticulocytes
- Increased cholesterol (fasted patient)
- Increased triglycerides (fasted patient)
- Mildly increased liver enzymes: ALP, ALT
- Mildly increased creatine kinase (CK)

Hyperthyroidism cat:

- Increased renal parameter (urea, creatinine)
- Increased liver enzymes: ALP, ALT
- Possibly mildly increased hematocrit, RBC number, MCV
- „Stress-Leucogram“:
    - Neutrophils increased
    - Lymphocytes increased
    - Eosinophils decreased
    - Monocytes increased
- Mildly increased glucose

5. Summary

- T4 ↓ in dogs with decreased thyroid function/ hypothyroidism
- T4 ↓ in pronounced non-thyroidal illnesses or after cortisone administration
- T4 ↑ in cats with increased thyroid function/ hyperthyroidism
- T4 ↑ in dogs → extremely rare
- TSH and fT4 as confirmatory test in dogs with hypothyroidism
- T3 no advantage over T4, is not measured

References:

Stockham & Scott, Fundamentals of Veterinary Clinical Pathology. 2008, 2nd ed., Blackwell Publishing

Ettinger & Feldman, Textbook of Veterinary Internal Medicine. 2005, 6th ed., Elsevier Saunders