Joyce Niblack Memorial Conference

Review of thyroid function

Susan J. Leclair, Ph.D., CLS(NCA)
Chancellor Professor Emerita
University of Massachusetts

Introduction

If it helps, thyroid function and testing is hard for everyone – clinical scientists, physicians, researchers, etc. So don't feel left out.

MPN EDUCATION FOUNDATION

What does the thyroid do and is it important?

Short answers: a lot and oh my, yes.

- T3 and T4 control the basal metabolic rate (energy).
  - Control of Body temperature
  - Pulse rate, cardiac output and other cardiac functions
  - Glucose metabolism, fat metabolism, protein degradation in tissues such as muscles and
  - Brain function (alertness, forgetfulness, balance, decision making, levels of concentration, etc.)
  - Growth in children; change in bone density in adults
  - and more

MPN EDUCATION FOUNDATION

How does it do this

It makes and stores to be released on demand three major compounds

- Triiodothyronine T3
- Tetraiodothyronine thyroxine or T4
- Calcitonin (not going to mention again)

MPN EDUCATION FOUNDATION

How

The thyroid hormones use iodine in their synthesis. This is the only place of important iodine concentration.

Iodine is found in

fish (such as cod and tuna),
shrimp and other seafood,
Dairy products (milk, eggs, etc.)
Bread made with iodized salt
seaweed,
enriched pasta
beef
iodized salt

Absorbed in the GI tract and stored in the thyroid

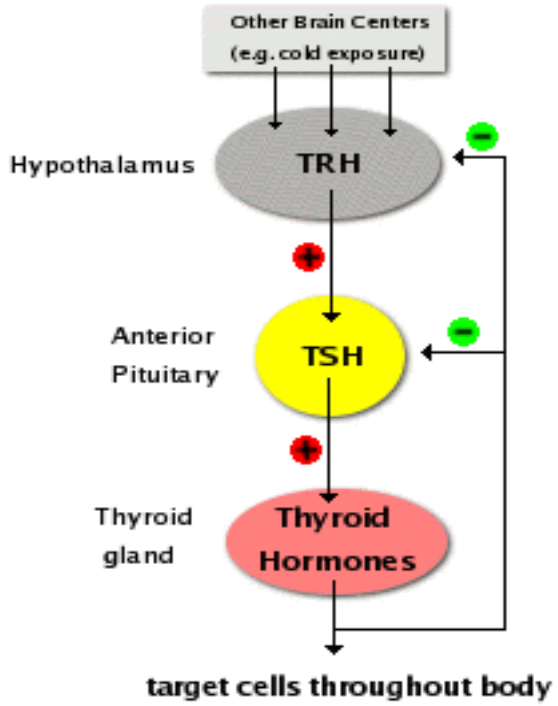
MPN EDUCATION FOUNDATION

Step 3

- A complicated feedback loop
- The brain make a hormone called thyrotropin releasing factor (TRH) This stimulates the pituitary gland.
- The pituitary gland them makes the thyroid stimulating hormone (TSH). This tells the thyroid to make and release T3 and T4.

MPN EDUCATION FOUNDATION

Thyroid function



TRH – made in the brain in response to nerve signals (think cold/hot temperatures).

Stimulates

TSH – made in the pituitary gland

stimulates

T_3 and T_4 – made in the thyroid

MPN EDUCATION FOUNDATION

TRH versus TSH versus T_3 and T_4

TRH responds to both the internal (ex., fever, dieting, emotional stress, inflammation, etc.) and external (temperature, stress, change in lifestyle) environments

TSH stimulates the production of T_3 and T_4 until the need is met and then shut off.

If the need is not met (because the thyroid is not responding for some reason), then there is an increase in TSH.

MPN EDUCATION FOUNDATION

Testing for most common situations

- TRH testing is usually not done.
  - Too low a concentration
  - Too difficult to interpret due to external issues
- TSH testing is most often done
  - Direct relationship with thyroid control
  - Can be used in diagnosis ad in monitoring therapy
- T4 and T3 testing (comes in two forms free and bound)
  - Are most important in diagnosis
  - But, by themselves, cannot discern if the problem resides in the thyroid or in the pituitary (lack of TSH production)

MPN EDUCATION FOUNDATION

Testing for most common situations

- Typical
  - ↑TSH causes ↑T_3 and T_4
  - ↓TSH causes ↓T_3 and ↓T_4
- Hyperthyroid
  - ↓TSH no TSH control ↑T_3 and T_4
- Hypothyroid
  - ↑TSH no response ↓T_3 and ↓T_4

MPN EDUCATION FOUNDATION

Are there other weird situations?

Sure

Pituitary disease (source of TSH) can suppress TSH so it looks as if the thyroid is not working when it is simply not being stimulated.

↓TSH causes ↓T_3 and ↓T_4

Medication such as some dopamine stimulating agents or cranial radiation can suppress TRH. Since we don't test for this, this determination requires a physician to interpret

↓TRH causes ↓TSH causes ↓T_3 and ↓T_4

MPN EDUCATION FOUNDATION

Are there other weird situations?

Sure

- Hormones
  - Need a binding protein to store the compound
  - Need another binding protein to carry the hormone to the designated sites of action.
  - Need correctly constructed binding sites on the target cells

  - If any of these do not work correctly, then there are can too much or too little hormone action at the cell level.
  - If there is a binding protein problem, can test for free T_3 & T_4

And this list can go on.

MPN EDUCATION FOUNDATION

Are there other weird situations?

Most hormones need storage and carrier proteins.

- The major protein that stores the inactive T3 and the more active T4 is called thyroxin-binding globulin
  - Globulins are antigenic so it is possible to to develop antibodies to the globulin. Hormones are made but not active since they are bound to damaged TBG. This results is a deficiency of T3 and T4 and causes an increase in TSH.
    - Can look a lot like hypothyroidism but isn't.
      Indeed the thyroid can be overworked if severe.
  - TBG can be increased in liver disease and pregnancy.
    - Can look a lot like hyperthyroidism

MPN EDUCATION FOUNDATION

Are there other weird situations?

Most hormones need enzymes to be store and liberated on need. Interference with these enzymes can cause problems.

- Thyroid peroxidase antibodies
  - Hashimoto's Disease - This is an autoimmune disease and the most common cause of hypothyroidism.
  - Grave's Disease - This is also an autoimmune disease and the most common cause of hyperthyroidism.

MPN EDUCATION FOUNDATION

The list is very long

Most physicians will check the TSH on patient who have other conditions since the relationship between disease-states and the ability of the TRH, TSH, T3 and T4 to function correctly is very sensitive.

MPN EDUCATION FOUNDATION

The list is very long

As people age, the relationship between the pituitary and thyroid gland can become compromised so as one ages, it is possible to have a hypothyroid condition which will enhance or mask a lot of signs and symptoms seen in other conditions, causing delays in diagnosis and treatment.

MPN EDUCATION FOUNDATION