Goiter in children

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GOITER IN CHILDREN (THYROMEGALY)
Outline

- Definition of Goiter in children and adolescents
- Pathophysiology of Goiter
- Approach to diagnosis
- Management
Definition of goiter

Enlargement of the lobes greater than the terminal phalanx of the patient’s thumb

WHO Classification/Grading:

0: No goiter
1a: Palpable lobe
1b: Noticeable gland on neck hyperextension
2: Gland noticeable with neck in normal position
3: Visible gland at a distance of 10 m
Clinical vs ultrasonographic definition

- Thyroid volume (formula of a rotation ellipsoid model): width x length x thickness x 0.52 for each lobe
Thyroid volume measurement by ultrasound in children as a tool for the assessment of mild iodine deficiency

P Vitti, E Martino, F Aghini-Lombardi, T Rago, L Antonangeli, D Maccherini, P Nanni, A Loviselli, A Balestrieri and G Araneo

1) thyroid volume in children, as assessed by ultrasound, increases with age
2) in every age group, thyroid ultrasound shows greater thyroid volume in an IDA group than in controls
3) a discrepancy between palpation and ultrasound is found in 23.9% of children living in an IDA

palpation is relatively inaccurate for assessing the prevalence of goiter in mild iodine deficiency
indicate that thyroid volume measurement by ultrasound in children provides a useful tool for the assessment of goiter in mild iodine deficiency.
<table>
<thead>
<tr>
<th>Age, years</th>
<th>Volume (mL), mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>3.1 ± 1.3</td>
</tr>
<tr>
<td>8</td>
<td>3.3 ± 1.2</td>
</tr>
<tr>
<td>9</td>
<td>3.6 ± 1.3</td>
</tr>
<tr>
<td>10</td>
<td>4.0 ± 1.5</td>
</tr>
<tr>
<td>11</td>
<td>4.9 ± 1.5</td>
</tr>
<tr>
<td>12</td>
<td>5.3 ± 1.4</td>
</tr>
<tr>
<td>13</td>
<td>6.1 ± 1.6</td>
</tr>
<tr>
<td>14</td>
<td>6.3 ± 1.5</td>
</tr>
</tbody>
</table>

- Thyroid volume in Italian children without iodine deficiency, as measured by ultrasound. Aghini-Lombardi, F, Antonangeli, L, Pinchera, A, et al, Clin Endocrinol Metab 1997; 82:1136
Pathophysiology of Goiter in children
Stimulatory Mechanism

- thyrotropin (TSH) secretion resulting from hypothyroidism
- antibodies that activate TSH receptors (Graves' disease)
Inflammatory Mechanism

- Infectious (Suppurative thyroiditis)
Inflammatory Mechanism

- Infectious
- Non-infectious
Infiltrative Mechanism

- Malignancies
- Histiocytosis
- Tuberculosis
Thyroid Hormone Biosynthesis
Causes of Diffuse thyromegaly in children

- Thyroiditis
- Environmental Goitrogens
- Iodine Deficiency
  Food & drinking water (Brassica vegetables, cassava)
- Medications (thionamides, lithium)
- Familial Goiter (dyshormogenesis, Pendred syndrome)
Causes of Nodular goiter in children

- Hypofunctioning thyroid nodules
  - Benign Adenoma
  - Thyroid Cancer
  - Metastatic nodule
- Hyperfunctioning thyroid nodules
- Suppurative thyroiditis
<table>
<thead>
<tr>
<th>Median Urinary Iodine Concentration (mcg/L)</th>
<th>Corresponding Approximate Iodine Intake (mcg/day)</th>
<th>Iodine Nutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>&lt;30</td>
<td>Severe deficiency</td>
</tr>
<tr>
<td>20-49</td>
<td>30-74</td>
<td>Moderate deficiency</td>
</tr>
<tr>
<td>50-99</td>
<td>75-149</td>
<td>Mild deficiency</td>
</tr>
<tr>
<td>100-199</td>
<td>150-299</td>
<td>Optimal</td>
</tr>
<tr>
<td>200-299</td>
<td>300-449</td>
<td>More than adequate</td>
</tr>
<tr>
<td>&gt;299</td>
<td>&gt;449</td>
<td>Possible excess</td>
</tr>
</tbody>
</table>
Republic Act 8172, "An Act Promoting Salt Iodization Nationwide (ASIN) and for Related Purposes", also referred to as ASIN Law is in its 6th year of implementation. The law requires all food grade salt, i.e. salt for human and animal consumption, to be iodized. It also mandates all salt producers and traders to make iodized salt available to all Filipinos.

Republic Act 8172 was signed into law on 20 December 1995 and took effect on 20 January 1996.
Recommended Daily Iodine Intake

- 150 micrograms for men
- 120 micrograms for women
- (150 micrograms during pregnancy, 170 micrograms during lactation)
- Children 70-120 micrograms
- Infants 50-60 micrograms
## IODINE CONTENT OF SOME FOODS

<table>
<thead>
<tr>
<th>FOOD</th>
<th>IODINE CONTENT (micrograms per 100 grams of food)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt (iodized)</td>
<td>3000</td>
</tr>
<tr>
<td>Seafood</td>
<td>66</td>
</tr>
<tr>
<td>Vegetables</td>
<td>32</td>
</tr>
<tr>
<td>Meat</td>
<td>26</td>
</tr>
<tr>
<td>Eggs</td>
<td>26</td>
</tr>
<tr>
<td>Dairy products</td>
<td>13</td>
</tr>
<tr>
<td>Bread and cereals</td>
<td>10</td>
</tr>
<tr>
<td>Fruits</td>
<td>4</td>
</tr>
</tbody>
</table>
One teaspoon of iodised salt provides 150 micrograms of iodine

1 serve (100g) of seafood provides about 60 micrograms

100g of vegetables or meat or eggs provides about 25 micrograms of iodine

100g of dairy products or bread/cereals provides about 10 micrograms.
<table>
<thead>
<tr>
<th>Foods</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava, lima beans, linseed, sorghum, sweet potato</td>
<td>Contain cyanogenic glucosides; they are metabolised to thiocyanates that compete with iodine for thyroidal uptake(^{13})</td>
<td></td>
</tr>
<tr>
<td>Cruciferous vegetables such as cabbage, kale, caulifower, broccoli, turnips, rapeseed</td>
<td>Contain glucosinolates; metabolites compete with iodine for thyroidal uptake(^{13})</td>
<td></td>
</tr>
<tr>
<td>Soy, millet</td>
<td>Flavonoids impair thyroid peroxidase activity(^{14,15})</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industrial pollutants</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Perchlorate</td>
<td>Competitive inhibitor of the sodium/iodine symporter, decreasing iodine transport into the thyroid(^{16})</td>
<td></td>
</tr>
<tr>
<td>Others (e.g. disulphides from coal processes)</td>
<td>Reduce thyroidal iodine uptake(^{3})</td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td>An important goitrogen; smoking during breastfeeding is associated with reduced iodine concentrations in breastmilk; high serum concentration of thiocyanate due to smoking might compete with iodine for active transport into the secretory epithelium of the lactating breast(^{17})</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nutrients</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Selenium deficiency</td>
<td>Accumulated peroxides might damage the thyroid, and deiodinase deficiency impairs thyroid hormone synthesis(^{12,18})</td>
<td></td>
</tr>
<tr>
<td>Iron deficiency</td>
<td>Reduces haeme-dependent thyroperoxidase activity in the thyroid and might blunt the efficacy of iodine prophylaxis(^{19,20})</td>
<td></td>
</tr>
<tr>
<td>Vitamin A deficiency</td>
<td>Increases TSH stimulation and goitre through decreased vitamin A-mediated suppression of the pituitary TSH(\beta) gene(^{21})</td>
<td></td>
</tr>
</tbody>
</table>

SH= thyroid-stimulating hormone.

**Table 1: Goitrogens and their mechanism**
Approach to Thyromegaly

DETERMINE FUNCTIONAL/PHYSIOLOGIC STATUS

GOITER

- EUTHYROID
- HYPERTHYROID
- HYPOTHYROID

HISTORY

PE
<table>
<thead>
<tr>
<th>Deficiency state</th>
<th>Action of thyroid hormone</th>
<th>Excess hormone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothermia Cold Intolerance</td>
<td>INCREASE OXIDATIVE METABOLISM</td>
<td>Hyperthermia Heat Intolerance</td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td>Increase glucose metabolism</td>
<td>Hyperglycemia</td>
</tr>
<tr>
<td>Obesity</td>
<td>Increase fat metabolism</td>
<td>Wasting</td>
</tr>
<tr>
<td>Deficiency state</td>
<td>Action of thyroid hormone</td>
<td>Excess hormone</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>------------------------------------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>Short Stature</td>
<td>Promote growth and development</td>
<td>Normal stature</td>
</tr>
<tr>
<td>Mental retardation</td>
<td>Influence nervous system development And function</td>
<td>Deterioration of school performance – short attention span</td>
</tr>
<tr>
<td>Deterioration of school performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental sluggishness</td>
<td>Influence mental activity in older children and adults</td>
<td>Restlessness and anxiety</td>
</tr>
<tr>
<td>Deficiency state</td>
<td>Action of thyroid hormone</td>
<td>Excess hormone</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>bradycardia</td>
<td>Augment Cardiac Function – Increase HR, cardiac contractility and CO</td>
<td>Tachycardia palpitations</td>
</tr>
<tr>
<td>Delayed puberty</td>
<td>Allow normal reproductive function</td>
<td></td>
</tr>
<tr>
<td>infertility</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Features of Hypothyroidism

- Growth failure
- Lethargy
- Constipation
- Deterioration of school performance
- Obesity
- Dry, puffy skin
- Bradycardia
- Delayed or precocious puberty
Features of Hyperthyroidism

- Hyperphagia without weight gain
- Excessive sweating
- Increased BM
- Deterioration of school performance

- Hypertension
- Tachycardia
- Widened pulse pressure
- Warm, moist hands
- Tremors
- Exophthalmos
### Incidence (Percentage) of Common Signs and Symptoms in Thyrotoxic Patients and Controls (De Groot, 2003)

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Toxic</th>
<th>Control</th>
<th>Symptom</th>
<th>Toxic</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyspnea</td>
<td></td>
<td></td>
<td>Goiter</td>
<td>87</td>
<td>11</td>
</tr>
<tr>
<td>Tiredness</td>
<td>80</td>
<td>31</td>
<td>Diffuse</td>
<td>49</td>
<td>11</td>
</tr>
<tr>
<td>Preference for cold</td>
<td>73</td>
<td>41</td>
<td>Nodular</td>
<td>32</td>
<td>0</td>
</tr>
<tr>
<td>Excess sweating</td>
<td>68</td>
<td>31</td>
<td>Single adenoma</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Nervousness</td>
<td>59</td>
<td>21</td>
<td>Lid lag</td>
<td>62</td>
<td>16</td>
</tr>
<tr>
<td>Increased appetite</td>
<td>32</td>
<td>2</td>
<td>Hyperkinesis</td>
<td>39</td>
<td>9</td>
</tr>
<tr>
<td>Decreased appetite</td>
<td>13</td>
<td>3</td>
<td>Finger tremor</td>
<td>66</td>
<td>26</td>
</tr>
<tr>
<td>Weight loss</td>
<td>52</td>
<td>2</td>
<td>Sweating hands</td>
<td>72</td>
<td>22</td>
</tr>
<tr>
<td>Weight gain</td>
<td>4</td>
<td>16</td>
<td>Hot hands</td>
<td>76</td>
<td>44</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>8</td>
<td>0</td>
<td>Atrial fibrillation</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>Constipation</td>
<td>15</td>
<td>21</td>
<td>Pulse over 90</td>
<td>68</td>
<td>19</td>
</tr>
<tr>
<td>Excess menses</td>
<td>3</td>
<td>6</td>
<td>Average pulse in beats/min</td>
<td>100</td>
<td>78</td>
</tr>
</tbody>
</table>
Examination of Thyroid Gland

- Goiter
  - Diffuse
  - Nodular
GOITER

1. Diffuse Non-toxic Goiter
2. Diffuse Toxic Goiter
3. Nodular Non-Toxic Goiter
4. Nodular Toxic Goiter
Diagnostic Tests In Children with Goiter

- Depends on:
  1. Functional state of patient
  2. Anatomical character of thyroid gland
  3. Presence of symptoms suggestive of another disorder
DIAGNOSTIC TESTS for Diffuse GOITER

- Asymptomatic/ Hypothyroid
  - Serum T4, TSH
  - Thyroid antibodies
  - Thyroid Ultrasound

- Hyperthyroid features
  - Serum T3, T4, TSH
  - Thyroid antibodies
  - Thyroid Ultrasound
  - Thyroid Scan
DIAGNOSTIC TESTS for Nodular GOITER

- Asymptomatic/Hypothyroid
  - Serum T4, TSH
  - Thyroid Ultrasound
  - Thyroid Scan
  - Fine needle Aspiration Biopsy

- Hyperthyroid
  - Serum T3, T4, TSH
  - Thyroid Ultrasound
  - Thyroid Scan
Nuclear Medicine Thyroid Scan

Abnormally Decreased Uptake

Enlarged Thyroid Gland

Abnormally Increased Uptake
Therapeutic Management of Goiter

- Depends on functional and anatomical status
  - More aggressive approach in hyperthyroid patients, and those with nodular goiters
- For asymptomatic simple goiter, treatment will depend on goiter size
Therapeutic Management: Hypothyroid with Diffuse Goiter

- Hypothyroid: Levo-thyroxine
  - Age 1 to 3 years — 4 to 6 mcg/kg BW
  - Age 3 to 10 years — 3 to 5 mcg/kg
  - Age 10 to 16 years — 2 to 4 mcg/kg

- large goiter with compression symptoms: Surgery
Therapeutic Management: Hypothyroid Adolescent with Nodular Goiter

- Hypothyroid: Levo-thyroxine

- Surgery after FNAB depending on cytologic findings
Nodular Goiter

FNAB

Benign
- Observe on levo-thyroxine

Malignant
- UTZ after 6mos
- surgery
Therapeutic Management: Hyperthyroid with Diffusely Enlarged Goiter

- Medical:

  Methimazole (0.25-1 mg/kg/day)

  Betablockers
Side-effects of antithyroid medications

- Liver dysfunction
- **Granulocytopenia**
- Dermatitis
- Arthralgia/arthritis
- Lupus-like syndrome
- Peripheral neuritis
- Nausea, abdominal discomfort
- Edema
- Conjunctivitis
- Thrombocytopenia
- Toxic psychosis
- Sensorinueral hearing loss
- DIC
Therapeutic Management: Hyperthyroid with Nodular Goiter

I. Control Toxic state
   ➢ Medical:
     Methimazole
     Betablockers
Predictors of Remission

- lower thyroid hormone concentrations at presentation
- older age
- euthyroid status after three months of antithyroid drug therapy
- smaller goiter size
- higher body mass index (BMI)

- 25% remission in 2 years
- Relapse rate of 3-47%
Alternative Rx.. For Hyperthyroidism

- Surgery
  - failed initial medical therapy
  - relapse after medication cessation
  - non-compliance
  - significant medication side effects
Alternative Rx.. For Hyperthyroidism

- Radioactive Iodine

- Indications
  - nonresponse to antithyroid drugs
  - adverse reactions to antithyroid drugs
  - prior thyroid or other neck surgery
  - contraindications to surgery, such as severe heart, lung or renal disease
Summary

- Goiter is one of the most common endocrine disorders in childhood.
- Predominant cause is different from adults.
- Approach to management depends on the physiologic and anatomic status of the thyroid gland.
Summary

- Approach to nodular goiter is aggressive
- Pharmacotherapy is similar to adults
- PTU is no longer recommended for children
- Surgery and RAI are alternative to antithyroid medications
Thank you and have a nice day!