Thyroid Sonography
In Pediatrics

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Thyroid Sonography in Pediatrics

1. Incidental thyroid abnormalities
2. Congenital abnormalities
3. Nodules / Carcinoma
4. Multinodular thyroid
Incidental thyroid abnormalities (ITA) on Sonography (US)

**Adults**
- Prevalence 13 - 33%
- Majority benign

**Children**
- ? Prevalence
- ? US characteristics
- ? Significance
Incidental thyroid abnormalities identified on neck ultrasound for non-thyroid indications

Institutional REB approval

Retrospective analysis

2-year period (Jan 2006 – Dec 2007)

Inclusion - Children with Neck US for non thyroid indications

Exclusion - Thyroid not adequately imaged

Review - PACS & clinical records

Shivaram Avula, Alan Daneman, Oscar M. Navarro, Rahim Moineddin, Stacey Urbach, Denis Daneman
Results

1228 - Non-thyroid neck US examinations

Thyroid adequately depicted - 287

- **Age**: 1 d – 17.5 y (mean – 6.2 y)
- **Sex**: 1.2 M : 1 F

ITA - 52 (18%)

- **Age**: 1 m – 17.3 y (mean – 8.1 yrs)
  Statistically diff from those without ITA (5.8yrs; P=.003)
- **Sex**: 1.1 M : 1 F
Cystic lesions = 35

- Well defined
- Single/multiple
- <4mm
- +/- hyperechoic foci
  - microcrystals
  - comet tail

13 yr Male

12 yr Male
Hyperechoic foci = 3

4 yr Male

11 yr Male

2 years later
Hypoechoic Solid = 9

- Heterogeneous 7
  Homogeneous 2

- Smooth, straighter margins

- Similar to thymus

- **Mean age** - 2.5 years
  
  Statistically different (p=0.023) from the mean age of remaining children - 6.3 yrs

- **Sex ratio** - 8M : 1F (p=0.0196)
Intrathyroid ectopic thymus

- **Mean age** - 2.5 yr
- **Male : female** - 8:1

* 6 paediatric case reports - 5:1 (M:F)


Incidental thyroid abnormalities

- **Mean age** - 8.1 yr
- **Male : female** - 1.1:1
Intrathyroid ectopic thymus
Intrathyroid ectopic thymus
Isoechoic nodule = 1

17 yr Female
Conclusion

- Incidental findings in children - 18%
- Spectrum of incidental lesions - mostly cysts
- No development of thyroid dysfunction or malignancy - follow up 10m - 2.8y
- Management - conservative
- Intra thyroid ectopic thymus common in younger boys - US characteristics similar to thymus
INDICATIONS

1. ANOMALY – present/absent OR ectopic

2. NODULE/MASS – palpable OR ultrasound
   - Intra / Extra thyroid
   - Single / Multiple
   - Echogenicity
     - echofree – benign
     - echogenic/complex – ?solid
       - ?malignant

3. MULTIFOCAL/DIFFUSE – Differentiate
Sonographic features

1. **Echogenicity**: hyper, hypo, anechoic
2. **Composition**: solid, cystic, mixed
3. **Margins**: regular/smooth, ill-defined/irregular
4. **Halo**: complete, incomplete, absent
5. **Calcifications**: micro, macro
6. **Shape**: taller (AP) than wide (TRANS)
7. **Vascularity**: central, peripheral

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8. **Lymph nodes**: size, echogenicity
THYROID CARCINOMA - PRESENTATION

20 PATIENTS

- Asymptomatic mass/nodule - 17
  - present up to 2 years
  - Incidental - 3
  - multiple palpable - 1

- Hoarseness and cough - 1

- Raised Calcitonin in MEN 2B - 2

- Euthyroid - 20
SECOND TUMORS - 45

1. Osteochondromas - 24
2. Thyroid neoplasms - 9
3. Osteogenic Sarcoma - 5
4. Others - 7
The American Thyroid Association (ATA) risk stratification method which classifies thyroid nodules based on US patterns associated with suspicion for malignancy.
The **TI-RADS- Thyroid Image Reporting and Data System** assigns an increasing likelihood of malignancy based on the number of suspicious US features within a thyroid nodule.

<table>
<thead>
<tr>
<th>TI-RADS</th>
<th>Thyroid finding</th>
<th>Risk of malignancy</th>
<th>Sonographic features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal thyroid gland</td>
<td>0 %</td>
<td>For TIRADS 4 and 5:</td>
</tr>
<tr>
<td>2</td>
<td>Benign lesions (cyst, mixed, spongiform, comet sign)</td>
<td>0 %</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Probably benign lesion (Hashi’s pseudonodule)</td>
<td>&lt; 5 %</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Suspicious lesions</td>
<td></td>
<td>Solid component</td>
</tr>
<tr>
<td>4a</td>
<td>1 suspicious feature</td>
<td>5 - 10 %</td>
<td>Markedly hypoechoic nodule</td>
</tr>
<tr>
<td>4b</td>
<td>2 suspicious features</td>
<td>10 - 50%</td>
<td>Microlobulations/ Irregular margins</td>
</tr>
<tr>
<td>4c</td>
<td>3-4 suspicious features</td>
<td>50 - 85%</td>
<td>Microcalcifications</td>
</tr>
<tr>
<td>5</td>
<td>Probably malignant lesion- All 5 suspicious features</td>
<td>&gt; 85%</td>
<td>Taller-than-wide shape</td>
</tr>
<tr>
<td>6</td>
<td>Biopsy proven malignancy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Horvath E et al. 2009 *J Clin Endocrinol Metab.* 90:1748-1751
Problem:

Neither of these two methods have been validated in pediatric patients

Objective:

To evaluate the utility of these two adult-based US approaches for assessment of thyroid nodules in children
Results

• 124 children with thyroid nodule on US
  • 40 M : 84 F
  • Age range 3-17 y (average 13.6 y)

• Nodules
  • 71 (57.3%) benign, 52 (41.9%) malignant, 1 (0.8%) indeterminate

• Readers reported greater confidence scoring malignant nodules than with benign (mean of 4.3 vs. 3.6 on the 5 point Likert scale), although this difference was not significant

• Confidence did not vary between TI-RADS or ATA methods
The overall likelihood of malignancy was 75% for High, 43% for Intermediate, 14% for Low, 10% for Very Low, and 0% for Benign categories.
**ATA Risk Stratification**

**Challenges:** There is overlap between ATA classes and not all the cases fit into any category.
The overall likelihood of malignancy for TI-RADS 2(0%), 3(0%), 4a(21%), 4b(29%), 4c(70%), and 5(86%)

<table>
<thead>
<tr>
<th>Validity Tests TI-RADS</th>
<th>%</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accu</td>
<td>76.4</td>
<td>67.9 – 83.6</td>
</tr>
<tr>
<td>NPV</td>
<td>80</td>
<td>68.7 – 88.6</td>
</tr>
<tr>
<td>PPV</td>
<td>71.7</td>
<td>57.7 – 83.2</td>
</tr>
<tr>
<td>Sen</td>
<td>73.1</td>
<td>59 – 84.4</td>
</tr>
<tr>
<td>Spec</td>
<td>80</td>
<td>67.6 – 87.7</td>
</tr>
</tbody>
</table>
TI-RADS

2

3

4a

4b

4c

5

B

B

B

M

M

M

B

B

B

M

M

M

B

B

B

M

M

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B

B

B

M

M

M

M
## Sonographic features validity tests

<table>
<thead>
<tr>
<th>Features % and (95% CI)</th>
<th>Composition: Solid</th>
<th>Echogenicity: Hypoechoic</th>
<th>Margins: Ill-defined margins</th>
<th>Halo: Absent/Partial Halo</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensitivity</strong></td>
<td>81% (68-91%)</td>
<td>62.3% (48-75%)</td>
<td>83% (70-92%)</td>
<td>94% (84-99%)</td>
</tr>
<tr>
<td><strong>Specificity</strong></td>
<td>77.5% (66-86.5%)</td>
<td>70.4% (58-81%)</td>
<td>63% (51-74.5%)</td>
<td>7% (2-16%)</td>
</tr>
<tr>
<td>+ PV</td>
<td>73% (60-84%)</td>
<td>61% (47-74%)</td>
<td>63% (51-74%)</td>
<td>43% (34-53%)</td>
</tr>
<tr>
<td>- PV</td>
<td>85% (73.5-92%)</td>
<td>71.4% (59-82%)</td>
<td>83% (71-92%)</td>
<td>62.5% (25-92%)</td>
</tr>
<tr>
<td>+ LR</td>
<td>3.6 (2-6)</td>
<td>2.1 (1.4-3)</td>
<td>2.3 (1.6-3)</td>
<td>1 (0.9-1)</td>
</tr>
<tr>
<td>- LR</td>
<td>0.24 (0.1-0.4)</td>
<td>0.5 (0.4-0.8)</td>
<td>0.3 (0.1-0.5)</td>
<td>0.8 (0.2-3.2)</td>
</tr>
</tbody>
</table>
## Sonographic features validity tests

<table>
<thead>
<tr>
<th>Features % and 95%CI</th>
<th>Calcifications: Micro Ca+</th>
<th>Shape: Taller &gt; wide</th>
<th>Increased Vascularity</th>
<th>Suspicious Lymph nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensitivity</strong></td>
<td>64% (50-77%)</td>
<td>15% (7-28%)</td>
<td>91% (80-97%)</td>
<td>42% (27-58%)</td>
</tr>
<tr>
<td><strong>Specificity</strong></td>
<td>82% (70-90%)</td>
<td>88.7% (79-95%)</td>
<td>15.5% (8-26%)</td>
<td>86% (75-94%)</td>
</tr>
<tr>
<td>+ PV</td>
<td>72% (57-84%)</td>
<td>50% (25-75%)</td>
<td>44% (35-54%)</td>
<td>70% (48-86%)</td>
</tr>
<tr>
<td>- PV</td>
<td>75% (64-84%)</td>
<td>58% (48-68%)</td>
<td>69% (41-89%)</td>
<td>67% (55-77%)</td>
</tr>
<tr>
<td>+ LR</td>
<td>3.5 (2-6)</td>
<td>1.3 (0.5-3)</td>
<td>1 (1-1.2)</td>
<td>3 (1.5-6.4)</td>
</tr>
<tr>
<td>- LR</td>
<td>0.4 (0.3-0.6)</td>
<td>1 (0.8-1)</td>
<td>0.6 (0.2-1.6)</td>
<td>0.7 (0.5-.08)</td>
</tr>
</tbody>
</table>
MULTINODULAR THYROID

1. Isolated
2. Autoimmune disease
3. Carcinoma/Radiation
4. McCune-Albright Syndrome
5. Thyroid & Renal cysts & Polydactyly
McCune-Albright Syndrome

1. Café au lait spots
2. Polyostotic fibrous dysplasia
3. Endocrinopathies