THYROID NODULE ULTRASOUND
Evidence Base & BTA Guidelines

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AIMS

- Thyroid cancer incidence
- Thyroid nodule appearances
- Scoring systems & Guidelines
- New BTA Guidelines
- Common misunderstandings
- Thyroid US standards
Inappropriate use and reporting of imaging will result in an epidemic of thyroid nodules, the majority of which will be benign.
Calvin and Hobbes

The more you know, the harder it is to take decisive action.

Once you become informed, you start seeing complexities and shades of gray.
# US Signs Predictive of Cancer

<table>
<thead>
<tr>
<th>Feature</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro-calcifications</td>
<td>40%</td>
<td>90%</td>
</tr>
<tr>
<td>Absence of halo</td>
<td>66%</td>
<td>46%</td>
</tr>
<tr>
<td>Irregular margins</td>
<td>64%</td>
<td>84%</td>
</tr>
<tr>
<td>Hypo-echoic</td>
<td>83%</td>
<td>49%</td>
</tr>
<tr>
<td>Intra-nodular flow</td>
<td>70%</td>
<td>65%</td>
</tr>
<tr>
<td>MicroCa. &amp; irreg m.</td>
<td>30%</td>
<td>95%</td>
</tr>
<tr>
<td>MicroCa. &amp; hypoechoic</td>
<td>28%</td>
<td>95%</td>
</tr>
<tr>
<td>Solid &amp; hypoechoic</td>
<td>73%</td>
<td>69%</td>
</tr>
</tbody>
</table>
Ultrasound Scoring System

- Mayo Clinic Thyroid US Chart
- TIRADS Scoring System
- U₁ – U₅ Classification
**Almost Certainly Benign**

- No FNA
  - Cysts with bright echo
  - Cystic nodule
  - Sponge-like nodule
  - Cystic with debris
  - Large cystic nodule with septations
  - Cystic nodule with debris
  - Multiple isoechoic similar nodules (multinodular goiter)
  - Multiple discrete solid hypoechoic nodules with coarse parenchymal septations (Hashimoto’s Thyroiditis)

**Indeterminate**

- Solid with cystic component
- Cystic with mural nodule
- Solid, homogenous with thin halo
- Solid, homogenous

**Worrisome for Malignant**

- Solid with irregular margins
- Solid with micro Ca**
- Solid with micro Ca**
- Solid with micro Ca**
- Fine and coarse Ca**
- Solid with Coarse Ca**
- Cystic with solid elements and Ca**
- Solid with micro and peripheral Ca**

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**For Indeterminate Nodules Additional Relevant Factors That Would Encourage FNA**

- Family history of thyroid CA
- Previous radiation exposure
- Younger age
- Larger size of nodule
“This approach has been effective for the majority of patients with thyroid nodules in our practice. Colour doppler may be of use in selected cases.”

2007 Mayo Clinic Foundation for Medical Education and Research
Ultrasound is rarely of use in assessment of thyroid nodules. It may help guide FNA.
BTA Guidelines (2014)

- Separate chapter on thyroid nodule US
- Rationalise thyroid US / FNA
  - Suggested standards for reports
  - Indications for FNA
  - Based upon US scoring system
  - U1 – U5
  - Follow up based upon US appearances
Thyroid nodules – Ultrasound(U) classification

U1. Normal

U2. Benign:
(a) halo, hyper- / iso-echoic
(b) cystic change +/- ring down sign (colloid)
(c) micro- cystic / spongiform
(d) shape (taller > wide)
(e) characteristic associated lymphadenopathy

U3. Indeterminate/Equivocal:
(a) homogenous, hyper - echoic (markedly), solid, halo (follicular lesion).
(b) hypo-echoic, equivocal echogenic foci, cystic change
(c) mixed/central vascularity.

U4. Suspicious:
(a) solid, hypo-echoic (cf thyroid)
(b) solid, very hypo-echoic (cf strap muscle)
(c) disrupted peripheral calcification, hypo-echoic
(d) lobulated outline

U5. Malignant
(a) solid, hypo-echoic, lobulated / irregular outline, micro-calcification (? Papillary carcinoma)
(b) solid, hypo-echoic, lobulated/irregular outline, globular calcification (? Medullary carcinoma)
(c) intra-nodular vascularity
(d) shape (taller > wide)
(e) characteristic associated lymphadenopathy
U1 - Normal
U2 – Benign (cyst)
U2 – Benign
(cyst with colloid)
Aggregation of micro-cystic spaces comprising >50% of a nodule
99.7% specificity, 100% if isoechoic nodule

U2 – Benign
(large cyst with septations)
U2 – Benign (cyst with debris)
U2 – Benign
(multiple isoechoic nodules)
U2 – Benign
(cyst with retracting clot)
U2 – Benign
(peripheral egg shell calcification)
U2 – Benign
(peripheral blood flow)
U3 – Indeterminate
(cystic / solid nodule + doppler flow)
U3 – Indeterminate
(follicular lesions)
U3 – Indeterminate (follicular lesions)
U4 – Suspicious
(slightly hypoechoic, heterogenous nodules)
U₄ – Suspicious
(extension beyond eggshell rim)
U5 – Malignant
(markedly hypoechoic)
U5 – Malignant (ill defined margins)
U5 – Malignant
(micro-calcification)
U5 – Malignant
(taller than wide)

AP > TR in the transverse plane
U5 – Malignant (cystic papillary cancer)
U5 – Malignant
(nodes with micro-calcification)
U5 – Malignant (cystic nodes)
Ultrasound Rating (U1 – U5)

- FNA any indeterminate or suspicious / malignant nodules
- FNA of U3 – U5
- U3 – most will be benign, but follicular lesions are included, and the occasional cancer may be present
Ultrasound Rating (U₁ – U₅)

- FNA of U₃ – U₅
Ultrasound Rating – additions...

Score 1: Entire area is evenly shaded green as is surrounding tissue.
Score 2: Lesion area has mosaic pattern of green, blue and red (soft).
Score 3: Central part of area is blue and peripheral part green.
Score 4: Entire area is blue (stiff).
Score 5: Both entire area and its surrounding area are blue (stiff).

FIGURE 3. Ueno classification (Hitachi software).

Courtesy of Dr Andrew McQueen
Ultrasound Scoring Systems

Implementation of Evidence-Based Guidelines for Thyroid Nodule Biopsy: A Model for Establishment of Practice Standards

AJR 2011;196: 655 - 660

- Use of scoring systems is robust
  - Training possible
  - Good inter observer variability
  - Allows effective audit / follow
Ultrasound Scoring Systems

- *Ultrasound based reporting system for thyroid nodules improves patient management and cost-effectiveness by reducing unnecessary FNA*

Guidelines

- American Thyroid Association (ATA)
- American Association of Clinical Endocrinologists (AACE)
- Kim / Korean Society of Radiologists
- Society of Radiologists in US (SRUS)
- British Thyroid Association (BTA)
- Mayo Clinic Thyroid US Chart
- Guidelines represent expert opinion based upon a selection of retrospective studies

- There is a lack of prospective randomised control trials assessing effectiveness of Guidelines in detecting thyroid cancer
The majority of guidelines currently available still recommend biopsy for the majority of thyroid nodules.

This leads to a massive cost implication, with resultant surgery for often benign disease, and all to exclude a cancer with excellent long term survival rates.
Biopsy of Thyroid Nodules: Comparison of Three Sets of Guidelines

Sung Soo Ahn¹
Eun-Kyung Kim¹
Dae Ryong Kang²
Sung-Kil Lim³
Jin Young Kwak¹
Min Jung Kim¹

AJR 2010;194:31-37

Kim
AACE
SRUS

1398 nodules
Kim Criteria

- FNA of any nodule with one of:
  - Markedly hypo-echoic
  - Micro-calcification
  - Irregular margins
  - Taller-than-wide shape

AACE Criteria

- FNA of any nodule with:
  - Marked hypo-echogenicity + one other:
    - Micro-calcification
    - Irregular margins
    - Taller-than-wide shape

FNA any nodule with:

- >10mm with micro-calcification
- >15mm if solid
- >15mm if coarse calcification
- >20mm if solid and cystic

- Kim Criteria
  - Sensitivity 92.7%
  - Specificity 80.9%
  - NPV 97.3%

- AACE Criteria
  - Sensitivity 74%
  - Specificity 94.4%
  - NPV 95%
SRUS

- Uses size criteria

- Sensitivity 35%
- Specificity 54%
- NPV 80%
Common Misunderstandings

- Nodule size
- Dominant Nodule FNA
- Follow up post benign FNA
- Nodule growth
Nodule Size

- Nodules > 4cm have been claimed as having malignancy rates > 20%

- Nodule size > 4cm increases neither the false negative rate of FNA, nor the rate of malignancy

Nodule Size

- 661 nodules > 3cm diameter
- US and FNA are accurate in nodules > 3cm.
- US features are still predictive even with larger nodule size

Yoon JH, Kwak JY, Moon HJ. The diagnostic accuracy of ultrasound guided fine needle aspiration biopsy and the sonographic differences between benign and malignant thyroid nodules 3cm or larger. *Thyroid* 2011: 21(9): 993 – 1000
FNA of a dominant nodule is a common but mistaken practice

- Decision to FNA should be based upon US appearances.
- Selecting nodules purely on size criteria encourages lazy / incomplete assessment.
It's all about the apples....
### Value of US Correlation of a Thyroid Nodule with Initially Benign Cytologic Results

**Purpose:** To investigate the value of ultrasonographic (US) features in thyroid nodules with initially benign cytologic results.

**Radiology** 2010. 254 (1): 292 - 300

1343 nodules with US, FNA, pathological correlation

<table>
<thead>
<tr>
<th></th>
<th>Benign (%)</th>
<th>Malignant (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>98.1%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Benign initial US + Thy 2 FNA:</td>
<td>99.4%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Suspicious initial US + Thy 2 FNA:</td>
<td>79.6%</td>
<td>20.4%</td>
</tr>
</tbody>
</table>

**Jin Young Kwak, MD**
**Hyeryoung Koo, MD**
**Ji Hyun Youk, MD**
Follow Up Post FNA

- Clinico-radiologic-cytologic correlation

- Benign US and benign FNAC does not need repeating after 6 – 12 months
  - Low cost effectiveness

- Suspicious US and Thy 2 must be repeated as malignancy rates are significant
Follow Up Post FNA

- Long term follow up of benign nodules
  - Associated with increased US studies
  - Associated with increased FNA rates
  - No improvement in malignancy detection rates

Nodule Growth

- Presence or absence of growth is not an indicator of malignancy or benignity
- Interval growth has low PPV for malignancy
Nodule Growth

- 294 / 330 Thy 2 nodules enlarged
- Average 15% growth
- 74 nodules had significant growth (≈ 69%)
- Re-FNA showed cancer in only 1 / 74.


- Growth of nodules is an expected finding in benign thyroid disease
US Standards
Images & Reports

- Radiologist, sonographer, surgeon, endocrinologist
- Formal images, recorded on PACS, with appropriate formal report on RIS system
- Training in accordance with RCR Guidelines / Non–radiologist US Training Document
- Assessment of any indeterminate or suspicious nodules
<table>
<thead>
<tr>
<th><strong>TABLE 4.4</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Suggested features to consider/include in US reporting/assessment of thyroid nodules:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Relevant Nodule Size:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Nodule Composition:</strong></td>
<td>Solid, cystic, mixed solid/cystic, micro-cystic/spongiform.</td>
</tr>
<tr>
<td><strong>Cystic Component:</strong></td>
<td>? Ring down sign - colloid</td>
</tr>
<tr>
<td><strong>Echogenicity:</strong></td>
<td>Markedly hypo-echoic, hypo-echoic, iso-echoic, hyper-echoic</td>
</tr>
<tr>
<td><strong>Calcifications:</strong></td>
<td>Micro-calcification, macro-calcification, rim/egg shell</td>
</tr>
<tr>
<td><strong>Margin:</strong></td>
<td>Well defined, irregular/lobulated, spiculated</td>
</tr>
<tr>
<td><strong>Taller than Wide:</strong></td>
<td>AP &gt; TR : Y / N</td>
</tr>
<tr>
<td><strong>Halo:</strong></td>
<td>Regular / continuous, interrupted, absent</td>
</tr>
<tr>
<td><strong>Colour flow:</strong></td>
<td>Central, peripheral, mixed, none</td>
</tr>
<tr>
<td><strong>Extent:</strong></td>
<td>Retrosternal extension / tracheal deviation</td>
</tr>
<tr>
<td><strong>Classification:</strong></td>
<td>Benign (U2), equivocal / indeterminate (U3), suspicious (U4), malignant (U5)</td>
</tr>
<tr>
<td><strong>Lymphadenopathy:</strong></td>
<td>Suspected malignancy – ? metastases: anatomical location/levels</td>
</tr>
<tr>
<td><strong>Biopsy:</strong></td>
<td>FNAC / core biopsy, needle gauge, number of passes. Location of nodule biopsied. Complications : Y/N.</td>
</tr>
</tbody>
</table>
Ultrasound Standards

- Interest / regular practice of thyroid imaging
- Participation at Thyroid MDT
- US images / report stored on PACS system
  - Report attached to images
  - Assess the likelihood of cancer
  - Regular audit of cases / FNA results

**MINIMUM STANDARD OF PRACTICE**
Incidental Thyroid Nodules

- Massive cost to NHS of follow up / FNA
  - >£5 million per annum for UHB NHSFT for US + FNA
  - Stable mortality rates despite investigation

- No CT feature reliably characterises nodules

- Clinical evaluation (not US / FNA), but consider US / FNA initially if:
  - Risk factors in history
  - Ill defined margins, young age, micro-calcification
Focal FDG activity within thyroid
Meta-analysis shows malignancy \( \approx 35\% \)

US / FNA must be performed for focal uptake

Soelberg KK, Bonnema SJ, Brix TH, Hegedus L. Risk of malignancy in thyroid incidentalomas detected by 18 FDG PET: a systematic review. *Thyroid* 2012; 22(9): 918 – 925.
US images stored on PACS system
- Formal documented report
- Report attached to images
- Regular audit of cases / FNA results

Interest / regular practice of thyroid imaging

Participation at Thyroid MDT
FNA of a dominant nodule in a MNG is a common but mistaken practice.

Use ultrasound to risk stratify nodules:
- Mayo Clinic
- BTA U1-U5 scoring system

FNA indeterminate or suspicious / malignant nodules
Summary (3)

- Follow up post FNA should be based upon nodule appearances on US

- Close liaison with thyroid / endocrine team
  - Clinical history is important
  - Repeat sampling of Thy 2 but suspicious US

- Incidental FDG avid nodules on PET CT need definite follow up with US / FNAC
Any Questions?