Thyroid Nodules: What do Ultrasound Images Tell Us?

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What is ultrasound?

• Transducer emits high frequency sound into the neck
• Neck tissues reflect some of the sound producing echoes
• Images are made from these echoes – hence the term “echogenicity”
What do things look like on ultrasound??

- Depends on the degree to which sound is reflected
- Fluid appears black ("anechoic")
- Calcium/gas appears white ("hyperechoic") and reflects the sound
- Other tissues are different shades of gray
What does the term “Nodule” mean??

• To a physician who is examining a patient’s neck, it means a palpable lump, bump or irregularity in the thyroid
• On ultrasound, it means an area of the thyroid that looks different from the background
How common are thyroid nodules in the United States on Ultrasound?

Mazzaferri, N Engl J Med 1993
What nodules can’t we feel? Ultrasound vs. Palpation

Brander, J Clin Ultrasound 1992
Sonographic Thyroid Nodule

• “Nodule” - one or more areas of the thyroid with a different echotexture than surrounding parenchyma
• Most nodules are not true tumors but hyperplastic regions of the thyroid
• Most thyroid nodules are detected “incidentally”
Focal Thyroid Lesions on Ultrasound that Undergo FNA

- Benign hyperplastic nodules (at least 70%)
- Benign thyroid adenoma (10%)
- **Thyroid carcinoma (5 to 12%)**
  - Papillary carcinoma (70-80%)-includes mixed papillary and follicular carcinoma
  - Pure Follicular Carcinoma (10 to 15%)
  - Medullary Carcinoma (5 to 10%)
  - Anaplastic carcinoma (<1%)
- Focal area of thyroiditis (1 to 5%)
- Unusual lesions: Intrathyroidal parathyroid, true cyst, metastatic disease
Hyperplastic nodule

• Area of the thyroid that is stimulated to grow and accumulate large pools of colloid
• Composed of follicles of various sizes and age, colloid, macrophages
What happens when we see a nodule on an Ultrasound exam?

• A decision is made to determine if a biopsy is needed
• The decision is made based on a number of factors, one of which is how the nodule looks on Ultrasound
What nodule features raise concern for a tumor?

- All solid consistency
- Calcifications, especially tiny or microcalcifications
- Really dark appearing or hypoechoic
- Irregular, aggressive appearing margins
- Suspicious neck lymph nodes
Solid and Hypoechoic

- Most papillary cancers are hypoechoic
- However, since benign nodules are much more common, most hypoechoic nodules are benign
- *The likelihood of a cancer increases if marked hypoechogenicity is combined with all solid consistency, calcifications and/or intranodular flow*
Microcalcifications

- Multiple bright punctate (under 1 mm) echoes
- Most specific sign of malignancy
- 85-95% chance of thyroid cancer

Papillary carcinoma
Calcifications

Complete, regular or “eggshell”

Interrupted

Papillary ca

Usually benign

Follicular ca

Usually benign
Coarse calcifications are common in multinodular goiters secondary to dystrophic calcifications in long standing benign nodules.

When present in a solitary nodule have malignancy rates approaching 75%.

Khoo ML, Arch Oto Head Neck Surg 2002
Aggressive, Infiltrative Borders
“Taller than Wide”

- Nodule is taller than wide on the transverse view
- Most commonly noted in small, less than 10 mm cancers

Kim AJR 2002; Cappelli Clin Endocrinol 2005; Moon Radiology 2008
Invasion through the capsule and into muscle
Invasion of capsule and metastatic lymphadenopathy

Sagittal view of left lobe

Trv view of left lateral neck

11 mm Papillary Thyroid Carcinoma
How important is the size of the nodule?

Less important than its sonographic features and its aggressiveness!
42 yo woman with palpable left upper neck mass

FNA showed metastatic PTC in a LN
Pathology:
Left 3mm and 2 mm PTC
Right 2 mm and 1mm PTC
How reliable are these features?

• Sensitivity-tells us what % of all cancers show the feature
  – 80% sensitivity means the feature is present in 80 out of 100 cancers

• Specificity- reflects the likelihood that if the feature is present the lesion, it is a cancer and not a benign lesion
  – 90% specificity means that for every 100 lesions that have the feature, 90 are cancer
## US Prediction of Thyroid Cancer

<table>
<thead>
<tr>
<th>Feature</th>
<th>Sensitivity</th>
<th>Specificity</th>
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</thead>
<tbody>
<tr>
<td>Microcalcifications</td>
<td>43%</td>
<td>90%</td>
</tr>
<tr>
<td>Taller than wide</td>
<td>40%</td>
<td>91%</td>
</tr>
<tr>
<td>Irregular margins</td>
<td>51%</td>
<td>76%</td>
</tr>
<tr>
<td>Hypoechoic</td>
<td>80%</td>
<td>53%</td>
</tr>
<tr>
<td>Marked Hypoechogen</td>
<td>41%</td>
<td>94%</td>
</tr>
<tr>
<td>Increased intranodular flow</td>
<td>67%</td>
<td>81%</td>
</tr>
<tr>
<td>Absent halo</td>
<td>66%</td>
<td>43%</td>
</tr>
</tbody>
</table>

- **MicroCa^{2+} + irreg margin**: 30% (95%)
- **MicroCa^{2+} + hypoechoic**: 26% (96%)
- **Solid + hypoechoic**: 68% (69%)

References:
20 to 30% of Thyroid Cancers are Predominantly Follicular Lesions

- Follicular variant papillary thyroid cancer
- Pure Follicular Thyroid Cancer
Sonographic features:

**Papillary vs. Mixed Papillary and Follicular Thyroid Cancer**

- Hypoechoic
- Absent halo
- Irregular margins
- Solid
- MicroCa2+

* Chan, J Ultrasound Med 2003; Yuan, Clin Imaging 2006; Jeh, Korean J Rad 2007
20-30% of all cancers are Iso/hyperechoic: predominantly follicular/ Hürthle cell
US Features

CANCER

BENIGN

BENIGN

BENIGN

BENIGN
Nodules which are likely benign

- Entirely cystic nodule
- Nearly entirely cystic nodule with no flow or calcification in the solid part (under 2 cm)
- Honeycomb or spongiform nodule without calcifications (under 2 cm)
- “Pseudonodules” in autoimmune thyroid disease (chronic lymphocytic thyroiditis)
- Mixed cystic and solid nodules with a functioning solid component (any size)
Completely cystic: Colloid cysts
“Spongiform” nodules

• aggregation of multiple microcystic components in more than 50% of the volume of the nodule
• “honeycomb of internal cystic spaces”
• Less than 1% risk of malignancy

Moon Radiology 2008; 247: 762-70
Bonavita AJR 2009; 193:207-13
LOW RISK: “Spongiform” nodules--a benign appearance

Only 1 of 360 cancers had this appearance ➞ specificity 99.7%

Moon, Radiology 2008; 247:762-770
• Society of Radiologists in Ultrasound\textsuperscript{1}

\textit{Incidentally detected nodules in low risk adult patients}

• American Thyroid Association\textsuperscript{2}

• American Association of Clinical Endocrinologists/European consensus\textsuperscript{3,4}

\textit{Size, sonographic features and clinical history}

\textsuperscript{1} Frates MC et al, Radiology 2005; \textsuperscript{2} Cooper DS et al, Thyroid 2006 and 2009;; \textsuperscript{3} Gharib et al, Endocr Pract 2006 and 2010; \textsuperscript{4} Pacini et al, Eur J Endocrinol 2006;
FNA for Low Risk Patients Without Abnormal LNs

- micro Ca$^{2+} \geq 8\text{mm}$
- hypoechoic (solid) $\geq 10\text{mm}$
- Iso or hyperechoic and solid $\geq 10-15\text{mm}$
- Complex, non-calcified $\geq 15-20\text{mm}$
  - Classic spongiform may be followed
- Multiple nodules:
  - prioritize based upon above
  - if multiple sonographically similar, coalescent nodules without suspicious US features, FNA largest
Multinodular thyroid with one sonographically suspicious nodule

Microcalcifications, Hypoechogenic, Solid
Thyroid Nodules
Multinodular goiter ≠ Multiple nodular gland

Enlarged thyroid with multiple sonographically similar nodules with little or no normal parenchyma

Normal parenchyma with more than one nodule