Neck Ultrasound
Pattern Recognition in the
Evaluation of Thyroid Nodules

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Low Risk Ultrasound Features of Nodules

- Colloid nodules (cat’s eye, comet tail artifact)
- Spongiform nodules
- Simple cysts
- Isoechoic/Hyperechoic
  - Especially a hyperechoic nodule with background Hashimoto’s (“white knight”)
- Thin, regular halo
Thin-walled Cyst
Comet Tails

• Reverberation artifact from vibrating desiccated colloid
• Most common in cystic or partially cystic nodules
• Best appreciated in real-time as can be confused with microcalcifications
Colloid Within Nodule “Cat’s Eye” (Comet Tail, Stepladder or Ringdown artifact)
“Spongiform” nodules

- Aggregation of multiple microcystic components in more than 50% of the volume of the nodule
- “Honeycomb of internal cystic spaces”
- Only 1 in 360 spongiform nodules malignant
  - 99.7% Specificity (Moon)

Moon Radiology 2008; 247: 762–70
Bonavita AJR 2009; 193:207–13
SPONGIFORM NODULES
Spongiform Echotexture

Note: Bright Linear Reflectors all posterior to the microcystic areas
Halos & Margins

- **Halo:** sonolucent rim around an iso/hyperechoic nodule representing capsule
  - Thin/regular – lower risk
  - Thick/irregular – higher risk

**Hypoechoic Nodules ---- Margins:**

- **Smooth and regular**
- **Poorly Defined:** interface between nodule and surrounding parenchyma is difficult to delineate
  - Lower risk, seen in hyperplastic nodules
- **Irregular:** the demarcation between the nodule and parenchyma is clearly visible but demonstrates an irregular, infiltrative or spiculated course.
  - Higher risk
Halo

Edge Artifact
Hypoechoic Nodules
No Halo, but a Smooth Margin
Halo irregular

Follicular adenoma
Halo

Benign Follicular Adenoma

Follicular CA
Margins

Irregular

Poorly defined, but not infiltrative (spongiform)
Suspicious Ultrasound Features of Nodules

• Markedly hypoechoic
• Invasive, infiltrative margins
• Microcalcifications
• Taller than wide shape (AP>TRV in transverse view)
• Abnormal cervical lymph nodes
Markedly Hypoechoic

Compare to strap muscles and SCM
Calcifications: Pattern recognition

- Microcalcifications
- Coarse Calcification
- Colloid “Ring-down” Reverberation Artifact
- Posterior Acoustic Enhancement Artifact
PTC with Microcalcifications
Microcalcifications vs Comet Tails
NOT microcalcifications!

Small hyperechoic linear streaks just posterior to small cystic area → posterior acoustic enhancement!
Ultrasonographic appearance of Follicular Variant Papillary

Isoechoic, variable thickness halo
Sonographic Features of Follicular Variant Papillary Cancer versus Conventional Papillary Cancer

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>FOLLICULAR VARIANT (n=44)</th>
<th>CONVENTIONAL PAPILLARY (n=74)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (mean)</td>
<td>17 mm</td>
<td>10.5 mm</td>
</tr>
<tr>
<td>Ovoid to round shape</td>
<td>95%</td>
<td>73%</td>
</tr>
<tr>
<td>Isoechoic</td>
<td>52%</td>
<td>8%</td>
</tr>
<tr>
<td>Halo</td>
<td>25%</td>
<td>3%</td>
</tr>
<tr>
<td>Taller than Wide</td>
<td>5%</td>
<td>22%</td>
</tr>
<tr>
<td>Marked Hypoechoogenicity</td>
<td>5%</td>
<td>38%</td>
</tr>
<tr>
<td>Microcalcifications</td>
<td>3%</td>
<td>24%</td>
</tr>
<tr>
<td>FNAB Dx of Papillary CA</td>
<td>28%</td>
<td>56%</td>
</tr>
<tr>
<td>FNAB Indeterminate</td>
<td>46%</td>
<td>19%</td>
</tr>
</tbody>
</table>

Sonographic features:
Papillary vs. Follicular Variant of PTC

Kim J Ultrasound Med 2009
Isoechoic/Hyperechoic and Solid

Benign Hürthle cell adenoma

PTC foll variant

Follicular thyroid cancer

Hyperplastic nodule

Hyperplastic nodule

~20% of all cancers are Iso/hyperechoic: predominantly follicular/ Hürthle
Taller than wide

Nodule is taller than wide on the transverse view
Infiltrative/Irregular Borders
Invasion of strap muscle
Microcalcifications
Hypoechoic
Invasion of Carotid Sheath
Cystic PTC

Microcalcifications

Irregular, eccentric solid component
Cystic change

• 360 thyroid cancers at Mayo Clinic:
  Solid or minimally (5%) cystic: 88%
  <50% cystic: 9%
  >50% cystic: 3% and another suspicious sonographic feature present

1 Henrichsen et al, RSNA 2005
What About Intranodular Flow?

NO LONGER CONSIDERED AN INDEPENDENT
Vascularity - What to do?

• Consider whether features are suspicious for papillary or follicular cancers.
  • Hypoechoic or features of papillary:
    • Vascularity may be less important
  • Iso or hyperechoic with variable thickness halo:
    • Consider intranodular vascularity as potential risk.

• AACE 2010 guidelines do consider vascularity.
• Korean 2011 and ATA 2015 guidelines do not consider vascularity
• **Don’t be reassured by absence of vascularity.**
LYMPH NODES

NORMAL

- Rounded & Infiltrative
- Hilum – with vascular flow

ABNORMAL

- Rounded & Infiltrative
- Calcifications
- Peripheral Vascularity
Suspicious Lymph Node Features

- Rounded Shape
- Peripheral/Chaotic Vascularity
- Loss of hilar line
- Jugular Compression

Suspicious features not seen here
- Calcification
- Cystic change
Longitudinal View of Right level IV Node

- Chaotic/pericpheral vascularity
- Jugular compression
- Loss of hilar line
Malignant Node
US of Thyroid only.....

LEFT Nodule -- PTC

US of Entire Neck reveals.....

LEFT Lateral Neck: Abnl LNs

Differential Diagnosis for Lymph Nodes

- Reactive lymphadenopathy (recent URI, dental work, AITD, etc)
- Metastasis – thyroid, head/neck SCCA, breast, lung, melanoma
- Sarcoidosis
- Lymphoma
- CLL
- Infectious granulomatous disease
Ultrasound Patterns in Autoimmune Thyroid Disease

• Heterogeneous echotexture
• Hashimoto’s typically hypoechoic, but can be hyperechoic
• Pseudonodularity
  • Small multiple hypoechoic psuedomicronodules ("lakes of lymphocytes")
  • Banding fibrosis creating pseudomicronodular appearance
• Giraffe pattern – hyperechoic globular pattern (w/ hypoechoic borders)
• White knight – regenerative hyperechoic nodules
• Reactive cervical lymph nodes
• Isthmus AP thickened (>5mm)
Autoimmune Thyroid Disease
Normal vs Hashimoto’s

Side-by-side virtual panoramic transverse views
Left panel demonstrates normal homogeneous echotexture
Right panel shows heterogeneity, fibrosis and hypoechogenicity typical of Hashimoto’s thyroiditis.
Pseudomicronodules

Small hypoechoic areas < 1cm represent lymphocyte infiltration and pseudomicronodules.
Pseudomicronodules

“Swiss Cheese” In this pattern the pseudonodules are more well defined and slightly larger. This is commonly misinterpreted as a multinodular goiter
Drug Induced Thyroiditis

This patient with metastatic melanoma was initially seen for an incidentally discovered right nodule which was benign. The left panel shows the normal left lobe at initial evaluation. Subsequently she was treated with Ipilimumab and developed thyroiditis after four months with typical sonographic changes of heterogeneity, fibrosis, and hypoechogenicity.
Hyperechoic Nodule

With background Hashimoto’s ➔ WHITE KNIGHT

Bonavita AJR 2009; 193:207-13
Hyperechoic with background of Hashi’s
Giraffe Pattern
Cleft Sign (aka Mitten Sign)

Thick hyperechoic fibrotic band separates the posterior and anterior components of the lobe in transverse view creating the appearance of a hypoechoic nodule (arrow) with hyperechoic halo (note: true halos are only hypoechoic)
In Sagittal view, it is evident that there is no discrete nodule.
Cleft Sign

In transverse view, there appears to be a hypoechoic nodule in the posterior aspect of the right lobe (arrow). In sagittal view, it becomes clear that a band of fibrosis created the appearance of a nodule (thin arrow).
Cleft sign w/ Tubercle of Zuckerkandl

Figure 22. The left panel shows a transverse view giving the appearance of a nodule in the posterior right lobe. The right panel sagittal view confirms this to be hyperechoic banding fibrosis, in this case with an extension at the inferior posterior aspect of the lobe representing a tubercle of Zuckerkandl (arrow) which frequently creates a more prominent cleft sign.
Tubercle of Zuckerkandl

Superior Parathyroid Gland

Tubercle of Zuckerkandl
Multiplicity

Multiple blocks of hyperechogenicity separated by bands of hypoechogeticity with low probability of malignancy

“Giraffe pattern” Bonavita AJR 2009
Multinodular Goiter

Enlarged thyroid with multiple sonographically similar nodules with little or no normal intervening parenchyma
Multinodular Goiter: Characteristics matter more than Size

A patient with multinodular thyroid has a similar risk of malignancy as a patient with a single thyroid nodule.
Multiplicity

Multiple discreet nodules need to be evaluated individually.
Parathyroid

- Hypoechoic
- Polar feeding vessel
- Shape conforms to thyroid
- Often posterior-medial to CCA
Parathyroid Adenoma
Transverse Cervical Spine Process

- Calcified “spike” in lateral neck
- Posterior shadowing
- Often indents SCM
- More frequently seen in women with thin necks
- Don’t confuse with a calcified lymph node
Sonographic Mimics
Zenker

ATA 2015 Guidelines

Nodule Evaluation is Based on RISK STRATIFICATION of PATTEN
ATA 2015: Nodule Sonographic Pattern Risk of Malignancy

High Suspicion 70-90%
- microcalcifications
- hypoechoic nodule, irregular margin
- hypoechoic, taller than wide
- hypoechoic, irregular margin, extrathyroidal extension
- hypoechoic, interrupted rim calcification, with soft tissue extrusion
- nodule with irregular margins, suspicious with internal lymph node

Intermediate Suspicion 10-20%
- hypoechoic solid regular margin
- hypoechoic solid regular margin

Low Suspicion 5-10%
- hyperechoic solid regular margin
- hypoechoic solid regular margin
- partially cystic with eccentric solid area
- partially cystic with eccentric solid areas

Very low Suspicion <3%
- spongelike
- partially cystic, no suspicious features
- partially cystic, no suspicious features

Benign <1%
- cyst

Haugen et al.; Thyroid, January 2016
HIGH Suspicion Pattern 70-90%

- Hypoechoic, microcalcs, irreg margin
- Hypoechoic, irreg margin (microlobulated/spiculated)
- Hypoechoic, irreg margin, taller than wide
- Hypoechoic, irreg margin, extrathyroidal extension
- Hypoechoic, interrupted rim calcification with soft tissue extrusion
- Irregular margins, suspicious left lateral lymph node
Intermediate Pattern 10-20%

Hypoechoic without:
• Microcalcifications
• Taller than wide shape
• Infiltrative borders
• Abnormal lymph nodes
LOW Suspicion Pattern 5-10%

- Hyperechoic solid reg. margins
- Isoechoic solid reg. margins
- Partially cystic with eccentric solid areas

WITHOUT: MicroCa, Irregular Margin, Taller than Wide or Extra-thyroidal Extension
VERY LOW Suspicion Pattern <3%

spongiform

partially cystic no suspicious features, note solid areas
BENIGN pure cyst
### R8 US Pattern and suggested FNA cutoffs

<table>
<thead>
<tr>
<th>Sonographic Pattern</th>
<th>Estimated malignancy risk</th>
<th>FNA size cutoff</th>
<th>Strength of rec</th>
<th>Quality of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>High suspicion</td>
<td>&gt;70-90%</td>
<td>≥ 1 cm</td>
<td>Strong</td>
<td>Moderate</td>
</tr>
<tr>
<td>Intermediate suspicion</td>
<td>10-20%</td>
<td>≥ 1 cm</td>
<td>Strong</td>
<td>Low</td>
</tr>
<tr>
<td>Low suspicion</td>
<td>5-10%</td>
<td>≥ 1.5 cm</td>
<td>Weak</td>
<td>Low</td>
</tr>
<tr>
<td>Very low suspicion</td>
<td>&lt; 3%</td>
<td>≥ 2 cm</td>
<td>Weak</td>
<td>Moderate</td>
</tr>
<tr>
<td>Benign</td>
<td>&lt; 1%</td>
<td>No biopsy</td>
<td>Strong</td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>FNA is not recommended for nodules that do not meet the above criteria, including all nodules &lt; 1 cm</strong></td>
<td></td>
<td></td>
<td>Strong</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

*One option is surveillance*

Haugen et al. Thyroid; January 2016
# R23 Follow-up of nodules with benign cytology

<table>
<thead>
<tr>
<th>Sonographic Pattern</th>
<th>Strength of rec</th>
<th>Quality of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High suspicion</strong></td>
<td>Strong</td>
<td>Moderate</td>
</tr>
<tr>
<td>Repeat US and US FNA within 12 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intermediate/ Low suspicion</strong></td>
<td>Weak</td>
<td>Low</td>
</tr>
<tr>
<td>Repeat US at 12-24m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If growth or new suspicious US feature, repeat FNA OR continued observation</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Very low suspicion</strong></td>
<td>Weak</td>
<td>Low</td>
</tr>
<tr>
<td>Utility of surveillance US and assessment of nodule growth as an indicator for repeat FNA is not known. If repeated, US should at &gt; 24 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IF 2nd US FNA done with benign cytology, US surveillance for continued risk of malignancy is no longer indicated</strong></td>
<td>Strong</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

*Haugen et al. Thyroid; January 2016*
## R24 Recommended follow-up of nodules that have not undergone FNA

<table>
<thead>
<tr>
<th>Sonographic Pattern</th>
<th>Strength of rec</th>
<th>Quality of evidence</th>
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</thead>
<tbody>
<tr>
<td><strong>High suspicion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeat US 6-12 months</td>
<td>Weak</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Intermediate/ Low suspicion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeat US at 12-24m</td>
<td>Weak</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Very low suspicion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 1cm: Utility and time interval of repeat US for risk of malignancy is not known. If repeated, do at &gt; 24 months</td>
<td>NO rec</td>
<td>Insufficient</td>
</tr>
<tr>
<td>&lt;1cm: Do not require routine US surveillance</td>
<td>Weak</td>
<td>Low</td>
</tr>
</tbody>
</table>

Haugen et al. Thyroid; January 2016