ULTRASOUND OF THYROID NODULES

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Evaluation and Analysis of Thyroid Nodules

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Thyroid Ultrasound

1. Diagnostic use compared to physical examination
2. US predictors of malignancy
3. US as a guide for what to FNA
Palpation is NOT sensitive or specific for detection of thyroid nodules

16% of patients with a palpable abnormality on PE will have no nodules on US

15% of patients will have another nodule on US that was not palpable on PE

How good are we at finding nodules?

Ultrasound vs. Palpation


<table>
<thead>
<tr>
<th>Nodule Size by US</th>
<th>Ultrasound (Nodules Found)</th>
<th>Palpation (Nodules Missed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1cm</td>
<td>94%</td>
<td></td>
</tr>
<tr>
<td>1-2cm</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>&gt;2cm</td>
<td>42%</td>
<td></td>
</tr>
</tbody>
</table>

Palpable Thyroid Nodules
Nonpalpable Thyroid Nodules
Not all that is palpable is a nodule.....
Thyroid Nodule Management Guidelines

Thyroid sonography should be performed in all patients with known or suspected thyroid nodules.
Strong recommendation, high-quality evidence

Haugen et al 2016 Thyroid 26: 1-133

US evaluation is recommended for patients who are at risk for thyroid malignancy, have palpable thyroid nodules or goiter, or neck lymphadenopathy suggestive of a malignant lesion.

Gharib et al 2016 Endo Practice 22: 622
US Prediction of Thyroid Cancer
Echogenicity

• Normal thyroid is homogeneously hyperechoic compared to the strap muscles
• Normal thyroid is of similar echogenicity to the submandibular gland
• Nodule echogenicity is defined relative to the normal thyroid (Hashi’s background)
  – Isoechoic
  – Hyperechoic
  – Hypoechoic Sensitivity 81%, Specificity 53%
  – marked hypoechogenicity, defined as relative to strap muscles

¹Kim et al, AJR 2002
Normal Thyroid Echogenicity

Sagittal View, Thyroid

Submandibular Gland
Echogenicity

- Isoechoic
- Hyperechoic
- Hypoechoic
- Anechoic
- Markedly Hypoechoic
Isoechoic nodule

Hypoechoic nodule

Markedly hypoechoic nodule\textsuperscript{1} [sensitivity 27\%, specificity 94\%]

\textsuperscript{1}Kim et al, AJR 2002
Iso- or Hyperechoic nodules

If uniformly solid or associated with an irregular halo → concerning for a neoplasm often a follicular or Hurthle cell adenoma or carcinoma

If associated with minute cystic spaces → hyperplastic

Slide courtesy of: S. Mandel
Hyperechoic area in thyroiditis

- Hyperechoic masses are usually benign (Hurthle cell aggregates)
- “white knight”

Posterior Acoustic Enhancement

- Posterior Acoustic Enhancement = Cystic
- Absence of posterior acoustic enhancement = solid
- Posterior acoustic enhancement in a solid nodule
Cystic change

- 30-50% of nodules have cystic change
- Simple cysts = rare <2%
Cystic change

• 360 thyroid cancers at Mayo Clinic:
  Solid: 78%
  <50% cystic: 19%
  >50% cystic: 3% and another suspicious sonographic feature present

\(^1\)Henrichsen et al, RSNA 2005
Spongiform nodules
Calcifications

Microcalcifications (psammomatous) in papillary thyroid cancer

Coarse calcifications in follicular thyroid cancer
Microcalcifications

• multiple bright ($\leq 1$ mm) echoes without shadowing usually in a HYPOechoic nodule
• pitfall: colloid with reverberation artifact (“comet tail”) in a hyperplastic nodule
Punctate Calcifications
Comet-tail artifact
Coarse calcifications

- Larger than 1mm—look for posterior signal dropout
- Coarse calcifications common in lymphocytic thyroiditis secondary to dystrophic calcifications
- Present in parenchyma WITHOUT associated nodule
- Concerning for malignancy if mixed with microcalcifications or present in a SOLID nodule
Other calcifications

Eggshell

Signal drop-out
Eggshell calcifications

Complete, regular or “eggshell”

Interrupted

Papillary cancer

Follicular cancer

Usually benign
NOT microcalcifications!!!

Small hyperechoic linear streaks just posterior to small cystic area → posterior acoustic enhancement!
Association of Calcifications with Malignancy c/w with Absence of Calcifications

- Micro calcifications - 3x risk
- Central coarse calcifications - 2x risk
- Peripheral/eggshell calcifications - 2x risk

Frates MC et al, J Clin Endo Metab 2006; 91:3411-3417
US Prediction of Thyroid Cancer

Margins

• Well-defined and regular
• Infiltrative, spiculated, microlobulated\(^1\)
  – Sensitivity 55\%, Specificity 79\%
  – some malignant nodules have a predominately regular border but are irregular in only small portion requiring high-resolution technique
• Irregular is NOT the same as INFILTRATIVE

\(^1\)Kim et al, AJR 2002
Infiltrative Borders
Blurred margins
US Prediction of Thyroid Cancer

Halo

• Hypoechoic or sonolucent rim surrounding the nodule (thought to represent the compressed perinodular vessels)
  – present
  – absent—suggestive of an infiltrative malignancy

Sensitivity 66%, Specificity 43%

• A thick, irregular halo is more suggestive of a neoplasm (CAPSULE --follicular or Hurthle cell carcinoma or adenoma; encapsulated papillary cancer)¹

¹Cerbone et al, Hormone Res 1999
Thin halo

Thick, irregular halo

Thin halo is compressed blood vessels

Follicular cancer
Halo

Absent Halo

Absent Halo
US Prediction of Thyroid Cancer

Taller than wide

- Nodule is taller than wide on the transverse view

Kim AJR 2002; Cappelli Clin Endocrinol 2005; Moon Radiology 2008
Height greater than width
## US Predictors of Malignancy for Thyroid Nodules

<table>
<thead>
<tr>
<th>US feature</th>
<th>Mean sensitivity (range)</th>
<th>Mean specificity (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased flow</td>
<td>77 (57-92)</td>
<td>79 (35-97)</td>
</tr>
<tr>
<td>Irregular borders</td>
<td>58 (48-78)</td>
<td>85 (74-95)</td>
</tr>
<tr>
<td>Taller than wide</td>
<td>58 (33-84)</td>
<td>81 (60-92)</td>
</tr>
<tr>
<td>Hypoechogenicity</td>
<td>53 (26-87)</td>
<td>73 (43-94)</td>
</tr>
<tr>
<td>Microcalcifications</td>
<td>42 (29-59)</td>
<td>91 (86-95)</td>
</tr>
</tbody>
</table>

*Review of 15 large studies*

Sipos JA, Thyroid 2009;19:1363-1372
Benign <1% FNA not indicated

Simple Cysts

Haugen et al 2015 Thyroid
Very low suspicion
<3%
FNA ≥2cm

Partially cystic no suspicious features

Spongiform

Haugen et al 2015 Thyroid
Low suspicion
5-10%
FNA $\geq$ 1.5cm

Hyperechoic solid regular margin

Isoechoic solid regular margin

Partially cystic with eccentric solid

Haugen et al 2015 Thyroid
Sonographic features
Papillary vs Follicular Thyroid Cancers

Jeh 2007 Korean J Radiol 8: 192-7
Sonographic features
FVPTC vs Conventional PTC

Intermediate Suspicion

10-20%

FNA $\geq 1\text{cm}$

Hypoechoic solid, regular margin

Haugen et al 2015 Thyroid
High Suspicion
70-90%
FNA ≥1cm

Solid hypoechoic nodule or a solid hypoechoic component in a partially cystic nodule with one or more features: irregular margins, microcalcifications, taller than wide shape, disrupted rim calcifications or ETE

Haugen et al 2015 Thyroid
Summary

• US of the neck for all patients suspected of having a thyroid nodule
• Individual sonographic features for characterization
• Pattern recognition for malignancy risk