Ultrasonography of the Neck as an Adjunct to FNA

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Basic Features of Head and Neck Ultrasound and Anatomy

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Objectives

• High points of how to get the best image
• Optimizing the US exam
• Normal head and neck ultrasound anatomy
• Ultrasound features of thyroid nodules
Basis of US

• The generation of ultrasound images relies on sound reflection from interfaces between tissues with different acoustical characteristics.
Basics of US

• The amount of energy reflected at interfaces depends on the difference in acoustic impedances between the two media.

• The larger the difference in the impedances the larger the reflection.
Basics of US

• Since the basis of US is the detection of reflected sound energy, anything that attenuates the energy of the returned waves limits the depth of penetration.

• Sound waves are characterized by the term frequency (Hz).
Artifacts of US Anatomy

- Air has a very high attenuation, thus the hypoechoic appearance within the trachea.
- The carotid has a relative lack of attenuation through the blood, thus producing a hyperechoic posterior enhancement.
- Reverberation artifacts can be seen at the trachea due to closely spaced interfaces with significantly mismatched acoustic impedances (tracheal rings and thyroid).
Physics

• $R = (Z_2 - Z_1)^2 / (Z_2 + Z_1)^2$

• $10 \times \log_{10}(0.01 / 100) = 10 \times \log_{10}(0.0001)$

• $f_D = f_0 \left(\frac{2v}{c}\right) \cos 0$

• $(JuS)^T / k\mu D$ (in G)
Optimizing the US Exam

• The transducer:
  – A “small parts” transducer at a frequency of 7.5 to 15 MHz or greater. This high frequency results in greater resolution at the expense of depth penetration. Lower frequencies allow deeper penetration of the sound wave.

  – The majority of anatomic structures in the neck are within 4cm of the skin so loss of penetration is usually of little concern.
US Features

• Gain:
  – Refers to the overall brightness of the image on the screen.
  – If the gain is too high, the image is bright (white) - hyperechoic.
  – If the gain is too low, the image is dark – hypoechoic.
US Features

• Color-flow Doppler:
  – Identification of blood vessels vs lymph nodes or ducts
  – Assessing the vascularity of structures
    • Can be helpful in benign vs malignant
Performing The Ultrasound
Normal Head and Neck Anatomy
Starting View
Right Lobe Transverse

Sternohyoid

Sternothyroid
Right Strap Muscles
Longitudinal Thyroid

Subcutaneous fat

Strap muscles
Left Lobe transverse

Strap muscles
Left Transverse
Transverse and Longitudinal Carotid Strap muscles
Lateral to the Carotid
Ultrasound Features of Thyroid Nodules
Ultrasound Anatomy Quiz
Adding Ultrasound to your FNAs
Performing the FNA

- Localize the nodule with U/S
- Skin Prep with sterile technique
- Local anesthetic

Benign complex thyroid nodule
Performing the FNA

- Visualize needle placement with U/S guidance
- Perform aspirations
  - Slide and cytology/cell block preparation
Placement of the needle

Long axis technique

Short axis technique
Long axis technique

• Goal: Line up the needle parallel to the long axis of the probe
• Enter the skin in the center of the short axis of the probe
Long axis technique

• Advantages
  • Working in one plane
  • Better visualization of entire needle

• Disadvantages
  • Needle travels longer distance to get to the nodule
  • Adjacent structures may obstruct
  • May require working in planes other than the axial plane
Short axis technique

- **Goal:** Line up the needle parallel to the handle of the probe
- **Enter the skin in the center of the long axis of the probe**
Short axis technique

• **Advantages**
  • Needle travels shorter distance to get to the nodule
    • Less likely for adjacent structures to obstruct
  • Easier to access nodule under bony structure i.e. mandible or sternoclavicular bone

• **Disadvantages**
  • More complex image-working in 2 planes
  • Needle is more difficult to visualize due to less of it in the field of view and results in decreased echo due to angle of approach
Ultrasound Features of Thyroid Nodules
Features

- Heterogeneity
- Circumscribed
- Calcifications
- Blood flow
Heterogeneity

Longitudinal view
Case 1

- Rubbery nodule in medial left lobe
- Freely mobile upon swallowing, well delineated
- No lymphadenopathy
- TSH 1.5

Radiology. 2005 Dec;237(3):794-800
Case 1

FNA =
Benign colloid nodule
Spongiform Nodule

Malignant Features

Table 2
Ultrasonographic Characteristics Associated With Malignant Involvement in Thyroid Nodules

- Hypoechogenicity
- Microcalcifications
- Irregular or microlobulated border
- Absent or irregular thick halo
- Increased intranodular vascularity
<table>
<thead>
<tr>
<th>Ultrasound Findings</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
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</thead>
<tbody>
<tr>
<td>Microcalcifications</td>
<td>29</td>
<td>95</td>
</tr>
<tr>
<td>Irregular margins</td>
<td>77.5</td>
<td>85</td>
</tr>
<tr>
<td>Intranodular vascular images</td>
<td>74.2</td>
<td>80.8</td>
</tr>
</tbody>
</table>
Internal Doppler flow

Radiology. 2005 Dec;237(3):794-800
Microcalcifications

- Punctate echogenicities
- Papillary thyroid carcinoma
- Comet-tail artifact
- Benign nodule
Calcifications
Benign complex nodules
Multinodular goiter

- Risk of cancer in a patient with a multinodular goiter is the same as a patient with a solitary nodule

- Should biopsy the most suspicious nodules, up to four or five nodules
Biopsying the largest nodule in a patient with 2 nodules would have missed 13.7% of cancers. In patients with 3 nodules, 48.2% of cancers would have been missed by biopsying only the largest nodule.

<table>
<thead>
<tr>
<th>FNA performed on</th>
<th>No. of nodules &gt;10 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 (n = 73)</td>
</tr>
<tr>
<td>Largest nodule</td>
<td>86.3</td>
</tr>
<tr>
<td>Largest 2 nodules</td>
<td>100</td>
</tr>
<tr>
<td>Largest 3 nodules</td>
<td>100</td>
</tr>
<tr>
<td>Largest 4 nodules</td>
<td></td>
</tr>
</tbody>
</table>

Results are percentages.
Questions?
Case 2

Increased central Doppler flow -- Papillary thyroid carcinoma

Radiology. 2005 Dec;237(3):794-800
Case 2

FNA = Metastatic PTC

Level III lymph node

Radiology. 2005 Dec;237(3):794-800
Case 4

FNA
Indeterminate
Summary

- Ultrasounds can add to the nodules that cytopathologists can biopsy.
- Adds a level of comfort to knowing you are in the lesion.
- Helps identify nodules that are suspicious