Uses of Ultrasound Outside of Radiology

<table>
<thead>
<tr>
<th>Specialty</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anesthesiology</td>
<td>guide injecting needles when placing local anaesthetic solutions near nerves</td>
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<tr>
<td>Cardiology</td>
<td>an essential to diagnose e.g. dilatation of parts of the heart and function of heart ventricles and valves</td>
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<tr>
<td>Emergency Medicine</td>
<td>assessing significant hemoperitoneum or pericardial tamponade after trauma and right upper quadrant abdominal pain who may have gallstones or cholecystitis.</td>
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<tr>
<td>Obstetrics</td>
<td>commonly used during pregnancy to check on the development of the fetus</td>
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<tr>
<td>Pulmonology and Gastroenterology</td>
<td>EBUS-FNA and EUS-FNA</td>
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<tr>
<td>Pathology</td>
<td>US-FNA</td>
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Ultrasound

- Sound waves with frequencies higher than those audible to humans (>20,000 Hz)
- Ultrasonic images are made by sending pulses of ultrasound into the tissue via a probe
- The sound echoes off the tissue, with different tissues reflecting varying degrees of sound waves
Advantages and Disadvantages to Ultrasound

- Images in real-time
- Portable - can be brought to the bedside
- Substantially lower in cost than CT/MRI
- Does not use harmful ionizing radiation
- Requires patient cooperation
- Difficulty imaging structures behind bone and air
- Requires a skilled operator.

Ultrasonix Touch

General Principals of Pathologist use of US for FNA

- For visualizing the mass and assessing its characteristics
  - Not for formal interpretation and reporting of US features for diagnosis
- For guiding the needle into the lesion when needed
  - May not be needed
  - Information from evaluation still valuable
How Ultrasound works

- Frequency
- Wavelength
- Attenuation (intensity)
- Penetration
- Resolution

High frequency for subcutaneous masses (14 MHz)
Medium frequency for deeper masses (10 MHz)

Ergonomics of USFNA

- An US machine should be positioned on the opposite side of the patient’s lesion, with the operator standing on the same side that needs to be examined.
- The transducer is usually held in the operator’s non-dominant hand, with the needle in the dominant hand.
- The transducer should gently be held quite low on the probe, close to the scanning surface, rather than harshly gripped on the top of the handle.
**USFNA Approaches**

- Parallel approach
- Perpendicular approach

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**Basic Principles of US Characteristics**

Echogenicity: ability to reflect or transmit US waves in the context of surrounding tissues. 6 types of echoes:

<table>
<thead>
<tr>
<th>Term</th>
<th>Compared to Normal</th>
<th>Example</th>
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</thead>
<tbody>
<tr>
<td>Hyperechoic</td>
<td>More echoes: Brighter</td>
<td><img src="image" alt="Hyperechoic Example" /></td>
</tr>
<tr>
<td>Hypoechoic</td>
<td>Less echoes: dimmer</td>
<td><img src="image" alt="Hypoechoic Example" /></td>
</tr>
<tr>
<td>Anechoic</td>
<td>No echoes</td>
<td><img src="image" alt="Anechoic Example" /></td>
</tr>
<tr>
<td>Isoechoic</td>
<td>Equal echoes: same</td>
<td><img src="image" alt="Isoechoic Example" /></td>
</tr>
<tr>
<td>Homogeneous</td>
<td>Diffusely similar echoes</td>
<td><img src="image" alt="Homogeneous Example" /></td>
</tr>
<tr>
<td>Heterogeneous</td>
<td>Different echoes throughout</td>
<td><img src="image" alt="Heterogeneous Example" /></td>
</tr>
</tbody>
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**Acoustic enhancement and Shadowing**

- An artifact that occurs due to the lack of impedance when echoes pass through fluid resulting in increased echoes from underlying structures, e.g., cyst fluid and other structures with poor attenuation, often (but not always) a BENIGN finding.
- An artifact that occurs when echoes are reflected back causing a window in the underlying tissue, e.g., calcifications, cancer, and other structures with high attenuation, often (but not always) a MALIGNANT finding.
Features Favoring Benign

- Sharp and smooth margins
- Posterior acoustic enhancement
- Homogeneous echo pattern or no echoes
- Compression effect on shape and internal echoes
- Wider than tall

Features Favoring Malignant

- Jagged, indistinct margins
- Posterior Acoustic shadowing
- Heterogeneous echo pattern
- No compression effect on shape or internal echoes
- Taller than wide

Normal Thyroid Anatomy

Right Neck Axial View:
1. Right thyroid lobe
2. Thyroid isthmus
3. Carotid
4. Jugular
5. Trachea
6. Strap muscles
7. SCM
8. Longus coli muscle
Nodular Hyperplasia of Thyroid

Sonographic Features that favor a nodule is benign:
Well-defined smooth border.
Mostly cystic with multiple septations.

Nodular Hyperplasia of Thyroid

Sonographic Features that favor a nodule is benign:
Well-defined smooth border.
Mostly solid with small cystic component.
Isoechoic or hyperechoic.
Thin uniform halo.

The Halo

A completely uniform halo around a nodule is highly suggestive of benignity, with a specificity of 95%.
However, a halo is absent in more than half of all benign thyroid nodules.
BUT, 10%–24% of papillary thyroid carcinomas have either a complete or an incomplete halo.

Hypoechocic rim.
Produced by pseudocapsule of fibrous connective tissue, chronic inflammation, and compressed thyroid parenchyma.
Papillary Thyroid Carcinoma

Partial halo, seen in 10-24% of PTC

Benign nodule with colloid crystals.

“Comet Tail Artifact”

MacroCA++

> 2mm

Papillary thyroid carcinoma.

Microcalcifications (<2mm) suspicious for malignancy.
The “Ring of Fire”

Usually associated with benign nodules, but is variable.

Can be used to confirm presence of an isoechoic nodule.

Color Doppler image of peripheral hypervascularity.

Malignant Vascularity

Central vascularity greater than peripheral

Target Solid Component of Solid and Cystic Nodules

...
Ultrasound of the Parotid

- Superficial lobe readily imaged.
- Deep lobe not easily visualized; partly obstructed by mandible.
- Retromandibular vein used to separate superficial and deep lobes.
- Facial nerve not seen, but location inferred (plane just superficial to retromandibular vein).

Accessory parotid tissue (20% of patients) is found along parotid duct.

The parotid duct runs across the cheek, from the deep lobe (earlobe level) to the ampulla adjacent to the upper 2nd molar tooth.

The parotid duct will not be visualized unless dilated.

Transverse view of left parotid
Longitudinal view of left parotid gland

Left Parotid Gland

Lymph node in left Parotid Gland

A normal lymph node embedded within the Parotid gland. The parotid gland is far more ectopic than the submandibular gland and may contain embedded lymph nodes. The submandibular gland term’s earlier embryology and should never contain other tissue.
Parotid: Pleomorphic adenoma

Hypoechogenic.
Relatively homogeneous.
Well-circumscribed.
Posterior enhancement.
May be lobulated.
Peripheral vasculature.

This lesion is located in the superficial lobe.

Enlarged pleomorphic adenoma may mimic malignancy

Large.
Hypoechogenic internally.
Focally ill-defined margins.

Also possible:
Internal calcifications.
Cystic change.

Parotid Oncocytoma

Sonographic features are similar to those of pleomorphic adenoma.
**Parotid Warthin Tumor**

Sonographic features are similar to those of pleomorphic adenoma:
- Hypoechoic
- Heterogeneous
- Well-circumscribed
- Posterior enhancement
- May show cystic changes

**Parotid Malignancy**

- Ill-defined mass.
- Heterogeneous.
- Hypoechoic.
- Extracapsular extension (arrows).

Dx: Acinic cell carcinoma.

**Small low grade malignancies can mimic benign tumors**

- Low-grade mucoepidermoid carcinoma of parotid.
- Sonographically similar to typical pleomorphic adenoma appearance.
Example of abnormal vascularity

Parotid mass:
Hypoechocic
Solid
Posterior enhancement
Chaotic internal vascularity

Dx: B-cell lymphoma
(Arrow: reactive appearing node with echogenic hilum and hypoechoic cortex)

Lymph nodes

Normal Intraparotid Lymph Node

Hypoechoic, oval.
Echogenic hilus is continuous with adjacent soft tissue.
Normal Posterior Triangle Node

Reactive Neck Lymph Node

Doppler of Reactive Node

Hypoechoic, elliptical, echogenic hilus.

Hypoechoic, oval, echogenic hilus.

Vessels begin in hilus (arrows) and branch out radially toward node periphery.
Neck node partially involved by metastatic breast carcinoma

Oval, eccentric cortex, no echogenic hilus.

Neck node with metastatic lung carcinoma

Hypoechoic, round, taller than wide, no echogenic hilus.
Discrete-appearing echogenic focus is necrosis (arrowheads).

LN with metastatic carcinoma

Hypoechoic, round (arrows), no echogenic hilus.
Multifocal cystic necrosis (arrowheads).
Non-Hodgkin Lymphoma

Hypoechogenic, round, no echogenic hilus, intranodal reticulation (micronodular appearance, arrows).

LN involved by carcinoma

Ill-defined borders (arrows) = extracapsular spread.

Doppler of LN involved by carcinoma

Peripheral vascularity with branches that perforate into lymph node parenchyma.
Normal inguinal nodes

Medial aspect: Lymph node (arrows), with fatty hilum (Hi).
Lateral aspect: Femoral artery (A) and femoral vein (V).

Reactive inguinal lymph node

Inguinal LN with B cell lymphoma

Round enlarged node, no visible hilum, notable peripheral vascularity.
Inguinal LN with B cell lymphoma

- Large irregular mass
- Highly vascularized

Not everything round is a node

Schwannoma in the groin, mistaken for an inguinal lymph node.

Example Cases
Case 1

- 86 year old mass presents with a parotid mass. He was sent to the FNA clinic for diagnosis.

Physical Exam

- The patient appeared well-developed, well-nourished, and in no acute distress.
- The right parotid gland showed an approximately 1 cm minimality-tender, well-defined, round, rubbery and fixed nodule. It was barely palpable.
- Ultrasound was used to evaluate the lesion and showed a 1.7 x 0.9 cm lesion that was well-defined, round, heterogeneously hypoechoic without significant internal vascularity.
- US-FNA was successful with 1 pass.
Diagnosis

- Oncocytoma
- Patient did not need a more expensive or invasive diagnostic procedure.
- Surgery avoided.
Case 2

- 85 year old man presented with a large, complex solid and cystic mass in the neck. He was sent to the FNA Clinic for biopsy and diagnosis.

Physical Exam

- Constitutional: generally feeling well.
- Physical Exam: Constitutional: The patient appeared well-developed, well-nourished, and in no acute distress. He presented with a 6 day history of this growing mass.
- The right neck showed an approximately 7 cm complex lesion that was tender, ill-defined, irregular rubbery and fixed
- Ultrasound was used to evaluate the lesion and showed an approximately 8 cm complex lesion that was ill-defined, irregular, solid and cystic heterogeneously hyperechoic and hypoechoic without significant internal vascularity. Within the lesion is an enlarged lymph node measuring 2 x 2 cm.
- Clinical suspicion was that the mass was a hematoma but US showed the enlarged node in the mass, which was targeted.
Ultrasound

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Flow Cytometry

Diagnosis

• Satisfactory for Evaluation
• Positive for Malignancy
• Non Hodgkin lymphoma, favor low-grade follicular lymphoma
IHC

CD20, PAX5, CD10, BCL6, MUM1, CD5, CD30, MYC

HPC 30%
Ki67 70%

Diffuse Large B cell lymphoma- germinal center B-cell like type

Summary

- Ultrasound is available to practicing physicians in every medical specialty
- For pathologist-run FNA Clinics, ultrasound provides a tool to improve diagnostic yield and insure sampling of the mass
- Pathologists do not provide a diagnostic ultrasound report, but need to have a basic understanding of ultrasound principles for effective utilization in the clinic

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