Ultrasound Guided Percutaneous Biopsy of the Breast

Objectives

• State rationale for performing image guided biopsies
• List steps to accurate and safe performance of image guided biopsy
• Describe pitfalls in performing image guided biopsy

The challenge of breast cancer detection

• In US, 275,000 new cases each year, 41,000 deaths
• Nearly 1 million breast biopsies performed each year
• Mammography PPV 20-25%
• Ultrasound PPV 10%
• Important to minimize morbidity

Percutaneous Breast Biopsy

• Accurate pathologic diagnosis
• Minimally invasive
  • Minimizes surgery
    • no surgery if benign
    • definitive lumpectomy if malignant
  • Minimizes morbidity, patient inconvenience
• Biopsy devices
  • 14 G automated core needle biopsy
  • Directional vacuum assisted biopsy device

Importance of Image Guided Percutaneous Biopsy

• Nonpalpable screening detected findings
  • Image guidance required to target finding for biopsy
• Palpable findings
  • Palpation alone may not target the mass from overlying parenchyma
• Image guidance
  • Precisely targets the abnormality for palpable or non-palpable masses

Accuracy

14 Gauge core needle, 1352 cases (2008)

• 98.5% sensitivity
• False negative 1.6% (all identified prospectively)
• 6% were high risk lesions requiring excision (31% upgraded at excision)

Sensitivity of 14 G biopsy

Youk et al, Radiographics 2007

<table>
<thead>
<tr>
<th>Study/Year*</th>
<th>No. of Cancers</th>
<th>No. of Cancers Seen at Core Biopsy</th>
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<tbody>
<tr>
<td>Park et al 1993 (7)</td>
<td>34</td>
<td>34 (100)</td>
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<tr>
<td>Liberman et al 1998 (9)</td>
<td>56</td>
<td>56 (100)</td>
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<tr>
<td>Smith et al 2001 (9)</td>
<td>128</td>
<td>24 (97)</td>
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<td>Mahfouz et al 2002 (10)</td>
<td>128</td>
<td>119 (93)</td>
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<td>Berg et al 2003 (11)</td>
<td>567</td>
<td>145 (26)</td>
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<td>Schwartz and Ferris 2001 (12)</td>
<td>265</td>
<td>254 (96)</td>
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<tr>
<td>Badernejad et al 2002 (13)</td>
<td>272</td>
<td>254 (93)</td>
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<td>Chryso et al 2005 (14)</td>
<td>325</td>
<td>111 (34)</td>
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<tr>
<td>Total</td>
<td>2518</td>
<td>1456 (58)</td>
</tr>
</tbody>
</table>

*Numbers in parentheses indicate reference numbers.
*Numbers in parentheses indicate percentages.

History of percutaneous biopsy

• By 1914, needle aspiration biopsy used for lung and lymph nodes
• With increased use of mammography:
  – 1970’s: Stereotactic device introduced

Methods of Guidance for Percutaneous Biopsy

• Palpation
• Mammography
  – Grid
  – Stereotactic
• Ultrasound
• MRI

Ultrasound Guided Biopsy - Advantages

• Utilizes existing equipment
• Quick procedure (20-30 minutes total room time)
• Comfortable position for most patients
• Accesses masses that are inaccessible to or invisible on mammography
• Disadvantage: Significant learning curve
  – Requires excellent sonographic skills (both scanning and interpretation) and hand-eye coordination

Ultrasound Guided Biopsy

lesion difficult to approach on mammography

Ultrasound Guided Biopsy

lesion difficult to approach on mammography
Ultrasound Guided Biopsy
lesion difficult to approach on mammography

Ultrasound Guided Biopsy:
Implants
Precise aim with US guidance

Ultrasound Guided Biopsy
lesion difficult to approach on mammography

Fundamentals of Ultrasound Guided Percutaneous Biopsy of the Breast

The Breast Needle Biopsy Program
• Clinical protocols
  – Patient selection (medications, tolerance)
  – Abnormality selection
  – Modality for image guidance
  – Pathology correlation and recommendations
  – Patient notification and follow-up instructions
  – Practice audit

The Breast Needle Biopsy Program
• Administrative protocols
  – Consent form
  – Pre-biopsy instructions
  – Post-biopsy instructions
  – Scheduling protocols
  – Specimen handling
  – Record keeping
  – Quality assurance
The Breast Needle Biopsy Program

• Modalities for image guidance
  – Depends on available equipment
  – Ultrasound
    • High resolution linear transducer, minimum 10MHz
  – Stereotactic
    • Upright add-on
    • Dedicated prone unit
  – MRI
    • Breast coil with localizing device, biopsy needle

Fundamentals

• Technique of biopsy
  – Operation of biopsy device is simple for any image modality
• Image guidance for biopsy
  – Evaluating location of biopsy device relative to target is challenging for all modalities
  – Correct evaluation guarantees that correct area is sampled
  – Requires high level expertise in ability to interpret the modality used for guidance

Fundamentals of image guided biopsy

• Indirect (Image guidance) vs. direct visualization
• Requires expertise in the imaging modality
• Concerns of image guided biopsy:
  – Are you actually seeing the area of concern?
  – Did you aim the needle appropriately?
  – Did the needle subsequently sample the right area?

Preparation for Needle Biopsy

• Pre-biopsy screen for:
  – Anticoagulant use
  – Bleeding disorder
  – Allergies/sensitivities
• Obtain informed consent
  – Describe procedure
  – Describe alternative diagnostic methods
  – Describe known complications
    • Bleeding, infection
    • High risk lesion requiring excision
    • Sampling error
  – Allow patient to ask questions
• Pre-scan the patient
• Determine the best approach
  – Consider
    • Location of lesion
      • Relation to chest wall
    • Tissue density/firmness
      • Approach from periphery usually traverses less glandular tissue
    • Comfort
      • Yours and hers!
Patient Positioning

- Supine or semi upright, flat or oblique
- Ipsilateral arm raised over head
- Change position to achieve best approach
  - Area of interest should be
    - As flat as possible
    - As accessible as possible
    - As ergonomic as possible
  - Make patient as comfortable as possible

Prepare the procedure tray

- Skin cleansing solution
- Sterile drape
- Sterile probe cover
- Sterile gel or iodine solution as coupling agent

Local Anesthesia

- 1% lidocaine or xylocaine (lidocaine and epinephrine)
- deliver anesthetic
  - 1-3cc superficially at needle insertion site, 25 g needle
  - 10 cc along anticipated biopsy track, 20 g spinal
  - Image during injection of anesthetic
    - Confirm adequate approach
    - Observe changes in appearance of target

Image while administering deep lidocaine

- Observe approach
- Observe post lidocaine appearance
- Confirm adequate infiltration of biopsy track
- Manipulate lesion

Core Biopsy Technique: Aesthetics

- Consider location of skin nick
  - periareolar
  - avoid upper inner quadrant
- Minimize size of skin nick
- Cosmetically acceptable scars
  - follow contour of Langer’s lines

Biopsy devices

- 14 G Automated core needle
  - Advantages
    - Less expensive
    - No bulky equipment
  - Disadvantages
    - May need more specimens to ensure sampling
    - Therefore possible longer procedure time
- Vacuum-Assisted
  - Advantages
    - Larger cores
    - Complete sampling in fewer passes
    - Shorter procedure time
  - Disadvantages
    - May remove entire lesion
    - More expensive
    - Bulky equipment
US Guided Vacuum Assisted Biopsy

Relative Size of Specimens
11 g vacuum assisted vs 14 g core biopsy specimens

Clip Placement
- To mark site of biopsy
  - For future localization in cases of malignancy
  - To define area of biopsy for future follow-up imaging
- To mark site of cancer treated with neoadjuvant chemotherapy
- Gel based/titanium visible on US, mammo, and MRI

Post-Biopsy Care
- Manual compression after each sampling
- Steri-strip on skin nick
- Pressure dressing
- Ice pack
- Avoid strenuous activity for 24 hours
- Watch for excessive bleeding, pain, fever
Techniques for Ultrasound Guided Percutaneous Biopsy of the Breast

Ultrasound Guided Biopsy-Technique

- Patient position to facilitate sonographic approach and patient comfort
- Identify abnormality
- Pick approach based on safety, ergonomics
- Prepare skin site, anesthesia, make skin nick
- Position needle, acquire tissue
- Confirm needle position in mass post-fire

Fundamentals: Positioning and approach of needle

Early technique

Positioning of the Needle: Longitudinal approach

- Entire length of needle should be visible
- Needle path ideally approaches a parallel course relative to chest wall
  - To best visualize the needle
  - To avoid chest wall trauma and pneumothorax
Steps to a successful biopsy:
14 G automated core needle
- Image target
- Aim at target
- Deploy device
  - Fire gun (automated core needle)
- Confirm post fire location
  - Most accurate assessment with 2 views: long axis and orthogonal views
- Acquire tissue

Image target:
Plan approach

Note dimension on sag vs. trv view: pick approach with bigger target

Aim at target

Difficult to confirm needle in mass
Confirms needle in mass

Fire: mass and tissue will shift
Re-assess position of needle in 2 views
After biopsy device is deployed and location confirmed

• Remove needle
• Remove specimen from needle
• Place specimen in formalin container
• Repeat for desired number of specimens
  – Number depends on assessment of adequacy of sampling on each post fire image
• Hold pressure (5-10 minutes)
• Steri strips on skin nick; gauze pressure dressing or elastic wrap

Steps to a biopsy:
Directional vacuum assisted device

• Image target
• Aim at target
• Deploy device
  – Confirm post deployment location
  – Most accurate assessment with long axis and orthogonal views
• Open specimen chamber
• Acquire tissue

Image target:
Plan approach

Place biopsy device within or under mass; check position in orthogonal view

Sample mode

After biopsy device is deployed and location confirmed

• Remove needle
• Remove specimen from needle
• Place specimen in formalin container
• Repeat for desired number of specimens
  – Number depends on assessment of adequacy of sampling on each post fire image
• Hold pressure (5-10 minutes)
• Steri strips on skin nick; gauze pressure dressing or elastic wrap, ice packs
Challenges in US guided breast biopsy

- Visualizing needle
- Lining up needle and target
- Creating and maintaining safe approach along chest wall
- Confirming accurate position after sampling
- Pathology correlation

Helpful hints on visualizing biopsy needle

Best visibility of needle when parallel to transducer

Further Improvement: Needle Visualization

- Linear objects produce brighter echoes when insonated perpendicular to the US beam

Visualization of 25 g needle in phantom

- Close to parallel to transducer face
- Nearly 90 degrees to transducer face
Lining up the needle with the target

Ideal Needle Placement
Mass successfully targeted

Ultrasound image

Bird's eye view

Needle Askew
Mass missed

Ultrasound image

Bird's eye view

If your needle is askew…

Look at your hands
Note orientation of needle to transducer

Rotate and position needle under and parallel to the transducer

Transducer askew
Mass Missed

Ultrasound image

Bird's eye view
Look at your hands
Note orientation of transducer to target

Rotate transducer to see mass

Rotate and position needle under the transducer

Needle and transducer lined up but can't see needle

Ultrasound image

Bird's eye view

Transducer is rocked or angled

Pitfall of needle visibility:
Needle track from previous sample, not to be confused with actual needle during next pass

Creating and maintaining safe approach along chest wall

Ideal longitudinal approach

Ideal longitudinal approach
Approach too steep

Supoptimal approach: angle of needle aims at chest wall

Difficult suboptimal approach

Needle approach is straighter but still close to pectoral muscle. If this is only available approach, place copious lidocaine under mass to lift it off chest wall
More optimal approach with this region of chest wall

Tricks to maintain safe longitudinal approach while minimizing length of needle course through tissue

Limiting Distance of Needle Excursion

• Think of needle as a lever
• Take advantage of the malleable nature of the breast

Parallel to chest wall but far from mass

Start closer to mass but too steep

Advance part way to mass then lever needle into parallel course
Keep pressing down (gently) till needle is near parallel to chest wall.

Then biopsy.

Confirming accurate sampling of target.

Aim at target.

Fire: mass and tissue will shift. Re-assess position of needle in 2 views.

Difficult to confirm needle in mass. Confirms needle in mass.
Why re-assess needle position?
Pre-fire: perfect position
Post-fire may still miss

Needle motion can shift mass and tissue during firing

Pre-sample placement
Sample mode

Need orthogonal view to confirm needle location in mass
US image shows needle apparently in mass

Another way to confirm needle in mass: “bent” needle

Pathology Correlation
Pathology Correlation

- Accurate correlation depends on accurate targeting at time of biopsy
- Pathology result should satisfactorily explain the lesion
- Consider sampling error if pathology does not fit with imaging
- Refer high risk lesions to surgical excision
- Routine follow up for concordant benign

Pathology Correlation

- 6-10% of core needle biopsies require surgical excision
- About 1/3 of high risk lesions are upgraded at surgical excision

High Risk Lesions: Excision Recommended

- Atypical ductal hyperplasia (ADH)
- Atypical lobular hyperplasia and lobular neoplasia
- Radial scar
- Phyllodes tumor
- ± Lobular carcinoma in situ (LCIS)
- ± Papillary lesions

Summary: Ultrasound guided percutaneous breast biopsy

- Standard of care for minimally invasive diagnosis of breast masses
- 98.5% sensitivity, 1.6% false negative (compare with surgical excision)
- Requires expertise in US imaging and biopsy techniques
- With careful technique and correlation, minimal morbidity for breast cancer diagnosis