ADVANTAGES OF ULTRASOUND GUIDED PERCUTANEOUS BREAST BIOPSY

- Accurate pathologic diagnosis
- Accurately targets abnormality for image detected as well as palpable findings
- Minimally invasive
  - Minimizes surgery and morbidity
  - Surgery if benign (up to 80%)
  - One surgery if malignant (lumpectomy)

ADVANTAGES OF IMAGE GUIDED PERCUTANEOUS BREAST BIOPSY

- Minimizes patient inconvenience
- Minimizes cost (surgical biopsy can cost up to 5X as much)

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
  - 1980's: Automated core biopsy guns, paired with US and stereotactic imaging

METHODS OF GUIDANCE FOR PERCUTANEOUS BIOPSY

- Palpation
- Stereotactic
- DBT Guided
- Ultrasound
- MRI

STEREOTACTIC BIOPSY

- Stereotactic needle aspiration biopsy used for lung and lymph nodes
- With increased use of mammography:
  - 1970's: Stereotactic device introduced
  - 1980's: Automated core biopsy guns, paired with US and stereotactic imaging
TECHNICAL CONSIDERATIONS: STEREOTACTIC BIOPSY

- Compressed breast thickness
- Abnormality must be able to be placed in window (deep lesions and superficial lesions may not be able to be adequately visualized)
- Abnormality must be well visualized on work station monitor
- Weight limit for prone tables

MRI GUIDED BIOPSY

ULTRASOUND GUIDED ASPIRATION OR BIOPSY - ADVANTAGES

- Utilizes existing equipment
- Quick procedure (20-30 minutes, biopsy takes 1 minute)
- Comfortable position for most patients
- Able to survey remainder of the breast and axilla and biopsy additional masses as necessary

US GUIDED FINE NEEDLE ASPIRATION

- Symptomatic Cysts (painful)
- Suspected Abscess (correlate with history/symptoms/physical exam)
- Hematomas/Seromas
- Solid breast masses when core biopsy not feasible or available

US GUIDED CORE BIOPSY

- Complex cystic and solid masses (BI-RADS 4-5)
- Calcifications that correlate with suspicious mammographic finding
- Axillary lymph node
ULTRASOUND GUIDED BIOPSY EQUIPMENT OPTIONS

- Spring Loaded Core Needle Biopsy / Vacuum Assisted Core Needle Biopsy / Combination
- Disposable/Non-Disposable
- Single-Pass/Multiple Pass
- Sample Collection – single sample vs aggregate of all samples
- Portable/Console (attached)
- Multimodality Capability (Stereo, MRI)

BIOPSY DEVICES

SPRING LOADED 10-18G
Advantages
- No bulky equipment, disposable options
- May be better for small, superficial, dense, mobile masses

Disadvantages
- Multiple needle insertions, multiple samples may be necessary

VACUUM ASSISTED 7-12G
Advantages
- Complete sampling in one needle insertion
- Able to remove entire lesion

Disadvantages
- More expensive
- Bulky equipment
- Larger core sampling may not be appropriate for all patients

ACCURACY: 14 GAUGE CORE NEEDLE 1352 CASES (2008)
- 98.5% sensitivity
- False negative 1.6%
- 6% were high risk lesions requiring excision (31% upgraded at excision)


CORE NEEDLE BIOPSY

No statistically significant difference in specimen adequacy or diagnostic accuracy comparing 14, 16, 18 gauge automated cutting needle biopsy devices, and review of the literature

Microbiome 14:158

US GUIDED CORE NEEDLE BIOPSY

- Spring loaded biopsy more commonly performed, just as accurate for masses
- Larger core vacuum assisted biopsy more accurate for calcifications in stereotactic biopsy
- Vacuum assisted biopsy may be more cost effective (cost per cancer diagnosis – combined cost of biopsy and surgery)
RELATIVE SIZE OF SPECIMENS
11g vs 14g specimens

PREPARATION

Screen for:
- Anticoagulant use, aspirin, NSAIDs
- Bleeding disorder
- Allergies/sensitivities

PREPARATION

Review imaging and reports:
- How many masses have been recommended for biopsy and/or follow-up
- Size, shape and location of mass – deep, superficial
- Surrounding parenchyma – dense or fatty
- Size of breast

PREPARATION

Informed consent:
- Describe procedure
  - Describe alternative diagnostic methods
  - Describe known complications
    - Bleeding, bruising, infection
    - High risk lesion requiring excision
    - Sampling error
    - Clip placement
- Allow patient to ask questions

PATIENT POSITIONING

Supine or semi-sedentary, flat or tilted
- Ipsilateral arm raised over head
- Change position to achieve best approach

PREPARATION - IMAGING

Pre-procedure imaging:
- Image size:
- Determine the best approach:
  - Location of lesion
  - Relation to chest wall
  - Tissue density/firmness
  - Comfort
PROCEDURE TRAY
- Skin cleansing solution
- 1% Lidocaine
- 2% Lidocaine with Epinephrine
- 11 blade scalpel
- Sterile drape
- Sterile probe cover
- Sterile gel
- Gauze

CORE BIOPSY TECHNIQUE
- Cleanse skin, drape if necessary
- Consider location of skin nick approx. 2 cm from transducer, farther away for deeper lesions to maintain parallel approach

LOCAL ANESTHESIA
- 1% lidocaine w/wo bicarbonate for superficial
  - 1-3 cc, superficially at needle insertion site, 25g needle
- xylocaine (2%lidocaine and epinephrine) for deeper up to 10 cc along anticipated biopsy track, 20g spinal needle
  - Image during injection of anesthetic to confirm best parallel approach

IMAGE WHILE ADMINISTERING DEEP LIDOCAINE
- Observe/test approach
- Observe post lidocaine appearance
- Confirm adequate infiltration of biopsy track
- Too much lidocaine can obscure small masses

POSITIONING OF THE NEEDLE:
- Longitudinal approach
  - Entire length of needle should be visible under the long axis of the transducer
  - Needle path ideally approaches a parallel course relative to chest wall
  - To avoid chest wall trauma and pneumothorax
SPRING LOADED CORE NEEDLE BIOPSY
HOW IT WORKS

• Image target
• Place needle at edge of target
• Deploy device
• Fire gun
• Confirm post fire location
• Most accurate assessment with 2 views: long axis and orthogonal views
• Acquire tissue
• Repeat as necessary

SPRING LOADED CORE NEEDLE BIOPSY
TECHNIQUE

PRE FIRE

• Deploy device outside of the breast
• Advance into or under mass with collecting chamber open – avoids the throw, acquire tissue
• Good for masses where deploying device (firing) into the breast may be unsafe
• Good for lymph nodes, superficial masses
**POST-FIRE: MASSES AND TISSUE MAY SHIFT**

**RE-ASSES POSITION OF NEEDLE IN 2 VIEWS**

Long axis view may not confirm that needle is in mass.

Short axis view confirms needle in mass.

**RECORDING IMAGES**

- Pre-biopsy – mass in 2 orthogonal planes
- Pre-biopsy = Pre Fire
- Post Biopsy = Post fire

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**VACUUM ASSISTED CORE NEEDLE BIOPSY**

**HOW IT WORKS**

- Place cutting needle in or under mass
- Cutting sheath retracts and mass is suctioned into open sample chamber
- Cutting sheath recovers sample chamber, cutting sample into chamber
- Sample is suctioned into collection chamber

**VACUUM ASSISTED CORE NEEDLE BIOPSY**

**TECHNIQUE**

- Image target
- Aim at target
- Place device within or under target
- Confirm position of needle tip and collecting chamber
- Most accurate assessment with long axis and orthogonal views
- Open specimen chamber (push sample button)
- Acquire tissue
- Repeat as necessary

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**PLACE BIOPSY DEVICE WITHIN OR UNDER MASS**

**CHECK POSITION IN ORTHOGONAL VIEW**

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RECORDING IMAGES

Pre-biopsy - mass in 2 orthogonal planes

Post biopsy - long axis of needle in tissue acquiring position

AFTER SAMPLING

- Remove needle
- Remove marker from inside of marker chamber
- Place specimen in formalin container
- Repeat for desired number of specimens
- Place post biopsy marker clip

CLIP PLACEMENT

- To mark site of biopsy
- For future localization in cases of malignancy
- To define area of biopsy for future follow-up imaging
- Mass may have been completely removed at biopsy
- To mark site of cancer treated with neoadjuvant chemotherapy
- Gel based/titanium visible on US, mammo, and MRI
**AFTER CLIP PLACEMENT**
- Hold pressure (5-10 minutes)
- Steri strips on skin nick; gauze pressure dressing or elastic wrap, may need ice
- Post biopsy mammogram

**POST-BIOPSY CARE**
- Steri strip on skin nick
- Pressure dressing/-wrap
- Ice pack
- Keep area dry
- Avoid strenuous activity for 24-48 hours
- Watch for excessive bleeding, pain, fever

**AXILLARY LYMPH NODE BIOPSY**
- Will guide decision for axillary dissection even when sentinel lymph node is performed
- Less favorable outcome for patients with ultrasound biopsy positive
- Can use either spring loaded or vacuum assisted
### DOCUMENT IN REPORT

- Informed consent
- Details of procedure
- Complications
- If clip on post biopsy mammogram is in the expected biopsy location, if not, how many cms/mms away
- If there is residual lesion
- Pt given post procedure instructions
- Path pending

### 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

### NEEDLE VISUALIZATION

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

### IDEAL LONGITUDINAL APPROACH

- Best visibility when needle is perpendicular to ultrasound plane
- Needle exit = patient skin

### STANDARD, SAFER APPROACH

- Longitudinal Approach

Images courtesy of C. Piccoli
If you cannot see the entire long axis of the needle and the mass in your image, your needle or transducer may be askew - angled off of target or your transducer may be tilted off of plane of the target.
Needle Askew transducer over target complete mass in view partial long axis of needle in view

Look at your hands
Note orientation of needle to transducer
Rotate and position needle under and parallel to the transducer

If transducer askew transducer over target entire mass in view partial long axis of needle in view

Transducer askew transducer over target entire long axis of needle in view partial mass in view

Look at your hands
Note orientation of transducer to target Rotate transducer to see mass Rotate and position needle under the transducer

Transducer angled entire mass in view needle not in view

Transducer is rocked or angled

PATHOLOGY CORRELATION

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

- Flat Epithelial Atypia
  - Atypical ductal hyperplasia (ADH)
  - May be partially or completely filling duct
  - Calcifications common
  - Can be associated with low grade DCIS, lobular neoplasia, or IDC or ILC
  - 0-21% upgraded to DCIS/IDC
  - Surgical excision/surgical consultation

- Atypical Ductal Hyperplasia
  - Atypical epithelial cells partially or completely filling duct
  - Involving 1 or 2 ductal spaces measuring ≤2 mm in size
  - 0-62% upgrade rate
  - Surgical excision

- Atypical Lobular Hyperplasia and LCIS
  - Young women, bilateral and multifocal
  - Calcifications/mass
  - Upgrade rate ALH: 0-67%, LCIS: 0-60%
  - Surgical excision

- Mucocele-like Lesions
  - Solid mass, complex cyst and/or calcifications
  - Epithelium may be benign, atypical, malignant
  - Surgical excision/consultation if not benign

- Papillary Lesions
  - Palpable or nipple discharge
  - Mass, intraductal or intracystic - fibrovascular stalk
  - Benign, atypical, malignant
  - Upgrade benign 0-36% (14 G needle)
  - Surgical excision atypical or malignant
  - Consider follow up if benign or if papilloma entirely removed/surgical consultation
PATHOLOGY CORRELATION
HIGH RISK LESIONS

Radial Scar
- radial sclerosing lesion/complex sclerosing lesion
- central collection surrounded by epithelial proliferation – benign to malignant
- upgrade 0–16%
- malignant involvement of radial scar may be focal or patchy
- surgical excision

PATHOLOGY CORRELATION
HIGH RISK LESIONS

Flat Epithelial Atypia
- excision

Atypical ductal hyperplasia (ADH)
- excision

Atypical lobular hyperplasia and lobular carcinoma in situ (LCIS)
- excision

Mucocele-like lesion
- atypical/malignant
- excision

Papillary Lesions
- atypical
- excision

Radial scar
- excision

Merida, Mexico, July 2013
RSNA IVP
SUMMARY: IMAGE GUIDED PERCUTANEOUS BREAST BIOPSY

- Standard of care for minimally invasive diagnosis of breast abnormalities
  - 98.5% sensitivity, 1.6% false negative (compares with surgical excision)
  - Requires expertise in image modality and in biopsy techniques, path correlation
  - With careful technique and correlation, minimal morbidity for both benign and malignant diagnosis

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

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)

KEEP PRESSING DOWN (GENTLY) TILL NEEDLE IS NEAR PARALLEL TO CHEST WALL

THEN BIOPSY
CONFIRMING ACCURATE
SAMPLING OF TARGET

Why re-assess needle position?
Pre-fire: perfect position
Post-fire may still miss

Mass shifted to the side when the needle fired
Mass and needle can volume average in US image
and appear to be successful biopsy

Need orthogonal view to confirm needle location
in mass

US image shows needle apparently in mass
THE BREAST PERCUTANEOUS BIOPSY PROGRAM

• Administrative protocols
  - Consent form
  - Pre-biopsy instructions
  - Post-biopsy instructions
  - Specimen handling
  - Quality assurance

PATHOLOGY CORRELATION

• Pathology findings must be concordant with imaging findings.
• Pathology correlation requires confidence in targeting during biopsy.
• Discordant findings suggest sampling error.
  - In other words, biopsy missed the lesion.
• Supportive need to confirm imaging assessment of targeting during biopsy.

PATHOLOGY CORRELATION

• Confirming appropriate sampling during biopsy.
  - Stereotactic biopsy for calcs:
    - Radiograph tissue samples.
    - Confirm that pathologist sees adequate calcs.
  - Ultrasound guided biopsy:
    - Evaluate needle position in mass during biopsy.

STEREOTACTIC BIOPSY

PRINCIPLES OF STEREOTACTIC TARGETING

• Stereology:
  - "Determining 3-D information from planar 2-D views.
  - Parallax:
    - Apparent shift from a "reference object.

PRINCIPLES OF STEREOTACTIC TARGETING

- Stereotactic scout view:
  - Confirm that the abnormality is in field of view.
- Stereotactic pairs:
  - Precisely identify a specific target on each view.
  - Shift of target from midline determines depth from reference point.
STEREOTACTIC SCOUT AND PAIRS

PRINCIPLES OF STEREOTACTIC TARGETING

- Coordinate systems
  - Provide location in three dimensions
  - Systems use either Cartesian coordinates or Polar coordinates

CARTESIAN COORDINATES

- Cartesian system (Lorad)
  - Defines a target by distances from 3 axes x, y, z, that intersect at right angles
  - X = left - right, y = up - down, z = depth
  - Distance from reference point given in mm
  - Familiar and intuitive, errors easy to identify and correct

POLAR COORDINATES

- Polar system (Fischer)
  - Defines a target by distances from a fixed point and angular distance from a reference line, given as H, V, D (horizontal, vertical, depth), in angles
  - Needle travels in an arc
  - Uses trigonometric calculations
  - More accurate targeting
  - Errors are not obvious and difficult to correct
  - Extremely dependent upon accuracy of initial targeting

CENTERING LESION ON SCOUT VIEW

- Accuracy of stereotactic biopsy depends on accuracy of targeting
  - How well can you interpret the stereotactic scout view and stereo pairs?
  - Abnormality selection: a focal structure must be identifiable on these three views
  - High likelihood of inaccurate targeting:
    - Soft tissue masses, scattered uniform calcifications
TARGET MISIDENTIFIED

PROCEDURE FOR STEREOTACTIC BIOPSY

- Obtain stereotactic scout view
  - Confirm that the abnormality is in field of view
- Obtain stereotactic pairs
  - Precisely identify a specific target on each view
- Prepare biopsy site
  - Cleanse, anesthesia, skin nick
  - Needle to pre-fire position, obtain stereo pairs
- Abnormality at needle tip
- Fire needle, obtain tissue samples
- Confirm adequate sampling

MR GUIDED BIOPSY

Pathology: sclerosed papilloma
Screening Mammography: Costs and Use of Screening-related Services

Steven P. Poplack, MD, et al. 1

From the Departments of Radiology (S.P.P.), Community and Family Medicine (P.A.C., J.E.W., L.T.E., M.E.G., A.N.A.T.), and Medicine (A.N.A.T.), Dartmouth Medical School, Dartmouth-Hitchcock Medical Center

99,064 women studied
87% screening mammography only
13% additional imaging
3% breast interventional procedure
20% total financial resources
76% diagnosed with benign disease

"The panel agreed that percutaneous needle biopsy has demonstrated accuracy equivalent to open biopsy performed in the operating room in terms of sensitivity and specificity for imaging-detected breast abnormalities. A major benefit of using image-guided percutaneous core-needle biopsy as the initial procedure is its ability to establish a definitive tissue diagnosis for the majority of imaging-detected abnormalities. In this manner, patients avoid the need for a diagnostic open surgical biopsy, which can be time-consuming and potentially painful. The use of percutaneous biopsy for diagnosis significantly reduces the overall cost of treatment and potential risk of complications for patients with breast lesions."