Making the best use of available technologies……..

ULTRASOUND
Thirlestaine Breast Centre - Cheltenham
Overview

- Technology
- Indications for ultrasound
- Guidelines
- Focal Zone
- Tissue Harmonics
- Colour Doppler
- Elastography
- Second look ultrasound post MRI
Technology

Technology

- 1970s declined interest breast ultrasound

- Most relevant advances in US:
  - high frequency scanning 7 – 18MHz.

- 15MHz probe lateral + axial spatial resolution 2x higher than 7.5MHz probe

- 1995 – Stavros characterisation solid breast lesions grey scale imaging
Modern Ultrasound

- Retrospective study of 1212 patients with palpable masses, combined false negative rate of mammography/US is 2%.

- Mammographically dense breasts, US improves supplemental cancer detection rate by 3-4% per 1000 women.

Indications for Breast Ultrasound

Box 1. Updated indications for high-resolution US [AQ1]

Advanced indications for high-resolution US:
- Differentiation of cysts and solid tumors
- Differentiation between solid, benign and malignant lesions
- Characterization of palpable abnormalities
- Assessment of mammographic screening abnormalities
- Dense breasts showing with reduced mammographic sensitivity
- Diagnosis and follow-up of women with benign breast disease or risk lesions
- Women, during pregnancy or lactation
- Significant nipple discharge
- Under hormonal replacement therapy
- Inflamed breast and abscesses formation
- Extended screening for high-risk patients
- Second look after magnetic resonance mammography
- Guidance of interventional procedures, such as fine needle aspiration, core biopsy, diagnostic and therapeutic vacuum biopsy and preoperative tumor localization, axillary lymph node biopsy
- Preoperative staging of lesion size, skin and nipple distance for planning breast conservative surgery, mastectomy or oncoplastic reconstruction with implants, assessment of multifocality, multicentricity, intraductal extension, lymph node changes and contralateral lesions
- Preoperative staging and follow-up under neoadjuvant chemotherapy
- Surveillance after breast-conservation therapy
- Silicone implants

US ultrasound
Guidelines

Professional guidelines high quality breast ultrasound published American College of Radiology (ACR)
1) Linear-array transducer greater than 7 MHz

2) Set the focal zone at the depth of the lesion

3) Gain settings allow simple cysts and solid masses to be distinguished.

4) Areas of interest in the breast should be viewed in two perpendicular projections

5) Maximal dimensions of the mass

6) Correctly labelled images

7) Permanent identification labels
Focal Zone

Breast US – most significant effect diagnostic accuracy improper placement FZ
Breast Cyst

http://emedicine.medscape.com/article/1948269-overview
Tissue Harmonics

- Characterise cyst/subtle solid lesions

- US pulse distorted creates harmonic frequencies
- Returning signal – original fundamental frequency and multiple harmonics
- Higher harmonic images selected and used to create grey-scale US image
- Lower frequency superficial reverberation echoes reduced
Malignant tumours stimulate growth new vessels

- Secrete angiogenic factors
- Highly tortuous new vessel formation, increased endothelial proliferation + increased capillary growth rate
<table>
<thead>
<tr>
<th>Malignant</th>
<th>Benign</th>
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<tbody>
<tr>
<td>□ &gt;1 vascular pole</td>
<td>□ Weak</td>
</tr>
<tr>
<td>□ Abnormal afferent vascularity (tortuous vessels penetrating tumour)</td>
<td>□ Peripheral</td>
</tr>
<tr>
<td>□ Hypervascularity irregular, disorganised</td>
<td>□ Fewer central vessels</td>
</tr>
</tbody>
</table>

Parallel Artery and Vein: Sign of Benign Nature of Breast Masses

Horvath E1, Silva C, Fasce G, Ferrari C, Pinochet MA, Galleguillos C, Soto E.
Study

- Prospective study 2003 – 2008
- Patients undergoing biopsy of breast mass enrolled
- Prior biopsy colour doppler performed
- Parallel artery vein sign present 142/1074 masses
- 137/142 (96.5%) – benign
- 2/142 (1.4%) – malignant
- Specificity benignity 99.3%, PPV 99%
Malignant Doppler
Elastography

- Conventional US - limited ability to differentiate mechanical properties of tissue
- Differentiate benign + malignant lesions
- Tissue strain analytics (elastography):
  - Qualitative + quantitative assessment of mechanical stiffness (elasticity)
- Siemens’ ACUSON S Family ultrasound system
Elastography

- Hardness/stiffness

Elastography creates images of tissue stiffness

Types:
- Strain elastography
- Shear wave elastography

Invasive ductal carcinoma
Malignancies with mean higher stiffness –
poorer prognostic features (size, lymph node involvement, vascular invasion)  $P < .0001$
101 cases

Evans A et al. Invasive Breast Cancer: Relationship between Shear-wave Elastographic Findings & Histological Prognostic Factors
Radiology 2012 ;263: 673-677
BREAST CYST
FIBROADENOMA
LIPOMA
Distinguishing Benign from Malignant Masses at Breast US: Combined US Elastography and Colour Doppler US—Influence on Radiologist Accuracy

Nariya Cho, MD, Mijung Jang, MD, Chae Yeon Lyou, MD, Jeong Seon Park, MD, Hye Young Choi, MD, and Woo Kyung Moon, MD

From the Department of Radiology, Seoul National University College of Medicine,
Study Design

- 367 biopsy proven cases
- Non palpable – breast screening, pain, nipple discharge
- B mode US, Colour doppler, US elastography
- 5 readers – independently graded likelihood malignancy
- 4 data sets
• B mode US alone
• B mode US + doppler
• B mode US + elastography
• B mode + doppler + elastography

Grading B mode 1-5
Doppler 0 – 3
Elastography 0 - 3
All readers, addition of colour doppler and elastography to conventional B mode ultrasound improved differentiation of benign and malignant masses.
<table>
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<th></th>
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<tbody>
<tr>
<td>Sensitivity (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reader 1</td>
<td>85.5 (59/69)</td>
<td>91.3 (63/69)</td>
<td>.219</td>
<td>92.8 (64/69)</td>
</tr>
<tr>
<td>Reader 2</td>
<td>100 (69/69)</td>
<td>97.1 (67/69)</td>
<td>NA</td>
<td>97.1 (67/69)</td>
</tr>
<tr>
<td>Reader 3</td>
<td>87.0 (60/69)</td>
<td>94.2 (65/69)</td>
<td>.063</td>
<td>91.3 (63/69)</td>
</tr>
<tr>
<td>Reader 4</td>
<td>100 (69/69)</td>
<td>85.5 (59/69)</td>
<td>NA</td>
<td>97.1 (67/69)</td>
</tr>
<tr>
<td>Reader 5</td>
<td>92.8 (64/69)</td>
<td>94.2 (65/69)</td>
<td>&gt;.99</td>
<td>95.7 (66/69)</td>
</tr>
<tr>
<td>Mean ± standard deviation</td>
<td>93.1 ± 6.2</td>
<td>92.5 ± 3.9</td>
<td>...</td>
<td>94.8 ± 2.6</td>
</tr>
<tr>
<td>Specificity (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reader 1</td>
<td>40.9 (122/298)</td>
<td>41.6 (124/298)</td>
<td>.892</td>
<td>34.2 (102/298)</td>
</tr>
<tr>
<td>Reader 2</td>
<td>18.1 (54/298)</td>
<td>24.8 (74/298)</td>
<td>.031</td>
<td>21.1 (63/298)</td>
</tr>
<tr>
<td>Reader 3</td>
<td>34.2 (102/298)</td>
<td>31.5 (94/298)</td>
<td>.382</td>
<td>24.5 (73/298)</td>
</tr>
<tr>
<td>Reader 4</td>
<td>6.4 (19/298)</td>
<td>46.0 (137/298)</td>
<td>&lt;.001</td>
<td>10.4 (31/298)</td>
</tr>
<tr>
<td>Reader 5</td>
<td>26.8 (80/298)</td>
<td>35.6 (106/298)</td>
<td>&lt;.001</td>
<td>25.2 (75/298)</td>
</tr>
<tr>
<td>Mean ± standard deviation</td>
<td>25.3 ± 12.1</td>
<td>35.9 ± 8.3</td>
<td>...</td>
<td>23.1 ± 8.6</td>
</tr>
</tbody>
</table>

Note.—Data in parentheses were used to calculate percentages. NA = not applicable because the McNemar test is not applicable when the sensitivity or specificity of one modality is 100%.

* P values indicate comparison between B-mode US alone and B-mode US and US elastography.
† P values indicate comparison between B-mode US alone and B-mode US and Doppler US.
‡ P values indicate comparison between B-mode US alone and B-mode US, US elastography, and Doppler US.
§ Biopsy decision rate for malignant masses.
¶ Follow-up decision rate for benign masses.
Second look ultrasound

- MRI – high risk screening, sizing known cancers, determine focality.
- Higher sensitivity than mammography detecting cancer.
- Relatively low specificity
- Lesions detected on MRI often mammographically occult, demonstrated on US
Enhancing masses detected MRI found US 58-65% cases

<table>
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<tr>
<th>Size</th>
<th>Probability</th>
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<tbody>
<tr>
<td>≤ 5mm</td>
<td>50%</td>
</tr>
<tr>
<td>6 – 10mm</td>
<td>56%</td>
</tr>
<tr>
<td>11 – 15mm</td>
<td>73%</td>
</tr>
<tr>
<td>&gt;15mm</td>
<td>86%</td>
</tr>
</tbody>
</table>

If sonographic correlate on US increased probability malignancy

Meissnitzer M, Dershaw DD, Lee CH, Morris EA. Targeted ultrasound of the breast in women with abnormal MRI findings for whom biopsy has been recommended. AJR Am J Roentgenol 2009;193(4):1025–1029.
Typical malignant US features may be absent

Study 180 enhancing lesions on MRI, most malignancies benign ultrasound features:

- Oval shape
- Circumscribed margins
- Parallel orientation

Nam SJ, Kim EK, Kim MJ, Moon HJ, Yoon JH. Significance of incidentally detected subcentimeter enhancing lesions on preoperative breast MRI: role of second look ultrasound in lesion detection and management. AJR Am J Roentgenol. 2015;204(3):W357-62
Lobular Carcinoma
Second Focus
Techniques to improve diagnostic accuracy:

- Focal zone
- Tissue Harmonics
- Colour Doppler – parallel artery/vein sign
- Elastography
- Combination B mode US + Doppler + Elastography
- Second look post MRI