New Developments in Ultrasound Imaging

\[ \lambda (m) = \frac{v (m/s)}{f (1/s)} \]

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State of the Art Ultrasound Technology

- Multielement focus and high frequency probes with good sound penetration
- Digital broad-band technology
- Speed of sound adjustment
- Sensitive color systems
- Matrix array transducer
- Realtime compound scan
- Panorama-view
- 3-D and ABVS
- Tissue and contrast harmonic imaging
Influence of Sound Propagation Speed

Resolution depends on frequency, focus and beam forming technology.

The higher the frequency, the better the resolution \( (\lambda = \frac{c}{f}) \)

**BUT!**

Image reconstruction is based on uniform speed of sound (in m/sec)

Speed is determined by the density and stiffness of the tissues, low in gases - high in solids.

<table>
<thead>
<tr>
<th>Tissue Component</th>
<th>Speed of Sound (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>soft tissue</td>
<td>~ 1540</td>
</tr>
<tr>
<td>fat</td>
<td>1470</td>
</tr>
<tr>
<td>connective tissue</td>
<td>1545</td>
</tr>
<tr>
<td>bone</td>
<td>2600-4000</td>
</tr>
</tbody>
</table>

Different tissue components influence image quality (velocity mismatch).

-> Test images on phantom
Tissue and Contrast Harmonic Imaging

Advantage:

Increased frequency spectrum reflected from tissue (or microbubbles) -> Improved image quality
Matrix array vs. Conventional Transducer

Improved slice thickness resolution
Uniform image quality throughout whole penetration depth
High spatial resolution
High tissue contrast
Display of small structures
Realtime Compound Scan

Why?

• Electronic multielement transducer
• Simultaneous image reconstruction from different scan directions
  -> Improved display of anatomical details
  -> Improved sound penetration
  -> Reduction of artefacts
Steering an Array

Focusing an Array
Simple vs. Realtime Compound Scan

Simple scan -> image reconstruction from one scan direction

Compound scan -> simultaneous image reconstruction from different scan directions
Panoramic Scan - advantage

- Complete display of large anatomical structures
- Improved Documentation and comparison with other imaging methods
3 D Technology

- Mechanical volume scan
- Magnetic-optical: electromagnetic recognition of 3D tissue data
- Freehand – 3 D: reconstruction by correlation of image characteristics

Possible Advantages

- Standardization
- Independent reporting
- Better documentation and comparison with other examinations
- Preoperative assessment
- Additional diagnostic information
ABUS-Systems / U-Systems / GE raises the clinical value of breast ultrasound by combining the reproducibility of mammography with the clarification of ultrasound.
Ultrasound - CT

Breast Ultrasound Tomography
–Peter Littrup, MD, Neb Duric, PhD,
–Cuiping Li, PhD, Steven Schmidt, Olsi Rama, Lisa Bey-Knight, Bryan Ranger, and Erik West
–Karmanos Cancer Institute, Wayne State University, Detroit MI
–and Delphinus Medical Technologies Inc, Plymouth MI
Conclusion

• State of the art breast ultrasound
  -> high spatial and contrast resolution
  -> improves differential diagnosis
  -> and early cancer detection

• Future role with new technologies
  -> better standardization of examination technique
  -> reduced investigator variability
  -> improved interpretation

• Technological developments will further extend the use of breast ultrasound.