The Role of Advanced Image Guidance in Liver Surgery

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Background

- Ultrasound is a routine part of hepatic surgery
  - Identification of tumors
  - Define intraparenchymal vascularity
  - Targeting for biopsy, ablation, others…

- Ultrasound is 2D (real time)

- Advancements in imaging / image guidance
  - Cross sectional
  - US
Traditional Image Guidance
Traditional Image Guidance
Advanced Image Guidance
CT
Advanced Image Guidance
CT with US registration
Advanced Image Guidance
US
Early Targeting Reflectors
Study Results - Overall

Accuracy = % of Tumors Hit
P <0.0001
N=60 per user  5mm Target
EMF System
EMF System

- 6DOF tracking sensor embedded into protrusion
- Sensor's wire channel
- Plastic mounting ring
EMF System

Results of the Phase I laparoscopic quantitative targeting study.

<table>
<thead>
<tr>
<th>Target “Hit” Rates</th>
<th>No Guidance</th>
<th>With Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novices</td>
<td>4.5%</td>
<td>100%</td>
</tr>
<tr>
<td>Experts</td>
<td>59%</td>
<td>100%</td>
</tr>
</tbody>
</table>
AIG with RFF
AIG with RFF
Precommercialization Study

• 3 groups
  – Novices - no formal surgical/medical training
  – Intermediates – surgical residents
  – Experts - HPB-Surgeons

• Each participant was asked to identify phantoms by US guidance

• Phantom targeting was then randomized
  – US guidance alone (USG, n=10)
  – 3-D image guidance using the Emprint™ SX device (3DG, n=10)
MW Ablation Platform and configuration
Targeting Configuration
Targeting Configuration
Targeting Configuration
Microwave Ablation Platform & Configuration

SCAN DEPTH: 6.0 CM
TIP TO PLANE: 0.5 CM

POWER: 100 W  TIME REMAINING: 00:00
# Results

<table>
<thead>
<tr>
<th></th>
<th>Sonographic targeting</th>
<th>3-D Guided targeting</th>
<th>p – value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean time to identify target (sec.)</strong></td>
<td>31.8</td>
<td>34.1</td>
<td>0.7168</td>
</tr>
<tr>
<td><strong>Mean time to needle position (sec.)</strong></td>
<td>129.2</td>
<td>18.3</td>
<td>0.0000</td>
</tr>
<tr>
<td><strong>Number of hits/Total targets</strong></td>
<td>26/40</td>
<td>40/40</td>
<td>0.0000</td>
</tr>
<tr>
<td><strong>Number of misses</strong></td>
<td>206</td>
<td>7</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Table 2: Unguided targeting versus 3-D guided targeting in intermediates.

<table>
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<tr>
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<th>Sonographic targeting</th>
<th>3-D Guided targeting</th>
<th>p – value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean time to identify target (sec.)</strong></td>
<td>22.3</td>
<td>23.1</td>
<td>0.8457</td>
</tr>
<tr>
<td><strong>Mean time to needle position (sec.)</strong></td>
<td>102.1</td>
<td>18.6</td>
<td>0.0002</td>
</tr>
<tr>
<td><strong>Number of hits/Total targets</strong></td>
<td>37/40</td>
<td>40/40</td>
<td>0.0832</td>
</tr>
<tr>
<td><strong>Number of misses</strong></td>
<td>149</td>
<td>10</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Table 3: Unguided targeting versus 3-D guided targeting in experts.
Results
Conclusions

- More accurate – less complications?
- Improvement of surgical outcomes
- Application to other procedures:
  - Vascular access
  - Biopsy
  - Bile duct cannulation
Advanced Image Guidance for Liver Ablation
Advanced Image Guidance for Liver Resection ?? !!
AIG Prototype
AIG Prototype
AIG Liver Resections (ex-vivo)
AIG Liver Resections (in-vivo)
Holographic Enhanced MWA
Holographic Technology
Holographic Technology
Holographic Technology
Future of Liver Surgery

Binocular laparoscopic telescope
Future of Liver Surgery

- 3D rendering of DICOM image
- Surface mapping with hololens technology
- Real time ongoing vascular registration by US
- RF tracking of instruments
- Virtual reality representation of intraparenchymal or intracorporeal instruments

- Laparoscopic view rendering
- Overhead of surgeon view rendering
Future of Liver Surgery

Enhanced reality - Laparoscopic View
Future of Liver Surgery

Enhanced reality - Surgeon View (Hololense)
Advanced Image Guidance

- Systems for ablation will be commercially available in 2017
- Clear advantages over 2D US
- AIG for liver resection in very early stages of development
- Promising technology to facilitate lap resections
- “Fusion” of technologies for enhanced reality is the longer term vision
Thank You

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Division of HPB Surgery

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