

Ultrasound and MRI for monitoring pancreas motion during radiation therapy delivery

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Professor and Chief Physicist



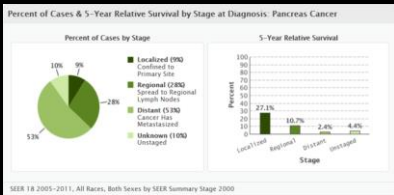
AAPM, MO-DE-210-1, July 13th 2015

Acknowledgements

- > Eenas Omarí, Ph.D
- > Beth Erickson, MD,
- > Francisco Quiroz, MD
- > Christopher Ehlers, BS
- > Martin Lachaine, PhD
- > David Cooper, B.Sc
- > Eric Paulson, Ph.D
- > An Tai, PhD
- > George Noid, PhD
- > Habib Alsaleh, PhD
- > Philip Prior, PhD

Funding Supports: Elekta Inc.

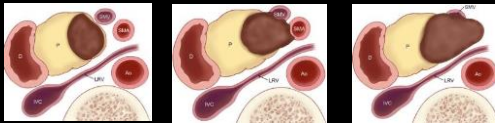
Pancreatic Cancer



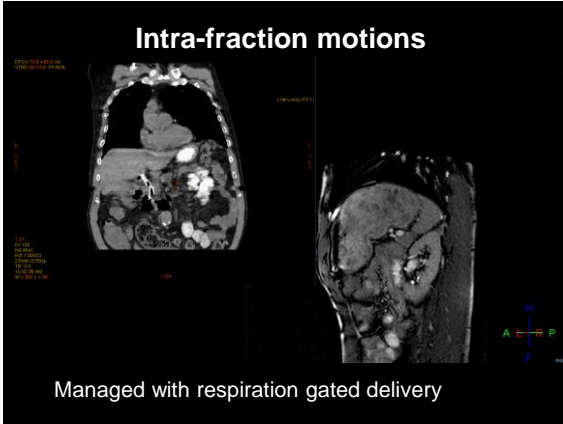
Resectable

Borderline

Unresectable



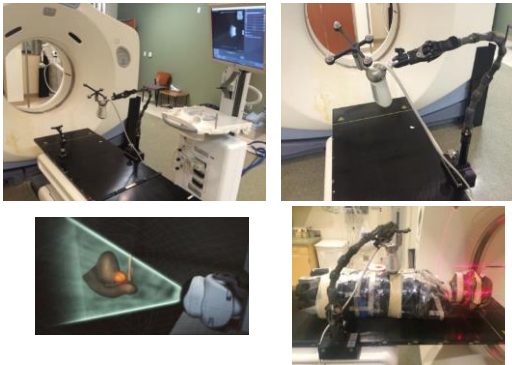
Von Hoff DD, Evans DB, Hruban RH. Pancreatic Cancer. Sudbury, MA: Jones and Bartlett, 2005.



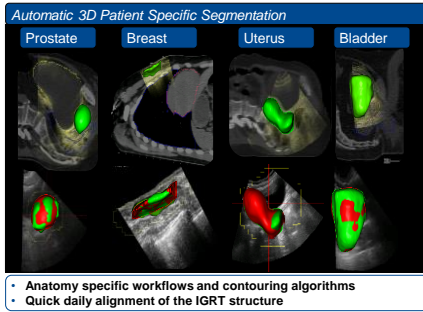
We are investigating:

MRI and US for monitoring intra-fractional motions

Clarity Hand-Held Autoscan Probe (m4DC7-3/60) 3-5MHz



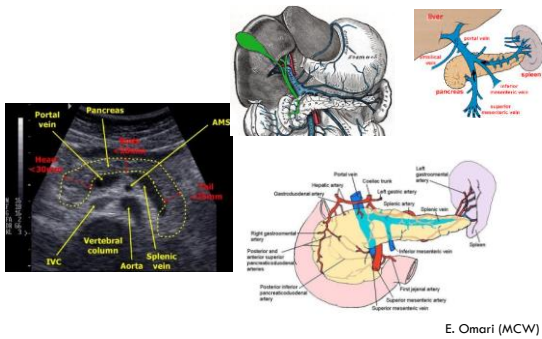
US-based IGRT



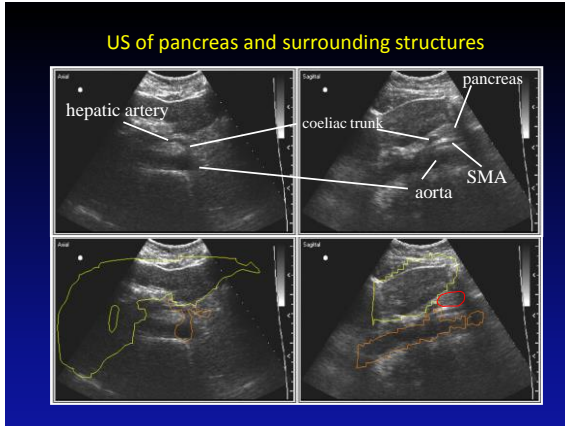
US acquisition



Pancreas and the Portal Vein



E. Omari (MCW)

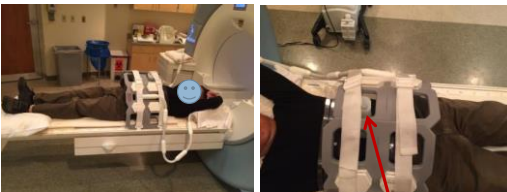


MRI acquisition

- A 3-Tesla MRI scanner, with a 4-Channel Body Matrix Coil.
- Imaging sequence: Axial T2-weighted HASTE (spin-echo)
- Imaging parameters:
 - field of view (FOV): 360x276 mm; slice thickness: 5mm; Voxel Size: 1.18x1.18x5; time repetition (TR)/time echo (TE): 2000/96 ms;



MRI acquisition

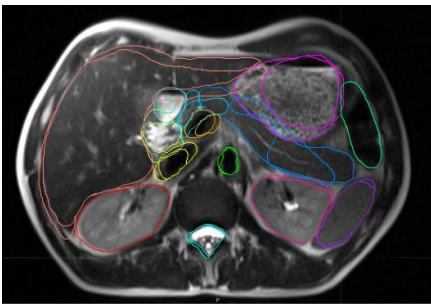


US-probe deformation

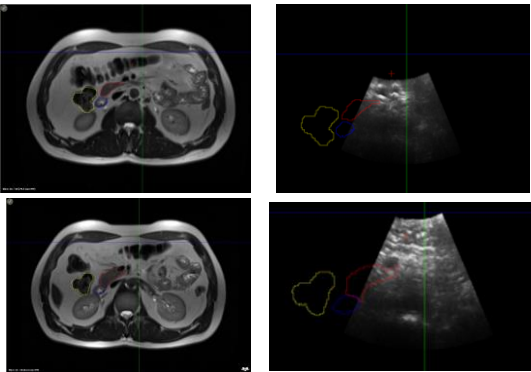
MR-US Probe Deformation

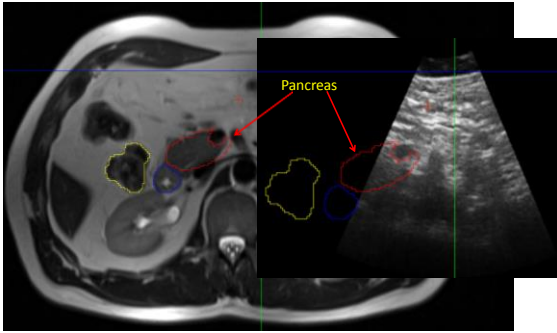


MR-US Probe Deformation

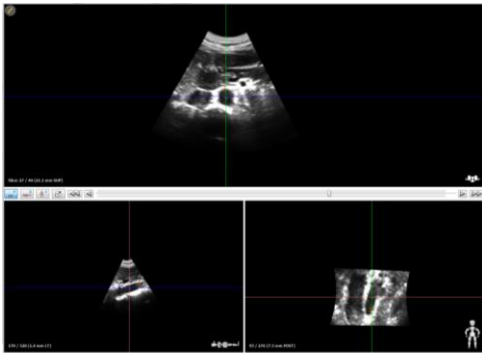


MRI-US registration

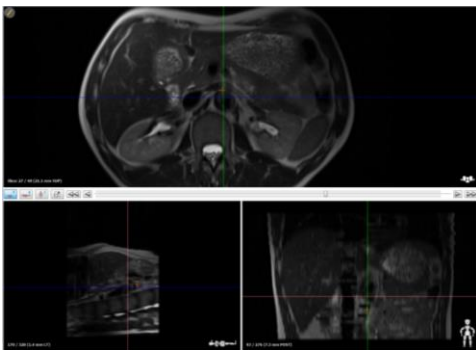




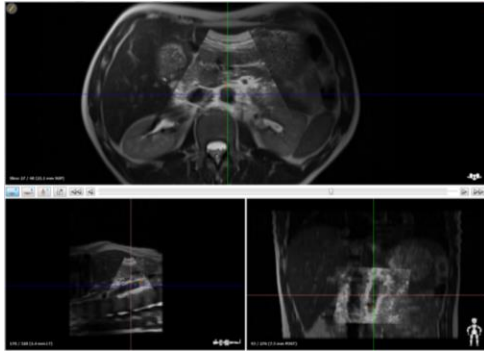
US



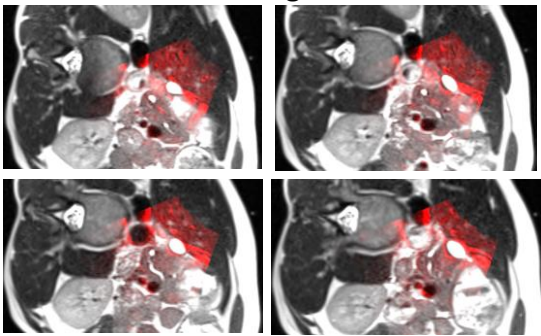
MRI



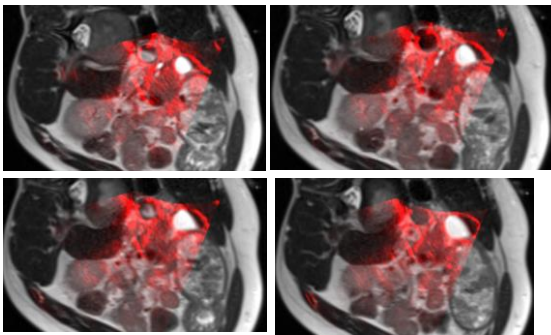
MRI-US registration



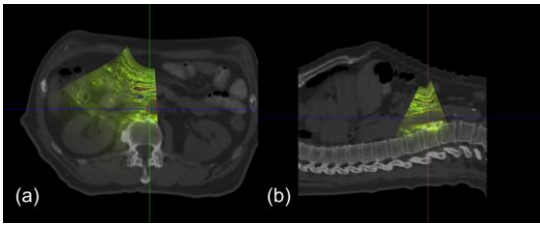
MRI-UIS registration



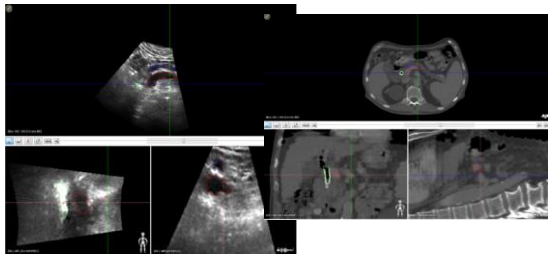
MRI-US registration



US registered with CT



Registered US-CT for a patient with a tumor in the tail of the pancreas. Yellow: Portal-Splenic Vein. Red: Aorta. Blue: Superior Mesenteric Artery (SMA).



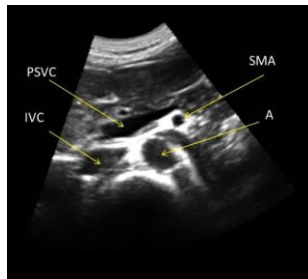
Registration of US and CT images for a patient with a tumor in pancreas head. The contours are created using the US which are translated into the CT. Red: Portal-Splenic Vein Confluence (PSVC). Blue: Dilated Pancreatic Duct. Green: Stent.

US for pancreas motion monitoring

Difficult to track pancreas head.

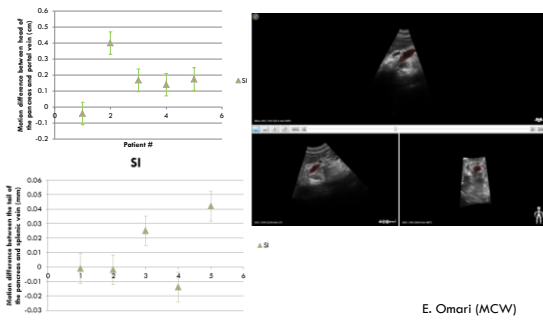
Easy to see:

- PSVC:** Portal-Splenic Vein Confluence
- IVC:** Inferior Vena Cava
- A:** Aorta
- SMA:** Superior Mesenteric Artery

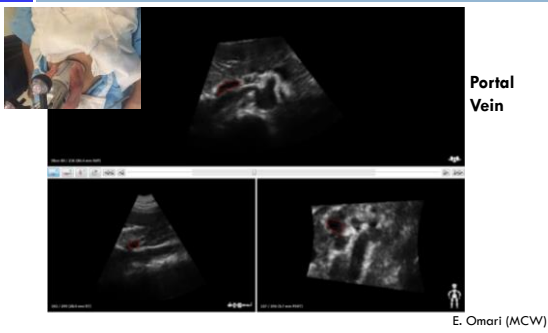


E. Omari (MCW)

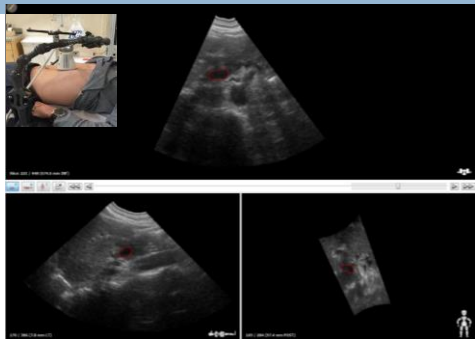
Motion difference between surrogates and pancreas



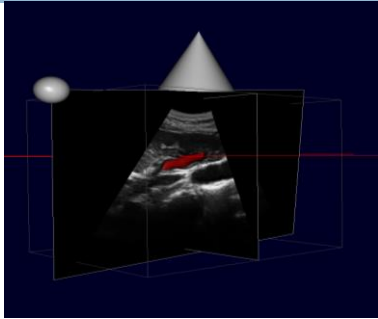
Axial Acquisition



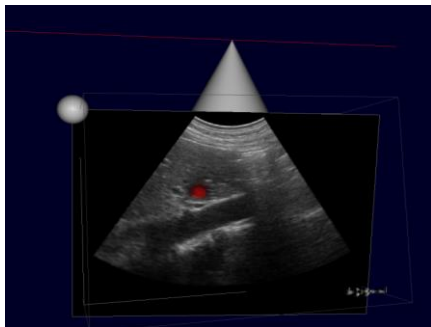
Sagittal acquisition



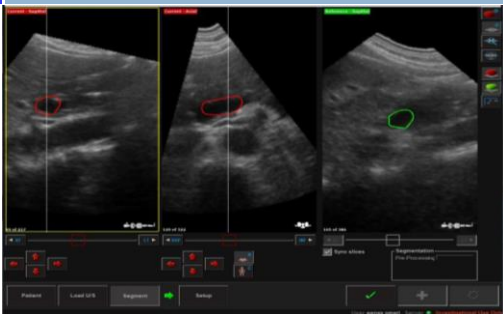
3D Volume

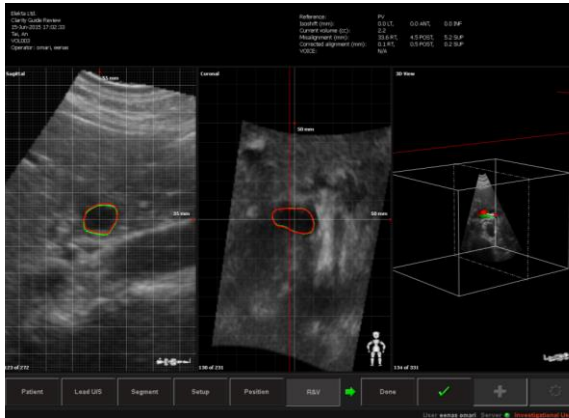


3D Volume

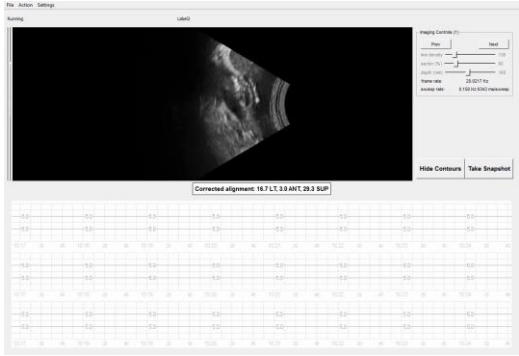


Segmentation

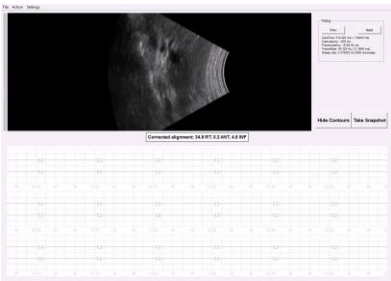




Motion monitoring prior to/during delivery



Monitoring Session (max motion SI)



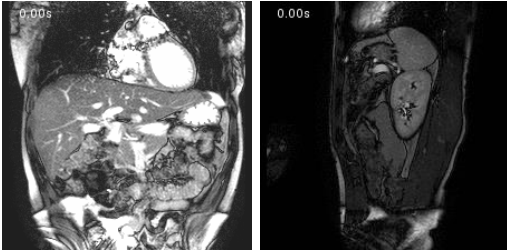
Monitoring Session (max motion SI/LR)



Motion Management with MR-Linac



The advertisement features a header with a glowing particle-like graphic. Below it are three medical images: a cross-section of a pelvis, a cross-section of a chest, and a sagittal view of a spine. Text below the images reads: 'High resolution (0.7mm x 0.7mm x 1mm), 3D acquisition with exquisite image quality in all planes'. Below this is another two medical images: a coronal view of a spine and a cross-section of an abdomen. Text below these images reads: 'High frame-rate, multi-planar acquisition for motion monitoring'. At the bottom left is the PHILIPS logo. At the bottom right is the ELEKTA logo. In the center, there is a small disclaimer: 'MR-Linac is currently a research programme. It is not available for sale and its future availability cannot be guaranteed. Confidential and privileged information. Not for distribution.'

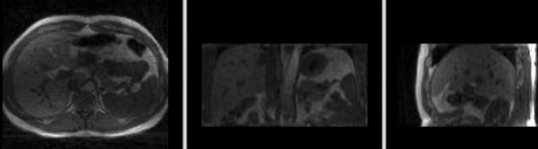


1.5 T diagnostic MRI quality

Courtesy of
Bas Raaijmakers



4D-MRI



- Self-navigated
- Switchable contrast modes (T1, or mixed T2/T1)

E. Paulson (MCW)

Summary:

- Portable, non-invasive, and inexpensive ultrasound imaging may be used as an alternative imaging modality for motion monitoring during RT delivery for pancreatic cancer;
- Surrogate structures or anatomic land markers surrounding the pancreas that are moving along with the pancreas may be used for the motion tracking;
- The MRI and/or CT acquired with ultrasound at the same patient treatment position may be used to help identify or to verify the locations and shapes of the pancreas and surrogates on the ultrasound images.
