MRg HIFU: Current and future trends of MR guided Focused Ultrasound in Radiation Oncology

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Disclosure

InSightec
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Focused Ultrasound Foundation
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Journal of Therapeutic Ultrasound
http://www.jtultrasound.com

ISTU
http://www.istu.org
Topics:

1) MR guided HIFU possible role in oncology
2) MR guided HIFU High level clinical overview
3) Current MR guided HIFU application
4) Future MR guided HIFU application
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MR guided HIFU role

MR guided HIFU is:

• Image guided, personalized, radio-surgery.

Another view could be

• RF ablation without a needle
MR guided HIFU role

Why?

- MR guided HIFU kills everything
- MR guided HIFU is image guided
- MR guided HIFU enable treatment personalization
But what are the advantages of MR guided HIFU?
MR guided HIFU role

MR guided HIFU differences:

1) No-ionizing therapy
2) Repeatable treatment
3) Closed loop thermal feedback
4) Very sharp lesion margins
5) None-invasive therapy.
Possible uses of MR guided HIFU:
Combining HIFU with EBRT

1) Big lesions targeted and treated by localized therapy

- Prostate cancer focal therapy
- Breast lumpectomy replacement
Combining HIFU with EBRT

2) Synergistic effects on same target

- Pain palliation of bone metastasis
- Using HIFU for hyperthermia
MR guided HIFU role

Replacing radiosurgery RF ablation with HIFU

1) Brain treatments, (Tumors, neuro-functional)

2) Treatment for young children, (tumors, epilepsy)
MR guided HIFU role

When radiation dose is maxed out

1) Prostate cancer salvage therapy

2) Selected cases of bone metastasis
When HIFU will not be a good choice?
MR guided HIFU can not do well:

1) Metastasis at vertebra body
2) Vascular Aneurism
3) Lung cancer
4) Treat intervertebral disk
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Clinical status

Accumulated number of indications entering first in human stage
## Global Development Landscape

<table>
<thead>
<tr>
<th>Neurological</th>
<th>Oncological</th>
<th>Musculoskeletal</th>
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<tr>
<td>Essential Tremor</td>
<td>Bone</td>
<td>Back Pain</td>
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<tr>
<td>Parkinson’s Disease</td>
<td>Prostate Tumors</td>
<td>Osteoarthritis</td>
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<td>Neuropathic Pain</td>
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<td>Osteoid Osteoma</td>
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<td>Brain Tumors</td>
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<td>Epilepsy</td>
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<td>Stroke</td>
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<td>Hydrocephalus</td>
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<td>Trigeminal Neuralgia</td>
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<td>OCD</td>
<td>Colon</td>
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<tr>
<td>Cancer Pain</td>
<td>Esophagus</td>
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</tbody>
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### Cardiovascular
- Hypertension
- Atherosclerosis
- Atrial Fibrillation
- Septal Perforation

### Miscellaneous
- Uterine Fibroids
- Uterine Adenomyosis
- Breast Fibroadenomas
- Acute Tubular Necrosis
- Obesity
- Diabetes
- Glaucoma
- Benign Prostatic Hypertrophy
How about some numbers?
Overall, more than 80,000 patients have been treated using HIFU.
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HIFU in practice
Mechanism of action and applications

Energy deposition into tissue

Thermal effect
- Tissue death
  (Ablation)
  - Tumor ablation
  - Functional neurosurgery
  - Pain applications
- Tissue change
  (Hyperthermia)
  - Targeted drug delivery

Mechanical effect
- Tissue death
  (Histotripsy, Thrombolysis)
  - BPH
  - Stroke
- Tissue change
  (BBB opening, Sonoporation)
  - Drug delivery
Clinically tested

Brain Indications

• Neuropathic pain
• Essential Tremor
• Tremor Dominant Parkinson
• Parkinson Dyskinesia
• OCD
Clinically tested

Gynecological and urological indications

- Prostate cancer
- Kidney tumors
- Symptomatic uterine fibroids
- Adenomysis
Clinically tested

Abdominal indications

- Liver tumors
- Pancreatic cancer
Clinically tested

MSK indications

- Bone metastasis
  - Osteoid Osteoma
  - Facet Rhizotomy
Other indications

- Benign Thyroid nodules
- Hyperparathyroidism
- Renal nerve denervation
- Glaucoma
- Breast cancer
  - Breast Fibroadenoma
Regulatory status

- USA – UF and Bone Mets
- Europe – UF, Bone Mets, Thalamotomy, Prostate cancer, Thyroid nodules, Breast Fibroadenoma, Liver and pancreatic cancer, Breast cancer, Kidney tumors, Facet arthritis and Osteoid Osteoma
- Asia – UF, Bone Mets, Prostate cancer
Prostate Cancer - Transrectal
Liver Tumors

Pain Palliation of Bone Metastases

Patient with osteolytic breast cancer metastasis at right iliac bone
Pain score of 5.5 before treatment  reduced to 0 at 3M follow up

CT Before Treatment

Note: At 3M new bone formation and thickening of cortical layer in treatment area
Breast Cancer

Pre-treatment

Two weeks post treatment
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Future brain indication

1) Brain Oncology
   1) Tumors
   2) BBB opening
   3) Sonodynamic therapy

2) Epilepsy

3) Brain aneurism(*)
Future Body indications

1) Lung cancer (*)
2) Sacroiliitis
3) Infected implant sterilization
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Questions?

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