Multiparametric Functional Imaging in Radiation Therapy
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MR in RT
Adding valuable information on tissue properties

CT provides:
- Geometric accuracy
- Delineation of bony structures
- Electron density information for dose calculation

MR adds:
- Excellent soft-tissue contrast
- Valuable information on the tumor extent and activity

CT image: Courtesy of Radiologische Allianz, Hamburg, Germany

Functional and Quantitative Imaging with MR

- Diffusion
- BOLD
- Perfusion
- T1 and T2 mapping
- Spectroscopy
**RESOLVE: Readout-segmented, multi-shot diffusion-weighted EPI**

- Reduced susceptibility and blurring artefacts due to reduced TE and echo spacing
- Insensitivity to motion-induced phase errors


**Conventional single shot EPI**

Minimal susceptibility artifacts for better detection and delineation of lesions

Image courtesy: Wuhan Tongji Hospital, Wuhan

**RESOLVE is recommended by experts for RT planning**

Study performed on a 3T Skyra comparing single shot EPI and resolve based DWI for prostate imaging

"We have shown that this technique [RESOLVE] provides the most robust and reliable data set and would seem to be the preference for RT planning studies."

Liney GP et al., Br J Radiol. 2015 May;88(1049):20150034.
RESOLVE is recommended by experts for RT planning

Study performed on a 3T Verio (MRIS) comparing single shot epi and resolve based EPI for cervical and prostate imaging.

“[RESOLVE... ] provided superior geometric performance...” In phantom studies and in-vivo, applied to patients enrolled in genito-urinary trials including cervix and prostate MRI at 3 T.


Simultaneous Multi-Slice for MR imaging
Analogous to the revolution brought to CT by multi-slice technology

Multi-slice technology was the key behind the significant acceleration of CT imaging.

Simultaneous Multi-Slice
Simultaneous excitation of multiple slices with blipped CAIPIRINA

MRF slice excitation simultaneous

Blipped CAIPIRINA applied during echo train

Slice-GRAPPA based unaliasing

Slice-GRAPPA based unaliasing

Investing SMS into more diffusion directions (3 time more) to improve diffusion tractography results for better presurgical planning

Study performed on a 3T Skyra

Conventional 16 directions

SMS 192 directions

Tripling the number of diffusion directions by SMS increased conditional probabilities to reconstruct the superior longitudinal arcuate fasciculus.

High temporal sampling improves detection of resting state networks to map functional cortices in individuals

Study performed on a 3T Skyra

Conventional BOLD, TR 3s, 3mm resolution

SMS 3 TR 1.5s, 1.8 mm resolution

SMS improves mapping of language networks with resting state single subject fMRI at higher spatial resolutions.

SMS RESOLVE® for low distortion DWI in the same scan time as conventional diffusion

Study performed on a 3T Skyra

Distortions with conventional DWI of soft tissue base lead to projection of lymph node (arrow) over the submandibular gland.

With RESOLVE, distortions are significantly reduced. Equivalent image quality of RESOLVE with and without SMS, with slice acceleration reducing scan time by nearly a factor of 2.

*[These features are currently under development; they are not for sale in the U.S. and all other countries. Their future availability cannot be guaranteed]*

Dynamic Contrast Enhanced (DCE) Perfusion Imaging

Study performed on a 3T Verio
Processing done using Tissue4D
Primary central nervous system lymphoma demonstrated significantly higher volume transfer constant and flux rate constant values compared with glioblastoma.


Perfusion Imaging: DSC (T2* weighted imaging) or DCE (T1 weighted imaging)

Multi-Center Study including Siemens 1.5T and 3T systems
"Increased tumor perfusion, vascular volume, vascular permeability, are negative prognostic markers in newly diagnosed GBM patients and these important physiological markers can be measured safely and reliably using MRI" Gerstner ER. et al. Clinical Cancer Research - May 2016

Combination of Diffusion and Perfusion for therapy response assessment in rectal cancer

Patient 1: Week 3 histograms and maps showed both a shift in distribution of ADC of voxels to higher values and $K_{trans}$ of voxels to lower values compared to the pre-CRT histogram.

Pham T. et al. MAGNETOM Flash (65) 2/2016: 48-51
MR Spectroscopy: Choline as a biomarker for GBM progression*

Study performed on a 3T TimTrio.

"Patients with a decreased or static mean or median Cho/NAA values had less risk of progression."

"Patients with an increase in mean or median Cho/NAA values at the 3rd week RT scan had a significantly greater chance of early progression."


MR Spectroscopy: 3D MRSI based Spectral Editing for 2-hydroxyglutarate (2HG) Detection*

Study performed on a 3T TimTrio.

2HG is not present in healthy or non-mutated tumor tissue in the spectra but is present in the IDH mutation. The presence of 2HG can be followed using spectral editing with 3D MRSI.

Jafari-Khouzani K et al. Neuro-Oncology 2016

Magnetic Resonance Fingerprinting* Paradigm shift in quantitative MR

*MRF has the potential to quantitatively detect and analyze complex changes.

*These features are currently under development; they are not for sale in the U.S. and all other countries. Their future availability cannot be guaranteed.

Handzettel 6
Further developing MR Fingerprinting™

Inventors exclusively partner with Siemens

First WIP installations

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Magnetic Resonance Fingerprinting™

Ongoing clinical studies in oncology patients

T1 Map
T2 Map

Lower grade part of tumor
Solid part of tumor
Central necrosis
Surrounding edema / infiltration zone
Normal appearing white matter

Medical University of Vienna, Austria

StarVIBE: Motion-insensitive, T1-weighted brain imaging

MRAD: Matrix 512, sl 2.0, TA 4:32
StarVIBE: Matrix 224, sl 2.0, TA 3:50

MR scanning has not been established as safe for imaging fetuses and infants under two years of age. The responsible physician must evaluate the benefit of the MRI examination in comparison to other imaging procedures.

Images courtesy Jan Ypermann, Ieper, Belgium
One-click export to syngo.via RT Image Suite for contouring and further investigation such as dosimetric evaluation.

These features are currently under development; they are not for sale in the U.S. and other countries. Their future availability cannot be guaranteed.

Access a comprehensive view of your patient:
- View up to 4 single or 8 fused series concurrently over up to 2 monitors*
- Concurrently view information acquired with multiple PET tracers or multi-parametric MRI, or all information needed for analyzing moving tumors
- View all information needed to make a decision on how to treat or to assess change as treatment progresses.

*Optional

Courtesy of Radiologische Allianz, Hamburg, Germany

Thank you for your attention !!!