MRI Safety Issues for Interventional MRI

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Interventional MR Scanners

1.5 T

1 T

0.5 T

0.2 T
Passive

Visualization

Active

Cordis and Philips Research Laboratories
MR-guided Stent Placement

20 images / sec

guide wire marker

mounted stent
MR-guided Stent placement

20 images / sec

- partially deployed stent
- completely deployed stent
5F Catheter with Guidewire

Iron particles on guidewire as markers for passive visualization
Catheterization of LCA
Obscuration of LCA by Marker
Active Tip Tracking - PTA
Active Visualization - 20 Images per Second

stenosis

active tip tracking

catheter
Active Visualization - 20 Images per Second

balloon
Gd (1:200)
Safety Aspects - Long Metallic Wires
Safety Aspects - Long Metallic Wires

Worst Case

excentric position of animal (40 kg) - varying positions

SAR 3.9 W/kg - continuously running sequence

(FOV=500, TR=5.4, TE=2.3, FA=10/90)

slow manipulation of guide wire
Safety Aspects - Long Metallic Wires

**In vivo** Experiments

Heating as measured at guide wire tip

Temperature elevation up to 44° K
Safety Aspects
Design for Fast Optical Switching of Resonant Circuits

- optical detuning of the circuit
- photodiode as optical sensor
- sequence triggers illumination

[Diagram of a catheter with an optical fiber and a resonant circuit, triggered by a laser diode.]

Courtesy of Steffen Weiss
PFL Hamburg, Philips
MR-Safe Fiducial Markers

optically

switched off and switched on
Active VCI-Filter* Placement and Thrombus Imaging

Radial B-FFE (10 images/sec)
Schaeffter T et al. MRM 2001
Spuentrup E et al. Circulation 2002

* provided by SIMAC Inc., Germany

in vitro

in vivo (pig)

B-FFE MR-Venography
Spuentrup E et al. RoFo 2001;173(8):686-90
Basic Principle
Safe Transmission Lines

catheter
conductor
electric Field E

Courtesy of Steffen Weiss
PFL Hamburg, Philips
Basic Principle

- Multiple short sections
- Transformers pass signal but block resonances
- Division into segments shorter than $\lambda/2$
- Shift of cable resonances to $> 100$MHz
Safe Transmission Lines
The lack of MR compatible (and safe) instruments slows the progress of vascular and cardiac Interventional MR to clinical applications.
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