21.1 Tesla Rat Heart Magnetic Resonance Microimaging By Paramagnetic Anti-Troponin Bound Polyethylene Based Iron-Oxide Nanoparticles And Image Processing

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Objectives and Methods Used

- A nanoparticle (SPIOT) containing antitroponin coated and polyethylene encapsulated biotin-avidin-iron-oxide core in center was prepared
- Microimaging of rat heart at 21 Tesla MR by rapid 3D fast low angle shot, 3D gradient echo flow compensated and mutislice multiecho MR imaging techniques
- Image processing of the rat heart images for the measurement of cardiac wall, ventricle volume, aorta, possible orientation details of cardiac myofibrils tissue
- cardiac atlas with cardiac shape, texture and motion analysis.

Microimaging Techniques

i. GE Flow compensated

ii. 3D FLASH pulse sequence

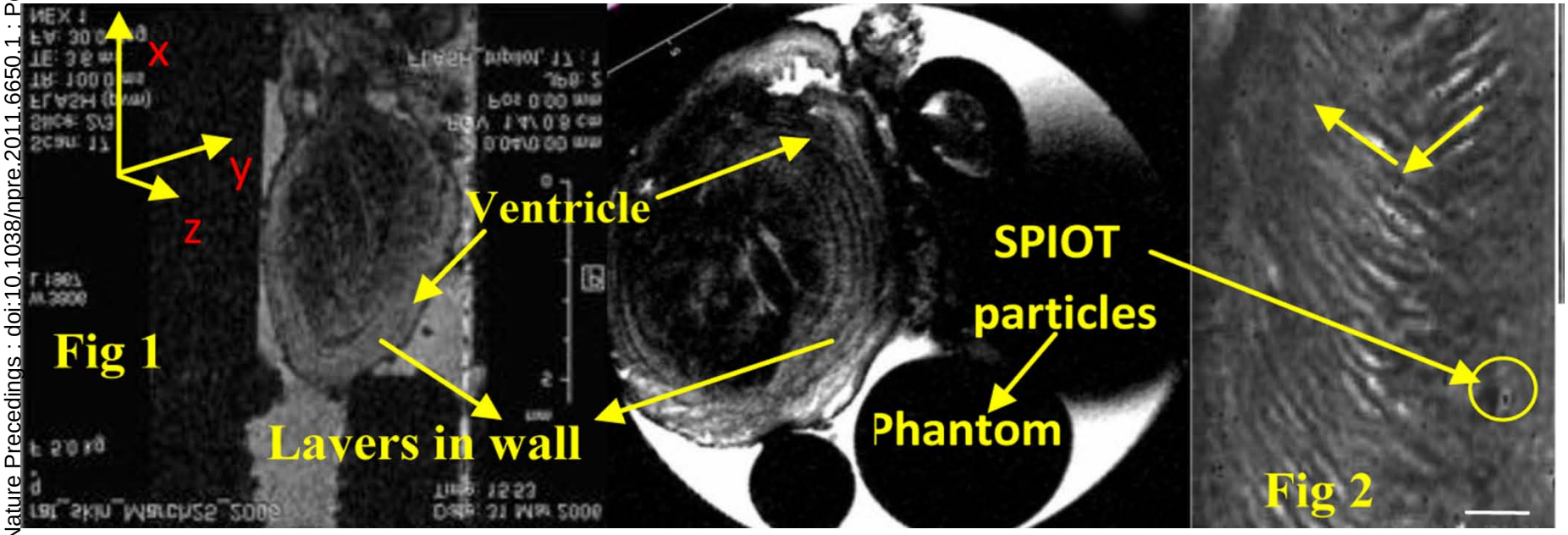
iii. Multislice multiecho spin echo sequence

iv. Diffusion-Tensor Mapping (TE = 18 ms; TR = 10000 ms; time interval between gradient pulses = 5 ms; gradient pulse duration = 0.5 ms, gradient factor = 950 s/mm^2, b value 950 s/mm^2, in-plane resolution 35 x 35 µm, slice thickness = 1 mm, slice gap = 0.5 mm, # slices covering heart = 7

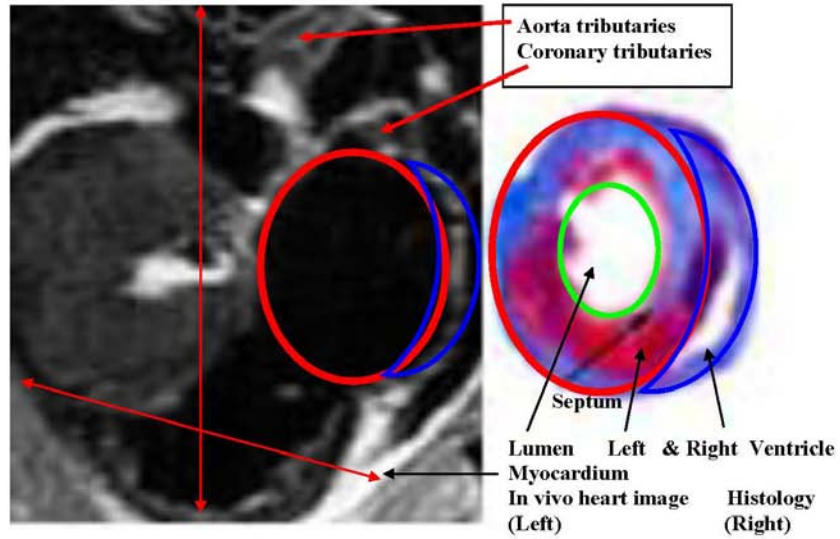
Results

- At 21.1 T ultrahigh resolution, cardiovascular layers were well defined. The route and location of nanoparticles were visible on images.
- The cardiac muscle fiber orientation was visible by diffusion-wt images.
- Other analyses were: Construction of probabilistic atlas of heart; Probabilistic maps; Intensity template.
- Semiautomated robust segmentation showed effective diffusion tensor (D_{eff}), diffusion characteristics, myocardial fiber orientation, and Laminar fiber sheet orientation. http://www.freepatentsonline.com/y2009/0220434.html

21 T MR Microscopy of Heart



http://www.freepatentsonline.com/y2009/0220434.html



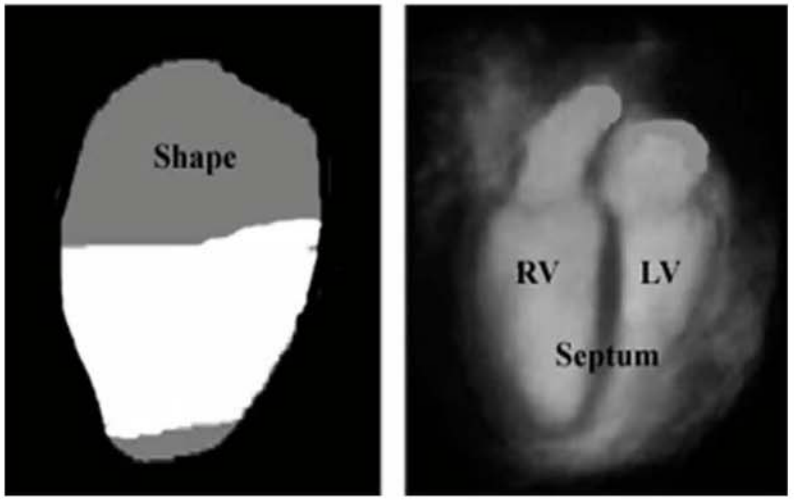


FIG. 14 (top) Histology-MRI correlation: (bottom left) shape analysis and (bottom right) functioning heart by SENSE technique

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Cardiac mass

Cardiac shape

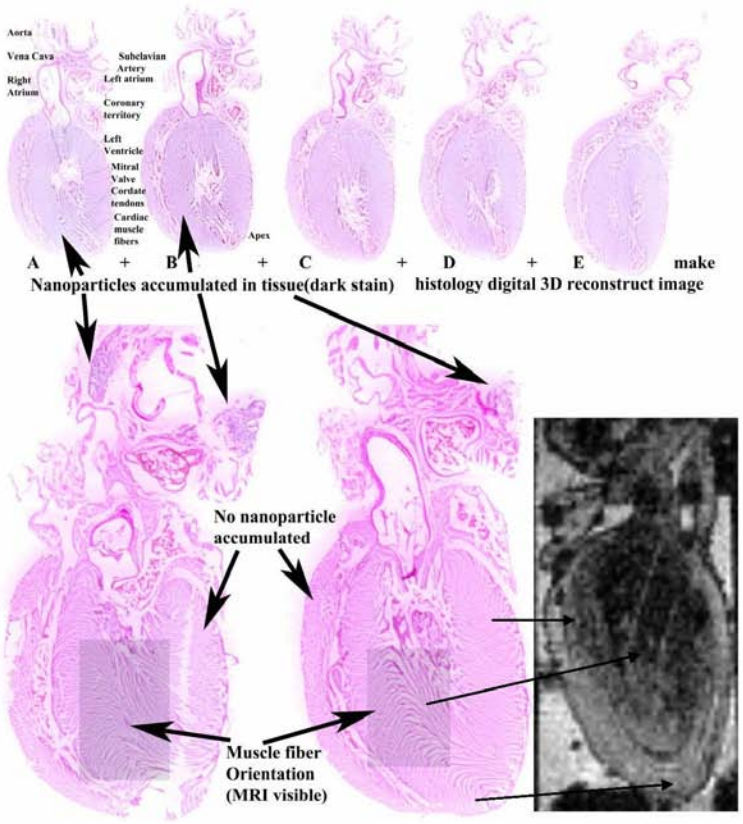


FIG. 15

Histology-MRI match

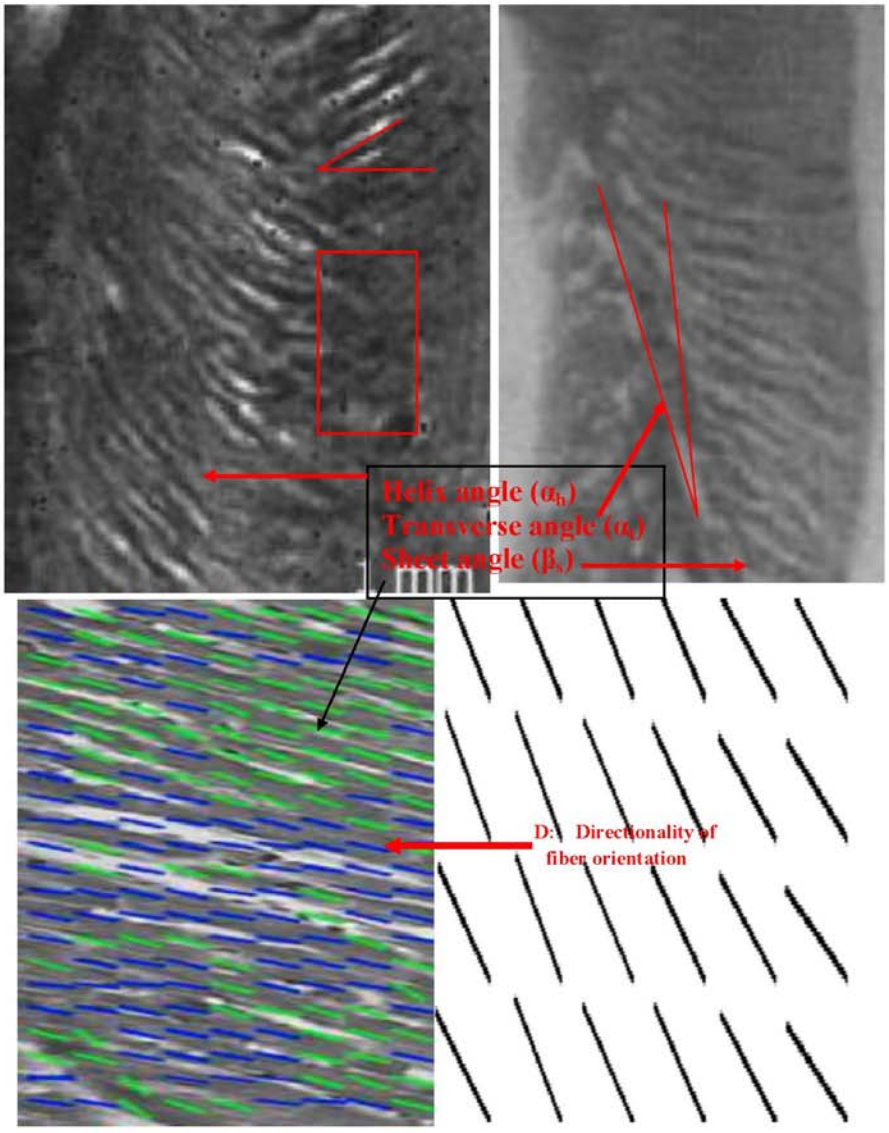
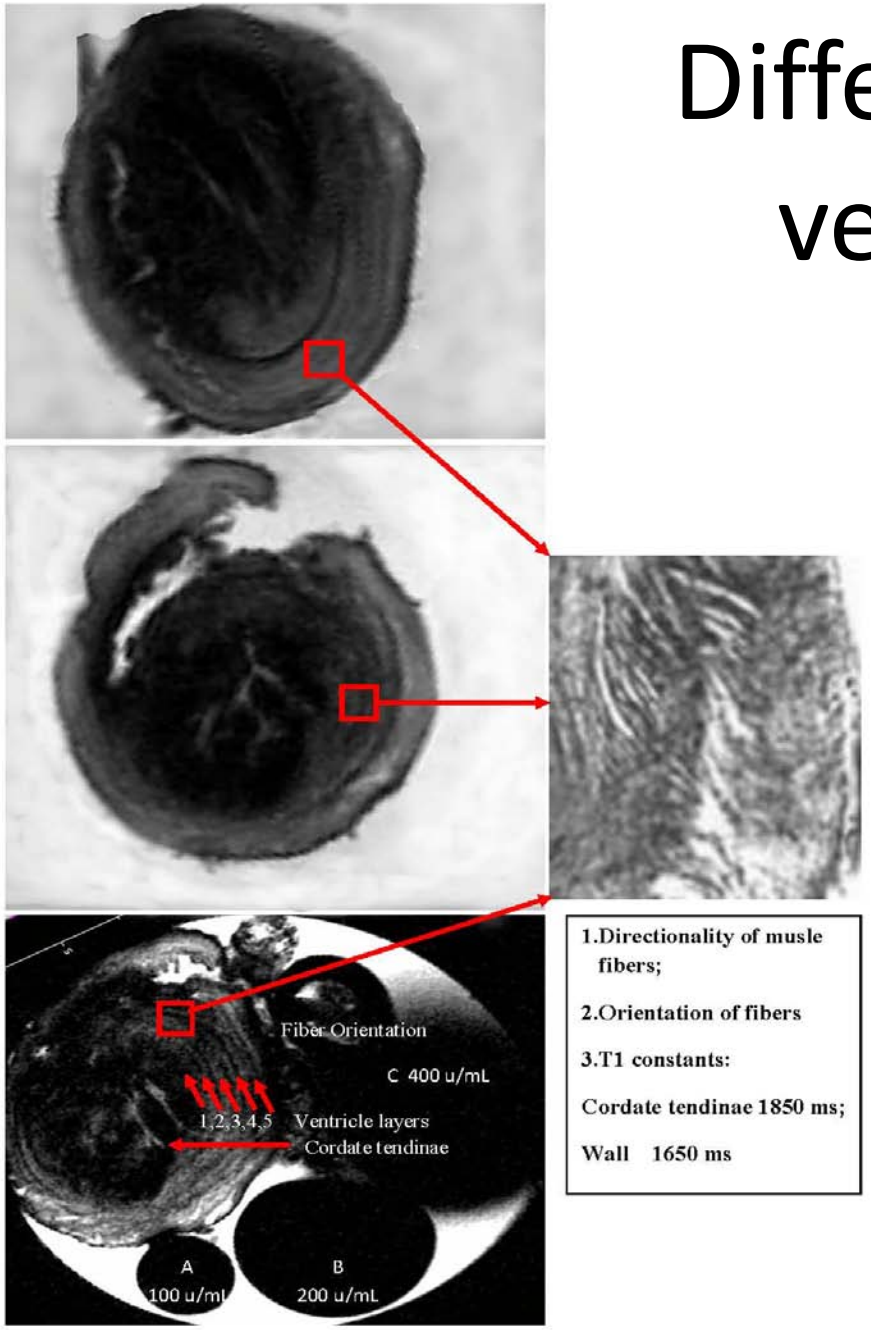


FIG. 13

Cardiac muscle orientation

Different layers in ventricle wall



1.Directionality of musle fibers;

2.Orientation of fibers

3.T1 constants:

Cordate tendinae 1850 ms;

Wall 1650 ms

7805305.4

Conclusion

- The heart microimaging was able to visualize fibers well with trapped nanoparticles to do segmentation and analysis of muscle fiber orientation.
- The microimaging technique by 21T MRI is technical advancement suitable to design functional imaging contrast agents.