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Multi-band SWIFT Improves MRI (20140121, Dr. Idiyatullin, Dr. Garwood)

Technology No. 20140121

IP Status: Issued US Patent; **Application #:** 15/305,708

Multiband Excitation in SWIFT

Multi-band SWIFT (MB-SWIFT) is a magnetic resonance pulse sequence that produces better diagnostic images by significantly increasing excitation and acquisition bandwidths, which reduces blurring, increases signal-to-noise ratio (SNR) for fast relaxing spins, and allows imaging even without comprehensive shimming of the static magnetic field B0. This method is the first in the class of ultra-short (or zero) TE sequences to use a multiband excitation for imaging. The MB-SWIFT technology can image all types of human tissues including cortical bone or dental tissues that are problematic in current scanners, and will be advantageous in musculoskeletal and maxillofacial imaging, particularly near implants. It is also expected to be useful for lung imaging as well as in iron nanoparticle-based imaging and MR-PET combination scanners where accurate determination of bone location is critical. It also has the potential to look at other nuclei, such as phosphorus, to directly measure bone mineral density and could replace dual-energy X-ray absorptiometry. In addition, using high bandwidths allows shortened time for acquisition of 3D images, which is beneficial for fast diagnostics or functional imaging types of study.

Increased Excitation Bandwidth and RF Efficiency

Some of existing ultra-short (or zero) TE sequences can reach a high RF efficiency, but are limited by effective excitation bandwidth. Others can use high excitation bandwidth, but only at the cost of RF efficiency, which results in limited flip angles and less than optimal SNR. MB-SWIFT technology offers the flexibility to add a required number of pulse elements to excite extremely high bandwidth at still optimal flip angles. This advancement can be especially useful for MRI scans that necessitate the use of big and inefficient body or other RF coils.

Reduces SAR and Increases SNR Relative to Regular SWIFT

SWIFT (SWeep Imaging with Fourier Transformation) MRI is a “quiet” imaging technique that can image a wide variety of tissue types, including bone. However, limited bandwidth, inherent in all imaging, decreases transmit power efficiency and sensitivity in ultrashort TE imaging. And it reduces the amount of information about fast and slow relaxing spins in a single scan. As a result, SWIFT suffers from decreased signal-to-noise ratio (SNR), increased specific absorption rate (SAR) and increased off-resonance blurriness. Similarly, current “silent” imaging sequences suffer from low SNR and blurring. This MB-SWIFT technology is a next generation of gapped SWIFT pulse sequence in which multiband (sideband) excitation dramatically increases bandwidth with reduced RF power, resulting in reduced SAR and increased SNR. In addition, it is easier to implement this version of SWIFT on current scanners, since pixels are based on the number of sidebands rather than number of gaps. Its improved diagnostic capabilities, due to increased image fidelity, allow expansion of MR into areas of the body that are less conducive to MR imaging, and for anatomical regions currently visualized well by conventional MRI methods, MB-SWIFT can add silence and increased speed.

BENEFITS AND FEATURES:

- MR pulse sequence
- Significantly increases excitation bandwidth
- Increases SNR
- Produces better diagnostic images; reduces blurring
- Uses multiband excitation for imaging objects with fast relaxing spins
- Images certain types of tissue (e.g., cortical bone) that are problematic in current MR scanners
- Musculoskeletal and maxillofacial imaging, particularly near implants
- Iron nanoparticle-based imaging
- MR-PET combination scanners
- Can look at nuclei, such as phosphorous, to directly measure bone mineral density
- May replace DXA
- Fast imaging for fMRI
- Easy to implement

APPLICATIONS:

- Clinical and pre-clinical MRI of soft and hard tissues
- MRI of materials
- Installed on scanners or software upgrade
- Addresses critical attributes of SWIFT to improve performance and expand potential applications
- imaging objects with fast relaxing spins
- Images certain types of tissue (e.g., cortical bone) that are problematic in current MR scanners
- Musculoskeletal and maxillofacial imaging, particularly near implants
- Iron nanoparticle-based imaging
- MR-PET combination scanners

- Measuring bone mineral density
- Dental imaging
- Lung imaging
- fMRI

Phase of Development - Proof of concept; proof of principle experiments; ex vivo images of teeth, bone containing a screw, and phantoms.

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Publications

Multi-Band-SWIFT
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