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Dynamic Quantification of Myocardial Tissue MRI

MRI Sequence Acquires T1 Mapping with B1+

A magnetic resonance imaging (MRI) sequence acquires cardiac phase resolved native T1 maps of the myocardium, with integrated B1+ quantification at a temporal resolution of up to 40 ms in a single breath-hold. This sequence, TempOrally-resolved Parametric Assessment of Z-magnetization recovery (TOPAZ) is based on contiguous FLASH imaging readout after magnetization inversion from the pulsed steady-state. Segmented k-space data is acquired over multiple heartbeats before reaching steady-state. This results in sampling of the inversion recovery curve for each heart-phase at multiple points separated by an R-R interval. Joint T1 and B1+ estimation are used for analytical correction of flip-angle variations and slice-profiles, reconstructing cardiac phase-resolved T1 and B1+ maps. Numerically optimized sequence parameters are employed for optimal sensitivity. High-quality in vivo quantitative maps obtained throughout the entire cardiac cycle show promise in improving diagnostic confidence in myocardial T1 mapping by easing the delineation of surrounding structures (e.g., sub-endocardial fat, or myocardial cysts).

Current Myocardial T1 Mapping Technology Limitations

Myocardial T1 mapping is an emerging quantitative technology increasingly used for diagnosis and prognosis of cardiomyopathies in the clinic. T1 mapping is commonly performed with a series of 2D single temporal snapshot images of the cardiac cycle acquired with systolic or diastolic triggering, allowing quantification of only a single temporal snapshot of the cardiac cycle and limiting ability to evaluate quantitative relaxation and functional properties. In addition, different tissue types (e.g., muscle, blood and fat) exhibit very distinct T1 characteristics and must be carefully delineated to maximize the diagnostic quality of T1 mapping.

This new pulse sequence and imaging method for cardiac phase-resolved myocardial T1 mapping uses the TOPAZ technique to present quantification at multiple phases throughout the heartbeat. In particular, it provides a pulse sequence and quantitative reconstruction technique that allows dynamic T1 mapping of multiple different cardiac phases, which can then be used to create a quantitative video of a heartbeat. Thealtered T1 times observed in a single phase can be substantiated by cross-comparison throughout the cardiac cycle, which might be particularly useful in diseases that display reduced myocardial wall thickness that form complicated focal/diffuse scar patterns such as in HCM or amyloidosis.

BENEFITS AND FEATURES:

- Dynamic quantification of myocardial tissue
- Cardiac phase resolved T1 mapping with integrated B1+ assessment
- Produces quantitative maps on a longitudinal relaxation parameter (T1) with integrated transmit field (B1+) characterization
- Acquires multiple k-space lines per heartbeat and per cardiac phase
- Creates quantitative video of a heartbeat
- Temporal resolution of 40ms

Technology ID
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Category
Engineering & Physical Sciences/Instrumentation, Sensors & Controls
Engineering & Physical Sciences/MRI & Spectroscopy
Life Sciences/Diagnostics & Imaging
Life Sciences/Human Health
Life Sciences/MRI & Spectroscopy
Software & IT/Algorithms
Agriculture & Veterinary/Veterinary Medicine

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APPLICATIONS:

- Conventional MRI scanners
- Magnetic resonance imaging (MRI)
- Quantitative evaluation of cardiomyopathies
- Wall motion abnormalities, such as restrictive cardiomyopathy

Phase of Development - Pilot scale demonstration. TOPAZ effectiveness and usefulness shown with numerical simulations, in phantom and in vivo. Collection of initial clinical data underway.

Researchers

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Publications

Temporally resolved parametric assessment of Z-magnetization recovery (TOPAZ): Dynamic myocardial T1 mapping using a cine steady-state look-locker approach.
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