Materials and Methods: High resolution along with short detection-time TD in SPI is achieved at 3T (BRUKER MEDSPEC S300) using a powerful 20cm-gradient-system (G=200mT/m) in combination with a 1H-free 15mm birdcage-resonator (voxel-size: 364x364x438µm^3). Quantification of the polymerization process is obtained via T2*, which is obtained from a uniexponential fit to the SPI-image with different detection-times (TD=140,200,300µs). Errors are obtained from regression-analysis. The composite is composed mainly of BIS-GMA and a mixture of barium-aluminum-fluoride with silicon-dioxide as filler and used for conservative dentistry ("Charisma Syringe", Heraeus-Kulzer, Dormagen, Germany). Small (12x12x2mm^3) disks are illuminated with different exposure-time between 5s and 20s.

Results: An increase of the relaxation-rate R2*=1/T2* with exposure time is observed (fig.1) indicating the polymerization process in the composites. For investigating spatial resolution we irradiated the composite paste via an absorption mask consisting of 270µm and 520µm periodic openings in a brass-grid. The periodic modulation in the T2*-weighted SPI-image due to incomplete solidification under the absorption finger can be observed, enabling qualitative access to the resolution obtained (fig.2).

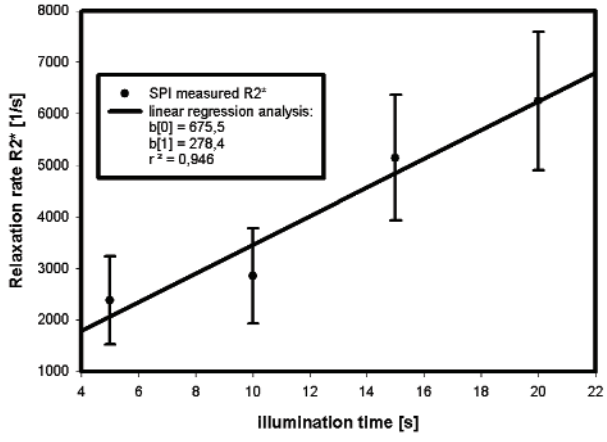

Figure 1. *SPI-obtained relaxation rate R2* in composite disks with different light exposure for solidification.*

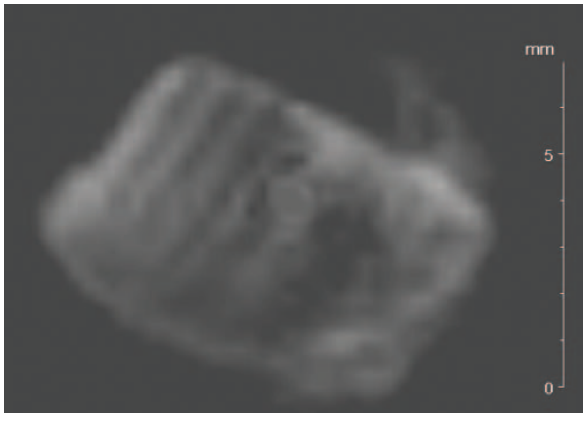

Figure 2. *T2*-weighted SPI image of an irradiated composite disk. Dark stripes indicate the solidification process under the brass grid (half period a=500µm) to estimate the resolution obtainable.*

Conclusion: The solidification process in polymers can be delineated by T2*. The completely hardened composites however cannot be visualized. A resolution below 600µm in incomplete solidification might be obtained but is actually depending on the individual T2* of the biocompatible material and gradient-strength available.

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Ultra-high temporal resolution cardiac function in a single breath-hold

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Introduction: A clinical cardiac magnetic resonance (CMR) exam used to evaluate cardiac function acquires a series of images of a slice of the heart at different times during the cardiac cycle. Previously, the temporal resolution of these cine scans was ~30-50ms, limited only by the breath-hold length typically 5-20s. This temporal resolution is sufficient to study general cardiac function but it precludes the detailed study of extremely rapid mechanical cardiac phenomena.

To optimally capture tissue motion the temporal and spatial resolutions should be matched to the maximum expected velocity. Based on a maximum myocardial velocity of 10cm/s during diastolic filling, tissue can move one pixel (~1.4mm) in 14ms, suggesting that the current temporal resolutions >30ms are insufficient to fully assess the motion.

We propose a technique for the acquisition of a cine loop of the motion of the heart with temporal resolutions <5.5ms in a single, reasonable breath-hold.

Methods: Imaging was performed in a 1.5T GE scanner using an 8-channel phased array coil and a custom built 8-channel receiver. To achieve maximum acquisition efficiency a 3-echo steady-state free precession (SSFP) imaging sequence with hardware optimized gradient waveforms was used for all acquisitions. Matrix sizes of 256x144 and 192x144 with 36x27cm FOVs were acquired, yielding in plane resolutions of 1.4x1.9mm and 1.9x1.9mm, with slice thickness of 8mm and with temporal resolutions (TR) of ~5.4 and ~4.5 ms respectively. A parallel imaging technique (TSENSE) was used to accelerate the acquisition by a factor of 2-4 with an expected decrease in SNR. Upon detection of an ECG trigger imaging was performed for 90% of the cardiac cycle under breath-holding. A fat saturation pulse applied at the end of imaging and a linearly increasing flip angle series were used to alleviate artifacts at the initiation of imaging. The first imaging heartbeat was discarded.

Results: Cardiac cine loops with whole heart coverage including 2 and 4-chamber views were acquired in 3 normal human volunteers. Image quality was excellent and ghosting from the use of TSENSE was minimal. The cine loops revealed motion not typically visible in regular cine imaging: e.g., vibrations from closing and opening of valves.

Conclusion: A CMR cine imaging technique with a temporal resolution of ~5 ms is presented. The breath-hold lengths were as short as 13 heartbeats, making the acquisitions possible on patients.