

# **Fast isotropic T2-weighted MRI using three-dimensional radial acquisition trajectories**

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The relatively long acquisition time required to image at high spatial resolution with adequate volumetric coverage remains a limitation of magnetic resonance imaging (MRI), and thus rapid imaging has attracted constant interest in MR research.

In true 3D projection reconstruction (PR) imaging, data are collected in the spatial frequency domain, known as k-space in MR, along radial lines in spherical coordinates. The spatial resolution of the images is determined primarily by the readout resolution of each projection, thus angular undersampling can be adopted to shorten the acquisition time while introducing normally acceptable diffuse background artifacts. A multiple-echo acquisition scheme is developed in this work, which achieves a near optimal acquisition efficiency and thus dramatically improves this sequence's imaging performance. To reduce the artifacts caused by eddy currents or gradient delays, an effective k-space deviation correction approach based on the measuring of the actual k-space trajectories on three physical axes is implemented.

Meanwhile, balanced steady-state free precession (SSFP) imaging provides useful tissue contrast and high SNR. However, short repetition times (TRs) are usually required by this technique to reduce its sensitivity to magnetic field inhomogeneity. The multiple echo 3D PR sequence with SSFP contrast is advantageous due to its short TR capability, especially when acquiring two echoes per TR. The ultra short TRs achieved also enable the excellent suppression of the undesired bright lipid signal in SSFP images using the linear combination SSFP (LCSSFP) method. A disadvantage of this approach is its need to sample the same k-space locations twice. By exploiting the magnetization behaviors of fat and water spins during a repetition, we have developed a new technique that achieves fat/water separation in a single acquisition by combining the echoes and then using the phase information to further suppress the undesired signal.

These techniques have been successfully applied to musculoskeletal imaging, non-contrast-enhanced MR angiography (MRA) as well as contrast-enhanced MRA, and have demonstrated great potential. Excellent images with high isotropic resolution over a large volume have been achieved in our volunteer and patient studies with reasonable acquisition times.