



Acquisition & Analysis

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Microstructural Biomarkers via Transverse Relaxation MRI at 7T: Impact of Spatial Resolution

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Quantitative MRI enables non-invasive assessment of tissue microstructure through biomarkers derived from transverse relaxation parameters (T2 and T2*). These biomarkers offer sensitivity to subvoxel-scale architecture in various biological systems, including trabecular bone and cerebral vasculature. However, their reliability can be significantly affected by acquisition parameters such as spatial resolution, particularly at high field strengths like 7 Tesla.

The resolution dependence of transverse relaxation-based biomarkers has been systematically investigated in two structurally distinct tissues. In trabecular bone, T2 and T2* relaxometry was performed on ex vivo human and bovine samples at multiple spatial resolutions. Structural indices were extracted and validated against high-resolution micro-CT. Results showed that T2 values remained stable across resolutions, supporting their robustness as biomarkers of trabecular microarchitecture. In contrast, T2* values degraded significantly at lower resolutions, reflecting greater sensitivity to voxel size and local field inhomogeneity.

In cerebral imaging, vessel size index (VSI) was examined using in vivo GRE and SE acquisitions at multiple resolutions, complemented by Monte Carlo simulations modeling $\Delta R2^*$ and $\Delta R2$ behavior across varying vessel radii. VSI was found to be overestimated at coarser resolutions, especially in regions containing small vessels such as the hippocampus and corpus callosum.

These findings emphasize the need for resolution-aware acquisition strategies when using transverse relaxation metrics as microstructural biomarkers at 7 Tesla. The degree of resolution dependence varies with both tissue type and relaxation contrast mechanism, underscoring the importance of tailoring imaging protocols to the biological and technical context.

Keywords: Transverse relaxation, Microstructural biomarkers, Spatial resolution, 7 Tesla, Vessel size index, Trabecular bone