Volumetric mapping of the secular component of T2: a new application of the mixed-TSE pulse sequence

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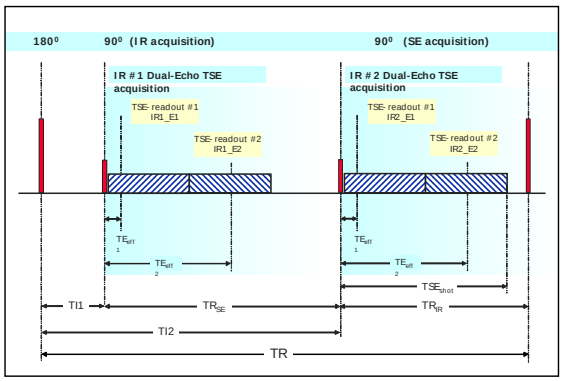
Purpose: To develop a quantitative MRI technique for mapping the volumetric distribution of the secular component ($T_2^{(sec)}$) of the transverse relaxation time.



Theory: Secular_T2 is related to (regular) T2 and T1 via: $T_2^{(sec)} = T_2/(1 - T_2/2\,T_1)$. It represents the "pure spin-spin" component of T2 whereby the contribution of the spin lattice-component or non-secular T1 component has been removed.

Methods: Images were acquired with a 1.5 T superconducting MR imaging system (NT-Intera Philips Medical Systems, N.A.) with a maximum gradient of 23 mT m^{-1} and a maximum slew rate of 105 mT m^{-1} ms^{-1}. Mixed turbo spin echo [1,2] (mix-TSE) is a multislice 2D pulse sequence that combines (see Fig. 1) the principles of T_1-weighting by inversion recovery and T_2-weighting by multi-echo sampling into a single mixed MRI acquisition. Directly acquired images were post-processed, first with Q-MRI algorithms to generate the PD, T1, and T2 maps. Secondly, the intracranial tissues were segmented using a previously described dual-space clustering algorithm [3].

Results: Representative T2_secular maps are shown in Fig. 2; as expected, the visual appearances of these are very similar to the corresponding T2 maps. Quantitatively however, measurable differences are observed. Overall, the histogram distribution of the intracranial tissues is shifted to longer values by approximately 10%. Localized ROI measurements show tissue specificity as shown in Table 1.

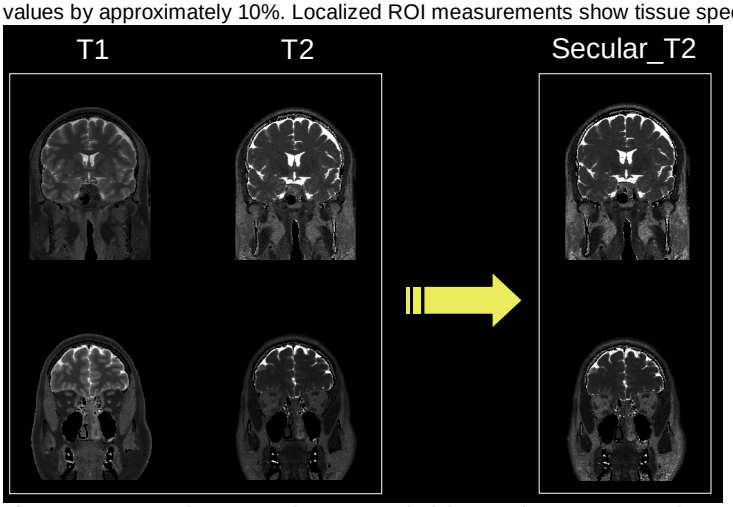


Fig. 2: Representative maps of T1, T2, and of the secular component of T2.

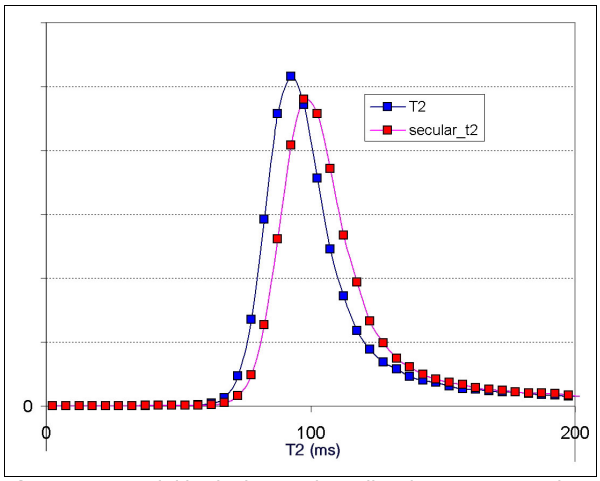


Fig. 3: Intracranial brain tissues (~1.5 liters): WM, GM, and CSF.

	Secular T2	T2	T1
	Mean ± SD	Mean ± SD	Mean ± SD
Fat (sub-cut)	246±25	179±11	339±16
Fat (p_orbital)	214±19	166±10	379±21
Muscle	52±9	50±8	859±66
WM	93±6	87±6	665±59
GM	94±7	90±6	1,024±37
CSF	2,658±387	2,024±291	4,366±662

Table 1: Region-of-interest measurements in various intra- and extra-cranial tissues.

Conclusion: A quantitative MRI technique for generating volumetric distributions of the secular T2 relaxation time has been developed. Initial results in the healthy human brain show that on average, secular_T2 is approximately 10% longer than standard multi-echo-derived_T2 for the intracranial tissues. Differences are however tissue specific. Because the dependences of secular_T2 on the internal magnetic fields and the correlation time are simple (specifically: $T_2^{(sec)} = \left(\gamma^2 h_z^2 \tau_c\right)^{-1}$), knowledge of this parameter could be useful for tissue modeling and potentially useful as a biomarker for disease processes.

REFERENCES

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