Volumetric mapping of the longitudinal to transverse relaxation times ratio (T1/T2) of the entire human breast

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Purpose: Early breast NMR work by Medina et al. (Ref. 1) showed that T2 exhibited relatively greater elevations in cancerous tissue than T1, and found that calculated values of the ratio T1/T2 provided improved discrimination of fibroadenomas from adenocarcinomas at $p < 0.05$. The purpose of the present work was to develop a quantitative MRI technique for mapping the longitudinal-to-transverse relaxation times ratio (T1/T2) of the entire human breast. The technique consists of a breast optimized mixed-TSE pulse sequence and T1/T2 computation algorithm.

Methods: Mixed turbo spin echo (mixed-TSE) multislice 2D pulse sequence was applied in the coronal plane providing full breast coverage with null interslice gap: 0.78 x 0.78 x 4mm^3 voxel size. Mixed-TSE combines the principles of T1-weighting by inversion recovery and T2-weighting by dual-turbo spin echo sampling into a single mixed MRI acquisition. Self-coregistered T1 and T2 maps were generated and used as input for a T1/T2 ratio algorithm that avoids singularities with a pixel-wise Boolean conditional statement. Images were acquired with a 1.5 T superconducting MR imaging system (NT- Intera Philips Medical Systems, N. A.) on two female research subjects, both 47 years of age. For both subjects, glandular and adipose tissue were segmented using a Q-MRI based morphologic algorithm (as illustrated in Fig. 2) and segmental T1, T2, and T1/T2 histograms were generated.

Results: Representative T1, T2 and T1/T2 maps are shown in Fig 1. The T1/T2 maps show a very high glandular-to-adipose intrinsic contrast ratio. Segmental glandular and adipose 3D reconstructions are displayed in Fig 2.

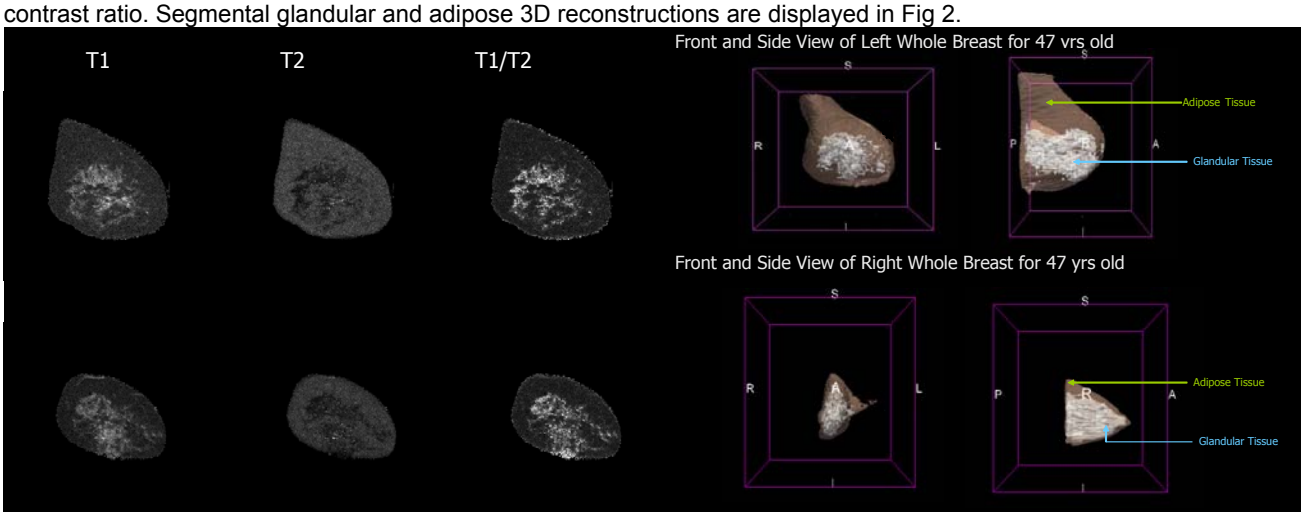

Figure 1: T1, T2, T1/T2 maps.

Figure 2: Glandular segmentation.

		mean T1 (ms)	std T1 (ms)	mean T2 (ms)	std T2 (ms)	mean T1/T2
Left 47 yrs old	Whole Glandular Tissue	575	43	95	24	6.25
	Whole Adipose Tissue	365	80	175	35	2.09
Right 47 yrs old	Whole Glandular Tissue	635	35	55	10	11.54
	Whole Adipose Tissue	435	74	135	47	3.22

Table 1:Segmental glandular and adipose T1, T2, and T1/T2 measures in two research subjects. These are within the commonly accepted ranges for T1 (Ref. 2).

Conclusion: We have developed a quantitative MRI technique for mapping the longitudinal-to-transverse relaxation times ratio (T1/T2) of the entire human breast with high spatial resolution and full organ coverage. This technique gives reliable quantitative results and produces high image quality on T1, T2, and T1/T2 maps, as tested on two research subjects with different breast sizes. To our knowledge, this is the first report of T1/T2 ratio mapping in the human breast. The idea of combining high quality quantitative information of several different tissue properties (e.g. T1/T2 ratio) may provide the basis for improving the specificity of diagnostic imaging as applied to breast pathology, thus potentially leading to a reduction in the number of biopsies.

References

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