R2′ imaging in Acute Stroke Patients

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Introduction: In acute ischemic stroke, oxygen extraction fraction (OEF) has been shown to increase in tissue at risk of infarction[1] and may provide a more direct indicator of tissue metabolic status than can be obtained with the diffusion and perfusion sequences that are currently in clinical use. While R2' is a combination of OEF and venous blood volume[2], some have suggested measuring OEF indirectly from R2' using quantitative T2 and T2* mapping [3, 4]. R2' may also be measured using an asymmetric spin echo acquisition[5-7]. We investigated the utility of ASE in stroke patients imaged within 48 hours of symptom onset.

Methods: Acute adult ischemic stroke patients presenting with acute lesions greater than 5 cm^3 were prospectively enrolled in an MRI study of stroke patients within 48 hours of symptom onset. The subset of subjects who received asymmetric spin echo (ASE) sequence was analyzed. MRI studies were performed on Siemens Trio and Skyra 3T systems. ASE images were collected with a single-shot echo planar image sequence with a variable tau echo shift. The time offset was selected to preserve the R2' contrast. We collected 3 offsets of tau=25 ms, starting at offset -50 ms, and repeated 9 times. Imaging parameters were acquisition matrix of 128x128, FOV of either 220x220 or 240x240 mm, 5 mm slice thickness with 1 mm gap, phase partial Fourier 6/8, PAT=GRAPPA, acceleration factor=2,TR/TE=3000/65 ms. Number of slices ranged from 24 – 31 slices. Sequence duration was 1 minute 30 seconds. Data was motion corrected, smoothed, and R2' calculated from offsets at -50 and -25 on a voxel-wise basis and averaged across the 9 acquisitions. DWI was also acquired in these subjects. R2' maps and follow-up images, when available, were co-registered to the DWI (MNI Autoreg[8]).

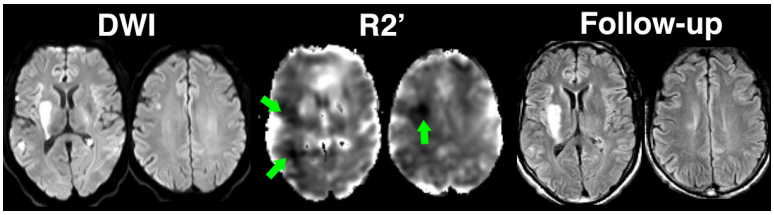

Fig 1: Example of reduced R2' (green arrows) in tissue that does not infarct in a patient imaged post-thrombolysis (Subject 2).

Results: Seven subjects met the inclusion criteria. Demographics are in the Table. Patterns of R2' varied from increased to decreased to normal. Figure 1 shows an example of a patient (Subject 2) with decreased R2' surrounded by regions of elevated R2'. The MRI was post-thrombolysis. Note the areas of decreased R2' encompass the DWI lesion. This region was not infarcted on follow-up imaging at 7 days. Figure 2 shows an example of a patient (Subject 6) with increased and decreased R2'. Like Subject 2, the MRI was also acquired post-thrombolysis. Regions of increased R2' are primarily within the DWI lesion. Both regions are infarcted on follow-up imaging.

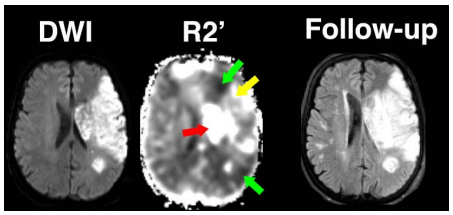

Fig 2: Example of increased (yellow arrow) and decreased (green arrows) R2' in Subject 6. Regions of hemorrhage are especially high (red arrow).

Discussion: R2' is a reflection of OEF and cerebral blood volume (CBV). OEF is proportional to cerebral metabolic rate, but inversely proportional to cerebral blood flow (CBF). Regions of elevated R2' are consistent with tissue that is at risk of infarction, either due to increased CBV (result of compensatory vasodilation) or increased OEF. Elevated R2' are also present in regions of hemorrhage. Decreased R2' can potentially reflect two disparate states of tissue status – tissue that is already dead (reduced OEF) or tissue likely to survive (increased CBF). Future studies should include measures of CBF and CBV to better discriminate tissue status.

Table: Demographics and R2' findings

Patient Number	Age (years)	Sex	Time-to-MRI (hours)	Time-FU-MRI (Days)	Post-thrombolysis?	R2' Findings (excluding hemorrhage)
1	80	Male	36	1.8	No	+/-
2	59	Male	27	6.8	Yes	-
3	74	Female	33	33.2	No	+
4	66	Male	19	N/A	No	Obscured
5	47	Male	36	1.1	Yes	-
6	73	Female	32	3.4	Yes	+/-
7	68	Female	49	N/A	No	+/-

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