

## Mini Review

# Recent Advances of Non-Invasive MR pH Imaging Using Chemical Exchange Saturation Transfer

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Alteration in tissue pH is an indicator of many pathological processes. Noninvasive MR pH imaging will be much helpful for disorder characterization and therapy, even monitoring cell viability. Noninvasive brain pH measurements have routinely relied on <sup>31</sup>P magnetic resonance spectroscopy techniques, which require additional hardware, take too long to be clinically useful, and provide very limited spatial resolution. Chemical Exchange Saturation Transfer (CEST) is a versatile technique for MR molecular imaging. The potential of Amide Proton Transfer (APT) had been proved for imaging pH effects in ischemic rat brain noninvasively [1].

With combination of amide and guanidyl CEST, the sensitivity of pH-weighted MR imaging can be enhanced for ischemic rat brain in a recent study [2]. Iopamidol, as a chemical exchange-dependent saturation transfer contrast medium, has been used to measure extracellular pH (pHe) [3]. A single dose of cariporide can induce a rapid change of intracellular pH (pHi) in animal glioblastoma multiforme, which is observed by using Amine/Amide Concentration- Independent Detection (AACID) CEST MR imaging

[4]. The major contributors to *in vivo* T<sub>1</sub>-normalized MTR<sub>asym</sub> (3.5 ppm) contrast between white and gray matter in normal brain are pH-insensitive macromolecular Magnetization Transfer (MT) and nuclear Overhauser enhancement. The pH-sensitive amine and amide effects account for nearly 60% and 80% of the MTR<sub>asym</sub> changes seen in white and gray matter, respectively, after global ischemia, indicating that MTR<sub>asym</sub> is predominantly pH-sensitive [5]. Clinical translation of pH-weighted MR imaging has been conducted for diagnosing human brain tumors [6].

In our most recent studies, *in vivo* gas challenge in an experimental glioma model of rats showed that enhanced pH-weighted MR imaging could more effectively localize tumor periphery. In addition, ioversol (a clinical CT contrast medium) CEST MR imaging can be exploited to achieve pHe mapping of human liver cancer microenvironment.

## References

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