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Quantitative Sodium MR Imaging: A Review of its Evolving Role in Medicine

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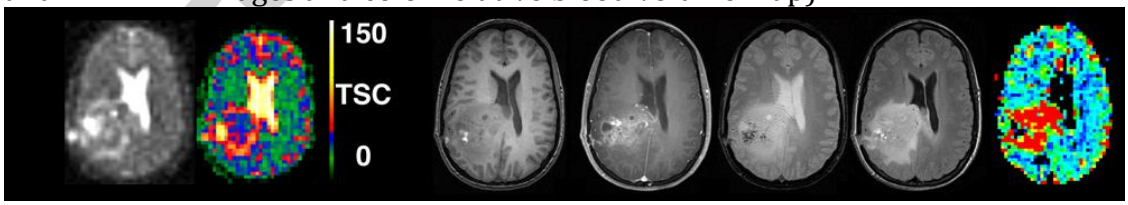
Abstract:
Sodium magnetic resonance (MR) imaging in humans has promised metabolic information that can improve medical management in important diseases. This technology has yet to find a role in clinical practice, lagging proton MR imaging by decades. This review covers the literature that demonstrates that this delay is explained by initial challenges of low sensitivity at low magnetic fields and the limited performance of gradients and electronics available in the 1980s. These constraints were removed by the introduction of 3T and now ultrahigh (≥7T) magnetic field scanners with superior gradients and electronics for proton MR imaging. New projection pulse sequence designs have greatly improved sodium acquisition efficiency. The increased field strength has provided the expected increased sensitivity to achieve resolutions acceptable for metabolic interpretation even in small target tissues. Consistency of quantification of the sodium MR image to provide metabolic parametric maps has been demonstrated by several different pulse sequences and calibration procedures. The vital roles of sodium ion in membrane transport and the extracellular matrix will be reviewed to indicate the broad opportunities that now exist for clinical sodium MR imaging. The final challenge is for the technology to be supplied on clinical ≥3T scanners.

Graphical Abstract:
Integrated $^{23}Na/^{1}H$ MR examination at 3 Tesla of a patient with a brain tumor in right parietal lobe showing (from left to right) quantitative gray scale sodium MR image and TSC bioscale with color scale followed by co-registered proton anatomic images (non contrast T1-weighted, contrast enhanced T1-weighted, T2*-weighted and T2-FLAIR images and color relative blood volume map).



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