Current Development of Human in vivo P-31 MR Spectroscopy: Cardiac Application

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Wide range of chemical shifts, relatively high sensitivity of phosphorus containing compounds related in the energetics of living system make P-31 MRS an ideal means of monitoring the energetic state ranging from living cells to various organs. Advantages in P-31 MRS include straightforward identification of resonance, non-invasive and continuous observation of intracellular pH, and an ability to measure metal ion binding interaction and chemical exchange process.

For human in vivo studies, good deal of efforts has been made to address several issues: contamination out of the ROI, quantitation of metabolite concentration, impaired spectral resolution and poor sensitivity/related long acquisition time. Localized in vivo application of P-31 MRS has been well established for certain organs, yet it is highly challenging task for others like heart. The prospect of routine clinical utility of P-31 cardiac spectroscopy is still unclear despite the progress recently made in this field. The challenges involve pulse sequence design, new pulse developments, building high efficiency resonator, proton decoupling/NOE, acquisition technique, developing new scheme of reconstruction and absolute quantitation.

Robust gradient, quality cardiac/respiratory gating systems and multi-channel rf chain can be the critical components in some applications. Commercial product for independent proton decoupling system is recently available. Large size P-31 volume coil can also be built by modifying proton volume coil for lower field.

Two or three-dimensional chemical shift imaging with acquisition weighting showed improved sensitivity and reduced contamination. Whatever localization technique is employed, however, sensitivity of P-31 signal is the primary limitation dictating the in vivo P-31 MRS. Among recently developed spatia localization techniques, SLIM and SLOOP draw attentions by using compartment images as a basis functions that deal with issues such as poor localization, poor sensitivity, and absolute quantitation.