AbstractID: 11944 Title: Recent advances in quantitative MR Spectroscopy

In vivo magnetic resonance spectroscopy (MRS) based on protons (^{1}H) but also on phosphorous (^{31}P) or carbon (^{13}C) nuclei aims at noninvasive determination of tissue concentrations of various metabolites and compounds in animals or humans. It therefore enables metabolism to be investigated in vivo and pathological as well as drug or exercise induced changes of the metabolism to be detected. For its use for clinical diagnostics as well as for physiological studies precise quantification of the metabolite concentration is indispensable.

Quantitative MRS relies on the fact that the intensity of the free induction decay in the time domain as well as the area underneath a resonance line in the frequency domain are proportional to the number of spins that contribute to the signal and hence also to the tissue concentration of the respective metabolite. Advanced line fitting approaches have been introduced that resolve overlapping resonance lines using prior knowledge of the contributing spin systems and included baseline models and thus enable a precise determination of the intensity of resonance lines. However, additional factors such as volume size, T_1 and T_2 relaxation times, transmit and receive homogeneity or temperature influence the quantification results and need to be corrected for. In addition a reliable reference standard has to be used to convert signal intensities into tissue concentrations in mM. Last but not least statistical measures such as Cramer-Rao lower bounds (CRLB) or correlation matrices along with the inspection of the spectrum for artifacts can give information about the reliability of the obtained quantification results.

After briefly reviewing the basic principle in vivo MR spectroscopy is based on, the current lecture gives an overview about state of the art line fitting approaches, discusses influence factors, possible reference standards and ways to evaluate quantification results. Practical examples are given to illustrate theory and recent developments in quantitative in vivo MRS such as electric reference to assess in vivo concentrations (ERETIC), 2-dimensional prior knowledge fitting (ProFit) and quantitative metabolite mapping at 7T (FIDLOVS) are included.

Learning objectives:
- review basic principles of in vivo MR spectroscopy
- understand state of the art fitting methods for in vivo MR spectroscopy
- understand which additional factors influence the quantification results
- understand how to use reference standards to translate areas into tissue concentrations
- understand how to evaluate the quantification precision and reliability