Taking Bioimaging to the next level

Imaging methods are vital tools in clinical practice for diagnosis and follow-ups. Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) scans are imaging methods capable of providing detailed anatomical, physiological and molecular information. However, current in vivo imaging methods cannot monitor metabolism of substances in our body, something which could prove useful for detecting diseases at their early stages, in particular, different types of cancer and other metabolic diseases.

A group of researchers at EMV, Lund BioImaging Center and CRC have been working with a new imaging technique, which enables the user to follow metabolism of specific substances in the body, which cannot normally be detected by conventional in vivo imaging methods. The technique is called hyperpolarized magnetic resonance (HP-MR) and was invented by the Amersham company in Malmö, around 2003. Several researchers, including Vladimir Denisov, saw the potential in the method and wanted to use it for metabolic imaging in pre-clinical research at LU.

Initial joint projects with the inventors of the technique triggered events which led to the establishment of the Lund BioImaging Center. Today, the facility is hosting two HP-MR machines, one for in vitro studies and another for in vivo animal studies; the machines have been constructed in collaboration between EMV, Lund BioImaging Center and the Laboratory for Functional and Metabolic Imaging at EPFL, Switzerland.

Complimentary to the anatomical information provided by MRI, the HP-MR method allows for monitoring of specific substances administrated in the body. In short, solution of a biomarker agent is frozen to 1 K inside a magnet. The biomarker is then exposed to microwaves, which leads to the hyperpolarization of atomic nuclei in the biomarker, typically $^{13}$C. Once hyperpolarized, the biomarker is then dissolved in a hot buffer, generating a liquid probe ready for administration. Once administered, the probe can yield MR signals 10 000 times stronger compared to if the biomarker wasn’t hyperpolarized. This enables the use of specific biomarkers which normally cannot be detected with MRI, and provides the possibility for real-time monitoring of the biomarker’s distribution and metabolism in the body, in health and disease.

The HP-MR technique is very powerful; however, it has certain limitations, e.g. not all molecular biomarkers can be effectively polarized. In addition, for in vivo studies the administered biomarker should not exceed toxic concentrations. Lastly, since the probe’s magnetic hyperpolarization has a limited lifetime of several minutes, the MR analysis must be performed shortly after the probe has been polarized.

In the past few years the method has gained a lot of popularity and the work is underway in several world centers to explore fields where the method can be applied. Recently, the first commercial HP-MR equipment for use in clinics has been announced by GE Healthcare. The hyperpolarizer has been used at University of California, San Francisco in the first clinical trials for prostate cancer diagnostics. Currently, it is of great interest to develop HP-MR biomarkers for diseases such as cancer, diabetes and neurodegenerative disorders. Vladimir’s own research (now performed at the Biomedical...
Engineering, IKVL) focuses on *in vitro* evaluation of several biomarkers, e.g. choline, pyruvate and their metabolites, for monitoring metabolic alterations in diabetes and cancer. As Vladimir expresses it, the HP-MR technique could soon become a game changer for reaching the next level of diagnostic bioimaging.

- Joakim Hising