Master Internship 2020-2021

Multiparametric MRI for the staging of hepatic steatosis at 11.7 T

Laboratory : CREATIS
Research team : MAGICS Team
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Scientific background and rationale: Obesity is a major issue in developed countries with a high incidence on life expectancy. Hepatic steatosis is a frequently associated pathology and being able to stage and understand its development can greatly help in reversing it through drugs intake and/or changes in lifestyle. The latter effect has been demonstrated in mice [1] and in particular, the restoration of interactions between mitochondria and endoplasmic reticulum is key in enabling it. Accessing this information requires being able to examine hepatic tissues which is an invasive procedure. On the other hand, magnetic resonance imaging (MRI) with its numerous available techniques is a proven non-invasive diagnostic tool for soft tissues and in particular the liver [2,3]. This internship will serve as preliminary work for a collaboration with CarMeN laboratory who possess the know-how for mice models, biological and cellular analysis for characterization of mitochondrial and endoplasmic reticulum interactions.

Aim: To develop and apply various non-invasive parametric MRI techniques on the liver and adipose tissue of mice on the newly acquired 11.7T preclinical MRI. Most of the techniques mentioned below have already been used on the previous preclinical MRI system (4.7T). However, a change of system to 11.7T requires that specific instrumentation (for MRE) will have to be developed and parameter fine-tuning carried out so as to take into consideration the constraints and advantages of this ultra-high field. At the end of the internship, a validated protocol enabling reproducible measurements will have been setup and initial tests on Ob/Ob mice undergoing specific diets (High Fat High Sucrose) carried out.

Description of the internship work:

1. Development of an advanced *in vivo* MRI protocol on mice with a targeted examination duration of less than two hours. This protocol will include :
    1. MR spectroscopy for fat quantification and composition in the liver and adipose tissue at a voxel level.
    2. Multi gradient-echo imaging for fat quantification in the liver and adipose tissue at the organ level.
    3. MR elastography for the measurement of viscoelastic parameters of the liver.
    4. Intra-voxel incoherent motion for the measurement of diffusion and perfusion parameters in the liver.
2. Data processing of the MRI/MRS data

References

[1] : E. Tubbs et. al., Diabetes. Vol.63 p3279 -3294, 0ct. 2014
[2] : A. Nemeth et. al. Journ. Magn. Reson. Imag. Vol49, Issue 6, p1587-1599, Jun. 2019
[3] : M. Yin et. al. Magn. Reson. Med. Vol. 58, Issue 2, p346-353, Aug. 2007

Skills required: Physics, signal processing, instrumentation, biomedical