In vivo animal NMR studies using implantable micro-coil

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Introduction: The feasibility to use a new generation of micro-coils was proposed in a recent study [1]. It demonstrated to have potential opportunities in terms of increased signal-to-noise ratio (SNR), spatial resolution, and limits of detection (LOD) [2] compared to the surface coil [3]. This work aims to *in vivo* explorations using implantable micro-coils. The originality of the present work is to show how to realize brain implantable NMR detectors, tolerated by rats for several weeks.

Materials and methods: For *in vivo* implantation, rats Wistar (230-300g) were used. The animals handling was carried out according to recommendations of the local ethics committee. MRI and MRS experiments were performed using a 4.7T-Bruker Biospec System. The micro-coil, "needle" part only, was introduced into the brain by stereotaxy, Figure1. *In vivo* MRI acquisitions was carried out using a Rapid-Biomed birdcage coil (6.9cm diameter) and a RARE sequence TR/TE = 4000/60 ms, FOV=30x30 mm², matrix 256x192, 1mm thickness, acquisition time 17mn. Proton spectrum was obtained with a micro-coil for signal detection only in active decoupling mode.

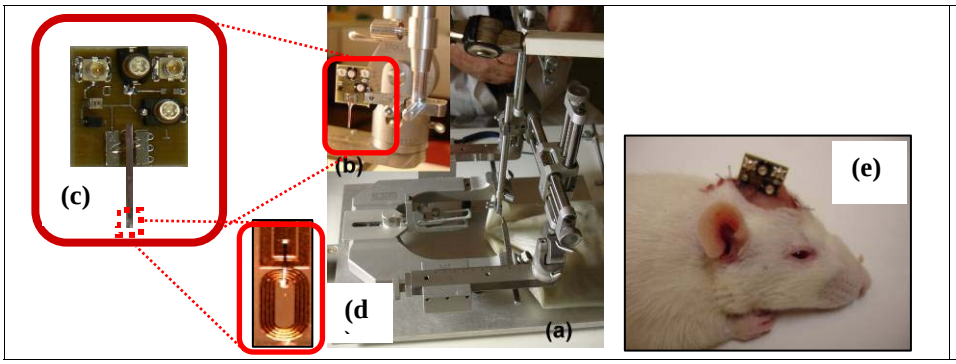

Figure 1. (a) Stereotaxy setup (David-Kopf), (b) Microcoil positioning, (c) Microantenna with tuning and matching circuit, (d) Needle-coil observed with scanning microscope (e) Rat equipped with microcoil.

Results: First results demonstrate that micro-coil positioning in intra-cerebral structure is well reproducible under stereotaxic conditions. With chronic implantation, the rats survived up to 4 months. Consequently, the biocompatibility aspect is also validated. Axial MRI slices, Figure2(a), allow measurements of the lesion dimensions, compared then with the micro-coil size and to stereotaxic coordinates determined thanks to the rat atlas [5] and histological control, Figure2(b). The chosen location coordinates (artery basilar, cerebellum) are visible by MRI. The obtained *in vivo* water proton spectrum opens cerebral metabolites measurements capabilities.

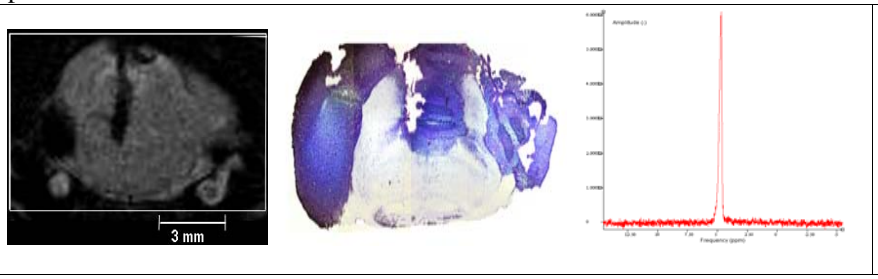

Figure 2. (a) MRI axial slice, (b) histological slice (40 µm), (c) *In vivo* water Proton spectrum acquired with a microcoil in a rat brain.

Discussion/Conclusion: An ultra localisation technique should result from this study, (spatial resolution associated with micro-coils use). So the proposed "needle-coil" concept implies a breakthrough in biomedical research towards NMR micro-detector used for brain exploration, early diagnosis and treatment follow up. To the best of our knowledge, no *in vivo* study has been already done with such sensors. Reinforced by acquisition and signal processing methodology, it aims at pushing the limits of *in vivo* detection.

References: [1] Baxan *et al,* C.R.Chim.2007; [2] Lacey *et al*, Chem.Rev.1999; [3] Kadjo *et al* submitted ESMRMB.2008; [4] Vanhamme *et al,* JMR.1997; [5] Paxinos and Walton, *Academic Press*.1998.