Rabbit's Intervertebral Disc *in vivo* Imaging at 9.4 T

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INTRODUCTION:

Although back pain related to intervertebral disc (IVD) degeneration is a leading health problem, the causes of disc degeneration remain poorly understood. Magnetic Resonance Imaging (MRI) provides an interesting non invasive tool to study intervertebral disc degeneration *in vivo*. To our knowledge, there was no *in vivo* study of the rabbit's IVD by high field MRI. We have developed the technical and methodological means to study the rabbit's IVD at 9.4T, and obtained the first images. These images must allow us to identify easily the degeneration of the IVDs.

METHODS:

Probe's Making. A simple surface coil (rectangular current loop) and a "half birdcage" coil with four strips were designed. Efficiency of these two coils was tested with a homogenous phantom and rabbits.

Animals. Three female New Zealand White rabbits (weighting approximately 1.3 – 2.2 kg each and 8-12 weeks old) were used. All experiments complied with French legislation and guidelines for animal research.

Surgical Techniques. The surgical intervention was done under sterile conditions and general anaesthesia of the rabbit. The skin and the tissues on the left flank were incised. The vertebral column was exposed. Three lumbar intervertebral discs were damaged by a puncture-aspiration. After the discs damage, the different tissues and skin were closed with absorbable sutures.

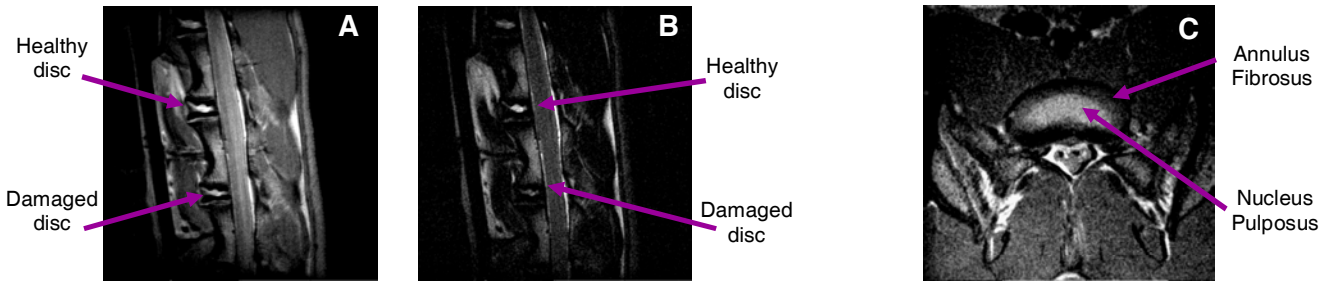
Magnetic Resonance Imaging. MRI experiments were performed 28 days after surgical discs injury using an imaging spectrometer equipped with a 9.4 T horizontal magnet (Bruker Biospin MRI, Wissenbourg, Fr). During MRI exam, animals were put under gaseous anaesthesia.

Sagittal (FOV 6x6 cm, matrix 256x256) and axial (FOV 3.7x3.7 cm, matrix 256x256) ρ-weighted images (TR/TE/TE_{eff} =8000/11/22 ms) were acquired. A sagittal T_2-weighted image (TR/TE/TE_{eff} = 8000/ 22.5/90 ms, FOV 6x6 cm, matrix 256x256) was also obtained.

RESULTS:

Results obtained with the two coils show that the "half birdcage" coil is the best for rabbit's IVD imaging *in vivo.* In opposition to the surface coil, the "half birdcage" coil gives an exploration area with an adapted depth to see the discs, and most of all, it is possible to put the maximum intensity of the image at the IVDs location. Geometric properties of the coil were determined by computation of the shape of the B_1 emission field (Field [1]).

The following figure shows (A) a sagittal ρ-weighted image where healthy and damaged discs can be differentiated. There is a characteristic loss of signal intensity for the damaged disc in comparison with healthy disc. Part B shows a sagittal T_2-weighted image (same rabbit, same slice than A) where healthy and damaged discs are clearly differentiated: damaged disc presents a loss in water content (caused by the disc degeneration [3,4,5]) so a loss of signal intensity for the damaged disc in comparison with healthy disc can be observed [2,3,5]. Part C shows an axial ρ-weighted image where the two parts of the disc can be identified: the Nucleus Pulposus (NP), the central part of the disc which contains principally water, and the Annulus Fibrosus (AF) which encloses the NP and is mainly composed of collagen fibres [5].



In vivo images obtained with a « half birdcage » coil.
A: sagittal ρ-weighted image. B: sagittal T_2-weighted image. C: axial ρ-weighted image (healthy disc).

DISCUSSION AND CONCLUSION:

In this preliminary study, it was shown that a new probe equipped with a "half birdcage" coil is optimal for rabbit's IVD imaging. Probe's exploration area is ideal to observe several IVDs. The first *in vivo* images obtained on healthy and damaged IVDs are very promising.

The final goal of this work is to study *in vivo* intervertebral disc degeneration mechanisms and estimate the efficiency of new disc restitution methods and new treatments in rabbit.

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ACKNOWLEDGEMENTS: the authors thank Abbott Spine Company for the financial support of this study.