

MR Lymphography with Fe₃O₄ Nanoparticles in Rabbits: In vivo Investigation of Metabolism of Fe₃O₄ Nanoparticles

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Metabolism of Fe₃O₄ Nanoparticles in Rabbits

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【Abstract】

Purpose: Ultrasmall superparamagnetic iron oxide (USPIO) nanoparticles are of great potential to evaluate diseases in the reticuloendothelial system (RES), including liver, spleen, bone marrow, and lymph nodes. It is a good negative contrast for MRI. The metabolism of magnetic nanoprobe for MRI in living body is very important in the determination of optimized diagnosis time for the most contrast imaging and precise discovery of nidus. The purpose of the experiment is to investigate the signal changes of different organs after Fe₃O₄ nanoparticles administration so that we can detect the way of metabolism of Fe₃O₄ nanoparticles in vivo, with histological findings as the reference standard.

Materials and Methods: Experiments were performed by using 2 normal white rabbits weighing 3.0 kg. 2 rabbits were implanted Freud Adjuvant to induce reactive inflammation lymph nodes. After precontrast MR imaging, Fe₃O₄ nanoparticles (21 mg of iron per kilogram in 10 mL of normal saline) was administered to each animal via an ear vein during approximately 10 minutes. Sequential MR imaging was performed by using axial T1-weighted spin-echo, T2-weighted spin-echo, and T2*-weighted MR imaging sequences immediately after, and every half an hour after Fe₃O₄ nanoparticles administration. In the experiments, changes in T2-weighted signal intensities (SIs) in the liver, kidney, spleen, bone marrow, popliteal lymph nodes and inguinal gland were observed before and after Fe₃O₄ nanoparticles administration.

Results: After injection of these NPs into rabbits, a significant darkening effect on the liver epithelial net lymph tissue was observed in 20 min, with about 20% reduce of the spin-spin relaxation time T₂ (Figure 1). The signal of liver reduced to the lowest on T2WI about 3 hours after NPs administration (Figure 2). 3 days later, the pathologist examined the organs and lymph nodes with respect to the presence of iron deposition in the cells which can represent blue in the slice, and found that these nanoparticles only deposited in spleen (Figure 3).

Conclusion: The metabolism study on these nanoparticles indicated that they did not show any weak toxicity to organs detected and finally entered into the hematopoietic organ – spleen without obvious retention in any related organs after recycling for 3 days.

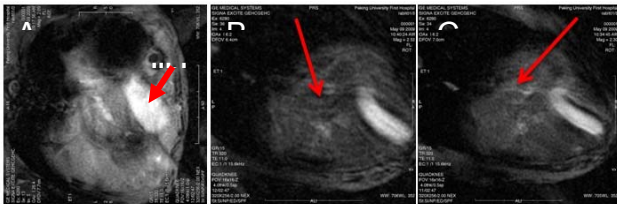


Figure 1

Figure 1: MRI images of liver in rabbit before and after injection of Fe₃O₄ nanoprobe. A: Before injection; B: After 20 min since injection; C: After 26 min since injection. T₂* is reduced from 9.298±0.893ms to 7.517±0.830ms, by ~20% reduction.

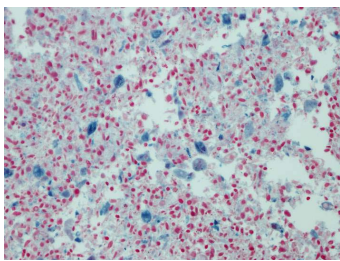


Figure 2: Time-signal intensity curve diagram of signal changes before and after NPs injection

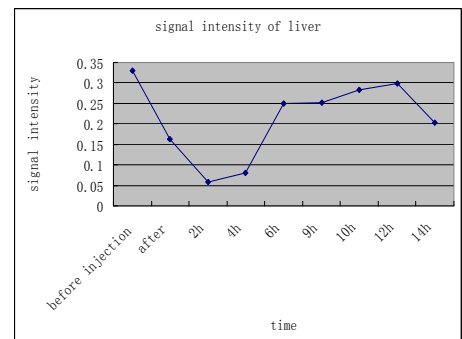


Figure 2

Figure 3: Spleen: iron deposition (blue particles)(×10

Reference:

[1]Wu, E. X. et al. *NMR Biomed* 2004, 17, 478-483.

[2]Taschner, C. A. et al, *AJR* 2005, 185, 1477-1486.