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Poster presentation

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Feasibility of a whole-body 3 T MRI system for detecting macrophages in mouse carotid atherosclerosis using feco/graphite core-shell nanocrystals

Hisanori Kosuge*[1], Sarah Sherlock[2], Toshiro Kitagawa[1], Masahiro Terashima[1], Joëlle Barral[3], Hongjie Dai[2] and Michael V McConnell[1]

Address: [1]Cardiovascular Medicine, Stanford University School of Medicine, Stanford, CA, USA, [2]Department of Chemistry, Stanford University, Stanford, CA, USA and [3]Department of Electrical Engineering, Stanford University, Stanford, CA, USA

* Corresponding author

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Introduction

Novel FeCo/graphite core-shell nanocrystals (FeCo/GC) appear promising for detecting macrophages in mouse arteries with 7 T small-bore MRI, but use of whole-body MRI systems would be advantageous for clinical translation.

Purpose

To evaluate whole-body 3 T MRI for FeCo/GC-enhanced imaging of mouse carotid atherosclerosis with 7 T comparison.

Methods

1) Mice

Seven FVB mice were fed a high-fat diet for 4 weeks and had diabetes induced by streptozotocin injections, followed 2 weeks later by left carotid ligation.

2) FeCo/GC nanocrystals

Composed of an iron-cobalt core encapsulated by a biocompatible graphite shell (size - 7 nm) with Cy5.5 attached for fluorescence imaging. FeCo/GC have superior MRI properties with both cellular imaging and heating attributes. A higher dose (25 mgFe/kg) was used for detection at 3 T than 7 T (6 mgFe/kg).

3) MRI

2 weeks post-ligation, mice (n = 4) were imaged on a whole-body 3 T MRI scanner (Signa HDx, GE Healthcare) with installed gradients (50 mT/m, 150 T/m/s) and a custom 3 cm surface RF coil. As a comparison, another group of mice (n = 3) were imaged on a small-bore 7 T system (30 cm bore magnet, Varian Inc. plus GE "Micro-Signa" environment), with a 9 cm gradient insert (770 mT/m, and 2500 T/m/s, Resonance Research, Inc.) and a custom 6-cm RF coil. Similar gradient echo sequences were used (3 T: TR/TE = 100 ms/10 ms, slice thickness = 1.0 mm,

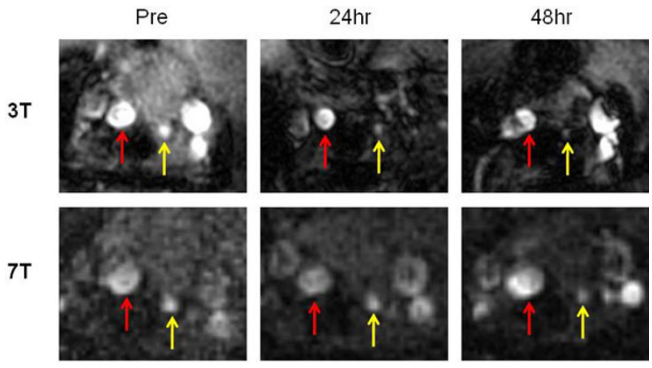

Figure 1

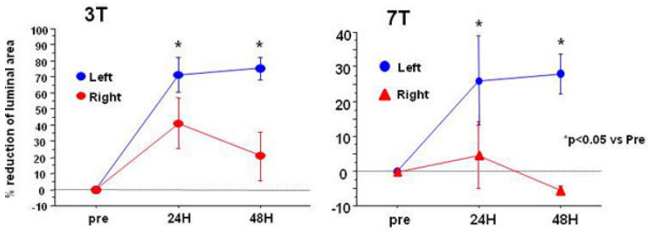

Figure 2

FOV = 3 cm, matrix = 256 × 256, FA = 60; 7 T: TR/TE = 50 ms/4.2 ms, slice thickness = 0.5 mm, FOV = 3 cm, matrix = 256 × 256, FA = 50). MRI was performed pre and 24 and 48 hrs post IV injection of FeCo/GC. FeCo/GC accumulation was assessed by measuring the extent of T2*-induced reduction in carotid lumen size (% reduction of carotid lumen area).

4) Histology

Immunofluorescence staining was performed to confirm co-localization of FeCo/GC and macrophages.

Results

Images prior to FeCo/GC show the left carotid artery (yellow arrow) was smaller than the right (red arrow) due to ligation (Figure 1). After FeCo/GC administration, serial MRI images at 3 T show a further reduction in left carotid lumen area due to T2* signal loss, similar to the findings at 7 T. There was no evidence of lumen area reduction in the non-ligated right carotid arteries (Figure 1). The measured percentage reduction of left carotid lumen area was significant at both 24 and 48 hrs for 3 T and 7 T (Figure 2) and was greater at 3 T, likely due to the larger FeCo/GC dose. Immunofluorescence staining revealed colocalization of FeCo/GC and macrophages (Figure 3).

Conclusion

Whole-body 3 T MRI can detect plaque macrophages using FeCo/graphite nanocrystals in mouse atherosclerosis, encouraging the translation to clinical studies.

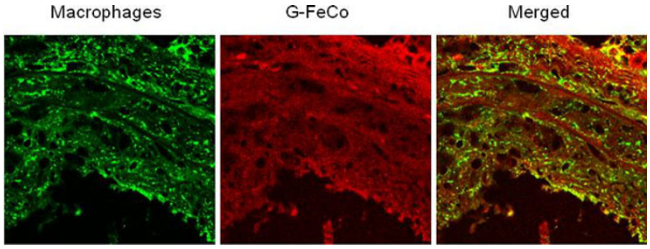

Figure 3