Clinical Applications of Nanoparticle Enhanced MRI

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Disclosure

• I do not have any relevant financial relationships with any commercial interests
Nanomaterials

Preclinical

Clinical
Ferumoxytol Biodistribution

17 sec Bolus Injection

Increasing Concentration in blood

1 – 10 days
0 – 15 hrs
< 2 min
> 15 days

Ferumoxytol that is in the blood pool
Ferumoxytol that is inside macrophages
Ferumoxytol that has been converted to elemental iron, and incorporated into the body’s iron stores

Increasing Concentration in Tissue

Vascular Imaging

PE-MRI
Perfusion Enhanced MRI
VE-MRI
Vascular Enhanced MRI

Macrophage Imaging

ME-MRI
Macrophage Enhanced MRI

Modes of Magnetic Resonance Imaging

Perfusion Enhanced MRI
Vascular Enhanced MRI
Macrophage Enhanced MRI

Iron from Ferumoxytol is Incorporated into body’s iron stores
Clinical Applications Of Ferumoxytol

• Vascular Imaging
  – Can be used in renal failure patients
  – No Risk of NSF

• Oncology Imaging → Uptake by RES system → Macrophage uptake (liver, spleen, marrow and lymph nodes)
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Vascular Imaging

TOF without Contrast  15 min post GD  15 min Ferumoxytol

Vascular Imaging

Gd

Ferumoxytol; 24 hours

Ferumoxytol; 26 hours; IntraOp MRI

Vascular Imaging

Area of Aortic Annulus

Hope et al; AJR Sept 2015
Vascular Imaging

Ferumoxytol: First Pass

Ferumoxytol: Equilibrium State

Hope et al; AJR Sept 2015
Vascular Imaging

Ferumoxytol: First Pass

Ferumoxytol: Eq State

Hope et al; AJR Sept 2015
UTE Vs. Conventional CE-MRA

VIBE: 16 sec

UTE: FB
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Perfusion
Enhanced MRI
Vascular Enhanced MRI
Macrophage Enhanced MRI
Ferumoxytol

Harisinghani et al; Neoplasia 2007
Nodal Staging: Dose 7.5 mg Fe/kg

Baseline

24 Hours

Malignant LN: Sensitivity

Baseline 24 Hours
Malignant LN

Baseline

24 Hours
Malignant LN: Sensitivity
Imaging Inflammation

- Type 1A diabetes (T1D)
  - Autoimmune Disease
- Noninvasive method to visualize T1D at the target organ level in patients with active insulitis
Insulitis is associated with inflammatory infiltrate and capillary “leak”
Delta R2* Entire Pancreas

Gaglia, Harisinghani et al. PNAS Early Edition 2015
Role of Inflammation in Carcinogenesis

Baseline 24 Hours

Hayano et al. / Pancreatolog 16 (2016) 121e126
Conclusion

- Magnetic nanoparticles are bridging critical gaps in imaging
  - Bench to bed side applications ➔ Vascular and Macrophage Imaging
- Good Science should also include awareness of Regulatory requirements
- Logistical hurdles for clinical application
  - Who Pays; how do we use these techniques for clinical applications
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