Whole Body DWI in Body Applications

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Outline

• Why whole body imaging
• Why DWI
• Technique for whole body MRI
• Image Processing
• Indications for WBI
• Summary
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Why Do Whole Body Imaging?

• Global view of “body”
  Head, neck, chest, abdomen, pelvis, extremities

• Detection of metastatic lesions
  Bone
  Soft tissue / viscera

• Quantify treatment response

• Evaluate systemic diseases
  MSK: Myositis
  Nerves: NF1, NF2
  Autoimmune: Arthritis
Why Do Whole Body Imaging?

Current whole body imaging modalities include:
- Nuclear Scans (\(^{99}\text{Tc}\))
- Computed Tomography (CT)
- Positron Emission Tomography/CT (PET/CT)
- Novel: Whole Body MRI
  - \text{T2WI} and/or \text{T1WI}
  - \text{Diffusion Weighted Imaging}/ADC maps
  - \text{Contrast Enhanced}
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Tumors demonstrate restricted diffusion due to high cellularity, resulting in an increased ratio of cell walls per unit of volume, which restricts motion of free water molecules.

Increased cellularity & reduced extracellular space = restricted diffusion
“There is an extraordinary opportunity for DW-MRI to evolve into a clinically useful method that is useful for pharmaceutical drug development and for predicting therapeutic efficacy”

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Whole Body Imaging Technique

Magnet: 1.5 T or 3T?

Body regions?
- Head, neck, chest, abdomen, pelvis, extremities?
- Chest, abdomen, pelvis?
- Upper extremities included?
- Body habitus?

WB DWI with/without WB MRI?

Add dedicated organ sequences?

Gad?

Image interpretation?

Billing codes?
WB Imaging @ Hopkins

3T

**Siemens:** TIM (Total Imaging Matrix)

**Philips:** DWIBS (DW Whole Body Imaging with Background Body Signal Suppression)

Up to 6 body regions: head, neck, chest, abdomen, pelvis, extremities

- T2WI
- DWI/ADC
- T1WI
- Contrast Enhanced
Whole Body Imaging at 3T

**Orientation:** Coronal or sagittal ~ 45 min

**T2-weighted Imaging**
- Turbo SE (TR/TE =6640/84; FOV=400x400; ST=4mm; Nex=1)
- Space (TR/TE =3000/342; IR=220; FOV=400x400; ST=4mm; Nex=1.8)

**Diffusion-weighted Imaging**
- b values (50, 400, 800)
- SE-EPI (TR/TE =2000/60; FOV=400x400; ST=4mm; Nex=4; BW=1700Hz)

**T1-weighted Imaging**
- Vibe (TR/TE =2.43/0.88; FOV=400x400; ST=1.5-4mm; Nex=1)
- Contrast enhanced – up to six times points (WIP)
HASTE Coronal
Axial Acquisitions ???

b=50  b=300  b=600  ADC map

Courtesy: Jacobs MA
3D-Rendering

ADC map

DWI

Breast ca mets

Courtesy: Jacobs MA
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Image Processing: Integrated CAD
T1: Fatty and normal tissue separation
T2: Vasogenic/bulk edema
DWI/ADC mapping: Cellularity/cytotoxic edema
Dynamic CE: Vascular profile and morphology
PET/CT: Metabolic state of tissue based on SUV

Courtesy: Jacobs MA
3D Registration

Patent Number: P11421,61/443,770

3D Registration based on 3D Wavelet Transform and 3D interpolations
Corrects for imaging plane
Corrects for different FOVs
Maintains spatial resolution

Courtesy: Jacobs MA
Field of View and Matrix Correction

Registration was done in 3D, figures show a typical slice from volume data

Subtraction Results
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Colorectal Cancer
Prostate Cancer

$^{11}$C PET
CT

MRI
T1
T2
ADC

Fused Choline PET/CT
“Due to high CNR of DWI compared to T1W and T2W STIR, detection of malignant lesions should be facilitated by DWI, except for sclerotic bone mets”.

“The addition of DWI to conventional whole-body MRI sequences enhanced lesion conspicuity and improved diagnostic accuracy for lymphoma”.

Gu et al, AJR (2011) 197, W384-391
ADC maps

T1WI

Screening for NF

T2WI

ADC maps
NF treated with Avastin

Courtesy: Jacobs MA
Myositis
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- Whole body MRI is a novel imaging method used for whole body imaging.
- Role of whole body DWI evolving.
- WB DWI should be acquired and interpreted as part of whole body MRI.
- Multimodality approach potentially more useful than single modality (PET/MR?).
- Need for advanced image processing rising (image registration/segmentation, etc.)
Thank you