



# **191** Vertebral Column Quantitative Susceptibility Mapping using Joint Background Field Removal and Dipole Inversion







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### **Declaration of**

## **Financial Interests or Relationships**

Speaker Name: Maximilian N. Diefenbach

I have the following financial interest or relationship to disclose with regard to the subject matter of this presentation:

Company Name: Philips Healthcare Type of Relationship: Grant Support

- [1] Wright et al. Journal of Bone and Mineral Research 29.11 (2014), pp. 2520–2526. [2] Hernlund et al. Archives of Osteoporosis, 8(1-2), 136 (2013). doi:10.1007/s11657-013-0136-1
- → strong need for **osteoporosis screening**

 Treatment possible for early diagnosis Mapping (QSM)

Results

Discussion

Quantitative Susceptibility



Methods



пп

• High Prevalence:

Background

*I*RI

•

Osteoporosis

~ 1 in 3 post-menopausal women in developed countries<sup>1,2</sup>

Definition: increased bone weakness  $\rightarrow$  fractures

 $\rightarrow$  great economic burden on health care



Diefenbach et al., ISMRM 2016, #677; Diefenbach et al., ISMRM 2017, #850; Diefenbach et al., ISMRM 2018, #533

\*/commons.wikimedia.org/wiki/Category:Osteoporosis 4

#### Purpose

# To develop a method for trabecular bone susceptibility mapping in in the spine and to report initial results

#### Challenges for spine QSM

- large FOVs  $\rightarrow$  scan time/voxel size trade-off
- respiratory motion  $\rightarrow$  artefacts
- presence of fat  $\rightarrow$  modulations MR-signal evolution
- cropped imaging object
- variable coil sensitivities  $\rightarrow$  invisible parts of the imaging object

#### inside the FOV

- complex background fields
- cortical bone, air inclusions  $\rightarrow$  signal voids in non-UTE images

MRI
Background
Methods
Results
Discussion
Summary
TIM

Time-interleaved multi-gradient-echo sequence (TIMGRE)
Time-interleaved multi-gradient

#### TIMGRE: hybrid multi-echo multi-acquisition sequence



Scan time



[\*] Hernando et al., MRM, 59(3), 571–580 (2008). doi: 10.1002/mrm.21522

Field-to-susceptibility inversion

#### Joint Background Field Removal (BFR) + Dipole Inversion (DI)



#### Consecutive BFR + DI

- Manual definition of background mask
- Laplacian Boundary Value Method [\*\*] + MEDI[\*\*\*]

[\*] Chatnuntawech et al., NMR Biomed, 30(4), 3570 (2016). doi: 10.1002/nbm.3570 [\*\*] Zhou et al., NMR Biomedicine, 27(3), 312–319 (2014). doi: 10.1002/nbm.3064



#### In vivo experiments

#### Lumbar spine

5 patients



# 2 healthy volunteers



| СТ |  |
|----|--|
|----|--|

| Sequence Parameter   | Value                          |
|----------------------|--------------------------------|
| Field strength       | 3 T                            |
| Number of echoes     | 6 (2 interleaves)              |
| TE1/delta TE/TR      | 6.9/1.12/0.9 ms                |
| Voxel size           | 1.8 mm isotropic               |
| FOV                  | 220 x 220 x 80 mm <sup>3</sup> |
| Flip angle           | 3 deg                          |
| Scan time            | 3:03.2 min                     |
| Freq. enc. direction | anterior-posterior             |
| coils                | body + 16 ch.                  |











• Feasibility of susceptibility mapping in the lumbar spine

Graph cut field mapping

TIMGRE

freedom in experimental design

field map water-fat speparation + field map unwrapping Field-to-suscept. inv.



susceptibility

joint background field removal + dipole inversion

• Susceptibility contrast detection/differentiation of calcified tissues

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