

MRI-DIFFUSION WEIGHTED IMAGING (DWI): A NEW METHOD TO DETECT ACTIVE LUNG INFLAMMATION IN CYSTIC FIBROSIS?

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BACKGROUND

CF is characterized by chronic airways infection and inflammation and progressive lung disease from early childhood [1].

- Currently no sensitive, radiation free methods are available to localize and quantify lung inflammation. PET-CT has been proposed for the localization and quantification of active inflammation in the lung, but its use is restricted by high ionizing radiation exposure and costs [2].
- DWI is a promising tool for the identification of active foci of inflammation in lung parenchyma. DWI strictly depends on water movement in the extra-cellular volume, which is influenced by the presence of inflammation. Therefore, an abnormal DWI can be considered as a sign of inflammation [3]. DWI accuracy in the identification of inflammation has been proven in organs such as: brain, liver, and intestines.

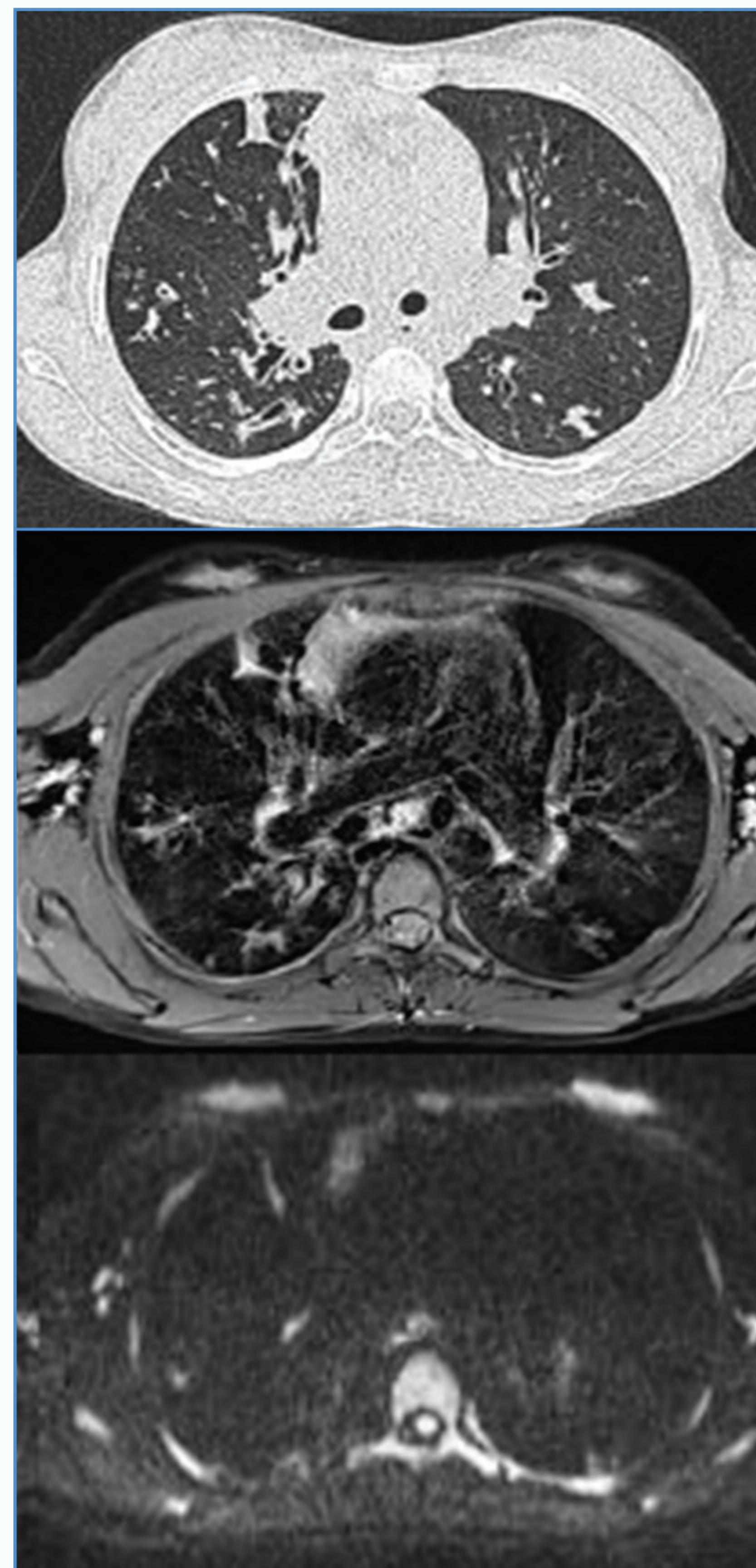
OBJECTIVE: To investigate DWI in the lungs in a cohort of CF patients.

MATERIALS AND METHODS

This 2 center study was approved by the institutional review boards.

- 33 stable CF patients (14 males) had a low-dose CT and MRI performed on the same day.
- MRI protocol (1.5 T scanner, Avanto, Siemens, Germany):
 - Morphological evaluation: respiratory triggered T2w BLADE sequence (TR: 2000; TE = 27; FOV 400 mm; flip angle: 150; slice thickness 5 mm);
 - DWI: TR: 5632,12; TE: 83; flip angle: 90; slice thickness 5 mm.
- Scans were anonymized and randomly scored by 2 independent observers:
 - CTs and morphological MRIs scored using a validated CF-CT score (upgraded Brody II).
 - DWI scored with a newly developed semi-quantitative scoring method, taking in account the number of areas with altered signal intensity (hot spots) in lung parenchyma.
- Overlay techniques were used to study overlap between DWI and morphological MRI.
- DWI scores were correlated to clinical and radiological parameters reflecting disease severity: FEV1 % predicted, Body Mass Index (BMI), CF-CT and MRI bronchiectasis (BE) scores. Patients without DWI hot spots were compared to those with hot spots. Scores are expressed as % of the maximal possible score.

RESULTS



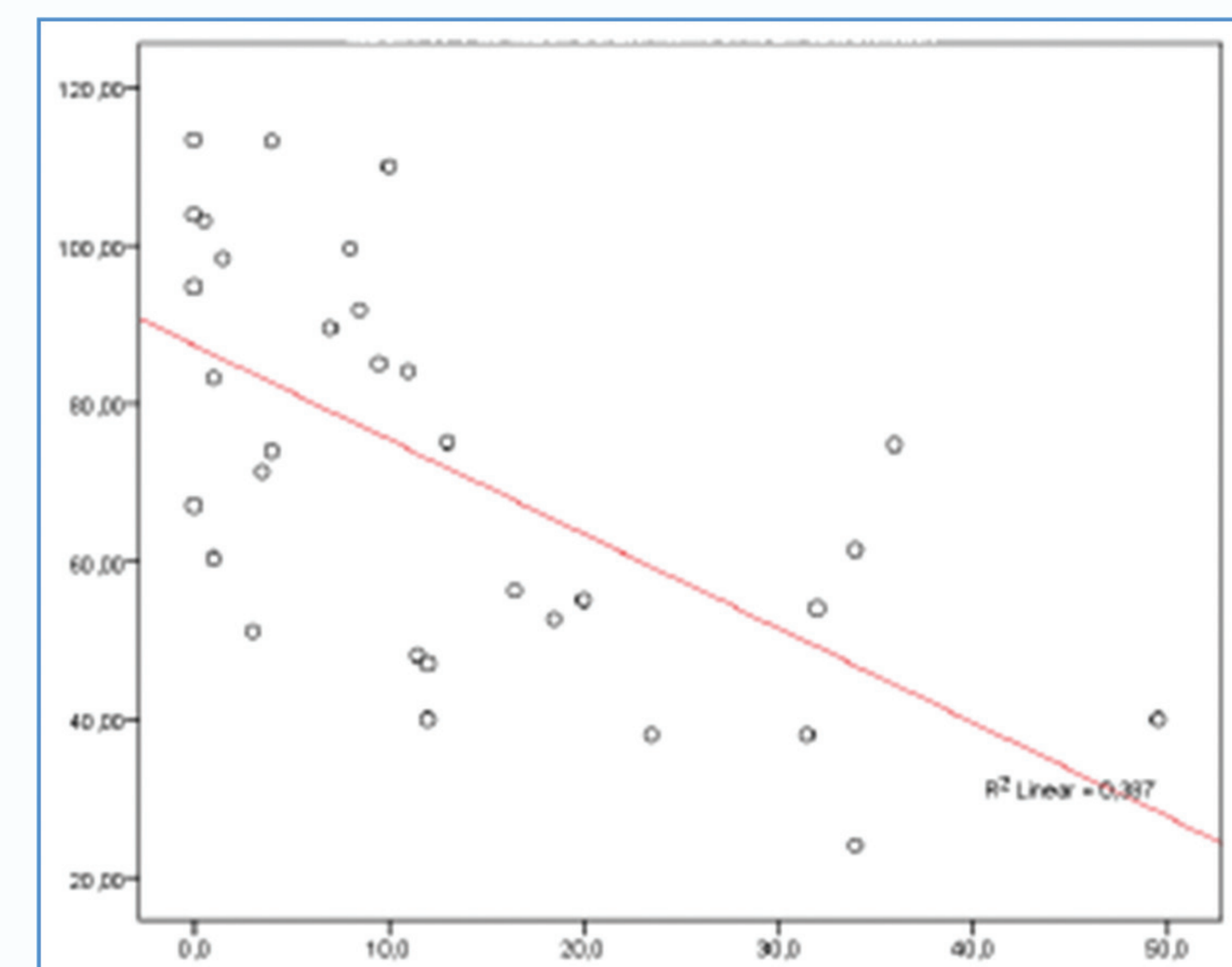
CT (upper), Morphological MRI (middle), DWI (b500, lower).

Mean age 24.6 years (range 8-51 years); FEV1 % predicted 78,64 (38 to 113); DWI score 9,89 (0 to 37); total CT scores 22,88 (3 to 49); total MRI scores 20,65 (7 to 40).

- DWI score:
 - Positive correlation to total CT score ($r=0,66$, $p=0,0001$); total MRI score ($r=0,599$, $p=0,001$); CT-BE score ($r=0,615$, $p=0,001$).
 - FEV1 and BMI of patients without DWI hotspots ($n=10$) was higher (all $p<0.0001$) than patients with hot spots.
 - DWI pattern only in part overlapped that of structural abnormalities on morphological MRI or CT.

DISCUSSION

DWI could potentially be used to localize and quantify active lung inflammation in CF. Further validation is needed to specify the exact nature of the hot spots.

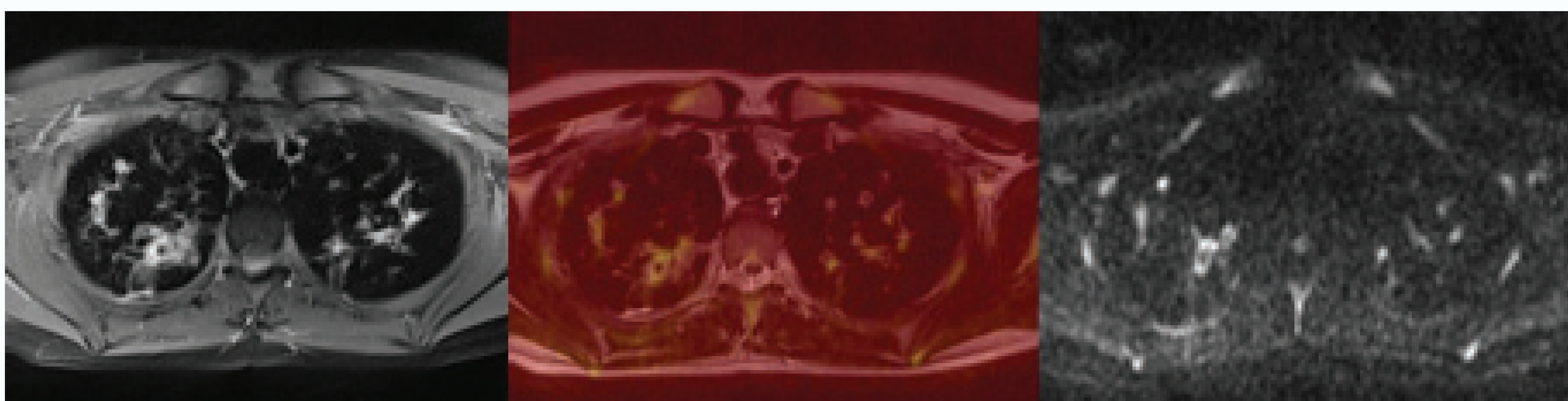


Scatter plot of correlation between FEV1 (y-axis) and Total DWI signal (x-axis)

CONCLUSIONS: In CF lung disease DWI is able to distinguish between hot and cold spots that overlap in part the structural abnormalities as can be seen on MRI and CT.

References

- [1] Cystic fibrosis lung disease starts in the small airways: can we treat it more effectively? Tiddens HA, Donaldson SH, Rosenfeld M, Paré PD. *Pediatr Pulmonol.* 2010 Feb;45(2):107-17. Review
- [2] Uptake of 18 fluorodeoxyglucose in the Cystic fibrosis lung: a measure of lung inflammation? Labris NR, Nahmias C, Freitag AP, Thompson ML, Dolovich MB. *Eur Respir J* 2003;21:848-854.
- [3] Diffusion-Weighted MR Imaging: Applications in the Body. Dow-Mu Koh and Harriet C. Thoeny. Springer Ed. 2010



Morphological MRI (left), Fusion imaging (middle), DWI (right)

