Diffusion-weighted MRI in metastatic gastrointestinal tumours (GIST): a pilot study on the assessment of treatment response in comparison with 18F-FDG PET/CT

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Purpose

To evaluate the clinical potential of diffusion-weighted high-field (3Tesla) MR imaging with apparent diffusion coefficient (ADC) mapping for the assessment of gastrointestinal stromal tumor (GIST) response to targeted therapy in comparison with $^{18}$F-FDG PET/CT.

Methods and Materials

This study complies with the local ethical guidelines and was approved in the present form by our institutional ethical board.

During a 12-month period (June 2008-June 2009), five consecutive patients (3W/2M, mean age 56.4±13.4 years) known for metastatic GIST underwent $^{18}$F-FDG PET/CT and MRI before and after change in medical targeted therapy, to evaluate the response of the secondary lesions to KIT-inhibitor therapy.

Inclusion criteria were patients previously operated on intestinal GIST and known for active hepatic and/or extrahepatic metastases that were hypermetabolic on $^{18}$F-FDG PET/CT.

Exclusion criteria were the known contraindications of MRI (pacemaker, claustrophoby) renal failure and patients with lesions without metabolic activity on $^{18}$F-FDG PET/CT.

Mean elapsed time between the two pairs of examinations (MRI and $^{18}$F-FDG PET/CT), performed before and after change in medical therapy were 4.2±2.9 months. Mean delay between each pair of MRI and $^{18}$F-FDG PET/CT was 3.2 days (range 0-9).

MR data were acquired on a 3.0 Tesla MR-unit (TRIO or VERIO, Siemens Healthcare, Erlangen, Germany) with a maximum gradient strength of 40 mT/m. In order to include the whole abdomen in our examination protocol we combined two 12-channel phased-array body coils simultaneously fixed around the upper and around the lower abdomen (Fig 1) on page , respectively.

All patients were orally administrated about 1 L of water about 30-45 minutes before the image acquisition. We also intravenously (IV) injected 20mg of scopolaminbutylbromide (Buscopan®, Boehringer Ingelheim, Basel, Switzerland) or, if contraindicated, 1 mg of glucagon (GlucaGen, Novo Nordisk, Bagsvaerd, Denmark), to reduce imaging artifacts.
caused by peristalsis. The details of our MR acquisition protocol can be seen in Table 1 on page 3. 3D-VIBE sequences were performed before and after IV Gadolinium injection (Gd-DTPA-BMA, 0.1mmol/kg of body weight) followed by 40 ml de NaCl 0.9%.

**Diffusion-weighted imaging**, acquired before IV Gadolinium injection during free but shallow breathing [15], included transverse single-shot spin-echo echo-planar sequences in three orthogonal directions (frequency-encoding, phase-encoding and slice-selection) with three b-values (0, 300, 600 s/mm²). These b-values were chosen in order to obtain images with a sufficient contrast-to-noise ratio [16]. The ADC map was then automatically computed with a vendor-provided software. Window width and level are set to adequately visualize the whole abdomen.

**18F-FDG PET/CT** (Discovery LS, GE Healthcare Milwaukee, Wisconsin) included a whole body acquisition (from the skull base to mid-thighs) performed 60min after IV injection of 5MBq/kg of 18F-FDG. It was followed by a craniocaudal acquisition of MDCT (four-row-detector machine) for attenuation correction and localization (140kV, 80mA; pitch 1.5, 5-mm slice thickness).

**MRI and PET/CT studies** were first analyzed blinded to each other. Using an Advantage Window workstation with version 4.3 software (GE Medical Systems, Buc, France) two radiologists, in consensus, read the baseline and follow-up MR-images: The maximal size of each lesion were measured on axial Gd-enhanced VIBE MR-images. Infracentimetric metastases were excluded from the analysis. The signal of contrast-enhancement were measured by means of a region of interest (ROI) centred on the area with the most intense Gd-uptake visible within each lesion.

Drawing a ROI within the most restricted area visible on DWI-images, ADC was calculated for each metastasis. Furthermore, the standard deviation (STD) of these two measurements was assessed, considered as a surrogate for the heterogenicity of the lesion

18F-FDG PET/CT were read by two nuclear medicin physicians in consensus and the maximal standardized uptake value corrected for body mass (SUV) of the hyperactive metastatic lesions were measured, both on the baseline and follow-up examination. Then, 18F-FDG PET/CT images were co-registered to Gd-enhanced VIBE-MR images for lesion detection. In consensus, radiologists and nuclear medicin physicians identified up to six metastatic lesions visible on MRI in each patient.

The relationship between their SUV max and ADC was calculated by means of the Spearman's correlation.
Results

Twenty-five metastatic lesions (16 hepatic and 9 non-hepatic) were analyzed on both modalities. Three PET/CT lesions (12.5%) were initially not considered on ADC and 4 lesions on the second PET/CT were excluded because of hepatic vascular activity spillover.

The maximal size of the remaining 18 lesions ranged from 12-95mm (mean 36.7mm) before, and from 8-94mm (mean 34.3mm) after medical targeted treatment (Fig.2).

The mean degree of signal intensity (SI) demonstrated by these 18 lesions on Gd-enhanced MR-VIBE images changed from 652.2 (STD 41.3) before to 460.2 (STD 33.2) after treatment.

$\text{SUV}_{\text{max}}$ decreased from $7.2 \pm 7.7 \text{g/mL}$ to $5.9 \pm 5.9 \text{g/mL}$ ($P=0.53$) and ADC increased from $1.2 \times 10^{-3} \text{mm}^2/\text{s} \pm 0.4$ to $1.4 \times 10^{-3} \text{mm}^2/\text{s} \pm 0.4$ ($P=0.07$) (Fig 2 on page , Fig 3 on page , Fig 4 on page , Fig 5 on page ).

The evolution of these 18 lesions showed significant association between $\text{SUV}_{\text{max}}$ decrease and ADC increase ($\rho=-0.64$, $P=0.004$) (Table2).

There was no correlation between the evolution of the maximal lesions’ size and the ADC values neither between the signal intensity and the ADC values measured before and after medical targeted treatment.

Images for this section:
Fig. 1: Table 2

\[ y = -64.1 \times + 178.5 \]

\[ \rho = -0.64, P = 0.004 \]
Conclusion

Changes in ADC from diffusion-weighted MRI reflect response of $^{18}$F-FDG-avid GIST to therapy. The exact diagnostic value of DWI needs to be investigated further, as well as the effect of lesion size and time under therapy before imaging. Furthermore, the proven association between SUV$_{\text{max}}$ and ADC may be useful for the assessment of treatment response in $^{18}$F-FDG non-avid GIST.

References


Personal Information

This poster has jointly been submitted by the departments of diagnostic radiology and nuclear medicine of the University Hospital in Lausanne, Switzerland.